

Section 3

Rehabilitation and Mine Closure

3.1 Introduction

Terra Gold recognises that environmental rehabilitation and closure of its sites is an essential requirement of a responsible mining company and has adopted the principles and objectives of the Minerals Council strategic framework for mine closure (ANZMEC, 2000).

Closure planning is integral to the whole life of mine plan. Long-term liabilities can be constrained in the development phase by managing risk by design, in particular by minimising the mine footprint and level of environmental risk, and continuing this strategy through the operational phase to closure planning. Regular critical review based on operational monitoring of environmental impacts will underpin a continuous improvement approach to environmental management throughout the life of the mine.

Rehabilitation and closure requirements will be documented in a Rehabilitation and Mine Closure Plan (RMCP). An outline of the RMCP will be submitted to DPIFM as part of the first annual MMP, and will be finalised when operations commence. The RMCP will form the basis for accounting for rehabilitation and mine closure budget provisions as well as providing the basis for the security bond determination.

3.2 Rehabilitation and Mine Closure

Terra Gold estimates a post-closure monitoring period of approximately five years would be required to demonstrate that the site was left in a stable condition with no detriment to the receiving environment. This is sufficient time to demonstrate that the revegetation is successful and resilient to natural environmental impacts such as fire and drought, and that surface water quality and landform stability are acceptable. Decommissioning will occur when the site is rehabilitated to a level that is considered acceptable by DPIFM. Section 1.4.3 provides additional information on the operational timeframe.

3.3 Anticipated Rehabilitation Works

Rehabilitation of disturbed areas with revegetation will be required from the operational phase through to closure.

The anticipated rehabilitation works are summarised in Table 3-1.

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Table 3-1 Anticipated Rehabilitation Works

Infrastructure	Footprint area (ha)	Area already disturbed (ha)	Additional land disturbance (ha)	Rehabilitation techniques applied
Existing Open Pit Void	2.7	2.7	0.0	Pit to be made safe and stable and safety bunds to be installed around the perimeter
Box-cut access for the underground mine decline portal	0.7	0	0.7	As above, plus close off the portal access to prevent access
ROM ore pad - will also be used as waste rock stockpile, during initial mine development (decline etc)	1.6	1.6	0.0	Remove contaminated material and incorporate it into the pit backfill. Deep ripping, immediately followed by direct seeding for woodland vegetation, or pasture
Existing Waste Rock Stockpile – to be utilised as Mine Water Dam	4.6	4.6	0.0	Removal of the walls of the mine water dam, and contouring, ripping and seeding.
Miscellaneous Infrastructure (Bunding, Internal Roads, Office and Change Rooms, Contractors Laydown Area, Workshops, Fuel Bays and Explosive Areas, Sediment Ponds)	2.4	0.0	2.4	Infrastructure and contaminated soil to be removed and incorporated into the pit backfill and covered with clean waste rock. Area will be ripped and revegetated, or left intact if required as a pastoral property improvement
Sub-total: Operational mine area	12.0	8.9	3.1	
Irrigation Area, Infrastructure, Pumps, Pump House, Centre Pivots and Irrigation Piping	84	84 ²	0	Irrigation infrastructure to be left intact as a pastoral property improvement
Access Route: Option 1. Preferred access route and power lines Option 2. Alternative upgrade of existing access route ¹	17.9 (26.0)	2.9 (15.6)	15.0 (10.4)	Road left intact as a pastoral property improvement
Sub-total: Outside operational mine area	101.9	86.9	15.0	
Totals¹	113.9	95.8	18.1	

¹ The total does not include alternative option impacts.

² The existing cleared pastoral area available for irrigation is 160 ha, and exceeds the 84 ha area required.

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Terra Gold will ensure that:

- Where practical topsoil will be conserved and respread over disturbed areas such as bunds and drainage inverts;
- Where practical any cleared vegetation will be used to as a sediment trap to treat any off-site runoff from disturbed areas;
- disturbed areas will be progressively revegetated with suitable pasture species (as recommended by DPIFM) or common and abundant woodland species identified in the flora baseline study (Section 7);
- final rehabilitation of the mine area at closure is effective, based on a detailed sediment and erosion control plan and timely revegetation of all bare areas to ensure at least 50 % vegetative cover (for weed control and surface stability) over the site leading into the first wet season; and
- site contamination issues will be identified and remediated.

3.4 Post-Mining Land Uses and Landforms

It is anticipated, based on stakeholder consultation and current pastoral leasehold title, that the land will revert to its previous land use, pastoral grazing. The primary closure objective is to leave the area in a condition suitable for pastoral grazing.

It is noted that the adjacent Nitmiluk National Park management plan incorporates nature conservation objectives, however at its closest point the existing mine is located 1 km from the park. The proposed mine plan has been developed to retain this buffer distance (refer Figure 2.2).

It is expected that areas impacted by mining operations will be classified as either restorable or non-restorable land. The pit void and portal box-cut are considered to be the only areas that are non-restorable. These areas will be stabilised and made safe. The total area of the pit void and portal box-cut, including proposed safety bund areas, is 3.4 ha. However it is noted that the pit void may also be utilised for stock drinking purposes. Further information on rehabilitation of the pit voids is presented in Section 3.7.1.

As stated above, restorable areas will be primarily targeted for pastoral use purposes. In order to provide long term stability and rehabilitation success, pastoral use is not considered suitable for the existing waste rock stockpile (the proposed mine water dam site) over the longer term, and this area will be targeted for rehabilitation as mixed native woodland for limited future use and nature conservation.

A summary of proposed end land uses and associated revegetation types are outlined in Table 3-2. Final land use objectives will be defined as part of the development of the RMCP.

Section 3**Rehabilitation and Mine Closure****Table 3-2 Proposed End Land Use**

Domain	Proposed End Land Use
Existing Open-cut Pit Void, and box-cut for underground mine decline portal.	Physically and chemically stable land, but closed to public use. The open pit will naturally fill with water to provide a potential water source for water fowl or pastoral use. Other possible future uses may include further mining.
Mining infrastructure areas	Mixed native woodland and/or grassland for pastoral grazing.
Existing waste rock stockpile (proposed location of Mine Water Dam)	Native savannah vegetation, potentially for nature conservation.
Miscellaneous infrastructure (including administrative areas, contractor's areas, etc.)	Native savannah vegetation and grassland for pastoral grazing

3.5 Closure Objectives and Commitments

With the exception of the open pit and box-cut voids and irrigation infrastructure, it proposed that there will be no permanent facilities left on site at decommissioning. However, particular items of mining infrastructure could be left for post-mining use, depending on stakeholder consultations during the operating life of the mine.

The specific objectives that Terra Gold will adopt for decommissioning and closure (which apply to all GBS sites) are to:

- protect the environment and public health and safety by using safe and responsible closure practices;
- minimise potential environmental effects, such as surface or ground water impacts, when operations have ceased;
- remove any waste or potentially hazardous substances from site;
- develop landforms that, within reasonable and practical limits, blend with the surrounding terrain;
- work towards achieving water quality standards in downstream watercourses consistent with Australian and New Zealand Guidelines for Water Quality (ANZECC 2000);
- establish vegetation that is self-sustaining, perpetual and provide habitat for local fauna and successive flora species, and to achieve long-term stabilisation and protection of the previously disturbed / artificial landforms consistent with the proposed end land use;
- develop an end land use that takes into account the beneficial uses of the site and surrounding areas (which is predominantly pastoral use, plus the Nitmiluk National Park to the north);
- achieve long-term stabilisation of the waste rock with self sustaining vegetation and minimise erosion;

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- leave a closed mine that does not represent a risk to the health and safety of the community;
- reduce the requirement for long-term monitoring and maintenance by establishing stable rehabilitated areas.

In addition to these objectives Terra Gold will also consider any requirements of this EIS (developed during the environmental approvals process), the requirements of the MMP (to be developed prior to mine operations), relevant Territory and Federal legislation, any pre-existing stakeholder commitments, the Australian and New Zealand Minerals and Energy Council's Strategic Framework for Mine Closure (ANZMEC 2000), and the Department of Industry, Tourism and Resources' Leading Practice Sustainable Development Program for the Mining Industry, in particular the Mine Closure and Completion and the Mine Rehabilitation Handbooks (DITR 2006a, 2006b).

3.6 Community Involvement

A communications strategy will be developed during the preparation of the RMCP. A fundamental part of the communication strategy developed during the RMCP preparation will be the establishment of agreed indicators of effective mine decommissioning and reclamation. Post closure, these indicators will be applied and will provide certainty that the closure process has implemented the reclamation objectives outlined above.

The following indicators or endpoints are proposed.

- Water quality in streams and rivers leaving the lease are not significantly worse than baseline data over a full wet season;
- Water in the open pit is suitable for water fowl or for pastoral use;
- Mine components are rehabilitated according to the procedures in the RMCP;
- Erosion rates on disturbed land are of the same order as erosion rates in similar natural landscapes; and
- Vegetation is established in accordance with criteria set out in the RMCP.

3.7 Progressive Rehabilitation Strategy

Detailed rehabilitation plans will apply the following rehabilitation guidelines:

- reshaping of batter slopes to be not greater than 1:4 (V:H);
- contouring and ripping parallel to contours of disturbed areas;
- seeding, when ground conditions are favourable, with a native seed mix that is suitable for pastoral use;
- seeding areas identified for savannah woodland (e.g. waste rock stockpile) with a seed mix of common and abundant local woodland species identified in baseline flora surveys (Section 7);
- seeding with a stabilisation grass mix should this be required;
- bunding of the pit void and portal box-cut, and fencing and signage for public safety;
- retention of infrastructure that will enhance pastoral land use value (depending on stakeholder consultations during the operating life of the mine); and

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- removal of other mining infrastructure from the site at the completion of mining.

Contaminated soils will be identified and remediated or disposed of into the pit backfill with a clean waste cover or, in the case of any hazardous waste, to a suitable waste disposal facility.

Those areas that are unsuitable for rehabilitation will be bunded with a lockable gate/fence at access points to discourage access by livestock and the public.

3.7.1 Pit

Rehabilitation of the existing open pit, box cut and underground portal access will focus on minimising inadvertent public access to the abandoned mine area, and ensuring the long term stability of the entire area.

However, consideration will be given to directing surface water to the pit void and constructing beaches on the outside edge of the void so that it can be used for stock watering. At this time, it is proposed that the void be fenced to exclude stock and the public. However the void may be left unfenced for stock watering purposes, depending on stakeholder consultations during the operating life of the mine, within the context of public safety considerations.

3.7.2 Waste rock stockpile / mine water dam

As noted in Section 2, Terra Gold propose to use the material from the existing waste rock stockpile to construct the access roads, after which the remaining stockpile would be shaped to accommodate the mine water dam (Figure 2-3).

Geochemical tests have determined the waste rock stockpile material is non-acid forming (NAF), owing to low sulphide concentration and a moderately high capacity to consume acid. At closure, the walls of the mine water dam will be removed, and the area reshaped and revegetated with local savannah woodland species. The end land use objective for the waste rock stockpile is woodland on pastoral land. The rocky substrate and steep batters of the waste rock stockpile landform reduces its suitability for pasture development. However, reforesting the stockpile with woodland species will restore some natural environmental values.

While there is stakeholder interest in leaving the mine water dam intact as a water supply dam for pastoral land use, to minimise liability at closure (based on current knowledge) Terra Gold currently proposes to rehabilitate the waste rock stockpile / mine water dam footprint. A risk assessment of the post-closure mine water dam options has been undertaken (Section 17.1.2), which supports the option of rehabilitation of the mine water dam as preferred.

The preferred option may be reconsidered in stakeholder consultations during the operating life of the mine. Any decision to provide land for pastoral activities will need to be supported by acceptable water quality.

3.7.3 ROM pad

Any reactive mineralised material from the ROM pad will be placed as initial pit backfill, to ensure adequate cover with clean fill, consistent with best practice guidelines for managing sulphidic mine waste (EPA 1997d).

Following removal of this material, the ROM pad will be contoured and shaped, deep ripped and seeded for woodland vegetation or pasture.

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3.7.4 Irrigation areas

Any spray irrigation infrastructure will be left intact as a pastoral land improvement.

3.7.5 Other infrastructure

Infrastructure that is not suited to farm development will be removed. Concrete slabs will be broken up and placed as initial backfill in the pit, then covered with clean fill. Bare areas will be prepared and revegetated according to best practice guidelines (EPA 1997a), namely ripping along the contour, any seeding onto freshly disturbed ground immediately prior to the onset of wet season rain and managing any initial sediment movement.

3.8 Rehabilitated Landform Design

Illustrated views of the proposed landscape pre- and post-mining for Maud Creek mine site are presented in Figure 3.1. There will be no additional mine landforms or mine infrastructure in the post-mining landscape. Best practice guidelines on landform design will be followed (EPA 1997c). The cover material will be assessed to ensure that risk of potentially reactive, acid forming material is low. Landform stability will be monitored during the post-mining rehabilitation period. Actions will be taken as required to address any identified issues, such as erosion and any changes to the integrity of bund walls.

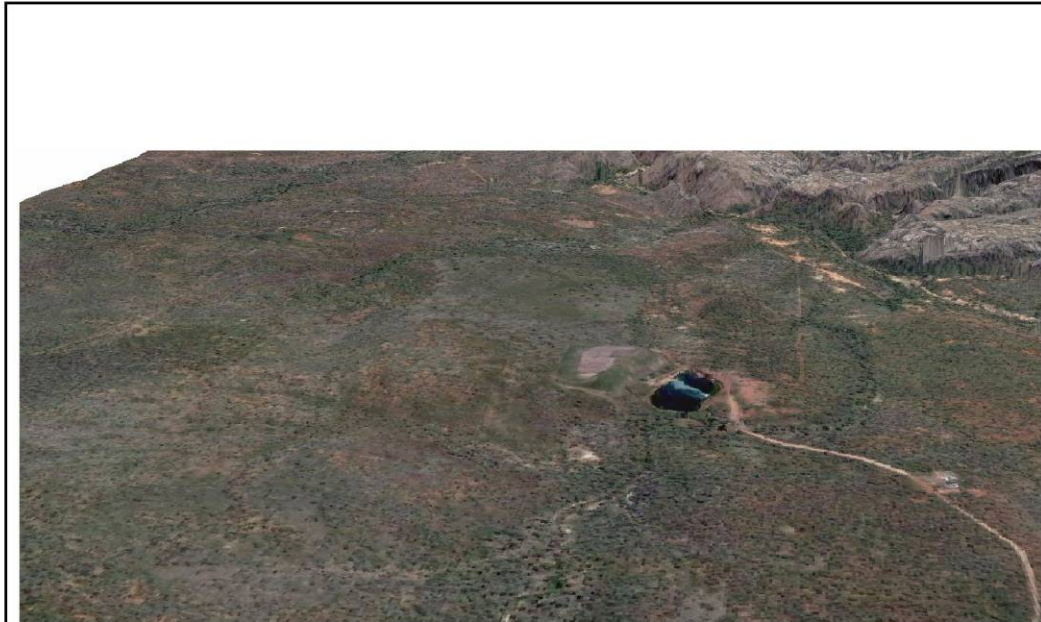
3.9 Revegetation Strategies

The revegetation strategy aims to ensure rapid revegetation of disturbed areas prior to the onset of heavy wet season rain and to achieve revegetation endpoints that are consistent with pastoral leases in the local area. Material properties that determine the fertility status of the cover and constraints to revegetation will be assessed and ameliorated as required to ensure successful revegetation.

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Figure 3-1 Current and Post-rehabilitation Landscape



Landscape Pre Mining



Source: Imagery from 'Google Earth'		Landscape Post Mining	
Client Terra Gold Mining Ltd	Project MAUD CREEK GOLD PROJECT		Title PROPOSED LANDSCAPE BEFORE AND AFTER MINING AT MAUD CREEK
	Drawn: JD	Approved: IH	Date: 9 Nov 2007
	Job No.: 42213775	File No.: 42213775-03-2.mxd	
Figure3.1			Rev. A A4

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Weed control will be a critical issue in terms of meeting pastoral lease conditions and obligations to control the spread of weeds into the neighbouring national park and pastoral properties. Weed surveys of the mine area will be conducted during operations, and in the rehabilitation period after closure, to assess the extent and type of weed problems and to focus control effort.

Site preparation for revegetation will include weed control. Fire management will also be critical to the success of revegetation. Waste rock landforms that are revegetated with savannah woodland species will be monitored until they are demonstrated to be acceptably resilient to fire and weed infestation.

This will depend on achieving sufficient cover and size in the vegetation to control site resources to the extent that weeds will not proliferate and fire does not kill the plants. Components of the revegetation strategy are outlined in Table 3.3.

Table 3-3 Components and details of revegetation strategies

Revegetation Strategy	Specifics
Species selection	In particular, common and abundant overstorey species from the local woodland environment will be selected for revegetating the waste rock landscape. Detailed flora survey data supporting the revegetation plan are presented in Section 7. Suitable pasture species based on the best available advice will be selected for revegetation of cleared natural land surface.
Establishment	Topsoil may be conserved and respread to rapidly re-establish ground cover in disturbed areas during the operational phase. Weed infested areas may need to be scraped prior to revegetation to remove the weed seed source. Revegetation will be planned for the onset of wet season rain in December – January. Establishment of eucalypt, fire resistant woodland will be monitored where appropriate.
Seed collection and purchase	The viability of the seed used for revegetation will be tested. Terra Gold will seek to involve the local community in the provision of seeds for revegetation.
Seed processing and storage	Seed will be stored and handled appropriately to ensure viability and prevent insect and fungal attacks.
Seed treatments	Treatment to stimulate seed germination will be applied where appropriate.
Seed bed preparation	Land surface will be ripped along the contour immediately prior to direct seeding.
Seeding methods	Seeding densities will be appropriate to establishing rapid vegetative cover in the short term as well as sustainable in the long term. Practice demonstrates that seeding rates of 3.5 kg/ha of native eucalypt dominant mixtures can achieve rapid and sustainable cover that will ensure adequate weed and erosion control. Commercial advice on pasture seeding rates will be used.
Weed control	A weed control plan for access roads and areas disturbed by mining activity based on identifying the type and extent of weed infestation and applying the appropriate control strategies will be developed.

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3.10 Monitoring and Maintenance

A monitoring program will be developed to address closure risks including:

1. erosion control and stabilisation;
2. revegetation success;
3. receiving environment water quality; and
4. site contamination.

The closure criteria will be set and reviewed during the life of the mine. However, in principle, the site will be left in a condition that does not cause significant aesthetic or environmental impact and meets with the pastoral beneficial land use. The monitoring program will be designed to determine whether the rehabilitation complies with detailed closure objectives.

3.10.1 Surface water quality

Surface water quality will be monitored to determine compliance with ANZECC (2000) drinking water guidelines in the receiving environment. The monitoring strategy will assess water quality in terms of the metals of concern associated with the Maud Creek mine, general parameters and turbidity.

The impact assessment will be based on upstream (control) and downstream (impact) sites. Further information on the proposed groundwater monitoring program is presented in Section 5. A copy of the Terra Gold Surface Water EMP is included in Section 19.2.

3.10.2 Groundwater quality

Groundwater monitoring bores will be utilised to establish whether closure objectives have been reached. Post closure groundwater quality should be within the ANZECC (2000) guidelines for stock drinking water.

Monitoring of groundwater quality prior to commencement, during and following the completion of mining will be undertaken. Groundwater monitoring will extend to the irrigated land application area. Groundwater levels, metals of concern and general parameters will be measured on production bores on a monthly basis.

Environmental monitoring bores inside and immediately down gradient of land application areas will be monitored during the operation and during the closure monitoring phase. A chemical analysis including cations, anions, trace metals, general parameters of samples from all of the production bores will be taken on a 6 monthly basis.

Further information on the proposed groundwater monitoring program is presented in Section 6. A copy of the Terra Gold Groundwater EMP is included in Section 19.1.

3.10.3 Rehabilitation monitoring

Rehabilitation areas will be inspected and photographed annually to monitor rehabilitation success. Criteria developed by Terra Gold to assess the effectiveness of revegetation include:

- Ground cover comparable to natural vegetated landscape (generally greater than 50 %);

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- Similar range and abundance of common overstorey woodland species in revegetated woodland areas;
- Functional ecosystems in rehabilitated areas demonstrated using Ecosystem Function Analysis (Tongway & Hindley 2004), a monitoring method used at other mine sites in the NT, WA and Queensland;
- Fire resilience – monitoring regrowth following fire;
- Weed control consistent with surrounding pastoral land use;

3.10.4 Weed monitoring

The type and distribution of weeds within the operation and in the rehabilitated areas during the closure phase will be mapped and appropriate control methods will be implemented and reported upon in the MMP.

A final weed survey will be reported to the Weeds Branch of the Department of Natural Resources, Environment and the Arts (NRETA) prior to decommissioning. The aim will be to assess compliance with accepted standards of weed control in the vicinity of the mine. A copy of the Terra Gold Weed and Pest EMP is included in Section 19.5.

3.10.5 Fire management

Rehabilitated areas will be protected under the Terra Gold Fire Management Plan. The aim of the plan is to preclude fire from rehabilitated woodland areas for at least five years.

To determine if rehabilitated woodland environments are fire resilient, they will be subjected to a low intensity fire after this period. A copy of the Terra Gold Fire EMP is included in Section 19.8.

3.11 Security Calculations

Terra Gold will calculate security requirements based on the completion criteria defined in the RMCP, using the guidelines published by DPIFM.

Securities calculations will involve:

- Calculating the physical area proposed to be disturbed;
- Defining close-out criteria prior to calculation of the securities and commencement of mining;
- Determining specific rehabilitation activities required for the areas of disturbance; for example re-contouring, ripping, re-vegetation and monitoring (rehabilitation requirements will be based on the commitments made in this EIS, the MMP and the RMCP); and
- Calculating the costs associated with these activities on an area basis in accordance with the Mines Division Advisory Notes PA6-009 (Self Assessment Procedure) and PA6 – 008 (Security Calculation Procedure) (DPIFM 2006).

Costs will be based on personnel and equipment costs and will include any mobilisation and demobilisation costs. Where appropriate, local contractors that have experience in undertaking rehabilitation works will be approached to tender for these works.

Securities will be reviewed when significant changes occur to operations to ensure that they reflect current mining activities.

Section 3**Rehabilitation and Mine Closure****3.12 Commitments**

Terra Gold commits to rehabilitation in accordance with an approved RMCP.

Terra Gold commits to monitoring rehabilitation success with the aim of continually improving the quality of its rehabilitation and closure outcomes.

Terra Gold commits to consulting with relevant stakeholders on the potential use of the pit voids and mine water dam for stock watering, and whether or not to fence the pit voids and mine water dam around the abandonment bunds.

Terra Gold commits to documenting rehabilitation and closure requirements into a RMCP, consistent with DPIFM requirements for rehabilitation and closure, and to accounting for rehabilitation and mine closure costs. An outline of the RMCP will be included in the MMP.