9.0 MALFUNCTIONS AND ACCIDENTS

9.1 Identification of Malfunctions and Accidents

Project design and operational performance are keys to ensuring a safe and environmentally sound operation. The residual risk of potential malfunctions and accidents for the Rainy River Project (RRP) was identified from a variety of sources, including: experience with other similar mining projects (directly and through the literature), internal risk assessment discussions, workshops and comments received from government representatives, stakeholders and Aboriginal groups, including on the draft Environmental Assessment (EA) Reports (Versions 1 and 2).

Only specific and important malfunctions and accidents that could have a material environmental effect, and that have a reasonable probability of occurring during the life of the RRP were considered. For credible malfunctions and accidents, the effects were assessed based on a reasonable worst case scenario. Occurrences where environmental effects are only likely to arise through situations that are practically impossible to attain (such as the failure of multiple back-up systems) have not been assessed. Medical and similar emergencies while important are unlikely to have an environmental impact. These are not addressed herein and will be addressed through the RRP emergency response plan.

The following potential malfunctions and accidents were identified for effects assessment:

- Structural failures: open pit slope failure, underground stope or rock burst failure, east mine rock stockpile slope failure, overburden stockpile slope failure, tailings management area dam failure, pond dam failure and creek diversion failure;

- Accidents: explosives accident, tailings pipeline failure, water pipeline failure, fuel release during truck transport, fuel releases from storage facilities and dispensing areas, transportation accident (fuel shipment, shipment of hazardous materials and shipment of non-hazardous materials), chemical spills within contained facilities and chemical spills from pressurized vessels; and

- Other malfunctions: unexpected water quality concerns including related to acid rock drainage (ARD), fires (project-related), excessive disturbance to neighbours and/or wildlife.

In the sections that follow, each identified credible malfunction and accident is described, potential environmental concerns identified and the associated risk assessed. Proposed design, mitigation measures and operations safeguards, as well as proposed contingency and emergency response procedures are also provided as relevant. An overall contingency and response plan is provided in Appendix V.

Detailed emergency response procedures beyond those summarized in Appendix V, will be established as part of the environmental management system. After any incident, a review would be conducted to ensure that the required design changes and procedures and appropriate monitoring measures are in place to ensure that incident will not be repeated.

9.2 Structural Failures

9.2.1 Open Pit Slope Failure

The open pit is excavated through overburden and into bedrock where the ore is found. The geotechnical stability of the rock and overburden in the proposed open pit area was assessed by AMEC as part of the Feasibility Study (BBA 2013a). This information was used to develop a safe and stable open pit design.

Rock was found to be generally of good geotechnical quality in the pit vicinity. Accordingly, pit development will use triple benching with heights of 30 m and bench faces with 50° to 75° angles. Ultimate slope heights will range from 80 to 370 m and overall slope angels will range from approximately 37° to 50°.

Overburden thickness ranges from 25 to 45 m in the vicinity of the open pit and the ultimate overburden slope has been designed as 3H:1V to 4H:1V depending on overburden depth (shallower slope where overburden is thicker). Rock fill blankets and buttresses may be used to allow the overburden slope to be steepened further and thereby reduce the final open pit footprint. More gradual slopes will extend the diameter (areal extent) of the pit. Additional rock mechanics and geotechnical studies may lead to revised designs for the open pit.

9.2.1.1 Potential Environmental Concerns

Two primary slope failures were considered:

- Failure of the bedrock slopes caused by improper mine design and operational procedures; and
- Failure of the overburden slopes caused by pre-shearing or uncontrolled erosion.

Improperly designed and operated open pits can pose a safety hazard to workers during construction and operation, and potentially the surrounding environment, if a pit slope failure (bedrock triggering overburden failure, or overburden failure alone) enlarges the open pit footprint.

Open pits are not subject to catastrophic release of rock pressures such as rock bursts, unlike some underground mines. Rock bursts underground are created through sudden changes related to the mining geometry after blasting, causing a build up of strain energy around underground openings. In an open pit environment due to the open nature of the excavation, strain energy is dissipated with blasting instantaneously such that rock bursts do not occur. Buckling and heaving of rock floors can occur typically in regions of horizontally oriented geological structure (Franklin and Dusseault 1989), but such movements of any appreciable magnitude are unlikely at the RRP, due to the subvertical nature of the geology and strength of the rock. Some stress induced damage to the rock mass may be anticipated as the open pit approaches the completion depth; however, this damage is manageable and of the same order of magnitude as the damage created through back break following blasting.

A catastrophic rock failure of the south wall of the open pit could increase the open pit diameter of the top of the bedrock face by approximately 10 m toward the Pinewood River. A failure of the north or east walls could extend the bedrock face outward by up to 20 m. The toe of the overburden slope will be set back from the top of the bedrock face of the open pit by 20 m. Therefore in either case, the surface is not expected to be impacted by a bedrock slope failure. No environmental impacts will result unless the overburden slope requires subsequent recontouring outward to maintain pit access.

A failure of the overburden slope within the pit could be caused by pre-shearing conditions. An overburden slope failure that extends beyond the open pit boundary could increase the ultimate pit footprint by causing the adjacent ground surface to slump into the open pit. A worst case overburden slope failure could cause a slump that extends up to 40 m beyond the expected maximum open pit perimeter. Any ground that slumps into the open pit would be damaged. If surface waters are located in the slumped ground, the water would be diverted to the open pit.

The potential for a failure of the open pit overburden slope to extend to the Pinewood River and cause a rerouting of the river into the open pit was assessed. A flood protection berm will be constructed to the south of the open pit. The berm is designed to prevent any environmental design flood of Pinewood River from entering the open pit (Section 4.3.2). The only conceivable way for an open pit slope failure therefore to impact the Pinewood River is for the slump to extend to, and completely breach the flood protection berm coincidental with a large precipitation event. At its closest, the flood protection berm will be approximately 60 m from the maximum open pit extent. As a result the anticipated maximum overburden slope failure of approximately 40 m will therefore not impact the Pinewood River, even under this combination of events.

Depending on the location, a slump could however, disrupt haul and other roads used to access the open pit (Figure 4-1). After stabilization the roads would have to be re-established. Other site infrastructure is sufficiently set back from the open pit boundary and would not be impacted by an open pit slope failure. No environmental impacts would occur from slope failures along west, north and east face, in addition to the damaged land immediately adjacent to the open pit.

9.2.1.2 Design and Operations Safeguards

Considerable ongoing effort has been directed at the open pit bedrock and overburden slope design because of the need to protect worker safety. The design also needs to optimize pit walls and slopes to minimize the amount of overburden and mine rock production, to both control costs and to reduce the overall RRP footprint.

The open pit design provides for:

- Minimum factors of safety of 1.3 for overall bedrock slopes under dry and partially saturated conditions (as expected to be present);

- Minimum factors of safety for overburden slopes in the open pit range from 1.3 to 1.5; however, in a worst case scenario with pre-shearing the factor of safety remains 1.1;

- Bench heights of up to 30 m in rock; and

- Use of catch or geotechnical control berms 10.5 to 12 m wide, with geotechnical control berms at least every 120 m.

Ramp widths will be maintained at approximately 20 or 32 m (one-lane and two-lane access, respectively), with a grade of 10% for that portion constructed in rock and 8% when constructed in overburden. Inter-ramp design slope angles in rock will be maintained at 40° to 56° and bench face angles will range from 50° to 75°.

Geotechnical monitoring of pit wall stability directed by qualified geotechnical engineers will be continuous during pit excavation. Surface monitors may be installed at strategic locations to monitor any ground movement. Should any substantial slope movements occur, a review will be conducted by qualified engineers to assess whether design changes are needed to ensure safe mining operations. Minor sloughing is expected to occur and catch berms and geotechnical berms will be periodically cleaned to maintain effectiveness.

The angle of the overburden slopes will depend on the thickness of overburden and will generally range between 3H:1V for overburden thicknesses of less than 25 m thick; to 4H:1V or flatter when thicker than 40 m to ensure an appropriate factor of safety. Steeper slopes of 2.75H:1V may be used temporarily during the initial pit development where overburden is less than 25 m thick. Exposed overburden will be revegetated as soon as practical to assist with slope stability and progressive reclamation, once the maximum pit extent is reached.

The long term stability of the pit overburden slopes is sensitive to the groundwater phreatic surface. Piezometers may be installed along the south and west sections of the ultimate pit during operations to assist with slope monitoring. Slope movements may be monitored with equipment such a survey monuments and inclinometers to enhance slope maintenance.

If significant localized areas of erosion of the pit overburden slopes occur during operation, additional measures will be taken such as armouring the slope with mine rock or progressive revegetation with a more aggressive vegetation species with soil holding capabilities, even if the open pit is not at its greatest extent.

9.2.1.3 Contingency and Emergency Response Procedures

The bedrock pit wall angles have been established using a conservative approach. Falling rocks will generally be captured by the safety berms. In certain locations within the pit and depending on the stage of development, falling rock could reach the open pit floor. In the unlikely instance where workers are injured by slope failure, emergency response procedures which will be developed in detail prior to operation as part of the environmental management system and will be followed.

The proposed angle of overburden slope above the bedrock face is conservative. As a result, failure of the overburden slopes is likely to cause overburden to slide over the upper bedrock faces, with the potential for a backward slump extending outward up to approximately 40 m beyond the pit boundary in a localized area. A failure of the overburden is unlikely to impact pit activities, although additional remediation work (resloping impacted area of overburden, revegetation and armouring with mine rock) could be required. Localized repair of surrounding surface infrastructure may be required.

9.2.2 Underground Stope or Rockburst Failure

Underground mining will progress to approximately 750 m below the surface using a mechanical cut and fill mining method. A 6 m wide by 5.5 m high ramp will access the underground by means of a portal located outside the open pit (Figure 4-1). Additional accesses to the surface such as ventilation raises and emergency egress will also be constructed from both inside and outside the open pit as needed to ensure worker safety.

9.2.2.1 Potential Environmental Concerns

Improperly designed and operated underground mines can pose a safety hazard to workers should mine walls fail. As a result of the strength of the host rock and depth below surface, and the plan for backfilling (Section 4.4), stope failures or rock bursts are not anticipated to have an impact on the surface environment. No underground mining will occur close to the ground surface and a crown pillar will remain in place as all locations (excluding at the portal).

A near surface failure at an underground access could cause localized slumping leading to degraded habitat or ponding water. All accesses to underground will be designed to industry standards and failure is not expected to occur. Repair will be conducted immediately as underground mining is likely to cease until repairs can be made.

9.2.2.2 Design and Operations Safeguards

Stope sloughing is expected as part of the RRP mine design for mined out stopes. Access to these areas will be restricted or backfilled for safety reasons.

Rock bursts are rare in North America. They generally only take place in high-stress environments that occur as a result of depth and tectonic forces; often with a primary stress perpendicular to tabular ore bodies (Blake and Hedley 2003). The RRP geology and mine design is not conducive to rock burst conditions. Regardless, geotechnical monitoring of the underground stability directed by qualified geotechnical engineers and rock mechanics specialists will be continuous during underground operations. If areas with excessive stress or sloughing potential are identified, the area will be secured with bolting or other appropriate reinforcement required to secure the underground workings.

9.2.2.3 Contingency and Emergency Response Procedures

In the event of a major wall or unexpected portal failure which could cause the complete blockage of the ramp or an emergency egress, the primary priority is ensuring the safety of underground workers. The emergency response plan will be initiated immediately. Emergency response procedures are not currently established but could include broadcasting the emergency initiation which will be relayed over all channels. All work will cease and equipment shut off. Non-essential personnel will evacuate through the nearest exit if appropriate. The emergency response team and medical personnel will provide aid as needed.

Any substantive surface depressions caused by a failure will be stabilized underground if safe to do so, filled with non-potentially acid generating (NPAG) mine rock and overburden, stabilized and hydroseeded or planted. After any incident, a review will be conducted to ensure that the required design changes and procedures are in place to ensure that incident will not be repeated.

9.2.3 Slope Failure of East Mine Rock and Ore Stockpiles

The east mine rock stockpiles will store and encapsulate potentially acid generating (PAG) mine rock from the open pit and underground development brought to surface. A low grade ore stockpile will be located adjacent to the mine rock stockpile (Figure 4-1) and is expected to contain up to a maximum of 43 Mt of low grade ore for temporary storage.

9.2.3.1 Potential Environmental Concerns

A major slope failure of the east mine rock or an ore stockpile could result in the release of rock (and if progressively reclaimed, overburden) that will pose a safety hazard to any facilities in the immediate vicinity. If the failure is contained within stockpile runoff collection ditches boundaries and reshaping of the stockpile may be required, but no environmental concern is anticipated.

The rock stored in the stockpile is sized for transport only and is blocky in nature (therefore generally unlikely to roll or slide). The most likely, yet improbable, slope failure would occur during a pre-shearing event where part of the stockpile sinks into the ground and the toe of the stockpile is raised. No material would run from stockpile in this case and environmental impacts are not expected. Local remediation and monitoring of the failure would be appropriate.

Should it occur, the maximum potential distance of a run out failure is estimated to cover a distance of less than the height of the first bench (approximately 10 m from the stockpile toe). As the perimeter ditch will be over 10 m wide, mine rock is not expected to migrate beyond the perimeter ditch.

There are two primary concerns with a mine rock or ore stockpile failure: release of metal leaching / acid rock drainage (ML / ARD) affected runoff and overprinting of habitat. If the rock failure were to run out and infill a perimeter ditch, ML / ARD runoff (if present) could potentially overflow or otherwise exit the ditch and could drain toward the Clark Creek diversion or the Pinewood River. Effluent could contain pH, total suspended solids and ammonia in excess of applicable discharge criteria and could be mildly toxic to aquatic life. Perimeter ditch failure and the impact of a failure of the associated mine rock pond is assessed under Section 9.2.5.

Other sensitive receptors adjacent to the east mine rock stockpile include: Teeple Road, a Municipal landfill and SAR habitat. Teeple Road is adjacent to the south boundary of the stockpile and an existing Municipal landfill is located at the southeast corner of the stockpile. Both are located beyond the perimeter ditching and should not be impacted by any slope failure, although if perimeter ditch effluent were to be released, it could complicate effluent management at the landfill.

9.2.3.2 Design and Operations Safeguards

The east mine rock stockpile will be developed with a factor of safety of 1.3 for short term stability. In the long term, the factor of safety will increase to 1.5 as weight from the stockpile will force out excess groundwater from under the stockpile and increase the strength of the underlying overburden. Under a worst case scenario with potentially pre-sheared surfaces in the overburden layer immediately below the stockpile (pre-sheared surfaces have a lower strength and are more likely to slide along the shear), a factor of safety of 1.0 will be retained and closely monitored.

The ore stockpiles are planned only as temporary stockpiles and are internal to the RRP site. A similar factor of safety will be used for the temporary stockpiles to protect RRP facilities.

9.2.3.3 Contingency and Emergency Response Procedures

If a stockpile failure were to occur, the first response will be to cease all work in the area and ensure worker safety. When the failure area is secured, and depending on the scale of the failure, the stockpile slope would be recontoured in place. Any material which migrated as far as the drainage ditch area would likely be excavated and returned to the stockpile and if required, the drainage ditches repaired. Spill reporting and monitoring could be required if PAG rock or stockpile runoff migrated beyond the collection ditches.

9.2.4 Overburden / West Mine Rock Stockpile Slope Failure

An overburden / west mine rock stockpile is required to store waste overburden and most of the NPAG mine rock that will not be used in the construction of site infrastructure. Overburden will be stored in the northern portion of the stockpile and stacked in 15 m benches, to a maximum height of 60 m above ground. NPAG mine rock will be stored in the southern portion of the stockpile and stacked in 15 m benches to a maximum height of 90 m above ground.

9.2.4.1 Potential Environmental Concerns

Similar to the east mine rock stockpile, the most likely, yet improbable, overburden / west mine rock stockpile slope failure would occur during a pre-shearing event where part of the stockpile sinks into the ground and the toe of the stockpile is raised. No material would run from stockpile in this case and environmental impacts are not expected.

The NPAG portion of the stockpile could also run out and a worst case failure is expected to extend less than the height of the first bench, approximately 10 m from the stockpile toe. If the failed slope is contained within the stockpile boundaries, reshaping / re-development of the stockpile could be required, but no environmental concern would be anticipated.

If the run out interferes with, or blocks the perimeter ditching, stockpile runoff which contains elevated suspended solids and ammonia could be inadvertently released to the environment (West Creek diversion or Pinewood River). Suspended solids can interfere with aquatic life, particularly during periods of egg incubation. Sediments can damage fish gills, interfere with feeding or if they are deposited they can smother eggs by preventing oxygen exchange. Ammonia is toxic to aquatic life.

9.2.4.2 Design and Operations Safeguards

The following safeguards will minimize the hazard of an overburden / west mine rock stockpile slope failure:

- The overburden portion of the stockpile will be built with overall slopes of approximately 8H:1V, and the mine rock portion will be built with overall slopes of 6H:1V, which will meet a short term factor of safety of 1.3 and a long term factor of safety of at least 1.5 as weight from the stockpile will force out excess groundwater from under the stockpile and increase the strength of the underlying overburden;

- Internal roads will be designed to provide internal drainage and help dissipate construction induced pore pressure within the pile;

- If appropriate during final design, instrumentation may be installed to record pore pressures and deformation of the underlying ground and mineral waste in order to provide an early warning of potential failure;

- External slopes will be constructed with relatively dry clays or clays mixed with rock for stability; and

- The perimeter runoff collection ditches and sedimentation ponds will allow runoff management by capturing stockpile runoff in ditches and allowing it to settle in ponds prior to discharge to the environment.

9.2.4.3 Contingency and Emergency Response Procedures

When the failure area is secured, and depending on the scale of the failure, the stockpile slope will be recontoured in place. If any material migrated as far as the perimeter ditch, it would be excavated and returned to the stockpile and if required the drainage ditches repaired. If the slope failure caused effluent in the perimeter ditching to spill, silt fencing could be deployed downstream of the spill to prevent sediment laden waters from entering a watercourse.

9.2.5 Tailings Dam Failure

The tailings management area at its ultimate configuration will contain approximately 85 Mm^3 of tailings at a deposited dry density of 1.4 t/m^3. The tailings management area will cover an approximate area of 800 ha. The northeastern side will be bounded by high ground, with earthen rock fill dams along the remaining perimeters. Dams will be built in stages and constructed primarily with overburden and mine rock from the open pit development. Overall downstream dam slopes will be approximately 5.5H:1V. Subject to final design considerations, the maximum tailings management area dam height will be approximately 23.5 m above grade to an elevation of 279.5 masl. The ultimate tailings management area dam crest width will range from approximately 20 m.

The tailings management area dams have been designed to meet the most severe flood and earthquake criteria, being the probable maximum flood and maximum credible earthquake in accordance with the Ontario *Lakes and Rivers Improvement Act* requirements. The designs are supported by geotechnical investigations of sub-surface conditions conducted in 2010 by Klohn Crippen Berger (KCB), and in 2011 and 2012 by AMEC (2013j).

9.2.5.1 Potential Environmental Concerns

Under extreme and highly improbable circumstances, a partial or complete breach of a tailings management area dam would be theoretically possible resulting in a release of tailings solids and associated effluent into the surrounding environment. The risk of a flow slide from a tailings dam failure is negligible because of the tailings and dam material characteristics which prevent liquefaction.

In a worst case scenario, the breach could involve a portion of the contained solids and virtually all of the associated ponded effluent being released into the environment. This is considered highly unlikely to occur as the pond would be maintained in the northern central portion of the facility. The West Creek diversion is adjacent to the tailings management area and would act as a conduit for tailings slurry to enter Pinewood River in a breach scenario, although the release would be impeded by the constructed wetland. The constructed wetland would impede flow and retain a portion of the tailings solids run-out.

Uncontained discharge of a tailings slurry spill could smother terrestrial habitat it overprints, thereby damaging or destroying plants in the path. Animals (if any) caught in the slurry could be killed by the impact or by drowning. Any aquatic habitat such as Loslo Creek / Cowser Drain and the West Creek diversion could be coated with tailings, destroying any aquatic vegetation. Water quality in the watercourse could be degraded by the slurry such that in the near term it could not support aquatic life. A spill would also have the potential to affect groundwater as leachate could infiltrate the ground underlying the tailings spill. Infiltration of leachate would be impeded by the pervasive clay-rich till present at the RRP site. The environmental impact of a tailings spill could increase with time if not remediated since the tailings are PAG in nature.

If the breach were to occur under frozen ground conditions, the impact would be lessened as the tailings and frozen water could be readily removed prior to the snowmelt, thereby limiting the smothering effect on vegetation. If waterways are frozen, tailings slurry would not be able to enter a water course, which could negate the aquatic impact and prevent rapid downstream transport.

9.2.5.2 Dam Failure Assessment

RRR was requested by the government agencies whether a catastrophic dam failure could affect downstream First Nation communities, and wild rice and fishing interests in Lake of the Woods. An assessment was made of the potential environmental impact of an extreme, worst case dam failure (Appendix U). The worst case dam failure was defined as a complete failure of the tailings management area dam at its toe, releasing a large volume of tailings water into the Pinewood River, coinciding with the river in a zero flow, late summer condition.

The assessment was carried out based on conservative assumptions, of the effect on Rainy River and Lake of the Woods of a catastrophic dam failure. The Pinewood River which will receive any water discharges from the site joins the Rainy River southwest of the RRP site (Figure 5-6). The Rainy River marks the Canada / United States international boundary.

The intent of the assessment is to allow RRR to demonstrate the level of expected overall impact of such a failure, and to identify reasonable measures in the design and operation as appropriate, to mitigate the potential risk to the downstream environment. The results presented are not in any way intended to reflect upon the integrity of the tailings management area dams, or the likelihood of such a failure. They are intended to demonstrate the consequences of such an extreme event, were such an event to occur under worst case assumptions.

In order to reflect the most conservative case, contaminant transport in the Rainy River was modelled for 7Q20 low flow condition, defined as the lowest 7 day average flow based on a 20 year return interval. Greater mixing potentials would result in lower parameters concentrations in the Rainy River under higher river flow conditions. Conditions relating to higher Rainy River missing potentials were therefore not assessed.

The dam failure assessment included:

- Routing of a catastrophic tailings management area dam failure flood wave along Pinewood River to the confluence with Rainy River; and

- Evaluation of the potential for tailings solids to reach the Pinewood River following a catastrophic tailings dam failure.

The second part, evaluation of water quality effects on the Rainy River considered:

- Hydrologic evaluation of the Rainy River in relation to the potential for contaminant transport; and

- Evaluation of the spatial extent and concentration of a plume in the Rainy River expected to result from contaminant loading generated by a dam failure flood wave entering the Rainy River from the Pinewood River.

The tailings management area dam was assumed to fail as a piping failure in a sunny-day failure mode, which presents the highest potential upset water quality loading to the receiver.

The HEC-RAS hydraulic software package was used to simulate discharge of water and the down river flood flow from the dam failure.

The simulated peak discharge leaving the tailings management area for the modelled dam failure mode directly downstream of the dam is approximately 500 m^3/sec, declining to approximately 40 m^3/sec at the Pinewood River terminus (confluence with the Rainy River). The simulated peak flow would reach the Pinewood River terminus in about one day following a catastrophic dam failure. The total simulated quantity of water released by the failure is approximately 3.3 Mm^3.

The run-out of tailings solids from a simulated failure from a dam section vertical failure of 23.5 m is at projected at 4.6 km, based on a simplified regression analysis of similar failures, recognizing that the base data are highly variable. The 4.5 km value exceeds the 3.5 km distance between the dam toe and the Pinewood River, indicating that there is a reasonable potential for tailings solids to reach the Pinewood River in the event of a catastrophic dam failure. The constructed wetland located within the Loslo Creek / Cowser Municipal drain valley is expected to at least partially, contain tailings solids run-out in the event of such a failure.

Pinewood River flood wave parameter loadings to the Rainy River as a continuous flood water discharge, were estimated using a numerical flow and transport model. Hydraulic parameters characteristic of the river reach were obtained from review of existing data for open water conditions in the reach. The bathymetry of the study reach was estimated from the existing records and integrated with the topographic data to find the bottom elevations.

Characteristic discharges at the site were obtained through annual and low flow statistics and computed from the Water Survey of Canada station data. The hydraulic parameters characteristic of the other tributaries within the reach, were obtained from review of existing water level and discharge data for the open water condition. These parameters were used as baseline data to calibrate the flow and transport model AQUASEA, which was used to estimate plume concentrations in the Rainy River downstream of the Pinewood River flood inflow location.

The flow and transport modelling indicated that parameter concentrations in the Rainy River would be reduced by dilution and hydrodynamic mixing. At any point in the study reach greater than 15 km downstream within the Pinewood River the modelled parameter concentration does not exceed 30% of the source concentration. During low flow, at the end of the reach (Lake of the Woods), the maximum parameter concentration within the plume was predicted to be less than 27% of the initial source concentration. These percentage values would be much greater assimilation potential under higher flow conditions.

Based on the data presented, the Provincial Water Quality Objectives for the protection of aquatic life (or equivalent values) are expected to be met, or approximately met, even with a catastrophic failure under 7Q20 low flow condition, or approximately met, in the Rainy River downstream of the Pinewood River outflow, except for a smaller exposure zone confined to the north side of the river within 15 km of the Pinewood River confluence. The potential for adverse effects within this zone, if realized, would be minor and transient.

Due to the conservative modelling assumptions, it should be noted that actual parameter concentrations in the Rainy River during flood water discharge (excluding background additions to the computed values), would be expected to be lower than those predicted by the modelling. The reason for this is that any features that influence the flow path (rapids, islands, meanders, etc.), the effects of which were ignored and/or averaged during modelling, would increase turbulence, initiate secondary currents and promote mixing. These factors would further contribute to reducing overall predicted parameter concentrations.

By modelling a worse case dam failure condition, it has been demonstrated that there is no realistic potential for the downstream communities and interests on Lake of the Woods to be affected, even in the circumstance of a catastrophic failure.

9.2.5.3 Design and Operations Safeguards

The tailings management area dams will meet strict regulatory requirements including the requirements of the Provincial *Lakes and Rivers Improvement Act* and will be constructed to withstand the probable maximum flood and maximum credible earthquake. The probable maximum flood is the largest flood that could occur at the RRP tailings management area dam, while the maximum credible earthquake is the largest earthquake that could reasonably occur. The tailings management area dams will be designed to hold the environmental design flood over the maximum operating water level of the tailings management area dam. An emergency spillway will pass any flows in excess of the environmental design flood.

Operational safeguards include visual inspections of the tailings management area dams daily / each 12 hour shift. Piezometers and other geotechnical monitoring equipment will be installed to monitor any movement of the tailings management area dams and allow early maintenance if required. Geotechnical inspections of the tailings management area dams will be conducted at regular intervals.

9.2.5.4 Contingency and Emergency Response Procedures

The initial response of any failure will be to protect worker health and safety and shut down pumping of tailings to the tailings management area.

In the event of a failure or imminent failure of the tailings management area dams the emergency response plan would be initiated. The emergency response plan could include emergency repairs, if safe to do so. The tailings management area pond could be pumped to the water management pond if possible to reduce the amount of released effluent during the emergency repair. The spill would be contained to the extent possible using temporary earthen or snow dams, silt fences, turbidity curtains, sandbags and other available equipment.

RRR would work closely with local residents and authorities to ensure the needs of downstream residents are met should any such event occur.

A remedial action plan would be developed in consultation with appropriate government agencies in the event of dam failure. Spilled tailings will need to be effectively contained because of their ARD characteristics. This likely means that RRR would need to excavate spilled tailings and haul them back to the repaired tailings management area. Alternatively, a cover could be engineered over the deposited material. All areas where tailings are removed would be restored and revegetated to the extent practical.

A surface water and groundwater monitoring program will be created to monitor the movement of aqueous parameters and the success of rehabilitation measures.

9.2.6 Pond Dam Failure

The RRP will have a large network of ponds supporting the onsite water management including the:

- Mine rock pond;
- Stockpile pond;
- West Creek pond;
- Clark Creek pond (and potentially Teeple pond);
- Tailings management area pond;
- Water management pond;
- Water discharge pond; and
- Other runoff collection and settling ponds.

The tailings management area pond is enclosed in the tailings management area and a failure of the containment of this pond is addressed in Section 9.2.4.

9.2.6.1 Potential Environmental Concerns

Environmental concerns resulting from a pond dam failure depend on the quantity of water being stored in the pond, height of the dam (potential energy of stored water) and the quality of water contained therein.

The mine rock pond, water management pond, water discharge pond and some seepage collection ponds may contain elevated levels of aquatic parameters. If these ponds were to be released to the environment, flows would migrate ultimately towards the Pinewood River and aquatic impacts could result. Elevated levels of aquatic parameters can be toxic to aquatic life and could harm local fish, amphibian and benthic invertebrate populations. Suspended solids can interfere with aquatic life, particularly during periods of egg incubation. Sediments can damage fish gills, interfere with feeding or if they are deposited they can smother eggs by preventing oxygen exchange. A worst case scenario would be a complete failure of the minewater pond which could result in a spill of up to 6 Mm^3 of partially treated effluent. Note that any water contained in that pond would already have undergone cyanide destruction in the process plant and aging in the tailings management area pond.

The West Creek pond will contain only fresh water from West Creek upstream. In the event of a dam failure, West Creek would continue to flow through the West Creek diversion. The open pit will be protected from flooding by the haul road. Depending on the quantity of water being released and its discharge velocity, the down gradient environment of any pond failure could be damaged with scour and erosion. A major pond failure could damage vegetation, result in a temporary loss of aquatic habitat and harm any wildlife caught in the flow path.

Similarly, the Clark Creek pond, stockpile pond to a lesser extent, and Teeple pond (if developed) will contain only fresh water from upstream. In the event of a dam failure, the creek would continue to flow through the diversion. Depending on the quantity of water being released and its discharge velocity, the down gradient environment of any pond failure could be damaged with scour and erosion. A major pond failure could damage vegetation, result in a temporary loss of aquatic habitat and harm any wildlife caught in the flow path.

9.2.6.2 Design and Operations Safeguards

Ponds which contain mine-affected waters include the mine rock pond and water management pond. The maximum operating water level of mine-affected water ponds is based on the largest pond in 20-year annual wet conditions. Ponds containing mine-affected water will store the environmental design flood runoff above the maximum operating water level. Spillways will be constructed to ensure safe discharge to the environment should an event ever exceed the environmental design flood.

The mine rock pond and water management pond will have dam slopes of 4H:1V and a crest width of 10 m for stability, subject to further design. Ponds not affected by minewater will have slopes of 4H:1V with a crest width of 6 m.

All sedimentation ponds will be designed with a retention period to meet the Metal Mining Effluent Regulation discharge requirement for total suspended solids. Diversions will be sized to convey the environmental design flood.

Pond dams will be inspected on a regular interval by site employees for any visible signs of concern and particularly during and after major storm events. They will also be inspected periodically by a qualified geotechnical engineer on an interval that meets regulatory requirements at a minimum.

9.2.6.3 Contingency and Emergency Response Procedures

In the event of a failure or imminent failure of a pond dam, an emergency repair will occur once it is safe to do so. Pumping to the affected pond will immediately cease. If required, a spill report will be lodged and downstream health authorities will be notified. Silt fences, turbidity curtains, sandbags and other erosion and sediment control measures will be deployed as possible to prevent the entry of sediments into a downstream waterbody. Appropriate spill control equipment will be kept at the RRP site.

Should a release of deleterious waters occur, remediation may not be possible unless a downstream pond is present to catch released water. Although water from the mine rock pond and water management pond may be mildly toxic to aquatic life, it would be diluted to non-toxic levels when mixed with Pinewood River under the emergency condition. No long term environmental impacts are expected from a pond dam failure.

9.2.7 Watercourse Diversion Failure

The West Creek diversion is required to re-route West Creek away from the open pit. The diversion will begin at the West Creek pond and progress around the north side of the overburden stockpile. The diversion will drain south along the west side of the overburden stockpile and connect to the Loslo Creek (Cowser Drain). A trapezoidal channel is proposed, having a base width of 5 m, side slopes of 4H:1V and channel slope.

The Clark Creek diversion is required to divert the minor creek flows around the east mine rock stockpile. The diversion will begin in Clark Creek upstream of the east mine rock stockpile and drain south to a connection with an unnamed creek and on to the Pinewood River. The diversion will be built with a trapezoidal channel with a 3 m wide base and 4H:1V side slopes.

9.2.7.1 Potential Environmental Concerns

The worst case scenario for diversion failure includes virtually the complete loss of flow from a diversion channel during a major storm event. The failure of ponds which feed into the diversion channels is considered under Section 9.2.5.

The environmental damage of complete failure of a diversion channel will be related to erosion, sedimentation and loss of aquatic habitat. The flow path of the failure will likely experience erosion which will degrade terrestrial habitat as soil is washed out from under vegetation. Where the beached runoff re-enters surface waters extra sediments could be released to the water column. Suspended solids can interfere with aquatic life, particularly during periods of egg incubation. They can damage fish gills, interfere with feeding or if they are deposited they can smother eggs by preventing oxygen exchange.

An additional aquatic impact could occur to fish in the diversions. If flow through part of the either diversion were to cease, then fish and aquatic life downstream of the failure could become stranded and die as the remaining flow drains. There is however, some potential for fish to take refuge in any deeper areas with ponded water until flow is restored.

9.2.7.2 Design and Operations Safeguards

All diversions will be sized to convey the environmental design flood based on the SCS Curve Method. This method was used as it accounts for the effect of catchment size and response time, which are major determinants of the peak flow along the catchment area.

The initial portion of the West Creek diversion channel will also operate as the emergency spillway for the West Creek pond and was sized to convey the probable maximum flood without overtopping.

9.2.7.3 Contingency and Emergency Response Procedures

In the event of a failure or imminent failure of a diversion, the emergency response plan will be employed and an emergency repair will occur. If the failure occurs during a major storm event, it may not be possible to immediately repair the diversion although both diversions route only minor creeks. As both diversions are located in headwaters, flows should subside relatively rapidly after the event.

RRR would work closely with local residents and authorities to ensure the needs of downstream residents are met should any such event occur.

If possible, erosion and sediment control measures will be installed downgradient of the failure. Erosion and sediment measures could include, silt fences, turbidity curtains, sandbags, erosion mats and other equivalent measures.

9.3 Accidents

9.3.1 Explosives Accident

Explosives needed for mine development will be prepared in a dedicated explosives plant located to the north of the process plant. Explosives will be stored on site north of the explosives plant. If a local commercial operation can reliably transport explosives to site, this alternative may replace onsite storage. Explosives used at the RRP are expected to be ammonium nitrate / fuel oil, but could include emulsion or emulsion-blend explosives types.

9.3.1.1 Potential Environmental Concerns

Explosive components are not individually explosive and cannot be inadvertently detonated. Explosives will only explode if mixed in the correct proportions, placed under certain confined conditions, and detonated with an external device. Pre-packaged explosives also require an external detonation device.

The environmental concerns associated with potential malfunctions or accidents during explosives storage and usage are:

- Worker health;
- Excessive disturbance of nearby receptors including landowners and wildlife due to associated sound; and
- Damage to RRP infrastructure or facilities.

Disturbance due to excessive sound is considered in Section 9.4.3.

9.3.1.2 Design and Operations Safeguards

Any onsite explosives magazines or explosives manufacturing area will be located in accordance with the guidelines set out in the Quantity Distance Principles User's Manual published by the Explosives Regulatory Division of Natural Resources Canada (NRCan) with respect to the nearest inhabited building, airstrip, transmission lines, road and blast sites (NRCan 1995). This guide dictates locations of facilities, in part to ensure public safety.

The transportation of explosives is controlled by the Explosives Regulatory Division of NRCan and the Transportation of Dangerous Goods Directorate (Transport Canada). All companies that transport explosives materials for the RRP will be required to comply with the requirements of these agencies.

Explosive handling and storage is highly regulated in Canada and compliance is mandatory. The RRP will use one of the larger explosives companies that are well versed in the Canadian requirements, as dictated by the Federal *Explosives Act* and associated regulatory instruments and as enforced by NRCan.

A blasting plan will be developed describing all proposed blasting operations at the RRP site, and is expected to address:

- Personnel responsibilities;

- Type of equipment and materials to be utilized;
- Safety requirements including pre- and post-blast notification and/or notices for site personnel, pre- and post-blast pit inspections;
- Periphery signs;
- Dust suppression; and
- Spillage control and clean-up.

All personnel who handle explosives will have appropriate training; all other individuals will be restricted from access.

Destruction of explosives (such as those unfit for use) and misfire procedures will be according to applicable regulatory instruments. Deteriorated explosives are potentially more hazardous than explosives in good condition, and will be handled with even more care under strict procedures. All destruction will be completed by experienced personnel.

It is believed that by contracting an experienced explosives firm, by following the regulatory requirements, and ensuring good housekeeping in general, explosives will be well managed at the RRP with minimal likelihood of inadvertent detonation or other accidents.

9.3.1.3 Contingency and Emergency Response Procedures

The worst possible scenario will involve improper handling of explosives by experienced personnel causing bodily harm. Damage to facilities and infrastructure may be possible, but would generally only occur in association with the explosives storage, or where used at the open pit (and potentially quarry or other blasting locations). There is the potential that some minor blasting may also be required during RRP construction for excavations in bedrock areas. Any damage envisioned is recoverable, except for issues associated with worker health and welfare.

Explosives will not be stored or used in close proximity to the process plant or any other structure, and as a result, excessive damage and injuries to workers not involved in explosives preparation and use are not expected.

9.3.2 Tailings Pipeline Failure

The treated tailings at 50% solids by mass will be pumped at a rate of 1,300 m^3/hr, through an approximately 3.4 km length high density polyethylene pipeline from the process plant to the tailings management area for permanent storage. The tailings pipeline will cross West Creek between the process plant and the tailings management area. Prior to transport, the tailings slurry will be treated for the destruction of cyanide and the precipitation of dissolved heavy metals (Section 4.7.6). Despite this treatment, the tailings effluent is expected to retain a low level of toxicity due to the presence of residual levels of cyanide and dissolved heavy metals in the treated slurry, as well as to the presence of cyanate and ammonia (both breakdown products of the SO_2/Air cyanide destruction process).The tailings in the slurry will be PAG.

The system has been designed for an automatic shutdown in the case of a catastrophic break. If there is any significant difference in flow between the beginning and end of the pipeline the interlock for protection against a significant pipeline break will stop the pumping system within seconds of the detection of flow variation, which is instantaneous. In addition, four pressure transmitters along the pipeline will monitor the flow and pressure characteristics on a continuous basis. This will alarm any discrepancies or variations from the normal pressure and flow characteristics of the tailings pipeline operation.

A credible worst case spill scenario has been defined as a complete failure of the tailings pipeline during operation between the process plant and the top of the tailings management area dam, resulting in the release of tailings until pumping ceases and partial loss of pipeline contents thereafter (total contents estimated as 800 m^3 slurry, including 210 m^3 liquid and 590 m^3 solids). With a catastrophic break, pumping will cease immediately (within seconds). Once pumping is stopped, the coarse solids and fines will settle out of solution quickly within the pipeline, while a larger proportion of water will continue to be released. The spill is therefore estimated as an uncontrolled loss of 50% of liquid content remaining in the pipeline and 25% of solids and, or 105 m^3 of liquid and 148 m^3 of liquid.

A leak from the tailings pipeline will be found within six hours based on the proposed inspection times. A lower quantity of solids and liquid would be potentially released to the environment under this scenario, and would be proportional to the size of the leak.

9.3.2.1 Potential Environmental Concerns

A tailings slurry spill would have differing environmental effects depending on the time of the year, the location of the spill and the volume spilled. If the spill occurred when the ground was frozen, spilled material could be readily cleaned up and no environmental impact would be expected. During the remainder of the year, the spill would have a smothering effect on the immediate surroundings. The pipeline only crosses one watercourse (West Creek). The solids (essentially sand) contained in the slurry would be retained in close proximity to the pipeline rupture, irrespective of season. Liquid from the spill would flow by gravity toward the West Creek / West Creek diversion, the constructed wetland and potentially the Pinewood River.

Under the worse credible scenario described above, this would result in the release of approximately 800 m^3 of combined solids and liquid to the environment including 590 m^3 of tailings solids.

9.3.2.2 Design and Operations Safeguards

The primary operational safeguards are pressure sensors which automatically measure pressure at four locations along the pipeline route, as well as flow transmitters at the process plant and at the tailings management area dam. A vacuum relief valve is present at the tailings management area dam to ensure reverse flow is not possible. The pump will automatically shut off in the event of a pressure loss resulting from a failure.

In order to identify leaks of less than the pressure loss detection, the tailings pipeline is proposed to be inspected at least twice per 12-hour shift. Incidental observation could also provide notice in the event of a visible leak or failure.

The pipeline will be routed within a ditch / capture basin system, effectively acting as secondary containment.

9.3.2.3 Contingency and Emergency Response Procedures

In the event that a leak or failure is detected in the tailings pipeline, flow to the faulty pipeline will cease. Heavy equipment will be used along with spill containment materials in order to contain or limit the discharge of tailings and effluent in an uncontrolled manner to the environment.

Depending on the amount of tailings spilled and whether tailings enter West Creek, a remedial action plan may be developed in consultation with appropriate regulatory agencies. Spilled tailings will be excavated and loaded on a haul truck, or vacuumed, and transported to the tailings management area.

9.3.3 Water Pipeline Failure

Water pipelines on the RRP site can be characterized according to the quality of the water being transferred:

- Pinewood River downstream of McCallum Creek to mine rock pond for process plant start-up and contingency supply thereafter (fresh water);
- West Creek pond to the mine rock pond (fresh water);
- Water management pond to Pinewood River downstream of McCallum Creek for discharge of excess treated water;
- Water management pond to the mine rock pond to transport treated effluent for re-use in the process plant (treated water);

- Mine rock pond to the process plant (partially treated water);

- Open pit sumps and the underground mine to the mine rock pond (untreated water); and

- Stockpile pond to the mine rock pond (untreated water).

9.3.3.1 Potential Environmental Concerns

Rupture or a significant leak from any water bearing pipeline could cause erosion downslope from the force and volume of water being released. This could result in a short term sediment plume to be released if there is a nearby watercourse, which could affect aquatic life.

A break or leak from a fresh water or treated water pipeline would not have any other discernable environmental effect.

Discharge of untreated water to the environment could have a more significant effect; however, those pipelines are of the shortest length and any uncontrolled discharge would be captured by the site ditches and/or open pit and underground mine, and hence would be unlikely to have an environmental impact.

9.3.3.2 Design and Operations Safeguards

All active pipelines will be inspected twice per 12-hour shift and informally at other times. Should flow lessen or stop in a pipeline, an inspection will be immediately conducted. Incidental observation could also provide notice in the event of a visible leak or failure as a considerable length of the pipelines (and in particular those containing untreated effluent) run through well travelled areas of the site.

9.3.3.3 Contingency and Emergency Response Procedures

Upon discovery of a leak or failure, pumps will be shut down and the pipeline repaired. If possible, erosion and sediment control measures such as matting, straw bales or silt fencing could be employed to prevent overland runoff containing sediments from directly entering a watercourse.

9.3.4 Fuel Release during Transport

Fuel will be transported to the RRP along the regional road network by tanker trucks. The tanker trucks will consist of single units that typically have a capacity of 30,000 L. Dual trailer units (B-trains) will not be used. Tanker trucks are generally compartmentalized, such that if there were to be an accident, only a portion of the load will be lost except in a catastrophic incident. The principal type of fuel used at the site will be diesel for generator power supplementation during the construction phase and heavy equipment operation during construction, operation and closure.

Based on an average fuel consumption of 30 million L/a during operation and approximately half that amount during the construction phase, the average number of trips per year has been calculated as 500 during construction and 1,000 during operation. Fuel is transported safely throughout the local region and across Canada on a routine basis, by licenced and trained drivers, and the risk of incident involving a serious collision where fuel is released into the environment is small.

Smaller quantities of gasoline will be trucked to site by tanker truck or container on truck, also using licenced and trained drivers.

9.3.4.1 Potential Environmental Concerns

Despite all reasonable safeguards, there is a small potential for spills from tanker trucks due to collisions, accidents related to poor weather conditions, or other mishaps. A diesel spill from a truck travelling to site could affect the soil (or snow in winter) in the vicinity of the spill, and could potentially enter a waterbody if the accident occurred on or near a water crossing.

Diesel fuel and gasoline is toxic to aquatic life when spilled in fresh water. A tanker truck spill will have the greatest environmental impact if the spill reached a major watercourse that supports aquatic life. The diesel slick will move downstream, potentially impacting riverbanks over the length of the watercourse until the spill could be contained or it naturally degrades. A spill on land will be comparatively easy to contain and clean up, particularly under frozen ground conditions.

9.3.4.2 Design and Operations Safeguards

Regular maintenance of fuel trucks can significantly reduce the chance of an equipment failure caused accident. The need for compliance with the *Transportation of Dangerous Goods Act* and associated Regulations will be reinforced in all applicable contracts and vendor agreements

The potential for environmental impacts associated with malfunction and accidents on the trucking route will be minimized by the following operational procedures which will be incorporated into the environmental management system as possible and into trucking / supply contracts as reasonable:

- Speed limits are to be strictly adhered to;

- Strict adherence to national trucking hour limits and other applicable requirements;

- Drivers will be required to meet all applicable regulatory training requirements, be trained in spill response procedures for the materials they transport, and carry the appropriate Material Safety Data Sheets;
- All vehicles transporting materials to site will be required to maintain a supply of basic emergency response equipment, including communication equipment, first aid materials and a fire extinguisher; and
- Penalties for operational violations.

The emergency response plan included in the environmental management system will address the primary hazardous materials on site including procedures for spill response on the trucking route to the RRP site. Materials to be maintained in vehicles will be identified in the emergency response plan, but are likely to include absorbent materials and equipment to contain spilled material.

At the RRP site, the following additional controls will be in place to reduce the potential for or the severity of accidents involving hazardous materials:

- Speed limits, to be posted and enforced by RRP security personnel;
- Right of way procedures will be defined and haul trucks and loaded vehicles will be given preference;
- Traffic will be required to yield to wildlife as observed; and
- Where possible heavy traffic will be limited to site haul roads and other traffic limited to site access roads.

9.3.4.3 Contingency and Emergency Response Procedures

Emergency response procedures will be established as part of the environmental management system and include the following: medical response, notification, containment of spill, removal of spill, treatment of affected environment, monitoring of environment and learning from the accident.

The primary goal in any collision resulting in a fuel spill, will be to ensure public and worker health and safety. Potential ignition sources will be removed in the event of a spill of flammable or combustible materials, if safely possible, and the spill will be stopped or slowed using available equipment. Appropriate corporate and external personnel will be notified, and an assessment will be conducted to determine the best means to prevent immediate environmental impacts. Spill countermeasures may include the use of absorbent materials, establishment of a collection trench and setting containment booms on water. When fuel is contained by booms, berms or other means, it may be pumped, skimmed or mopped with absorbent matting, and disposed of in an approved facility designed to manage such wastes. If a spill were to directly enter a fast moving watercourse, it may not be possible to completely contain and remediate the spill.

Clean-up and potentially remediation will ensure long term environmental impacts are reduced to the extent practical. After any major spill, a review will be conducted to ensure that the required design changes, procedures and appropriate monitoring measures are in place to ensure that incident will not be repeated.

9.3.5 Fuel Releases from Storage Facilities and Dispensing Areas

Diesel fuel and gasoline will be stored at the fuel storage facility in double-walled Enviro tanks, or other equivalent storage with secondary containment such as a bermed facility with a petroleum resistant liner. The fuel storage facility will include a refuelling area for heavy and support mining equipment, and potentially for small vehicles.

9.3.5.1 Potential Environmental Concerns

The risk of a major environmental event associated with fuel storage and dispensing areas is less than that from truck transport because of the fixed locations selected to be isolated from water courses and other sensitive environmental features, the presence of collision protection barriers, secondary containment and the proximity to spill response and containment equipment.

Environmental impacts associated with fuel storage and dispensing will depend in part on final fuel storage facility design, but could include:

- A catastrophic failure of a tank and/or a major collision involving an Enviro tank resulting in the failure of both walls of the tank at the fuel storage facility;
- An accident resulting in a catastrophic failure of the tank of the remote fuelling truck; and
- Operator error with refuelling or damage to the dispensing system (such as a ruptured fuel line).

Impacts would likely be limited to the immediate terrestrial environment except in the case of a major spill or a spill during a rainfall event. The fuel storage facility will be located near the crusher where drainage will flow to the mine rock pond or stockpile pond. In either case, the spill / impacted runoff would be contained and could be treated prior to any effluent being discharged from the pond.

Depending on soil and its hydrological characteristics, a significant fuel spill that goes undetected could create a plume in the soil and leach into downstream watercourses resulting in aquatic and riparian impacts.

9.3.5.2 Design and Operations Safeguards

The potential for environmental impacts associated with malfunction and accidents of onsite fuel storage facilities and dispensing areas have been minimized by the following design and construction features:

- All tankage and storage areas will be constructed to recognized industry standards and conform to Technical Standards and Safety Authority leak detection requirements;
- Storage areas are distant from water courses and sensitive habitat (except where impractical, such as the pump houses for the water intake, where a minimum buffer of 50 m will be maintained if powered by generators);
- Use of bollards (collision protection poles) and other measures to prevent collision;
- Containment berms will placed around all permanent tanks that do not have internal secondary containment; and
- Enviro tanks will be situated to minimize the risk from collision and puncturing of both walls and protected using bollards or similar.

Operational procedures to minimize the potential of accidents or malfunctions will be incorporated into the environmental management system, and are expected to include:

- No smoking in the vicinity of the fuel storage facility or refuelling areas;
- At least daily inspections of all fuel storage locations;
- Formal weekly inspections using a protocol checklist to check for leakage and other operational problems;
- Volumes will be confirmed at all tanks containing petroleum product at least weekly, using a dip check or other method, with the result logged for comparison; any measurements different from anticipated volumes will immediately be investigated; and
- Fuel tanks will not be filled above 98% of capacity to allow for expansion due to temperature changes.

Procedures will be regularly reviewed as part of the environmental management system.

9.3.5.3 Contingency and Emergency Response Procedures

If fuel has escaped the secondary containment the emergency response plan would be implemented. The primary focus will be on ensuring human health and safety. When the area is secured the leak or failure will be sealed if possible. Absorbent materials or a downstream berm (earthen or snow) could be constructed to contain the spill. A large spill kit will be located at the fuel storage facility and will include absorbent material. Spilled fuel would be collected and hauled off site for disposal. Used absorbent material would be sent offsite to be disposed at a licenced facility. Notification and/or reporting will follow Provincial (Ministry of the Environment; MOE) and other applicable requirements.

If the spill migrates to the mine rock pond or stockpile pond, all pumping from the pond will cease. The spill could be contained with a boom and removed with a skimmer.

Soils in the vicinity of the spill will be tested for hydrocarbons and the affected soils delineated. Impacted soil will either be treated onsite in a bioremediation area or hauled offsite for treatment and disposal.

9.3.6 Transportation Accident (Hazardous Materials)

Various chemicals and materials in addition to fuel, including hazardous substances will be transported to and from the RRP. The quantities and packaging details for the reagents are described in Tables 4-1 and 4-2. During the construction phase, cement and paints will also be brought to site. Fuel releases during transport are considered in Section 9.3.4.

9.3.6.1 Potential Environmental Concerns

Consumables will be transported to the RRP by road. Access to the Canada-wide rail and freight transport network is available at Emo and Fort Frances (Canadian National Railway) and Thunder Bay (Great Lakes - St. Lawrence Seaway), and to the United States through Rainy River / Baudette or Fort Frances / International Falls. All materials of consequence will be shipped in sealed containers with secondary containment as appropriate, but as a minimum, in compliance with regulatory requirements, including the *Transportation of Dangerous Goods Act* and associated Regulations.

Transport vehicle accidents en route to the RRP site could result in a spill of the materials in shipment, including hazardous materials. The consequences of a spill will depend on the type and quantity of material spilled, and the location and timing of the spill. Spills involving cyanide in solid briquettes would be of particular concern. Spills on land, where the material does not immediately enter a watercourse are unlikely to have environmental consequences beyond the immediate footprint of the spill, since the spilled material and any associated soil (or snow) can be collected. The aquatic environment would be far more sensitive to a spill. The worst, but least likely, spill scenario will involve a collision or accident in which the entire shipment is spilled and enters a waterbody. The impact of such a spill will depend on the material spilled.

Materials transported by rail over the existing tracks and transferred to trucks will be in sealed containers. Should an accident occur, there may be an impact to a localized area if containers break open. Materials transported by ship could cause similar aquatic impacts as a transport vehicle spill to water, if materials were spilled from a ship or port.

9.3.6.2 Design and Operations Safeguards

All materials of consequence will be shipped in sealed containers, so that in the event of an accident, an uncontrolled spill will not occur unless the containers break open. Types of shipment containers will include tanker trucks, containers, shipment cubes (1,000 L), sealed bulk bags, 205 L sealed drums and smaller containers on pallets. All shipments will be in compliance with regulatory requirements, including the *Transportation of Dangerous Goods Act* and associated Regulations. The need for compliance with the *Transportation of Dangerous Goods Act* and associated Regulations will be reinforced in all applicable contracts and vendor agreements

The potential for environmental impacts associated with malfunction and accidents on the trucking route will be minimized by the operational procedures which will be incorporated into trucking contracts as possible and into the environmental management system. The operational procedures are anticipated to include:

- Speed limits are to be strictly adhered to;
- Oversized loads will only travel during daylight, to the extent practicable, to reduce the potential for collision;
- Transportation of material during times of limited visibility will be avoided where possible;
- Materials that pose a potential hazard will be shipped only in sealed containers;
- Drivers will be required to meet all applicable regulatory training requirements, be trained in spill response procedures for the materials they transport, and carry the appropriate Material Safety Data Sheets;
- All vehicles transporting materials to site will be required to maintain a supply of basic emergency response equipment, including communication equipment, first aid materials and a fire extinguisher;

- Regular vehicle maintenance; and

- Penalties for operational violations.

The emergency response plan included in the environmental management system will address the primary hazardous materials on site including procedures for spill response on the trucking route to the RRP site. Materials to be maintained in vehicles will be identified in the emergency response plan, but are likely to include absorbent materials and equipment to contain spilled material.

At the RRP site, the same controls identified in Section 9.3.4 related to fuel transport will be in place to reduce the potential for or the severity of accidents involving hazardous materials

9.3.6.3 Contingency and Emergency Response Procedures

The first goal will be to ensure public and worker health and safety. Potential ignition sources will be removed in the event of a spill of flammable or combustible materials if safely possible, and the spill will be stopped or slowed. Appropriate corporate and external personnel will be notified, and an assessment will be conducted to determine the best means to prevent immediate environmental impacts. Spill countermeasures may include the use of absorbent materials, establishment of a collection trench downslope and setting collection booms on water if effective for the spilled material.

RRR will work closely with local authorities to ensure public health and safety is maintained at all times.

Clean-up and remediation will ensure long term environmental impacts are reduced to the extent practical. After any hazardous material spill, a review will be conducted and a report issued to ensure that the required design changes and/or procedures are in place to avoid a repeat.

9.3.7 Transportation Accident (Non-Hazardous Materials)

Most of the material transported to and from the RRP will not be hazardous. Non-hazardous materials will follow similar distribution networks as hazardous materials.

9.3.7.1 Potential Environmental Concerns

A vehicular accident on site could happen at any time of the year. Onsite accidents are most likely to involve personnel vehicles or haul trucks transporting coarse materials (ore, mine rock or overburden). Offsite accidents could include construction materials and other non-hazardous materials needed for the RRP. Accidents involving strictly personnel and the public will have a detrimental impact on the families, communities and on the RRP. Notification and/or reporting will follow Provincial (MOE) and other applicable requirements.

Any spill of non-hazardous material would not be expected to cause a significant environmental disturbance, with the exception of the immediate footprint of the accident. Heavy materials such a mine rock could crush vegetation and compact any soil in the spill. Any impacts will be temporary in nature and readily remediated.

9.3.7.2 Design and Operations Safeguards

The potential for environmental impacts associated with malfunction and accidents on the trucking route will be minimized by the following operational procedures which will be incorporated into truck contracts as possible and the environmental management system are expected to include:

- Speed limits are to be strictly adhered to;
- Oversized loads will only travel during daylight, to the extent practicable, to reduce the potential for collision; transportation of material during times of limited visibility will be avoided where possible;
- Drivers will be required to meet all applicable regulatory training requirements,
- All vehicles transporting materials to site will be required to maintain a supply of basic emergency response equipment, including communication equipment, first aid materials and a fire extinguisher;
- Waste management and littering;
- Regular maintenance of fuel trucks; and
- Penalties for operational violations.

At the RRP site, the same controls identified in Section 9.3.4 related to fuel transport will be in place to reduce the potential for or the severity of accidents involving non-hazardous materials

9.3.7.3 Contingency and Emergency Response Procedures

For accidents involving non-hazardous materials, the first goal will be to ensure public and worker health and safety. Thereafter, appropriate corporate and external personnel will be notified as appropriate, and spilled material will be removed. The affected environment will be rehabilitated if needed. After any major accident, a review will be conducted to ensure that the required design changes and/or procedures are in place to avoid a repeat.

RRR will work closely with local authorities to ensure public health and safety is maintained at all times.

9.3.8 Chemical Spills within Contained Facilities

All chemicals such as liquid and solid reagents which pose a potential risk to the environment will be stored and as practical, used within contained areas, with sealed floors and sumps or drains reporting to facilities which will provide for retrieval of the spilled materials. As such there is no reasonable potential for such materials to be released directly to the environment or to have an environmental effect.

All chemicals used at the site will have a Material Safety Data Sheet, in order to comply with the best practices in the industry for health and safety, and to provide relevant regulatory standards for the safe use of these materials. This program will have continual reviews and updates to remain current. These will also be used in the training programs conducted by the health and safety department personnel.

9.3.9 Chemical Spills from Pressurized Vessels

Pressurized vessels are a necessary requirement to store certain gasses and liquids. There will be a number of pressurized vessels at the process plant used to store chemicals at the RRP site, most notably sulphur dioxide (SO_2) and oxygen (O_2). A portion of the ore processing is also completed under pressure (stripping vessel).

9.3.9.1 Potential Environmental Concerns

Pressurized vessels at the RRP site will be designed and constructed to industry standards, and will be operated in accordance with industry best practices. It is standard industry practice for all pressurized vessels to have relief valves to release excess pressure gradually if needed.

Failure of pressurized vessels could occur by:

- Structural failure of the vessel (such as through fatigue or corrosion not noted during construction / regular inspections);
- Over pressurization (overfilling and pressure relief system fails); or
- External damage (such as through significant vehicle impact).

Either catastrophic failure resulting in a near instantaneous release of all contents or limited vessel failure causing continuous release of contents is possible. As the contents are under pressure, the opening will cause a release of the gas that will continue to be released, until the atmosphere within the tank is at the same pressure as the atmosphere. The release of the gas could be prone to explosion if a spark is nearby.

The environmental concerns associated with potential malfunctions or accidents from pressurized vessel failure are:

- Worker health;
- Damage to RRP infrastructure or facilities; and
- Localized temporary air quality concerns.

Impacts would limited to the immediate area environment as a result of the fast dissipation of the material as it expands out from the vessel itself and the volume of gas contained.

9.3.9.2 Design and Operations Safeguards

Any onsite pressurized vessels will be located, designed and operated according to industry standards, including the presence of appropriate safety relief devices to avoid the potential for a catastrophic release through over pressurization and gas metering devices for personal safety. All pressurized vessels will be tested prior to entering service. Good safety practices will be following during any repairing or altering of the tanks subsequently, all work will be according to industry codes.

The pressurized vessels will be constructed according to the American Society of Mechanical Engineers (ASME) Section VIII Div. 1. This standard covers the general requirements (and non-mandatory recommendations) for methods of construction, materials, design, methods of fabrication, inspections and testing, and overpressure protection. The vessels will also be inspected and approved by provincial authority, either at the site of installation or fabrication following Technical Standards and Safety Authority requirements.

In addition to the above, the sulphur dioxide vessel is designed according to Lethal Service standards, due to the hazardous nature of the substance. The Lethal Service criteria specify that all of the welded joints shall be inspected using radiographic examination (x-ray). Radiographic examination is a non-destructive test used to verify the quality of the weld by detecting non-visible and subsurface defects.

All oxygen storage pressure boundary equipment will be fabricated and installed in accordance with the Ontario *Boiler and Pressure Vessels Act* and associated regulations. These regulations include the Boilers and Pressure Vessel Regulation (O.Reg #220/01) and the Ontario *Technical Standards and Safety Act, 2000*.

All piping designs will be done according to ASME B31.1 and B31.3 standards. Code B31 covers the requirements for the design, materials, standard for piping components, fabrication, assembly, erection, inspection, examination and testing for piping applications. The B31.1 code addresses power piping while the B31.3 relates to process piping.

All plans, drawings, and process and instrumentation diagrams will be signed and sealed by an engineer who is a member of the Professional Engineers Ontario.

Appropriate systems will be in place, such as continual level transmitter, high level switch, flow meter, excess flow valve, pressure transmitter, dual venting system (for SO_2), gas detection and alarms allowing a safe and automated operation. Inspections and testing will occur on a regular basis of pressure relief systems, as well as periodically inspecting the tanks for corrosion in defects during operation.

9.3.9.3 Contingency and Emergency Response Procedures

The worst possible scenario will involve a catastrophic failure of a pressure vessel, which due to the proximity of the tanks to other facilities, could be expected to cause bodily harm and potentially fatalities. For this scenario, significant damage to the process plant and environs is likely to occur. Any damage envisioned is recoverable at a significant cost, except for issues associated with worker health and welfare.

The sulphur dioxide vessel is designed for a normal operation at 100 pound-force per square inch gauge (psig) but can hold up to 150 psig. A first set of pressure safety valve will open and automatically vent the vessel in the process when internal pressure reaches 145 psig. If the pressure keeps rising (for example when all the liquid in the tank turns to gas in case of fire), another set of larger safety valves will open to empty the vessel to the atmosphere, thereby preventing explosion of the system. It should also be noted that the sulphur dioxide vessel will be pressurized by an independent compressor. The complete system and related piping is located outside the process plant, to ensure that no sulphur dioxide could harm personnel inside the building.

Similarly, the oxygen vessel will be equipped with both mechanical relief valves (for lower pressure relief) and rupture disks to prevent any risk of explosion.

All chemicals used at the site will have a Material Safety Data Sheet, in order to comply with the best practices in the industry for health and safety, and to provide relevant regulatory standards for the safe use of these materials. This program will have continual reviews and updates to remain current. These will also be used in the training programs conducted by the health and safety department personnel. Emergency response would be in accordance with the Material Safety Data Sheet and would focus on worker health and safety first.

The oxygen storage area includes a spill pad for liquid oxygen. Spills from the sulphur dioxide area will be managed in a containment area.

The gas plume would dissipate quickly once entering the natural environment and no further response / environmental effects are expected related to the gas itself.

9.4 Other Malfunctions

9.4.1 Unexpected Water Quality Concerns

The RRP will require management of the following effluent streams:

- Minewater (elevated total suspended solids; potentially ARD, total suspended solids, TSS and ammonia);
- Stockpile runoff (elevated TSS and potentially ARD, dissolved metals);
- Process plant and site area runoff (elevated TSS and potentially other constituents);
- Tailings slurry from the process plant (elevated TSS, dissolved metals, residual ammonia and reagents); and
- Treated sewage (elevated TSS, biological components).

Effluent is proposed to be discharged to the environment primarily from the water management pond pipeline to the Pinewood River below McCallum Creek. Discharges of treated effluent will also occur from the constructed wetland and potentially from various stockpile ponds, where treated water meets regulatory requirements.

Further information regarding water management for the RRP is provided in Section 4.12.

9.4.1.1 Potential Environmental Concerns

Effluent to be released from the water management pond could have related water quality concerns if:

- In-plant treatment of the tailings slurry for cyanide destruction is insufficient;
- Segregation of PAG from NPAG mine rock is extremely poor, or acid generation in the PAG stockpile is significantly faster than predicted (results of humidity cell testing suggest that the lag time to ARD in these materials is approximately 27 to 40 years);

- Acid generation in tailings stored in the tailings management area occurs at a rate faster than projected (results of humidity cell testing suggest that the lag time to ARD in these materials is approximately 27 to 40 years);

- Treatment of ammonia and cyanide natural degradation is insufficient;

- Settling of sediments does not occur at the expected rate; and/or

- If water management systems were temporarily disrupted to manage an emergency (such as requiring pumping from the tailings management area pond to the water management pond prematurely).

As long as sufficient capacity exists in the water management system, partially treated tailings effluent could be pumped back to an earlier pond for additional treatment. If RRR is unable to do so, the treated effluent could be released to the environment to avoid a dam overtopping. Partially treated effluent with a low pH, elevated dissolved metals, ammonia or cyanide could be mildly toxic to aquatic life. Although some dilution in Pinewood River will occur, there is very little assimilative capacity in the river and aquatic impacts could extend downstream until dilution sufficiently negated any residual toxicity.

9.4.1.2 Design and Operations Safeguards

Multiple levels of effluent treatment and water management capacity exist through the network of RRP ponds which offer considerable capacity beyond that required during normal operations. The only treatment ponds that freely drain to the environment under ordinary conditions are sedimentation ponds (assuming regulatory compliance is achieved, otherwise, the water will be held or pumped for additional treatment).

All final discharge points have a point of control to immediately cease discharge. All discharge locations will be regularly sampled in accordance with environmental approval requirements and will provide insight as to ongoing treatment system performance. If sampling reveals discharge concerns, treatment processes may be altered.

9.4.1.3 Contingency and Emergency Response Procedures

In the event that effluent quality concerns are observed, all practical efforts will be made to prevent discharge of the partially treated effluent to the environment. If this is not possible for operational or dam safety reasons, the discharge would be limited to the extent practical. The source of the poor water quality will be determined and operational or design changes made as appropriate.

RRR will work closely with local authorities to ensure public health and safety is maintained at all times.

For any chronic effluent quality issues, a review will be conducted to ensure that the required design changes and procedures are in place to ensure that poor effluent quality will not be repeated.

9.4.2 Unexpected Water Quality Concerns - ARD

Unexpected water quality concerns related to minewater and runoff from the mine rock stockpiles that could potentially be ARD is addressed in Section 9.4.1.

Mine rock is one of the primary construction materials proposed for the development of the RRP, along with overburden. Unexpected water quality concerns could arise if overburden or rock segregated and subsequently used in infrastructure development or other construction is found to be acid generating after placement. The overburden is not expected to be acid generating based on test work to date.

All mine rock used in construction will be selected from rock extracted from the open pit, segregated for construction purposes as NPAG on the basis of a specific protocol to be developed based on the results of the geochemical block model. In the case of rock is used in concrete manufacture, this material undergoes an increased level of testing to ensure longterm competency of the concrete and the potential for ARD related concerns with the material is considered negligible.

9.4.2.1 Potential Environmental Concerns

Should a portion of a structure such as a road or laydown yard be constructed with material that is subsequently determined to be acid generating (initially assessed through visual inspection), runoff from facility could have related water quality concerns (low pH and high metal content).

If the facility which is constructed inadvertently with PAG is in a location that drains to some part of the RRP water management system, there is no immediate environmental concern as runoff will be captured and treated. Similarly, if the area PAG is small and it is not located in an area heightened sensitivity (such as immediately adjacent to a watercourse), there would be no immediate environmental concern.

If however, the area of identified PAG is located immediately adjacent to a sensitive receiver, there is greater environmental concern, and immediate action is required.

9.4.2.2 Design and Operations Safeguards

As described in Section 5.2.5, the approach and methodology for the collection and characterization of mine waste materials at the RRP was based upon requirements described under the Ontario *Mining Act*; namely guidance found within the document Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials (MEND 2009).

Rock will be segregated for use as construction materials according to a site-specific protocol, which is expected to include:

- Preliminary identification of materials from the open pit for potential use in construction based on geochemical testing to date;
- Refinement based on a geochemical block model, to identify the location of blocks of material which are eligible for construction usage prior to extraction;
- Geochemical testing of the blocks periodically to assess appropriate location for storage or for construction use and confirm model results; and
- Visual inspection of material during placement and after construction for signs of ARD.

Should a visual inspection or other means suggest inappropriate use of PAG materials for construction purposes, a follow up geochemical sampling program will be completed.

9.4.2.3 Contingency and Emergency Response Procedures

If visual identification and subsequent sampling program identifies that some of the materials used in construction is acid generating (or is PAG material that could impact the surrounding environment recognizing that the surrounding mine rock may provide some buffering capacity), the material will either be extracted and transported to the East Mine Rock Stockpile for storage:

- In the near term, if a visual inspection identify that runoff / seepage from the exposed has the potential to cause an environmental impact beyond the localized area; or
- Otherwise when convenient based on the usage of the facility and anticipated potential environmental effect;

or, alternatively, there may be circumstances where it is prudent to leave the material in place and mitigate any potential environmental effects through encapsulation or other measures.

9.4.3 Project-related Fires

Fires can result from either natural (lightning) or human causes (human error, equipment malfunctions or accidents). Effects related to natural fires are addressed in Section 8.4.3.

9.4.3.1 Potential Environmental Concerns

Fires present a hazard to health and property, with the extent of concern dependant on the location of the fire, nearby facilities and its severity. A major fire at site could pose a serious health and safety concern, and could cause property damage and operations interruptions. Environmental impacts will include a temporary reduction of air quality and localized terrestrial habitat loss.

9.4.3.2 Design and Operations Safeguards

The RRP has been designed to meet all applicable fire protection system requirements and codes. This includes: fire detection and suppression systems, sprinkler and standpipe systems and a fire hydrant system. Appropriate buffer areas have been established around facilities to prevent the spread of any fires, recognizing the overall intent to maintain a compact footprint to minimize environmental disturbance.

Remote buildings such as the explosives storage, explosives plant, temporary construction buildings, pump houses and underground ventilation buildings will be equipped with portable extinguishers as required. A fire pumper truck will be present at the site and equipped with a foam generation system for use as required.

Regular fire drills will occur to ensure that all workers are familiar with fire response procedures, as dictated within the environmental management system. All workers and visitors on site will receive an orientation which includes fire reporting and response procedures.

9.4.3.3 Contingency and Emergency Response Procedures

Priorities for fire response will be to protect human health and to ensure that the fire does not spread. A trained site fire response crew will provide the initial fire fighting response, with assistance from local municipal volunteer fire fighting services potentially being requested. If local assistance is not sufficient, fire fighting resources from Fort Frances could be called upon for assistance.

RRR will work closely with local authorities to ensure public health and safety is maintained at all times.

9.4.4 Excessive Disturbance to Wildlife

Anticipated environmental effects on local wildlife are addressed in Section 7. Effects beyond that predicted could potentially occur if proposed mitigation measures are ineffective.

9.4.4.1 Potential Environmental Concerns

If measures to reduce expected impacts fail or are otherwise less effective than intended, excessive disturbance to wildlife could result from aspects such as:

- Unnecessary habitat displacement, including SAR habitat;
- Vehicular collisions;
- Excessive sound, light and vibration; and
- Exceedance of permit requirements for air and water discharge to the environment.

9.4.4.2 Design and Operations Safeguards

Habitat displacement will be minimized by maintaining as compact of a site footprint as practical and avoiding SAR habitat as practical. RRR will prioritize the minimum encroachment of site infrastructure on SAR habitat during final design and provide compensation habitat.

All RRP vehicles will be required to adhere to posted speed limits on roads to minimize the potential for wildlife collisions. Vehicles are to provide the right of way to animals when noted. Animal collisions will be recorded and if needed, additional mitigation measures implemented.

Sections 7.4.1 and 7.4.2 describe the measures proposed to reduce the potential for excessive sound and vibration levels.

Effluent in excess of discharge criteria will be managed as per Section 7.6.3.

Additional or alternative measures could be developed during the detailed design process.

9.4.4.3 Contingency and Emergency Response Procedures

If excessive disturbance is identified as a concern, an investigation will be conducted of measures that can be taken to reduce the impact in the short term and potentially longer term. These measures might include design and modification of equipment and facilities and avoidance of more sensitive areas to the extent practical during critical times of the year.

9.5 Risk Assessment

Each credible potential accident and malfunction discussed above was assessed according to likelihood of occurrence and magnitude / consequence of occurrence, and given a risk ranking of between 1 (highest) and 9 (lowest). Each risk ranking refers to a diagonal row of cells within a risk matrix shown in the same colour (Figure 9-1). As shown in the risk matrix, increased risk is associated with malfunctions and accidents having a greater likelihood of occurrence and increased level of consequence, as is intuitively true.

A qualitative approach has been taken to this environmental risk assessment, which is expected to be intuitive for the reader. The likelihood of occurrence has been defined as follows:

- Negligible: doubtful to occur over the life of the mine (<1/10,000 events per year);
- Very Low: unlikely to happen over the life of the mine (<1/1,000 events per year);
- Low: could happen over the life of the mine (<1/100 events per year);
- Moderate: probably will happen over the life of the mine (<1/10 events per year); and
- High: will happen regularly over the life of the mine (greater than 1/10 events per year).

The consequences of the occurrence are important from the environmental perspective. The range of malfunctions or accidents that are being considered and the varied sensitivity of the environments involved, do not lend themselves to typical environment-related criteria (such as level of toxicity, surface area affected, duration of impact). As a result, a surrogate measure of environmental consequence has been used, which includes a combination of potential effect and cost of remediation, as a measure of severity:

- Low: no long term effects, readily remediated with a cost in the $10,000’s;

- Moderate: typically limited or no long term effects, predictably remediated with a cost in the $100,000’s;

- High: typically, moderate long term effects expected, predictably remediated but costly with associated costs in the $1,000,000’s;

- Very high: significant long term effects expected, uncertain and costly remediation in the $10,000,000’s; and

- Extreme: highly significant long term effects likely, unlikely to be completely remediated and cost in the $100,000,000’s.

Where a range of risk ratings could occur, a conservative approach whereby only the highest risk ranking associated with a credible occurrence has been utilized and is listed. Risk ratings of greater than or equal to 4 are considered acceptable if there is a proposed management and mitigation plan. A risk rating of 3 requires further consideration, and risk ratings of less than or equal to 2 are unacceptable.

This methodology has also been utilized for a number of other mining-related undertakings which were subject to a proponent-driven Class EA process under the Ontario *Environmental Assessment Act*, that were reviewed by Federal and Provincial government agencies, other stakeholders and Aboriginal groups at the time.

Results of the risk assessment are provided in Table 9-1, with highest risk identified associated with an event having a likelihood of negligible and consequence of extreme.

Table 9-1: Malfunctions and Accidents Risk Summary

Malfunction / Accident	Issue of Concern	Likelihood	Consequence	Risk Ranking
Open Pit Slope Failure	Damage to habitat, limited flooding of open pit	Low	Moderate	6
Underground Rock Burst	Human environment	Negligible	Very High	6
Mine Rock Stockpile Slope Failure	Damage to terrestrial habitat, aquatic life	Very Low	High	6
Overburden Stockpile Slope Failure	Damage to terrestrial habitat, aquatic life	Very Low	Moderate	7
Tailings Dam Failure	Damage to terrestrial habitat, aquatic life and downstream	Negligible	Extreme	5
Pond Dyke Failure	Damage to aquatic life	Negligible	Moderate	7
Explosives Accident	Human environment	Negligible	Low	9
Tailings Pipeline Failure	Damage to habitat and aquatic life	Very Low	High	6
Water Pipeline Failure	Damage to aquatic life	Very Low	Low	7
Fuel Release during Truck Transport	Damage to aquatic life and downstream human environment	Very Low	High	6
Fuel Release from Storage Facilities and Dispensing Area	Damage to habitat	Low	Low	7
Transportation Accident – Hazardous Materials (excluding fuel)	Damage to habitat, aquatic life and downstream human environment	Very Low	High	6
Transportation Accident – Non-hazardous Materials	Local terrestrial environment	Low	Low	7
Chemical Spills from Pressurized Vessels	Damage to property and human environment	Negligible	Very High	6
Unexpected Water Quality Concerns	Damage to aquatic life	Very Low	High	6
Project-related Fires	Human environment, local terrestrial habitat loss	Negligible	Moderate to Very High	6 to 8
Excessive Disturbance to Wildlife	Damage to wildlife	Low	Moderate	6

Note: See text for explanation of colour coding and ranking system

Figure 9-1: Environmental Risk Matrix