Section 16 Waste and Hazardous Goods Management

16.1 Sources of Waste

It is anticipated that the types of wastes generated will include construction wastes, general operational waste and waste rock. It is expected that the total waste volumes generated will be low, due to off-site processing and the underground nature of the proposed mining operations.

Waste rock will be stockpiled temporarily before being used for backfilling of mined out stopes or return to the pit void. The total waste rock stockpile volume is not expected to increase in the long term, but should decrease as the existing stockpile is utilised as road base. Overall minerals management has been discussed in section 16.5.

Hazardous waste generated during construction activities will include general construction waste, hydrocarbons and other chemicals such as solvents, paints, cleaning products, sealants and adhesives. Most of these wastes will arise off-site as pre-fabricated offices and ablution block, and will be brought to site.

General operational waste will include oily waste produced from generators and vehicles, including waste oil, oily rags, oil filters and other disposable parts. Up to 40 operational personnel will be on site at any one time, generating putrescible wastes, including solid waste, liquid waste and sewage. During the operational phase the principal hazardous goods will comprise explosives and fuel. Other principal chemicals will be sodium hypochlorite (chlorine) solution for potable water treatment, and general domestic cleaning chemicals.

16.2 Existing Waste Management Program

Terra Gold has an existing waste management strategy that focuses on:

- minimising waste generation;
- ensuring all health and environmental hazardous materials are disposed of appropriately; and
- recycling and reusing waste wherever possible.

This strategy will be adopted for the Maud Creek Operation. Any hazardous and general operational wastes generated on site at Maud Creek will be transported off-site for disposal as per current Terra Gold procedures, which are described below.

The Environmental Management Plans (EMPs) for hazardous substances, domestic and industrial waste, and waste rock and ore stockpiles are outlined in Section 19. All personnel will be briefed on these draft EMPs during the induction process.

All health and environmental hazardous materials will be disposed of according to the relevant legislation, in particular the *Waste Management and Pollution Control Act.*

16.3 Management of General Waste

Table 16-1 outlines Terra Gold's disposal strategy for identified waste items that may arise at Maud Creek. This disposal strategy is based on the current waste management programs in place at other GBS mine sites in the Northern Territory. The management of hazardous waste is discussed in Section 16.4.

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Table 16-1 Waste Disposal Strategy for Maud Creek

Waste Material	Disposal Strategy
Wooden pallets and boxes	Landfill
Food scraps, general crib rubbish	Landfill
Waste plastics	Recycled / landfill
Rubber tyres	Removed from site
Chemical wastes – non-recyclable	Removed from site
Chemical wastes – recyclable	Removed from site or recycled
Scrap metal	Recycled / removed from site
Vehicle batteries	Recycled / removed from site
Waste oil, grease and oily waste	Recycled / removed from site
Contaminated soil (if arising)	Bioremediation farm
Waste paper products	Shredded and recycled

Sewage and domestic waste water effluent generated on site will be treated via an approved septic system which complies with the *Public Health and General Sanitation Regulation* (NT). The maintenance of the ablution facilities and septic tank/system will be in accordance with Department of Health and Community Services guidelines.

Solid waste generated from the operation will be putrescibles waste from crib/office facilities, and from packaging. The key principle for general waste disposal is segregation of waste for recycling. A recycling bin will be placed near the office for collection of waste paper and other recyclables. A waste disposal contractor from Katherine will conduct regular removal of rubbish from site. Mobile bins will be provided on site for the collection and disposal of waste material.

It is anticipated that waste volumes for the duration of the mining operation will be relatively low. It is estimated that food scraps, office waste and general rubbish will give rise to approximately $10m^3$ of waste per month. Other wastes (such as packaging and pallets, and oily waste, batteries, etc.) are estimated to comprise a further 5 m^3 per month of waste. These wastes will be removed weekly for disposal at existing landfills at Katherine.

A vehicle wash-down area will be provided on site, comprising a compacted hard-stand area, with water passing to the mine water dam.

16.4 Hazardous Substance Management

The mining equipment utilised in the operation of the mine will be diesel powered. Diesel will also be used to power drills, pumps and generators. An explosives supplier will deliver bulk explosive material to the site where it will be stored in a magazine in accordance with AS2187.1-1998, Explosives - Storage, transport and use.

The transportation of dangerous goods will be carried out in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (1998). Explosives will arrive on site premixed and will be held in a magazine. The transport, management and laying of explosives will be carried out by the mining contractor. Magazine areas will be locked at all times and will be the responsibility of the contractor to maintain.

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An 8,000 L mobile service fuel truck will be located on site during mining operations to refuel mine equipment including loaders, haul trucks and stationary diesel powered equipment. There will be a permanent 25,000 L fuel tank/station on site near the portal. Fuel supplies will be managed in accordance with the AS1940 – 2004 Storage and Handling of Flammable Liquids and Combustibles.

Waste chemicals and oily waste will be collected in 205 L drum or 1000L pods and identified as chemical and/or oily waste. Only very minor quantities are expected. It is proposed that these wastes will be taken to Katherine for collection by a waste recycling and disposal contractor (Drum Muster).

All fuel storage areas will be bunded in conformance with AS 1940 - 2004 to manage the risk of contamination of the surrounding environment. Maintanence of light vehicles will occur on site with some scheduled servicing taking place at established workshops at Katherine. Underground vehicles and site mobile equipment will be serviced on site in a dedicated workshop. One transport truck will be serviced at URGM. This strategy will minimise the contamination risks associated with hydrocarbons on site. All site fuel, chemicals and hazardous materials will be stored as per the relevant Australia Standards, as described in the Hazardous Substances Environmental Management Plan presented in Section 19.

All hazardous and dangerous goods will be handled according to the information provided on the Material Safety Data Sheets (MSDS). Copies of the MSDS for each of the hazardous and dangerous goods used on site will be held at Maud Creek. Registers of all hazardous materials imported to Maud Creek site or generated as a result of site activities will be maintained and held on site. These will document the hazardous material's name, MSDS, location, approximate volume, storage method and where applicable, disposal method for the substance and containers.

All personnel will be trained in appropriate handling, storage, disposal and containment practices for chemicals and hazardous goods as is relevant to their position. Personnel will have access to safety equipment required for the correct handling of hazardous goods. Spill response kits will be provided at Maud Creek for use, should an incident occur. An Emergency Response Procedure will be developed to ensure an appropriate response can be made to minimise the environmental impact caused by incidents involving hazardous materials.

As noted above, all processing of ore will take place off site, and therefore no large quantities of chemicals will be required on site. General chemicals, used for potable water treatment, hygiene and other related purposes, will be stored as per the manufacturer's specifications.

16.5 Waste Rock and Minerals Management

16.5.1 Existing waste rock infrastructure

The current existing mineral waste infrastructure at the Maud Creek site includes an open pit and a waste rock stockpile. The pit has a maximum depth of 40 m and the waste rock stockpile contains approximately 300,000m^3 of oxidised waste rock, occupying an area of approximately 4.3 ha (Phoenix Resources, 2000). Mineral processing has not occurred at Maud Creek in the past, therefore there is no processing plant or tailings storage facility on site. This will continue to be the case, with all ore being transported to URGM.

16.5.2 Mineral waste characterisation and assessment - background

In 1997, geochemical assessments of waste rock and ore samples were undertaken for Kalmet Resources NL. These assessments were conducted by Graeme Campbell & Associates (GCA, 1997a,b), and was included as part of the original Maud Creek Open-Pit EIS for Kilkenny Gold (Dames & Moore, 1998).

(Kalmet Resources NL was purchased by Kilkenny Gold in December 1997). The waste rock and ore geochemistry characterisation report (GCA 1997a) is provided in Appendix L.

The geochemical assessment work undertaken by GCA (1997a) had two aims:

- to identify material types that have the potential to produce acid rock drainage (ARD) through the oxidation of sulphide minerals; and
- to identify material types that are enriched in elements that may be of potential concern to water quality and vegetation.

16.5.3 Overall geochemical results

The results are reviewed here to assess the applicability of the existing geochemical data to the current mine proposal.

In total, 33 samples of waste rock, 11 samples of ore (of both low and high grade from the fresh zone) and two soil samples from beneath the current waste rock stockpile footprint underwent geochemical testing for acid-base accounting and multi-element analyses.

Waste rock

The geology of the open-pit mine plan proposed by AngloGold was expected to produce the following indicative ratios of waste rock (see table 16-2). The waste rock samples were derived from weathered and fresh (unweathered) zones represented by hanging-wall tuff, foot-wall sandstone and undifferentiated footwall sediments (GCA, 1997a).

Table 16-2 Indicative ratios of waste rock

Zone	Geology	Indicative % of total waste rock
Weathered	Hanging-wall mafic tuff	25
Weathered	Foot-wall sediments	5
	Total weathered zone	*30*
Fresh	Hanging-wall mafic tuff	55
Fresh	Foot-wall sediments	15
	Total fresh zone	*70*

Assuming these indicative ratios, the existing waste rock stockpile should comprise these approximate ratios of mined materials. GCA (1997a) reported that significant proportions of waste rock comprised limestone and carbonates and had low pyrite content.

The waste rock samples tested from the weathered zone and hanging wall fresh zone were all mildly alkaline and had low contents of soluble salts. Two samples of the footwall sediments from the fresh zone had moderate-high contents of soluble salts.

All but two of the 33 waste rock samples were classified as non-acid forming (NAF), due to low sulphide concentration and a moderately high capacity to consume acid. One footwall sandstone (fresh zone) sample was classified as potentially-acid forming (PAF) – low-capacity. One footwall sediment (fresh zone) sample was classified as PAF- high-capacity.

Assayed waste rock samples had element concentrations below, or close to, those typically recorded for unmineralised soils and rocks, with the exception of arsenic (As) and antimony (Sb).

Ore

Gold within ore occurred as free particulate gold as well as refractory gold associated with pyrite and arsenopyrite. The low-grade ore samples were geochemically similar to the waste rock samples (with respect to potential for acid generation and multi-element concentration).

Soil

The two soil samples collected and tested from the footprint area beneath the existing waste rock stockpile were both pH-neutral and had low contents of soluble salts.

Both samples had very low sulphide concentrations (<0.3%) and low acid neutralising capacity (ANC), and consequently, are classified as barren due to a very low capacity to produce and consume acid.

The soil samples had element concentrations below, or close to, those typically recorded for unmineralised soils and rocks, with the exception of bismuth (Bi) in one sample. Bismuth is expected to occur in the 'fixed' form in oxide and silicate minerals and should not be cause for concern.

16.5.4 Key findings of the 1997 geochemical assessment

The key findings of the 1997 geochemical assessment were:

- Acid rock drainage (ARD) should not be generated by the waste rock stockpile at Maud Creek.
- Run-off waters from the stockpile should be pH-neutral (pH 6 to 8) and of low salinity (less than 1000 mg/L total dissolved solids (TDS).
- Leachate within the waste rock stockpile should also be pH-neutral and of low salinity.
- Generally, run-off waters should have low concentrations of soluble metals. Run-off waters may be enriched in arsenic (As) and antimony (Sb) and will need to be monitored.
- Stockpiles of low-grade ore are expected to produce similar run-off and leachate water quality as the waste rock stockpile.

16.5.5 2007 geochemical validation testing

Geochemical testing of six samples collected from the waste rock stockpile at Maud Creek (Figure 6-5) underwent laboratory analysis for total sulphur, sulphate sulphur, ANC, Net Acid Generation (NAG) test, pH (paste), EC (paste), alkalinity (paste), total metals and soluble metals in 1:5 solid:water extracts. The samples were collected from a depth of approximately 2-3 metres below the top of the waste rock dump. The acid-base and total metals results are presented in Table 16.3, along with NEPC (1999) health-based investigation levels for soils, for comparison. The soluble metals in water extract results are presented in Table 16.4, along with ANZECC (2000) water quality guideline values for livestock drinking water, for comparison.

Table 16-3 Chemistry of waste rock solid - Maud Creek Project

Parameters	Laboratory limit of reporting	NEPC[1] Health-Based Investigation Level	Hole 001	Hole 002	Hole 003	Hole 004	Hole 005	Hole 006
Acid-Base Chemistry								
pH (paste) (pH units)	0.1	n/a	8.5	7.7	8.1	8.5	8.6	9
Alkalinity (paste) (kg H_2SO_4 /t)	0.005	n/a	0.0441	0.0294	0.0421	0.2264	0.0559	0.1597
Electrical conductivity (paste) (uS/cm)	5	n/a	297	797	359	155	158	110
Total Sulfur (%)	0.02	n/a	0.16	0.28	0.10	<0.02	0.04	<0.02
Sulfate Sulfur (%)	0.01	n/a	0.03	0.08	0.04	<0.01	<0.01	<0.01
Total Oxidisable Sulfur (%)	0.01	n/a	0.13	0.20	0.06	<0.01	0.04	<0.01
MPA (kg H_2SO_4 /t)	0.01	n/a	4.0	6.2	1.9	0.2	1.1	0.2
ANC (kg H_2SO_4 /t)	0.01	n/a	92.6	36.7	78.1	189	136	23.1
NAPP (kg H_2SO_4 /t)	0.01	n/a	-89	-30	-76	-189	-135	-23
NAG (kg H_2SO_4 /t)	0.01	n/a	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NAG pH (pH units)	0.1	n/a	10.9	9.4	10.4	11.1	11.2	9.1
Sample Classification	n/a	n/a	NAF	NAF	NAF	NAF	NAF	NAF
Elements and Major Ions	**ppm**							
Aluminium (Al)	500	-	20,400	11,300	22,000	21,600	32,300	8,000
Arsenic (As)	5	200 (total)	335	330	190	55	285	160
Boron (B)	20	6,000	80	120	60	<20	40	120
Cadmium (Cd)	0.5	40	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Calcium (Ca)	100	-	49,500	20,700	33,900	122,000	65,400	9,600
Chromium (Cr) (Total)	100	200	400	200	400	100	600	<100
Cobalt (Co)	0.5	200	44	21	44	29	49.5	12
Copper (Cu)	2	2,000	38	10	24	24	36	8
Iron (Fe)	500	-	70,100	51,700	65,800	50,500	94,100	28,400
Lead (Pb)	2	600	42	26	18	18	20	14
Magnesium (Mg)	100	-	42,100	11,500	43,100	41,600	57,200	10,100
Manganese (Mn)	0.5	3,000	1,390	599	938	513	1,380	235
Molybdenum (Mo)	1	-	<1	<1	<1	<1	<1	<1
Nickel (Ni)	2	600	494	254	424	152	622	94
Potassium (K)	500	-	2,000	2,500	2,000	500	500	2,500
Selenium (Se)	10	-	<10	<10	<10	<10	<10	<10
Sodium (Na)	500	-	<500	<500	<500	<500	<500	<500
Zinc (Zn)	5	14,000	110	65	80	70	95	25

Notes:

< indicates less than the analytical detection limit.

Shaded cells indicate values which exceed the applied NEPC guideline value.

1. NEPC (1999). National Environmental Protection Council (NEPC). National Environmental Protection (Assessment of Site Contamination) Measure (NEPM). Guideline on investigation levels for soil and groundwater. HIL(E); parks, recreation open space and playing fields.

The acid-base results in Table 16-3 show that the waste rock material is slightly alkaline, non-saline, non-acid-forming (NAF) and has a very low total oxidisable sulphur (TOS) content, in most cases less than 0.1%, indicating the material is also benign. These results support the pre-mining geochemical assessment of these materials with respect to their limited ability to generate acid.

Table 16-4 Chemistry of waste rock water-extracts - Maud Creek Project

Parameters	Laboratory limit of reporting	ANZECC[1] Livestock drinking water guideline levels	Hole 001	Hole 002	Hole 003	Hole 004	Hole 005	Hole 006
Soluble Major Ions	mg/L							
Calcium (Ca)	0.1	1,000	25.8	137.4	37.4	17.4	11.0	5.8
Magnesium (Mg)	0.1	-	10.1	15.6	16.8	6.0	7.1	2.5
Sodium (Na)	0.1	-	4.4	2.6	2.9	3.3	4.5	2.7
Potassium (K)	0.1	-	26.2	36.2	15.9	6.5	8.2	16.2
Chloride (Cl)	0.1	-	10.8	4.0	5.2	0.9	14.6	2.6
Sulphate (SO_4)	0.1	1,000	93.4	412.0	131.6	10.5	11.5	7.6
Soluble Metals & Metalloids		mg/L						
Aluminium (Al)	0.02	5	0.08	0.06	0.06	0.06	0.10	0.16
Arsenic (As)	0.0004	0.5	0.0110	0.0100	0.0070	0.0030	0.0120	0.0610
Boron (B)	0.01	5	0.10	0.12	0.11	0.10	0.09	0.10
Cadmium (Cd)	0.0004	0.01	<0.0004	<0.0004	<0.0004	<0.0004	0.0004	<0.0004
Chromium (Cr)	0.002	1	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	0.0002	1	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Copper (Cu)	0.0002	0.5	0.0008	0.0008	0.0008	0.0036	0.0008	0.0004
Iron (Fe)	0.04	-	<0.04	<0.04	<0.04	0.04	<0.04	0.12
Lead (Pb)	0.0002	0.1	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Manganese (Mn)	0.0002	-	0.0056	0.0426	0.0106	0.0012	0.0014	0.0010
Mercury (Hg)	0.0004	0.002	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Molybdenum (Mo)	0.001	0.15	0.003	0.003	0.002	<0.001	0.002	<0.001
Nickel (Ni)	0.0002	1	0.0006	0.0032	0.0006	0.0010	0.0002	<0.0002
Phosphate (as P)	0.004		0.008	0.004	0.004	0.008	0.004	0.020
Selenium (Se)	0.004	0.02	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Zinc (Zn)	0.002	20	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002

Notes:

< indicates less than the analytical detection limit. Shaded cells indicate values that exceed the applied ANZECC guideline value.

1. ANZECC and ARMCANZ, Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra, ACT (2000). Livestock drinking water (cattle).

The total metals results in Table 16-3 show that some waste rock materials in the waste rock dump have total arsenic (As), total chromium (Cr) and total nickel (Ni) concentrations greater than the applied NEPC (1999) guideline level for soils in "open" spaces. Despite this, the immediate solubility of these and other metals is very low, as indicated in Table 16-4, which shows that the soluble metal concentration in all samples is well below the applied ANZECC (2000) guideline values for livestock drinking water. These results support the pre-mining geochemical assessment of these materials with respect to their limited ability to generate leachate waters with high metal concentrations.

Overall, the validation sampling of the waste rock dump has supported the predictions made in the pre-mining geochemical assessment that the waste rock material contained within the dump is non-acid forming, with little capacity to generate acid, and should generate pH-neutral runoff with a low concentration of soluble metals and salts.

16.5.6 Waste rock management

Waste rock mined during the construction of the decline will be stockpiled temporarily, and subsequently placed in the open pit or used for underground stabilisation of mined out stopes. There will be no long-term storage of waste rock on the surface, other than the current stockpile. However the waste rock in the current waste rock stockpile will be used as road base, and its suitability for this purpose has been confirmed (i.e. tests that contribute to assessing whether or not the material is non-acid forming). Thus the existing stockpile is expected to be reduced in size.

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16.6 Commitments

Terra Gold commits to all heath and environmental hazardous materials being disposed of in accordance with relevant legislation.

Terra Gold commits to the maintenance of mobile ablution facilities and sewage disposal in accordance with Department of Health and Community Services guidelines.

Terra Gold commits to utilising a mobile fuel tanker and bunding fuel storage areas in accordance with AS1940 - 2004 Storage and Handling of Flammable Liquids and Combustibles.

Terra Gold commits to storing and handling explosives in accordance with AS2187.1-1998 Explosives - Storage, transport and use.

Terra Gold commits to handling all hazardous and dangerous goods in accordance with the relevant MSDS. Copies of all relevant MSDSs will be held at Maud Creek mine site.

Terra Gold commits to storing all fuel, chemicals and hazardous materials as per relevant Australian Standards.

Terra Gold commits to transporting dangerous goods in accordance with the Australian Code for the Transport of Dangerous Goods by Road and Rail (1998)

Terra Gold commits to maintaining a register of all hazardous materials imported to the site or generated as a result of site activities at Maud Creek.

Terra Gold commits to training all personnel in the appropriate handling, storage, disposal and containment practices for chemicals and hazardous goods, as relevant to their position.

Terra Gold commits to providing all personnel with appropriate safety equipment required for the correct handling of hazardous materials.

Terra Gold commits to providing spill response kits at Maud Creek mine site.

Terra Gold commits to developing an Emergency Response Procedure to ensure that the appropriate action is taken to minimise the environmental impact caused by incidents involving hazardous materials.

Terra Gold commits to placing waste rock mined from the portal during construction of the decline and underground mine development into the base of the open-pit or into a temporary stockpile for later placement underground or within the pit void.