# Section 17 Risk Management

## 17.1 Risk Assessment Approach

This environmental impact assessment emphasised the identification, analysis and treatment of risks through the whole project risk analysis. The detailed risk analysis followed an initial assessment of mine planning alternatives and the selection of the best practicable approach. This enabled the integration of economic and environmental goals using a precautionary approach to risk and irreversibility.

Through this process a through range of risks presented by the proposed action (including those of concern to the public) were acknowledged and discussed. The risks were quantified and ranked so that the reasons for the proposed management responses were made clear. Uncertainties in the risk assessment, and the community members expected to bear any residual risk, are explicit in the assessment process.

The analysis of alternatives sets a reasonable context within which risks must be managed. The risks are subsequently identified, analysed and evaluated. Risk management responses are cross referenced to section 18 where appropriate.

## 17.2 Analysis of alternatives

### 17.2.1 Best practice assessment method

Alternative proposals were considered and either accepted or rejected using a best practice technology (BPT) approach based on that applied by the Commonwealth Department of Environment and Water Resources within the National Strategy for Ecologically Sustainable Development (NSESD). The goal was to ensure the protection of the environment through the application of relevant technologies, within a strategic environmental management system. The NSESD principles are:

- integrating economic and environmental goals in policies and activities;
- ensuring that environmental assets are properly valued;
- providing for equity within and between generations;
- dealing cautiously with risk and irreversibility; and
- recognising the global dimension.

The option that reasonably achieves the maximum environmental benefit should also be the option that achieves the most efficient allocation of environmental protection resources. That is, the environmental benefit derived from the resources applied to environmental protection should be maximised.

To identify the option that maximises environmental benefit, an assessment is made against the following six criteria:

1. best practice – in this case, the environmental standards achieved by gold mining operations elsewhere in Australia with respect to (i) level of effluent control achieved; and (ii) the extent to which environmental degradation is prevented;
2. potential water management impacts - in particular on Katherine's water supply;
3. cost-effectiveness – the level of environmental protection to be achieved by the technology and resources applied, compared with the costs of implementation;

4. proven effectiveness – proposals supported by previous practical evidence should be favoured over proposals for which there is only experimental or theoretical evidence;
5. age of equipment – the age of any equipment or facility employed may affect its integrity and contribute to a higher environmental risk, thus technology in use should be reviewed periodically to determine whether or not recent advances have been made that would result in enhanced environmental protection;
6. social factors – consideration of the views of the regional community where the introduction of new technology would improve the level of environmental protection, but may also have negative social consequences.

### 17.2.2 Application to the project

According to the EIS Guidelines (Appendix A), the primary environmental objectives at the Maud Creek mine site, are:

- protection of Katherine town water supply;
- protection of Maud Creek and the Katherine River; and
- protection of Nitmiluk National Park.

Consequently, the size of the environmental footprint of the project and risks to human health and facilities were key considerations in the options analysis. The components of the project that are analysed using BPT include:

a) mine planning, processing & transport options;

b) water management options; and

c) decommissioning options.

Options for each component were assessed against the criteria described in Section 17.1.1 above, and a three-scale performance ranking (where a score of 1 is “poor”; 2 is “fair”; and 3 is “good”) was applied. By adding the scores from all the criteria used in the assessment, a total performance ranking was derived and a “preferred” option selected. The BPT assessments for the three main components of the Maud Creek project are tabulated and discussed below.

#### *Mine planning and transport corridor options*

The BTP assessment of mine planning and transport options is presented in Table 17-1.

As shown, the option for Underground mine with off-site processing is preferred for mining and processing. This option significantly reduces the mine footprint and places potentially contaminating processing activities outside the Katherine water supply catchment.

However, this option results in increased risk associated with haulage of ore to the processing facility at URGM. Two haulage route options via the Stuart Highway are also presented in Table 17-1. Option 1, the development of a new road alignment for connection to the highway, reduces the risk associated with combining mine vehicles with public traffic, and avoids the need for a Gold Creek road crossing.

Analysis of options for workforce accommodation is not explicitly addressed in Table 17-1. Off site workforce accommodation has clear environmental and socio-economic advantages over on site accommodation.

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**Table 17-1 Best practice technology assessment of mining, processing and transport options**

| Best Practice | Water Management | Cost Effectiveness | Proven Effectiveness | Age of Equipment | Social Effectiveness | Total Ranking (/15) |
|---|---|---|---|---|---|---|
| **MINING & PROCESSING OPTIONS** | | | | | | |
| A) Not proceeding with project | | | | | | |
| 2 – some existing environmental issues at site would not be addressed | 2 – neutral, no net impact, existing poor conditions will remain | 2 – neutral, no net commercial benefit | 2 – neutral, no net benefit or detriment | 2 – no net effect | 1 – loss of potential social benefits in employment, training and services | 11 |
| B) Open cut mine + on site processing | | | | | | |
| 1 – significant environmental footprint | 1 – significant potential impact in a water supply catchment | 2 – lower cost of production, potentially more expensive in terms of closure, expenses in infrastructure upgrades | 3 – well established mining technology | 3 – new equipment | 3 – significant employment opportunity | 13 |
| C) Underground mine + off site processing | | | | | | |
| 3 – reduced environmental footprint | 2 – neutral, no net impact | 1 – more expensive mining technology, savings in closure, expenses in infrastructure upgrades | 3 – proven mining methods | 3 – new equipment | 2 – significant employment opportunity, added transport risks | 14 |
| **TRANSPORT OPTIONS** | | | | | | |
| **A) New haul road across Maud Creek Station** | | | | | | |
| 2 – clearing associated with new alignment | 3 – avoids need for Gold Creek road crossing | 3 – cost effective | 3 – proven effectiveness | 3 – new road | 3 – separates mine traffic from public traffic | 17 |
| B) Existing access track and Ross Road, with a crossing over Gold Creek for all weather haulage | | | | | | |
| 3 – uses existing alignment | 1 – Gold Creek road crossing required | 3 – cost effective | 3 – proven approach | 3 – upgraded road | 2 – does not separate mine traffic from public traffic | 15 |

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### *Water management options*

Owing to the importance attributed in the EIS guidelines to protecting Maud Creek and the Katherine River, a BPT assessment of water management options was undertaken. Five water management options were assessed, namely:

A. direct discharge into local waterways;

B. dry season irrigation of new pasture area on clay plain at 10 mm/day, and wet season storage in the mine water dam;

C. dry season irrigation of old pasture area on deep sandy loam at 10 mm/day, and wet season storage in the mine water dam;

D. year round irrigation of old pasture area on deep sandy loam at 10 mm/day, and emergency storage only in a small mine water dam; and

E. irrigation of old pasture on deep sandy loam at 10 mm/day dry season and 5 mm/day wet season, and reduced wet season storage in the mine water dam.

The analysis is presented in Table 17-2.

Option E (Table 17-2) of year-round irrigation with reduced storage in the mine water dam is preferred. This option reduces the footprint of the mine water dam, while the 10 mm/day dry season irrigation rate is sustainable and consistent with agricultural irrigation practices in the Katherine district. This rate is unlikely to lead to water table rise or drainage discharge through the surface (Appendix D). This option applies a lower irrigation rate (5 mm per day) in the wet season to account for the number of rain days when there would be no irrigation.

Option D (Table 17-2) of irrigating year-round at the dry season rate of 10 mm/day would reduce the mine water dam to less than 1 hectare, sufficient only for emergency storage during high rainfall years. This is an attractive option as it reduces reliance on an engineered mine water dam in a municipal water supply catchment and increases reliance on an irrigation system, which could be expanded to increase capacity if this were needed. However, a precautionary approach with a reduced wet season application rate is warranted at this stage.

### *Mine closure options*

The mine water management options that were considered in Table 17-2 have a significant effect on the size of the mine water dam and hence the management of this facility at closure. The closure treatment of the other mine infrastructure described in Section 3 is not expected to pose as significant an environmental risk, i.e. waste rock will be placed inside the pit and cleared areas will be rehabilitated.

The BTP assessment of closure options for the mine water dam is presented in Table 17-3. The three options considered are:

1. leave the mine water dam intact;
2. breach the walls of the mine water dam and drain; and
3. remove walls of the mine water dam, and contour.

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As shown in Table 17-3, option C for remove walls of the mine water dam is preferred. Limiting the extent of potential mosquito breeding habitat was the main factor in selecting this option. Leaving the walls intact or breaching the walls of the mine water dam would create additional wetland habitat for biting insects.

**Table 17-2 Best practice technology assessment of water management options at Maud Creek**

| Best Practice | Cost Effectiveness | Proven Effectiveness | Age of Equipment | Social Effectiveness | Total Ranking (/15) |
|---|---|---|---|---|---|
| A) Direct discharge into local waterways | | | | | |
| 1 – no mine water dam reduced environmental footprint, however stream flow rates and water quality may impact on the receiving environment | 3 – low cost | 1 – no effective control over stream water quality during the dry season | 3 – new equipment | 1 – socially unacceptable in Katherine water supply catchment | 9 |
| B) Dry season irrigated new pasture on clay plain @ 10 mm/day + wet season storage in the mine water dam | | | | | |
| 2 – requires clearing of native woodland and pasture development | 2 – significant infrastructure costs | 2 – high risk of runoff from clay soils | 3 – new equipment | 3 – acceptable zero discharge objective | 12 |
| C) Dry season irrigated old pasture on deep sandy loam @ 10 mm/day + wet season storage in the mine water dam | | | | | |
| 2 – no clearing required, but large mine water dam footprint | 2 – significant infrastructure costs | 3 – proven technology on this soil type | 3 – new equipment | 3 – acceptable zero discharge objective | 13 |
| D) Year round irrigated old pasture on deep sandy loam @ 10 mm/day + emergency storage in the mine water dam | | | | | |
| 2.5 – no clearing required, small mine water dam footprint, enhanced groundwater recharge | 2.5 – reduced infrastructure cost associated with smaller dam | 2.5– need to investigate impacts on groundwater of 10 mm/day application during wet season | 3 – new equipment | 3 – acceptable zero discharge objective, more reliance placed on the capacity of the irrigated disposal system | 13.5 |
| **E) Dry season @ 10 mm/day & wet season 5 mm/day irrigated old pasture on deep sandy loam + reduced wet season storage in the mine water dam** | | | | | |
| **2.5 – no clearing, small mine water dam footprint, reduced groundwater recharge** | **2.5 – reduced infrastructure cost associated with smaller dam** | **3 – proven technology on a known soil type** | **3 – new equipment** | **3 – acceptable zero discharge objective, more reliance placed on the capacity of the irrigated disposal system** | **14** |

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The mine water dam will only remain full throughout the year if water is pumped into it during the dry season. The preferred option could be reconsidered in stakeholder consultations during the operating life of the mine. In the event that plans are developed to actively manage the dam after closure, the preferred option may change.

**Table 17-3 Best practice technology assessment of mine closure options at Maud Creek.**

| Best Practice | Cost Effectiveness | Proven Effectiveness | Age of Equipment | Social Effectiveness | Total Ranking (/15) |
|---|---|---|---|---|---|
| A) Leave the mine water dam intact | | | | | |
| 1 – the dam would be seasonally wet and provide mosquito habitat | 2 – cost associated with environmental metals testing of sediment and water | 1 – risk of wall failure and uncontrolled discharge | 2 – aging of structure and potential for failure | 2 – possible water storage for the land manager, but broader stakeholder concerns of risk of containment failure and mosquito habitat | 8 |
| B) Breach the walls of the mine water dam and drain | | | | | |
| 1 – areas within the dam area may the borrow for the dam walls would be seasonally wet and provide mosquito habitat | 2 – small earthmoving cost and environmental metals testing of sediment and water | 2 – effective control of risks to water quality, however no control over mosquito habitat | 3 – no longer fit for purpose as a dam | 2 – removed containment wall failure risk, no useful water storage for land manager, broader stakeholder concerns related to mosquito habitat | 10 |
| **C) Remove walls of the mine water dam, and contour** | | | | | |
| **3 – no change to pre-mining mosquito breeding habitat** | **1 – more significant earthmoving cost and environmental metals testing of sediment** | **3 – no issues with environmental performance** | **3 – no issues with an aging engineered structure** | **2 – likely to be more acceptable to community, but and less acceptable to land manager** | **12** |

## 17.3 Risk Analysis

Risks associated with the preferred options identified in the preceding BPT assessment were ranked to prioritise the way that resources are allocated in the environmental management program. The risk analysis addressed the EIS guidelines (Appendix A) and included impacts on human health and facilities; hydrology/hydrogeology; regional socio-economics; landform and erosion; ecology and biodiversity; air quality and noise; cultural environment; greenhouse gas emissions and biting insects.

### 17.3.1 Risk assessment method

As a first step, the environmental impacts and receptors that were identified in the EIS guidelines (Appendix A) and assessed during the course of this EIS were mapped against components of the Maud Creek mining project to produce an environmental impact matrix (Table 17-4). This matrix provided the issues framework for the risk assessment that follows. Subsequently, the risks of environmental impacts from the proposed Maud Creek project were qualitatively assessed according to the Australian Risk Management Standard (AS/NZS 4360:2004).

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AS/NZS 4360:2004 addresses environmental risk in terms of likelihood and the consequence and uses a four class system to assess severity. Risk severity is assumed to be a multiple of likelihood and consequence rankings and different levels of management response are linked to the risk severity assessment with the aim of reducing the residual risk to a low level. Terra Gold has adopted this standard to assess the environmental risks and corresponding environmental management requirements for the proposed operations.

Classifications of consequence (Table 17-5) and likelihood (Table 17-6) were applied to each potential environmental impact. The likelihood and consequence values for each impact were multiplied and the product used to rank residual risks as low, moderate, significant or high (Table 17-7) to prioritise environmental management responses.

The assessment of the consequence and likelihood for each impact type relied on the expert judgement of the assessment team, namely:

- George Jenkins, Project Manager GBS;
- Sven Sewell, Environment Manager GBS;
- Vic Farrington, Senior Principal Environmental Engineer, URS;
- Chris MacHunter, Principal Hydrogeologist, URS;
- Andrew Piggin, Principal Civil Engineer, URS; and
- Carrie Doncon, Senior Environmental Scientist, URS.

Assessors reviewed environmental impacts identified in the impact assessment process and evaluated the existing Terra Gold Environmental Management System (which is based on the EMS of the parent company, GBS), development and operational plans to determine whether residual risk was acceptable.

## 17.3.2 Risk assessment summary

The summary of the risk assessment associated with particular construction, operation and closure activities are presented in Table 17-8. Impacts with a risk ranking of 5 or more in Table 17-8 (shown shaded) were considered moderate to high risks to the environment, employee and community safety, social/ socio-economic factors and business viability. Subsequently, management system and planning measures are proposed in section 18 and section 19 of this report to reduce the resulting environmental risks to a low level.

While issues with a score of less than 5 were considered a low risk to the environment and able to be managed using standard operating procedures, further consideration in the project design will be given to potential mitigation measures, based on the precautionary approach.

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**Table 17-4 Environmental impact matrix (numbers refer to receptor)**

| Project Component | Receptor | | | | | | | | Type of Impact | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. Human health & facilities | 2. Surface water | 3. Groundwater | 4. Mosquito habitat | 5. Ecology & biodiversity | 6. Nitmiluk N.P. | 7. Air quality & noise | 8. Cultural values | Acid rock drainage | Socio-economic | Water quality | Habitat destruction | Waste/contamination | Greenhouse emissions | Biting insects | Tailings | Traffic & transport | Pest animals & plants | Dust | Blast noise | Hydrocarbons |
| **Mine development** | | | | | | | | | | | | | | | | | | | | | |
| *Clearing & earthmoving* | 1 | 2 | | 4 | 5 | | 7 | | | | 2 | 5 | | 7 | 4 | | | 5 | 1 | | |
| *Road construction* | 1 | 2 | | | 5 | | | 8 | | 8 | | 5 | | | | | 1 | | | | |
| *Power line construction* | | 2 | | | 5 | | | | | | 2 | 5 | | | | | | 5 | | | |
| *Waste rock stockpile & pit* | | 2 | | 4 | | | | | 2 | | | | | | | | | | | | |
| *Mine dewatering* | | | 3 | | 5 | | | | 3 | | 3 | 5 | | | | | | | | | |
| *Mine water dam* | | 2 | | | | | | | | | | 2 | | | | | | | | | |
| *Decline construction* | 1 | 2 | | | | | | | | | | | | | | | | | 1 | 1 | 2 |
| *Irrigated water disposal* | | 2 | 3 | 4 | | | | | | | 2 | | 3 | | 2 | | | | | | |
| *Administration Buildings* | 1 | | | | | | 7 | | | | | | 1 | 7 | | | 1 | | | 1 | |
| *Stakeholder community* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 2 | 8 | 2 | 5 | 3 | 7 | 4 | 2 | 1 | 5 | 5 | 1 | 2 |
| **Mine operation** | | | | | | | | | | | | | | | | | | | | | |
| *Underground mining* | 1 | | 3 | | | | 7 | | | | | | 3 | 7 | | | | | | 2 | 3 |
| *Stockpiling & truck loading* | 1 | 2 | | | | | 7 | | | | | | | | | | 7 | | 1 | | 2 |
| *Haulage to URGM* | 1 | 2 | | | | | 7 | | | | 2 | | | 7 | | | 7 | | 7 | | 2 |
| *Mine dewatering* | | 2 | 3 | | 5 | | | | 3 | | | | 3 | | | | | | | | |
| *Mine water dam* | 1 | 2 | | | | | | | | | | | | | 1 | | | | | | |
| *Irrigated water disposal* | 1 | | 3 | 4 | | | | | | | 3 | | 1 | | 4 | | | | | | |
| *URGM in pit disposal* | | | 3 | | | | | | | | 3 | | | | | | | | | | |
| *Water management bund* | 1 | | | 4 | | | | | | | | | | | 1 | | | | | | |
| *Administration buildings* | 1 | | | | 5 | | 7 | | | | | | 1 | 7 | 1 | | 1 | 5 | | | |
| *Stakeholder Community* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 2 | 1 | 2 | 5 | 3 | 7 | 4 | 2 | 1 | 5 | 5 | 1 | 2 |
| Extreme Events | 1 | 2 | | | | | | | | 1 | 2 | | | | | | | | | | |
| **Mine closure** | | | | | | | | | | | | | | | | | | | | | |
| *Underground mine* | | | 3 | | | | | | 3 | | 2 | | 3 | | | | | | | | |
| *Operational area* | 1 | 2 | | 4 | 5 | | | | | | 2 | | 1 | | 4 | | | 5 | | | |
| *Land application area* | 1 | | 3 | | 5 | | | | | | 3 | | 1 | | 4 | | | 5 | | | |
| *Mine water dam* | 1 | 2 | | 4 | 5 | | | | | | 2 | | 2 | | 4 | | | 5 | | | |
| *Waste rock stockpile* | 1 | 2 | 3 | 4 | 5 | | | | 3 | | 2 | | 1 | | 4 | | | 5 | | | |
| *Open pit* | 1 | 2 | | 4 | | | | | | | 2 | | | | 4 | | | | | | |
| *Revegetation* | | 2 | | | 5 | | | | | | 2 | | | | | | | 5 | | | |
| *Removal of facilities* | 1 | | | | | | | | | 1 | | | 1 | | | | | | | | |
| *Stakeholder Community* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 2 | 1 | 2 | 5 | 3 | 7 | 4 | 2 | 1 | 5 | 5 | 1 | 2 |

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**Table 17-5 Consequence ratings**

| Level | Descriptor | Example Detail Description | | | | |
|---|---|---|---|---|---|---|
| | | Safety | Cultural | Socio-economic | Business | Environment |
| 1 | Insignificant | Minor injury, requiring first aid only | None to minimal impact on Indigenous or Historical heritage sites or values. | None to minimal reported complaints about Project. No socio-economic impacts. | <$10,000 | An incident that is contained within controls and/or an incident that is too minor to cause a measurable impact. |
| 2 | Minor | Medical attention required | Minor impact on Indigenous or Historical heritage sites or values (e.g. restricted access to recreation areas). | Some inconvenience to stakeholders, minimal adverse impact on socio-economic environment, and some intervention required. | $10,000 to < $100,000 | An incident that causes localised low level damage that is controlled and remedied with minimal resources. |
| 3 | Moderate | Disability/Lost Time Incident (LTI) | Moderate impact on Indigenous or Historical heritage sites, which can be managed under normal procedures. Some negative media coverage could be expected. | Moderate disruption or inconvenience to stakeholders. Require careful management to restore trust. | $100,000 to < $500,000 | An incident that causes widespread temporary damage that requires extended resources to remedy resulting in full recovery. |
| 4 | Major | Permanent Disability / Fatality | Major disturbances to 1 or 2 significant Indigenous or Historical heritage sites or values. Major breach of statutory obligation, access to resource denied in the medium to long-term. | Significant adverse impacts to sectors of the community and stakeholders. Long-term social disruption, diminished quality of life of large or specific sectors of the community. | $500,000 to < $1M | An incident that causes substantial long-term effect with significant resources to control resulting in minor permanent damage. |
| 5 | Catastrophic | Multiple Fatalities | Major disturbances to a number (3 or more) of significant Indigenous or Historical heritage sites or values. Major breach of statutory obligation, access to resource permanently denied. | Irreversible damage to the socio-economic environment. Potential for civil commotion or riot and major damage to Terra Gold's property. | $1M or more | An incident that causes substantial permanent damage to widespread and sensitive areas. May result in prosecution. |

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**Table 17-6 Likelihood ratings**

| Level | Measure | Description | Guide |
|---|---|---|---|
| A | Almost certain | Issue will or almost certainly will occur, is currently a problem or is expected to occur in most circumstances. | Weekly |
| B | Likely to occur | Issue has been a common problem in the past and there is a high probability it will occur in most circumstances. | Once per month |
| C | Moderate | Issue may have arisen in the past and there is a high probability that it should occur at some time. | Once per year |
| D | Unlikely | Issue may have occurred in the past, and there is a moderate probability that it could occur at some time. | Once per 10 years |
| E | Rare | Issue has not occurred in the past, and there is a low probability that it may occur in exceptional circumstances. | Once per 100 years |

**Table 17-7 Risk Matrix**

| | CONSEQUENCE | | | | |
|---|---|---|---|---|---|
| **LIKELIHOOD** | **1 Insignificant** | **2 Minor** | **3 Moderate** | **4 Major** | **5 Critical** |
| **A. Almost certain** | M | S | H | H | H |
| **B. Likely to Occur** | M | M | S | H | H |
| **C. Moderate** | L | M | S | S | H |
| **D. Unlikely** | L | L | M | S | S |
| **E. Rare** | L | L | M | M | S |

Risk Definitions (AS/NZS 4360:1999):

| | |
|---|---|
| High (H) | Detailed research and management planning required at senior levels. Immediate action required |
| Significant (S) | Senior management attention needed |
| Moderate (M) | Management responsibility and integration into management plans required |
| Low (L) | Manage by routine procedures. |

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**17-8 Maud Creek mine project risk assessment summary**

| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| **Mine Development** | | | | | |
| Clearing and earthmoving | • Vegetation loss – greenhouse emission | 1 | A | M | Flora EMP – Section 19.3<br>Rehabilitation and Mine Closure Planning – Section 3 |
| | • Increased weed species | 2 | D | L | Weeds and Pests EMP – Section 19.5 |
| | • Loss of individual threatened and/or endangered species. | 4 | E | M | Flora EMP – Section 19.3<br>Fauna EMP – Section 19.4<br>Weeds and Pests EMP – Section 19.5 |
| | • Interference/ damage or destruction of Aboriginal or European heritage. | 2 | A | S | Cultural and Heritage EMP – Section 19.10 |
| | • Alteration of natural drainage flows and diversion of surface water causing erosion. | 2 | D | L | Surface Water EMP – Section 19.2<br>Rehabilitation and Mine Closure Planning – Section 3 |
| | • Creation of mosquito habitat | 3 | D | M | Biting insects EMP – Section 19.6 |
| | • Dust generation from exposed areas and machinery. | 3 | C | S | Air Quality and Noise EMP – Section 19.7 |
| Road construction | • Vegetation loss – greenhouse emission | 1 | A | M | Flora EMP – Section 19.3<br>Rehabilitation and Mine Closure Planning – Section 3 |

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| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| Power line construction | • Vegetation loss – greenhouse emission | 1 | A | M | Flora EMP – Section 19.3<br>Rehabilitation and Mine Closure Planning – Section 3 |
| Generation of acid drainage from existing pit walls during operation and after | • Increase acidity of groundwater, surface water and soil contamination. | 4 | D | S | Groundwater EMP – Section 19.1<br>Surface Water EMP – Section 19.2<br>Rehabilitation and Mine Closure Planning – Section 3 |
| Dewatering impacts on regional aquifer during mine development | • Decrease in regional groundwater level which may impact on vegetation in the area | 2 | B | M | Groundwater EMP – Section 19.1 |
| | • Change in regional water quality. | 4 | D | S | Groundwater EMP – Section 19.1<br>Surface Water EMP – Section 19.2 |
| **Surface Activities – Stockpiling and Haulage** | | | | | |
| Stockpiling and loading | • Nuisance dust | 2 | A | S | Air Quality and Noise EMP – Section 19.7 |
| | • Hydrocarbon spillage (other than fuel transport and storage) leading to contamination of soil, groundwater and surface water | 2 | C | M | Hazardous Substances EMP – Section 19.11<br>Domestic and Industrial Waste EMP – Section 19.12 |
| | Generation of acid rock drainage and erosion from ore stockpile on ROM pad (1 week storage) leading to<br>• increased acidity of soil, ground water and surface water<br>• soil contamination | 2 | E | L | Waste Rock and Ore Stockpile EMP – Section 19.13<br>Surface Water EMP – Section 19.2<br>Rehabilitation and Mine Closure Planning – Section 3 |

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| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| | Generation of acid rock drainage and erosion from temporary waste rock storage facility (max 2 years storage)<br>• Increased acidity of soil, ground water and surface water<br>• Soil contamination | 2 | C | M | Surface Water EMP – Section 19.2<br>Waste Rock and Ore Stockpile EMP – Section 19.13<br>Rehabilitation and Mine Closure Planning – Section 3 |
| Haulage from Maud Creek to URGM | • Safety risks to other road users and pedestrians | 4 | D | S | Operational Safety Procedures<br>Traffic and Transport EMP – 19.9 |
| | • Nuisance noise and traffic | 2 | A | S | Traffic and Transport EMP – Section 19.9 |
| | • Risks to wildlife | 2 | B | M | Traffic and Transport EMP – Section 19.9 |
| | • Nuisance noise and vibration | 2 | B | M | Air Quality and Noise EMP – Section 19.7 |
| | • Contribution to Australia's overall greenhouse gas emissions<br>• Contribution to human-induced climate change | 1 | A | M | Air Quality and Noise EMP – Section 19.7 |
| **Existing Waste Rock Stockpile** | | | | | |
| Generation of acid rock drainage from existing waste rock stockpile | • Increased acidity of soil, ground water and surface water<br>• Soil contamination | 4 | D | S | Surface Water EMP – Section 19.2<br>Waste Rock and Ore Stockpile EMP – Section 19.13<br>Rehabilitation and Mine Closure Planning – Section 3 |
| Erosion of battered faces of waste rock stockpile | • Build up of sediment in storm water drains and surface water systems | 2 | D | L | Waste Rock and Ore Stockpile EMP – Section 19.13<br>Rehabilitation and Mine Closure Planning – Section 3 |

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| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| **Fuel Transport and Storage** | | | | | |
| Spillage of hydrocarbons during bulk transport to site | • Contamination of soil, groundwater and surface water<br>• Fire<br>• Safety | 4 | D | S | Hazardous Substances EMP – Section 19.11<br>Subcontractor Management Procedures |
| **Waste Management** | | | | | |
| Putrescible waste | • Leachate<br>• Odour<br>• Landfill greenhouse gas emissions<br>• Attraction of vermin/ feral animals | 2 | C | M | Domestic and Industrial Waste EMP – Section 19.12<br>Weeds and Pests EMP – Section 19.5 |
| Sewage treatment | • Contamination of soil, groundwater and surface water<br>• Odour | 2 | C | M | Domestic and Industrial Waste EMP – Section 19.12 |
| Hydrocarbons waste | • Contamination of soil, groundwater and surface water | 2 | C | M | Surface Water EMP – Section 19.2<br>Domestic and Industrial Waste EMP – Section 19.12 |
| **General Operations** | | | | | |
| Creation of biting insect breeding sites | • Increased incidence of bites<br>• Spread/ introduction of biting insect borne disease | 2 | D | L | Biting Insects EMP – Section 19.6<br>Surface Water EMP – Section 19.2<br>Rehabilitation and Mine Closure Plan – Section 3 |
| Attraction of biting insects | • Increased incidence of bites<br>• Spread/ introduction of biting insect | 3 | C | S | Biting Insects EMP – Section 19.6<br>Surface Water EMP – Section 19.2<br>Rehabilitation and Mine Closure Plan – Section 3 |

# Section 17 Risk Management

| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| | borne disease | | | | |
| Damage to power lines and transformers (disruption to power supply) due to bats | • Loss of power to mine | 3 | B | S | Fauna EMP – Section 19.4 |
| Light vehicle accident | • Injury to employee/s or members of the public | 5 | C | H | Terra Gold Emergency Management Plan |
| | • Risks to wildlife | 1 | B | M | Traffic and Transport EMP – Section 19.9 |
| Mine water dam fails | • Unacceptable water quality impact | 2 | D | L | Operational Procedures<br>Surface Water EMP – Section 19.2 |
| Irrigation area contaminates groundwater | • Degradation of beneficial use | 4 | D | S | Operational Procedures<br>Surface Water EMP – Section 19.2 |
| Irrigation area generates runoff | • Discharge to creeks<br>• Groundwater degradation<br>• Land degradation<br>• Hold up operations | 4 | D | S | Operational Procedures<br>Surface Water EMP – Section 19.2 |
| **Underground Mining Activities** | | | | | |
| Failure of the dewatering pipelines | • Temporary business risk – cease operations | 4 | D | S | Operational Procedures<br>Engineering Design |

# Section 17 Risk Management

| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| Explosives accident | • Injury to employees<br>• Damage to mine infrastructure | 5 | E | S | Terra Gold Emergency Management Plan<br>Procedure for handling explosives |
| Heavy equipment accident | • Injury to truck driver/ other employees | 4 | C | S | Terra Gold Emergency Management Plan |
| Fall of earth, or underground fire | • Injury to employees | 5 | D | S | Terra Gold Emergency Management Plan |
| | • Disruption to production | 4 | D | S | Terra Gold Emergency Management Plan |
| Flooding of underground mine (e.g. from surface water) | • Injury to employees | 5 | D | S | Engineering Design<br>Terra Gold Emergency Management Plan |
| | • Disruption to production | 5 | E | S | Engineering Design<br>Terra Gold Emergency Management Plan |
| | • Potential contamination to waterways due to mine dewatering | 4 | E | M | Terra Gold Emergency Management Plan |
| Spillage of hydrocarbons underground | • Safety<br>• Fire<br>• Contamination of groundwater | 3 | C | S | Hazardous Substances EMP – Section 19.11 |
| **Extreme Events** | | | | | |
| Flood | • Loss of essential supplies (fuel, reagents, consumables) | 4 | D | S | Terra Gold Emergency Management Plan |
| Seismic event/ earthquake | • Collapse of mine infrastructure<br>• Loss of access to underground mine | 5 | E | S | Terra Gold Emergency Management Plan |

# Section 17 Risk Management

| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| | • Induces major fire/explosion<br>• Disruption to security/communications | | | | |
| Severe electrical storm | • Employees struck by lightening<br>• Lightning initiating fire or explosion | 4 | D | S | Terra Gold Emergency Management Plan<br>Procedure in place in event of lightning |
| | • Disruption to power/ security systems | 3 | B | S | Terra Gold Emergency Management Plan |
| Cyclone | • Mine water dam filled to capacity | 4 | D | S | Emergency discharge to Gold Creek |
| | • Loss of access to underground mine<br>• Loss of essential supplies (fuel, reagents, consumables etc) | 3 | C | S | Terra Gold Emergency Management Plan |
| | • Medical emergency (inability to evacuate ill or injured personnel) | 5 | D | S | Terra Gold Emergency Management Plan |
| Major infectious disease outbreak/ biological contamination | • Infection to persons providing first aid treatment to others<br>• Employee illness<br>• Adverse reaction/panic by other employees | 4 | D | S | Terra Gold Emergency Management Plan |
| Major bushfire | • Damage to site infrastructure<br>• Injury to employees fighting the bushfire | 4 | C | S | Fire and Fuel EMP – Section 19.8<br>Terra Gold Emergency Management Plan |

# Section 17 Risk Management

| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| | | | | | |
| **Rehabilitation & Closure** | | | | | |
| Contaminated land | • Environmental risk<br>• Human health risk | 4 | D | S | Rehabilitation and Mine Closure Plan – Section 3 |
| Poor vegetation establishment | • Loss of vegetation<br>• Slow growth rates<br>• Loss of stabilization of soil | 3 | D | M | Rehabilitation and Mine Closure Plan – Section 3 |
| High soil erosion rate | • Sediment build up in surface drainage systems;<br>• Failed revegetation<br>• Compromised cover design | 3 | B | S | Rehabilitation and Mine Closure Plan – Section 3 |
| Damage by grazing animals | • Vegetation overgrazed<br>• Trampling of slopes damaging soil structure causing erosion and inability of plants to establish. | 3 | C | S | Rehabilitation and Mine Closure Plan – Section 3 |
| Generation of acid rock drainage from existing waste rock dump | • Increased acidity of soil, ground water and surface water<br>• Soil contamination | 3 | D | M | Surface Water EMP – Section 19.2<br>Waste Rock and Ore Stockpile EMP – Section 19.13<br>Rehabilitation and Mine Closure Planning – Section 3 |
| Impact on environment over time after mine closure | • Change in groundwater levels and quality | 3 | D | M | Groundwater EMP – Section 19.1<br>Rehabilitation and Mine Closure Plan – Section 3 |

# Section 17 Risk Management

| Key Issues | Key Potential Impacts | Consequence Ranking | Likelihood Ranking | Risk Ranking | Management Controls Recommended |
|---|---|---|---|---|---|
| | • Attraction of feral animals to water source in pit void | 2 | C | M | Weeds and Pests EMP – Section 19.5<br>Rehabilitation and Mine Closure Plan – Section 3 |
| | • Instability of ground surface due to pit wall collapse | 2 | D | L | Rehabilitation and Mine Closure Planning – Section 3 |
| | • Contamination of stock drinking water in pit void | 3 | D | M | Rehabilitation and Mine Closure Planning – Section 3<br>Ground Water EMP – Section 19.1 |
| | • Potential health effects to recreational users of water in pit void | 5 | E | S | Rehabilitation and Mine Closure Planning – Section 3 |
| | • Mine water dam contamination | 2 | C | M | Rehabilitation and Mine Closure Planning – Section 3 |
| | • Land application area contamination | 2 | C | M | Rehabilitation and Mine Closure Planning – Section 3 |
| | • More intense fire environment due to spread of weeds | 3 | C | S | Rehabilitation and Mine Closure Planning – Section 3 |

# Section 17 Risk Management

### 17.3.3 Risk Management

Effective risk management aims to prioritise issues and make appropriate use of available resources. Terra Gold designed the Environmental Management Program to mitigate issues that are identified with high and moderate risk levels in Table 17-8. In principle, the highest risks should receive the highest priority to maximise the return of investment of resources. Allocating appropriate staff and other resources is essential to successfully reducing risks.

However, direction and priorities may need to be changed as particular aspects of the project design are completed. During the construction phase of the project, mitigation actions address the moderate to significant risks of environmental impacts associated with clearing and earthmoving, road construction, power line construction, waterway disturbance, decline construction, water management, traffic and constructing high quality facilities which will assist in ensuring a high level of environmental performance during the operational phase of the project.

During the project operation, mitigation actions will aim to reduce moderate to significant risks of impacts that are associated with the mining, ore transport, pest control (weeds and feral animals), fire management, water management and Nitmiluk National Park. Site security, maintenance and monitoring activities will be important components of the risk management system.

During the decommissioning phase of the project, mitigation actions will aim to minimise the risks arising from land disturbance to waterways, pest management (weeds and feral animals), fire management, site contamination, site stability, water management, revegetation, socio-economic disruption and meeting stakeholder expectations of the closure process.

The EMS (section 18) incorporates management and monitoring strategies to address priorities from the risk assessment process. Also, a safety management plan (SMP) is in operation by Terra Gold to ensure a healthy and safe workplace for all staff, employees, contractors and visitors to the Maud Creek site. As the mine becomes operational, and in accordance with the EMS and SMP, each department will be required to formally identify any hazards, and assess the risk and initiate control measures on all its activities, products and services (including those of its contractors).

## 17.4 Emergency Management

It is Terra Gold's policy to take all reasonable steps to protect the environment and comply with all legal obligations. Occasions may arise when an environmental incident occurs even though all reasonable precautions have been taken to minimise the risks. Emergency management aims to minimise the environmental, health and safety effects of any incident via a prompt and effective response.

### 17.4.1 Emergency Management Plan

Terra Gold will maintain a current site-specific Emergency Management Plan to provide management and staff with detailed information on how to identify and respond to specific emergency situations. The Emergency Management Plan will form part of the Terra Gold emergency and crisis management system, which comprises plans, procedures, responsibilities, forms and checklists necessary for the management of emergency situations.

Incidents requiring an emergency response could occur either on or off site, and may involve Terra Gold or contractor employees, or possibly members of the public. The impacts could include injury, equipment or environmental damage, legal action, loss of production or damage to company reputation.

# Section 17 Risk Management

### 17.4.2 Emergency response facilities

Terra Gold will install and maintain all of the following emergency response facilities on site at Maud Creek:

- a first aid room with appropriate medical equipment;
- an ambulance dedicated to the mine site;
- first aid kits inside all vehicles;
- fire extinguishers inside all vehicles;
- fire hydrants with high pressure water supply at various locations around the site, including in the underground mine; and
- fire suppression systems in all underground equipment (fitted as standard by manufacturers, and maintained while at Maud Creek).

First aid training will be provided to appropriate numbers of mine personnel. Consultation with Katherine Hospital has confirmed that local medical services can cope with the emergency situations that are likely to occur with the Maud Creek project.

## 17.5 Integration into the EMS

The risk assessment identified that environmental management plans for flora, fauna, surface water, groundwater, weeds and pests, biting insects, air quality and noise, fire, traffic and transport, culture and heritage, hazardous substances, domestic and industrial waste and waste rock and ore were required for the project to implement the EMS in the mining operation. The details of the EMS integration are discussed in section 18 and 19.

## 17.6 Commitments

*Terra Gold commits to an iterative process of risk assessment, where risks are reviewed on an ongoing basis to take account of changes in operational conditions, and community and stakeholder expectations.*

*Terra Gold commits to maintaining an emergency and crisis management system, providing a strategic framework for emergency prevention, as well as response in the event of an emergency situation.*