4.0 ACCIDENTS AND MALFUNCTIONS

4.1 Background

The Project is located within with the Kenora Mining Division in northwestern Ontario. The Project site is approximately 4 km northwest of the village of Wabigoon, 20 km east of Dryden and 2 km north of the TransCanada Highway 17 and within the Hartman and Zealand townships.

A major component of the EIS process is the identification and assessment of potential accidents and malfunctions that could occur throughout all phases of the Project. Treasury Metals understands the risks associated with the Project and is committed to operate the Project to the highest standards for operation, security and health and safety. The assessment of the potential accidents and malfunctions of the Project have been completed in accordance with the EIS Guidelines (Appendix Y) issued by the Canadian Environmental Assessment Agency (the Agency).

The proponent will identify the probability of potential accidents and malfunctions related to the Project, including:

- An explanation of how the potential accidents and malfunctions were identified;
- Potential consequences (including the environmental effects);
- The methodology for assessing potential risks;
- Definitions of assessment characterization criteria (e.g., likelihood and severity);
- The plausible worst case scenarios and the effects of these scenarios;
- Identification of the magnitude of an accident and/or malfunction, including the quantity, mechanism, rate, form and characteristics of the contaminants and other materials likely to be released into the environment during the accident and malfunction events;
- Identification of the safeguards that have been established to protect against such occurrences; and
- Contingency/emergency response procedures in place if accidents and/or malfunctions do occur.

The process for identification of potential accidents and malfunctions, potential environmental effects, methodology for assessing potential risks, assessment characterization criteria, worst case scenarios, preventative procedures, and contingency procedures are included in this section. The identification of the magnitude of an accident and/or malfunction (e.g., quantity, mechanism, rate, form, and characteristics of the contaminants) is included in Section 6 of the EIS.

4.2 Approach

Accidents and malfunctions were identified using a Failure Mode and Effects Analysis (FMEA) methodology. An FMEA is a risk analysis procedure used to identify and characterize accidents and malfunctions (i.e., failure) based on the likelihood of occurring and the severity/magnitude of the failure. Through the FMEA process, a total of 463 failure modes were identified and analyzed, as described in the following sections.

The FMEA process for this Project assessed the likelihood of a potential failure and the consequences of the failure in three main categories:

- Environment;
- Safety and health; and
- Production.

The FMEA process was completed in four general phases:

- Data input;
- Summary of risks and risk matrices;
- Likelihood and severity assessment; and
- Analysis of controls.

4.2.1 Data Input

A team of experts involved with the Project (Table 4.2.1-1) was assembled and an FMEA workshop was conducted from January 30, 2015 to February 1, 2015 under the facilitation of Dave Ireland of Tetra Tech.

Table 4.2.1-1: FMEA Workshop Participants

Name	Company	Role	01/30/2015	01/31/2015	02/01/2015
D. Ireland	Tetra Tech	Facilitator	√	√	√
M. Rutherford	Tetra Tech	Scribe/Team Member	√	√	√
J. Jones	Tetra Tech	Team Member	√	√	√
M. Grégoire	Tetra Tech	Team Member	√	√	√
M. Herrera	Tetra Tech	Team Member	√	√	
N. Bush	Treasury	Team Member	√	√	√
M. Wheeler	Treasury	Team Member	√	√	√
M. Potter	Treasury	Team Member	√	√	√
A. Cluegh	Orway Mineral Consultant	Team Member	√	√	

The potential environmental risks were identified, including potential consequences of the occurrence. The likelihood and magnitude of an accident and/or malfunction were also identified. Once the accidents and malfunctions were identified, control measures were established to protect against such occurrences as well as emergency response procedures if accidents or malfunctions failures occur. The FMEA data were gathered and input to a worksheet that uses a structured approach to identify and assess potential risks.

4.2.1.1 Activity / Step / Area or Category

Potential accidents and malfunctions are organized into categories and each category is further divided into sub-categories or items.

The major categories evaluated are:

- General development;
- Mine underground;
- Mine open pit;
- Mine site process;
- Mine site utilities;
- Mine site facilities;
- Mine site tailings;
- Mine site temporary facilities; and
- Off-site infrastructure.

4.2.1.2 Hazard / Aspect or Threat

The Hazard/Aspect or Threat describes the potential risk or type of failure being evaluated. A failure mode can occur naturally, by an engineering system failure, or operational failure due to inadequate control measures or operator error. For example, the clearing of vegetation (site preparation category) requires heavy equipment and releases from equipment failure are a potential hazard or threat. Since there may be several hazards in one category, the FMEA only includes the most significant or likely hazards that may potentially occur.

4.2.1.3 Unwanted Event

The Unwanted Event describes the adverse effects or outcome of the hazard / threat occurring, whether it relates to the environment, safety and health, or reputation. For example, potential unwanted events that could occur when clearing vegetation with heavy equipment include accidents, collisions, spills, air emissions, injury to humans or wildlife, and habitat removal.

4.2.1.4 Life of Mine

The Life of Mine refers to the phase(s) of the Project the potential hazard / threat may occur in. Depending on the type of failure identified, it may be a potential threat at only one Project phase or multiple Project phases. The six phases of the Project are: exploration, study, site preparation and construction, operation, closure, and post-closure. As the exploration and study phases of the Project are either complete or currently underway, they are not considered in the FMEA. During the post-closure phase, there will be little or no activity at the Project site, and thus post-closure was not included in the FMEA. The FMEA focuses on the site preparation and construction, operations, and closure phases of the Project when activities will be occurring at the site.. Some potential failures may have a different severity or likelihood of occurring depending on the phase.

4.2.1.5 Existing Controls and Contributing Factors

Within the Existing Controls and Contributing Factors category, there are six sub-sections that provide information on:

- Factors contributing to the unwanted event;
- Current controls in place (i.e., elimination, substitution, separation, administrative, engineering, personal protective equipment, and emergency response);
- Effectiveness of controls (i.e., effective, limited, or partial);

- The total effectiveness of controls for each category based on a combination of effectiveness ratings for each control; and
- Reasons why the controls are either effective or not effective.

4.2.1.6 Impact Categories

As indicated in Section 4.2, the impact categories are:

- Environment;
- Safety and health; and
- Reputation.

4.2.1.7 Residual and Inherent Risks

The Residual and Inherent Risks describe the overall level or rank of each hazard / threat. Residual risk is defined as the amount of risk remaining once the controls have been applied and inherent risk is defined as the risk associated with a hazard / threat where no controls have been implemented. The level of both the residual risk and inherent risk are determined as a function of likelihood and severity. The likelihood is the expected frequency of occurrence and the severity is the consequence expected as a result of the occurrence.

There are no mathematically or statistically derived formulas for determining the actual risk of a hazard / threat. Therefore, likelihood and severity are based on experience and judgment of qualified professionals involved in the Project (i.e., FMEA workshop participants). However, the FMEA incorporates a semi-quantitative method for estimating the likelihood and severity based on a five-category scale.

Likelihood

Likelihood is described as the possibility that the identified failure will occur for each of the impact categories. The likelihood ratings range from "almost certain" to "rare" and are coded A to E, respectively (Table 4.2.1.7-1).

Table 4.2.1.7-1: Ratings for Likelihood of Failure Modes

Code	Description	Definition
A	Almost Certain (i.e., the event will occur)	90% to 100%
B	Expected (i.e., the event will probably occur in most circumstances)	55% to 90%
C	Likely (i.e., the event could occur at some time)	30% to 55%
D	Unlikely (i.e., the event may occur at some time)	5% to 30%
E	Rare (i.e., the event may occur only in exceptional circumstances)	< 5%

Severity

Severity is the degree of consequence expected as a result of a failure mode. That is, the greater the severity, the more negative the consequence. Severity, unlike likelihood, is assessed separately for each impact category. The severity rating applied to the Project uses a scale of "limited" to "severe" and are coded 1 to 5, respectively (Table 4.2.1.7-2).

4.2.1.8 Rank and Risk Level

The rank and risk levels are determined using the likelihood and severity categories for each failure mode. The combination of likelihood and severity for a failure mode assigns a rank ranging from 1 to 25 (Table 4.2.1.8-1). The greater the likelihood and/or severity, the lower the rank (i.e., smaller ranks represent greater risk). For example, a failure mode that has a high likelihood (i.e., likelihood rating of A - almost certain to occur) and high severity (i.e., severity rating of 5) would be considered the highest rank (i.e., rank = 1).

The risk level is based on ordering the 25 ranks into three risk management categories: low, medium, and high (Table 4.2.1.8-1). Each cell in the matrix has two values: the first is whether the failure mode is low (L, green), medium (M, yellow), or high (H, red) and the second is the rank.

Table 4.2.1.7-2: Rating for Severity of Failure Modes

Severity Rating	1	2	3	4	5
Safety & Health	First aid -or- minor reversible health effects of no concern	Medical treatment -or- reversible health effect of concern (no disability)	Lost time injury / illness -or- severe, reversible health effect resulting from acute, short-term exposure -or- progressive chronic condition, infectious disease	Single fatality -or- permanent disability -or- exposure resulting in irreversible health effect of concern	Multiple fatalities or health effects resulting in multiple disabling illnesses leading to early mortality
Environment	Limited environmental impact, no regulatory reporting, minor closure delays of 1 to 2 years	Minor on-site environmental impacts, reportable to regulators, closure delays of 3 to 6 years	Moderate environmental impacts, extending beyond site boundary, regulatory violations with fines, significant potential delays of 6 to 10 years	Serious medium-term environmental impacts, major regulatory violations, long term closure impacts of >10 years	Severe long-term environmental impacts, severe breach of regulations with operation suspended, closure severely impacted
Stakeholder Relations and Reputation	No impact on stakeholder confidence in management of company	Limited impact on stakeholder confidence in management of company	Medium impact on stakeholder confidence in management of company	High impact on stakeholder confidence in management of company	Loss of stakeholder confidence in management of company

Table 4.2.1.8-1: Criteria for Risk Matrix

Likelihood Rating						
	A	L_{18}	M_{11}	H_6	H_3	H_1
	B	L_{20}	M_{14}	M_{10}	H_4	H_2
	C	L_{22}	L_{19}	M_{12}	H_7	H_5
	D	L_{24}	L_{21}	M_{15}	M_{13}	H_8
	E	L_{25}	L_{23}	M_{17}	M_{16}	H_9
		1	2	3	4	5
Severity Rating						

The high-risk level (i.e., red, ranks 1 to 9) indicate failure modes with a severity rating of greater than 3 and a likelihood rating of A to C. The medium-risk level (i.e., yellow, ranks 10 to 17) indicate failure modes with a severity rating of 2 to 4 and broad range of likelihood. The low-risk level (i.e., green, ranks 18 to 25) indicate failure modes with a severity rating of 1 to 2 and a broad range of likelihood.

4.2.1.9 Recommended Action

The Recommended Actions column of the FMEA worksheet provides a list of methods that were identified during the FMEA workshop for improving existing controls and implementing new controls for each failure mode.

4.2.2 Risk Registers and Risk Matrices

4.2.2.1 Risk Across all Impact Categories

Treasury has committed to a wide-range of control measures designed to reduce inherent risk in all facets of the Project development, operation, and closure (Appendix HH). As a result, the remainder of this section will focus on the characterization and discussion of residual environmental risk. Across the three impact categories, there are 463 potential failure modes. One (0.2%) of the failure modes are considered high-residual risk, 69 (14.9%) are medium-residual risk, and 393 (84.9%) are low-residual risk (Table 4.2.2.1-1).

Table 4.2.2.1-1: Summary of Residual Risk Ranks

Likelihood Rating						
	A	0	3	0	0	0
	B	6	0	0	0	0
	C	15	6	0	0	0
	D	81	58	10	7	0
	E	211	16	28	21	1
		1	2	3	4	5
		Severity Rating				

The summary of the residual risk categories indicates that the majority of medium and high risk categories are due to the potential impact of failure modes on environment (14) and safety and health (47), whereas only nine were associated with reputation (i.e., one high-risk and eight medium-risk) (Table 4.2.2.1-2).

Table 4.2.2.1-2: Risk Level by Impact Category

Impact Category	Low Risk	Medium Risk	High Risk	Total
Environment	123	14	0	137
Safety & Health	174	47	0	221
Reputation	96	8	1	105
Total	**393**	**69**	**1**	**463**

4.2.2.2 Evaluation of Environmental Failure Modes

To evaluate the environmental residual risks, the following steps were taken:

- Filtering from the FMEA worksheet the failure modes exclusive to the environment category;
- Selecting the failure modes in the environment category that had risk rankings (both residual and inherent) of high- or medium-risk levels (i.e., yellow or red on risk matrix); and
- Documenting the rationale behind their rank and subsequent risk level assignment.

The environment impact category has a total of 137 failure modes. 123 of these failure modes are considered low-residual risk (green) and 14 are considered medium-residual risk (yellow). There were no high-residual risk (red) environmental failure modes identified during the FMEA process as shown on the risk matrix (Table 4.2.2.2-1).

Table 4.2.2.2-1: Summary of Identified Environmental Residual Risks

Likelihood Rating	Severity Rating: 1	2	3	4	5
A	0	3	0	0	0
B	2	0	0	0	0
C	2	6	0	0	0
D	41	15	4	0	0
E	50	7	7	0	0

4.2.2.3 Low Environmental Risks

All of the 123 low residual risk environmental failure modes were considered to have a low severity rating with limited to minor potential environmental effects (i.e., severity rating of 1 or 2). There were no environmental low-residual risk failure modes with a severity of greater than 3. Of the low-residual risk environmental failure modes, two were determined to be "expected" to occur (i.e., likelihood rating B), eight were found to be "likely" to occur (i.e., likelihood rating C), 56 were determined to be "unlikely" to occur (i.e., likelihood rating D), and 57 were found to be "rare" (i.e., likelihood rating E).

Further information regarding low-residual risk environmental failure modes including a description / consequence, area of impact, phase, severity, likelihood, risk level/rank, and controls and applicable management/monitoring plans for low environmental risk failure modes is included in Appendix HH.

4.2.2.4 Medium Environmental Risks

Fourteen of the failure modes are considered medium environmental risks. Of the 14 medium residual risk environmental failure modes, three were considered to have a severity rating of 2 (i.e., minor environmental effects) and the remaining 11 were considered to have a severity rating of 3 (i.e., moderate environmental effects). Of all the medium-risk environmental failure modes, three were determined to be "almost certain" to occur (i.e., likelihood rating A), four were considered to be "unlikely" to occur (i.e., likelihood rating D), and seven were considered to be "rare" (i.e., likelihood rating E).

Further information regarding medium-risk environmental failure modes including a description / consequence, area of impact, phase, severity, likelihood, risk level / rank, and controls and applicable management / monitoring plans for medium environmental risk failure modes is included in Appendix HH.

4.3 Effects of Failure Modes on Environmental Valued Components

4.3.1 Identification of Potential Interactions between Failure Modes with Intermediate and Receptor Valued Components

The medium risks identified within the environment category were selected for further analysis and categorized into three failure modes for further environmental assessment (Table 4.3.1-1):

1. Failure of TSF;
2. Spills and releases; and
3. Cyanide.

After the FMEA process was complete and failure modes identified, the next phase of the accidents and malfunctions analysis is the identification of the effects of potential failure modes on valued components (VCs). VCs are those aspects of the environment that are particularly notable or valued because of their ecological, scientific, resource, socio-economic, cultural, health, aesthetic, or spiritual importance, and which have a potential to be adversely affected by project development or have the potential to have an effect on the Project. The potential to be affected means there has to be some interaction, either directly or indirectly, between the environmental component and some component or activity associated with the Project during all phases. In this way, the assessment becomes focused on the identification and management of potential adverse effects.

Table 4.3.1-1: Description, Prevention, and Responses to Potential Medium Environmental Residual Risk Failure Modes

Potential Failure Mode	Potential Environmental Effects	Control Measures and Preventative Procedures	Emergency Response and Contingency Procedures	Follow-up Monitoring
Failure of tailings storage facility	The potential primary effects would be to soil, terrain, and surface water in the vicinity of the release with potential secondary effects on aquatic resources and fish and fish habitat.	1.0 Dam Safety Management Plan 2.0 CDA Dam Safety Guidelines 3.0 MNRF Best Management Practices 4.0 Provincial Lakes and Rivers Improvement Act 5.0 Operational and storm water management 6.0 Existing site conditions and historical climatic data incorporated into the predictive hydrological modelling 7.0 The spillway will be designed to route flows resulting from the Inflow Design Flood as prescribed by the HPC of the dam. 8.0 The embankment heights will also be designed with the required freeboard allowances, for normal and minimum freeboard, as prescribed by the guidelines listed above. 9.0 The embankments will be designed with zoned earth fill raises and meet the standards set forth by the applicable guidelines. The embankments will be designed to be stable and meet the required minimum Factors of Safety under the required conditions. 10.0 A qualified Engineer will inspect the system as part of the annual Dam Safety Inspections and routine Dam Safety Review. 11.0 Operations, Maintenance and Surveillance (OMS) Plan will be developed for the TSF. The OMS will include items such as o Operational pond levels will be established and an allowance to hold the volume of water resulting from the EDS will be developed. o Dam inspections will be completed as required by guidelines and best managements practices. o The seepage collection system will be inspected as part of the daily visual inspections to identify early potential problems or concerns. o Ground movement sensors will be used to detect any early movement on TSF 12.0 Emergency Preparedness Plan (EPP) will be prepared to include the proper procedure for dealing with a failure of the TSF. This Plan will be updated as required by the current operating plan. 13.0 A compliance monitoring program will be developed prior to construction to assess the performance of the TSF and collection	In the event of a dam breach, the following must occur as outlined in the EPP: 14.0 The seepage reclaim system would be shut down to prevent water from being routed to the containment area. 15.0 The reclaim system would be re-routed to transfer water back to the plant site if capacity is available, or alternatively it could be pumped to the open pit for temporary storage if worker safety is not compromised. 16.0 In the event of a pump failure, a temporary pump can be installed during repairs. The standby pump can also be diesel-powered in the event of power loss at the site. 17.0 In the event that water breaches the seepage collection system; the area would be cleaned up by removal and proper disposal of the potentially impacted material into the TSF.	18.0 If the TSF was to fail as in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures. 19.0 A compliance monitoring program would be developed to ensure that cleanup activities are effective.
Spills/Releases	Primary effects would be to the soil, snow and surface water. Potential secondary effects on aquatic resources, fish and fish habitat and wildlife habitat.	20.0 OMS Plan will be developed mine operations. The OMS will include items such as o Regular maintenance of fuel trucks; o Speed limits are to be strictly adhered to, to be posted and enforced by Treasury security personnel; o Strict adherence to national trucking hour limits and other applicable requirements; o 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 MSDS; o Right-of-way procedures will be defined and haul trucks and loaded vehicles will be given preference; o Traffic will be required to yield to wildlife as observed; o Where possible, heavy traffic will be limited to site haul roads and other traffic limited to site access roads; o Transportation of material (i.e., fuel) during times of limited visibility will be avoided where possible; o All vehicles transporting fuel 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 o Penalties for infractions. 21.0 All materials will be stored and handled according to manufacture specification or MSDS 22.0 All liquid containments will be designed to include a secondary containment area which will hold 150% the contained volume. 23.0 All personnel on the project site will be trained in the proper handling proper handling of chemicals. 24.0 Spill Management Plan (SMP) will be prepared to include the proper procedures for handling spills to land and water, locations of spill containment equipment, safe areas to access spills, disposal of spill contaminated material and reporting requirements. This plan will be updated as required by the current operating plan. 25.0 EPP will include the proper procedure for dealing with spills. This Plan will be updated as required by the current operating plan.	The emergency response protocols will be followed as outlines in the ERP and SMP in the event of a worst-case scenario fuel release include the following: 26.0 Identify immediate hazards to human life and health; 27.0 Identify source of spill and control source; 28.0 Contain the released material; 29.0 Notify appropriate personnel and reporting to applicable government agencies; 30.0 Conduct clean-up area impacted by release; 31.0 Incident investigation; and 32.0 Further assessment of effected environment, including surface water bodies in vicinity of the release.	33.0 Review of reported spill will be conducted periodically which may warrant design changes, procedure changes, or need for additional measures. 34.0 Compliance monitoring programs would be implemented to assess clean-up requirements and disposal of impacted soil/snow, if required.

Potential Failure Mode	Potential Environmental Effects	Control Measures and Preventative Procedures	Emergency Response and Contingency Procedures	Follow-up Monitoring
Cyanide	Primary effects would be to the terrain and soil, as well as surface water if the release occurs near a surface water body. Potential secondary effects on aquatic resources, fish and fish habitat and wildlife habitat.	35.0 Cyanide, cyanide compounds and related chemicals will each have an MSDS 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. All materials will be stored and handled according to manufacture specification or MSDS 36.0 All liquid containments will be designed to include a secondary containment area which will hold 150% the contained volume. 37.0 All personnel on the project site will be trained in the proper handling proper handling of cyanide chemicals and associated PPE. 38.0 Regular inspections of holding tanks and operational procedures will be carried out. 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. 39.0 Operations and designs for hazardous materials, such as cyanide transport, will comply with applicable regulatory requirements for the transportation of dangerous goods. 40.0 Operational safeguards for compressed gases will be enforced, operations personnel will be trained to use appropriate health and safety safeguards, and infrastructure will be regulatory maintained and inspected as per standard operating procedures. 41.0 Operations and designs for hazardous materials, such as cyanide transport, will comply with applicable regulatory requirements for the transportation of dangerous goods. 42.0 Specific remediation measures are implemented and followed including: o All vehicles and drivers involved with transport will be licensed, trained, and inspected for competency. o Proper transportation containers and proper transport vessels (appropriate vehicle) will be used. If liquid cyanide must be transported, containers will have appropriate hydraulically controlled internal valves. o All trucks will have their needed MSDS, will be properly maintained to company and Transport Canada standards, and will have all safety equipment on hand (including medical and spill response material). o All incidents and near-misses will be reported, and regular audits will be conducted. o Drivers will maintain constant communication and/or GPS tracking during the transportation of cyanide. o SMP will be prepared to include the proper procedures for handling CN spills to land and water, locations of spill containment equipment, safe areas to access spills, disposal of spill contaminated material and reporting requirements. This plan will be updated as required by the current operating plan. o EPP will include the proper procedure for dealing with cyanide. This Plan will be updated as required by the current operating plan.	The contingency and emergency response plan for transport related emergencies will ensure the following: 43.0 Best route for access to incident site, including an evaluation of transportation route condition 44.0 Specific remediation measures are implemented and followed including: o Recovery and treatment of contaminated soil; o Decontamination or management of soil and other contaminated material; o Disposal of clean-up debris; and o If possibility of contamination to drinking water, appropriate emergency response measures will be enforced to protect drinking water users. Emergency response plans for SO_2-Air cyanide destruction process failure: 45.0 Ore processing plant will be shut down and all pumping outputs and inputs to the plant will cease. 46.0 Body and eye wash stations will be established at the ore processing plant as a first response measure. 47.0 Personnel and the ore processing plant area will be equipped with HCN gas sensors with an alarm system, should gas reach unacceptable ambient levels. 48.0 All workers will be provided notification and cease all work and be evacuated as per established emergency response procedures. 49.0 Any gas plume present will be allowed to dissipate to ensure worker safety. Notification to workers downwind of the incident and ore processing plant shutdown may be required in order to secure the area. 50.0 SO_2-Air cyanide destruction process will remain closed until full operational ability is restored.	51.0 After any major release or accident from cyanide use, transport, storage or handling an in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures. 52.0 Compliance monitoring programs would be implemented to assess clean-up requirements and disposal of impacted materials, if required.

4.3.2 Failure of Tailing Storage Facility

4.3.2.1 Tailing Storage Facility Description

The TSF is expected to have a final footprint area of approximately 88 ha. It will be constructed in stages to provide containment for the tailings solids, along with operational and storm water management. The final crest is anticipated to have a final elevation of approximately 420 masl and the maximum dam height is anticipated at approximately 22 m. The slopes of the embankments have been preliminarily assigned at 2.25H:1V to 2.5H:1V and will be dependent on the final design. The TSF will include an emergency spillway, a downstream seepage collection and a pump-back system along with a tailings delivery and deposition pipeline to deposit the tailings into the facility and a water reclaim pipeline to route water back to the process plant for use in processing operations. Approximately 9.07 million dry tonnes of tailings solids are anticipated to be directed to the TSF during the planned years of operations. A water cover is planned for the operations to minimize acid generating potential of the deposited tailings.

The TSF embankments will be designed as a zoned earth fill structure to control potential seepage flows through the embankment. A seepage collection and pump-back system will also be utilized to capture and return potential seepage from the embankments back into the containment facility. The seepage collection ditches will be designed with sufficient capacity to accommodate the anticipated seepage rate and runoff from the upstream catchment that will include the downstream slopes of the TSF.

The design of the embankment heights will include allowances for operating pond levels, containment of the Environmental Design Storm (EDS), a spillway designed to pass expected flows (in accordance with the Inflow Design Flood [IDF]) and the required freeboard as identified in the CDA Dam Safety Guidelines and the *Lakes and Rivers Improvement Act* Best Management Practices. Water pond levels and embankment heights will be designed for each embankment stage for operational and storm water management:

- Maximum Operating Level – Required to contain runoff from average and wet precipitation conditions considering the volume of water being removed from the facility (evaporation and water transferred to treatment and process) while maintaining a water cover.

- Spillway Invert Level – Pond level providing storage capacity between the invert of the spillway and Maximum Operating Water Level to contain the EDS, currently assigned as the volume of water resulting from the 1:1,000 year, 24-hour. precipitation event.

- Embankment Height – Sufficient to maintain freeboard above the invert of the spillway for each embankment stage to prevent water from overtopping the dam during the occurrence of the prescribed IDF that will be determined once the dam's hazard potential classification (HPC) has been established during final design.

- It should also be noted that the design of the Project as it is being advanced by Treasury Metals allows for the spillway to be directed into the open pit. With this feature in place it ensures that any overtopping event will direct any spilled within the operations area water management system and be wholly contained within the open pit. This water will be treated prior to discharge to the environment or, if possible once the water level within the TSF has been stabilized, directed back to the TSF for further treatment. It is expected that such an overtopping event would take place over a sufficient amount of time that all operation personnel will be evacuated from any areas that may risk flooding. These areas could include the process plant area, the open pit or the underground mining areas.

4.3.2.2 Control Measures and Preventative Procedures

The TSF will be designed using sound engineering principles and accepted standards to ensure protection of the environment during operations and in the long term (after closure) and to achieve effective reclamation at mine closure. Designs will be in accordance with the latest version of the CDA Dam Safety Guidelines (2007), the MNRF Best Management Practices (2011) and the Provincial Lakes and Rivers Improvement Act. The TSF will be designed for operational and storm water management. Existing site conditions and historical climatic data will be incorporated into the hydrological modelling. Operational pond levels will be established and an allowance to hold the volume of water resulting from the EDS will be developed. The spillway will be designed to route flows resulting from the IDF as prescribed by the HPC of the dam. The embankment heights will also be designed with the required freeboard allowances, for normal and minimum freeboard, as prescribed by the guidelines listed above. The embankments will be designed with zoned earth fill raises and meet the standards set forth by the applicable guidelines. The embankments will be designed to be stable and meet the required minimum Factors of Safety under the required conditions (Table 4.3.2.2-1).

Table 4.3.2.2-1: Minimum Factors of Safety

Loading Conditions	Minimum Factor of Safety	Slope
End of construction (before reservoir filling)	1.3	Downstream and upstream
Long-term (steady state seepage, normal reservoir level)	1.5	Downstream and upstream
Full or partial rapid drawdown	1.2 to 1.3	Upstream
Pseudo-static	1.0	Downstream and upstream
Post-earthquake	1.2 to 1.3	Downstream and upstream

A Dam Safety Management program will be implemented during the operations and will consist of the following:

- Daily visual inspection of all embankments and berms, pipelines, pumps, culverts, spillways etc. to look for obvious problems such as pipeline damage, blockage, embankment seepage, and slope instabilities. During high precipitation periods or spring freshet, more frequent inspections will be warranted.

- A more detailed inspection of all facilities will be conducted on a monthly basis to look for any less obvious signs of potential problems.

- During and following any extreme events, including snowmelt and precipitation, a more detailed inspection will need to be conducted to assess if any damages (e.g., due to erosion) require attention.

- The facility will be inspected by a qualified geotechnical engineer on annual basis (Dam Safety Inspection) to verify that the embankments are performing as designed and that the operations are being continuing as intended. The inspections would likely be carried out during or shortly after the spring melt under snow free conditions. A full Dam Safety Review will also be completed at the prescribed time intervals, but most likely on a 5-year basis.

- Ground movement sensors will be install on the TSF to detect any early movement on embankments, berms and dams.

The perimeter seepage collection ditches will be designed to contain the potential volume of water from seepage through the embankment and upstream runoff. All seepage will be collected and routed to a collection point for return to the TSF containment area. The ditches will also be designed with sufficient freeboard to ensure that water overflows do not occur. The ditches will be lined to ensure that seepage is contained within the ditch and that erosion damage does not occur.

A compliance monitoring program will be developed prior to construction to assess the performance of the TSF and collection. Surface and groundwater monitoring programs will also be used to ensure that seepage flows are not leaving the containment system.

4.3.2.3 TSF Failure Modeling Summary

Treasury Metals was required by the CEA Agency to assess the potential impacts of a catastrophic failure of the TSF. Although such a failure is highly unlikely, an assessment of the event was completed and is presented in Appendix GG. The assessment was conducted to simulate worst-credible conditions of a hypothetical catastrophic failure, but are not a reflection of the actual safety conditions of the TSF after it is designed and built. This exercise allowed the development of an understanding of the environmental consequences of a TSF failure, and also to develop mitigation measures to reduce or eliminate any potential impacts to the environment and/or human health should such a highly improbable event take place.

The assessment included the following steps:

- Dam breach assessment, to determine the release hydrograph from the TSF failure;

- Hydraulic routing, to determine the extent of the released materials from the TSF after the failure;

- Geochemical modelling, to determine concentrations of selected water quality parameters from the supernatant, pore water and tailings; and

- Water quality modelling of Wabigoon Lake to determine the extent of the contamination and changes in parameter concentrations in the lake.

For the selection of a credible worst-case scenario two failure modes were considered: piping (sunny-day failure) and overtopping. Overtopping was considered to be more critical for the receiving environment as the volume of released materials from the TSF would be larger, and the anticipated flows in Blackwater Creek would not provide enough dilution to alleviate the contaminant loads. Furthermore, larger flows in Blackwater Creek would create the conditions to transport a larger amount of fine sediments and pore water liquid from the released tailings into Wabigoon Lake.

The dam breach and initial flood hydrograph was conducted to evaluate breach opening, time of dam failure and the subsequent breach flow into Blackwater Creek. The peak outflow from the breach was calculated to be 78 m^3/s, and the total spill volume was calculated at 1,695,958 m^3, made of 753,480 m^3 of settled tailings, 880,000 m^3 of supernatant and 62,478 m^3 corresponding to the 100-year storm inflow. Worst case conditions were assumed where all of the supernatant stored in the TSF is released.

Using the output from the breach analysis, the two-dimensional hydraulic model was used to produce an inundation map. The results from the model indicate that all of the released supernatant would reach Wabigoon Lake, as well as the pore water from the tailings, however, the released tailings solids would remain on the land without reaching the lake. This is due for the most part to the viscous properties of the tailings which act as a hyper-concentrated fluid, and the relatively flat terrain.

In order to better assess the quality of the released fluids, a preliminary geochemical model was conducted. Results from the modelling provided concentrations of the various components of the effluent, including supernatant, pore water and tailings. Concentrations of all parameters remain below the Metal Mining Effluent Regulations (MMER) limits, with the exception of lead which may increase to roughly 1.5-times the limit of 0.2 mg/L after acid generating conditions are established in the tailings material. Aluminum, cadmium, cobalt, copper, iron, lead, mercury, selenium, silver, thallium, uranium, and cyanide may exceed their respective Provincial Water Quality Objectives (PWQO) at the point of release, but does not take into consideration any dilution effects from the receiving waters. Sulphate concentrations decrease after the initial flushing of readily soluble material to a local minimum prior to the onset of acid-generating conditions. pH of any release should remain circumneutral.

Wabigoon Lake is a large body of water with a surface area of 104 km². The water level of the lake is controlled by the dam located in Dryden, approximately 18 km west of the TSF. Blackwater Creek enters Wabigoon Lake in Kelpyn Bay. A two-dimensional numerical model was created to simulate the hydrodynamic conditions in Wabigoon Lake. The failure inflow hydrograph corresponds to TSF overtopping failure. The maximum discharge from this hydrograph is 64.6 m³/s and the total hydrograph volume is 1.2 hm³ at the point of discharge into the lake. The contaminant concentration of the water entering Wabigoon Lake at Blackwater Creek is set to 1.0 (unity) in the calculations. The simulation was run for 30 days following TSF failure. The flood wave enters Wabigoon Lake 6.9 hours after failure. Results from the simulation show that no contaminant is transported in the East part of the Lake. Therefore, the community of Wabigoon is not impacted by the TSF failure. The model also shows that concentrations at Dryden are negligible and that only in the immediate vicinity of the discharge point there would be some parameters that would exceed the PWQO. The duration of the exceedance would not last more than a few hours.

4.3.2.4 Potential Environmental Effects

In the highly unlikely scenario of a dam breach or failure, the resulting flood wave could damage or destroy plants in its path. It would cause erosion along Blackwater Creek until the flood wave velocity is attenuated as it reaches bends and beaver ponds along the creek. The aquatic habitat in the zone affected by the high velocity flood wave could be damaged or destroyed. In addition to the flood wave, the tailings solids could coat the ground surface and sections of Blackwater Creek in the relative vicinity of the failure and affect terrestrial habitat and aquatic environment if it is not removed.

As the model indicates, the effect on the water quality of Wabigoon Lake would not last more than few hours and would be mostly limited to Kelpyn Bay, well away from the communities of Wabigoon and Dryden. Although the concentration of some parameters may exceed the PWQO, rapid dilution below threshold levels is expected as the flood wave enters Wabigoon Lake, therefore resulting in minimal effects, if any, on the aquatic resources and fish and fish habitat.

Accidents of this type could occur during the operations and reclamation phases of the Project. In the construction phase, there will be no tailings placed within the TSF and post-closure is expected to produce a final reclaimed site that guards against or eliminates such long-term TSF failures.

A tailings breach occurring during winter months, when conditions are below freezing, is anticipated to have a lesser effect compared to a breach occurring during non-frozen conditions. Tailings released from the facility in winter would be contained by snow cover that would aid in facilitating cleanup activities. In addition, minimum flow would be occurring in the streams and therefore water released would potentially freeze up before traveling a significant distance from the facility and into existing water bodies. All potential TSF solids and water would be removed as per the spill management plan to ensure no further environmental damage to Blackwater Creek and Wabigoon Lake.

If best management practices are not undertaken and a dam overflow occurs, procedures similar to TSF failure will be enacted. Potential environmental effects of an overflow are similar to TSF failure. Potential effects will be greatest at the point of failure, with the potential to directly affect the Blackwater Creek watershed and Wabigoon Lake.

4.3.2.5 Potential Secondary Effects of Releases to Environment

Treasury Metals will implement management plans for the Project that would require the isolation, and removal of any tailings solids release in the unlikely event of a TSF failure. It is only if the tailings solids dispersed on land and waterbodies are not removed in a timely manner following a TSF dam breach (which is contrary to the management plans set out by Treasury Metals) that there could be a long term risk of migration. Runoff could mobilize tailings particles into Blackwater Creek and negatively affect its water quality (i.e., turbidity and chemical composition). It is less likely that remobilized particles would affect the quality of Wabigoon Lake since they would likely settle in slow moving water such as beaver ponds along Blackwater Creek. However, high water levels and velocities, such as spring freshet, could remobilize the settled particles and affect the water quality of Wabigoon Lake. In addition, acid generating conditions may begin where tailings solids are exposed constantly or intermittently to air.

4.3.2.6 Contingency and Emergency Response

The following emergency response and contingency procedures have been identified in the event that a TSF dam breach occurs:

- The seepage reclaim system would be shut down;
- The reclaim system would be re-routed to transfer water back to the plant site if capacity is available, or pumped to the open pit for temporary storage if worker safety is not compromised;
- In the event of a pump failure, a temporary pump can be installed during repairs; and
- In the event that water breaches the seepage collection system; the area would be cleaned up by removal and proper disposal of the potentially impacted material into the TSF.

A remediation plan will be initiated immediately after the short-term actions of the Emergency Preparedness Plan (EPP). The plan will be developed in consultation with the applicable government agencies. Tailings that were released from the TSF impoundment structure will need to be contained to limit damage to the surrounding environment. The damaged TSF embankment would need to be reconstructed to the original design to ensure that containment of tailings solids and impacted water is reinstated. Released tailings and impacted natural ground would be removed by excavation and deposited into the reinstated facility.

In the event of a dam breach, the seepage reclaim system would be shut down to prevent water from being routed to the containment area. The reclaim system would be re-routed to transfer water back to the plant site if capacity is available, or alternatively it could be pumped to the open pit for temporary storage if worker safety is not compromised. In the event of a pump failure, a temporary pump can be installed during repairs. The standby pump can also be diesel-powered in the event of power loss at the site. The seepage collection system will be inspected as part of the daily visual inspections to identify early potential problems or concerns. A qualified Engineer will inspect the system as part of the annual Dam Safety Inspections and routine Dam Safety Review. In the unlikely event that water breaches the seepage collection system; the area would be cleaned up by removal and proper disposal of the potentially impacted material into the TSF. Spill reporting and monitoring could be required under this condition. The surface and groundwater monitoring programs would be used to monitor the effectiveness of the rehabilitation work.

Another primary concern in the event of a dam breach will be to ensure site personnel and worker safety. The tailings flows being routed to the TSF will need to be shut down to prevent additional tailings solids and water from entering the facility. As part of the Operations, Maintenance and Surveillance (OMS) plan for the site, an EPP will be prepared and in-place during the operations. It will be expected that personnel responsible for the operations of the TSF will be familiar with and trained to implement the EPP. The EPP will be initiated and repair work initiated if worker safety is not compromised. These works could consist of building temporary dams of local borrow material to contain the tailings solids and direction of water to the plant site, if possible, or to the open pit mine if worker safety would not be compromised.

4.3.2.7 Follow-up Monitoring

In the unlikely event of a TSF failure, an in-depth review will be conducted, which may warrant design changes, procedure changes, or need for additional measures.

A compliance monitoring program would be developed to ensure that cleanup activities are effective.

4.3.3 Spills/Releases

4.3.3.1 Issue Description

Diesel fuel and gasoline will be stored at the fuel storage facility in double-walled tanks or other equivalent storage, with secondary containment such as a bermed facility with a petroleum resistant liner. Since these risks have been addressed with secondary containment, they are considered to be low environmental risk.

Some site activities have the potential for fuel releases from vehicles or heavy equipment, especially during general development of the mine site (i.e., bulk earthworks / site preparation and site road development). However, as part of part the developing technical work for the Project, which has been included in this EIS, Treasury Metals has proposed to construct a perimeter ditch around the operations area to contain all runoff from the active mining areas of the Project. Any possible spills associated with the operations of the mine will be wholly contained within this operations area, and within the water management system. Any excess waters not used in the process will be treated to meet PWQO prior to release to the environment.

Since there will be many vehicles operating and traveling both on- and off-site through all phases of the Project, there is the potential for an accident to occur, resulting in a release of fuel to the adjacent environment.

Fuel will be transported to the Project site along the regional road network by tanker trucks. 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 Project will be diesel for generator power supplementation during the construction phase and heavy equipment fleet operation during construction, operation and closure. Fuel is transported routinely and safely throughout the local region and across Canada by licensed 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 the Project by tanker truck or container on truck, also using licensed and trained drivers. During the construction phase, cement and paints will also be brought to the site.

All chemicals such as reagents that may pose a potential risk to the environment will be stored and used within contained areas if practicable (i.e., ore processing plant reagents), with sealed floors and sumps or drains reporting to facilities which will provide for retrieval of the released materials. These measures greatly reduce the release of such materials directly to the environment. Since these risks have been addressed with secondary containment, they are considered to be low environmental risk.

Various chemicals and materials including non-hazardous and hazardous substances will be transported by road to and from the Project site. Access to the site is available via Anderson Road/Tree Nursery Road linking to the Trans-Canada Highway (Highway 17) just to the west of the Village of Wabigoon.

Accidents along public roads and highways may have a higher risk of occurrence than on-site accidents due to other road users and higher speed limits. On-site design and operation procedures will continue to apply on off-site roads along with provincial and national road regulations and laws. The same potential environmental concerns indicated under on-site vehicular accidents will apply for off-site accidents.

4.5.1.1 Control Measures and Preventative Procedures

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 effects associated with accidents and malfunctions 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:

- Regular maintenance of fuel trucks;
- Speed limits are to be strictly adhered to, including on-site;
- 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 MSDS;
- All vehicles transporting fuel 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 infractions.

The emergency response plan that will form part of the environmental management system (Section 12) will address the primary hazardous materials on-site, including procedures for spill response on the trucking route to the Project. 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 released material.

At the Project site, the following additional controls will be put in place to reduce the potential for, or the severity of, accidents involving fuel:

- Drivers will be required to meet all applicable regulatory training requirements;
- Speed limits are to be strictly adhered to, to be posted and enforced by Treasury 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;
- Where possible, heavy traffic will be limited to site haul roads and other traffic limited to site access roads;
- Transportation of material (i.e., fuel) during times of limited visibility will be avoided where possible;
- All vehicles transporting fuel 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 infractions.

4.3.3.2 Potential Environmental Effects

Reasonable safeguards have been taken into account for the design of the Project, but a small potential for releases along all transport routes from tanker trucks still exists due to possible accidents related to poor weather conditions, collisions and other factors. A release from a tanker truck could potentially contaminate the soil or snow it covers, or enter a nearby water body or at a watercourse crossing. The consequences of any release will depend on the type and quantity of the material released, as well as the location and time of the release. Fuel that does not enter any water body is likely to have low or no environmental effects beyond the immediate footprint of the release. The released fuel and contaminated soil and/or snow can be collected and hauled away for appropriate disposal. A worst case scenario would be the release of the entire contents of the fuel being transported to the site through a collision.

Effects of this worst-case scenario would typically be limited to the immediate terrestrial environment unless the release occurs during a rainfall event or if in close proximity to a surface water body. Depending on the soil and its hydrological characteristics, a significant fuel release could create a plume in the soil and leach into downstream watercourses resulting in aquatic and riparian effects. Therefore, primary effects would be to the terrain and soil, as well as surface water if the release occurs near a surface water body. Potential secondary effects on aquatic resources, groundwater, fish and fish habitat and wildlife habitat.

Diesel fuel and gasoline are toxic to aquatic life and a release in a water body or watercourse that supports aquatic life would have a major effect on the environment. A release to land over frozen ground presents a lower environmental effect as it could be readily contained and cleaned up.

Spatially on-site, the main concern would be a contaminant of concern entering into the local Blackwater Creek watershed and the direct impact to terrestrial habitat.

A vehicular accident on-site could happen at any time of the year. On-site accidents are most likely to involve personnel vehicles or haul trucks transporting coarse materials (e.g., ore, mine rock or overburden). Off-site accidents could include construction materials and other non-hazardous materials needed for the Project. Accidents strictly involving personnel and the public will have a detrimental effect on the families, communities and on the Project itself, and efforts will be undertaken to enforce safe driving habits on-site, with penalties if required.

Any release of non-hazardous material will not be expected to cause a significant environmental effect, with the exception of the immediate footprint of the accident. Heavy materials such a mine rock could crush vegetation and compact soil. Any effects will be temporary in nature and readily remediated as needed.

During all phases of the Project, accidental fuel releases to receiving waters could result in exceedances of applicable federal and provincial regulations and guidelines. These exceedances, however, are not expected to be measureable beyond the construction period and are expected to occur infrequently.

4.3.3.3 Contingency and Emergency Response

The following emergency response and contingency procedures will be followed as outlined below in the event of a worst-case scenario release:

- Spill response measures; and
- Incident Specific Remediation action plans.

The affected environment will be rehabilitated as needed. Clean-up and remediation will ensure long-term environmental effects are reduced to the extent practical. After any major environmental release, a review will be conducted to ensure that the required design changes and procedures and appropriate monitoring measures are in place to ensure that the incident will not be repeated.

In general, the emergency response protocols in the event of a worst-case scenario fuel release include the following:

- Identify immediate hazards to human life and health;
- Identify source of release and control source;
- Contain the released material;

- Notify appropriate personnel and reporting to applicable government agencies;
- Conduct clean-up of area affected by the release;
- Incident investigation; and
- Further assessment of effected environment, including surface water bodies in vicinity of release.

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

Although the environmental effects of a release are very important, another primary goal in any collision resulting in a release will be to ensure public and worker health and safety. Potential ignition sources will be removed in the event of a release of flammable or combustible materials, if possible, and the release 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 effects. Counter-measures 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 release were to directly enter a fast moving watercourse, it may not be possible to completely contain and remediate the area affected by the release.

4.3.3.4 Follow-up Monitoring

Review of reported spill will be conducted periodically which may warrant design changes, procedure changes, or need for additional measures.

Compliance monitoring programs (water, soil or air) would be implemented to assess clean-up requirements and disposal of impacted materials, if required.

4.3.4 Cyanide

4.3.4.1 Issue Description

The Project will extract gold from gold-bearing ore using cyanide leaching (Appendix HH). Cyanide leaching is a technically proven and cost-effective technique for the recovery of gold. Cyanide will occur in both liquid (free cyanide and complexed with heavy metals) and gaseous phases (hydrogen cyanide [HCN] gas).

The ore processing plant will be designed according to best practice engineering standards for safe operation, with appropriate ventilation systems. As ore processing plant design involving cyanide is common industry practice, including detailed cyanide management plans, there is no reasonable potential for HCN gas to be unintentionally released from the ore processing plant.

Cyanide for ore processing at the Project site will be transported and delivered by truck. The preferred form of cyanide is solid sodium cyanide pellets or briquettes. If the preferred form is not available, cyanide in a liquid form may be transported to site. If liquid cyanide is required, a risk assessment and an update to the emergency and spill response plan will be required. Transportation of cyanide will adhere to all regulatory requirements for the transportation of dangerous goods. With the safety and operational procedures in place, the likelihood that a cyanide release should occur during transport and delivery to the Project is low; however, a worst-case scenario would be an accident involving a vehicle carrying hazardous material (e.g., cyanide), which would result in a release to the environment.

Ore will be leached with cyanide in agitated leach reactors. The Project will be designed to operate in compliance with the International Cyanide Code as well as federal and provincial regulations and guidelines. Cyanide consumption will be decreased using a recovery thickener to recycle cyanide, and cyanide concentrations of the leach tails will be reduced to acceptable discharge limits using the SO_2-Air cyanide destruction process prior to discharge to the tailings facility. This process is technically proven and well-established technology that is unlikely to fail during normal operations.

4.3.4.2 Control Measures and Preventative Procedures

Designs and operational practices will be prepared to limit worker exposure to cyanide and cyanide compounds in compliance with exposure limits established in Canada, and / or as recommended by the International Cyanide Management Institute.

The SO_2-Air cyanide destruction process is an industry standard process designed for safe and responsible management and use of cyanide. Operational safeguards for compressed gases will be enforced, operations personnel will be trained to use appropriate health and safety safeguards, and infrastructure will be regulatory maintained and inspected as per standard operating procedures. Due to design and use of best practices employed at the Project site, there is no reasonable potential for the destruction circuit to fail, or for significant environmental effects.

As per other reagents and chemicals that will be used at the ore processing plant, cyanide, cyanide compounds and related chemicals will each have an MSDS 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. Regular inspections of holding tanks and operational procedures will be carried out. 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.

Operations and designs for hazardous materials, such as cyanide transport, will comply with applicable regulatory requirements for the transportation of dangerous goods. All vehicles and drivers involved with transport will be licensed, trained, and inspected for competency.

Proper transportation containers and proper transport vessels (appropriate vehicle) will be used. If liquid cyanide must be transported, containers will have appropriate hydraulically controlled internal valves.

All containers and trucks will have their needed MSDS, will be properly maintained to company and Transport Canada standards, and will have all safety equipment on hand (including medical and spill response material).

All incidents and near-misses will be reported, and regular audits will be conducted.

Drivers will maintain constant communication and/or GPS tracking during the transportation of cyanide.

4.3.4.3 Potential Environmental Effects

HCN gas can be harmful (i.e., toxic) to humans, wildlife and equipment upon exposure to elevated concentrations also poses a fire hazard. HCN gas release would be limited to the ore processing plant, all operations staff would be notified as per the emergency response plan, and evacuated if needed. HCN gas will be allowed to dissipate and will be removed to allow for safe working conditions for all staff. The HCN gas plume will quickly dissipate once entering the natural environment and no further response/environmental effects will be expected. The special boundary for this type of accident is expected to be limited to the property boundary as much of the HCN gas would likely be contained within the processing plant buildings and infrastructure. Accidents of this type are only considered during the operations phase as no use of cyanide is expected during the construction, reclamation and closure phases.

In the event of SO_2-Air cyanide destruction process failure, the potential environmental concerns include the release of high concentrations of cyanide and heavy metal effluent discharge to the TSF, and HCN and SO_2 releases within the ore processing plant. A release of this type would not cause direct environmental effects as the effluent would be released to the TSF and treated until effluent discharge limits are reached. Additional potential effects to the environment would occur should it be coupled with TSF dam failure. In this event, discharge would not meet Provincial Water Quality Objectives (PWQO), which would potentially effecting water quality, fish, and aquatic habitat within the Blackwater Creek watershed, and potentially Wabigoon Lake due to limited dilution characteristics of Blackwater Creek.

If cyanide is transported as liquid to the site, effects of this scenario would typically be limited to the immediate terrestrial environment unless the release occurs during a rainfall event or if in close proximity to a surface water body. Depending on the soil and its hydrological characteristics, a significant release could create a plume in the soil and leach into downstream watercourses resulting in aquatic and riparian effects. Therefore, primary effects would be to the terrain and soil, as well as surface water if the release occurs near a surface water body. Potential secondary effects on aquatic resources, fish and fish habitat and wildlife habitat.

The primary risk is the release of cyanide to the environment due to a vehicular accident during transport. The risk is heightened in areas near water bodies such as river crossings or bridges. Cyanide is toxic to humans, terrestrial, and aquatic life and can also damage equipment due to its flammable and corrosive nature. Due to the nature of the contaminant of concern and the potential for adverse and potentially detrimental effects the spatial boundaries of such an event are variable in nature. Accidents of this type could occur only during the operations phase of the project as limited to no cyanide use or transport is expected in any other phase.

4.3.4.4 Contingency and Emergency Response

The following emergency response and contingency procedures will be followed as outlined below in the event of a worst-case scenario of cyanide release:

- Spill response measures;
- Emergency response plan and associated Standard Operation Procedures; and
- Incident Specific Remediation action plans.

If the unlikely event of a vehicle accident that resulted in a cyanide release, the emergency and spill response plan would be deployed immediately. The incident would be reported to all relevant parties, public and worker safety would be ensured.

In the event of fire, the fire will be permitted to burn out unless the leak can be safely and immediately stopped. HCN gas fires are very resilient, and may not necessarily be put out with regular fire-fighting foam or water spraying.

The HCN gas plume will quickly dissipate once entering the natural environment and no further response/environmental effects will be expected. HCN gas degrades quickly and naturally in the environment due to sunlight and oxidation, and will not have any long-term effects on the environment.

The contingency and emergency response plan for transport related emergencies will ensure the following:

- Best route for access to incident site, including an evaluation of transportation route condition

- Specific remediation measures are implemented and followed including:

    - Recovery and treatment of contaminated soil;

- o Decontamination or management of soil and other contaminated material;
- o Disposal of clean-up debris; and
- o If possibility of contamination to drinking water, appropriate emergency response measures will be enforced to protect drinking water users.

After any major release or accident, an in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures.

Should the SO_2-Air cyanide destruction process fail, the ore processing plant will be shut down and all pumping outputs and inputs to the plant will cease. Body and eye wash stations will also be established at the ore processing plant as a first response measure. Personnel and the ore processing plant area will also be equipped with HCN gas sensors with an alarm system, should gas reach unacceptable ambient levels. All workers will be provided notification and cease all work and be evacuated as per established emergency response procedures. Any gas plume present will be allowed to dissipate to ensure worker safety. Notification to workers downwind of the incident and ore processing plant shutdown may be required in order to secure the area. SO_2-Air cyanide destruction process will remain closed until full operational ability is restored.

4.3.4.5 Follow-up Monitoring

After any major release or accident from cyanide use, transport, storage or handling, an in-depth review will be conducted which may warrant design changes, procedure changes, or need for additional measures.

Compliance monitoring programs (water, soil or air) would be implemented to assess clean-up requirements and disposal of impacted materials, if required.

4.4 Natural Hazards

Natural hazards that could potentially affect the Project include extreme flooding, natural fires, earthquakes, tornadoes and climate change. Additional items identified in the EIS Guidelines as potential natural events (e.g., ice jams, geohazards) are not likely to occur due to the topographical characteristics of the Project. All facets of the Project have been designed, and will be constructed and operated with consideration for local environmental conditions and the potential for extreme natural hazards.

4.4.1 Extreme Floods

Extreme flood events have the potential to cause structural failure of the TSF and flood site facilities particularly the open pit. To protect site infrastructure against the risk of extreme floods, the TSF has been designed to pass extreme flood events without affecting TSF stability, and compromising safety on site.

The design of the TSF embankment heights will include allowances for operating pond levels, containment of the Environmental Design Storm, spillway designed to pass expected flows (in accordance with the Inflow Design Flood [IDF]) and the required freeboard as identified in the CDA Dam Safety Guidelines and the *Lakes and Rivers Improvement Act* Best Management Practices. Water pond levels and embankment heights will be designed for each embankment stage for operational and stormwater management as presented below:

- Maximum Operating Level – Required to contain runoff from average and wet precipitation conditions considering the volume of water being removed from the facility (evaporation and water transferred to treatment and process) while maintaining a water cover.

- Spillway Invert Level – Pond level providing storage capacity between the invert of the spillway and Maximum Operating Water Level to contain the Environmental Design Storm (EDS), currently assigned as the volume of water resulting from the 1:1,000 yr, 24-hr. precipitation event.

- Embankment Height – Sufficient to maintain freeboard above the invert of the spillway for each embankment stage to prevent water from overtopping the dam during the occurrence of the prescribed IDF that will be determined once the dam's Hazard Potential Classification has been established during final design.

Based on proper water management practices that follow the final design requirements, once completed, the TSF should not experience overtopping due to the extreme flooding.

Any water due to an extreme flood event that enters the pit and collection pond system will be pumped out over several days. During this period, the process plant feed would derive from the ore stockpile.

Extreme flood events are not expected to affect the Project except as discussed above, and no resulting environmental effects are expected. This would be similarly true of floods of higher probability, such as the 5-year or 10-year floods, which represent less extreme events.

Treasury Metals, as part of on-going engineering refinements has included a mine dewatering pond, surface water runoff collection ponds and also a perimeter site containment ditch/berm system to provide additional contingency containment of mine contact water to prevent unintended releases to Blackwater Creek. Design of the seepage collection ditch, holding ponds and perimeter site containment system will be advanced to the detailed level of design that will include site investigation data that is planned for completion in the near future. All ditches and ponds will be designed to accommodate the Environmental Design Storm (EDS) for the site and will be submitted for Provincial Approval with Plans and Specifications. All containment or holding ponds, including the TSF, will be designed with contingency containment that will include allowance for the EDS. A comprehensive water balance analysis will be completed as part of detailed design that will be used to assess average, 1:20 year wet and dry precipitation conditions.

The assessment will be used to ensure that all facilities can be operated within the prescribed pond limits.

The following Planning, Design and Construction Strategies will be applied to the Project to minimize the potential effects from extreme flood events on the seepage collection system,

Planning

- Include a site perimeter ditch / berm to provide additional containment and prevent the release of mine contact water to the environment in the unlikely event that the seepage collection ditches are breached. Ditches will be designed to accommodate the Environmental Design Storm (EDS) for the site.

- Use excavated material from the ditch construction to construct a containment berm, on the downstream site of the seepage collection ditch, to provide additional containment during high flows resulting from significant storm events.

- Runoff can be routed to the open pit for containment if the capacity of the seepage collection ditches is exceeded.

- Complete detailed site investigations to collect site data for use in the design of the ditches and also for construction planning.

- Site surveys along ditch alignments to provide accurate field data for use in the design.

- Collect field information on the culvert at Tree Nursery Road.

- Preparation of a site Operations, Maintenance and Surveillance Manual after completion of detailed engineering for use during operations.

Design

- All diches will be designed to accommodate peak flows resulting from the EDS. The EDS will use station data for the area to accurately identify significant storm rainfall events.

- Include freeboard allowances for all ditches.

- Include contingency storage to accommodate the volume of water generated from the EDS in all holding ponds. The EDS allowance will be included in additional to allowances for the operating pond.

- Complete detailed water balance analysis for all containment facilities.

- Include riprap erosion protection to prevent scour and damage to diches.
- Include non-woven geotextile under riprap to aid in prevention of scour.
- Check capacity of culvert on Tree Nursery Road and design upgrade/improvement, as required.

Construction

- Prepare design drawings with technical specifications for use during construction.
- Provide full time construction monitoring during construction to ensure that work is being completed in accordance with the design intent and technical specifications.
- Implement a construction Quality Assurance and Quality Control (QA/QC) program for testing to ensure that construction materials meet the technical specifications.

4.4.2 Natural Fires

Within the Lake Wabigoon Ecoregion (Ecoregion 4S), where the Project is situated, forest fires are part of the natural regeneration cycle of the area. The forest fire cycle within Ecoregion 4S ranges between 50 and 187 years for upland coniferous forest areas. Mixed forest fires cycle ranged between 63 and 210 years.

Primary Project components that are most vulnerable to natural fire include the processing plant, the Project office, and the 115 kV/230 kV power lines running in parallel though the Project site. Fire suppression systems will be constructed to protect key buildings and help ensure the safety of personnel, and that multiple road and highway accesses would be available to evacuate people from site if needed. Should it be determined in the future that additional fire breaks are required, appropriate approvals will be obtained from the MNRF. The transmission line remains the most vulnerable Project component to fire. If the transmission line were to become damage these portions of the line would need to be repaired, operations would cease due to lack of power.

Natural fires have the potential to affect the Project; however, they are not expected to result in an additional an additional environmental effect, such as causing an accident or malfunction.

The risk of damage from natural fires to key infrastructure such as the explosives storage facility, fuel storage facility and process plant is assessed to be low / unlikely if the key mitigation measure of maintaining adequate special separation (fire break) between the facility and natural fire hazard is implemented.

Items such as oils, transformers, fuels or reagents will be stored on-site in adequately designed tanks within diked / bounded areas sized to capture 110% of the largest spill plus one hour of fire suppression water from either fixed fire suppression systems or fire hose streams. Coarse gravels will be used to surround these structures and maintain the clear fire break.

Planning, design and construction mitigation strategies to minimize the potential impacts of environmental effects from natural fires on the explosives facility, bulk fuel storage and process plant areas include:

- Clearing sufficient vegetation surrounding these facilities during construction to create an effective fire break, eliminating any potential impact from natural fire and possible flash over.
- Maintaining these fire breaks during plant operation.
- Ensuring the process plant and mine infrastructure fire suppression system is designed and operated in accordance with the National Fire Code of Canada (NFC), the National Fire Protection Agency (NFPA) codes and relevant FM global design guidelines.
- Fuel storage spills will be contained with ignition sources unlikely. Protection within fuel storage areas will be in line with the requirement of NFPA 30.
- The explosives storage facility construction and storage will be in compliance with the requirements of NFPA 495 Explosives Materials Code.
- The bulk fuel and explosive storage facilities will be classified as hazardous areas with potential ignition sources being designed out of these areas, i.e. only intrinsically safe equipment / instrumentation will be installed, etc.
- Onsite fire suppression equipment will be provided to support trained responders in extinguishing and ensuring exposure protection from natural fires. Site hydrants will ensure that cooling water can be applied if threatened by external fire source.
- Ensuring operations and construction personnel are adequately trained in responding to site natural fires.

The fire water main will be an underground buried HDPE pipe installed at a depth lower than the frost depth. For piping and risers exposed to extreme cold conditions, adequate freeze protection measures such as heat tracing, insulation or stainless steel wrapping will be used.

4.4.3 Earthquakes

The Project is situated within a low risk seismic zone. Accidents and malfunctions relating to earthquakes are presented with Section 4. The TSF dam will be designed to withstand the maximum earthquake in accordance with the latest version (2007) of the Canadian Dam

Association Dam Safety Guidelines, the Ministry of Natural Resources and Forestry Best Management Practices (2011) and the Provincial *Lakes and Rivers Improvement Act*. Further design specifications can be referenced within Appendix D. All TSF construction will be completed under the supervision of a qualified geotechnical engineer. The risk of TSF failure resulting from an earthquake is taken into consideration and is reflected with dam construction plans and design.

Seismic events are not expected to cause Project-related accidents or malfunctions that would result in environmental effects. Additional geohazards such as landslides and avalanches, associated with seismic activities and mountainous environments are not expected to affect the Project due to the topographical characteristics of the site.

4.4.4 Tornadoes

Project components and infrastructure are being designed as per best engineering practices to ensure safe operation. Personnel will be trained to take emergency measures as part of the emergency and spill response plan in the unlikely event that a tornado or other wind event occurs at the Project site. The procedures used as part of the emergency and spill response plan would be used as needed, repair and follow-up inspections would occur to ensure site safety.

Critical plant and mine infrastructure that may be affected by high wind or tornado events are the explosives, reagent and bulk fuel storage facilities. However, these facilities will be designed in accordance with the Ontario Building Code. Therefore, they would not be susceptible to high winds and tornadoes that could otherwise result in damage to the building and possible rupture and spills of the materials they are designed to safely store.

Critical components of the TSF that may be affected by high winds or tornado events consists of the upstream embankment and low-permeable zone as well as the embankment crest.

Wave action resulting from wind can result in erosion of low-permeable fill materials (i.e., clay) or loss of protection zones covering low-permeable engineered liners (i.e. HDPE). This can potentially lead to reduced containment capacity and increased seepage potential for low-permeable fill materials and exposure to potential sun degradation to low-permeable engineered liners. This can impact the environment by potentially having increased seepage potential from the facility of supernatant water.

Wave action can also result in overtopping of the embankments and damage to the embankment crest. The damage to the embankment crest can result in erosion damage that can lead to a loss of containment or instability of embankment. This can impact the environment by having loss of containment of tailings solids or supernatant water. The TSF design basis will address the protection of erodible materials during extreme wave run-up events.

The effects of tornadoes and high-wind events on the water cover during operations will consist of generating waves within the facility. Other effects can potentially consist of increased evaporation rate from the pond. The potential effects on the TSF structure from wave run-up and overtopping.

The perimeter runoff and seepage collection ditch that encompasses the entire TSF will contain any water that overtops the dam crest due to wave run-up. The ditch will be a low-permeability structure to provide effective containment in accordance with the requirements of the MMER and will prevent an effect to the environment. The perimeter runoff and seepage collection ditch is described in Section 3.8.

Water that overtops the spillway due to wave run-up will report to the open pit via the low-permeable swale that is described in Sections 3.7.1 and 3.7.4, and illustrated in Figure 3.0.1A. This TSF water will be consolidated with mine water and pumped to the minewater pond where it will be contained, thereby preventing an effect to the environment as a result of this overtopping. During the operations phase of the Project, while the pit is actively dewatered, there will be a net flow of groundwater into the pit and there is no potential for the TSF water to migrate out of the pit.

There is a risk reduction associated with overtopping from wave run-up that is based on operations of the TSF. Containment for tailings solids, operational and stormwater management is established with the perimeter embankment and the established crest elevation. The elevation of the crest is raised at strategic times over the life of the facility to accommodate the required storage capacity. The tailings surface elevation increases with the tailings deposition and the tailings rate of rise is established based on the design throughput of the plant. The risk of overtopping from wave run-up is significantly reduced during initial periods of tailings deposition for each embankment stage as significant elevation difference is present between the embankment crest level and the tailings beach level. The engineering design for wave run-up to establish the required crest height is based on the highest tailings beach surface for each stage.

For all process plant and mine infrastructure component design, the design wind loads will be determined in accordance with the Ontario Building Code (based on the Canadian National Building Code) Section 4.1.7. The design wind load is calculated by:

- The reference velocity pressure (q) is based on a probability of being exceeded in any one year of 1-in-50, and the reference velocity pressure design factor used for the Project will be specified in the building code for the Dryden site location.

- The ultimate load combination for a limit state design applies a 1.4 factor to the calculated wind load.

- An Importance Factor (Iw) is applied and is 1.0 for Normal Importance Category structures, or 1.15 for High Importance Category structures (i.e., storage facilities containing toxic, explosive or other hazardous substances).

The site wind velocity pressure data is determined from wind load data recordings at nearby weather stations and is reported in the building code.

Plant and mine infrastructure structures will be designed, checked and signed-off by licensed professional engineers (P.Eng.) who are certified and in good standing with Professional Engineers Ontario (PEO).

Items such as oils, transformers, fuels or reagents will be stored on-site within diked / bunded areas sized to capture 110% of the largest spill plus one hour of fire suppression water from either fixed fire suppression systems or fire hose streams.

The TSF detailed design will include suitable freeboard for containment of operational, stormwater and freeboard. Design for freeboard is completed in accordance with the *Lakes and Rivers Improvement Act* for Provincial approval by the Ontario Ministry of Natural Resources and Forestry (MNRF). Freeboard is determined for each embankment stage to ensure that overtopping from wave run-up is prevented. Determination of required freeboard utilizes computations of wind-generate wave height, set-up and run-up that incorporate a selection of reasonable combined occurrences of reservoir level, wind velocity, wind direction and wind duration based on site specific studies.

Planning, design and construction strategies to minimize potential environmental effects from tornadoes and high wind effects on the TSF are summarized below:

Planning

- Include protective covers over low-permeable zones for protection and to prevent erosion.
- Utilize non-woven geotextile in embankment construction to provide additional protection against erosion of protection layers to low-permeable zones.
- Use riprap erosion protection layer on upstream slope of embankment to add additional protection from wave action for the embankment fill that includes the low-permeable zone.
- Apply freeboard to contain wave run-up for each TSF embankment stage to prevent overtopping and protect the crest and dam.

Design

- Protective cover zones for low-permeable zones to properly filter graded and assigned sufficient thickness for protection.

- Non-woven geotextile design to be completed for wave action condition and also properly filter graded to prevent loss of cover material to maintain protection of low-permeable zone.

- Riprap gradation designed to withstand the design wave for the site to prevent embankment erosion

- Freeboard design to be completed in accordance with the LRIA and the MNRF Best Management Practices to prevent wave run-up from overtopping the dam. Minimum freeboard design to be assigned under worst case conditions consisting of maximum tailings beach level. Freeboard allowance to be assigned for each TSF embankment stage.

Construction

- Preparation of Construction Drawings and Technical Specifications sealed by a Professional Engineer in Ontario and submitted for MNRF approval under the LRIA.

- Construction monitoring to be completed by a qualified engineer to ensure that the construction product meets the requirements of the Construction Drawings and Technical Specifications to ensure the dam embankment and protection achieves the design intent.

- Implementation of a Quality Assurance and Quality Control Program (QA/QC) to ensure that the embankment zones and engineered products used for construction meet the requirements of the Construction Drawing and Technical Specifications.

4.4.5 Climate Change

Climate changes over the life of the Project could potentially result in a shift in weather conditions and/or the frequency of extreme weather events. These changes could increase the risk of environmental effects due to accidents and malfunctions. Climate change events would be minor relative to the life of the proposed Goliath Gold Project.

Various climate change assessments have been developed for northern Ontario. These statements predict an increase in temperature, stable to increasing precipitation, more episodic precipitation and an increased risk of natural fires. The primary effect of climate change on the Project is that of the potential variation to the water balance on site through the life of the Project, and a minor extent through the risk of natural fires.

Due to the short nature of the Project and historical and reference documentation, it would therefore appear that the runoff and water regimes of the area are likely to remain close to the current levels. Water balance determinations used to design the Project are unlikely to change during the life of the Project.

In addition to the requirements set out in the EIS Guidelines, guidance for incorporating climate impacts in environmental assessments can also be found in the current Federal guidance document (FPTCCCEA 2003). This guidance describes how the evaluation of climate impacts should do the following:

- Identify the sensitivities of the Project to variations and changes in climate parameters; and
- Review available information on how regional climate change may affect these parameters.

Identify Sensitivities of the Project to Climate Change

Given that the mining activities are planned to have ceased after 13 years, and the closure phase is expected to last two years, the only possible sensitivities of the Project to changing climate in the longer term will be those related to the functioning of the post-closure landscape. The key elements of the post-closure landscape for the Project include the following:

- Open pit mine;
- Underground mine;
- Stockpiles;
- Tailings storage facility (TSF); and
- Site drainage and water structures.

The following sections briefly describe each of the elements of the post-closure landscape, and their potential for susceptibility to longer term changes in climate.

Open Pit Mine

As described in the Section 3.14, by closure the open pit mine will be comprised of three interconnected pits. The west pit and part of the central pit will be backfilled with waste rock from the development of the central and east pits. Following mining, the open pits will be prepared for closure and allowed to flood. The operations area will be graded to direct all runoff into the open pit. A passive spillway will be constructed to allow the pit lake to eventually discharge into an existing ephemeral tributary of Blackwater Creek. The elevation of the spillway will be set to ensure the lake level is maintained within the overburden above the backfilled waste and bedrock. This will ensure that the waste rock and pit walls remain underwater during the post-closure phase. As both the pit walls and waste rock are currently classified as potentially acid generating (PAG), placing them under a water cover is a standard practice to prevent acid rock drainage /

metal leaching (ARD/ML). The open pit mine closure is intended to leave a functioning aquatic ecosystem while providing secure storage of waste rock underwater.

The water flooding the pit is expected to come from three sources: surface water runoff from the operations area, treated tailings water present in the TSF at closure, and groundwater inflow. The flooding of the open pit is projected to take between 6 and 9 years, depending on climatic conditions.

Changes in climate in the longer term have the potential to affect the open pit mine after operations cease in the following manners:

- Changes in precipitation rates could affect the rate at which the open pit mine is flooded; and

- Changes in the long-term annual water budgets (i.e., precipitation less evapotranspiration) could affect the long-term water levels in the open pits.

Underground Mine

As described in Section 3.14, once mining operations cease infrastructure and equipment will be removed from the underground mine, and any spills or waste will be cleaned up and removed. The upper ramp and portal will be sealed using clean, quarried rock backfill, and the area around the portal will then be backfilled, covered with soil, and vegetated. The ventilation raises will be sealed to prevent inadvertent access to the underground mine workings by humans and wildlife. The underground workings will then be allowed to flood, with groundwater levels eventually returning to near pre-development levels.

Changes in climate in the longer term have the potential to affect the underground mine following closure in the following manner:

- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate at which the underground mine floods.

Stockpiles

The three main stockpiles are the waste rock storage area (WSRA), the overburden stockpile and the low-grade ore (LGO) stockpile. The waste rock has been classified as PAG, therefore, the closure and reclamation WSRA will include full encapsulation with a water-shedding cap that is tied into the up-gradient clay layer, as well as placement of soil and vegetation over the cap and disturbed areas. The waste rock storage area (WRSA) will be graded to allow runoff to shed from the surface to runoff collection ditches that will be realigned to direct runoff into the open pits. At closure the material in the overburden stockpile will be used as cover material for the TSF closure as well as other reclamation activities requiring fill. Any material remaining in the overburden stockpile will be graded and vegetated. Finally, the LGO stockpile is expected to be depleted by the end of the underground mining operations. Any residual ore or PAG material on the LGO stockpile pad will be removed and placed in the TSF at closure, and the LGO stockpile pad will then be scarified and re-vegetated.

It is not expected that any longer-term changes in climate will have a potential effect on the stockpile areas following closure.

Tailings Storage Facility (TSF)

At closure the water will be withdrawn from the TSF, treated and used to help fill the open pit. The tailings would then be covered with a granular layer to physically isolate the tailings. Finally, the TSF will be covered with either a low-permeability cover or a water cover of non-process water to isolate the tailings from oxygen. It is not expected that longer-term changes in climate will potentially effect on the TSF following closure.

Groundwater

During the life of mining activities, dewatering is required in order to safely mine in the open pits and underground mine. At closure, the groundwater drawdown will be at the maximum extent. Once all mining has ceased the underground works will be allowed to flood, with the groundwater elevations eventually returning to pre-development levels (EIS, Section 11.4.3). It is anticipated the drawdown effects will be fully reversed in 20 to 30 years.

Changes in climate in the longer term have the potential to affect groundwater following closure in the following manner:

- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate of infiltration and the rate at which the underground mine floods, affecting the time to fully reverse drawdown effects.

Site Drainage and Water Structures

The pre-development headwater wetland of beaver ponds at the open pit site will be replaced by the pit lake. As described in Section 3.14, the operations area will be graded to drain towards the open pit as part of the closure activities. A passive spillway will be constructed to allow excess water from the open pit to drain to the former channel of Blackwater Creek Tributary 1. In general, the Project site post-closure is expected to experience an increase the amount of runoff as a result of hardening or surfaces. Anticipated flow increases are within the capacity of the existing creek channels.

Changes in climate in the longer-term have the potential to affect the site drainage and water structures following closure in the following manners:

- Changes in precipitation rates and intensities could increase peak flows beyond the capacities of the existing creek channels in Blackwater Creek (but this would also occur in the region irrespective of the Project).

Projections of Regional Changes in Climate

Although there are a multitude of sources available that describe the projections for future changes in climate in northwestern Ontario, Treasury Metals has tried to focus on those documents compiled by, or for the Ontario government. The two most heavily relied references were the climate change research reports CCRR-05 (Columbo et al, 2007) and CCRA-44 (McDermid et al, 2015).

The earlier policymaker summary report (Columbo et al, 2007) made use of data from the Canadian Coupled Global Climate Model (CGCM2) forecasts for emission scenarios presented in the Fourth Assessment Report (AR4) from the Intergovernmental Panel for Climate Change (IPCC, 2007). Specifically, Columbo et al (2007) presented the climate projections associated with the A2 emission scenarios, which is one of the four socio-economic scenarios relied on in AR4 (IPCC, 2007). Although the IPCC has not stated which of these scenarios are most likely to occur, the A2 scenario most closely reflects the current global socio-economic situation. In relation to the A2 scenario, scenarios A1, B1 and B2 result in lower long-term GHG emissions over the next century. Climate projections are presented as changes from the 1971 to 2000 baseline period, and are provided for the 2011 to 2040, 2041 to 2070, and 2071 to 2100 time horizons. These projections were used to compile the projected changes in summer and winter temperature and precipitation for the region near the Project.

Generally, the picture presented for future climate in the area is one of increasing temperatures in both the winter and summer periods for all of the forecast horizons. For precipitation, the summer rates are projected to increase for the 2011 to 2040 horizon, changing to a decrease for the 2041 to 2070 and 2071 to 2100 horizons. During the winter, future precipitation is projected to decrease for the 2011 to 2040 and 2041 to 2070 time horizons, but increasing the 2071 to 2100 time horizon. The results Columbo et al., 2007) presented in Table 4.4.5-1 suggest that the future climate for the region will continue to warm, with precipitation decreasing slightly except in the later stages of the century.

Table 4.4.5-1: Projections for Changes in Climate (relative to 1971 to 2000)

Period	Temperature		Precip[itation	
	Summer	Winter	Summer	Winter
2011 to 2040	+1 to +2°C	+1 to +2°C	0% to +10%	-10% to 0%
2041 to 2070	+2 to +3°C	+3 to +4°C	-10% to 0%	-10% to +10%
2071 to 2100	+4 to +5°C	+5 to +6°C	-10% to 0%	0% to +20%

Note: Data derived from Coumbo et al, 2007.

In the updated summary for policymakers (McDermid et al, 2015), use was made of data from the Fifth Assessment Report (AR5) from the IPCC (2013), which replaces the socio-economic emission scenarios relied on in AR4 (IPCC, 2007) with new emission scenarios, but uses four new emission scenarios that better represent climate processes used in the modelling. The updated summary considered the RCP 2.6, RCP 4.5, and RCP 8.5 emission scenarios, and shows the 2011 to 2040, 2041 to 2070, and 2071 to 2100 time horizons. The updated summary also relies on statistically downscaled data from Earth Systems Models rather than data from a single GCM. The data relied on by McDermid et al are described more fully by McKenney et al (2006; 2011; 2013). The results are presented numerically for the three major watersheds in Ontario (i.e., Great Lakes, Hudson Bay, and Nelson River), the most relevant one for this project being the Nelson River watershed.

The updated picture for future climate in the region (McDermid et al, 2015) is one of warming annual, summer and winter temperatures for all of the emission scenarios and forecast horizons. The annual and winter precipitation projections show increasing precipitation for all of the emission scenarios and forecast horizons. In contrast, the projections for summer precipitation show decreases for all of the emission scenarios and forecast horizons (Table 4.4.5-2).

Table 4.4.5-2: Projections for Mean Changes in Climate (relative to 1971 to 2000)

Period	Scenario	Temperatures (°C)			Precipitation (mm)		
		Annual	Summer	Winter	Annual	Summer	Winter
2011 to 2040	RPC 2.6	+2.3	+2.2	+2.3	+18.1	-18.6	+21.7
	RPC 4.5	+2.2	+2.1	+2.1	+28.7	-19.1	+19.4
	RPC 8.5	+2.4	+2.3	+2.7	+32.8	-20.8	+18.8
2041 to 2070	RPC 2.6	+3.0	+2.7	+3.2	+51.8	-7.4	+24.0
	RPC 4.5	+4.0	+3.4	+4.7	+37.5	-19.8	+21.6
	RPC 8.5	+4.8	+4.6	+5.6	+54.3	-27.7	+30.6
2071 to 2100	RPC 2.6	+3.1	+2.9	+3.6	+57.5	-2.9	+21.9
	RPC 4.5	+5.0	+4.4	+5.6	+40.6	-24.1	+30.6
	RPC 8.5	+8.3	+7.8	+9.3	+64.0	-43.6	+39.7

Note: Data derived from McDermid et al, 2015

Implications for Regional Changes Climate Projections for the Project

The primary susceptibilities of the Project to climate change were identified to be the following:

- Changes in precipitation rates could affect the rate at which the open pit mine is filled;
- Changes in the long-term annual water budgets (i.e., precipitation less evapotranspiration) could affect the water levels in the open pits.
- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate at which the underground mine floods;

- Long-term changes in precipitation and annual water budgets (i.e., precipitation less evapotranspiration) could affect the rate of infiltration and the time to fully reverse drawdown effects from dewatering; and

- Changes in precipitation rates and intensities could increase peak flows beyond the capacities of the existing creek channels in Blackwater Creek.

The filling of the open pit mine is predicted to take a period of nine years after the mining operations cease, which would fall within the 2011–2040 forecast horizon. Moderate increases in temperatures and increasing annual and winter precipitation for this period would suggest that climate change would not significantly alter the rate at which the open pit mine is filled. In addition, the filling of the open pit will not rely on precipitation and surface runoff only (EIS, Table 11.2.1), but will also rely on secondary treatment discharge and groundwater from wells outside of the mine zone of influence.

The longer-term site water budget will be affected by projections of increasing temperatures and annual precipitation rates over the remainder of century. This suggests that water levels will remain sufficient in the open pit mine to maintain a water cover for both the pit walls and waste rock, which are currently classified as PAG. The post-closure water level is anticipated to be above the overburden / bedrock interphase.

With respect to the underground mine, once the dewatering of the mine stops, it is expected to take between 20 to 30 years for the groundwater levels to recover to near pre-development levels. However, the underground workings are expected to fill more quickly as they will be influenced by the filling of the open pit. This would extend into the 2041 to 2070, or even the 2071 to 2100 forecast horizons. The longer-term water budgets that could influence the rates of infiltration into the underground workings will be affected by projections of increasing temperatures and annual precipitation rates over the remainder of century.

Finally, the precipitation rates for the region are projected to steadily increase through the remainder of the century. Although the model projections do not indicate whether intensities will increase, increasing precipitation is likely to increase the downstream peak flows in Blackwater Creek. To mitigate this, surface water collection ponds, diversion ditches, and seepage ponds can be converted into retention ponds (Section 3.8). This will reduce the potential effects of peak flows by slowing down the release to natural watercourses.

In conclusion, the possible Project susceptibilities to climate change were identified, and evaluated considering the projections for future changes in climate for the region. Generally, the relatively short life of the Project (17 years from site preparation through post-closure) means that climate change will be a minor concern for all aspects except those related to the post-closure landscape. Specifically, changes in the longer-term water balances could affects the effectiveness of the closed site. Projections of future climate for the region suggest steady increases in precipitation and temperature over the remainder of the century. As a result, it is expected the closed site will continue to function as proposed in the EIS. There could, however, be changes in the time required to flood the underground workings of the mine, and fully reverse the effects of dewatering on groundwater, with these possibly occurring slightly faster or slower than predicted in the EIS. In either case, there would not be a change to the conclusions reached in the EIS.

4.5 Conclusions

Accidents and malfunctions were identified using an FMEA process. The FMEA is a risk analysis procedure used to identify and characterize accidents and malfunctions based on the likelihood of occurring and the severity/magnitude of the failure. Through the FMEA process, a total of 463 failure modes were identified and analyzed within the environment, safety and health, and reputation impact categories.

Once all risks were identified, Treasury focused on the potential effects of accidents and malfunctions identified in the environment impact category. The environment impact category had a total of 137 failure modes; 123 of these failure modes are considered low-risk and 14 are considered medium-risk. There were no high-risk failure modes identified during the FMEA process as shown on the risk matrix.

The medium risks identified within the environment category were selected for analysis and were placed into broader failure modes for further assessment. There were three categories of failure modes considered for further environmental assessment: failure of the TSF, releases to land and water, and cyanide releases to land, water, and air. Potential primary environmental effects of the three categories of failure modes were generally to the terrain and soil and surface water. Potential secondary effects were generally determined to be to aquatic resources, groundwater, fish and fish habitat, and wildlife habitat.

As per the EIS guidelines, preventative procedures were identified to minimize impacts to the identified VCs, as well as contingency/emergency response procedures and follow-up monitoring for each failure mode.

Overall, the residual effects of the failure modes on the environment were determined to be not significant if all preventative procedures are adhered to throughout all phases of the Project.