

PANCONTINENTAL MINING LIMITED



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CROYDON GOLD MINE

**1996 (AMENDED)
DECOMMISSIONING PLAN FOR ML5248**

Prepared by Woodward-Clyde
May 1997

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Woodward-Clyde 
Engineering & sciences applied to the natural & built environment

Rele

PANCONTINENTAL MINING LIMITED ACN 009 712 092

19 May 1997
Project No. A3200280\0005

Department of Mines and Energy
159 Walsh Street
MAREEBA QLD 4880



Attention: Dr. Mike Gilbert

Dear Mike

**RE: CROYDON GOLD MINE 1996 (AMENDED) DECOMMISSIONING
PLAN (ML 5248)**

As you are aware, RGC Limited (RGC), on behalf of Pancontinental Mining Limited (Pancon), has initiated an upgraded rehabilitation program on ML 5248, associated with the Croydon Gold Mine. You will also be aware that prior to these additional works, the site was subject to the requirements of the Department of Mines and Energy (DME) approved 1993 Decommissioning Plan which outlined a proposed lease relinquishment program based on a detailed environmental monitoring plan. However, upon acquisition of the controlling interest in Pancon, RGC recognised that the 1993 Decommissioning Plan was inadequate to achieve satisfactory lease relinquishment conditions based on RGC's corporate environmental standards. Following a detailed site assessment, an upgraded Decommissioning Plan has been prepared and is attached.

It is proposed that the 1996 (Amended) Decommissioning Plan supersedes the 1993 plan and that the criteria contained within it be used by the DME to assess the success of the rehabilitation works. RGC, on behalf of Pancon, hereby seeks DME approval of the 1996 (Amended) Decommissioning Plan and attach herein three copies of the document.

Should you have any queries in relation to the above, please contact the undersigned.

Yours faithfully

Pancontinental Mining Limited

General Manager - Environment

- CC. - Croydon Shire Council
- Department of Lands
- CTPI 49-Sch4
- CTPI 49-Sch4

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INTRODUCTION

Pancontinental Mining Limited (Pancon) is the holder of ML 5248 situated immediately to the west of Croydon township. ML 5248 formed part of the Croydon Gold Project and was mined during the late 1980s subject to mining lease conditions contained in Appendix A. In 1995, RGC Limited (RGC) acquired a controlling interest in Pancon and immediately commenced reviewing the environmental performance of all Pancon sites.

Upon reviewing the rehabilitation status of ML 5248, RGC found that the rehabilitation works conducted to date were not adequate in meeting RGC's corporate environmental standards. In addition, it was found, based on these corporate standards, that the 1993 Decommissioning Plan (Woodward-Clyde, 1993) did not comprehensively address the environmental issues or meet the overall rehabilitation objectives for the site. This review provided the catalyst for updating the existing 1993 Decommissioning Plan.

The overall rehabilitation objective adopted for ML 5248 is:

- to secure the site for the long term by inhibiting the formation of Acid Mine Drainage (AMD) and subsequent release of AMD products into the surrounding environment; and
- to enhance the overall stability and sustainability of the developed landforms.

This objective is to be achieved by isolating AMD producing material either through disposal in open pits, or capping with low permeability constructed covers, and in conjunction with these works, to reprofile the existing landforms, as appropriate, and to revegetate final surfaces (either covered or uncovered). Additionally, all practical measures are to be taken to ensure the safety of the site for the public and livestock. A rehabilitation works program was carried out within ML 5248 in 1996 based on these general rehabilitation requirements.

This document has been prepared to support the process for relinquishment of ML 5248, and incorporates the following:

- a description of the 1996 rehabilitation works program including descriptions of site assessments carried out to confirm key rehabilitation design criteria, of options identified for rehabilitation of the mining-related landforms and of the basis for selection of the adopted works program;
- specification of an environmental monitoring program to assess the environmental performance of the rehabilitation works completed and appropriate performance criteria, as the basis on which relinquishment of the lease will be sought; and
- an outline of relevant requirements of the Department of Mines and Energy (DME) and Department of Environment (DoE) related to environmental security of the site and contaminated lands issues.

It is intended that this document be known as the 1996 (Amended) Decommissioning Plan for ML 5248, that it replaces the existing 1993 Decommissioning Plan, and that all commitments made in the 1993 plan be superseded by those detailed in this document. It is also intended that this document fulfills the role of an Environmental Management Overview Strategy (EMOS) and Closure Plan for the site.

To address the various requirements of the document, as outlined above, the 1996 (Amended) Decommissioning Plan has been structured as follows:

Section 2.0: provides a description of the site, including underlying land use and land capability;

Section 3.0: provides a description of the mining activities undertaken within the site;

Section 4.0: describes the site assessment that has been carried out to define the current rehabilitation works program for ML 5248, and the criteria and constraints on which the design of these rehabilitation works was based;



- Section 5.0: details the environmental monitoring program that will be maintained to objectively assess the performance of the rehabilitation works;
- Section 6.0: defines the proposed lease relinquishment criteria;
- Section 7.0: describes the documentation that will be prepared and submitted to DME to support the application for lease relinquishment; and
- Section 8.0: outlines the organisation and management details for the rehabilitation project.

SITE CHARACTERISTICS

2.1 SITE LOCATION AND DESCRIPTION

ML 5248 is located to the north west of the township of Croydon in North Queensland (refer Figure 1). The lease comprises an area of some 1.7 km² and extends along a corridor adjacent to the south side of the Normanton Developmental Road.

The lease area is dominated by mining related landforms, including pits and waste dumps. Generally these landforms (with the exception of the pits) have revegetated with grasses and shrubs (either from past sowing activities or by natural colonisation). These landforms, however, have been subject to some disturbance through erosion and livestock or vehicle trafficking. All open pits hold water, recharged either through direct rainfall, runoff or from groundwater entry. Each pit is surrounded by earthfill safety bunding and outer fencing.

Undisturbed areas surrounding the mining landforms, but within ML 5248, are generally grassed and/or partially covered with trees.

ML 5248 is located within the catchment of Slaughteryard Creek. This catchment drains a number of smaller tributaries, including Town Creek (from the Croydon township) and Belmore Creek (located within Belmore Station to the west). The site drainage is as follows:

- Eastern portion - southward, directly via Slaughteryard Creek.
- Western portion - generally westward via minor drainages to Belmore Creek thence into Slaughteryard Creek to the south west of Croydon.

An area of higher relief between the eastern and western portions of the lease acts as a drainage divide between these areas.

2.2 LAND TENURE

The owners of the land underlying ML 5248 are:

- Eastern Portion Town Common, Croydon Shire Council (CSC)
- Western Portion Crown Land, Department of Lands (DoL)

These landholders have indicated a desire to retain control over these land areas following relinquishment.

2.3 LAND USE AND CAPABILITY

The pre-mining land use within ML 5248 comprised cattle grazing on the western portion of the lease, with low levels of grazing on the eastern portion. Some cattle grazing continues in the western portion of the lease.

An assessment of pre-mining land capability was undertaken by Woodward-Clyde and reported in Woodward-Clyde (1993), in accordance with Rosser et al (1974). The assessment comprised inspection and sampling of soils not disturbed through mining within and adjacent to ML 5248. Based on this assessment, the pre-mining land capability of ML 5248 was determined as Class VII. Rosser et al (1974) defines Class VII as land which is not suitable for cultivation but on which pastoral use is possible only with careful management and for which pasture improvement on Class VII land involving the use of machinery is considered impracticable.

From 1990 to 1995 the Croydon Shire Council (CSC) used water contained within the Golden Butterfly North Pit (refer Figure 1) to supplement the existing town water supply, which was based on a borefield located on Slaughteryard Creek downstream from the lease area. Water was pumped from the pit to a tank (Town Tank) located on a hill at the south-eastern boundary of the lease area, for reticulation to the township. During 1995, a new water supply dam was constructed to the north of Croydon and is now used as the town water supply. The Golden Butterfly North Pit and the borefield are no longer used to supply water to the township. However, the water supply reticulation system from the borefield, including water pipes, tank and pumps, has been retained.



PROJECT DESCRIPTION

The Croydon Gold Project was operated between 1987 and 1990 by an unincorporated joint venture between Central Coast Exploration NL (CCE) and Pancon. Mining took place on several leases, including ML 5248, to the west and north-west of Croydon. Ore processing was carried out at facilities located on CCE leases. Mining and ore processing on both Pancon and CCE leases was carried out by Barrick Mine Management (BMM).

The Pancon operation commenced in December 1988 with mining from the Golden Butterfly Pit, located within the eastern portion of ML 5248, as shown on Figure 1. The mining operation was subsequently expanded with the development of the Golden Butterfly North Pit (adjacent to Golden Butterfly) and the Content and Lady Isabella pits located within the western portion of the lease area. Pancon's mining operation at Croydon ceased in April 1990, with processing of ore from these leases completed in August 1990. In total, approximately 445 000 tonnes of ore was treated to produce some 63 000 ounces of gold.

Following the cessation of mining in 1990, a portion of the original lease area was relinquished by Pancon. Only those areas covering the open pits and waste dumps, plus a connecting corridor, were retained. The current lease area is indicated on Figure 1.

On completion of mining, ML 5248 comprised the following mining related landforms:

- Golden Butterfly Pit and surrounds;
- Golden Butterfly North Pit;
- Golden Butterfly Waste Dump;
- Content Waste Dump;
- Content Pit and surrounds; and
- Lady Isabella Pit.

The locations of these landforms are shown on Figure 1.

In addition, mining hardstand areas (including old ore stockpile and crusher pad areas), a haul road and numerous open exploration drill holes related to the Pancon operations remained within the lease area. A number of open shafts from historical (i.e. pre-1900) mining activities were also present within the area.

The locations of the mining related landforms, as described above with respect to land tenure are described in Table 1 below.

TABLE 1
Underlying Land Tenure For Mining Related Landforms

LOCATION	MINING LANDFORM	BACKGROUND LAND TENURE
Eastern Portion of Lease Area	Golden Butterfly Pit Golden Butterfly North Pit Golden Butterfly Waste Dump	Town Common, Croydon Shire Council
Western Portion of Lease Area	Content Pit Lady Isabella Pit Content Waste Dump	Crown Land, Department of Lands

Hardstand areas, the haul road, drill holes and shafts occur within both land tenure areas.

4.1 BACKGROUND

Planning for rehabilitation of ML 5248 commenced in November 1992 at a site meeting involving representatives from Pancon, DME and Woodward-Clyde. During this meeting the key environmental concerns relating to the lease area were identified, as follows:

- development of acidic water within open pits;
- discharge of acidic water into Slaughteryard Creek from the Golden Butterfly waste dump and adjacent areas;
- off-lease movement of groundwater from the Golden Butterfly pits; and
- erosion and potential instability of existing mining related landforms.

Pancon committed, at that time, to address each of these concerns. In 1993, Pancon initiated a rehabilitation program which involved the following works:

- Golden Butterfly Waste Dump - reprofiling of the waste rock dump surface, including flattening of batters to a nominal slope of 3(H) to 1(V); construction of cover layers over plateau areas of the waste dump; construction of drainage runoff control areas and construction of stormwater diversion bunds.
- Content Waste Dump - reprofiling of the western batters to a nominal 3(H) to 1(V) slope; construction of cover layers over this batter and clean-up of waste rock piles adjacent to the dump.
- Open pits (Golden Butterfly, Golden Butterfly North, Lady Isabella and Content) - construction of peripheral safety bunds and fencing around each pit and erection of warning signs.



Revegetation of the waste dump surfaces was carried out by hand broadcasting of seed following completion of the earthworks portion of the program. Species used included improved pasture grasses and legumes and native shrubs.

4.2 SITE ASSESSMENT

Environmental monitoring carried out within the site following Pancon's initial (1993) rehabilitation program (monitoring data reported in Woodward-Clyde, 1994 and 1996) indicated that these works were inadequate to achieve the rehabilitation objective as outlined in Section 1.0, with evidence of continuing acid drainage and erosion from the waste dumps. Upon acquisition of the controlling interest in Pancon, RGC commissioned a detailed site assessment to identify the nature and extent of the problem areas. This site assessment formed the basis for design and implementation of a revised and upgraded rehabilitation works program.

The scope of the site assessment was as follows:

- (i) identification of acid producing materials within the existing waste dumps and identification of other visible areas of potentially acid producing material, including former ore stockpile and associated hardstand areas;
- (ii) characterisation of surface and groundwater within the site, with particular emphasis on discharge from the southern portion of the lease; and
- (iii) review of the existing environmental monitoring program currently in place for the tenement (contained within the 1993 Decommissioning Plan).

The site assessment was carried out in December 1995 and April 1996 by Woodward-Clyde, on behalf of RGC.

A description of the methodology and results of these works is provided below.



4.2.1 Waste Rock Characterisation

The purpose of this program was to identify the various rock types within the waste rock dumps and surrounding areas and, based on field and laboratory testing, to assess the acid producing potential of these materials.

The investigation was concentrated within areas that were known or suspected to contain acid producing materials. These areas included:

- Golden Butterfly waste dump and near surrounds; and
- Content waste dump and near surrounds.

The waste dump surrounds incorporate former hardstand and ore stockpile areas and drainage alignments which have been potentially impacted by waste dump areas.

The program comprised excavation of forty-nine (49) test pits within the above areas. Materials recovered from each pit were geologically logged, and tested for pH and electrical conductivity (EC) in the field. Representative samples of each identifiable waste rock unit were collected for laboratory analysis. Analysis for total sulphur and acid neutralising capacity (ANC) was carried out on these samples for estimation of the maximum potential acidity (MPA) and net acid producing potential (NAPP).

Classification of the waste rock materials into three broad categories was carried out using procedures developed through Canadian research (Brodie *et al.*, 1991; Smith & Barton-Bridges, 1991; Ferguson & Morin, 1991; and Ferguson & Robertson, 1994). The three categories used are as follows:

MPA : ANC Ratio	Net Acid Producing Potential
> 1:1 and total sulphur > 0.25%	Potentially Acid Producing
Between 1:3 and 1:1	Indeterminate
< 1:3 and total sulphur < 0.25%	Non Acid Producing

Note: Where waste rock has been exposed to oxidation, as in the case of the Croydon site, the testwork is unable to accurately gauge the degree to which the waste has already oxidised. As a result, sulphate oxidation products which are no longer acid producing are included in the maximum potential acidity. Therefore the net acid producing potential (NAPP) may be over estimated.

These categories, in conjunction with the field testing (pH and EC) results, have been used to characterise the waste rock materials sampled during the investigation program. The relationship developed between lithology and acid producing potential is described below:

4.2.1.1 Golden Butterfly Waste Dump

Four waste types were identified within the Golden Butterfly dump. These waste types, and acid producing potential are described as follows:

Red Sand/Sandstone waste

This unit exhibited a range in paste pH and EC across the dump, from 2.3 to 5.5 and 21 to 1770 $\mu\text{S}/\text{cm}$, respectively. One test pit was excavated to the north of the dump in what was considered to be the natural soil profile. The pH of this material was 5.2 and the EC, 9 $\mu\text{S}/\text{cm}$.

Laboratory testwork was conducted on two samples from this unit. Both samples had low total sulphur and ANC with a corresponding NAPP of - 0.19 kg H_2SO_4 . Due to the very low total sulphur content, this unit was classified as *non acid producing*.



White Granite waste.

Paste pH and EC results for this waste unit ranged from 3.9 to 5.7 and 50 to 150 $\mu\text{S}/\text{cm}$, respectively. The laboratory testwork indicates a low total sulphur content ($<0.01\%$) and ANC ($<0.5 \text{ kg H}_2\text{SO}_4/\text{tonne}$). The NAPP of the samples tested indicates an *indeterminate acid producing potential* due to the very low total sulphur content.

Clay

The clay materials were encountered over the surface of the dump. Field testing for paste pH and EC indicated a range of 4.5 to 6.7 and 160 to 600 $\mu\text{S}/\text{cm}$, respectively for these materials. No samples were collected from this unit. Due to the close proximity of the layer to the surface and the expected resulting oxidation and soil leaching processes, it is expected that this unit would be *non acid producing*.

Grey Granite waste

Paste pH and EC results for this unit ranged from 2.3 to 5.2 and 130 to 5210 $\mu\text{S}/\text{cm}$, respectively. This unit was highly variable in the degree of oxidation, grain size and colour. Visible sulphide mineralisation was common, as were oxidation products (iron oxides, sulphates etc.). The initial rehabilitation program has placed oxidised acidic material, previously on the surface, under clay and sand capping. The effectiveness of this capping is difficult to assess because the condition of the waste prior to capping is not known. However, the material under the capping in the test pits was generally acidic, moist and showed signs of sulphide oxidation. Surface outcropping of this waste type occurred within the northern portion of the dump.

Laboratory analysis of this unit indicates relatively high total sulphur content (0.45 to 1.81%) and low acid neutralising capacity ($<0.5 \text{ kg H}_2\text{SO}_4 / \text{tonne}$). Both samples tested recorded positive NAPP results placing them in the *potentially acid producing* category.

4.2.1.2 Content Waste Dump

Three waste types were identified within the Content Waste dump area. These waste types and associated acid producing potential are described below. The results of field pH and EC are noted for each of these materials.

Brown Sandy Topsoil.

The field pH and EC of this unit ranged from 4.1 to 5.3 and 14 to 15 $\mu\text{S}/\text{cm}$, respectively. Laboratory testwork on one sample from the unit indicated a low total sulphur content ($<0.05\%$) and low ANC (2.5 kg $\text{H}_2\text{SO}_4/\text{tonne}$). Calculation of the NAPP shows an *indeterminate acid producing potential* for the sample tested.

Red Gravelly Clay

Field pH and EC ranged from 2.9 to 4.9 and 136 to 1053 $\mu\text{S}/\text{cm}$, respectively for the unit. It appears that one test pit has possibly been contaminated by acidic leachate from the granite waste immediately below the red gravelly/clay layer, accounting for the elevated EC and low pH. Laboratory testwork undertaken on a sample of this waste type indicated low total sulphur and ANC. The NAPP category for the sample tested is *indeterminate*.

Grey Granite waste

Paste pH and EC ranged from 1.9 to 5.5 and 67 to 4570 $\mu\text{S}/\text{cm}$, respectively for this unit although the colour and degree of oxidation varied across the dump. This may be due to mixing of wastes from both the Content and Lady Isabella pits.

Two test pits located on the south west batter exhibited low pH and high EC. Laboratory testwork on a sample from this area showed an elevated sulphur content and a corresponding positive acid producing potential. The wastes within this area of the dump may be described as *potentially acid producing*. Conversely, samples of this waste rock type from other areas of the dump showed higher pH, lower EC and can be classified as *non acid producing*.

The heterogeneous nature of the dump and possibility that the waste rock has been sourced from two different pits indicates that isolated pockets of acid producing waste may be present within the dump.

4.2.1.3 Other Areas

Stockpile Area

The stockpile area is located to the west of the Golden Butterfly pit, between the pit and Slaughteryard Creek (refer Figure 1). It drains directly to the creek immediately upstream of the lease boundary. The soil profile consisted of red sand/sandstone up to 1.5m deep overlying granite waste. The red sand/sandstone exhibited similar characteristics to the Golden Butterfly dump sand/sandstone waste unit (refer Section 4.2.1.1) and is considered to be of *indeterminate acid producing potential*. The granite unit recorded field paste pH and EC of 3.4 and 200 $\mu\text{S}/\text{cm}$, respectively. These results and observed physical characteristics of the grey granite unit suggests similarities with the Golden Butterfly dump grey granite waste unit. It is expected that this material would be *potentially acid producing*.

Haul road

The haul road runs in a northerly direction between the Golden Butterfly and Content pits. One test pit was excavated into the haul road to the north east of the Golden Butterfly dump. Compaction of the haul road area restricted excavation to a maximum depth of 0.5 metres. The material used for the construction of the haul road appeared to be a mixture of granitic waste, sand and red gravelly clay. The field paste pH and EC was 4.0 and 300 $\mu\text{S}/\text{cm}$, respectively. The granitic material at the site tested is expected to be *potentially acid producing*.

Western side of the Content Pit

This area is located to the west of the Content Waste Dump and was levelled during reshaping of the Content Waste Dump. This area is located adjacent to the Content waste dump batter from which acidic discharge has been previously noted. Granite waste covers the surface of this area to a depth of up to 1 m with some surface salt crusting also noted.

The paste pH and EC of the granite wastes varied from 3.1 to 5.3 and 166 to 445 $\mu\text{S}/\text{cm}$, respectively. These wastes are similar to the grey granite wastes noted within the Content waste dump and are therefore considered to be *potentially acid producing*.

Beneath the granite waste, the natural soil profile was encountered (sandy A horizon and gravelly B horizon). Laboratory analysis of the granite waste from this area indicated that the sample tested has a low total sulphur (0.03%) and ANC (2.5 kg $\text{H}_2\text{SO}_4/\text{tonne}$) and is *non acid producing*.

This entire area is acting as a collection area for acidic leachate previously generated from the Content dump and may contain some pockets of material which are *potentially acid producing*.

Drainage channel.

A drainage channel (tributary of Slaughteryard Creek) is located on the eastern edge of the Golden Butterfly Dump. This channel acts as a collection area for drainage from the Golden Butterfly Dump. Test pits were excavated within the channel, and the materials encountered ranged from red clay to brown sandy clay. The paste pH and EC ranged from 2.3 to 2.7 and 800 to 17,200 $\mu\text{S}/\text{cm}$, respectively. Laboratory testwork indicates the red clay on the surface of the channel has a relatively high total sulphur content (1.2%). It also contains ions which have the potential to contribute to acid generating reactions. These soils are considered to be affected by the drainage from the waste dump, contaminated by by-products of AMD occurring within the dump. Despite this level of introduced contaminants, it is considered that these materials are inherently *non acid producing*.



Western side of the Content Pit

This area is located to the west of the Content Waste Dump and was levelled during reshaping of the Content Waste Dump. This area is located adjacent to the Content waste dump batter from which acidic discharge has been previously noted. Granite waste covers the surface of this area to a depth of up to 1 m with some surface salt crusting also noted.

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This entire area is acting as a collection area for acidic leachate previously generated from the Content dump and may contain some pockets of material which are *potentially acid producing*.

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Sandy Area to the North of the Golden Butterfly pit.

One pit was excavated in this area to determine the existing soil profile in the vicinity of the dump. The profile consisted of uniform red sand with a pH of 5.2 and low EC (9 μ S/cm).

The acid generating potential of this material was not determined; however, based on the non-mineralised nature of the soil, it is likely to be *non acid producing*.

4.2.1.4 Summary of Results

(i) Golden Butterfly Waste Dump

The results of the waste characterisation program within the Golden Butterfly Waste dump area indicate the following relationship between material type and acid producing potential:

Material	Potential for Acid Production
Red Sand/Sandstone	Indeterminate
White Granite	Indeterminate
Clay	Non Acid Producing*
Grey Granite	Potential Acid Producing

* Inferred classification - no confirmation testwork carried out.

The assessment indicates the profile within the waste dump comprises a surface soil layer (clay and red sand) overlying grey granite waste. At a number of sites, sandstone or white granite materials were encountered beneath the surface soils. It is believed that the sandstone and white granites originated from the Golden Butterfly North Pit and that these occur primarily within the south western portion of the dump. However, the investigation indicates that this material is scattered throughout the dump.

(ii) Content Waste Dump.

A relationship developed between material type and acid producing potential for the Content waste dump, based on the waste characterisation program, is as follows:

Material	Potential for Acid Production
Brown Sandy Topsoil	Indeterminate
Red Gravelly Clay	Indeterminate
Grey Granite	Generally non acid producing but with some localised acid producing areas

The investigation indicates the profile comprises a brown sandy topsoil layer overlying grey granite waste. Thin layers of red gravelly clay were encountered in some areas. Grey granite was encountered at the dump surface in a number of locations.

(iii) Other Areas

Waste rock characteristics within other areas within the lease area are as follows:

Haul Road: Waste rock materials within the haul road comprise a mixture of granite, sand and red gravelly clay. The mixed waste material is considered to be potentially acid producing, however, due to the level of compaction within the haul road formation, these materials are considered to be effectively encapsulated.

Stockpile Area: The stockpile area comprises surficial red sand/sandstone overlying grey granite, similar to those encountered within the Golden Butterfly waste dump. The sand/sandstone are of indeterminate acid producing potential and the granites considered to be potentially acid producing.

Western Side of Content Pit: This area is underlain generally by grey granite waste, similar to that encountered within the Content dump. Therefore this area is potentially acid producing

Drainage Channel: This tributary of Slaughteryard Creek within the channel area, downstream from the Golden Butterfly waste dump, comprises red clay to brown sandy clay. This channel is considered to be an area of contamination due to acidic drainage from the waste dump. The soils themselves are, however, considered to be non acid producing.

North of Golden Butterfly Pit: The natural soils encountered within this area are considered to be non acid producing.

From the above assessment, estimates of the relative volumes of non acid producing and potentially acid producing (including indeterminate) waste rock have been made and are presented in Table 2. These estimates are inferred on the basis of the area of surface exposure of the individual waste rock units.

TABLE 2
Estimate of Waste Rock Volumes

Site	Volume Non acid Producing Rock (x 10 ³ m ³)	Volume Potential Acid Producing Rock (x 10 ³ m ³)	Total Volume (x 10 ³ m ³)
Golden Butterfly Dump	980	800	1780
Content Dump	140	220	360
Stockpile Area	-	27	27
Haul Road	n.c.	n.c.	n.c.
Western Side of Content Pit	-	25	25
Drainage Channel	-	12	12
Sandy Area to North of Golden Butterfly Pit	n.c.	n.c.	n.c.

n.c., Not Calculatable

- Not Present

4.2.2 Characterisation of Surface and Groundwater Quality

A water quality monitoring program based on the requirements of the 1993 Decommissioning Plan commenced in February 1994. Monitoring was also carried out by (the operator), BMM, during mining with data available from 1989, and by Croydon Shire Council (CSC) with data from 1986. The following describes the surface and groundwater monitoring carried out and provides a brief interpretation of the available data.

4.2.2.1 Surface Water

Surface Water Sampling Sites

Surface water sampling has been carried out from the sites listed in Table 3. These sites are located on Figures 1, 2 and 3.

TABLE 3
Surface Water Monitoring Sites

SAMPLING SITE IDENTIFICATION	LOCATION
SW1	Adjacent borefield causeway on Slaughteryard Creek, downstream of lease.
SW2	Junction of Slaughteryard Creek and MLA boundary
SW3	Upstream of Golden Butterfly Waste Dump on Slaughteryard Creek
SW3A	Adjacent to Golden Butterfly Waste Dump
SW4	Upstream of Golden Butterfly Waste Dump within small CSC dam
Golden Butterfly Pit	Western Edge of Pit
Golden Butterfly North Pit	Western Edge of Pit
Content Pit	Western Edge of Pit
Lady Isabella Pit	Western Edge of Pit

Monitoring of surface water by CSC was carried out at the following sites:

- Borefield Causeway
- Slaughteryard Creek near bore
- Slaughteryard Creek
- Golden Butterfly Waste Dump Runoff
- Above Golden Butterfly Waste Dump
- Town Creek (200 m above Town Creek and Slaughteryard Creek confluence).

Accurate locations of the above sampling sites are not available and therefore they have not been indicated on the figures.

Surface Water Quality Analyses and Data Quality

Surface water quality analyses for each of these sites included the following suite of parameters:

pH	Arsenic
Total Dissolved Solids	Cadmium
Calcium	Copper
Magnesium	Iron
Total Solids	Lead
Nitrate	Manganese
Sulphate	Mercury
	Molybdenum
	Nickel
	Zinc

The pre-1993 data was collected by either the mine operator or CSC and has been compiled from unconsolidated data sheets and reports. No detail on sampling procedures and chain of custody protocols used during this sampling is available and therefore the



quality of the data obtained is unknown. Accordingly, these data are used for comparison only, and not for interpretation.

The post-1993 sampling has been carried out in accordance with the procedures contained in the 1993 Decommissioning Plan. As a result, consistent and appropriate handling protocols and laboratory analyses were used (with relevant documentation available). Post-1993 surface water quality data are therefore considered of adequate quality to allow interpretation.

Surface Water Quality Interpretation

A compilation of surface water quality data for the above sample sites and sampling periods is provided in Appendix F. Graphical representation of selected analytes based on this monitoring data is also provided in Appendix F. Interpretation and comparison (as appropriate) is provided below.

(i) Surface Drainages

From the post-1993 monitoring, the surface drainages located downstream of the Golden Butterfly Waste Dump (SW1, SW2 and SW3A) indicate similar water quality trends. Typically, these waters are characterised by low pH and high conductivity, with elevated levels of arsenic, cadmium, copper and iron, generally in excess of ANZECC (1992) guidelines for livestock (cattle) watering. This water quality indicates the presence of acidic drainage, which is considered to be sourced principally from the Golden Butterfly Waste Dump. It is noted also that surface water quality improves with distance from the Golden Butterfly waste dump. This appears to be a result of dilution from flow events in Slaughteryard Creek.

Two surface water sampling sites, SW3 and SW4, located upstream of the Golden Butterfly Dump on Slaughteryard Creek, were established in 1993 and 1996 respectively. One sampling event was carried out at each of these sites as part of the recent site assessment. (No sampling had previously been carried out at either site.) Surface water sampled at both sites was fresh (neutral pH and low conductivity) with no elevated metals.

This water complies with ANZECC (1992) guidelines for livestock (cattle) watering. It is considered that these water qualities would be characteristic of background conditions.

In general, the pre-1993 monitoring results are similar to more recent monitoring at Sites SW3 and SW4 and therefore are considered representative of background conditions. Many of these sites were located on Slaughteryard Creek downstream from the Golden Butterfly waste dump, and were monitored during or prior to 1988 (i.e. pre-mining). Therefore they were not subject to deterioration as a result of the mining activity. However, a distinct deterioration of water quality was recorded during this pre-mining period specifically at the Borefield Causeway and the Slaughteryard Creek Near Bore sites. There is no indication, however, as to the cause or source of this deterioration in water quality.

(ii) Pits

Golden Butterfly Pit-

Monitoring data indicates that water quality in the Golden Butterfly pit is poor. pH is low and EC high, with elevated metals including copper, zinc, nickel, cadmium and arsenic. Water quality appears to remain relatively stable between monitoring events. It is concluded that this poor water quality is triggered by oxidation of sulphides within exposed pit walls and dumped material within the confines of the pit.

Golden Butterfly North Pit-

Water quality in the Golden Butterfly North pit is neutral to slightly acidic and fresh, with negligible levels of metals. (This water has been used in the past to supplement the Croydon township water supply.)

Content Pit-

Content pit water has been acidic and brackish over the period of monitoring. Metals including cadmium and copper are slightly elevated. However, overall water quality is generally within livestock (cattle) watering guidelines (ANZECC, 1992).



Lady Isabella Pit-

Similar water quality trends to the Content pit have been observed, with low pH, elevated conductivity and slightly elevated metals. This water quality, however, is generally within livestock (cattle) watering guidelines (ANZECC, 1992).

4.2.2.2 Groundwater

Sampling Sites

Six groundwater monitoring bores, labelled GBMB1 to GBMB6, were established in early May 1989 to monitor any possible hydraulic connection between the Golden Butterfly Pit and the Slaughteryard Creek borefield. These bores are located to the south of ML 5248 along a line sub-parallel to Slaughteryard Creek, as shown on Figure 1.

In addition to the GBMB series bores, two bores (labeled BH1 and BH2) were installed in November 1995 on either side of the Golden Butterfly Pit, as shown on Figure 2. These bores were installed to monitor groundwater quality proximal to the pit.

Groundwater Quality Analyses and Data Quality

Groundwater quality analysis for each of these sites included the following suite of parameters:

pH	Arsenic
Total Dissolved Solids	Cadmium
Conductivity	Copper
Chloride	Iron
Nitrite	Lead
Sodium	Manganese
Carbonate	Mercury
Sulphate	Zinc

As with surface water quality, pre-1993 data (i.e. prior to the 1993 Decommissioning Plan) are "uncontrolled", and therefore the quality of the data obtained is unknown. Accordingly, these pre-1993 data are used for comparison only and not for interpretation.

Post -1993 data have been collected using the sampling procedures and chain of custody protocols as identified in the 1993 Decommissioning Plan. These data are therefore considered of adequate quality to allow interpretation.

Groundwater Quality Interpretation

A compilation of groundwater quality data for the above sample sites and sampling periods is provided in Appendix F. Graphical representation of selected analytes, based on this monitoring data, is also provided in Appendix F. Interpretation of the post-1993 groundwater quality data and comparison with the pre-1993 data is provided below.

(i) GBMB Series Bores

The GBMB Series bores intersect the sandstone unit associated with the Slaughteryard Creek borefield. This unit differs from the granite sequences in which the Golden Butterfly Pit is located. Distinctively, the granite unit comprises an isolated volcanic plug or vent in which mineralisation has occurred, and is considered to be of significantly lower permeability than the sandstones. In a regional context, the granite unit is of considerably lesser extent than the sandstones.

Groundwater quality from the GBMB Series bores can be characterised generally as being near neutral to slightly acidic, slightly brackish to brackish with slightly elevated metals concentrations (including copper and iron). Some variation in pH is noted both spatially and temporally, with a range of pH from 5 to 8. No clear explanation for this is apparent, other than potential influence from surface water recharge. (It is noted that a number of the bores are located close to the Slaughteryard Creek channel and therefore subject to inundation during flow events).

The following observations are made from a comparison between the pre- and post-1993 data:

- GBMB1- Groundwater was more acidic in the pre-1993 period with greater levels of arsenic, iron and zinc.
- GBMB2 - Sulphate levels were generally lower in the pre-1993 period.
- GBMB3 - Slight reductions in TDS, arsenic and sulphate were noted in the post - 1993 period. (pH and conductivity during the March 1994 sampling were anomalous against the other recorded parameters and the indicated trends of the previous monitoring. These results are therefore considered suspect.)
- GBMB4 - Slight pH variations were recorded post-1993 (as with other sites). Sulphate levels were elevated, however, with no corresponding increase in metals concentrations.
- GBMB5 - Generally groundwater quality pre-1993 and post-1993 is consistent. However, similar to GBMB4, in March 1994, the pH and conductivity are both higher than the pre-1993 trends.
- GBMB6 - Pre-1993 and post-1993 water quality data are generally consistent.



(ii) BH Series Bores

Groundwater levels within bores BH1 and BH2 show a considerable difference. The water level in BH1 appears to correspond broadly with the water level within the Golden Butterfly pit. The groundwater level within BH2 corresponds to the groundwater depth in GBMB1 located approximately 50 m to the southwest in Slaughteryard Creek and suggests a shallow, unconfined aquifer. Although both bores were constructed within granite, BH1 intersected competent, intact sequences while the granites within BH2 were highly fractured. (It is inferred that BH2 is located near the contact between the granite and sandstone units.) It is therefore indicated that the bores intersect two different and possibly unconnected aquifers. It is therefore likely that BH2 intersects the aquifer which hosts the Slaughteryard Creek borefield system.

Groundwater quality measured from these bores indicate near neutral pH for BH1 and low pH for BH2. Low salinity was observed in both bores, with slightly elevated sulphate levels. All other parameters were of similar magnitude and generally of the same order as the existing bores GBMB1 to GBMB6.

Given the similar water level between BH1 and the Golden Butterfly Pit, hydraulic connection may be assumed. However, due to the significant difference in pH levels, it is considered that the extent of mixing is limited, therefore, low permeabilities within the granite sequences are indicated (although no explanation can be given as to the reason for lower pH within BH2 than BH1). Furthermore, there is no similarity in water quality between BH2 and the Golden Butterfly Pit, other than pH. Indeed, due to the higher water level in BH2, nett groundwater movement from the area of BH2 towards the pit would be likely.



4.2.2.3 Summary

- (i) Acidic drainage is occurring from the Golden Butterfly waste dump. This is reflected in surface water quality within Slaughteryard Creek downstream of the dump, which is of low pH, high conductivity and elevated metals. This water quality does not meet ANZECC (1992) guidelines for livestock (cattle) watering, and is of poorer quality than surface water quality monitored in Slaughteryard Creek upstream of the dump.
- (ii) AMD is occurring in the Golden Butterfly, Content and Lady Isabella pits, characterised by low pH and elevated conductivity. Water quality is poorest in the Golden Butterfly pit.
- (iii) Groundwater quality within the sandstone aquifer located within the Slaughteryard Creek drainage area downstream from ML 5248 (i.e. host sequence of the Slaughteryard Creek borefield) indicates marginal water quality from a water supply perspective. However, the data available indicate no deterioration of groundwater quality since the time of mining, which suggests that connection between the aquifer and the Golden Butterfly pit does not exist.
- (iv) It is considered, based on relative groundwater levels, that there is possible groundwater flow towards the Golden Butterfly pit area from the surrounding sandstone aquifer. It is indicated, however, that the granite unit, in which the pit is formed, is of low permeability, therefore the rate of groundwater movement would be low.

4.2.3 Review of Existing Environmental Monitoring Program

The environmental monitoring program contained within the 1993 Decommissioning Plan is summarised in Table 4 and reviewed below:

TABLE 4
1993 Decommissioning Plan Environmental Monitoring Program

ITEM	PROCEDURES	MONITORING INTERVAL
Surface Water Quality	Sampling and analytical analysis	Monthly during wet season months (January to April) and on an event basis during dry season months (May to December) and/or high intensity storms
Groundwater Quality	Sampling and analytical analysis	Half yearly
Vegetation	Line intercept transects Quadrat surveys Use of photo-point stations	Assessment pre and post wet season
Erosion	Visual observations Photo point stations Measure of depth of gullies	Quantitative assessment monthly during wet season months (January to April) and on an event basis during dry season months (May to December) and/or high intensity storms.

Surface Water Quality

- (i) Until December 1995, surface water quality sampling had been confined to three sites (SW1, SW2 and SW3A). These sites provide an indication of water quality within Slaughteryard Creek downstream of the Golden Butterfly waste dump. Although a site was nominated upstream of the waste dump (SW3) to provide an indication of background water quality, no monitoring was carried out at this location prior to December 1995.
- (ii) No surface water quality monitoring has been carried out within the western portion (Content and Lady Isabella pit area) of ML 5248.



Groundwater Quality

- (i) No groundwater monitoring within the lease area was included in the monitoring program. As a result, no data are available on the groundwater regime around the Golden Butterfly pit area, its potential connection with adjacent aquifers, or the potential for recharge or drainage from the Golden Butterfly waste dump to groundwater.

Vegetation

- (i) Vegetation monitoring sites on the waste rock dumps were destroyed in the 1996 rehabilitation program. As a result, appropriate new sites will need to be installed.
- (ii) The vegetation control points (VC51 to VC55) are located on flat land surrounding the dumps. These sites do not represent topographic units similar to the recontoured waste dump batters, therefore new/supplementary sites are to be identified.

Erosion

- (i) Existing erosion monitoring sites were destroyed in the 1996 rehabilitation program.
- (ii) Erosion has not been monitored at the vegetation control points. New sites will be identified which will include land units with similar slope to the waste dump batters.

4.3 REHABILITATION ISSUES AND OPTIONS

Based on the site assessment described in Section 4.2, the following significant rehabilitation issues were identified:

- (i) Acid drainage from the Golden Butterfly waste dump area was occurring. This was due to the quantity and nature of the potentially acid producing waste rock within the dump. Based on the characteristics of the Content waste dump material, there was some limited potential for acid drainage from this area, however, there was no surface water monitoring within the area to confirm this condition.
- (ii) AMD was occurring within the Golden Butterfly, Content and Lady Isabella pits; the most severe case being within the Golden Butterfly pit.
- (iii) The existing environmental monitoring program was considered by RGC to be inadequate to support a comprehensive assessment of the performance of the existing or any future rehabilitation works, based on RGC's corporate environmental standards.

It was therefore considered that additional rehabilitation works were required within ML5248 to ensure compliance with the rehabilitation objective as outlined in Section 1.0. In conjunction with these works, the existing environmental monitoring program would also need to be upgraded.

4.3.1 Rehabilitation Options

Based on the identified significant rehabilitation issues outlined above, a list of rehabilitation options for the mining related landforms within ML5248 area was compiled. These options are tabled below:



Landform	Rehabilitation Options
Waste Dumps	(i) Do Nothing (ii) Drainage Re-direction (iii) Reprofilling and Capping (iv) Removal
Pits	(i) Do Nothing (ii) Backfilling
Other Areas *	(i) Do Nothing (ii) Removal

*Includes stockpile areas, Haul Road, western side of the Content Dump, Drainage Channel and Sandy area to the north of the Golden Butterfly Pit.

A brief review of these options follows:

Waste Dumps

It is considered that the "Do Nothing" and "Drainage Re-direction" options would not assist in compliance with the adopted rehabilitation objectives. The site assessment described in Section 4.2 indicates that under the "Do Nothing" option, continuing acid drainage from the Golden Butterfly waste dump and possibly the Content waste dump continues to occur. There would be opportunity to drain both waste dumps into adjacent pits, however, such discharge would likely lead to further deterioration in pit water quality, as well as creating a condition that would require ongoing management. Both of these options have been discounted, primarily due to the inability of either to control the poor quality discharge from the waste dump areas.

The two rehabilitation options considered viable for the waste dumps are:

- (i) Reprofilling and Capping
- (ii) (Waste Dump) Removal



Pits

The two pit rehabilitation options identified (i.e. "Do Nothing" or "Backfilling") are considered viable.

The water quality assessment carried out and summarised in Section 4.2 indicates limited potential for nett outward movement of Golden Butterfly pit water into the surrounding shallow groundwater system (although the impact on deeper aquifers was not assessed). For the other pits, it is considered that, due to the quality of the pit water, any mixing with surrounding groundwater would have lesser impacts on background groundwater quality than the Golden Butterfly pit. Provided that the pits do not overtop, therefore, the "Do Nothing" option for all pits is considered to be appropriate.

The "Backfilling" option would be carried out in conjunction with the "Removal" option for the waste dumps, with waste rock being directly backfilled to the pits. The issues to be considered in relation to this option are the potential release of pit water through overtopping during the rehabilitation works, as well as post-rehabilitation.

Other Areas

The site assessment identified areas that were potentially acid forming or that were contaminated from AMD. Although their contribution to overall environmental impact on the lease is not clear, it is considered prudent that material from these areas that is considered suspect be removed, while other materials could remain in place. The "Do Nothing" option is not considered appropriate for these areas, unless it can be identified that no potentially acid producing material occurs within the area.

Based on the above, the rehabilitation options considered appropriate for ML 5248 are as follows:



Landform	Appropriate Rehabilitation Option
Waste Dumps	Reprofiling and Recapping
Waste Dumps/Pits	Backfilling (Waste Dump to Pit)
Pits	Do Nothing
Other Areas	Removal (of suspect material)

4.3.2 Engineering Assessment of Rehabilitation Options

Engineering assessment of each of the rehabilitation options for ML 5248, identified in Section 4.3.1, has been undertaken. These assessments formed the basis for design of the selected options. A brief outline of these assessments is provided in Appendix B with a summary of each outlined below.

Waste Dumps - Reprofiling and Recapping Option

This option would comprise:

- (i) reprofiling of waste dump batters and regrading of surfaces;
- (ii) capping of waste dump surfaces and batters using compacted clay layers overlain by surface protection layer consisting of benign rock fill.

The key issues in relation to design of this option include the following:

- (i) The reprofiled surface needs to be designed to enhance geotechnical stability, to enable controlled surface water drainage and to allow construction of capping systems. Geotechnical and hydrological analyses were carried out in conjunction with this design.
- (ii) The capping layer needs to be designed (thickness and configuration) to limit ingress of water and oxygen into the dump, such that AMD potential is



mitigated. Hydrological (infiltration) modelling was carried out to support this design.

Design features of the reprofiling and recapping options are as follows:

(i) Reprofiling Works

Batter slopes of 3(H):1(V) minimum are required, with benches of some 5 m width provided at 50 m (maximum) vertical spacing.

(ii) Waste Dump Cover Configuration

Laser Type Surface	Waste Dump Surface	Waste Dump Batters
Capping Layer	Clay Fill - 600 mm thickness - Permeability $<10^{-8}$ m/s*	Clay Fill - 450 mm thickness - Permeability $<10^{-8}$ m/s*
Surface Protection Layer	Rock Fill - 400 mm thickness	Rock Fill - 400 mm thickness

* Recompacted to 98% of standard maximum dry density at -2% to +3% of optimum.

Waste Dump/Pits - Backfilling Option

The possible pit backfilling strategy for ML 5248 is:

- (i) Golden Butterfly waste dump to Golden Butterfly pit; and
- (ii) Content waste dump to Content pit and/or Lady Isabella pit.

The key issues related to the design of the backfilling option are as follows:

- (i) The backfilling option is controlled by the available pit volume;



- (ii) The pits currently contain significant quantities of water which may affect the achievable volume efficiency of the void, as well as contribute to possible pit overtopping; and
- (iii) Possible seepage discharge from the backfilled void resulting from saturation of the emplaced waste rock.

Based on the estimated available pit volumes and inferred compatibility properties of the waste rock materials, the following considerations have been made:

- (i) The Golden Butterfly pit will not fully contain, beneath the pit rim, the volume of material within the Golden Butterfly waste dump. Mounding of the finished surface will therefore be required.
- (ii) The Content pit void volume is slightly lower than that required for containment of the Content waste rock volume. Slight surface mounding will therefore be necessary.
- (iii) The Lady Isabella pit possesses limited void capacity and therefore would not have application under the pit backfilling option.

Hydrological modelling has been carried out to assess the effectiveness of the pit backfilling scenarios. Modelling was completed to define pit overtopping potential both during backfilling works and under service conditions. These analyses indicate the following:

- (i) the potential for pit overtopping during the construction phase would be marginal, depending on the level of compaction achieved within the backfill material; and
- (ii) it is possible that water levels within the backfilled pits will rise sufficiently to overtop the pit rim and migrate as a seepage front appearing at the toe of the mounded dump.



Pits - "Do Nothing"

The most significant engineering issue to be considered in relation to this option is the potential for overtopping of the pit rim. A basic hydrological analysis has been carried out to assess the condition, and indicates that pit overtopping is unlikely to occur.

Detailed assessment of the long term environmental impact of this option has not been undertaken, although, based on available groundwater monitoring data from the Golden Butterfly pit areas, no pit water migration has been indicated (refer Section 4.2.2.2). It is possible, however, that long-term equilibrium groundwater levels are higher than current pit water levels, therefore, the analysed pit overtopping and potential groundwater movement conditions, as described above, may vary with time.

Other Areas - Removal

Due to the potential for acid producing material existing within the stockpile, hardstand, and drainage areas located within the lease area, suspect materials should be removed and dumped into pits.

4.3.3 Selected Rehabilitation Options

Based on the engineering assessment, as summarised above and outlined further in Appendix B, RGC elected to offer four rehabilitation options to tender to obtain accurate details on costs and logistics. This information was combined with identified environmental and engineering considerations to determine the preferred option. From that assessment, the following rehabilitation scenario was selected by RGC for ML 5248:



Landform	Favoured Rehabilitation Option
Waste Dumps	Reprofiling and Capping
Pits	Do Nothing
Other Areas:	
- Stockpile Area	Remove
- Haul Road	Do Nothing
- Western side of Content Pit	Remove
- Drainage Channel	Remove
- North of Golden Butterfly Pit	Do Nothing

4.4 OTHER REHABILITATION ISSUES

In conjunction with rehabilitation works for ML 5248, the following additional rehabilitation issues require consideration:

- Background landholder requirements; and
- Contaminated Lands Act provisions.

4.4.1 Background Landholders Requirements

As stated in Section 2.2, the existing background landholders (i.e. DoL and CSC) will assume the management of the former ML 5248 on relinquishment by DME. Consultation between Pancon and these parties was initiated during the 1993 rehabilitation works and has continued through to the current stage. The outcomes of these discussions are summarised below:

Queensland Department of Lands (DoL)

Landholder requirements were received in 1993 from the DoL Regional Operations Manager of Land Services, Cairns (as contained in Appendix C) and were confirmed verbally in 1996. The desired post-mining land use as indicated by DoL is grazing. Specific rehabilitation requirements include the following:

- that road areas be rehabilitated with natural vegetation cover using endemic species, apart from minimal access roads suitable for local usage. (The location of the access tracks should be ascertained by reference to CSC);
- DoL has no specific requirements with regard to fencing around reserves but advises that the replacement or maintenance of any fencing damaged/removed/erected in the mining process be reviewed in consultation with the landowners in the locality, with their legal boundaries taken into consideration;
- areas used for grazing be revegetated with improved pasture;
- all foreign equipment and rubbish removed; and
- suitable vegetation be established to control soil erosion where necessary.

Croydon Shire Council (CSC)

Landholder preferences (Appendix C) were received in October 1993 from CSC and revised following discussions in 1996. The desired post-mining land use as indicated by the CSC is Town Common with a portion of the site being allocated as town water supply catchment (with grazing being discouraged within these areas). In addition, the following specific requirements were indicated:

- Maximisation of watershed catchment into Golden Butterfly North Pit (although CSC is not likely to require this resource again since the construction of a new water supply dam).
- Retention of access to Golden Butterfly North, Lady Isabella and Content pits; and
- Use of native tree species in the revegetation program.



Further to these requirements, CSC has confirmed that restrictions to livestock access within the Town Common area would be continued. CSC would take responsibility for control of access through fencing, and maintenance as required.

4.4.2 Contaminated Lands Act Provisions

RGC's understanding of the Contaminated Lands Act provisions are outlined below. This outline indicates the desired outcome of the lease decommissioning process as it relates to the Contaminated Lands Act.

The Contaminated Lands Act, 1992 (CL Act), is triggered upon the Mining Lease surrender. Currently there is no final agreement between the DME and DoE to allow the DME to administer the provisions of the CL Act and the Environmental Protection Act (EP Act). The current Queensland Government plans to amalgamate the CL Act into the EP Act but with no indicated fundamental changes to the provisions of the Act. The DoE, upon lease surrender, will review a site contamination report and assess the sites classification status. Site classifications are:

- Probable
- Former
- Restricted
- Released.

The Minerals Resources Act, 1987 requires a Final Rehabilitation Report (FRR) in which key elements include:

- Site Assessment/Investigation Report;
- Site Risk Assessment Report;
- Site Management Plan.

Until a memorandum of understanding (MOU) is signed between the DME and DoE on departmental administering roles, the FRR will need to be submitted to both departments.

The DME will use the FRR to allow surrender of the Mining Lease while the DoE will utilise the report for classification purposes, registering and deeming the adequacy of the Site Management Plan.

4.5 DETAILS OF UPGRADED REHABILITATION WORKS PROGRAM

An upgraded rehabilitation works program for ML 5248 was commenced in August 1996 by RGC and completed in December 1996. This program comprised the following works:

- Golden Butterfly Waste Dump

Clay fill capping and rock fill surface protection of the entire waste dump surface, including construction of a key trench around the dump perimeter;

- Content Waste Dump

Reprofiling of batter slopes (other than the western batter), with clay fill capping and rock fill surface protection of the entire dump surface;

- Other lease area activities, including:

- (i) Removal of potentially acid producing waste rock within hardstand areas adjacent to the Golden Butterfly and Content Waste dumps, with disposal of the excavated waste to adjacent open pits;
- (ii) Removal of channel bed sediments within the reach of the Slaughteryard Creek tributary which drains the Golden Butterfly waste dump;



In addition, miscellaneous rehabilitation works, that have not yet been addressed in this document but are necessary to complement the above major activities or to comply with specific background landholder requirements, are as follows:

- (i) Backfilling of open drill holes and removal of associated rubbish;
- (ii) Construction of surface drains and a pond to collect surface water drainage from the Content Waste Dump site (for the purpose of surface water sampling);
- (iii) General site clean-up;
- (iv) Backfilling of open mine shafts;
- (v) Removal of AMD producing material from an area adjacent to the lease which had the potential to affect that part of the Belmore Creek catchment on ML5248. (This material was discovered during the course of the rehabilitation works program, was a significant AMD source, and had the potential to mask any benefit from the works around the waste dump site.)
- (vi) Revegetation of disturbed areas including rehabilitated waste dumps.

The extent of the upgraded rehabilitation works within ML5248 (as-constructed) is shown in Appendix G.

4.6 REVEGETATION WORKS

The objective of the revegetation program is to establish a sustainable vegetative cover and provide long-term stabilisation and protection of waste dump surfaces and other disturbed areas on ML 5248. The revegetation work carried out comprised of sowing with a seed mix of native tree and shrub species similar to those found in the surrounding native woodland communities. A description of the revegetation works program is provided in Appendix H.

MONITORING

Environmental monitoring to objectively assess the performance of rehabilitation works within ML5248 forms the basis for determining the success of the 1996 (Amended) Decommissioning Plan. The environmental monitoring program has been designed to facilitate on-going, systematic monitoring addressing the following issues:

- Surface water quality;
- Groundwater quality;
- Vegetation; and
- Erosion.

It has been identified, as a result of the recent site assessment as described in Section 4.0, that the initial rehabilitation works carried out within ML 5248 were inadequate to effectively control AMD on the site. It was further identified that the environmental monitoring program included in the 1993 Decommissioning Plan was lacking, based on RGC's corporate environmental standards, and considered unable to support a comprehensive analysis of the performance of any ongoing rehabilitation works.

Accordingly, to provide substantiation for an application to relinquish the lease area, RGC decided to review and upgrade the environmental monitoring program. The details of this revised program are summarised in Table 5.

TABLE 5
Environmental Monitoring Schedule for ML5248

Category	Location	Site Description (refer Figures 1, 2 & 3)	Frequency
Surface Water-Pits	Golden Butterfly	Western Edge	Quarterly for all pits. (Samples to be taken in December, March, June and September - beginning of the month)
	Golden Butterfly North	Eastern Edge	
	Content	Western Edge	
	Lady Isabella	Western Edge	
Surface Drainage Sites	SW1	Adjacent to the borefield causeway on Slaughteryard Creek approx. 1.5 km downstream of ML 5248 boundary.	All sites monthly subject to the availability of water. <u>December 1996 to April 1997</u> All sites twice monthly subject to the availability of water (flowing only). (Monthly sampling to be done at the beginning of the month. Twice monthly sampling to be done at the beginning of the month and at mid-month).
	SW2	Junction of Slaughteryard Creek and the lease boundary.	
	SW3	Upstream of Golden Butterfly Waste Dump on Slaughteryard Creek.	
	SW3A	Drainage channel adjacent to the eastern side of Golden Butterfly Waste Dump.	
	SW4	Water storage dam on Slaughteryard Creek east of Golden Butterfly Dump.	
	SW5	Drainage control pond west of Content Waste Dump.	
Groundwater	GMB1, GMB2, GMB3, GMB4, GMB5, GMB6.	South of ML 5248 running in a line sub-parallel to Slaughteryard Creek.	All groundwater sites quarterly. (Samples to be taken in December, March, June and September - beginning of the month.)
	BH1, BH2.	Northern and southern sides of Golden Butterfly Pit.	
	BH3, BH7.	East of Golden Butterfly Waste Dump.	

TABLE 5 (Continued)
Environmental Monitoring Schedule for ML5248

Category	Location	Site Description (refer Figures 1, 2 & 3)	Frequency
Vegetation	Golden Butterfly and Content waste dumps and adjacent revegetated areas	<p>Permanent vegetation monitoring transects set up in representative vegetation units in undisturbed control areas. Permanent transects and quadrates installed on the waste dumps and adjacent disturbed areas.</p> <p>Transects and quadrates will be monitored for species richness (number of species per unit area), species frequency, plant density, and growth rate. Any weed species observed will be recorded. Perennial grasses will be recorded and their cover and amounts of litter will be estimated.</p> <p>Permanent photo monitoring points will be installed in both the control and revegetated areas.</p>	Initial monitoring visit late in financial year 1996/97, then late dry-season each year, commencing 1997.
Erosion	Golden Butterfly and Content waste dumps.	<p>Soil surface condition will be monitored using Landscape Function Analysis.</p> <p>Permanent transects and quadrates will be installed. Typically they will be orientated laterally across the site. Significant erosion observed will be described, measured and photographed.</p> <p>Permanent photo monitoring points will be installed.</p>	Initial monitoring visit late in financial year 1996/97, then late dry-season each year, commencing 1997.

The following sections provide a detailed description of the monitoring sites and procedures associated with this program.

5.1 SURFACE WATER QUALITY

The surface water quality monitoring program involves sampling and laboratory analysis of surface water from the pits and at surface flow/drainage sites.

5.1.1 Sampling Sites

Pits

Surface water contained within the four open pits, located within ML 5248, will be monitored. Water in these pits is a combination of direct rainfall, groundwater inflow and limited runoff from the area within the perimeter bunds.

Sampling will be carried out in accordance with the procedures outlined in Appendix D. Samples will be taken from the edge of the water body contained within each pit. Specific sampling locations are summarised below:

Golden Butterfly Pit	Western edge
Golden Butterfly North Pit	Eastern edge
Lady Isabella Pit	Western edge
Content Pit	Western edge.



Surface Flow/Drainage Sites

Six (6) sampling locations, labelled Sites SW1 to SW5 and SW3A, are established at surface flow/drainage sites within or surrounding the lease area. Sites SW1, SW2 and SW3 were nominated in the 1993 Decommissioning Plan. Site SW3A was established subsequently, and Sites SW4 and SW5 have been established by RGC as part of augmentation of the environmental monitoring program. These sampling sites are indicated on Figures 1, 2 and 3 and are described below:

- SW1 is located adjacent to the borefield causeway on Slaughteryard Creek approximately 1.5 km downstream of the ML 5248 boundary;
- SW2 is located at the junction of Slaughteryard Creek and the lease boundary;
- SW3 is located upstream of the Golden Butterfly Waste Dump on Slaughteryard Creek;
- SW3A was established in 1994 and is located in the drainage channel adjacent to the eastern side of the Golden Butterfly Dump;
- SW4 was established in March 1996 and is located in the water storage dam on Slaughteryard Creek east of the Golden Butterfly Dump, some 200 m downstream from SW3; and
- SW5 was established in May 1996 and is located in a shallow drainage control pond down-gradient and to the west of the Content Dump area.



The nominated surface water quality compliance point¹ is SW1 for the Golden Butterfly/Golden Butterfly North catchment. This compliance point will be maintained. However, RGC aims to achieve compliance criteria at SW2 on the lease boundary. There is no nominated compliance point for the Content/Lady Isabella catchment, therefore RGC has established a monitoring point (SW5) for that area, at which it aims to achieve the compliance criteria. The nominated background surface water quality site is SW3 for the lease area, with SW4 acting as a supplementary site, as it is a more permanent water body.

Sampling from these surface flow/drainage sites will be carried out in accordance with the procedures outlined in Appendix D.

5.1.2 Sampling Frequencies

Surface water will be sampled at the following frequencies:

- Pits Quarterly
- Surface Drainage Sites Monthly, subject to availability of water. During the first wet season (December 1996 to April 1997), the frequency of monitoring for these sites will be twice monthly (subject to the availability of water).

¹ The sites at which the target surface water quality as described in Section 5.0 will be achieved.

5.1.3 Analyses

Surface water samples collected will be handled in accordance with the Chain of Custody requirements as detailed in Appendix D, and will be delivered to a NATA registered laboratory. Laboratory analyses will be carried out on the following analytes:

pH	Arsenic
Total Dissolved Solids (TDS)	Cadmium
Electrical Conductivity (EC)	Copper
Calcium	Iron
Magnesium	Lead
Sodium	Manganese
Sulphate	Nickel
	Zinc

The above list of analytes is a modified suite based on a review of the 1993 Decommissioning Plan parameter list and the results of past monitoring. An explanation of the changes to the suite of analytes is provided in Section 6.1.

5.2 GROUNDWATER QUALITY

5.2.1 Groundwater Sampling Sites

The groundwater quality monitoring program will involve monitoring from ten (10) bores located within or on the surrounds of the lease area.

Six groundwater quality monitoring sites, labelled GBMB1 to GBMB6, were nominated in the 1993 Decommissioning Plan. These six sampling sites were installed in May 1989 and are located to the south of ML 5248, running in a line sub-parallel to Slaughteryard Creek, as shown in Figure 1. These bores were installed prior to decommissioning of the mine to monitor the potential impact of the operation on Croydon's water supply at that time (associated with the Slaughteryard Creek borefield).

Two (2) groundwater monitoring bores were installed in November 1995 on the northern and southern sides of the Golden Butterfly Pit (BH1 and BH2 respectively), as shown on Figure 2. These bores were installed to monitor the groundwater depth and quality proximal to the pit and to assess any relationship between pit water quality and quality of the surrounding groundwater.

Five (5) pre-existing shallow bores (BH3 to BH7) were established as monitoring points in May 1996 adjacent to the Golden Butterfly Waste Dump (refer Figure 2) to monitor possible shallow groundwater influences within the Slaughteryard Creek area resulting from drainage from the waste dump. Two of these bores, BH3 and BH7, will be sampled as part of the environmental monitoring program.

Sampling from the nominated groundwater monitoring sites will be carried out in accordance with the procedures outlined in Appendix D.

5.2.2 Sampling Frequency

Groundwater monitoring bores will be sampled quarterly.

5.2.3 Analyses

Groundwater samples collected will be handled in accordance with the Chain of Custody requirements as detailed in Appendix D, and will be delivered to a NATA registered laboratory. Laboratory analyses will be carried out on the following analytes:

pH	Arsenic
Total Dissolved Solids (TDS)	Cadmium
Electrical Conductivity (EC)	Copper
Calcium	Iron
Magnesium	Lead
Potassium	Manganese
Sodium	Nickel
Sulphate	Zinc
Chloride	

The above list of analytes is a modified suite based on a review of the 1993 Decommissioning Plan parameter list and the results of past monitoring. An explanation of the changes to the suite of analytes is provided in Section 6.2.

The parameter suite carried out on the BH series bore samples (i.e. from BH 1, BH 2, BH3 and BH7) will include the following:

pH
Total Dissolved Solids (TDS)
Electrical Conductivity (EC)
Sulphate
Iron

This suite is intended to provide an indication of trends in superficial groundwater quality in areas adjacent to the Golden Butterfly Waste Dump.

5.3 VEGETATION

Vegetation and erosion monitoring will be based on a method being developed by the CSIRO called Landscape Function Analysis (LFA). The application of LFA is described in CSIRO (1997). The basis of LFA is to measure how well a rehabilitated landscape is using water and nutrients, its ability to resist erosion and the landscape's progress towards becoming a stable self-sustaining unit, in comparison with selected control sites with similar topography.

Additionally, the following parameters will be measured and recorded:

- species richness (number of species per unit area);
- species frequency (% of quadrates in which that species is recorded);
- plant density; and
- growth rate.



Any occurrence of weeds will be recorded and control methods determined, where necessary.

Monitoring will involve the setting up of permanent transects and quadrates on both rehabilitated areas and control sites in the surrounding woodlands. The number of quadrates and transects installed will be determined by statistical requirements. A series of permanent photo monitoring points will also be installed. Typical sites are shown on Figures 2 and 3.

An initial monitoring visit will be made in May/June 1997 to measure the establishment of vegetation. Subsequently, annual monitoring visits will be made late in the dry season (October/November), also commencing in 1997.

The annual monitoring visits will be used to collect data to record the performance of the revegetated areas and plot their progress towards achieving completion criteria. The raw data collected and a data summary and analysis will be included in the annual monitoring report.

5.4 EROSION

LFA measurements of the rehabilitation areas, which includes Soil Surface Condition Classification (SSCC) as described in Tongway and Hindley (1995), will be used as a component of the erosion monitoring program. SSCC looks at ten soil surface features. Data from classifying these features are broken into three categories which focus on surface stability, infiltration, and nutrient cycling as indicators of landscape surface condition. Data from each of these categories are converted to percentage values to enable comparison.

Erosion monitoring will use the same network of transects, quadrates and photo monitoring points installed for the vegetation monitoring. The procedure will describe the geographic setting of the site, characterise the spatial pattern of soil and vegetation, and soil microtopography and texture. Forms of erosion will be described, measured and photographed, and cover of perennial grasses and litter will be estimated. Remedial earthworks will be prescribed for major erosion areas.

Using the methods described above, it will be possible to assess the rehabilitation success and to make predictions about the rate of development of a sustainable ecosystem.

In addition to monitoring the transects and quadrates, the overall surfaces of Golden Butterfly and Content waste dumps will be inspected and significant erosion observed will be described, measured and photographed.

The monitoring frequency will be the same as that used for vegetation and data collected will be reported in the same way.

5.5 MONITORING AND REPORTING

The environmental monitoring program will be maintained by RGC utilising a local representative and external consultants.

All data collected from the site will be compiled, analysed and reported to the DME annually. In addition, an annual inspection of the site will be carried out by RGC.

As part of the site relinquishment application, RGC will submit a Final Rehabilitation Report to DME (as outlined in Section 4.4.2), detailing the results of the environmental monitoring program and demonstrating successful attainment of the lease relinquishment criteria as defined in Section 6.0.

LEASE RELINQUISHMENT TARGET CRITERIA

Nominated target criteria by which lease relinquishment will be assessed were established in conjunction with DME and were included in the 1993 Decommissioning Plan. These lease relinquishment criteria have been revised by RGC to ensure they accurately reflect the effect of the rehabilitation works on the environmental condition of the lease and its surrounds.

A summary of these revised criteria is provided in Table 6 below. These criteria are described in detail in the following sections.

TABLE 6
Summary of Lease Relinquishment Criteria

Category	Location	Parameters	Compliance Levels/Target Criteria
Surface Water - Pits	Golden Butterfly and Golden Butterfly North, Content and Lady Isabella	pH, TDS, EC, Calcium, Magnesium, Sodium, Sulphate, Arsenic, Cadmium Copper, Iron, Lead, Manganese, Nickel, Zinc	No compliance criteria
Surface Drainage Sites	SW Series Sites	pH, TDS, EC, Calcium, Magnesium, Sodium, Sulphate, Arsenic, Cadmium Copper, Iron, Lead, Manganese, Nickel, Zinc	Livestock watering guidelines - beef cattle (ANZECC, 1992) or 115% of background surface water quality, whichever is greater.
Groundwater	1) GBMB Series Bores	1) pH, TDS, EC, Calcium, Magnesium, Potassium, Sodium, Sulphate, Chloride, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Nickel, Zinc	1) GBMB Series Bores: Maintain existing water quality measured during the period 1990 to 1993.
	2) BH Series Bores	2) pH, TDS, EC, Sulphate, Iron	2) BH Series Bores: No compliance criteria

TABLE 6 (Continued)
Summary of Lease Relinquishment Criteria

LOCATION		PARAMETERS	COMPLIANCE LEVELS/TARGET CRITERIA
Vegetation	Golden Butterfly and Content Waste Dumps and adjacent revegetated areas	<ul style="list-style-type: none"> • Landscape Function Analysis (LFA) Species richness (No. of species per unit area). • Species frequency (% of quadrates in which that species is recorded). • Plant density. • Growth rate. 	<ul style="list-style-type: none"> • Capture and decomposition of leaf litter. • Vegetation structural complexity trending towards control sites. • Vegetation compositional complexity trending towards control sites. • Habitat complexity trending towards control sites.
Erosion	Golden Butterfly and Content Waste Dumps and adjacent revegetated areas	<ul style="list-style-type: none"> • Integrity of bank/trough systems on waste dump sloping. • Erosion gully stability and depth. 	<ul style="list-style-type: none"> • Erosion depth not greater than 300 mm.

6.1 SURFACE WATER QUALITY

Pits

As no beneficial use has been established for the pits, it is proposed not to set relinquishment criteria for the quality of contained water. However, pit water quality will continue to be monitored and any trends examined, particularly with respect to trends in groundwater quality within adjacent monitoring bores.



Surface Drainage Sites

The surface water relinquishment criteria included in the 1993 Decommissioning Plan comprised the ANZECC (1992) guidelines for livestock watering (beef cattle). A suite of parameters was derived against which comparison of these guidelines was made. Based on the results of past monitoring, this suite of parameters was reviewed and revised. Mercury, molybdenum, nitrite and nitrate have been removed from the list of parameters as they have been at or below detection limits and compliance levels for the sites monitored during all monitoring events. Electrical conductivity (EC) has been added in order to provide a more complete indication of surface water chemistry. The laboratory analysis suites outlined in Sections 5.1.3 and 5.2.3 have been adjusted to reflect these changes.

A complete suite of surface water quality parameters adopted for the 1996 (Amended) Decommissioning Plan is provided in Table 7. Acceptable criteria for each analyte within this suite, based on ANZECC (1992) livestock watering guidelines, are also listed.

To reflect as accurately as possible the acceptable performance of the rehabilitation works, whilst taking into consideration the regional (upstream) land use activities, the adopted relinquishment criteria for surface water quality are as follows:

- ANZECC (1992) livestock watering guidelines (beef cattle); or
- 115% of background water quality;

whichever is higher. The background water quality plus 15% relinquishment criteria will be used to prevent RGC being required to ameliorate fluctuations in existing background quality as a result in change of land use or associated activities.

TABLE 7
Summary of ANZECC (1992) Livestock Watering Guidelines

PARAMETER	SYMBOL	UNIT	CRITERIA
pH	pH	-	NGR
Electrical Conductivity	EC	µS/cm	NGR
Total Dissolved Solids	TDS	mg/L	4000
Sodium	Na	mg/L	NGR
Calcium	Ca	mg/L	1000
Magnesium	Mg	mg/L	600
Sulphate	SO ₄	mg/L	1000
Arsenic	As	mg/L	0.5
Cadmium	Cd	mg/L	0.01
Copper	Cu	mg/L	5
Iron	Fe	mg/L	NGR
Lead	Pb	mg/L	0.1
Manganese	Mn	mg/L	NGR
Nickel	Ni	mg/L	1.0
Zinc	Zn	mg/L	20

NGR = No guideline recommended

As discussed in Section 5.1.1, background surface water quality for the site will be measured at Sites SW3 and SW4.

The adopted surface water compliance point for ML 5248, SW1, is located adjacent to the borefield causeway on Slaughteryard Creek (refer Figure 2) outside of the lease area. However, RGC aims to achieve the above water quality standards at the point where Slaughteryard Creek intersects the lease boundary (i.e. SW2), and at SW5 in the Content/Lady Isabella catchment.

6.2 GROUNDWATER QUALITY

GBMB Series Bores

Groundwater monitoring results for monitoring bores GBMB 1 to GBMB 6 over the period 1989 to 1990 were provided to the DME (formerly Department of Resource Industries), in 1990 (Australian Groundwater Consultants, 1990). DME reviewed these results and concluded that, based on the available results, "no immediate problems exist for the township water supply", which at that time was sourced from the Slaughteryard Creek borefield. Subsequent groundwater monitoring between 1990 and 1993 suggested that there had been no deterioration in groundwater quality within that period. As a result, the 1993 Decommissioning Plan established that the target criteria for groundwater quality for these bores would be to maintain the water quality monitored over the period 1990 to 1993.

For the purpose of the 1993 Decommissioning Plan a suite of parameters, against which comparison of the above guidelines would be made, was derived, principally based on the parameter suite that had been historically adopted. Based on the results of monitoring since that time, this suite of parameters has been reviewed and revised for inclusion in the 1996 (Amended) Decommissioning Plan. From this review, mercury and nitrate have been removed from the list of parameters as they have been at or below detection limits for all bores on all occasions. Major cations, calcium and magnesium, have been added in order to provide a more complete indication of the groundwater chemistry. The laboratory analysis suite outlined in Section 5.2.3 has been developed to reflect these changes.

BH Series Bores

No data are currently available for the BH Series bores and therefore no compliance criteria have been adopted for these sites. As discussed in Section 5.2.3, it is intended that the data obtained from sampling of these sites be used to indicate trends in groundwater quality.

Lease relinquishment criteria for groundwater monitored within the site will be as follows:

GBMB Series Bores

Maintain the groundwater quality within the GBMB series bores monitored over the period 1990 to 1993. No criteria are available for the analytes added to the suite (as discussed above). Relinquishment criteria are summarised in Table 8.

BH Series Bores

No relinquishment criteria. Water quality trends from these bores will be observed and analysed to monitor any influences of adjacent landforms.

TABLE 8
Summary Results of GBMB Series Bore Monitoring -Period 1990 to 1993
as Basis for Relinquishment Criteria

PARAMETER	UNITS	GBMB1	GBMB2	GBMB3	GBMB4	GBMB5	GBMB6
pH	-	3.6-6.15	7.3 - 8.15	6.65-7.25	5.95-6.5	5.6-6.95	5.85-6.85
Total Dissolved Solids (TDS)	mg/L	390-520	1290-2040	280-500	150-240	40-100	110-150
Electrical Conductivity (EC)	µS/cm	590-610	1970-2040	410-445	190-225	68-73	98-305
Sodium (Na)	mg/L	17-91	350-400	72-76	27-31	9.3-11	7-14
Sulphate (SO ₄)	mg/L	170-240	500-580	11-110	11-65	0.8-7.9	2.8-22
Chloride	mg/L	7-55	190-370	107-130	13-42	11-30	16-26
Arsenic	mg/L	0.01-0.06	0.03-0.07	0.01-0.04	0.02	0.01-0.02	0.01-0.06
Cadmium	mg/L	<0.01-0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	0.01-0.05	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	mg/L	2.1-6.2	1-1.8	1.8-3.7	2.2-2.6	1.3-3.6	1.7-2.9
Lead	mg/L	0.08-0.23	0.12-0.70	0.02-0.54	0.07-0.16	0.12-0.24	0.05-0.18
Manganese	mg/L	0.45-0.55	0.44-0.68	0.05-1.3	<0.01-0.04	<0.01-0.04	<0.01-0.03
Zinc	mg/L	0.04-0.34	0.02-0.15	<0.01-0.24	<0.01-0.45	0.05-0.19	0.03-0.18



6.3 VEGETATION

The objective of revegetation of ML 5248 is to achieve long term stabilisation and protection of the capped waste dump surfaces, minimising the potential for erosion and subsequent passage of water through the dump core.

The success of the revegetation program and erosion control systems will be measured by using a method developed by the CSIRO called Landscape Function Analysis (LFA), which is described in CSIRO (1997). This method includes Soil Surface Condition Class (SSCC) assessments. LFA involves the measurement of five indicators: integrity of the bank/trough system, litter buildup, tree growth, vegetation composition, and habitat complexity. From these measurements it is possible to determine if stable resource capturing landscapes have been created and determine their progress towards matching the control sites.

Completion criteria terms are defined as follows:

- Vegetational structural complexity - A measure of how well the tree layer is developing, determined by measuring tree diameter at breast height (DBH);
- Vegetation compositional complexity - The measure of how well the site is developing the mix of plant species found on the control sites;
- Habitat complexity - A measure to demonstrate how well vegetation structures and other landscape features, and their suitability as sites for wildlife, are developing.

Completion criteria for revegetation will be the following:

- Litter is being captured and is decomposing within the troughs created by ripping;
- Vegetation compositional complexity, as determined by development of a tree layer, will demonstrate a trend towards that of the control sites;
- Habitat complexity is trending towards that of the control sites.

6.4 EROSION

The objective for erosion control is similar to that for vegetation in Section 6.3; to achieve long term stabilisation and protection of the capped waste dump surfaces, and minimise erosion and subsequent passage of water through the dump core.

Completion criteria for erosion control will be the following:

- Integrity of the bank/trough systems on the waste dump slopes.
- Any erosion features that do form become stable and, on Golden Butterfly and Content waste dumps, erosion gullies do not exceed 300 mm in depth.

6.5 SUMMARY OF COMMITMENTS

RGC is committing to a range of actions and goals in order to achieve the rehabilitation objectives and completion criteria for lease relinquishment. These are summarised in Appendix E, together with a description of compliance at this stage.

The list of commitments will be detailed as part of the formal annual inspection of the lease by RGC, and a compliance report in the format of Appendix E will be included in the Annual Monitoring Report.



LEASE RELINQUISHMENT DOCUMENTATION

RGC proposes to continue monitoring the site for two wet seasons following completion of the 1996 rehabilitation work, i.e. 1996/1997 and 1997/1998. At that time, it is expected that the site's performance will demonstrate achievement of the rehabilitation objectives and completion criteria. Subject to that achievement, lease relinquishment will be sought.

In preparation for the lease relinquishment, a Final Rehabilitation Report (FRR) will be submitted to DME outlining the following:

- Scope of the monitoring program;
- Monitoring program results; and
- Reconciliation against target criteria.

The objective of the document would be to substantiate a request by RGC to the DME for the relinquishment of ML 5428.

Section 309 (1) of the Mineral Resources Act, 1989 requires the holder of a mining lease to apply for the surrender of the mining lease or any part of the land comprised therein at any time before the expiration of the mining lease term. To facilitate this process there is a requirement for a Final Rehabilitation Report (FRR) and Environmental Audit Statement (EAS) determining if the leaseholder has met the rehabilitation requirements outlined within the EMOS or Decommissioning Plan.

For RGC, the function of the FRR is to examine commitments made within the Decommissioning Plan made regarding protection and rehabilitation of the mine site. The FRR then assesses if these goals and specified relinquishment criteria have been met.

The FRR will be prepared in accordance with the Draft DME Policy for "Environmental Impact Assessment and Management for Mining in Queensland", 1994.

The FRR will be accompanied by an EAS in respect of the final rehabilitation status, confirming the technical validity of the FRR and that all statutory requirements have been met.

As part of an acceptable FRR where any residual land contamination occurs an appropriate site classification will be determined in accordance with Section 4.4.2. For the Croydon Gold Mine (ML 5248), it is considered that the most likely classification will be a "Former" and/or "Restricted" site.

An associated Site Management Plan (SMP) would be contained within the FRR and will describe on-going requirements. It is proposed that an annual audit/assessment of a landform stability, rehabilitation and water quality be conducted.

Currently the Memorandum of Understanding (MOU) to delegate administrative duties for the *Environmental Protection Act, 1994* (EP Act) and *Contaminated Lands Act, 1991* (CL Act) has not been signed. It is recognised that under the current CL Act, a site investigation or site contamination report is required. The SAR component of the FRR will be submitted to the DoE upon lease surrender if the MOU has not been signed at that time.

ORGANISATION AND MANAGEMENT

8.1 RGC ORGANISATION

The RGC representative responsible for the Croydon Mine ML 5248 rehabilitation program was [CTPI 49-Sch4] who reported to RGC's General Manager, Environment. The on-site RGC representative, and person responsible for the on-going sampling during the decommissioning phase is currently [CTPI 49-Sch4]. The contact for [CTPI 49-Sch4] is as follows:

[CTPI 49-Sch4]

C/- Reigate Station

Croydon Qld 4871

Phone [CTPI 49-Sch4]

RGC will engage specialist external consultants as required.

8.2 REHABILITATION PROVISION

Upon assumption of the lease, RGC increased the provision for rehabilitation of ML 5248 from \$365,000 to \$2.65M to cover all decommissioning costs through to lease relinquishment. This provision account is reviewed on a regular basis.

REFERENCES

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- Australian Groundwater Consultants (March 1990). *Croydon Gold Mine Golden Butterfly Operations Regional Surface and Groundwater Monitoring Program*. Report No. 4015/7.
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FIGURES



APPENDIX A

DETAILS OF MINING LEASE 5248 AND AMENDMENTS



QUEENSLAND
DEPARTMENT
OF MINES

G.P.O. BOX 184 BRISBANE 4001. Q.

QUEENSLAND MINERALS AND ENERGY CENTRE, 61 MARY STREET, BRISBANE. TELEPHONE: (07) 224 2111 FACSIMILE: (07) 229 7770 TELEX: AA43040-

Your Ref: MCH:gah
Our Ref: ML No. 4124, Mareeba

CTPI 49-Sch4

(070) 523 300

23rd December, 1988

Dear Sir,

Re: Mining Lease No. 4124, Mareeba

5243
New ML 5428

I refer to your letter of 28th November, 1988 with which you submitted a description of operations as required under Special Condition No. 5 attached to the above Lease.

Approval of that part of the description of operations referring to construction of the haul road was given on 9th December, 1988.

Approval of the remainder of the description of operations was given on 22nd December, 1988, for the period ending 30th June, 1989, with the following future requirements:

Approval is now also given to erection of the crushing plant on the Lease to treat minerals won from the Lease, in accordance with Special Condition No. 4.

For operations beyond 30th June, 1989, amendments to the description of operations must be submitted for approval including:

- (a) a waste-rock management plan, to ensure that water draining from sulphide-bearing waste does not pollute the waters of the State, and that sulphide-bearing waste is adequately covered. To assist planning, sampling of the material between 45 and 65 metres depth in the pit should be conducted as soon as practicable.
- (b) a further management plan for pit water and other waters on the Lease, containing details of groundwater monitoring carried out;
- (c) a report on the effects on neighbouring properties of blasting, noise and dust from the operations conducted and the results of any monitoring;
- (d) a review of the tailings disposal facilities on Mining Lease No. 3166, Mareeba, particularly in relation to the effect of the mining on Mining Lease No. 4124, Mareeba.

GEB
discuss

C.c Barrack Mine Management Pty Ltd,
Suite 3, A.F.T. House,
135 Abbott Street,
CAIRNS, QLD 4871

For your information.

for Director-General



CTPI 49-Sch4

General Manager (technical) - Mining,
Pancontinental Mining Limited,
AMP Centre,
50 Bridge Street,
SYDNEY, NSW 2000

It is understood that control, and where necessary monitoring, of the matters referred to in (a), (b), (c), (d) will be instituted immediately.

You are further requested to give an undertaking to retain geotechnical expertise, and to undertake geotechnical investigations of slope stability and blast monitoring to ensure that the proposed workings do not affect the town water supply, the water tank, the railway or the Northern Development Road.

Approval of this description of operations does not in any way affect your obligation to comply with the Special Conditions attaching to the Lease or with the Mining Act 1968-1986.

The description of operations now approved forms an integral part of the Lease conditions. Any departure from the description will constitute a breach of those conditions unless specific approval has been sought and obtained to amend the description.

Yours faithfully,

CTPI 49-Sch4

For Director-General

CTPI 49-Sch4

SSR.128861

OPERATIONS DIVISION					
DIST			DIST		
CWD	✓	CTPI 4	ACD		
			PSF		
DJG					
NCH	✓	CTPI 4	DEF		
RWN			CEH		
JGW			IRN		
BEH			GER	✓	CTPI 4
SJL			PEC		
RWL			CUF		
			JMP	✓	CTPI 4
Executive			QWV	✓	CTPI 4
Corp Devt			AFS		
Expd			JTC		
Marketing			QRT		
Admin			QMT		
Legal					
FILE 501-2					

CTPI 49-Sch4

Replied

11/1/89

Copied also + discussed action w. U

CTPI 49-Sch4

10/1/89

Gauge - we have 100ft
revised pit plan + drill
or identify suitable ss
for further waste character
analysis for 45-65 m
depth.



501-2

UCH

QUEENSLAND
DEPARTMENT
OF MINES

G.P.O. BOX 184 BRISBANE 4001. - Q.

QUEENSLAND MINERALS AND ENERGY CENTRE, 61 MARY STREET, BRISBANE. TELEPHONE: (07) 224 2111 FACSIMILE: (07) 229 7770 TELEX: AA43040

Your Ref:

Our Ref:

CTPI 49-Sch4

224 7292

Issued to CTPI 49-Sch4 18/8/88

Acknowledged receipt of letter to Dept of Mines
② Pay rental (\$27,473.96)

5th August, 1988

Dear Sir,

Re: Mining Lease No. 4124 - Mareeba

New ML 5428

The abovementioned Lease has been granted by the Governor in Council and the details of such grant are set out hereunder:-

Date of Minister's Recommendation : 1st August, 1988

Date of Grant : 4th August, 1988

Term : 21 years commencing from 1st September, 1988.

Rental : \$23 per hectare per annum payable at this rate in advance not later than 31st December, for each year of the term of the lease.

Lessee: : Pancontinental Mining Limited

Area : 1194.52 ha (approximately - subject to survey)

Conditions: : Subject to all covenants and conditions applying to all Mining Leases and subject also to the prescribed special conditions as detailed on the attached annexure.

A copy of the sketch plan indicating the boundaries of lease area and surface area is attached.

General Manager (Technical)-Mining,
Pancontinental Mining Limited,
AMP Centre,
50 Bridge Street,
SYDNEY. NSW 2000



Variation in shape was approved on 28th July, 1988.

The surface of any road Reserve as defined in Section 7 of the Mining Act 1968 - 1986 cannot be disturbed unless the consent of the Governor in Council is first had and obtained. It should be noted that consent to disturb the surface of road comprised in this Lease has not been obtained.

The Bank Guarantee submitted has been accepted.

Yours faithfully,

CTPI 49-Sch4

for Director General

188 126907

OPERATIONS DIVISION					
DIST			DIST		
CWD	✓	CTPI 4	ACD		
			AST		
BIG					
MCH	✓	CTPI	ACE		
RWN	✓	CTPI 4	SEA		
JGW			ITA		
BEH			SAH	✓	CTPI 49
SJL			SHI		
RWL			SHI		
			JMK		
Executive			GWV	✓	CTPI
Corp Devl TPR	Copy	CTPI	AWC		
Exp - LANDS	Copy	CTPI	JYC		
Marketing			QEU		
Admin		CTPI	GW		
Legal	Copy				
FILE 7-600-13.17.2					

CTPI 49-3

Copy.

med
Ludman
Barnes

CTPI

Prince Edwards.

Please enter on Land Agent System
& then pass to Operations

CTPI 49

ANNEXURE "D"
MINING LEASE NO. 4124, MAREEBA

Special Covenants:

1. The Lessee shall Pay all Local Authority rates applicable to the Lease when they become due and Payable.
2. The Lessee covenants and agrees to comply with any order or direction given by the Minister for the purpose of obtaining compliance with these covenants and conditions.

Special Conditions:

1. Where in these special covenants and conditions the term "approved" is used, it shall be read and construed as meaning "approved by the Minister in writing".
2. The Lessee shall at all times cause all steps and things to be taken and done to prevent mineralized or impure water or sludge or mining debris resulting from mining operations within the boundaries of the Lease from unlawfully polluting, obstructing, damaging or interfering with the sea, any watercourse, lake or reservoir or any land. Where such unlawful pollution, obstruction, damage or interference results from mining operations within the boundaries of the Lease, the Lessee shall, as and when required by the Minister, cause such mining operations to cease and not be resumed until all further steps and things are taken and done as will prevent such unlawful pollution, obstruction, damage or interference.
3. The Lessee shall at all times cause all steps and things to be taken and done as the Minister from time to time specifies with respect to mining operations within the boundaries of the Lease, and the impounding, retention, treatment and disposal of mineralized or impure water or sludge or mining debris, with a view to preventing unlawful pollution or obstruction of, damage to, or interference with the sea, any watercourse, lake or reservoir or any land.
4. Unless otherwise approved, the Lessee shall not:
 - (a) erect or operate any plant on the Lease for the purposes of treating or concentrating minerals won under the Lease;
 - (b) dispose of mill tailings within the boundaries of the Lease;
 - (c) erect or use buildings for domestic residence purposes within the boundaries of the Lease.
5. Prior to commencing initial mining operations on the area, and thereafter when so directed by the Minister, the Lessee shall submit for the approval of the Minister a description of operations to be carried out on the area of the Lease.

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Rel

The description shall consist of:

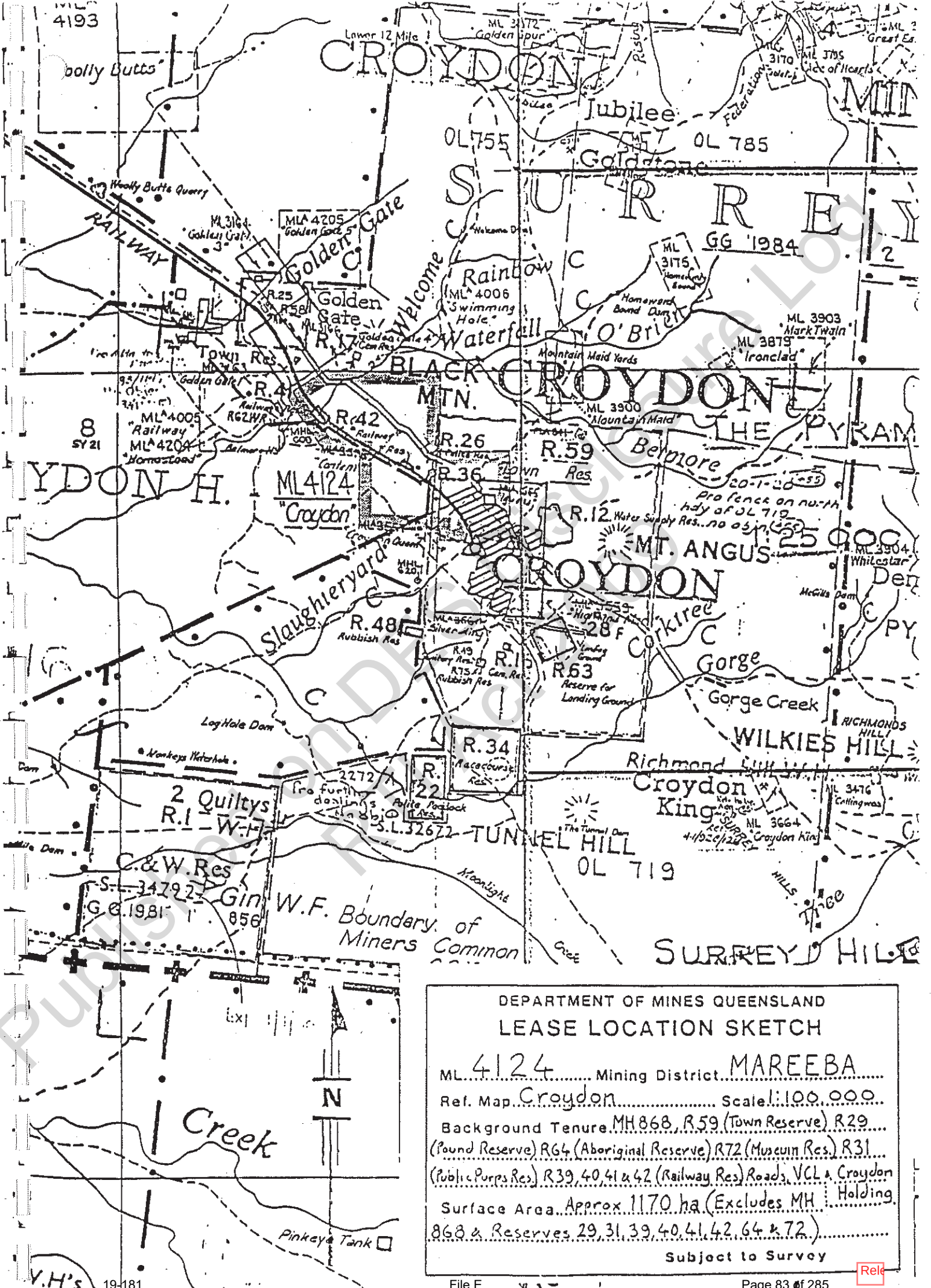
- (a) a plan showing the location of all the proposed activities within the area of the Lease;
 - (b) a general description of the nature and scale of all the proposed operations;
 - (c) a description of the physical and chemical natures of waste materials resulting from the proposed mining and the methods proposed for their disposal and storage;
 - (d) a description of the measures proposed to monitor and control:
 - (i) surface and ground water contamination; and
 - (ii) erosion;
 - (e) a description of:
 - (i) soil type and depth;
 - (ii) vegetation;
 - (iii) aboriginal artifacts; and
 - (iv) surface water quality and quantity;
 - (f) a statement of the proposed post-mining land use, and a description of the rehabilitation methods proposed to achieve this land use;
 - (g) a description of any arrangements proposed for residential purposes, the storage of water, and construction of roads on the area of the Lease; and
 - (h) a nominated term.
6. When a description of operations is required to be submitted pursuant to condition 5, the Lessee shall not mine other than in accordance with an approved description of operations.
7. Prior to the commencement of any clearing of any land on the Lease, or in a right of way relating to the Lease, the Lessee shall inform the owner of the timber, being the Department of Forestry in the case of timber on Crown Land, in sufficient time for the effective removal of timber, and the Lessee shall not commence clearing operations until the written permission of such owner or the Department of Forestry, as the case may be, is first had and obtained.
8. When, in the opinion of the Minister, a significant depth of organically enriched soil occurs on the area to be mined, or on an area where overburden or waste rock is to be deposited the Lessee shall:
- (a) Remove such organically enriched soil within a depth of three hundred millimetres below the surface; and

/3..

- (b) Stack such soil so that it will not erode, and so that it will be available for the rehabilitation of the mined and disturbed area and for no other purpose.
9. The Lessee shall grade and contour the mined area, overburden and waste rock dumps progressively, so that:
 - (a) final voids are landscaped and connected to the drainage pattern in the area for best practical advantage for use as water storage areas;
 - (b) rock and overburden dumps are contoured to conform as nearly as is practicable to the adjoining land forms in terms of slopes and slope lengths; and
 - (c) all disturbed areas are stabilized against the natural forces of erosion.
 10. After an area has been contoured in accordance with condition 9 the Lessee shall:
 - (a) Cover the surface of the contoured area with the soil removed in compliance with condition 8; and
 - (b) Take such measures as the Minister may direct to promote the stabilization of the area and the regrowth of vegetation during the term of the Lease.
 11. The Lessee shall ensure that the area of the Lease left unrestored as defined in conditions 9 and 10 at any one time does not exceed forty (40) hectares.
 12. The Lessee shall:
 - (a) Prior to the commencement of deposition of overburden or waste rock on any area of the Lease, satisfy the Minister that such area is suitable for such purpose; and
 - (b) Satisfy the Minister that adequate precautions have been taken to prevent water that may leach, drain, or wash from any overburden or waste rock flowing into any natural watercourse or reservoir, or satisfy the Minister that such water will be adequately treated.
 13. When the Minister so requires, the Lessee shall ensure that overburden or waste rock dumps that react with water to produce substances toxic to animal and plant life are covered by an approved layer of inert material.
 14. All fences on the Lease shall be kept intact at all times, except that, where the Lessee requires to remove a fence an alternative fence of a standard equal to or better than the displaced fence shall be provided by the Lessee.

/4..

15. All roads, tracks, and rights of way on the Lease area shall be maintained by the Lessee such that those persons who have a right to use such roads, tracks, and rights of way shall have access at all times, and if the Lessee desires to mine through the path of an existing road, track or right of way, an alternative road, track or right of way shall be provided by the Lessee and maintained at a standard at least equal to that of the original road, track or right of way. Nothing in this condition shall be read or construed so as to negate the provisions of Section 44 of the Mining Act 1968-1986.
16. The Lessee shall only construct dams on the Lease area in accordance with an approved method. This condition shall not be read or construed as negating the Lessee's duties and responsibilities under the provisions of the Water Act 1926-1987.
17. The Lessee shall maintain the Lease area in a tidy state and, prior to the termination of the Lease, remove all machinery and plant unless otherwise approved.
18. The Lessee shall observe at all times the provisions of the Rural Lands Protection Act 1985, Clean Waters Act 1971-1982, Cultural Record (Landscapes Queensland and Queensland Estate) Act 1987 and the Rural Fires Act 1946-1984, as they relate to the Lessee and to the Lease.
19. The Lessee shall ensure that the amount of noise, dust, gases and ground vibration generated on the Lease and affecting areas within or outside the boundaries of the Lease shall be at levels acceptable to the Minister, and when directed by the Minister, the Lessee shall take all steps necessary to reduce such noise, dust, gases and ground vibration to levels nominated by the Minister.
20. The Lessee shall not affect the use of the water tank operated by the Croydon Shire Council without the prior written permission of that Council first had and obtained. (ANNEXURE ENDS)



DEPARTMENT OF MINES QUEENSLAND
LEASE LOCATION SKETCH

ML 4124 Mining District MAREEBA
Ref. Map Croydon Scale 1:100,000
Background Tenure MH 868, R 59 (Town Reserve) R 29
(Pound Reserve) R 64 (Aboriginal Reserve) R 72 (Museum Res.) R 31
(Public Purps Res.) R 39, 40, 41 & 42 (Railway Res.) Roads, VCL & Croydon
Surface Area Approx 1170 ha (Excludes MH Holding
868 & Reserves 29, 31, 39, 40, 41, 42, 64 & 72.)
Subject to Survey

APPENDIX B

ENGINEERING ASSESSMENT OF REHABILITATION OPTIONS



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B1.0

WASTE DUMPS - REPROFILING AND RECAPPING OPTION**B1.1 PHILOSOPHY OF WASTE DUMP CAPPING DESIGN**

To achieve the adopted rehabilitation objective as stated in Section 1.0 of the 1996 (Amended) Decommissioning Plan, the primary features of this rehabilitation option would consist of:

- (i) reprofiling of waste dump batters and regrading of surfaces (within areas not previously reprofiled) to enhance geotechnical stability, to enable controlled surface water drainage, and to allow the construction of capping systems;
- (ii) capping of the waste dump surface and batters to reduce ingress of water and oxygen into the dump (i.e. two key components of AMD generation), using compacted clay, and a surface protection layer comprising benign rock fill. Revegetation of this surface would also be undertaken

B1.2 DESIGN ISSUES

The relevant design issues of this strategy are as follows:

- (i) A capping layer would possess characteristics (i.e. permeability and serviceability) that would substantially reduce the potential for infiltration of surface water and O_2 into the waste dump. These characteristics are dependent on the geotechnical properties of the capping material and the adopted construction specification.

- (ii) Related issues that would affect the performance of the capping layers are the subgrade condition (i.e. required to be of suitable quality to enable construction standards within the capping layer to be achieved), and the exposure conditions following construction (i.e. suitable protection/surface treatment required to reduce desiccation or weathering and erosion of the capping layer). Availability of construction materials would also be an issue.

B1.3 HYDROLOGICAL MODELLING

(i) Capping Design

Hydrological modelling was undertaken as the basis for selecting the configuration and thickness of surface capping for the Golden Butterfly and Content waste dumps.

The HELP (Hydrologic Evaluation of Landfill Performance) computer model was used as the basis for this capping layer design. The model provides estimates of infiltration through earthfill covers. The model divides the waste dump profile into a number of segments. As an initial condition, the model assumes the moisture content in each layer to be equal to the moisture content that would exist in the soil under drained conditions (i.e. field capacity). For each day of simulation, the model performs a water balance over the waste dump profile, monitoring the moisture content variation. Compared with the field moisture capacity of the material, the model calculates the volume of free water. Based on the permeabilities of these layers, the rate of flow is then estimated. This process is repeated over the various layers within the model.

The initial phase of the analysis was to "test" the sensitivity of the model to variations in the thickness of the evapotranspiration zone. These analyses indicated that an evapotranspiration zone of 1.0 m would be appropriate.

The second phase of the modelling was performed to test the effect of permeability and compacted clay layer thickness on the degree of infiltration through the cover system. A number of simulations were performed for a range of permeabilities, incrementing the thickness of the compacted layer with each simulation. The modelling showed that the permeability of the compacted layer has a significant effect on the simulated infiltration.

Compacted layer thicknesses and permeabilities can be selected to restrict infiltration to an appropriate level. For the purpose of design, it is considered that infiltration limited to 5% of total rainfall would be appropriate. On this basis, a minimum capping layer thickness of 0.6 m and possessing a maximum permeability of 10^{-8} m/s is considered a minimum requirement. The thickness of the compacted layer not only affects the amount of infiltration into the waste dump but contributes to the overall depth of cover (i.e. capping layer and rock mulch layer) over the waste dump material. At least 1.0 m of cover is desirable to isolate the materials from the evapotranspiration process. In addition to the 0.6 m compacted layer, therefore, an additional surface layer is required to achieve this minimum thickness of cover. This surface layer would comprise a select rock fill which would be used for erosion protection of the underlying compacted layer.

(ii) Drainage and Stability Design

An important consideration of the rehabilitation works is to facilitate rapid drainage away from the waste dump areas to limit the potential for infiltration into the dump.

Final waste rock dump landforms have been designed to drain surface water and discharge runoff from ML 5248 in an effective manner. Stormwater diversion bunds and sediment basins have been incorporated as control structures; each hydraulically designed on the basis of a 1 in 100 year, critical duration rainfall event.



The engineering design for the rehabilitation works incorporate batter slopes on waste rock dumps of 3 (horizontal):1 (vertical). This slope was selected for long-term geotechnical stability, taking into consideration the geotechnical characteristics of the waste rock materials. For long slopes in excess of 50 m length, benches will be necessary to reduce runoff velocities and hence mitigate erosion potential. A minimum bench width of 5 m is considered acceptable.

B1.4 SUMMARY

The analyses outlined above indicate that a waste dump cover system comprising a 0.6 m capping layer (maximum permeability of 10^{-8} m/s) with a 0.4 m layer of select rock fill would represent a minimum requirement to achieve the desired performance. This design would be appropriate for the flat areas of the dumps. It is inferred that on the batters, due to the increased grade, the rate of infiltration potential would decrease significantly (as a consequence of increased surface runoff). As a result, a reduced capping layer thickness would be suitable - a thickness of 0.45 m being selected¹, with a 0.4 m surface protection layer. To improve the effectiveness of the clay capping layer, a clay filled key trench around the waste dump perimeters would be required. This key trench would reduce the potential for either surface water entering the dump area or release of any water or leachate contained within the dumps.

An investigation into potential clay fill borrow areas near the lease identified a source to the west of the Content pit within Belmore Station. Geotechnical testwork on this soil indicated that permeabilities of the order of 10^{-8} m/s could be achieved in the field subject to a compaction standard of 98% of maximum (standard) dry density at -2 to +3% of optimum moisture content.

It will be necessary that rock fill used to form the surface protection layer would comprise benign (i.e. non-acid producing) waste rock sourced from the waste dump areas. The site inspections carried out indicate that sufficient quantities of these materials are available to complete the works.

¹ Selected on the basis of constructability rather than infiltration.



Prior to construction of these capping works, reprofiling of the waste dump surfaces to facilitate effective drainage of the landforms and ensure long term geotechnical stability would be required. Batter slopes of the order of 3(H) : 1(V) were thereby adopted, with benches of some 5 m width provided at 50 m (maximum) spacing measured along the batter slopes. Associated drainage structures including stormwater diversion bunds and sediment basins would also be required to manage the release of runoff from the waste dump areas.



B2.0

WASTE DUMP/PITS - BACKFILLING OPTION

B2.1 PHILOSOPHY AND CONCEPT OF PIT BACKFILLING

The possible pit backfilling strategy for ML 5248 is as follows:

- (i) Golden Butterfly Waste Dump to Golden Butterfly Pit; and
- (ii) Content Waste Dump to Content Pit and/or Lady Isabella Pit.

Pit backfilling would be carried out by a bulk earthworks program.

B2.2 CONSTRAINTS

The issues related to design and scheduling of the pit backfilling option are:

- (i) The capacity of the existing pits will limit the volume of waste that may be contained below the natural ground surface. This volume would also depend on the characteristics of the waste rock and the method of placement;
- (ii) The pits currently contain considerable quantities of water. The presence of water will implicate both the volume efficiency of the voids (due to the effects of saturation of the waste rock on placement) and the effects of displacement and possible pit overtopping as a result of waste placement; and
- (iii) The potential for saturation of the emplaced waste rock material within the pits and resulting seepage discharges also need to be considered.



B2.3 VOID CAPACITIES AND REQUIRED VOID VOLUMES

A survey of the pits was carried out as part of this study to estimate voids volumes. A summary of the data is provided in Table B1.

TABLE B1
Summary of Pit Geometry

Pit	Average Surface Area (m ²)	Average Depth to Water Surface** (m)	Total Void Volume *** (m ³)
Golden Butterfly	36 500	25	1 080 300
Content	18 000	22	300 846
Lady Isabella	15 000	12	176 060

* Golden Butterfly North Pit not considered due to past use as water supply.

** From surrounding ground surface

*** Obtained from in-pit survey and includes volume of water contained in pit

Based on a previous survey carried out as part of the initial rehabilitation works, the total volume of waste rock contained within each waste dump was estimated, as follows:

Golden Butterfly Waste Dump	1.78 million m ³
Content Waste Dump	0.36 million m ³

Available records show that the total waste rock quantity extracted and placed within the Golden Butterfly waste dump from the Golden Butterfly pit was 3.09 million tonnes. The Golden Butterfly waste dump also contains waste derived from the Golden Butterfly North pit. It is estimated that about 20% of the total dump volume represents Golden Butterfly North material, implying a total quantity of waste in the Golden Butterfly dump of approximately 3.8 million tonnes. Based on a waste rock volume for the Golden Butterfly waste dump of 1.78 million m³, this represents an average in-dump bulk density of 2.1 t/m³. Assuming similar densities can be achieved in the pit through the backfilling process within either the Golden Butterfly or Content pits, the following conclusions are made:

- The Golden Butterfly pit will not contain fully the volume of material within the Golden Butterfly waste dump. Mounding of the finished surface of the backfilled pit (above the natural ground level but abutting the adjacent hill) would therefore be required.
- The Content pit possesses a marginally lower volume than is required for containment of the Content waste rock volume. Minor mounding of the backfilled pit (sufficient to facilitate surface drainage) would therefore be required.
- Based on the slope, there is no requirement for the Lady Isabella pit for backfilling purposes.

B2.4 DESIGN ANALYSES - HYDROLOGICAL MODELLING

Hydrological modelling has been carried out in relation to the pit backfilling strategy to define the following conditions:

- Pit overtopping potential (Backfill scenario - during backfilling works).
- Pit overtopping potential (Backfill scenario - long term condition).

The modelling was carried out in relation to the Golden Butterfly pit, with results assumed to apply for the Content pit.

(i) Pit Overtopping Potential - Backfilled Pit Scenario (Construction Phase)

A simple spreadsheet model was developed to predict water levels in the Golden Butterfly pit, under a rapid backfilling condition. The pit cross-section and water levels assumed were similar to those for the open pit scenario outlined in Section B3.0. A surface area versus storage relationship for the pit was developed on the basis of these characteristics. This relationship indicates that, for a pit water level at a depth of 25 m below ground level, the total contained water volume would be of the order of 300 000 m³.

The model developed is dependent on the achievable porosity of the backfill material (i.e. ratio of void volume with total volume) to provide storage. It was considered for the purpose of analysis that rainfall, evaporation and groundwater system water inflow were balanced, on an annual average basis, and therefore were ignored (which, due to the considerable excess evaporation over rainfall of Croydon and the expected limited groundwater inflow to the pit, is an appropriate assumption). It was assumed that the pit was backfilled over a period of 90 days (i.e. backfilling would occur rapidly, inferring that no dissipation to the adjacent groundwater systems would occur during the period of backfilling) and that no rainfall occurred over that period.

Using the model developed, as described above, it was indicated that spillage from the backfilled pit could occur if the average porosity of the backfill material was 0.25 or less. Based on observed characteristics of the waste rock and by inference from established geotechnical correlations, it is considered that a porosity of around 0.25 could be obtained with considerable levels of compaction. For uncompacted backfill materials, a porosity of the order of 0.35 would be likely (which is consistent with the bulk density of 2.1 t/m³ estimated above). Re-analysis of this condition indicates that, over a 90 day backfilling period, the water level would rise to some 9 m below surrounding ground level.

These analyses, indicate that the potential for pit overtopping during the construction phase would be marginal, depending on the level of compaction achieved within the backfill material.

(ii) Pit Overtopping Potential - Backfilled Scenario (Long Term)

The hydrological process which would contribute to the longer term hydrology of the backfilled pit can be considered as a balance between infiltration and percolation of water into the pit and seepage out of the pit.

Assuming that no capping layer was constructed, the backfilled pit would have a high infiltration capacity (relative to surrounding areas). A significant proportion of incident rainfall would tend to infiltrate through the surface of the dump and move (percolate) rapidly down to the saturated zone or groundwater table within the pit. After the groundwater levels within the pit reach a level consistent with the regional groundwater table, further infiltration would cause groundwater mounding to form and a corresponding increase in outflow from the pit (due to the increasing hydraulic gradient generated by the mound). These processes (infiltration, mounding and outflow to the regional groundwater system) would continue until an equilibrium or balance occurred (i.e. mounding will continue while the rate of infiltration exceeds the rate of water movement out of the pit into the surrounding groundwater).

To assess the long-term situation which is likely to occur post-pit backfilling, an analytical model developed for simulation of large diameter well hydraulics was used to simulate the long term water levels in pits. The model is represented by the following equation:

$$Q = \frac{\pi K (h_o^2 - (h_o - h_w)^2)}{\ln r_o / r_{pit}}$$

Where

K = Saturated hydraulic conductivity of rocks

h_o = Groundwater level in the pit.

h_w = Height of water table above base of pit
(regional groundwater level)

r_o = Radius of influence

r_{pit} = Radius of the pit.

The following assumptions were made in the analysis.



- Infiltration of water through waste and into the pit equal to 30% of average rainfall for Croydon. This translates to an annual infiltration rate of 210 mm.
- Saturated hydraulic conductivity of pit wall rocks of 1×10^{-7} to 1×10^{-8} m/s (estimated from insitu permeability testing carried out within bores constructed adjacent to Golden Butterfly Waste Dump).
- Maximum available head above regional groundwater level = 25 m (i.e. maximum mounding before outflow occurs).

Results of this analysis indicate that, in the longer term, water levels in the pit are likely to rise sufficiently to overtop the pit and migrate as a seepage front appearing at the toe of the mounded dump. These conclusions are, however, based on the available knowledge of the regional hydrogeology which is fairly limited.

If the bulk permeabilities surrounding the pit were greater than 1×10^{-7} m/s and/or if infiltration through the dump was significantly less than 30% of rainfall, it is probable overtopping would not occur. For instance, in the event that nett pit surface infiltration was 20% of incident rainfall (i.e. rate of 140 mm/annum) as a result of construction of a surface capping layer, it is predicted that the final pit water level would rise to 10 m below surrounding ground surface and overtopping would therefore not be likely to occur.

B2.5 SUMMARY

Potential for overtopping from the Golden Butterfly Pit as a result of waste rock backfilling appears to exist during both construction or in the long term. This potential is affected by the following conditions:

- The higher the level of compaction achieved in backfilled material, the greater the potential for overtopping during construction.

- The greater the surface infiltration within the pit area following construction, the greater the potential for overtopping in the long term. Based on these results, it is considered that the most appropriate backfilling philosophy would be to provide moderate levels of compaction (i.e. essentially to limit the potential for significant ongoing ground surface settlement) and to cap the final ground surface to limit ground surface infiltration potential.



B3.0

PITS - DO NOTHING

AMD within the Golden Butterfly Pit, and to a lesser extent the Lady Isabella and Content Pits, is an ongoing process. Poor pit water quality, therefore, prevails within the Golden Butterfly pit, with marginal quality within the Lady Isabella and Content pits. Under a "Do Nothing" scenario for these pits, the most significant issue would be the risk of overtopping, thus causing release of poor quality water. A simple water balance analysis has, therefore, been undertaken in relation to the Golden Butterfly pit, to assess the long term potential for overtopping, with these results extrapolated to the Lady Isabella and Content pits.

The premise under which this analysis was carried out was that all surface water runoff is redirected away from the pit area by the existing safety bunding, with overtopping due predominantly to direct precipitation over the pit area and the inflow of groundwater.

The groundwater inflow rates to the pit would be controlled by the permeability of the exposed sequences within the pit. Based on insitu testing within bores constructed adjacent to the Golden Butterfly pit, the permeability of the pit wall rocks were estimated to be of the order of 10^{-7} to 10^{-8} m/s.

Groundwater inflows to the pit would occur while water levels in the pit were lower than the surrounding groundwater table levels. Inflows would be expected to continue toward the pit until the original groundwater levels were re-established. The original groundwater levels would have been about RL 100 m (i.e. some 10 m below existing ground surface, measured in BH2 - refer Section 4.2.2.2 of the main text). The current water level in the Golden Butterfly pit is around RL 87 (i.e. 25 m below ground level).

As discussed in Section B2.0, on an annual average basis, the effects of rainfall, evaporation and groundwater inflow are assumed to be balanced (assuming surface runoff is diverted away from the pit area). This condition was reflected in these analysis, and indicated that after equilibrium groundwater levels were restored in the pit, only minor short term mounding of pit waters would likely occur. Under typical wet season fluctuations it is expected that this mounding would not likely exceed 3 m (based on typical wet season rainfall excess at Croydon).

Based on this brief water balance analysis, it is expected that overtopping of the pit, even under the most extreme of wet seasons, would be unlikely.

B4.0**OTHER AREAS - REMOVAL**

As the stockpile area and the western side of the Content pit contain material with potential for acid production, it is considered prudent to remove these materials. Similarly, the drainage channel has been contaminated by seepage from the Golden Butterfly waste dump, and it is considered that the contaminated material should also be removed. It is considered that the haul road could remain intact because of its existing level of compaction.

It is proposed that all removed materials be dumped in the Golden Butterfly or Content pit, as appropriate.



APPENDIX C

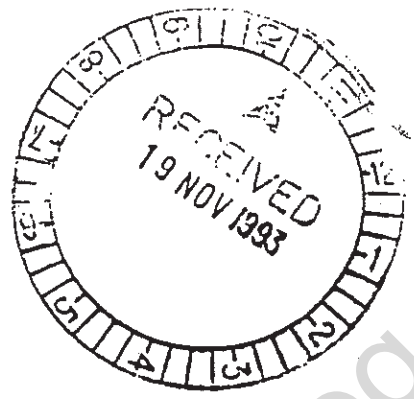
LANDHOLDER REQUIREMENTS

DEPARTMENT OF LANDS AND CROYDON SHIRE COUNCIL

A32\00280\0005\R002-D.DOC\22 MAY 1997\ASW:hun



Your Ref: David Newton
Our Ref: ATH/Gen



10 November 1993

Woodward Clyde
49 Park Road
Milton Qld

Dear Sir

RE: ML 5248 - Post Mining Land Use

I refer to faxes received on 21 September 1993 and 21 October 1993 concerning post mining land use of land covered by ML 5248.

This Department advises that the Trustees of the various reserves covered by the Mining Lease should be contacted to ascertain their requirements concerning post mining land use.

With regard to the vacant Crown land and any reserves of which this Department is Trustee, the Department refers you initially to the requirements of the Department of Minerals and Energy and their rehabilitation requirements. Apart from reinforcing that Department's requirements this Department requires:

1. that road areas be rehabilitated with natural vegetation cover using endemic species, apart from minimal access roads suitable for local usage. The location of the access tracks should be ascertained by reference to Croydon Shire Council and surrounding landowners.
2. This Department has no specific requirements with regard to fencing around reserves but advises that the replacement or leaving of any fencing damaged/removed/erected in the mining process be reviewed in consultation with the landowners in the locality, with their legal boundaries taken into consideration.
3. areas used for grazing be revegetated with improved pasture
4. all foreign equipment and rubbish removed
5. suitable vegetation to control soil erosion where necessary

Yours faithfully

CTPI 49-Sch4

M Linnan
Regional Operations Manager
Land Services



DEPARTMENT
LANDS

FOR NORTH
REGION

Main Street
Milton
POSTAL:
PO Box 250
Milton 4880

CONTACT:
Smout

PHONE:
3222

FAX NO:
7 2844



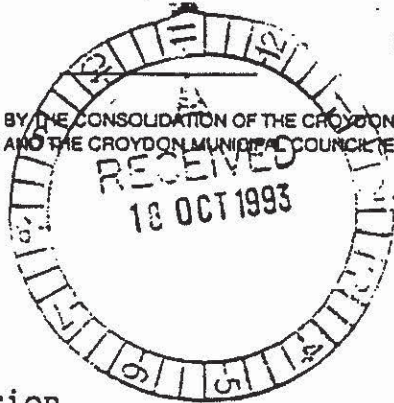
Croydon Shire Council

ESTABLISHED IN 1909 BY THE CONSOLIDATION OF THE CROYDON DIVISIONAL
BOARD (EST. 1888) AND THE CROYDON MUNICIPAL COUNCIL (EST. 1892)

Address all correspondence to
THE SHIRE CLERK

12 October 1993

Manager - Northern Division
AGC Woodward-Clyde Pty Ltd
49 Park Road
Milton Qld 4064



FORWARD TO

COPY TO

CROYDON 4871
North Queensland

Dear Sir

POST-MINE LAND USE OF ML 5248 CROYDON GOLD MINE

I refer to your letter dated 28 September 1993 and our facsimilie dated 6 October 1993 concerning the above matter.

The Golden Butterfly North open cut pit is currently used by the Council as a source of water supply for the township and it is essential for Council to retain access to the pit through the proposed bund wall via the existing access. We would suggest that when the area is fenced a suitable gate be erected to allow easy access for Council employees.

In addition, the adjacent top of the tailings dump and its rock wall acts as a water catchment and directs runoff into the pit through a concrete pipe located under the existing bund wall and it is requested that when the dump is capped, provision be made to retain these features.

With regard to capping material for the dump, an area immediately to the east of the dump face appears to be a suitable source for the loam/clay required for the capping operation. The resulting excavation would provide a catchment storage area for runoff water flowing westward from the northern side of the adjacent bitumen road. The exact location can be obtained from Councils Foreman Ron Diehm.

The Lady Isabelle and Content Pits are also being examined as possible future water supply sources and it is requested that ready access be provided in any intended works at those sites.

With reference to revegetation of the various sites, I will advise you further in that regard once I have consulted further with the Council.

Rel

I trust the foregoing is of some benefit to you as the proposals contained therein will certainly be of some benefit to the Croydon community.

Yours faithfully

CTPI 49-Sch4

Des Niesler
Shire Clerk

Croydon Shire Council

ESTABLISHED IN 1908 BY THE CONSOLIDATION OF THE CROYDON DIVISIONAL BOARD (EST. 1888) AND THE CROYDON MUNICIPAL COUNCIL (EST. 1892)

Address all correspondence to
THE SHIRE CLERK

CROYDON 4571
North Queensland

FACSIMILE TRANSMISSION

DATE:

6-10-93

TO:

CTPI 49-Sch4

COMPANY/FIRM:

WOODWARD - CLYDE

FACSIMILE NO:

07 364 74 77

FROM:

RON DIEHM

CROYDON SHIRE COUNCIL
FAX NO:

(077) 456 147

NUMBER OF PAGES
(INCLUDING THIS PAGE):

THREE

RE:

TELEPHONE CONVERSATION

MESSAGE:

ENCLOSING ROUGH PLAN OF WHERE COVER MATERIAL COULD BE OBTAINED.

THIS EXCAVATION COULD BE A BENEFIT TO COUNCIL, AS WE PROPOSE TO EXCAVATE A STORAGE DAM TO HELP REPLENTISH THE WATER LEVEL IN GOLDEN BUTTERFLY NORTH FOR THE TOWN WATER SUPPLY.

COUNCIL WOULD BE PLEASED IF ALL WATER OFF THE WASTE DUMP WENT INTO THE GOLDEN BUTTERFLY NORTH PIT IF NOT EFFECTED BY ANY MINERALS.

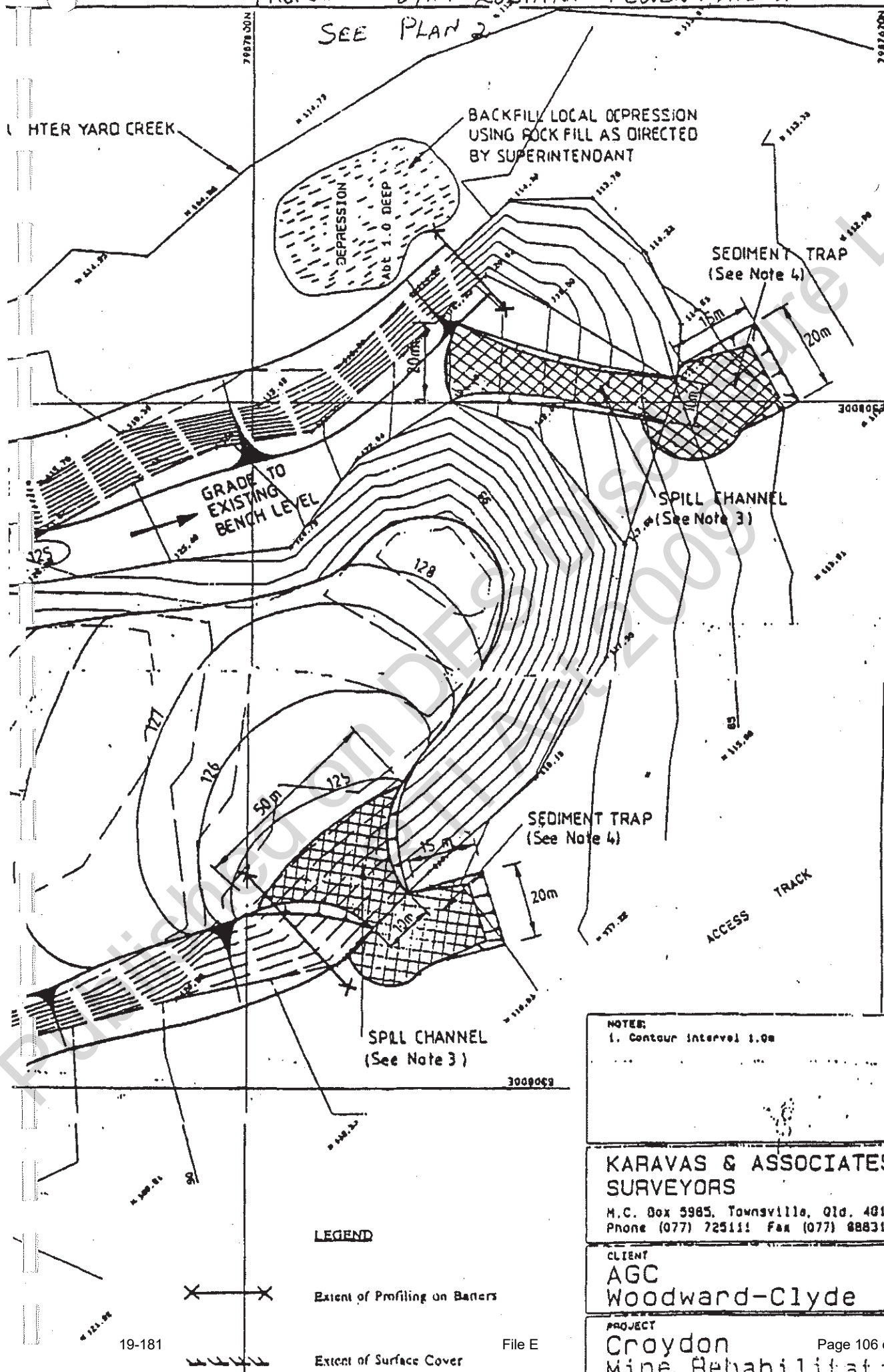
COUNCIL WOULD LIKE REVEGETATION TO CONTINUE GROWING ERAND, SECA, AMEGA + BUFFEL, THIS HAS GROWN WELL THERE WILL NOT BE ANY STOCK TO DESTROY THIS

THANKING YOU

CTPI 49-Sch4

PROPOSED DAM LOCATION + COVER MATERIAL

SEE PLAN 2



NOTES:
1. Contour Interval 1.0m

KARAVAS & ASSOCIATES
SURVEYORS

M.C. Box 5985, Townsville, Qld. 4810
Phone (077) 725111 Fax (077) 888317

CLIENT
AGC
Woodward-Clyde

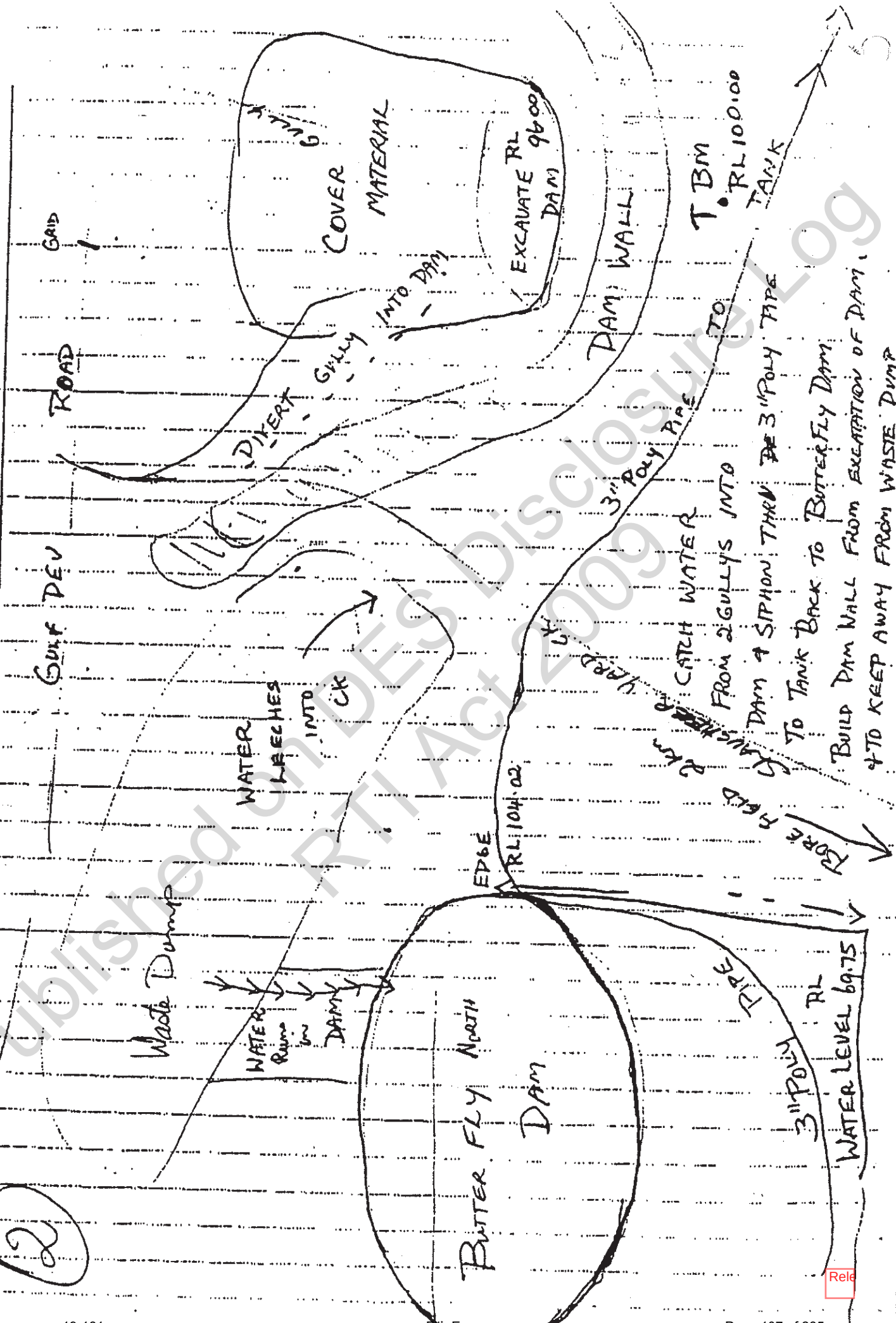
PROJECT
Croydon
Mine Rehabilitation

Page 106 of 285

Released

PROPOSED WATER STORAGE

2



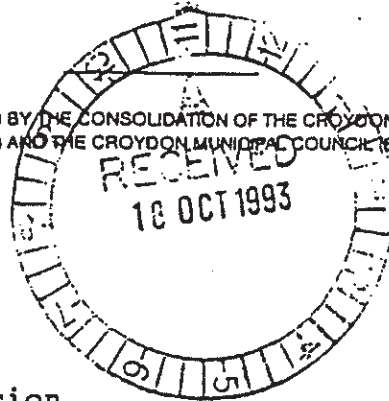
Croydon Shire Council

ESTABLISHED IN 1909 BY THE CONSOLIDATION OF THE CROYDON DIVISIONAL
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Address all correspondence to
THE SHIRE CLERK

12 October 1993

Manager - Northern Division
AGC Woodward-Clyde Pty Ltd
49 Park Road
Milton Qld 4064



CROYDON 4871
North Queensland

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I trust the foregoing is of some benefit to you as the proposals contained therein will certainly be of some benefit to the Croydon community.

Yours faithfully

Release

Des Niesler
Shire Clerk

APPENDIX D

SURFACE WATER AND GROUNDWATER SAMPLING
AND PRESERVATION INSTRUCTIONS

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CROYDON GOLD MINE

SURFACE WATER AND GROUNDWATER MONITORING
SAMPLING AND PRESERVATION INSTRUCTIONS

D1.0 INTRODUCTION

The key to achieving accurate monitoring results is to minimise potential contamination of the samples through the adoption of correct sampling procedures and the use of clean sample bottles, clean conditions during collection, correct sample preparation and rapid transport of the samples to the laboratory.

The following instructions provide step by step procedures for taking surface water and groundwater samples.

When practical have an ice filled esky ready before starting a sample collection run, and place the samples into it immediately after collection. It is necessary to chill samples to minimise degradation of the sample between the time of collection and analysis in the laboratory.

Samples are to be chilled to between 1°C and 4°C as soon as possible after collection.

Only use sample containers that have been prepared and supplied by a laboratory, it is generally impractical for field staff to prepare their own sample containers.

To avoid contaminating the sample, ensure that your hands are clean and the sample containers are clean on the outside before submerging them in the water to be sampled. For the same reason, do not write the sample identification on the container until after the sample has been taken.

Unless avoidable, do not collect samples from the surface of a waterbody, try and collect the sample from at least 20 cm below the surface.

Samples must be despatched to the laboratory as soon as possible after collection to minimise degradation. Whenever possible they should be received by the laboratory within 48 hours of being collected. Ensure that the samples are packed in sufficient ice to maintain their temperature below 4°C during transit - do not freeze the samples.

It may be necessary to alter the sampling schedule to fit in the bus company timetables, to minimise the delay between sample collection and analysis. However, samples should be collected as close as possible to the nominated sampling dates. Note that there is provision on the Field Data Sheet to reuse when no sample is available for collection.

D2.0 SAMPLE BOTTLE REQUIREMENTS (per site)

No.	Type	Size	Preservation	Label Colour
1	Narrow-mouthed plastic	1 Litre	"natural"	green
1	Narrow-mouthed plastic	250 ml	"acidified" (nitric acid)	red

These bottles can be obtained from Australian Environmental Laboratories (formally Analabs) in Cairns.

D3.0 FIELD DATA RECORDS

An example field data sheet is attached. One sheet is required for each sampling event. The sheet should be used at each site to record the following information:

- (i) sample site identification number;
- (ii) date of sampling;
- (iii) current weather conditions and rainfall in the previous 24 hours;
- (iv) for surface water samples - approximate depth of water at deepest point in the stream;
- (v) for groundwater samples - the depth from the surface to standing water;
- (vi) pH (use pH indicator tabs or pH meter); and
- (vii) conductivity (EC) (if a meter is available).

One copy of the completed sheet should be forwarded to Woodward-Clyde and RGE's General Manager Environment, with a copy retained by the sampler.

D3.1 SURFACE WATER SAMPLES

- Step 1** Label sample bottles with sample site identification number and date.
- Step 2** Immerse the "natural" bottle (green label) into the water.
Where possible, avoid taking the sample from the surface of the water. Fully immerse the bottle about 20 cm into the water or as far as possible and allow to fill. Attach the cap and shake for 15 seconds. Discard this sample downstream or onto the ground well away from the sample point.
- Step 3** Refill the "natural" bottle using the same method and transfer to the "acidified" bottle (red label). Fill the "acidified" bottle completely, but don't cause it to overflow and secure the cap firmly.
- Step 4** Refill the "natural" bottle using the same method, fill completely and secure the cap firmly.

- Step 5** Measure field pH and EC.
- Step 6** Store samples in an esky at or below 4°C (use ice or ice blocks to cool) and transport to the laboratory as soon as possible.

D3.2 GROUNDWATER SAMPLES

- Step 1** Label sample bottles with sample site identification number and date.
- Step 2** At each monitoring bore, measure the depth to the water level using a water level probe or weighted rope.
- Step 3** Remove and discard at least three bore volumes of water using a suitable pump.
- Step 4** Fill a bailer and discard three times before sampling on the fourth.
- Step 5** Measure field pH and EC.
- Step 6** Fill the “natural” bottle, attach the cap, shake for 15 seconds, discard.
- Step 7** Refill the “natural” bottle using the same method and transfer to the “acidified” bottle (red label). Fill the “acidified” bottle completely and secure the cap firmly.
- Step 8** Refill the “natural” bottle using the same method, fill completely and secure the cap firmly.
- Step 9** Measure field pH and EC.
- Step 10** Store samples in an esky at or below 4°C (use ice or ice blocks to cool) and transport to the laboratory as soon as possible.

D3.3 CHAIN OF CUSTODY/SAMPLE SUBMISSION RECORD

An example chain of custody/sample submission sheet is attached. One sheet is required for each sampling event. The sheet should be filled out and signed at the time of sample dispatch to the laboratory. It should be used to record the following information :

- (i) sampler's name and signature;
- (ii) date and time of sampling;
- (iii) sample identification number (cross out if not collected);
- (iv) number of containers for each sample identification number;
- (v) total number of containers;
- (vi) date, time and dispatch method used to transport the samples to the laboratory.

One copy of the record should be forwarded to each of the following:

- a) laboratory;
- b) Woodward-Clyde;
- c) RGE's General Manager Environment; and

one copy is to be retained by the sampler.

Published on DES Disclosure Log
RTI Act 2009

**CROYDON GOLD MINE
GROUNDWATER AND SURFACE WATER QUALITY
FIELD DATA SHEET**

SAMPLERS NAME:	
DATE:	

WEATHER CONDITIONS:	
RAINFALL (PREVIOUS 24 HRS):	

SURFACE WATER AND PITS	SITE (cross out if not collected)	TIME OF SAMPLING	DEPTH OF WATER (m)	FIELD PARAMETERS		CONTAINERS USED		SAMPLES STORED ON ICE (tick)	SAMPLES DISPATCHED TO ANALABS (tick)	OTHER
				pH	EC (µS/cm)	Natural 1 L (tick)	Acidified 250 ml (tick)			
	SW1									
	SW2									
	SW3									
	SW3A									
	SW4									
	SW5									
	Golden Butterfly Pit		N/A							
	Golden Butterfly North Pit		N/A							
	Content Pit		N/A							
	Lady Isabella Pit		N/A							

GROUNDWATER	SITE (cross out if not collected)	TIME OF SAMPLING	DEPTH TO WATER (m)	BORE PURGED (tick)	FIELD PARAMETERS		CONTAINERS USED		SAMPLES STORED ON ICE (tick)	SAMPLES DISPATCHED TO ANALABS (tick)	OTHER
					pH	EC (µS/cm)	Natural 1 L (tick)	Acidified 250 ml (tick)			
	GBMB1										
	GBMB2										
	GBMB3										
	GBMB4										
	GBMB5										
	GBMB6										
	BH1										
	BH2										
	BH3										
	BH4										
	BI15										
	BI16										
	BI17										

Woodward-Clyde

APPENDIX E

COMMITMENT COMPLIANCE - ML5248

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COMMITMENT COMPLIANCE - ML 5248

COMMITMENT	COMPLIANCE STATUS	COMMENTS
Identify background landholder requirements regarding rehabilitation of ML 5248	Completed (refer Section 4.4.1)	
Prepare and implement an upgraded and enhanced site environmental monitoring program.	Upgraded monitoring program proposed and being implemented	
Review environmental monitoring program annually in consultation with the DME to ensure the continued effectiveness of the program.		Review to be undertaken in conjunction with Annual Monitoring Report.
Golden Butterfly Waste Dump - Clay fill covering and rock fill surface protection of the entire waste dump surface and construction of a cut-off key around the dump perimeter.	Completed November 1996.	
Content Waste Dump - Reprofile batter slopes (other than western batter). Clay fill covering and rock fill surface protection of the entire waste dump surface.	Completed November 1996.	
Identify, remove and dispose of potentially acid producing material from the Golden Butterfly hardstand area.	Completed November 1996.	



COMMITMENT	COMPLIANCE STATUS	COMMENTS
Identify, remove and dispose of contaminated sediments in Slaughteryard Creek adjacent to the Golden Butterfly waste dump.	Completed November 1996.	
Revegetate waste dump surfaces, former hardstand areas and other disturbed areas with native woodland tree species.	Seeding completed January 1997.	Establishment to be monitored in Autumn 1997.
Revegetation performance will be monitored on an annual basis.		First monitoring due mid-1997.
Generation of sediment will be limited by: (i) diversion of upstream runoff and, (ii) sediment traps will be constructed where necessary.	Some works completed in 1993, remainder completed November 1996.	
The effectiveness of sediment control measures will be monitored on a regular basis.	Being inspected regularly by local representative.	
Erosion monitoring on the waste dump surfaces will be undertaken on a regular basis.		First monitoring due mid-1997.
Water monitoring of creek sites will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 5248.	Monitoring being undertaken in accordance with monitoring schedule.	



COMMITMENT	COMPLIANCE STATUS	COMMENTS
Water quality at monitoring sites SW1, (Golden Butterfly catchment) & SW5 (Content/Lady Isabella catchment) will comply with ANZECC (1992) Water Quality Guidelines for livestock watering (cattle), or not exceed 115% of background whichever is greater. Background will be measured at sites SW3 & SW4.	Insufficient data available to establish compliance at this stage.	Monitoring, analysis and interpretation continuing.
Water quality monitoring within open pits will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 5248.	Monitoring being undertaken in accordance with monitoring schedule.	
Pit water quality monitoring data will be reviewed annually, with any deterioration analysed and possible related impacts assessed.		Review to be undertaken in conjunction with annual monitoring report.
Groundwater quality monitoring will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 5248.	Monitoring being undertaken in accordance with monitoring schedule	
GBMB series groundwater monitoring bores - maintain water quality within the range of water quality data collected for these bores over the period 1990 to 1993.	Generally in compliance.	



COMMITMENT	COMPLIANCE STATUS	COMMENTS
BH series groundwater monitoring bores - water quality monitoring data will be reviewed annually, with any deterioration analysed and possible related impacts assessed.		Review to be conducted in conjunction with Annual Monitoring Report.
Monitoring data will be collated, interpreted and reported to the DME on an annual basis together with an audit of compliance status against commitments.	1996 Annual Monitoring Report submitted in September 1996.	Regular inspections carried out by local representative. Formal annual lease inspections to be carried out each year as planned.
An annual lease inspection will be carried out by RGC.		Regular inspections carried out by local representative. Formal annual lease inspections to be carried out each year as planned.
Where practicable runoff water will be diverted away from voids via diversion bunds.	Diversion bunds in place.	
Safety bunding and fencing will be erected around open pits.	Safety bunds and fencing in place	
Warning signs will be placed in strategic sites around the lease.	Warning signs in place.	
Abandoned shafts will be identified and backfilled.	Completed November 1996.	
Exploration drillholes will be located, plugged and covered over.	Completed November 1996.	
The lease will be monitored for the outbreak of noxious weeds, any outbreaks will be controlled by DPI recommended methods		Regular inspections carried out by local representative. Issue will be addressed in Annual Monitoring Report.
Submit to the DME a Final Rehabilitation Report		

A32-00280-0005-R002-D.DOC:22 MAY 1997-ASW:hmi

Released

APPENDIX F
WATER QUALITY DATA

Site		SW1									
Date		02-Feb-94	09-Mar-94	23-Mar-94	25-Mar-94	19-Jan-95	30-Jan-95	06-Dec-96	31-Dec-96	19-Jan-97	28-Mar-97
Lab Tested At		not recorded	not recorded	not recorded	not recorded	not recorded	ANALABS	AEL	AEL	AEL	AEL
Contained in Report		A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-005	A32-280-005	A32-280-005	A32-280-005	
Note											
CHEMICAL PROPERTIES											
pH		4.89	2.81	3.02	2.87	6.64	3.9	5.1	6.3	3.8	5
Conductivity	uS/cm	71	1870	690	1030	157					370
Filter Residue TDS	mg/L						300	110	100	430	200
FILTERED CONSTITUENTS											
Arsenic As	mg/L	<0.01	0.97	<0.01	<0.01	0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Cadmium Cd	mg/L	<0.005	0.03	0.01	0.02	<0.005	0.0051	<0.0005	0.0024	0.0078	0.0019
Calcium Ca	mg/L						6.8	3.7	3.4	28	12
Copper Cu	mg/L	<0.01	3.27	0.63	1.84	<0.01	0.38	<0.05	<0.05	0.33	0.06
Iron Fe	mg/L	0.29	102	2.4	0.2	1.9	1.9	5	3.5	1.2	0.08
Lead Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	0.022	13	1	<0.002
Magnesium Mg	mg/L					2	7.4	2	1.8	15	7
Manganese Mn	mg/L	0.1	4.65	3.22	2.91	0.08		0.37	0.14	3.2	0.92
Nickel Ni	mg/L						0.13	<0.05	<0.05	0.23	0.06
Sodium Na	mg/L										40
Sulphur as SO4	mg/L					33	200	33	17	330	190
Zinc Zn	mg/L	0.06	2.71	1.2	1.5	0.07	0.45	0.08	<0.05	0.97	0.28

Site		SW2											
Date		02-Feb-94	09-Mar-94	23-Mar-94	25-Mar-94	19-Jan-95	30-Jan-96	05-Mar-96	30-Oct-95	05-Dec-95	31-Dec-96	19-Jan-97	06-Feb-97
Lab Tested At		not recorded	not recorded	not recorded	not recorded	not recorded	ANALABS	ANALABS	AEL	AEL	AEL	AEL	AEL
Contained in Report		A32-280-002	A32-280-002	A32-280-002	A32-280-002		A32-280-002	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-0005	A32-280-0005
Note													
CHEMICAL PROPERTIES													
pH		3.82	2.32	2.25	2.48	2.8	3.32	3.8	6.2	3.9	4	4.1	3.5
Conductivity	uS/cm	1210	11200	13100	12200		2670						
Filter Residue TDS	mg/L					1040		9300	900	490	350	370	2500
FILTERED CONSTITUENTS													
Arsenic As	mg/L	<0.01	27.8	15	17	0.05	0.01	0.5	<0.02	<0.02	<0.02	<0.02	<0.02
Cadmium Cd	mg/L	0.015	0.52	0.55	0.47	0.024	0.06	0.18	0.00022	0.0051	7.6	0.0052	0.049
Calcium Ca	mg/L					13.1		78	34	23	21	25	110
Copper Cu	mg/L	1.3	61.2	71	59	2.06	2.65	22	<0.05	0.31	0.13	0.25	2.1
Iron Fe	mg/L	1.9	2890	1770	1850	23	0.7	197	<0.05	0.6	<0.05	0.12	1.3
Lead Pb	mg/L	0.01	<0.1	<0.1	<0.1	<0.005	<0.01	<0.1	<0.005	<0.005	<0.005	<0.001	0.001
Magnesium Mg	mg/L					27	121	224	14	19	11	13	21
Manganese Mn	mg/L	6.15	80.1	90.6	69.1		23.1		1.7	3.1	2	2.6	74
Nickel Ni	mg/L					0.66		7.2	0.07	0.27	0.14	0.16	1.3
Sodium Na	mg/L												
Sulphur as SO4	mg/L					950	1730	9600	620	340	220	290	1900
Zinc Zn	mg/L	2.61	49.4	50.5	47.2	2.2	5.75	19	<0.05	0.7	0.44	0.76	6.9

Site	
Date	28-Mar-07
Lab Tested At	AEL
Contained in Report	
Note	
CHEMICAL PROPERTIES	
pH	4
Conductivity	uS/cm 1000
Filter Residue TDS	mg/L 690
FILTERED CONSTITUENTS	
Arsenic As	mg/L <0.01
Cadmium Cd	mg/L 0.01
Calcium Ca	mg/L 33
Copper Cu	mg/L 0.45
Iron Fe	mg/L 0.12
Lead Pb	mg/L 0.002
Magnesium Mg	mg/L 29
Manganese Mn	mg/L 4.8
Nickel Ni	mg/L 0.29
Sodium Na	mg/L 78
Sulphur as SO4	mg/L 570
Zinc Zn	mg/L 1.3

Site		SW3A											
Date		02-Feb-94	09-Mar-94	25-Mar-94	24-Nov-95	30-Jan-96	05-Mar-96	03-Apr-96	13-May-96	31-May-96	08-Dec-96	19-Jan-97	28-Mar-97
Lab Tested At		not recorded	not recorded	not recorded	ALS	ANALABS	ANALABS	ANALABS	ANALABS	ANALABS	AEL	AEL	AEL
Contained in Report		A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-0005	
Note													
CHEMICAL PROPERTIES													
pH		4.93	4.39	3.98	1.59	2.5	2.8	2	1.9	1.7	4	3.9	4.2
Conductivity	uS/cm	146	190	430	26000								1400
Filter Residue TDS	mg/L					1570	11300	26000	55600	120000	560	2100	1100
FILTERED CONSTITUENTS													
Arsenic As	mg/L	<0.01	<0.01	<0.01	<0.01	0.4	5.4	12.5	25	80	<0.02	<0.02	<0.01
Cadmium Cd	mg/L	<0.005	<0.005	<0.005	4	0.037	0.18	0.295	0.7	4.4	0.0063	0.049	0.017
Calcium Ca	mg/L				690	11	41	45	95	4250	29	94	45
Copper Cu	mg/L	0.05	0.01	0.02	565	3.66	26	56	135	340	0.23	1.3	0.49
Iron Fe	mg/L	0.29	<0.1	<0.1	2310	90	630	1100	2720	4850	0.52	14	<0.05
Lead Pb	mg/L	<0.01	<0.01	<0.01	1	<0.005	<0.1	<0.05	<0.05	<0.05	0.005	0.069	0.004
Magnesium Mg	mg/L				4250	25	184	350	780	3400	27	110	60
Manganese Mn	mg/L	0.5	0.54	1.23	821					380	3.6	16	8.1
Nickel Ni	mg/L				151	0.91	6.3	13	33	80	0.29	1.2	0.4
Sodium Na	mg/L												120
Sulphur as SO4	mg/L				118000	1450	10600	18200	12000	24000	420	1700	880
Zinc Zn	mg/L	0.25	0.18	0.28	468	2.7	18	42	90	235	0.58	2.5	0.96

Site		SW3								
Date		30-Jan-96	05-Mar-96	05-Mar-96	13-May-96	06-Dec-96	31-Dec-96	19-Jan-97	06-Feb-97	24-Mar-97
Lab Tested At		ANALABS	ANALABS	ANALABS	ANALABS	AEL	AEL	AEL	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-0005	A32-280-0005	
Note										
CHEMICAL PROPERTIES										
pH		6.6	6.5	7.3	7.3	6	6.5	6	5.6	6.4
Conductivity	uS/cm									120
Filter Residue TDS	mg/L	130	140	190	180	130	150	130	170	80
FILTERED CONSTITUENTS										
Arsenic As	mg/L	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Cadmium Cd	mg/L	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.005
Calcium Ca	mg/L	2.5	4.3	7.3	6.7	2.4	3.7	4.4	5.5	2.4
Copper Cu	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron Fe	mg/L	0.84	1.53	0.54	0.8	6.5	1.5	3	<0.05	0.2
Lead Pb	mg/L	<0.005	<0.1	<0.05	<0.05	0.006	0.006	0.004	0.01	<0.002
Magnesium Mg	mg/L	1.9	1.9	2.6	3.5	1.5	1.7	2.2	2.3	1.9
Manganese Mn	mg/L			<0.05	<0.05	<0.05	0.09	<0.05	<0.05	<0.05
Nickel Ni	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium Na	mg/L									16
Sulphur as SO4	mg/L	35	53	74	58	20	36	27	71	39
Zinc Zn	mg/L	<0.05	<0.05	<0.05	0.14	<0.05	<0.05	<0.05	<0.05	<0.05

Site		SW4								
Date		05-Jul-96	07-Aug-96	05-Sep-96	09-Oct-96	30-Oct-96	30-Nov-96	31-Dec-96	28-Mar-97	31-Mar-97
Lab Tested At		ANALABS	ANALABS	ANALABS	ANALABS	AEL	AEL	AEL	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005		
Note										
CHEMICAL PROPERTIES										
pH		7.8	7.6	8.3	7.9	7.5	7	6.8	6.6	6.8
Conductivity	uS/cm								150	160
Filter Residue TDS	mg/L	210	270	410	470	530	300	290	170	190
FILTERED CONSTITUENTS										
Arsenic As	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02		0.05	<0.01	<0.01
Cadmium Cd	mg/L	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	0.0002	0.003	<0.0005	<0.0005
Calcium Ca	mg/L	9.5	10	15	20	22	12	7.9	4.3	4.3
Copper Cu	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron Fe	mg/L	0.67	0.15	0.5	0.33	1.3	0.76	2.7	0.38	0.5
Lead Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.005	<0.05	0.006	0.002	0.003
Magnesium Mg	mg/L	4.3	5	6.8	8.4	8.8	5	3.4	3.1	22
Manganese Mn	mg/L	<0.05	<0.05	<0.05	<0.05	0.13	0.18	0.12	<0.05	<0.05
Nickel Ni	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium Na	mg/L								19	23
Sulphur as SO4	mg/L	76	72	78	120	170	140	68	66	73
Zinc Zn	mg/L	<0.05	0.08	<0.05	<0.05	0.16	<0.05	<0.05	<0.05	<0.05

Site		SW5					
Date		06-Dec-96	31-Dec-96	19-Jan-97	06-Feb-97	28-Mar-97	31-Mar-97
Lab Tested At		AEL	AEL	AEL	AEL	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	A32-280-006	A32-280-006		
Note							
CHEMICAL PROPERTIES							
pH		6	6	5.7	5.4	5.7	5.4
Conductivity	uS/cm					130	650
Filter Residue TDS	mg/L	180	180	180	410	120	440
FILTERED CONSTITUENTS							
Arsenic As	mg/L	<0.02	<0.02	<0.02	<0.02	<0.01	<0.01
Cadmium Cd	mg/L	<0.0005	0.0012	<0.0005	0.0005	<0.005	0.0046
Calcium Ca	mg/L	4	6.3	11	10	3.3	24
Copper Cu	mg/L	0.05	0.05	<0.05	<0.05	<0.05	<0.05
Iron Fe	mg/L	6.2	4	0.72	<0.05	0.3	<0.05
Lead Pb	mg/L	0.024	0.023	0.003	20	0.003	<0.001
Magnesium Mg	mg/L	2.8	2.5	3.2	4.5	2	20
Manganese Mn	mg/L	0.22	0.51	0.34	0.22	0.12	1.9
Nickel Ni	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium Na	mg/L					16	57
Sulphur as SO4	mg/L	24	42	75	150	50	420
Zinc Zn	mg/L	<0.05	0.05	0.07	<0.05	<0.05	0.2

Site		Golden Butterfly Pit												
Date	08-Feb-91	20-Aug-91	05-Mar-92	16-Feb-93	11-Nov-93	02-Feb-94	21-Apr-94	19-Jan-95	24-Nov-95	05-Mar-96	03-Apr-96	13-May-96	31-May-96	
Lab Tested At	ALSB	ALSB	ALSB	ALSB	ALSB	not recorded	not recorded	not recorded	ALS	ANALABS	ANALABS	ANALABS	ANALABS	
Contained in Report				A371-7 Dec93	A371-7 Dec93	A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-005	A32-280-005	A32-280-005	A32-280-005	
Note														
CHEMICAL PROPERTIES														
pH		2.6	2.45	2.24	2.33	2.53	2.53	2.32		1.79	3.4	2.1	2.2	2.1
Conductivity	uS/cm	2670	4910	5180	5340	6690	6320			6540				
Filter Residue TDS	mg/L							9400			8200	8500	9700	10000
FILTERED CONSTITUENTS														
Arsenic As	mg/L	1.05	1.36	2.05	2.31	4.2	3.5			2.3	1.75	2.1	2.9	5
Cadmium Cd	mg/L	0.1	0.297	0.3	0.26	0.31	0.275	0.3		0.4	0.19	0.21	0.275	0.37
Calcium Ca	mg/L							308		345	241	205	260	320
Copper Cu	mg/L	12.4	33.8	28.7	26.8	38.1	33.1	32.9		39.6	24.4	26	32	33
Iron Fe	mg/L	310	971		19.4	1010	968	748		957	640	680	640	830
Lead Pb	mg/L	0.03	0.05	0.06	48.9	<0.01	<0.01	<0.1		<0.1	<0.1	<0.05	<0.05	<0.05
Magnesium Mg	mg/L													
Manganese Mn	mg/L	24.2	51	47.9	651	69.6	6.16	65.6		92.1				140
Nickel Ni	mg/L									9	5.6	5.8	6.8	7.5
Sodium Na	mg/L													
Sulphur as SO4	mg/L													
Zinc Zn	mg/L	8.66	20.9	19.2	0.06	27.2	27.3	24.4		35.5	21	22.4	27.8	27.5

Rela

Site		Golden Butterfly Pit (continued)							
Date		05-Jul-96	07-Aug-96	05-Sep-96	09-Oct-96	30-Oct-96	30-Nov-96	31-Dec-96	31-Mar-97
Lab Tested At		ANALABS	ANALABS	ANALABS	ANALABS	AEL	AEL	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	
Note									
CHEMICAL PROPERTIES									
pH		2.3	2.2	2.1	2.3	2.1	2.2	2.3	2.3
Conductivity	uS/cm								6700
Filter Residue TDS	mg/L	9900	9700	8700	12000	11000	11000	10000	9400
FILTERED CONSTITUENTS									
Arsenic As	mg/L	4.5	48	3.5	<0.2	4.4	3.4	3.1	3.2
Cadmium Cd	mg/L	0.6	0.3	0.32	0.00033	0.00032	0.00033	0.16	0.27
Calcium Ca	mg/L	250	250	300	290	250	250	280	180
Copper Cu	mg/L	33.8	34	34	33	34	35	31	26
Iron Fe	mg/L	1100	1000	860	930	940	890	760	67
Lead Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.025	<0.05	<0.005	<0.01
Magnesium Mg	mg/L	175	185	180	200	190	200	190	180
Manganese Mn	mg/L	82	7.8	69	79	88	89	79	67
Nickel Ni	mg/L	7.7	7.8	7.2	7.4	8.7	8.5	8.1	4.4
Sodium Na	mg/L								160
Sulphur as SO4	mg/L	5500	7600	7400	9500	7900	8400	7900	7400
Zinc Zn	mg/L	27	28	30	32	30	29	28	22

Site		Golden Butterfly North Pit												
Date		08-Feb-91	20-Aug-91	05-Mar-92	16-Jul-92	16-Feb-93	11-Nov-93	02-Feb-94	19-Jan-95	24-Nov-95	05-Mar-96	03-Apr-96	13-May-96	31-May-96
Lab Tested At		ALSB	ALSB	ALSB	ALSB	ALSB	ALSB	not recorded	not recorded	ALS	ANALABS	ANALABS	ANALABS	ANALABS
Contained in Report						A371-7 Dec93	A371-7 Dec93	A32-280-002	A32-280-002	A32-280-002	A32-280-005	A32-280-005	A32-280-005	A32-280-005
Note														
CHEMICAL PROPERTIES														
pH		6.35	6.79	6.1	7.17	6.69	5.88	6	7.38	7.21	8.2	7.7	7.2	7.8
Conductivity	uS/cm	185	226	259	303	281	351	212	259	381				
Filter Residue TDS	mg/L										190	185	200	220
FILTERED CONSTITUENTS														
Arsenic As	mg/L	0.01	0.02	<0.01	0.01	<0.01	0.04	0.01	0.02	0.02	0.04	0.02	0.02	0.03
Cadmium Cd	mg/L	<0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.0005	<0.0005
Calcium Ca	mg/L									47	21.3	21	15	21.8
Copper Cu	mg/L	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.03	0.01	0.02	<0.05	0.11	<0.05	<0.05
Iron Fe	mg/L	0.33	0.9		<0.1	0.04	0.81	0.18	<0.1	<0.1	0.13	0.12	0.14	0.06
Lead Pb	mg/L	0.01	<0.01	<0.01	<0.01	0.23	0.02	<0.01	<0.01	<0.01	<0.1	<0.05	<0.05	<0.05
Magnesium Mg	mg/L													
Manganese Mn	mg/L	0.01	0.01	0.15	0.02	<0.1	0.53	0.38	0.04	0.04	3.4	3.6	3.1	3.5
Nickel Ni	mg/L									<0.01	0.07	<0.05	<0.05	<0.05
Sodium Na	mg/L													
Sulphur as SO4	mg/L													
Zinc Zn	mg/L	<0.01	<0.01	0.02	0.01	<0.01	0.02	0.08	0.04	0.05	<0.05	<0.05	0.1	<0.05

Site		Golden Butterfly North Pit							
Date		05-Jul-96	07-Aug-96	05-Sep-96	09-Oct-96	30-Oct-96	30-Nov-96	31-Dec-96	31-Mar-97
Lab Tested At		ANALABS	ANALABS	ANALABS	ANALABS	AEL	AEL	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	
Note									
CHEMICAL PROPERTIES									
pH		7.6	8	7.9	8.1	7.6	7.7	7.2	7.3
Conductivity	uS/cm								270
Filter Residue TDS	mg/L	210	220	280	220	250	240	250	170
FILTERED CONSTITUENTS									
Arsenic As	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.01
Cadmium Cd	mg/L	<0.0005	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	0.0087	<0.0005
Calcium Ca	mg/L	22.5	22	20	23	25	23	20	12
Copper Cu	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	0.1	<0.05	
Iron Fe	mg/L	0.13	0.05	<0.05	<0.05	<0.05	0.1	0.52	<0.05
Lead Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.005	<0.05	<0.005	<0.001
Magnesium Mg	mg/L	4.5	3.9	4.4	4.7	4.6	4.2	4.4	3.7
Manganese Mn	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.29	<0.05
Nickel Ni	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium Na	mg/L								34
Sulphur as SO4	mg/L	64	60	67	64	72	72	59	68
Zinc Zn	mg/L	<0.05	0.07	<0.05	<0.05	0.07	0.22	<0.05	<0.05

Site	Lady Isabella Pt													
Date	20-Feb-90	20-Aug-91	05-Mar-92	06-Mar-92	16-Feb-93	11-Nov-93	02-Feb-94	21-Apr-94	19-Jan-95	24-Nov-95	05-Mar-96	03-Apr-96	13-May-96	
Lab Tested At	ALSB	ALSB	ALSB	SIMTR	ALSB	ALSB	not recorded	not recorded	not recorded	ALS	ANALABS	ANALABS	ANALABS	
Contained in Report					A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-005	A32-280-005	A32-280-005	
Note														
CHEMICAL PROPERTIES														
pH		4.15	3.36	3.17	3.5	3.24	3.18	3.47	2.97	3.39	3.74	4.3	3.4	3.4
Conductivity	uS/cm	570	608	781	830	970	1110	1090		1280	1045			
Filter Residue TDS	mg/L	460							870		930	930	940	
FILTERED CONSTITUENTS														
Arsenic As	mg/L	0.26	<0.01	0.01	15	<0.01	<0.01	<0.01	n/r	<0.01	<0.01	<0.02	<0.02	0.03
Cadmium Cd	mg/L	<0.0005	0.135	0.15	0.1	0.16	0.23	0.205	0.2	0.265	0.21	0.155	0.185	0.22
Calcium Ca	mg/L	20						n/r	70	n/r	81	59	55	57
Copper Cu	mg/L	0.42	1.34	1.44	1.5	1.68	2.05	1.92	1.73	2.12	1.75	1.38	1.38	1.45
Iron Fe	mg/L	11	1.89	?	0.6	4.07	0.22	0.34	0.5	0.5	0.4	0.76	0.62	0.32
Lead Pb	mg/L	0.01	<0.01	<0.01	0.1	3.71	0.04	<0.01	<0.01	<0.01	<0.01	<0.1	<0.05	<0.05
Magnesium Mg	mg/L	9							33	37	38	28.2	40.5	28
Manganese Mn	mg/L	1.4	2.62	3.01	3.2	0.5	5	4.97	4.58	6.03	6.11			
Nickel Ni	mg/L										0.73	0.6	0.59	0.57
Sodium Na	mg/L	59												
Sulphur as SO4	mg/L	220			310				482	555	679	680	660	670
Zinc Zn	mg/L	0.55	2.81	3.09	3.2	<0.01	5.31	6.04	4.88	6.37	5.7	4.5	4.6	4.99

Site		Lady Isabella Plr (continued)								
Date		31-May-96	05-Jul-96	07-Aug-96	05-Sep-96	09-Oct-96	31-Oct-96	30-Nov-96	31-Dec-96	31-Mar-97
Lab Tested At		ANALABS	ANALABS	ANALABS	ANALABS	ANALABS	AEL	AEL	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	A32-280-005	
Note										
CHEMICAL PROPERTIES										
pH		3.3	3.5	3.3	3.4	3.4	3.2	3.3	3.4	3.5
Conductivity	uS/cm									990
Filter Residue TDS	mg/L	980	930	960	940	1000	1000	970	910	850
FILTERED CONSTITUENTS										
Arsenic As	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.03	<0.02	<0.01
Cadmium Cd	mg/L	0.365	0.19	0.15	0.09	0.2	0.00022	0.03	0.02	0.16
Calcium Ca	mg/L	65	61	62	69	65	70	57	60	43
Copper Cu	mg/L	1.48	1.53	1.58	1.6	1.6	1.7	1.5	1.4	1
Iron Fe	mg/L	0.36	0.31	0.3	0.23	0.21	0.92	0.91	1.3	0.46
Lead Pb	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.005	<0.05	<0.005	0.005
Magnesium Mg	mg/L	32	33	33	36	35	36	32	31	26
Manganese Mn	mg/L	5.5	6.4	5.6	7.1	5.8	6.7	6.1	5.5	4.2
Nickel Ni	mg/L	0.63	0.64	0.6	0.64	0.64	0.74	0.73	0.67	0.43
Sodium Na	mg/L									60
Sulphur as SO4	mg/L	620	550	490	480	610	660	600	520	580
Zinc Zn	mg/L	4.9	4.7	4.85	5.9	5.4	6.9	6.6	4.8	3.5

Site	Content Pit											
Date	20-Feb-90	20-Aug-91	20-Aug-91	05-Mar-92	16-Feb-93	11-Nov-93	02-Feb-94	21-Apr-94	19-Jan-95	24-Nov-95	05-Mar-96	03-Apr-96
Lab Tested At	ALSB	ALSB	not recorded	ALSB	ALSB	ALSB	not recorded	not recorded	not recorded	ALS	ANALABS	ANALABS
Contained in Report					4571-7-Dec-93	4371-7-Dec-93	A32-280-002	A32-280-002	A32-280-002	A32-280-002	A32-280-005	A32-280-005
Note												
CHEMICAL PROPERTIES												
pH		2.85	2.87	2.07	2.75	2.84	3.07	3.11	2.81	3.03	3.15	4.2
Conductivity	uS/cm	1560	1420	1420	1420	1580	1640	1870		1780	1845	
Filter Residue TDS	mg/L	1260							1270		1200	1200
FILTERED CONSTITUENTS												
Arsenic As	mg/L	0.27	0.08	0.08	0.02	<0.01	0.04	<0.01	n/r	0.06	0.05	0.03
Cadmium Cd	mg/L	0.035	0.027	0.027	0.028	0.025	0.035	0.015	0.02	<0.005	0.01	0.019
Calcium Ca	mg/L	80						n/r	73	n/r	92	73
Copper Cu	mg/L	9.3	2.56	2.56	2.43	2.34	2.11	1.85	1.4	1.5	1.02	0.86
Iron Fe	mg/L	27	8.21	8.21	?	1.94	3.82	3.65	7.3	3.9	3.7	2.04
Lead Pb	mg/L	<0.01	<0.01	<0.01	<0.01	4	0.04	<0.01	<0.01	<0.01	<0.01	<0.1
Magnesium Mg	mg/L	25						n/r	41	44	44	38.7
Manganese Mn	mg/L	3.3	3.13	3.13	3.4	2.5	4.9	4.86	4.36	5.56	5.36	41
Nickel Ni	mg/L							n/r	n/r	n/r	0.51	0.48
Sodium Na	mg/L	110										0.48
Sulphur as SO4	mg/L	680										
Zinc Zn	mg/L	1.1	1.58	<0.01	1.62	<0.01	2.18	2.52	1.84	2.3	1.95	1.66

Site		
Date		31-Mar-97
Lab Tested At		AEI
Contained in Report		
Note		
CHEMICAL PROPERTIES		
pH		3.3
Conductivity	uS/cm	1700
Filter Residue TDS	mg/L	1300
FILTERED CONSTITUENTS		
Arsenic As	mg/L	<0.01
Cadmium Cd	mg/L	0.018
Calcium Ca	mg/L	64
Copper Cu	mg/L	0.6
Iron Fe	mg/L	4.3
Lead Pb	mg/L	0.003
Magnesium Mg	mg/L	40
Manganese Mn	mg/L	6
Nickel Ni	mg/L	0.38
Sodium Na	mg/L	140
Sulphur as SO4	mg/L	1000
Zinc Zn	mg/L	1.5

Site		GBMB1										
Date		29-May-89	13-Jul-89	30-Oct-89	02-Nov-89	14-Nov-89	05-Jan-90	08-Feb-90	20-Feb-90	09-Mar-94	05-Mar-98	31-May-98
Lab Tested At		ALSB	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	ANALABS	ANALABS
Contained in Report		4101-1 Jun 89	4015/2	4015/2	4133	4133	4015/2	4015/2	4015/2	A32-280-002	A32-280-005	A32-280-005
Note												
CHEMICAL PROPERTIES												
pH		5.8	6.15	3.9	3.9	5.5	3.6	3.85	3.9	7.68	7.8	7.4
Conductivity	µS/cm	605	610	600	600		590	600	560	3070	805	1045
Filter Residue TDS	mg/L	390	510	510			520	420			570	560
FILTERED CONSTITUENTS												
Arsenic As	mg/L	0.02	0.06	0.02	0.02	0.03	0.01	<0.01		<0.01	<0.02	0.03
Cadmium Cd	mg/L	<0.01	<0.01	<0.01			<0.01	0.03	0.022	<0.005	0.0005	0.0013
Calcium Ca	mg/L	12	11	10	10	12	10	11				
Chloride												
Copper Cu	mg/L	<0.01	<0.01	0.05			0.01	0.04	0.03	0.05	<0.05	0.08
Iron Fe	mg/L	6.2		3.7	3.7		2.1	2.5	3.2	1.2	1.96	0.66
Lead Pb	mg/L	0.08	0.14	0.23	0.23	0.24	0.14	0.26	0.19	0.08	0.9	<0.05
Magnesium Mg	mg/L	4.6	5	4.3			8.5	8.3			8.5	8.5
Manganese Mn	mg/L	0.55	0.5	0.53			0.45	0.56	0.52	0.21		
Nickel Ni	mg/L											
Potassium K	mg/L	20	20	82			21	19				
Sodium Na		89	91	17	82		62	67			130	119
Sulphur as SO4	mg/L	240	210	230	230	250	170	200			200	180
Zinc Zn	mg/L	0.34	0.04	0.2	0.2	0.3	0.28	0.35	0.31	0.17	0.15	0.05

Site		GBMB1 (continued)		
Date		25-Sep-96	02-Jan-97	31-Mar-97
Lab Tested At		ANA-ABS	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	
Note				
CHEMICAL PROPERTIES				
pH		6.6	6.5	6.9
Conductivity	uS/cm	800	760	810
Filter Residue TDS	mg/L	560	580	540
FILTERED CONSTITUENTS				
Arsenic As	mg/L	<0.02	<0.02	<0.01
Cadmium Cd	mg/L	0.0009	<0.0005	<0.0005
Calcium Ca	mg/L			11
Chloride				
Copper Cu	mg/L	<0.05	0.15	<0.05
Iron Fe	mg/L	11	3.9	1.6
Lead Pb	mg/L	1.4	130	0.018
Magnesium Mg	mg/L	8.4	8.5	8.8
Manganese Mn	mg/L			1
Nickel Ni	mg/L			
Potassium K	mg/L			
Sodium Na		220	120	120
Sulphur as SO4	mg/L	240	220	200
Zinc Zn	mg/L	0.24	0.09	<0.05

Site	GBMB 2											
Date	29-May-89	13-Jul-89	30-Oct-89	02-Nov-89	05-Jan-90	06-Feb-90	20-Feb-90	09-Mar-94	24-Nov-95	05-Mar-98	31-May-96	
Lab Tested At	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	ALS	ANALABS	ANALABS	
Contained in Report	4015/2	4015/2	4015/2	4193	4015/2	4015/2	4015/2	A32-280-002	A32-280-002	A32-280-005	A32-280-005	
Note												
CHEMICAL PROPERTIES												
pH		8.15	7.3	7.6	7.6	7.6	7.8	7.65	7.92	6.48	8.3	7.5
Conductivity	µS/cm	1970	2040	2120	2120	2070	2130	2010	947	1948	1620	2220
Filter Residue TDS	mg/L	1290	1400	1450		1480	1360				1400	1400
FILTERED CONSTITUENTS												
Arsenic As	mg/L	0.04	0.07	0.05	0.05	0.03	0.02		0.02	<0.01	<0.02	<0.02
Cadmium Cd	mg/L	<0.01	<0.01	<0.01		<0.01	<0.005	0.036	<0.005	<0.005	<0.0005	0.0082
Calcium Ca	mg/L	57	61	65	65	65	65			70		
Chloride												
Copper Cu	mg/L	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	0.03	0.01	<0.05	<0.05
Iron Fe	mg/L	1.7		1.8	1.8	1	0.87	1	0.5	<0.1	1.53	0.06
Lead Pb	mg/L	0.7	0.28	0.12	0.12	0.19	<0.01	0.01	0.03	<0.01	0.3	<0.05
Magnesium Mg	mg/L	16	17	18		16	15			17	15.2	13.6
Manganese Mn	mg/L	0.44	0.44	0.68		0.45	0.53	0.52	0.09	0.68		
Nickel Ni	mg/L									<0.01		
Potassium K	mg/L	28	28	27		26	23					
Sodium Na		390	400	350	350	350	360				370	370
Sulphur as SO4	mg/L	580	500	580	580	500	590			605	730	680
Zinc Zn	mg/L	0.15	0.06	0.03	0.03	0.02	0.02	0.09	0.08	0.12	0.11	<0.05

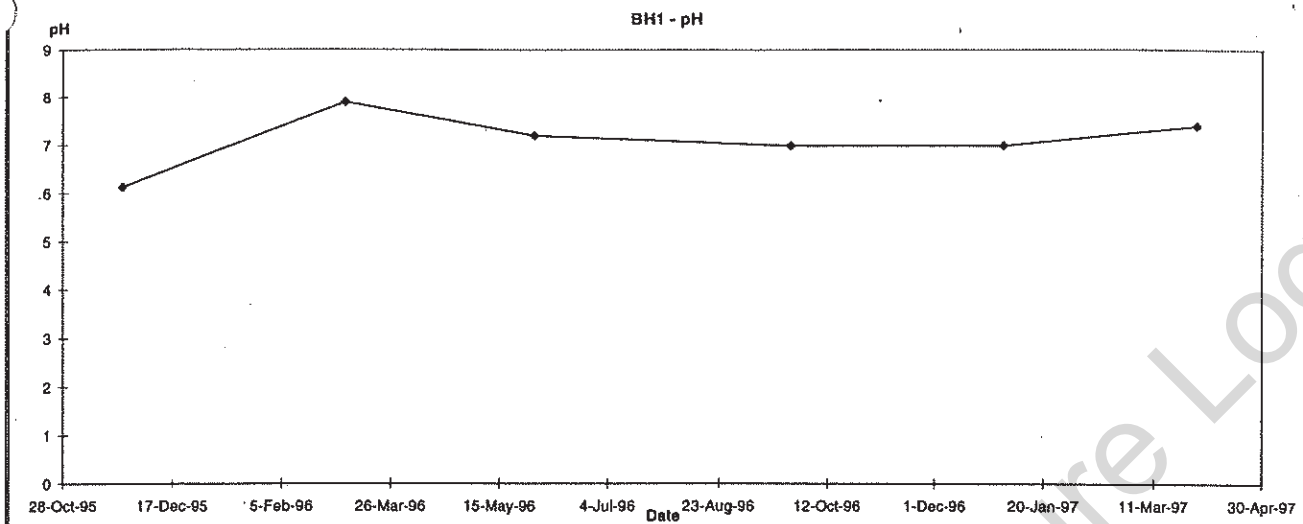
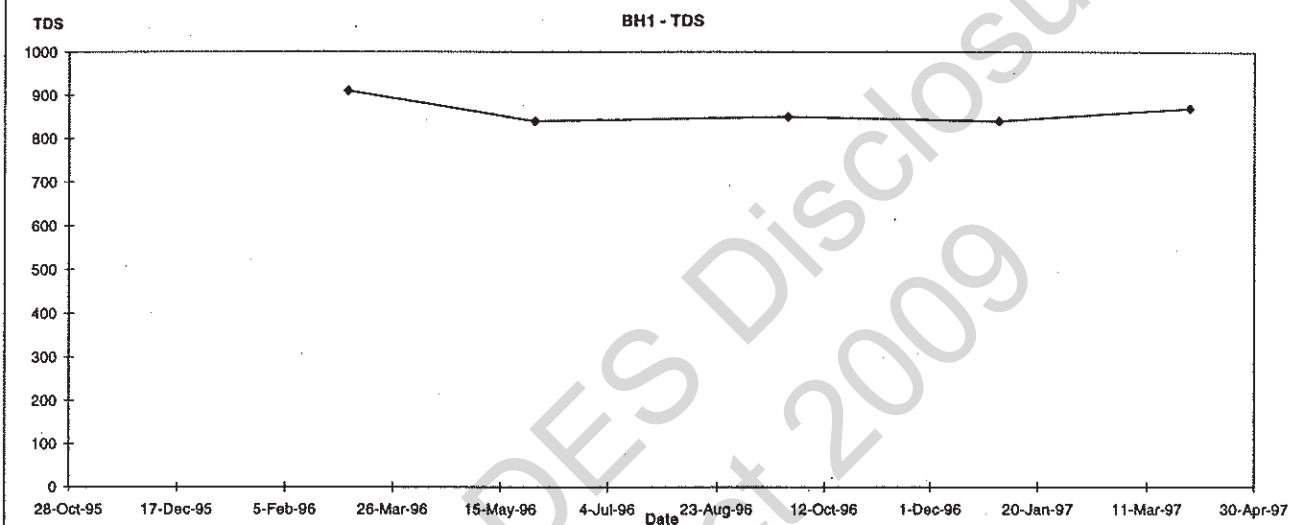
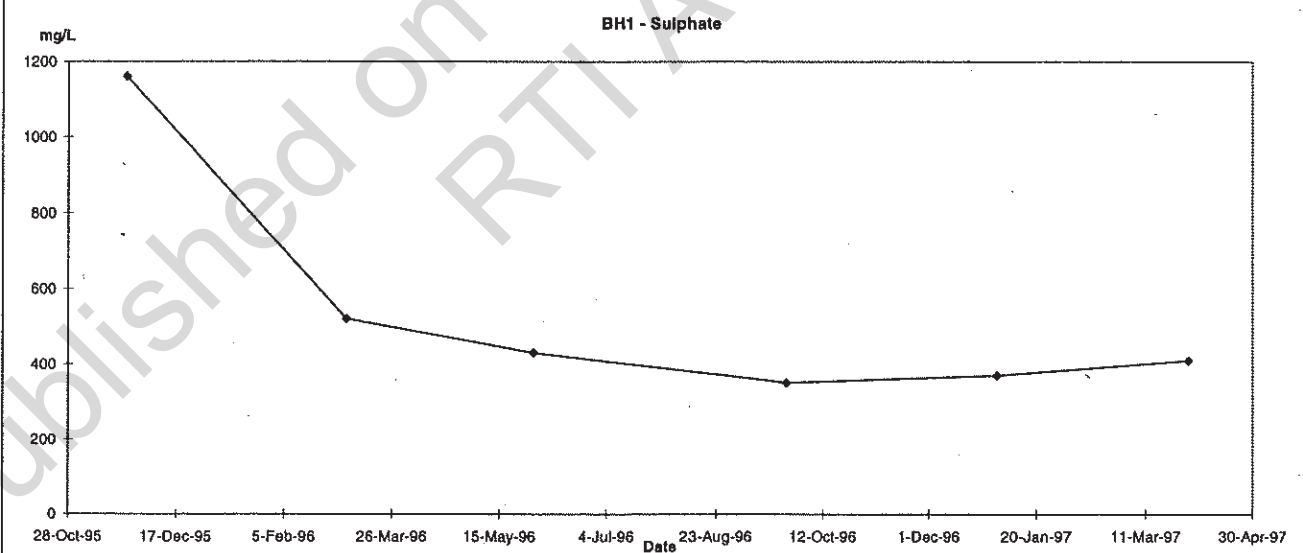


Site GBMB 2 (continued)				
Date	25-Sep-96	02-Jan-97	31-Mar-97	
Lab Tested At	ANALABS	AEL	AEL	
Contained in Report	A32-280-005	A32-280-005		
Note				
CHEMICAL PROPERTIES				
pH		7.3	7.2	7.2
Conductivity	µS/cm	2000	1900	2100
Filter Residue TDS	mg/L	1400	1500	1400
FILTERED CONSTITUENTS				
Arsenic As	mg/L	<0.02	<0.02	<0.01
Cadmium Cd	mg/L	0.0012	0.0005	<0.005
Calcium Ca	mg/L			63
Chloride				
Copper Cu	mg/L	<0.05	<0.05	<0.05
Iron Fe	mg/L	0.19	0.53	0.2
Lead Pb	mg/L	<0.05	0.022	0.014
Magnesium Mg	mg/L	17	18	19
Manganese Mn	mg/L			0.07
Nickel Ni	mg/L			
Potassium K	mg/L			
Sodium Na		370	350	370
Sulphur as SO4	mg/L	640	660	800
Zinc Zn	mg/L	0.07	<0.05	<0.05

Site	GBMB3										
Date	29-May-89	13-Jul-89	30-Oct-89	02-Nov-89	05-Jan-90	06-Feb-90	20-Feb-90	09-Mar-94	05-Mar-98	31-May-98	
Lab Tested At	ALSB	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	ANALABS	ANALABS	
Contained in Report	4101-1 Jun-89	4015/2	4015/2	4133	4015/2	4015/2	4015/2	A32-280-002	A32-280-005	A32-280-005	
Note											
CHEMICAL PROPERTIES											
pH		7.1	6.65	7.25	7.25	7.2	7.3	7.05	6.18	6.3	5.8
Conductivity	µS/cm	445	420	410	410	440	460	425	5460	58	78
Filter Residue TDS	mg/L	315	280	300		500	310			77	74
FILTERED CONSTITUENTS											
Arsenic As	mg/L	0.04	0.03	0.01	0.01	0.02	<0.01		<0.01	<0.02	<0.02
Cadmium Cd	mg/L	<0.01	<0.01	<0.01		<0.01	<0.005	0.008	<0.005	<0.0005	0.0016
Calcium Ca	mg/L	12	9	9.3	9.3	9.8	9				
Chloride											
Copper Cu	mg/L	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	0.03	<0.05	<0.05
Iron Fe	mg/L	2.8		1.8	1.8	3.7	0.01	2.4	0.5	8	0.13
Lead Pb	mg/L	0.54	0.04	0.02	0.03	0.37	0.01	0.01	0.03	0.1	<0.05
Magnesium Mg	mg/L	4.6	5	4.9		4.6	4				
Manganese Mn	mg/L	0.09	1.3	0.09		0.15	0.16	0.15	0.09	<0.5	<0.5
Nickel Ni	mg/L										
Potassium K	mg/L	8.1	7	6.5		6.2	5				
Sodium Na		78	75	72	72	75	68			12.8	11.3
Sulphur as SO4	mg/L	35	110	11	11	17	8			<5	<5
Zinc Zn	mg/L	0.24	0.08	<0.01	<0.01	0.05	<0.01	0.02	0.08	<0.05	<0.05

Site		GBMB3 (continued)		
Date		25-Sep-96	02-Jan-97	31-Mar-97
Lab Tested At		ANALABS	AEL	AEL
Contained in Report		A32-280-005	A32-280-005	
Note				
CHEMICAL PROPERTIES				
pH		5.3	5.6	6
Conductivity	µS/cm	70	88	89
Filter Residue TDS	mg/L	76	250	250
FILTERED CONSTITUENTS				
Arsenic As	mg/L	<0.02	<0.02	<0.01
Cadmium Cd	mg/L	<0.0005		<0.0005
Calcium Ca	mg/L			2.6
Chloride				
Copper Cu	mg/L	<0.05	<0.05	<0.05
Iron Fe	mg/L	2.4	5.8	3.3
Lead Pb	mg/L	<0.05	0.07	0.041
Magnesium Mg	mg/L	<0.5	1.4	15
Manganese Mn	mg/L			<0.05
Nickel Ni	mg/L			
Potassium K	mg/L			
Sodium Na		10	15	14
Sulphur as SO4	mg/L	<5	<5	27
Zinc Zn	mg/L	<0.05	0.15	<0.05

Site	GBMB4											
Date	29-May-89	13-Jul-89	30-Oct-89	02-Nov-89	05-Jan-90	08-Feb-90	20-Feb-90	09-Mar-94	24-Nov-95	05-Mar-98	31-May-98	
Lab Tested At	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	not recorded	ALS	ANALABS	ANALABS	
Contained in Report	4015/2	4015/2	4015/2	4133	4015/2	4015/2	4015/2	A32-280-002	A32-280-002	A32-280-005	A32-280-005	
Note												
CHEMICAL PROPERTIES												
pH	6.5	5.95	6.5	6.5	6.3	6.35	5.95	8.25	5.35	7.1	5.9	
Conductivity	µS/cm	225	190	190	190	220	220	200	4280	234	185	251
Filter Residue TDS	mg/L	150	240	220		210	190			210	200	
FILTERED CONSTITUENTS												
Arsenic As	mg/L	0.02	0.02	0.02	0.02	0.02	0.01		<0.01	<0.01	0.02	<0.02
Cadmium Cd	mg/L	<0.01	<0.01	<0.01		<0.01	<0.005	0.025	<0.005	<0.005	0.0005	0.0042
Calcium Ca	mg/L	2.5	1	1.2	1.2	1.7	1.4			2		
Chloride												
Copper Cu	mg/L	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01	0.03	0.01	<0.05	<0.05
Iron Fe	mg/L	2.3		2.2	2.2	2.6	2.5	2.5	0.5	<0.1	2.15	<0.05
Lead Pb	mg/L	0.16	0.07	0.12	0.12	0.13	0.12	0.11	<0.01	0.04	0.3	<0.05
Magnesium Mg	mg/L	1.6	1	0.86		1.1	0.7			1	1	1
Manganese Mn	mg/L	0.1	0.02	<0.01		0.04	0.04	0.04	0.11	0.04		
Nickel Ni	mg/L									<0.01		
Potassium K	mg/L	14	12	11		11	11					
Sodium Na		37	28	28	28	31	26				33.3	23
Sulphur as SO4	mg/L	20	65	17	17	11	15			24	32	23
Zinc Zn	mg/L	0.45	0.09	0.02	0.02	<0.01	<0.01	0.06	0.04	0.1	0.06	0.06



Date	Rev.	Description	Dwn	Chk'd
10/30/96	A	A32/00280/0005/Graph2	MRK	

Woodward-Clyde



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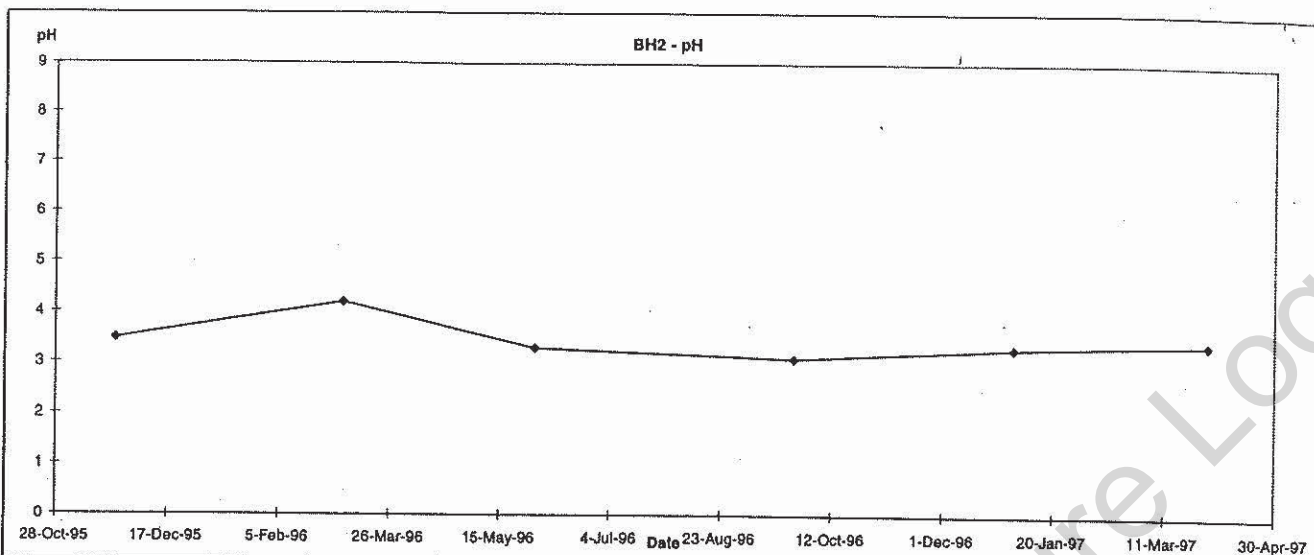
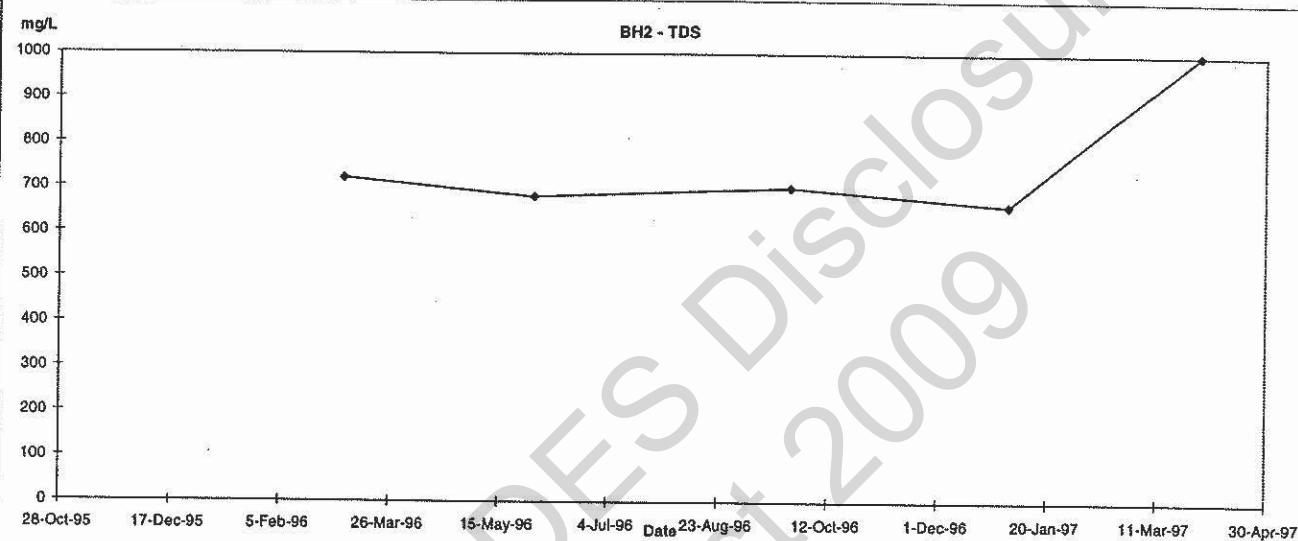
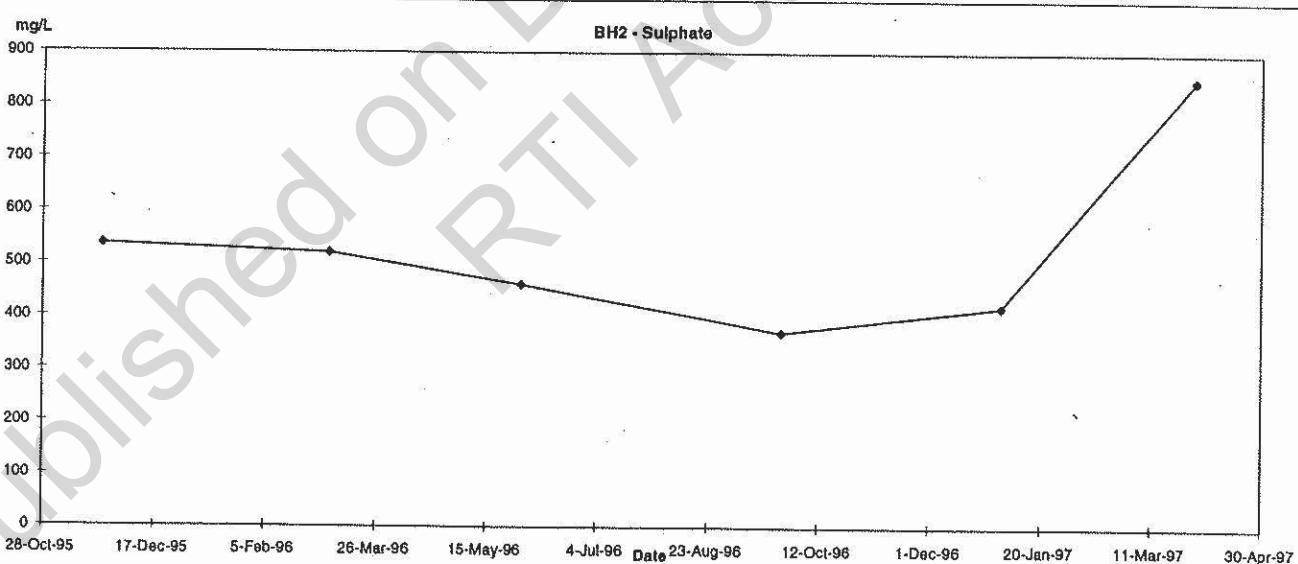
CROYDON GOLD MINE
WATER QUALITY MONITORING
BH 1

Project:
a32/280/0005

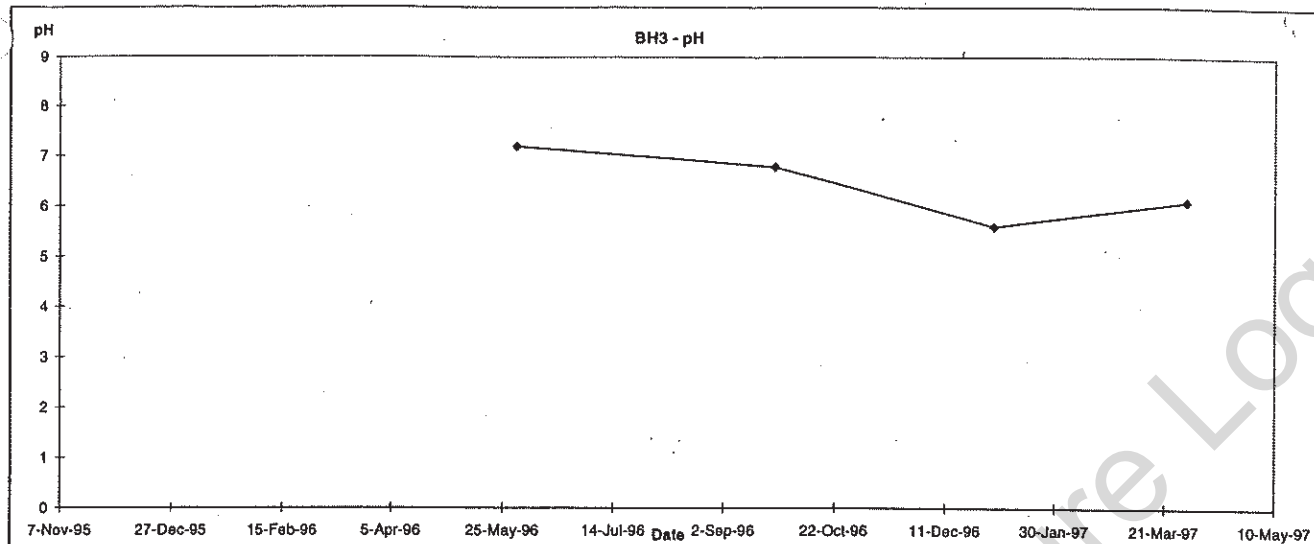
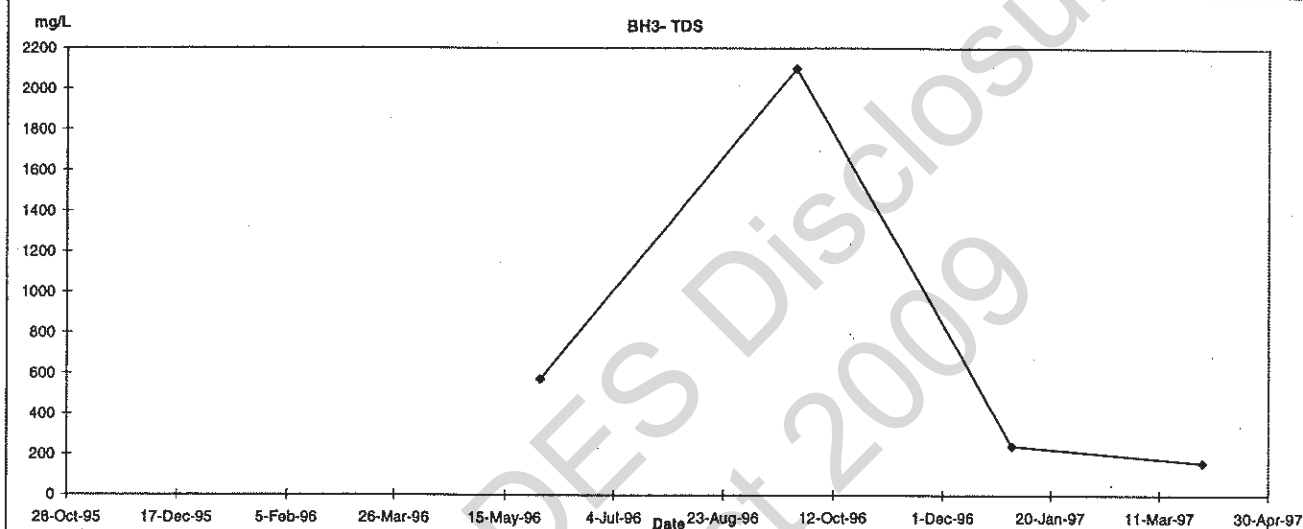
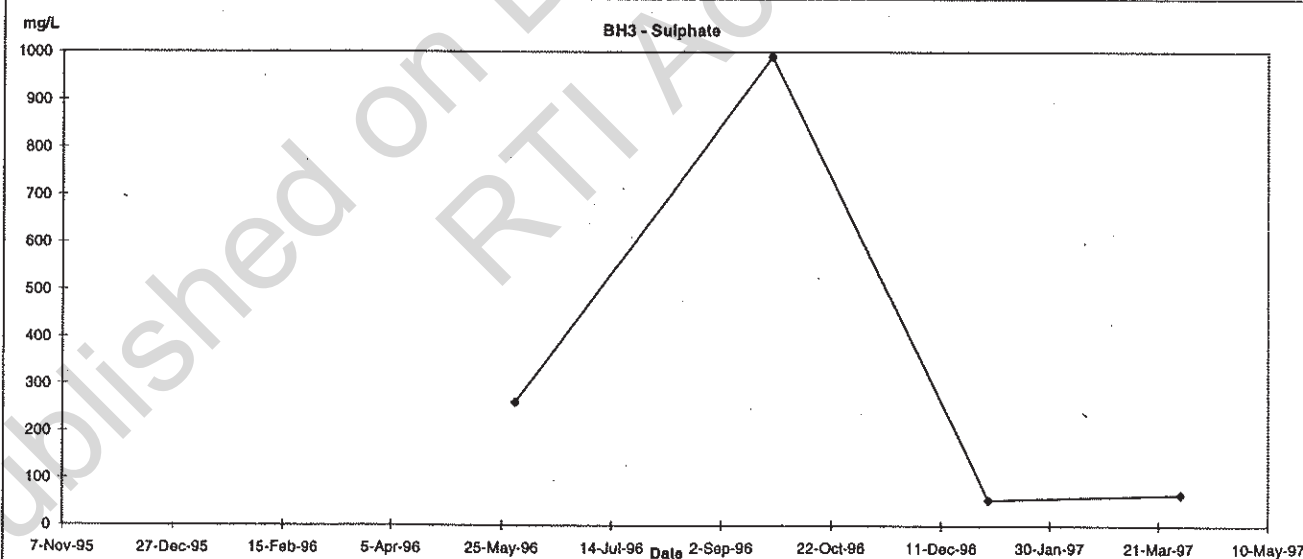
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Figure:
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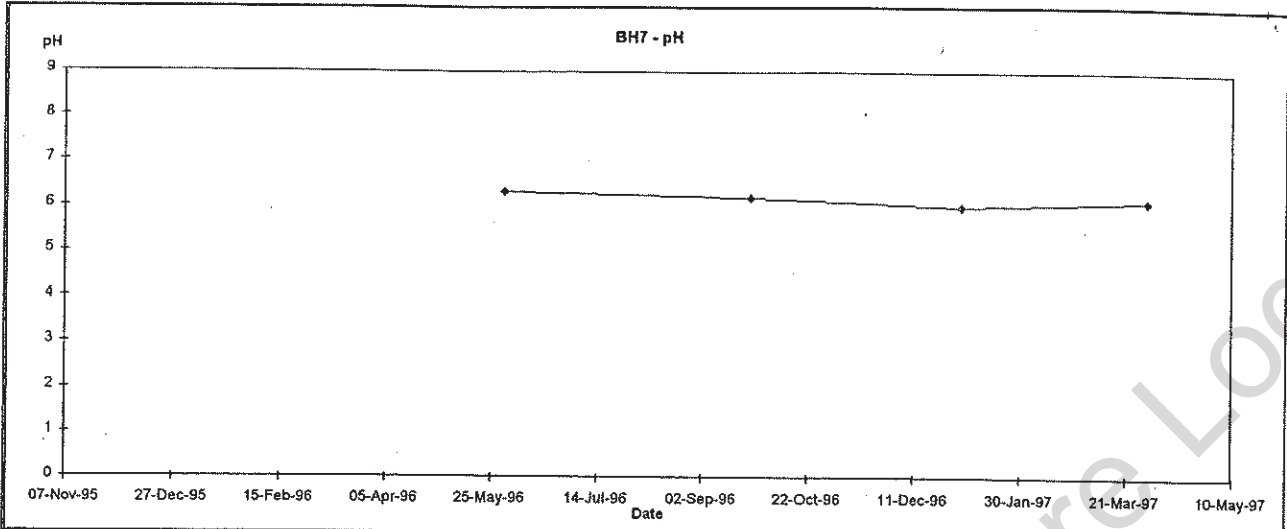
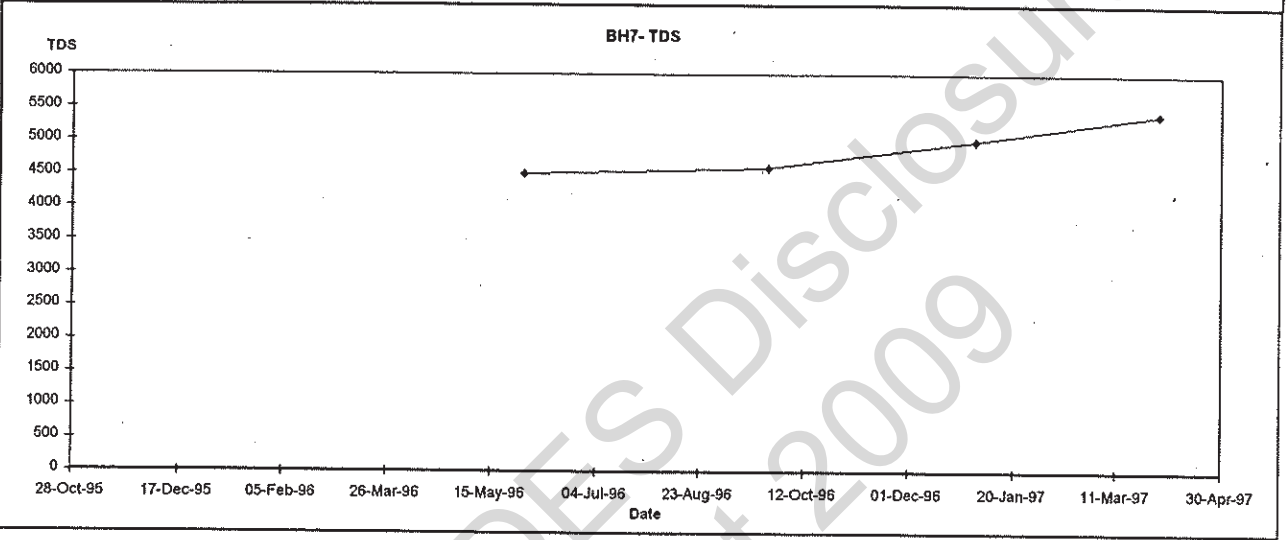
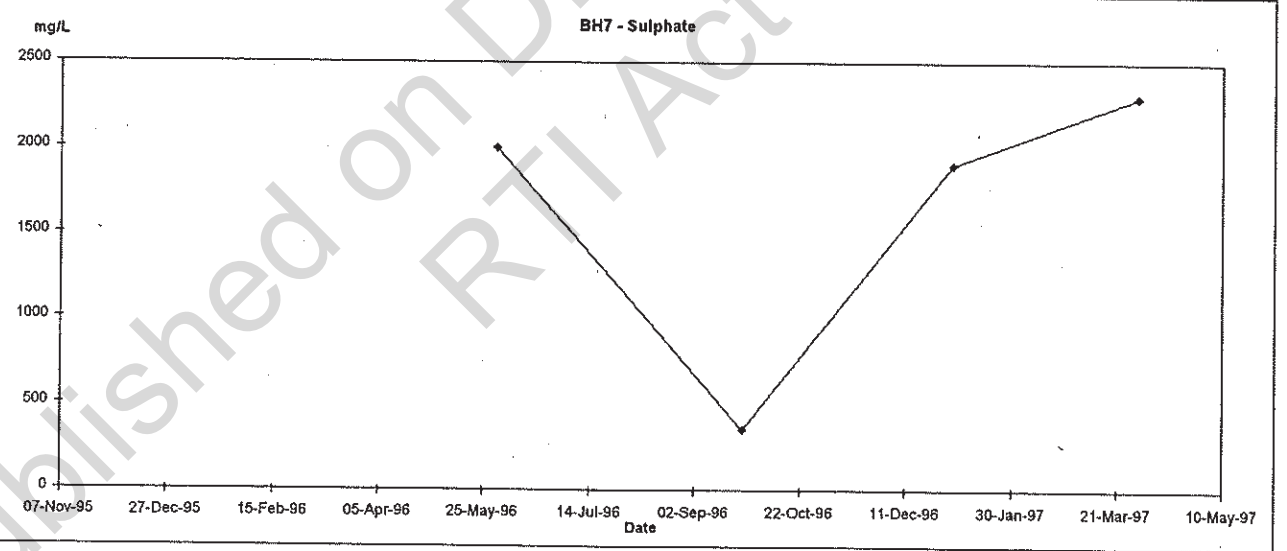


Date	Rev.	Description	Dwn	Chk'd	Woodward-Clyde  A.C.N. 000 691 690		
10/30/96	A	A32/00280/0005/Graph2	MRK				
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					a32/280/0005		11



Date	Rev.	Description	Dwn	Chk'd	Woodward-Clyde  A.C.N. 000 691 690			PANCONTINENTAL MINING LIMITED		
10/30/96	A	A32/00280/0005/Graph2	MRK					CROYDON GOLD MINE WATER QUALITY MONITORING BH3		
								Project:	Drawing:	Figure:
								a32/280/0005		11

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Date	Rev.	Description	Dwn	Chk'd
#####	A	A32/00280/0005/Graph2	MRK	

Woodward-Clyde



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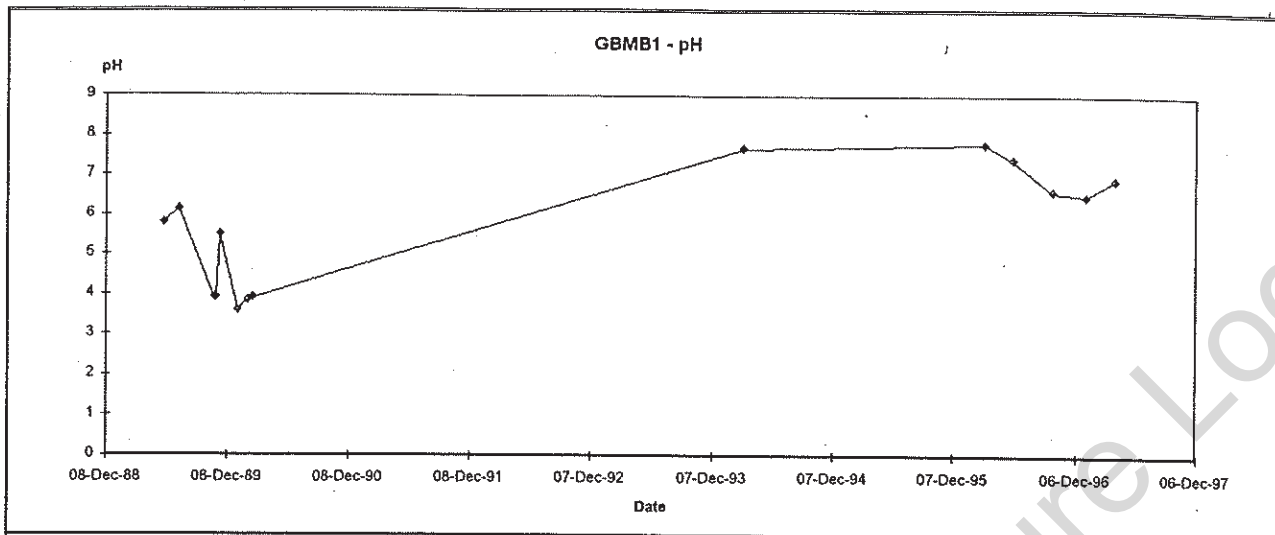
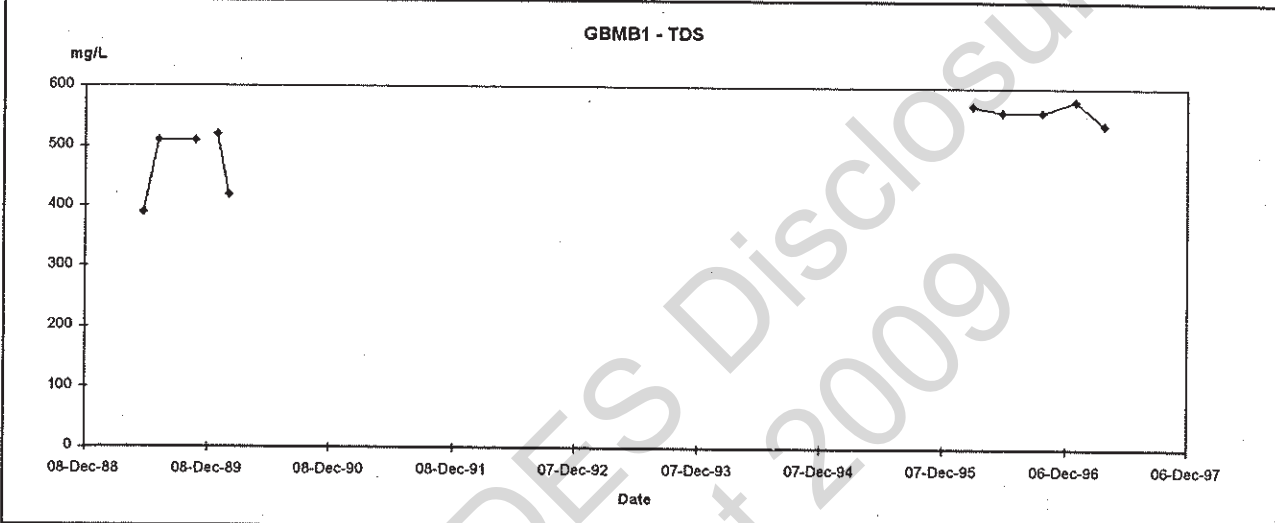
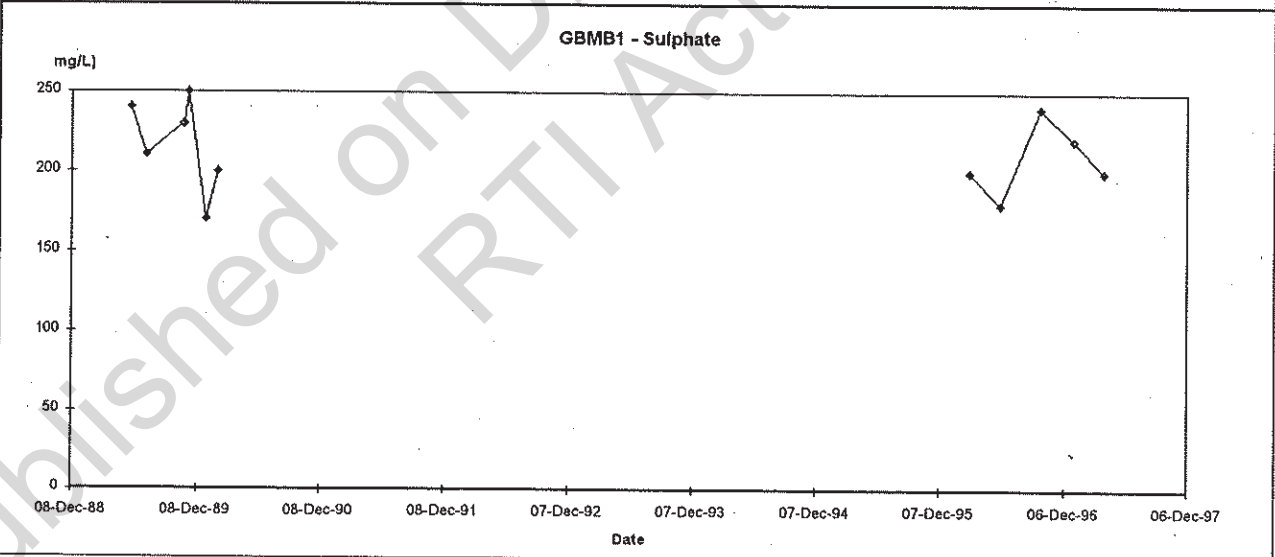
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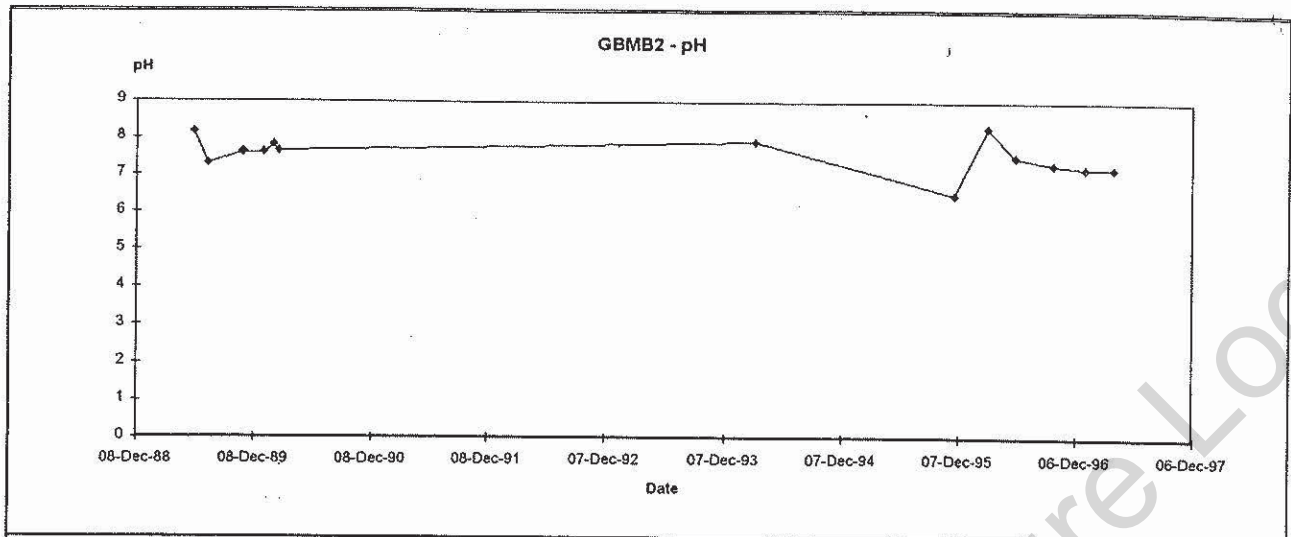
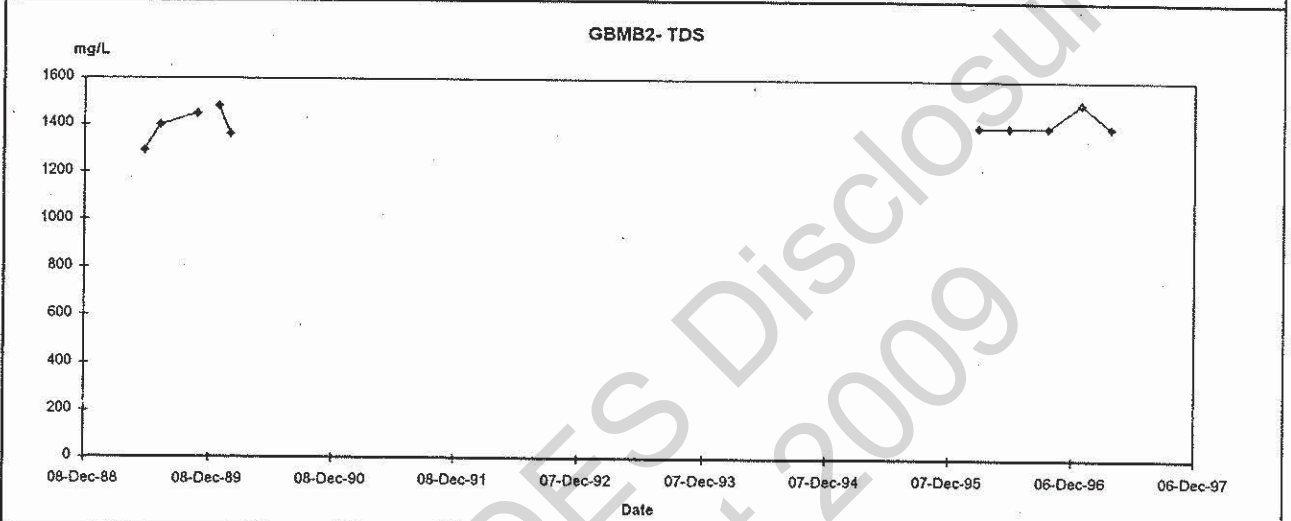
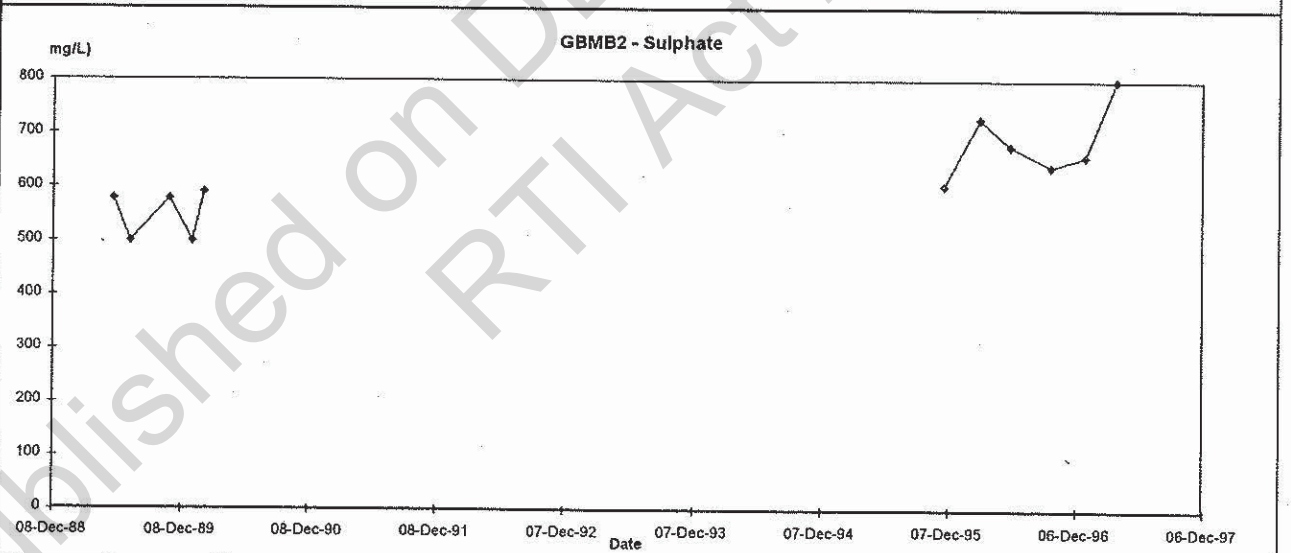
WATER QUALITY MONITORING

BH7

Project: a32/280/0005	Drawing:	Figure: 11
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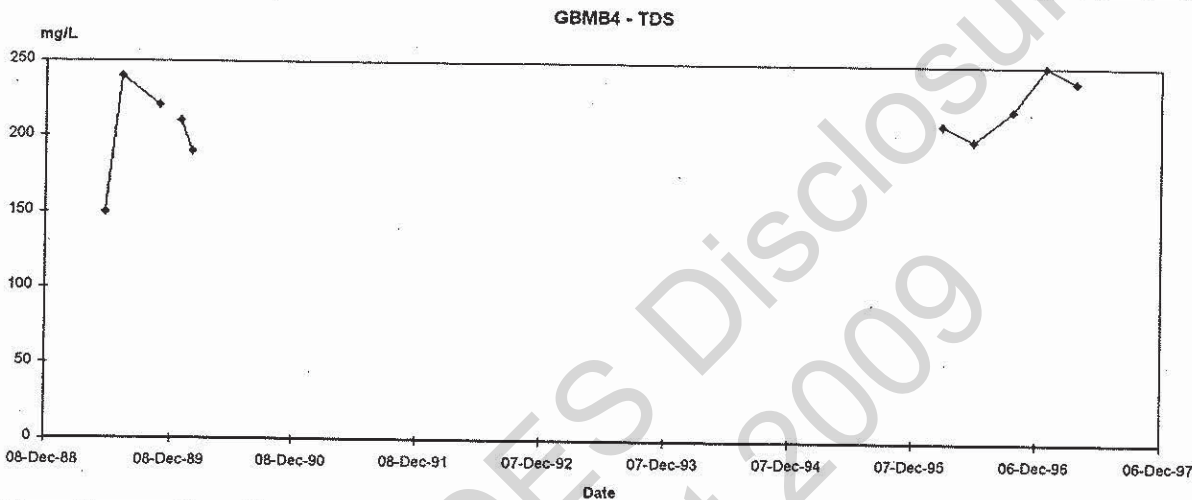
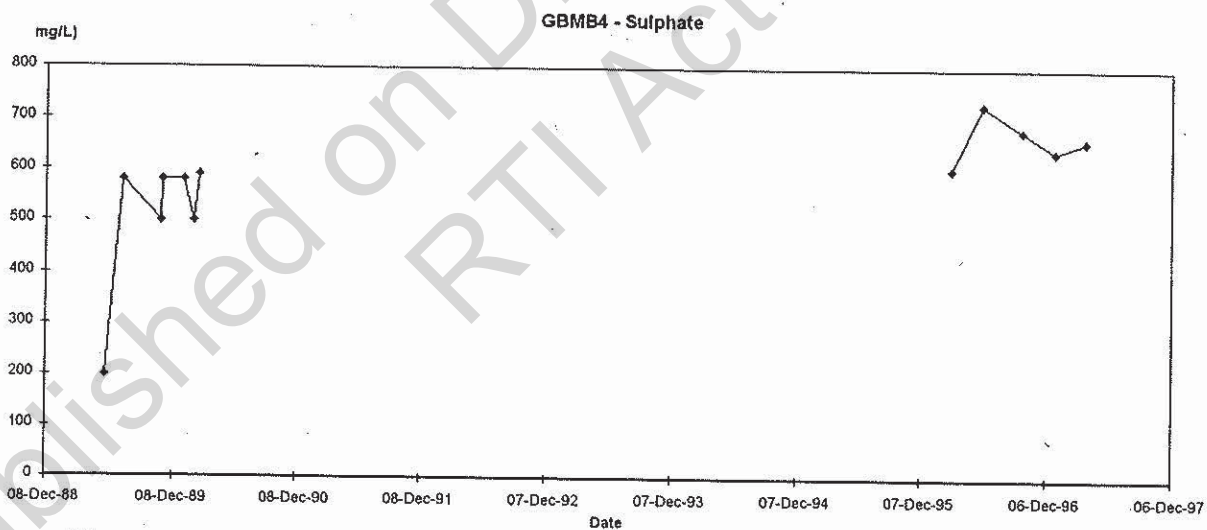


Date	Rev.	Description	Dwn	Chk'd	Woodward-Clyde  A.C.N. 000 691 690		
#####	A	A32/00280/0005/Graph2	MRK				
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					Project:	Drawing:	Figure:
					a32/280/0005		12

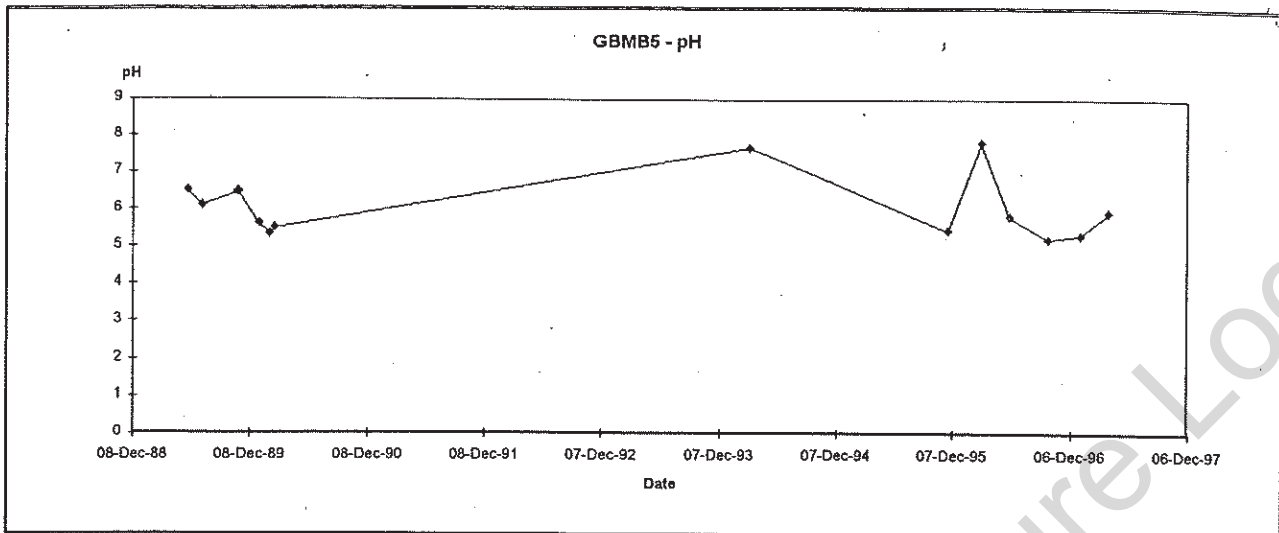
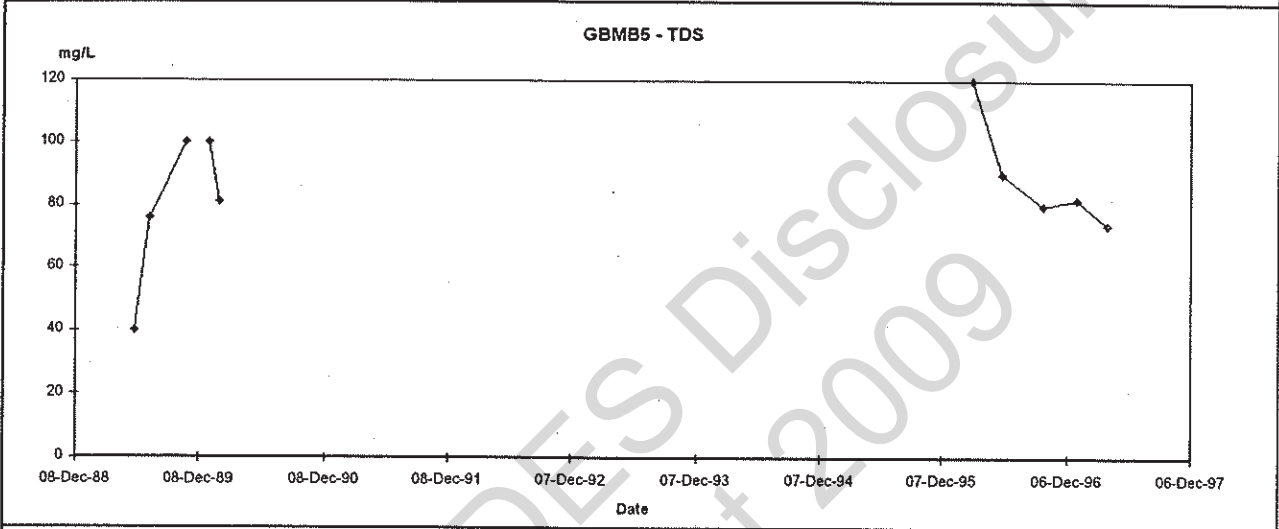
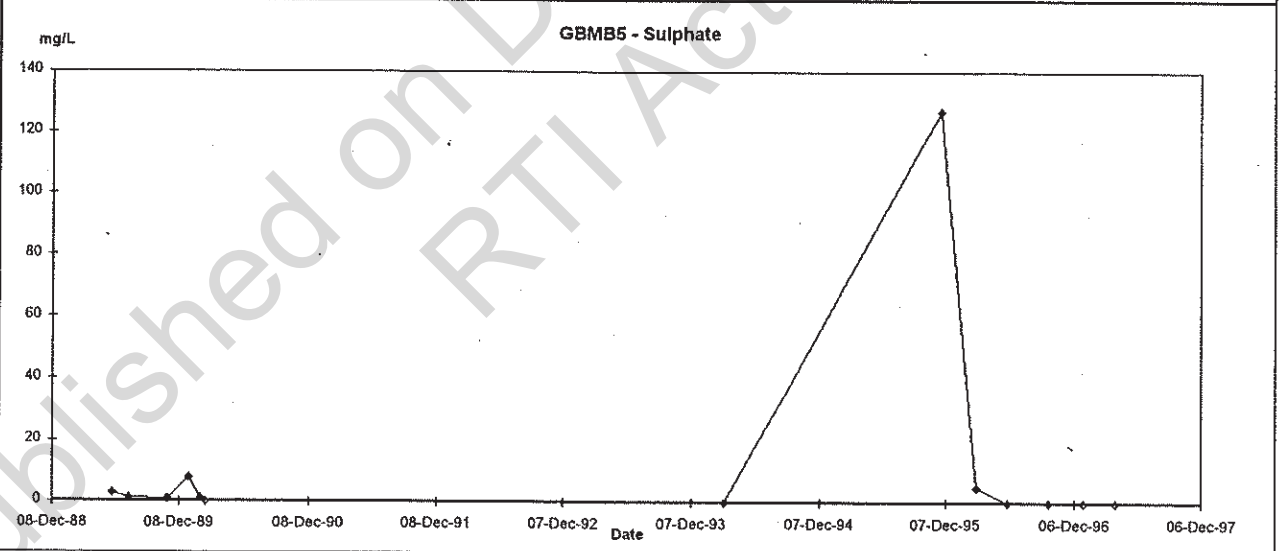


Date	Rev.	Description	Dwn	Chk'd	Woodward-Clyde  A.C.N. 000 691 690		
#####	A	A32/00280/0005/Graph2	MRK				
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Rel

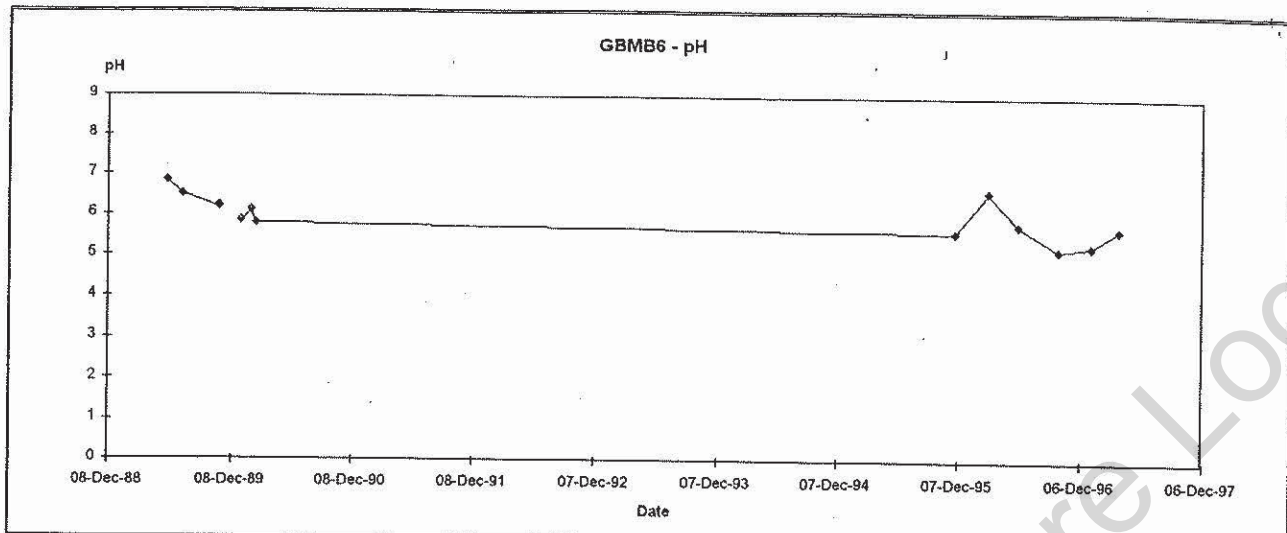
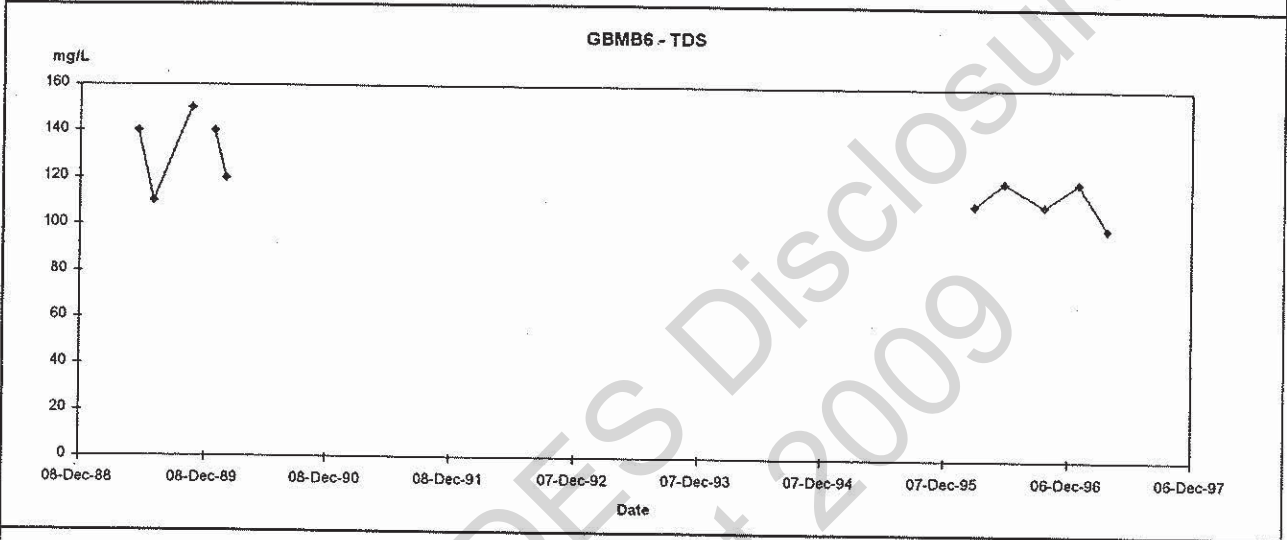
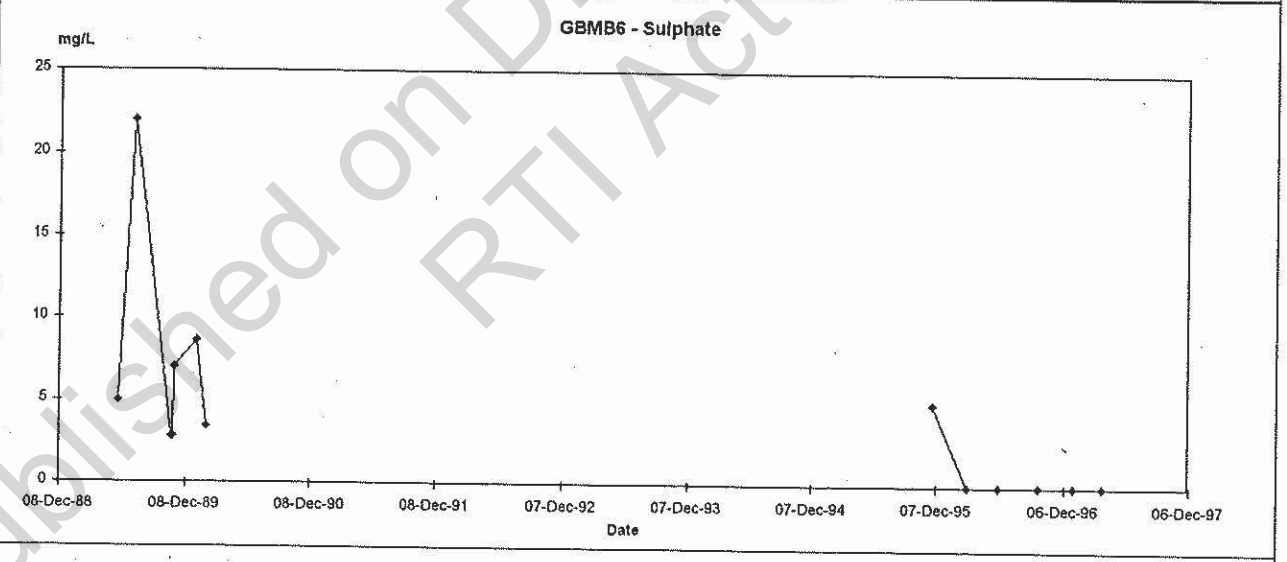


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#####	A	A32/00280/0005/Graph2	MRK			CROYDON GOLD MINE		
						WATER QUALITY MONITORING		
						GBMB 4		
						Project:	Drawing:	Figure:
						a32/280/0005		12



Date	Rev.	Description	Dwn	Chk'd	Woodward-Clyde  A.C.N. 000 691 690		
#####	A	A32/00280/0005/Graph2	MRK				
					PANCONTINENTAL MINING LIMITED CROYDON GOLD MINE WATER QUALITY MONITORING GBMB 5		
					Project:	Drawing:	Figure:
					a32/280/0005		12

Released



Date	Rev.	Description	Dwn	Chk'd
#####	A	A32/00280/0005/Graph2	MRK	

Woodward-Clyde



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PANCONTINENTAL MINING LIMITED

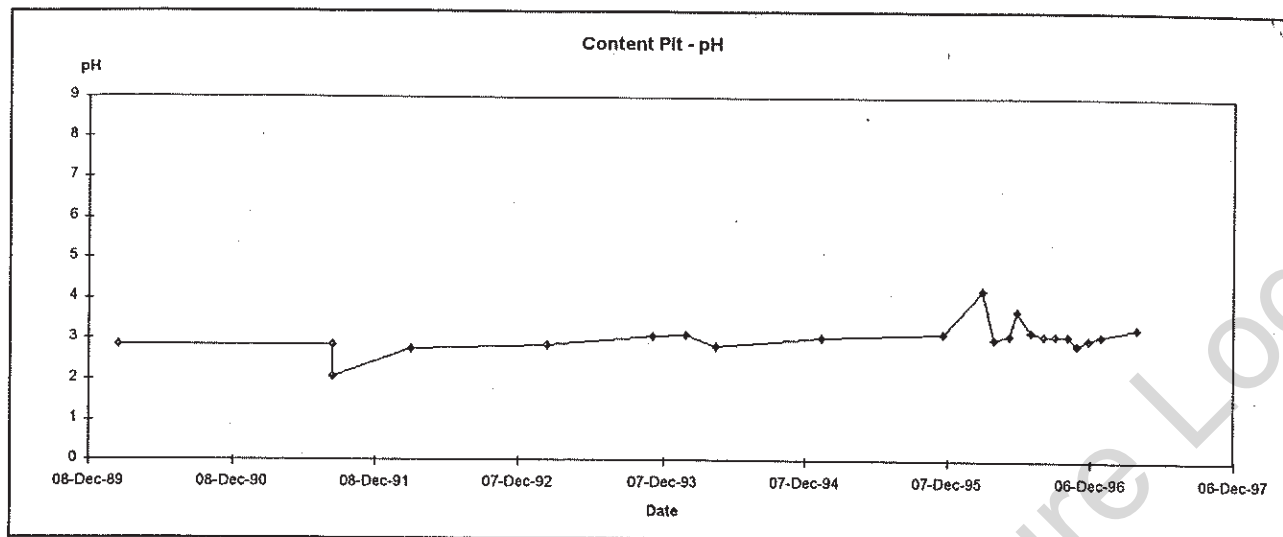
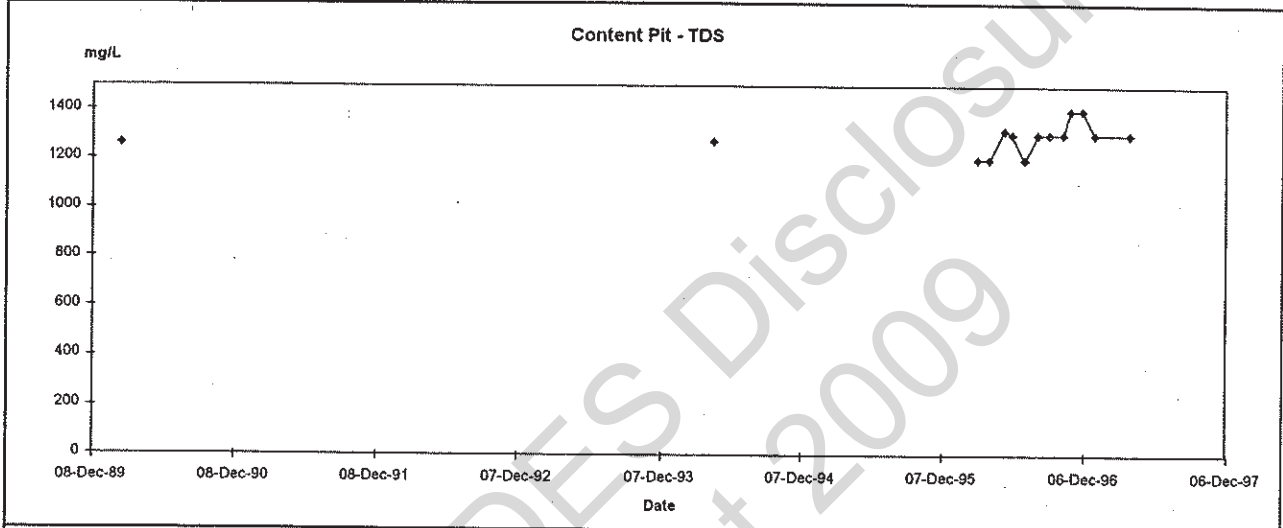
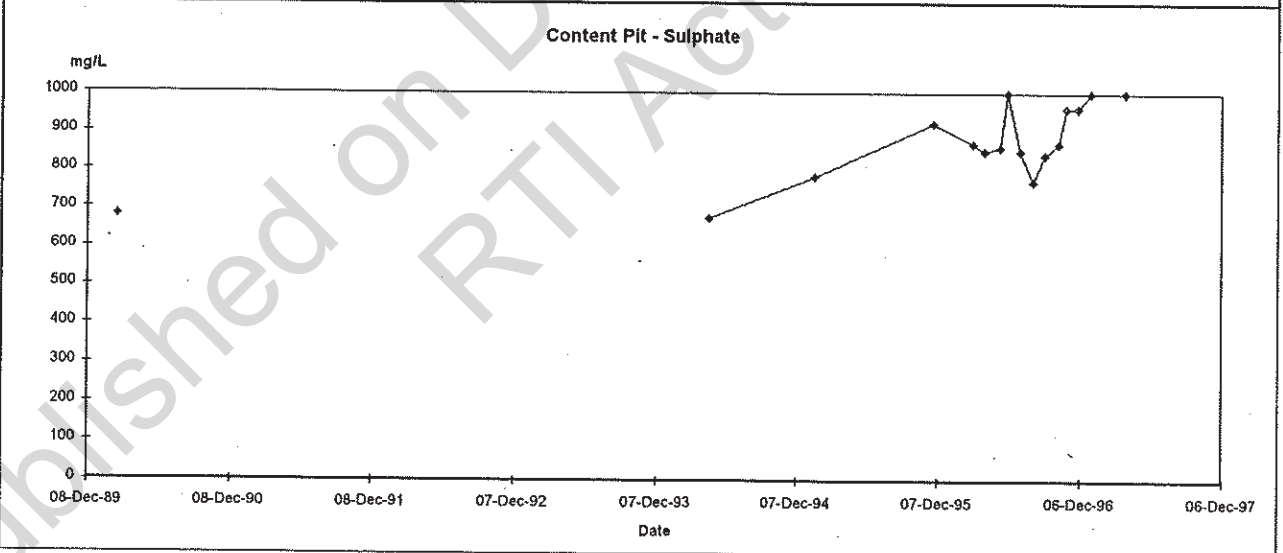
CROYDON GOLD MINE

WATER QUALITY MONITORING

GBMB 6

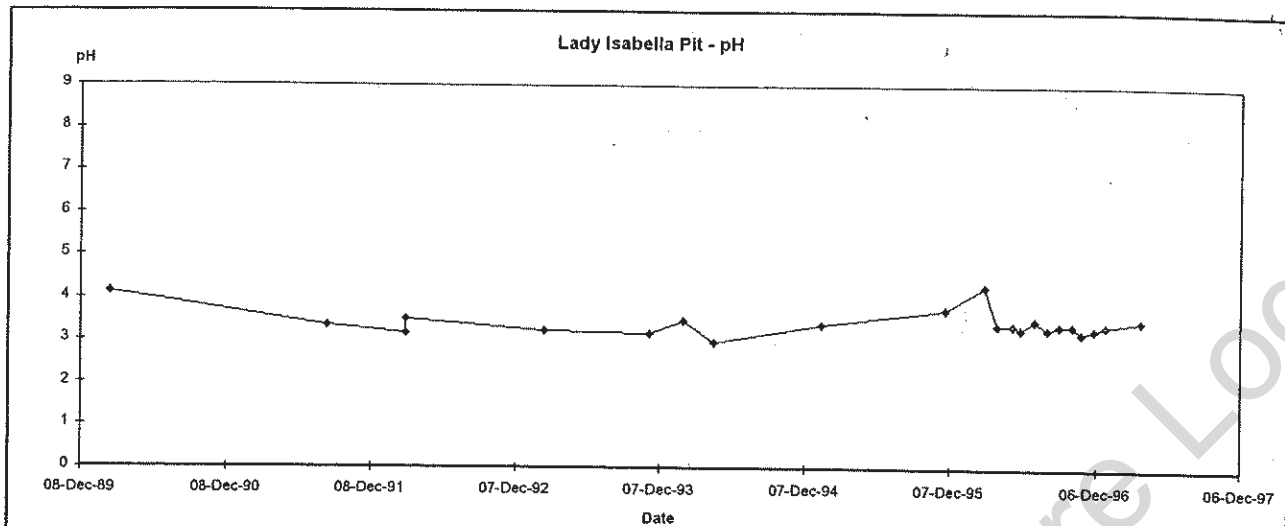
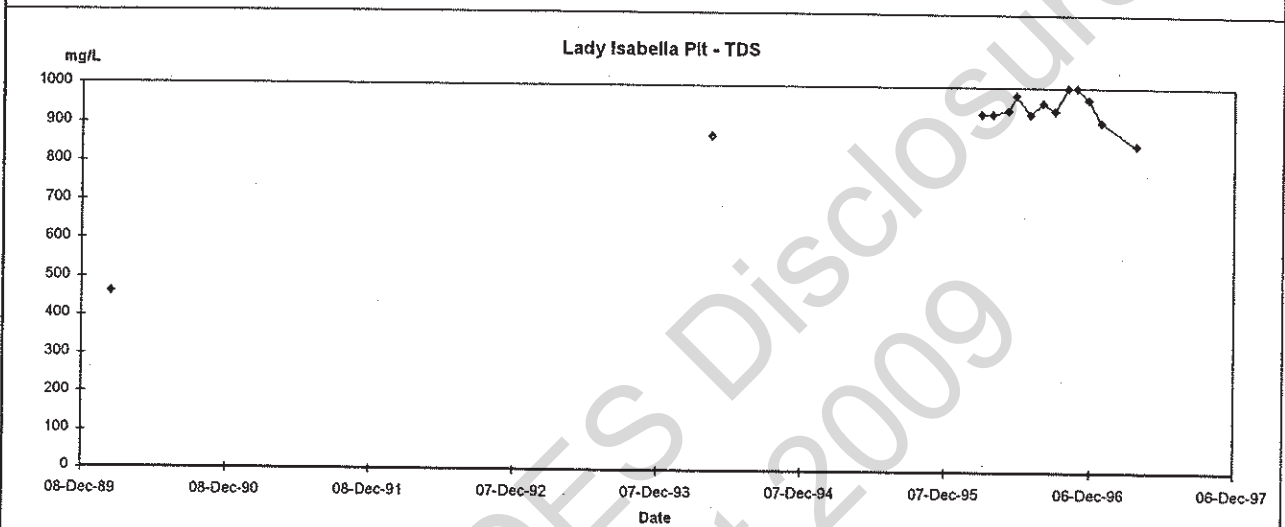
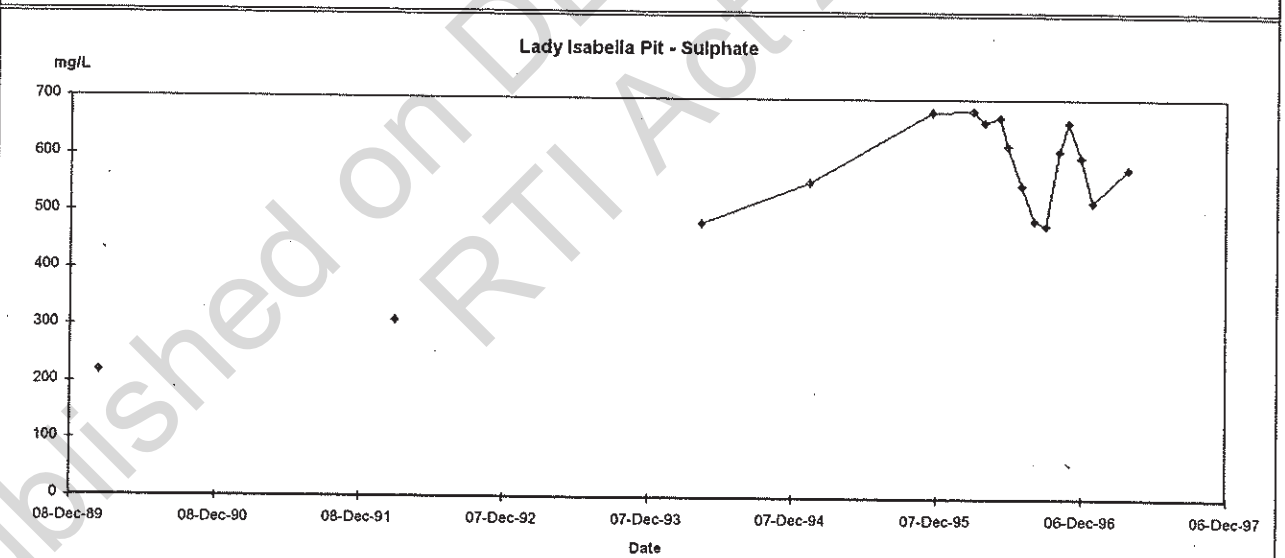
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Woodward-Clyde



A.C.N. 000 691 690

PANCONTINENTAL MINING LIMITED

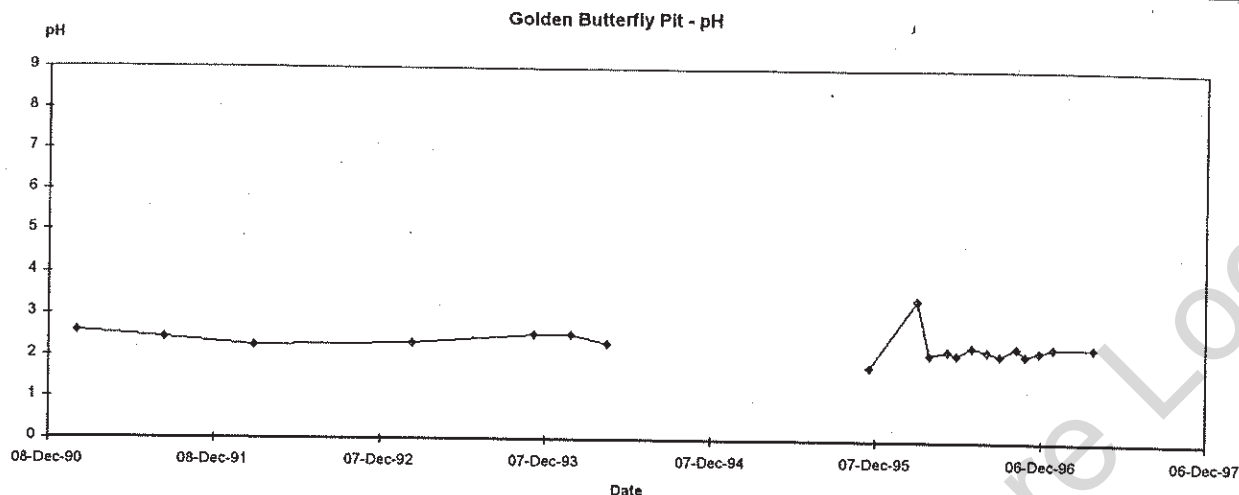
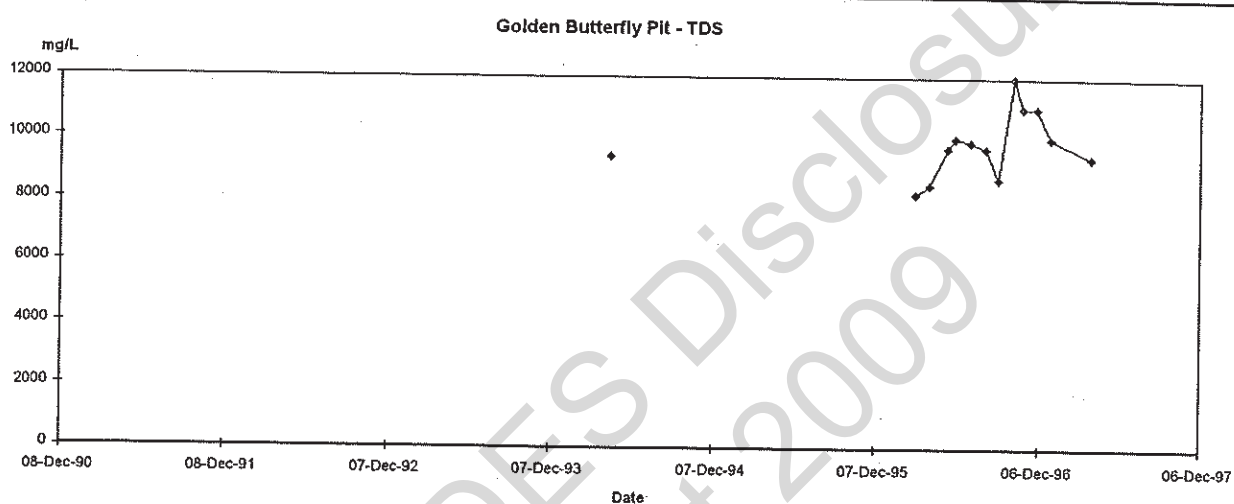
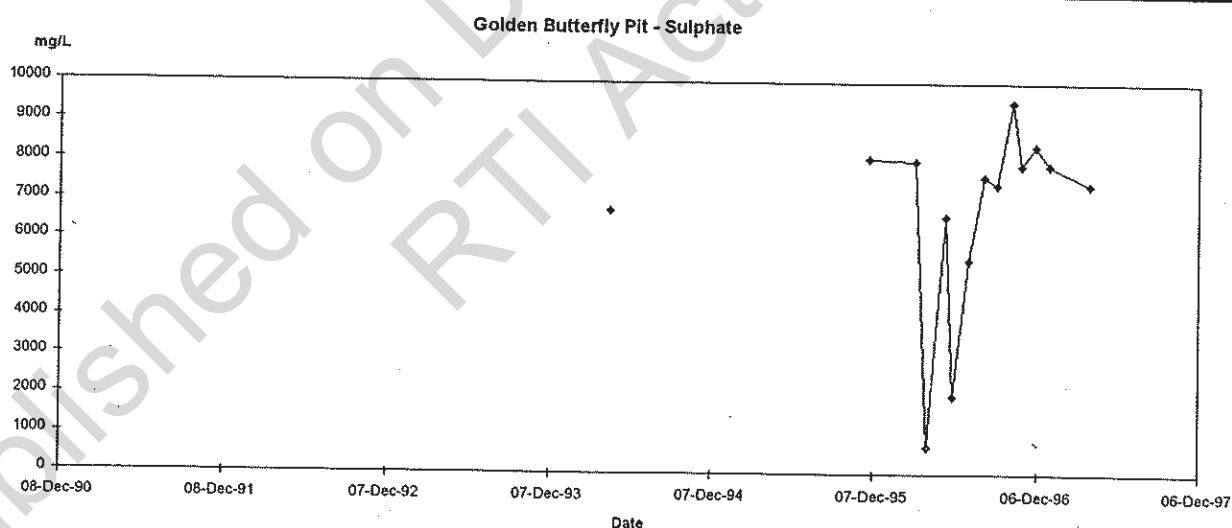
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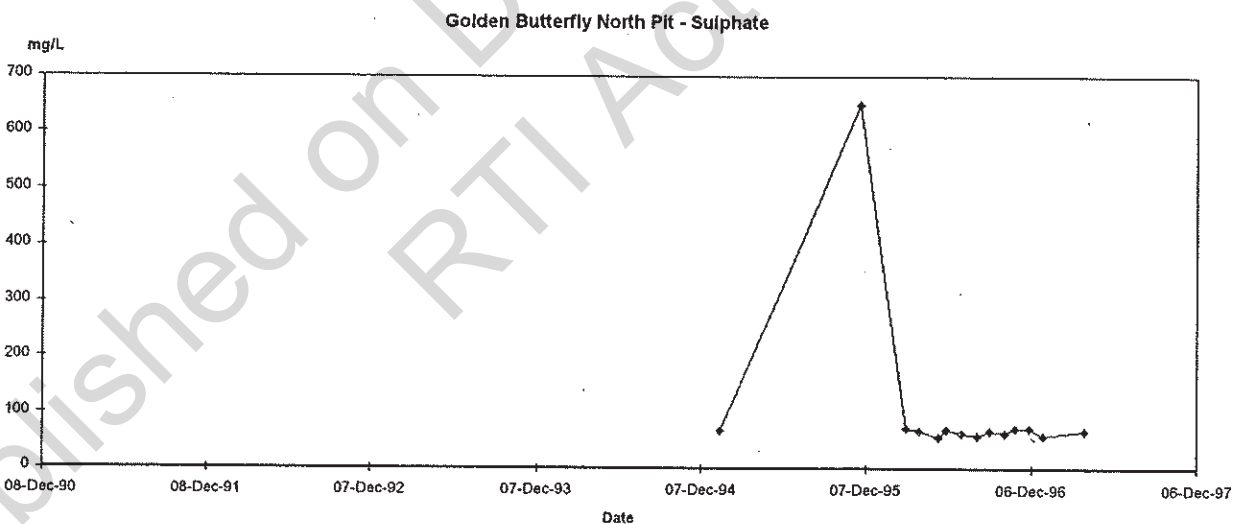
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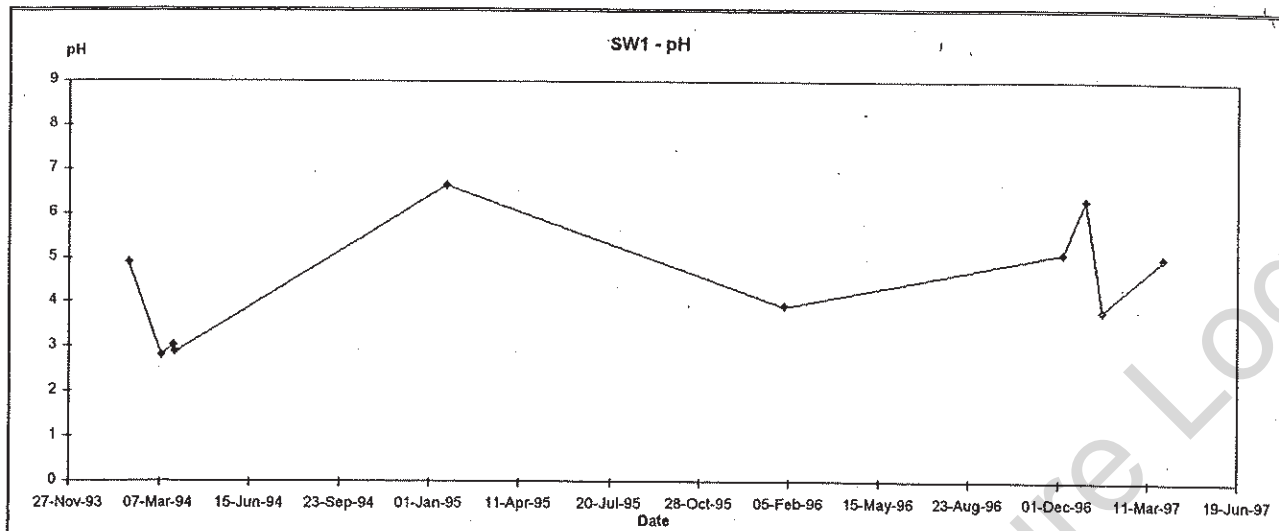
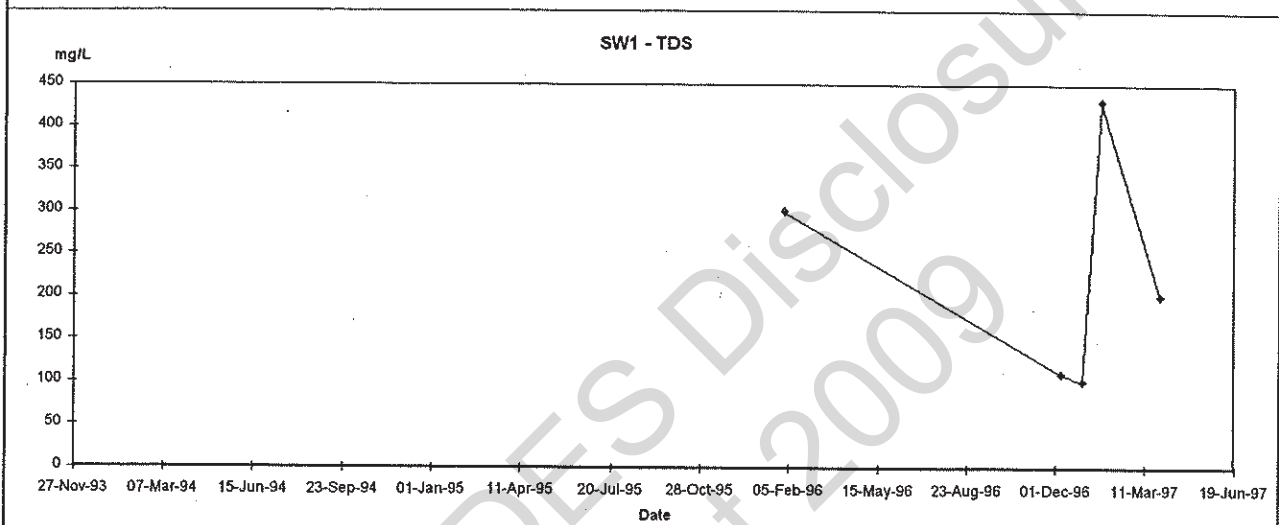
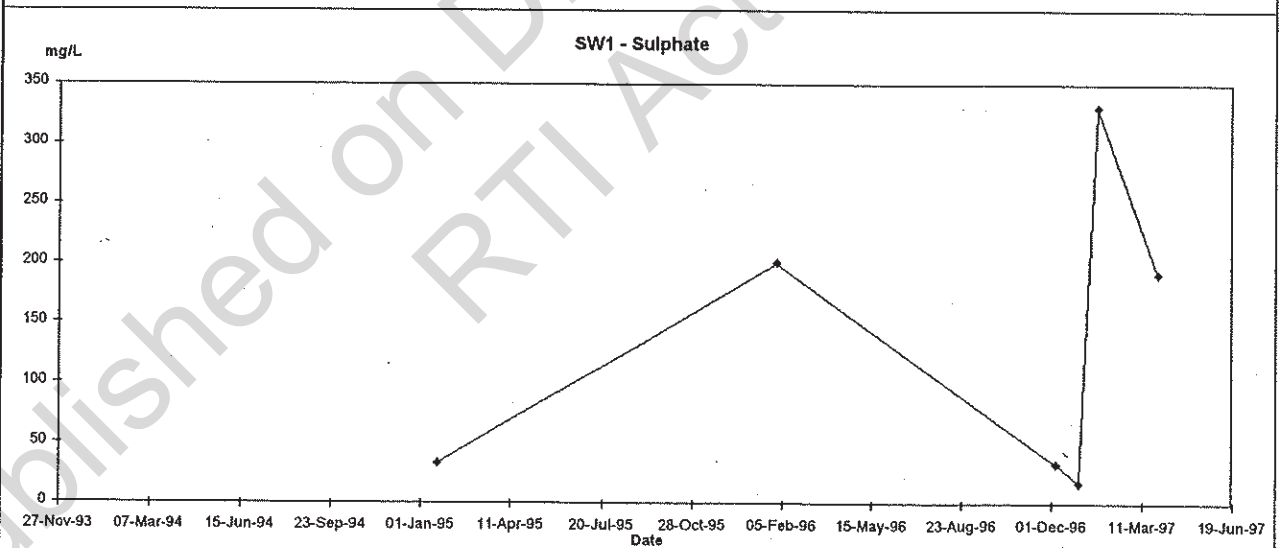
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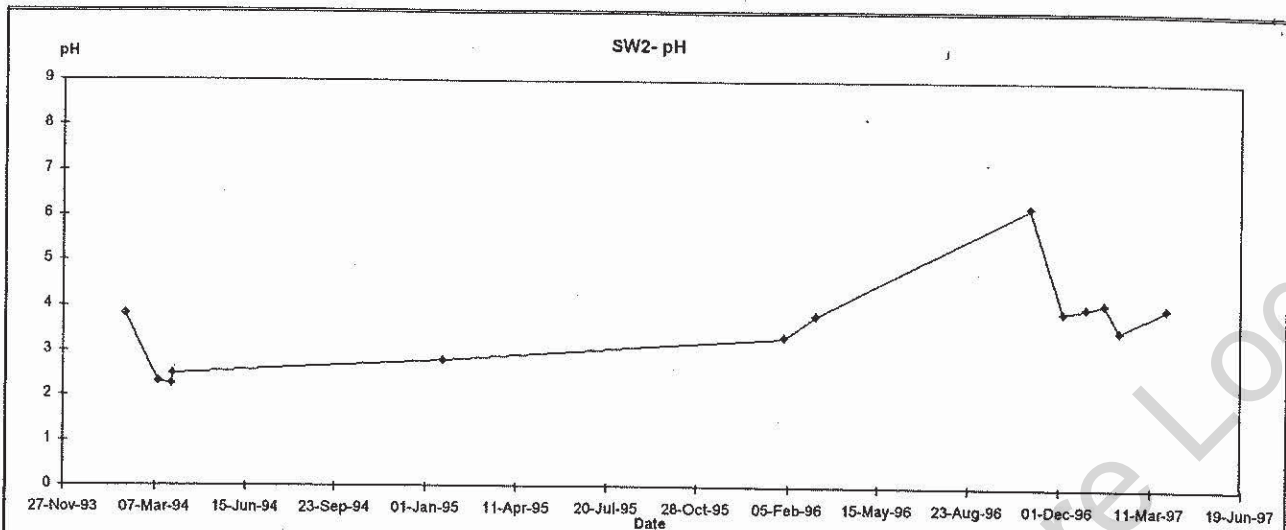
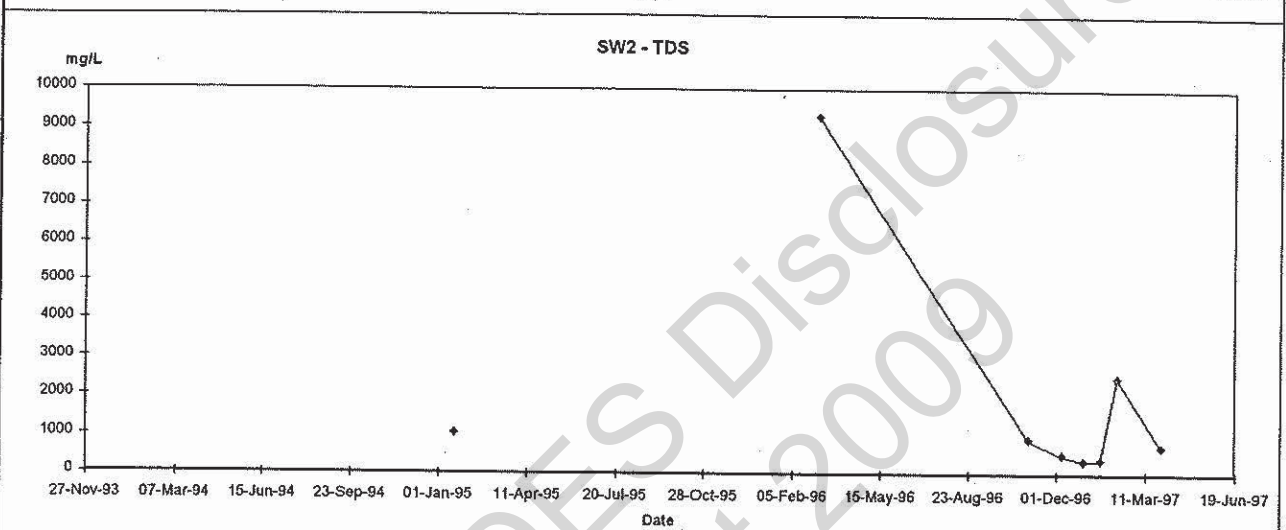
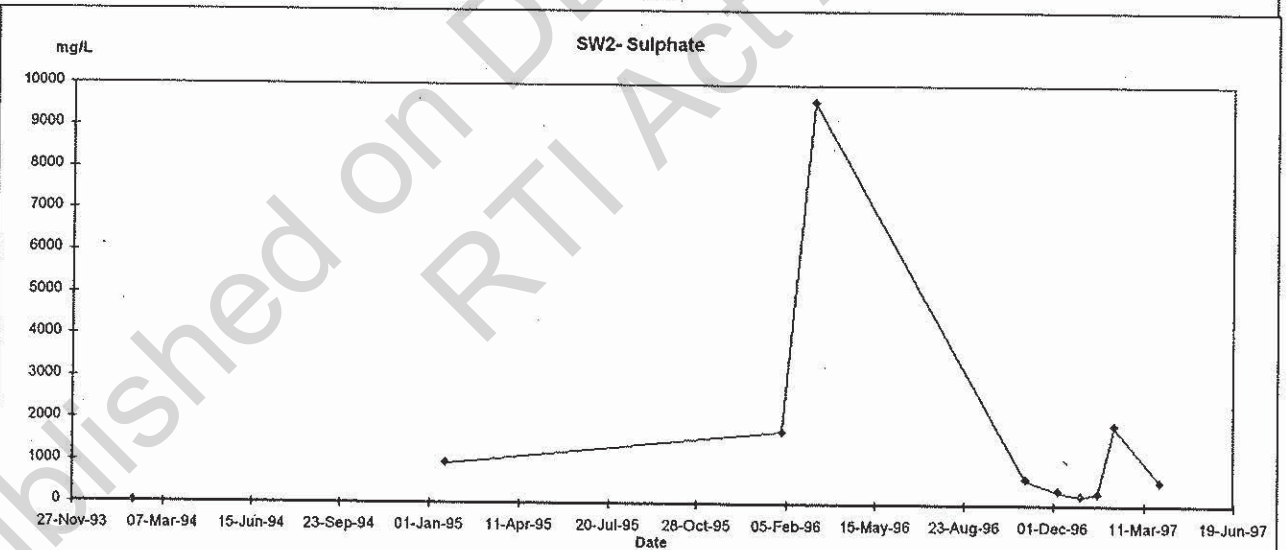


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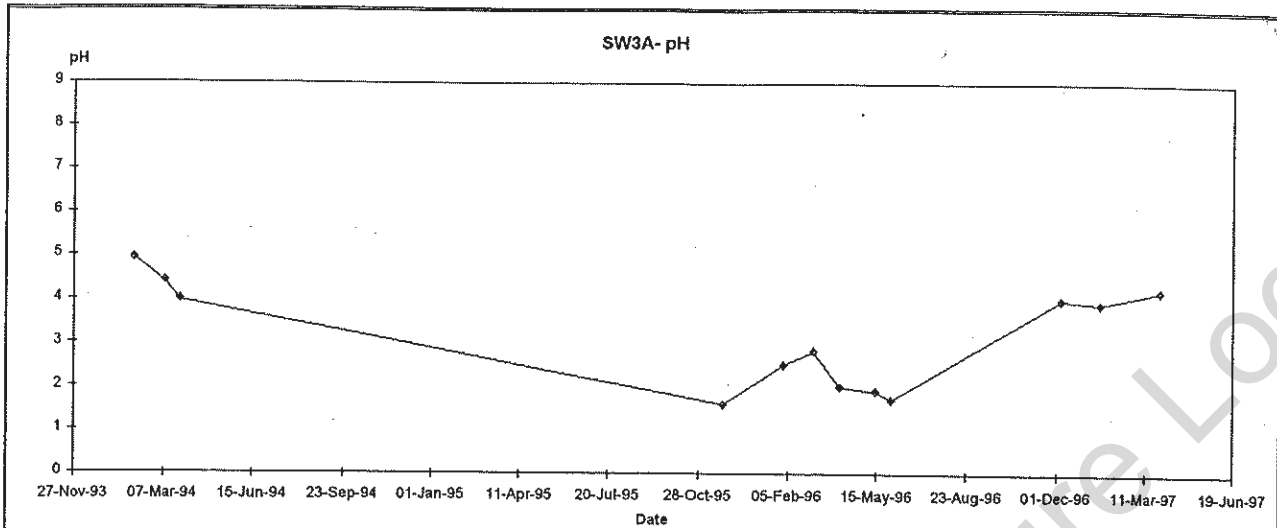
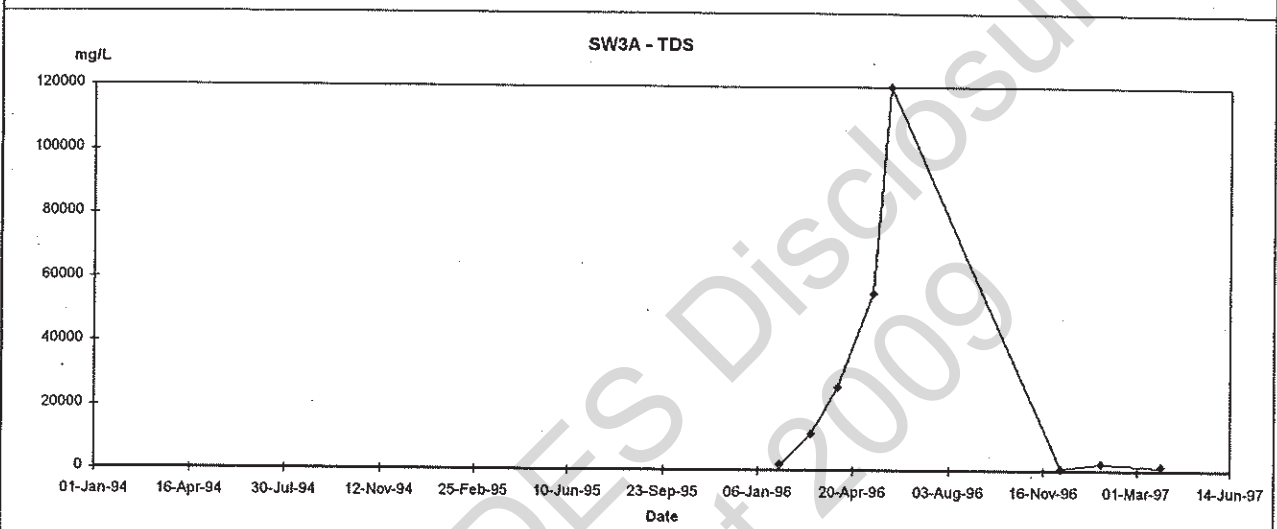
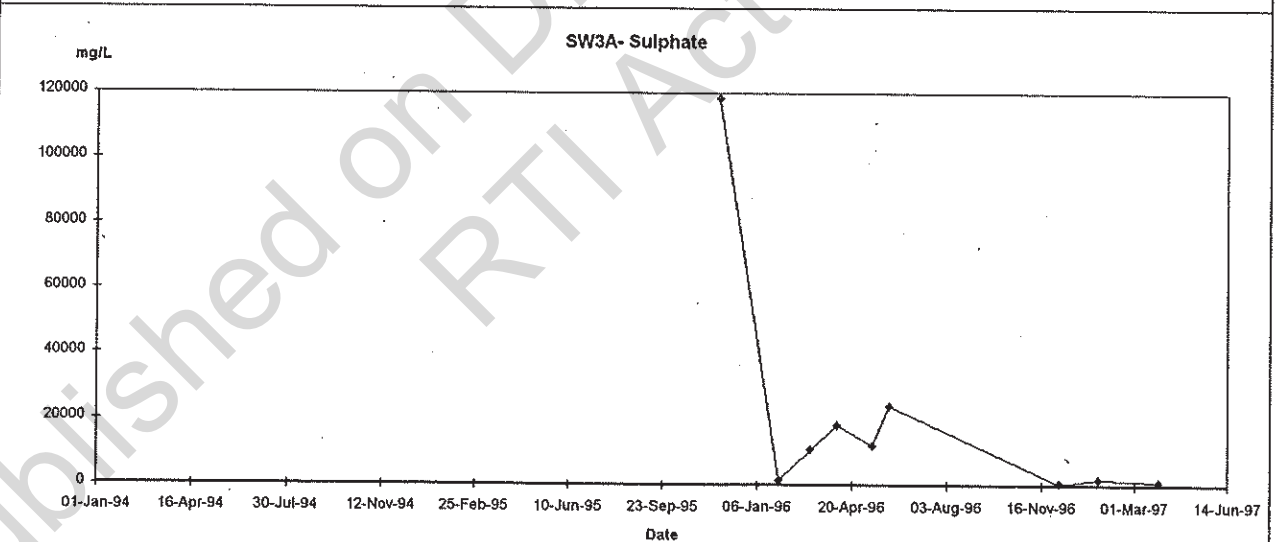
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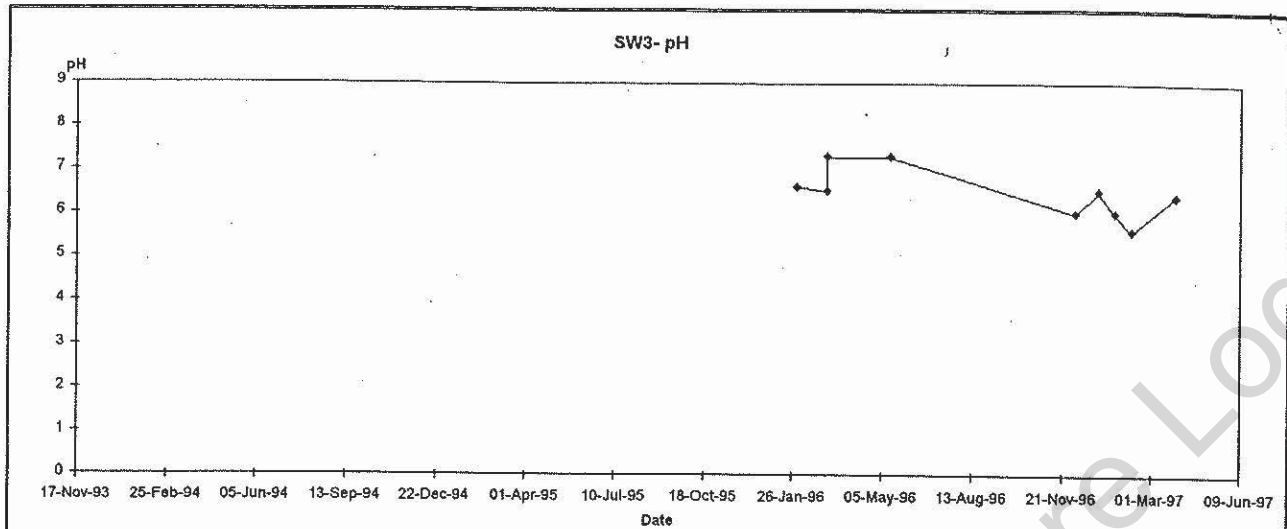
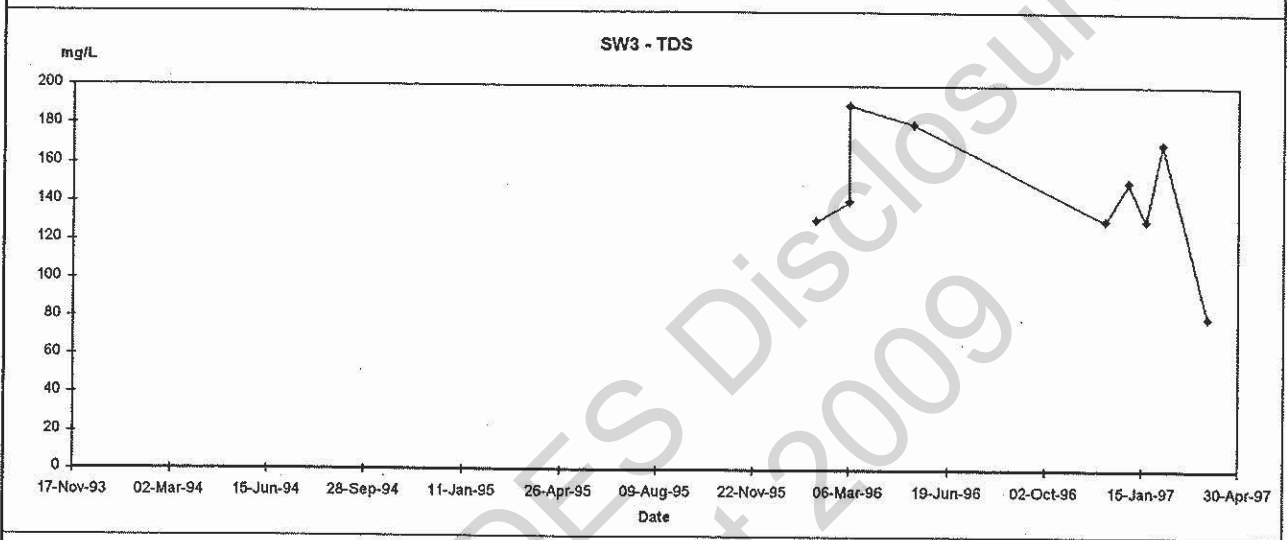
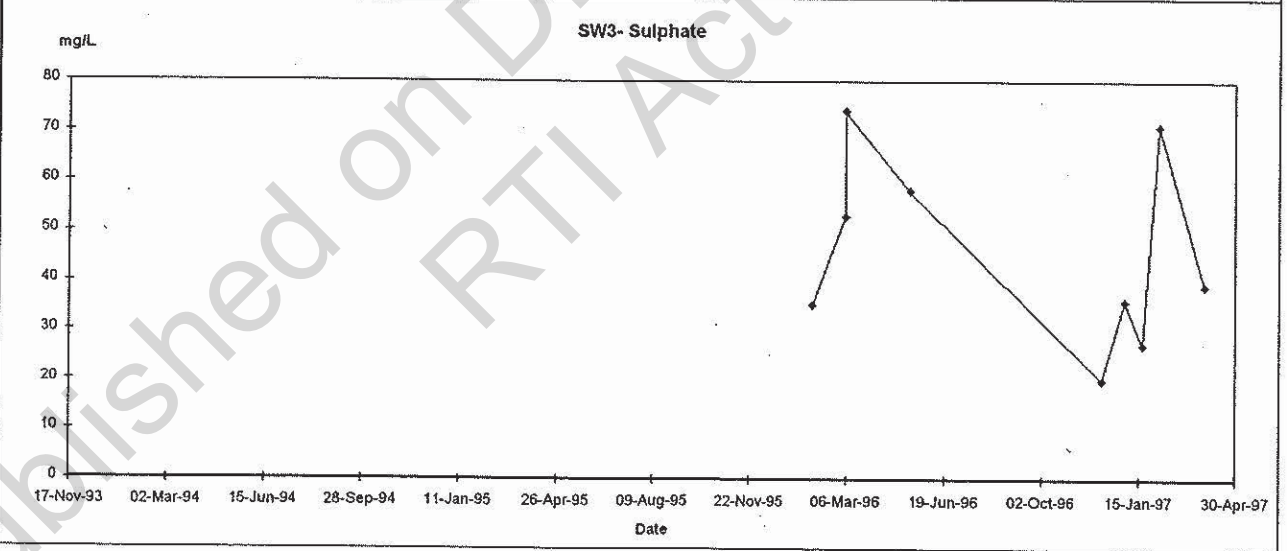


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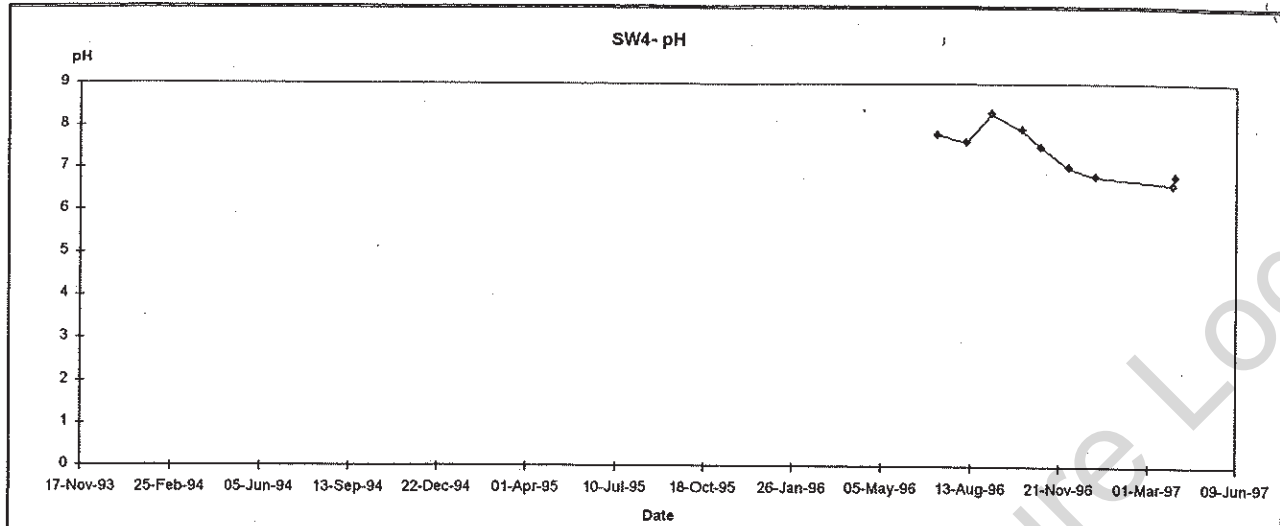
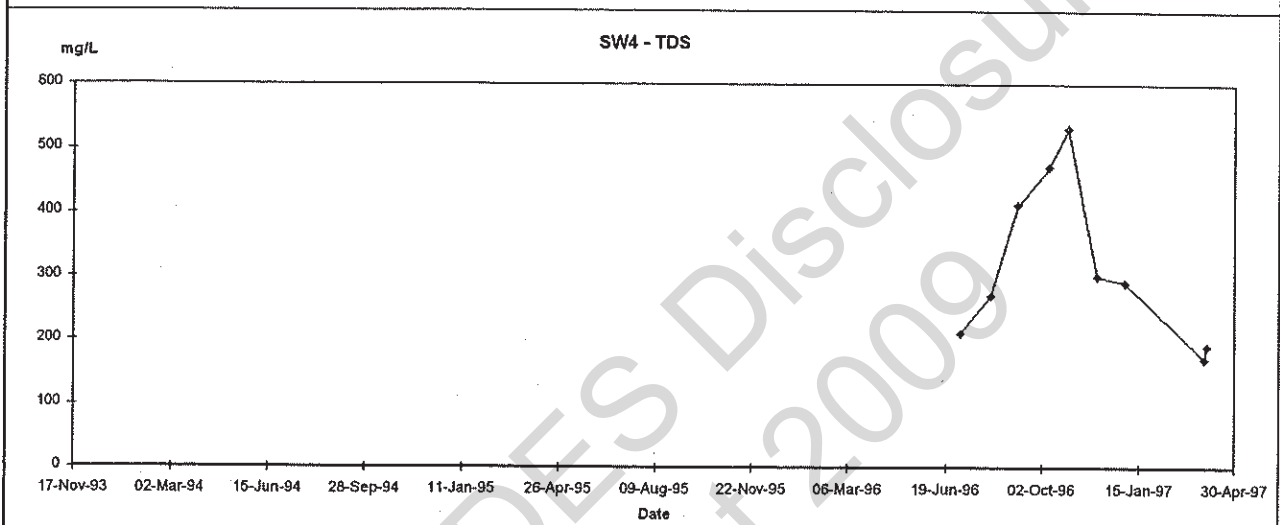
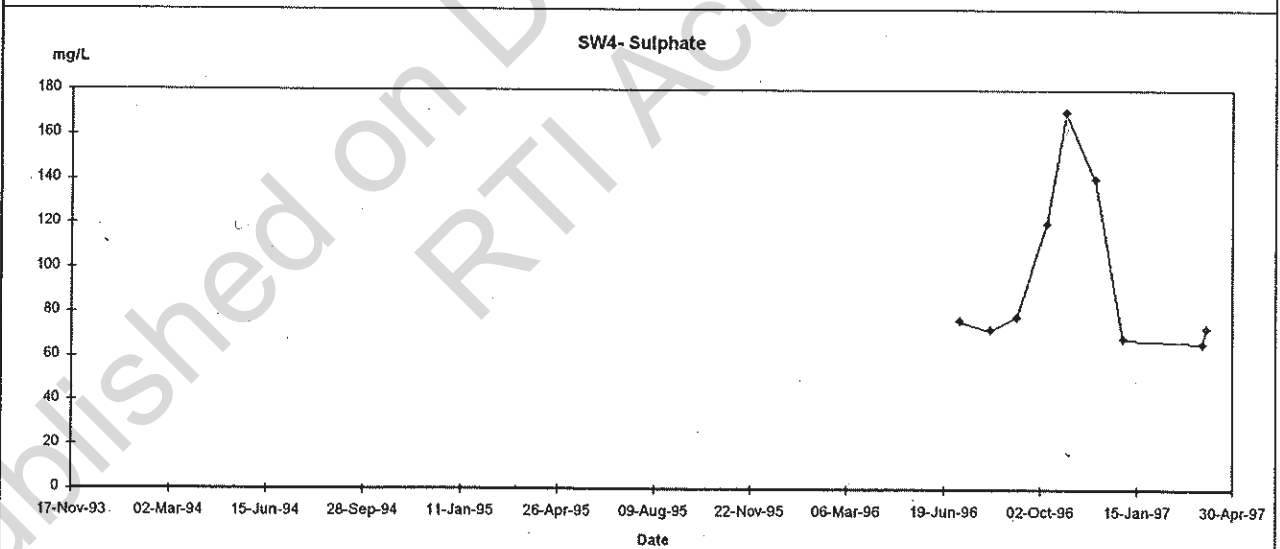
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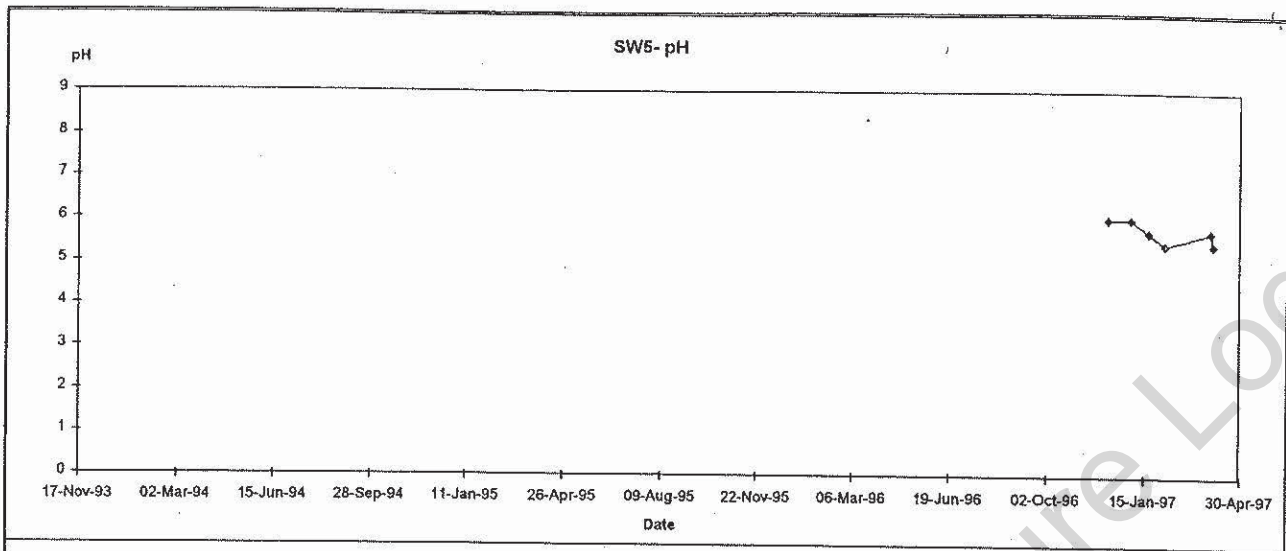
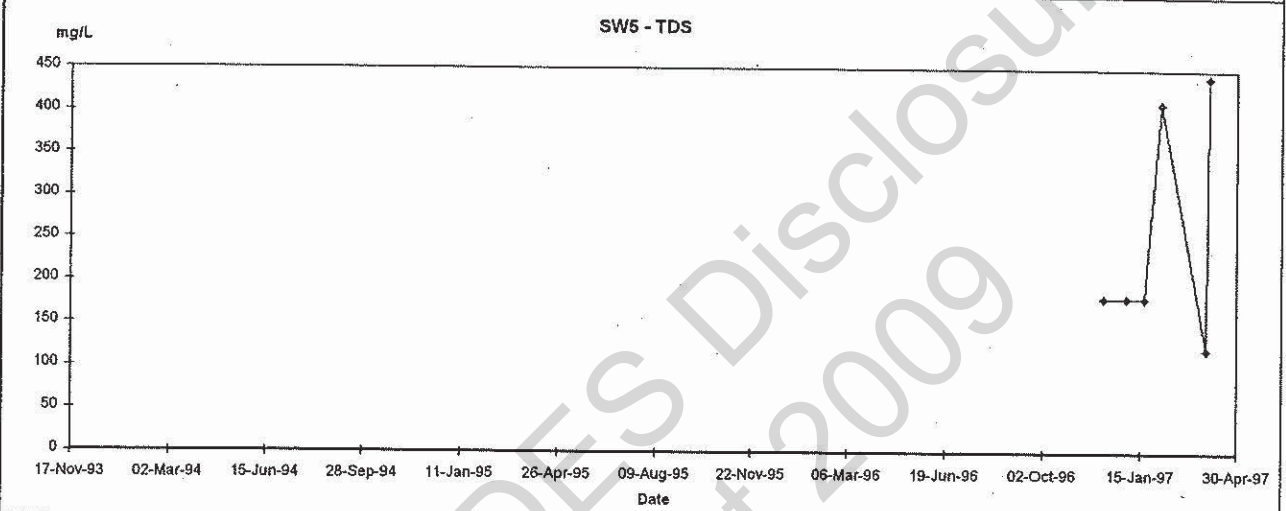
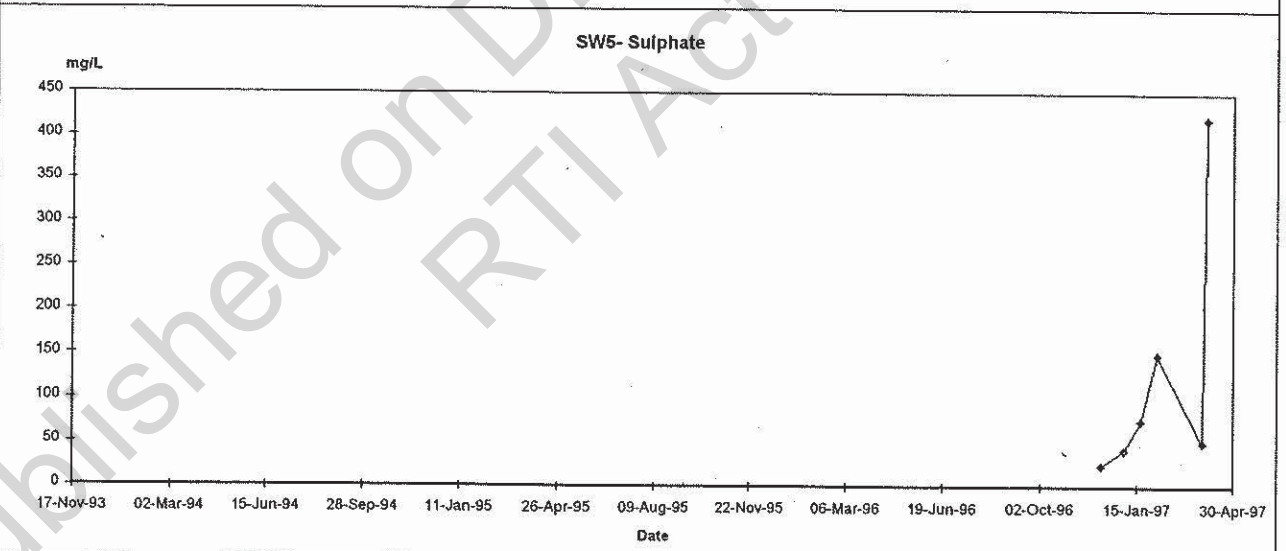
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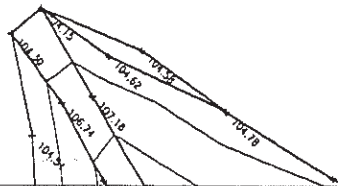
APPENDIX G

EXTENT OF 1996 REHABILITATION WORKS

Released



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LEVEL ORIGIN :- STATION 58 = R.L. 103.123 (AHDD)

File: 399924.Plt Scale: 1:1000 Point of interest: 628721.518, 7990006.958 Created on: 25/11/1996 at 11:13:55 using: GEOCOMP

C&B CONSULTING GROUP

C & B CONSULTANTS PTY LTD
CONSULTING SURVEYORS DEVELOPMENT CONSULTANTS

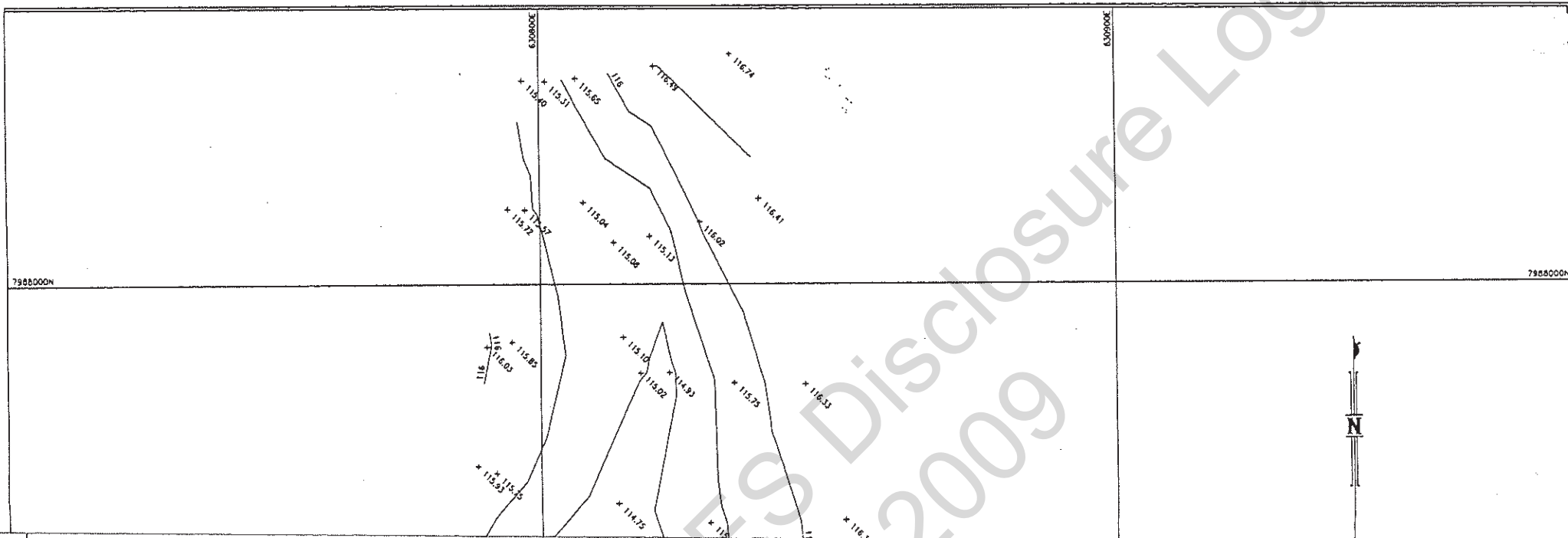
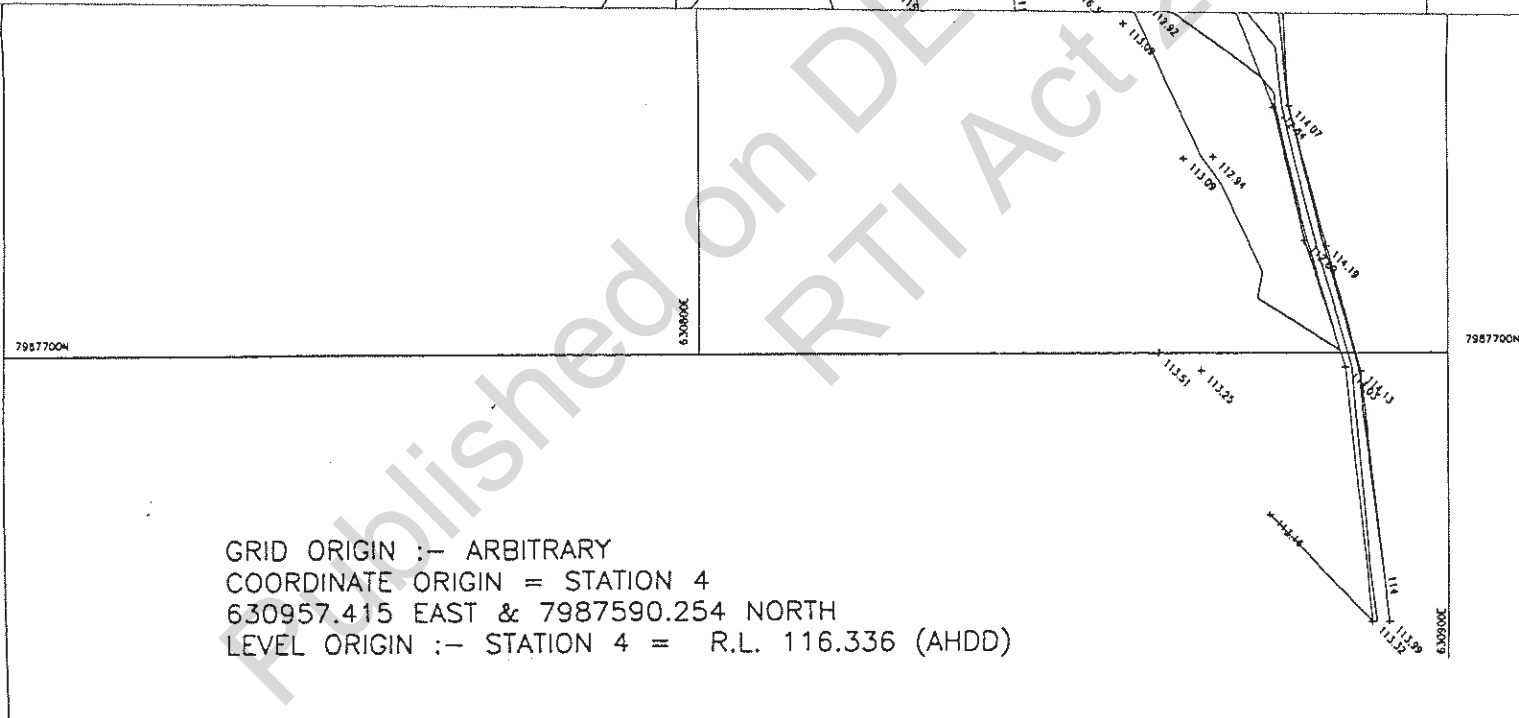
YORK PLUMBERS
P.O. Box 59 PH: (070) 61 2211
Innsdale Fax: (070) 61 4631
ACR 016 001 000

DESIGNED	SURVEYED
	AML 21.11.96
DRAWN	CHECKED
AML 25.11.96	AML 25.11.96

CTPI 49-Sch4

TITLE
CONTENT WASTE DUMP
POST WORKING
21.11.96

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OF	SHEET
SHEETS 1	SIZE A1
DRAWING No.	AMENDED
399924	ISSUE



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 COORDINATE ORIGIN = STATION 4
 630957.415 EAST & 7987590.254 NORTH
 LEVEL ORIGIN :- STATION 4 = R.L. 116.336 (AHDD)

C&B CONSULTING GROUP

C & B CONSULTANTS PTY LTD
 CONSULTING SURVEYORS DEVELOPMENT CONSULTANTS
 TONY PLANNERS

P.O.Box 59 PH: (070) 61 2211
 Inverail Fax: (070) 61 4631
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DESIGNED	SURVEYED
AWL	AWL
7.11.96	7.11.96

CTPI 49-Sch4

TITLE
GOLDEN BUTTERFLY
 SLAUGHTERYARD
 DRAIN/CREEK
 93.236

CAD	SCALE
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OF	856
SHEETS 1	SHEET
DRAWING No.	SIZE
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	AMENDED
	ISSUE

APPENDIX H REVEGETATION WORKS PROGRAM

A survey was undertaken to identify the main components of these vegetation units, and from this a species list to be used in the revegetation program was designed. Wherever possible, seed supplies with local provenance were sourced.

All *Acacia* seeds were treated in boiling water prior to sowing, with the exception of *Acacia shirleyi* which was supplied coated. Seed was weighed out and mixed into "1 hectare lots" to which small quantities of damp sand were mixed immediately prior to broadcasting.

Seed was sown between the 20 and 23 of January 1997 by representatives of RGC. A total area of approximately 40 hectares was sown at the rate of 2.045 kilograms of native tree seed per hectare (in the proportions as outlined below).

SPECIES	SOWING RATE kg/ha
<i>Acacia decora</i>	0.100
<i>Acacia julifera</i>	0.100
<i>Acacia platycarpa</i>	0.200
<i>Acacia shirleyi</i>	0.250
<i>Acacia torulosa</i>	0.200
<i>Acacia tropica</i>	0.005
<i>Erythrophleum chlorostachys</i>	0.100
<i>Eucalyptus confertiflora</i>	0.080
<i>Eucalyptus leptophelba</i>	0.140
<i>Eucalyptus melanophloia</i>	0.300
<i>Eucalyptus miniata</i>	0.340
<i>Eucalyptus polycarpa</i>	0.180
<i>Melaleuca nervosa</i>	0.050
TOTAL	2.045 kg/ha

Sowing was carried out by hand with the assistance of the Australian Trust for Conservation Volunteers (ATCV).

All surfaces were scarified immediately prior to sowing. The majority of the scarification was carried out using a Caterpillar D6H dozer, however, some of the flat areas adjacent to the Content Waste dump were scarified using a Mitsubishi MG400 grader. Scarifying was generally to a depth of approximately 300 mm, and on waste dump slopes significant effort was made to ensure that it was completed exactly along contour.

Fertiliser was applied in a one-off application by aerial topdressing. A custom blend of fertiliser with an N:P:K ratio of 16.3 : 7.6 : 7.6 was spread at a rate of 500 kilograms per hectare.

It is expected, from RGC experience elsewhere in northern Australia, that native grasses will colonise the site naturally.

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ENVIRONMENTAL MANAGEMENT PLAN

CROYDON GOLD MINE PROJECT ML 5248

Revision 3

February 2008

Barrick Gold of Australia

Re

Report submitted to: **Environmental Protection Agency**

Report submitted by: **Barrick Gold of Australia**
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Perth WA 6000
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DOCUMENT REVISION CONTROL

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Rev 3	29/2/08	CTP				Final for EPA submission

BARRICK GOLD OF AUSTRALIA

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1 INTRODUCTION

The Environmental Management Plan (EMP) has been prepared by Barrick Gold of Australia (Barrick) to satisfy the statutory responsibilities as the current leaseholder with a view to eventual relinquishment of Mining Lease 5248 (the Mining Lease). The document outlines commitments to protect the environmental values on and around the now decommissioned Croydon Gold Mine site (Mining Lease) and forms the basis for an Environmental Authority (EA) for the Croydon Rehabilitation Project.

Barrick is the holder of the Mining Lease. The project is located to the west of Croydon township in Northern Queensland. The Mining Lease forms part of the original Croydon Gold Project that was mined between 1987 and 1990. The mine was decommissioned in 1993 and rehabilitated according to a Decommissioning Plan submitted to the Queensland Department of Minerals and Energy. Ownership of the Mining Lease has since passed to Goldfields Limited (later AurionGold) in 1995, Placer Dome Asia Pacific in 2003 and finally to Barrick in 2006.

2 DESCRIPTION OF MINING TENURE

2.1 MINING LEASE

Croydon Mine is located in the Georgetown Mining District on the Mining Lease (18.2°S, 142.2°E). It is situated on the southern side of the Gulf Development Road, immediately to the west of Croydon township, 560km west of Cairns.

The Mining Lease was granted on 4 August 1988 to Goldfields Kalgoorlie Limited. The Mining Lease was later transferred to AurionGold Pty Ltd, before that company was acquired by Placer Dome Australia Ltd, in November 2003, and more recently by Barrick. Underlying land tenure includes parts of Lot 1, Ap5928 (Croydon Town Common) and Lot 952 C3591. There are a number of small landholdings within the Mining Lease area at the southern end.

The total Mining Lease area covers 174.4 hectares and consists of a western section covering approximately 67 hectares (containing the Content open cut pit and waste dump and the Lady Isabella open cut) and an eastern section covering about 95 ha containing the Golden Butterfly and Golden Butterfly North open cut voids and their associated waste rock dump. These two areas are joined by a haul road approximately 100 m wide and 1.4 km in length (Figure 2-1).

2.2 MINING HISTORY

Gold was first discovered in the area in the late 1880's and led to extensive mining for some 30 years before operations ceased. Mining recommenced at the Croydon Gold Project in 1987 as a joint venture between Central Coastal Exploration NL and Pancontinental Mining Limited (Pancon). Mining commenced in December 1988 at the Golden Butterfly Pit and over the next two years expanded to include the mining of Golden Butterfly North Pit, Content Pit and Lady Isabella Pit (Figure 2-1). Mining on the Mining Lease ceased in April 1990 by which time approximately 445,000 tonnes of ore had been treated to produce around 63,000 ounces of gold. All processing of ore was done off the Mining Lease and no tailings material was ever stored on the lease.

On cessation of mining activity Pancon relinquished a portion of the original Mining Lease and only retained those areas that contained permanent mine landforms such as the mine pits, waste rock dumps and original hardstands (ore stockpile and crusher pad areas). This Mining Lease area is shown on Figure 2-1. The Mining Lease now contains the following mining related landforms:

- Golden Butterfly Pit
- Golden Butterfly North Pit
- Golden Butterfly Waste Rock Dump
- Content Pit
- Content Waste Rock Dump
- Lady Isabella Pit.

The Mining Lease also contains hardstand areas, a haul ramp, numerous exploration bores and historical (pre-1914) open shafts and adits.

2.3 MINE SITE – PHYSICAL DESCRIPTION

The Mining Lease is 'sandwiched' between the Normanton Gulf Development Road, Croydon-Normanton railway line and Croydon township. The Mining Lease is fenced with access from several points along the Gulf Development Road.

The Mining Lease area is relatively flat with the only significant topography, a 25 m high hill, located between the two lobes that constitute the current lease area (Figure 2-1). The southeastern lobe ('Golden Butterfly' mining area) is within the upper catchment of Slaughteryard Creek and the north-western lobe ('Content and Lady Isabella' mining areas) within the Belmore Creek catchment. Gradients are however very low and sheetflow is the dominant hydrological process.

The undisturbed area within the Mining Lease is grassed with scattered trees, typical of the Gulf Savanna Landform System. The remaining mine landforms (waste rock dumps and hardstands) have been revegetated with grasses and shrubs, either from past sowing activities or by natural colonisation (HLA-Envirosciences, 2001). The mine pits although isolated from any surface drainage have been allowed to naturally fill through groundwater seepage and direct precipitation.

2.4 LAND USE AND LOCAL STAKEHOLDERS

The pre-mining land use within the Mining Lease comprised cattle grazing on the western portion of the lease and this continues at the present time. The eastern portions of the Mining Lease form part of the town commonage and have been used for low levels of grazing. A pre-mining land capability study by Woodward-Clyde (1993) concluded that the "land is not suitable for cultivation and that pastoral use is possible only with careful management". It also recommended that any form of pasture improvement involving the use of machinery be regarded as impracticable. It is noted that an earth impoundment located between Golden Butterfly pit and waste rock dump now serves as a stock watering facility. In addition the clay borrow pit dug during the 1996 reclamation programme now serves as an important permanent stock watering point on the neighbouring Belmore Station owned by the Pickering family.

Prior to 1995 the Croydon Shire Council used water pumped from the Golden Butterfly North Pit Lake to supplement the town water supply. This was discontinued with the introduction of the Lake Belmore water supply scheme. The pit lake has been used as an emergency town water supply. The original town borefield located within Slaughteryard Creek down stream of the Golden Butterfly landforms was decommissioned in the 1990's with the commissioning of Lake Belmore.

The close proximity to Croydon township means that a variety of property owners occupy or hold land within and/or directly adjacent to the Mining Lease. This group of stakeholders includes indigenous landowners who currently retain freehold title over a small-constrained area located along the extreme eastern end of the Mining Lease (Reference Code 7890/A1 Deed of Grant Issued, formerly Aboriginal Reserve 64). The Mining Lease area is included within a Native Title Claim Area (SDEDBA.QLD-DCDB Claim No QC98/043).

2.5 KEY ENVIRONMENTAL ISSUES

No mining activity has taken place since 1990 and the mine was decommissioned by late 1993. Reclamation performance was rigorously audited in 1995/96 and resulted in significant additional reclamation work during 1996/97. A further ten years of monitoring since then has helped establish the environmental issues which require attention prior to final relinquishment of the Mining Lease. The key remaining environmental issues include:

- Protection of local surface water resources in the Belmore Creek catchment to the northwest of the Mining Lease.
- Protection of local groundwater resources (including the former Croydon town water supply borefield aquifer).
- Management of access to the Golden Butterfly North Pit lake which continues to be used as an emergency water supply by the local community.
- Ensuring effective storm drainage off Content Waste Rock Dump to eliminate any potential long term erosion threat.
- Maintaining adequate vegetation cover in all rehabilitated areas to minimise erosion on mining related landforms.
- Final voids safety.

3 RECLAMATION RECORD

3.1 PRE-1996 RECLAMATION HISTORY

Reclamation activities began in 1993 and focused on environmental concerns relating to:

- Development of acidic water in the open pits.
- Acid Mine Drainage (AMD) within Slaughteryard Creek from the Golden Butterfly Waste Rock Dump and adjacent hardstands.
- Off-lease movement of groundwater from the Golden Butterfly pit.
- Erosion and potential instability of mining related landforms.

The programme included the re-profiling of the two waste rock dumps, construction of drainage control structures and the 'bundling' of all pits (HLA-Envirosciences, 2001).

3.2 1996-2002 RECLAMATION HISTORY

In 1995 on acquiring the Mining Lease Goldfields undertook a comprehensive reclamation review and established the following reclamation objectives:

- Secure the site for the long term by inhibiting the formation and release of AMD to the surrounding environment
- Enhance the overall stability and sustainability of the developed landforms.

The resultant reclamation programme comprised the following works:

- Clay capping and rock fill surface protection of the entire Golden Butterfly Waste Rock Dump including construction of a key trench around the dump perimeter.
- Re-shaping of outer slopes, clay fill capping and rock fill surface protection of the entire Content Waste Rock Dump. This excluded the western slope as the existing reclamation was considered adequate.
- The removal of potentially acid producing waste rock from the Golden Butterfly and Content Hardstand areas. The excavated material being placed in Golden Butterfly pit.
- The removal of potentially contaminated channel bed sediments from the drainage network that discharges into Slaughteryard Creek.
- General collection and removal of all rubbish and mining plant.
- Construction of surface drainage structures down gradient of Content Waste Rock Dump.
- Backfilling of open bores and mine shafts.
- Re-vegetation of disturbed areas including the reworked waste rock dumps.
- Introduction of a reclamation monitoring programme and annual reporting regime.

The 1996/97 reclamation work is fully reported in Fawcett (2001) and HLA-Envirosciences (2001). In addition, a Golden Butterfly Pit lake study was undertaken by HLA-Envirosciences in May 2001 and confirmed the hydrological isolation of the pit lake from the surrounding catchment.

A set of *Relinquishment Criteria* was proposed to, and accepted by, DME in 1996. These are summarised in Appendix B. In late 2001 AurionGold submitted a Draft Final Rehabilitation Report to the EPA. This was rejected due the following concerns:

- Re-current AMD from the Content waste rock dump – hardstand area.
- Pit lake water quality not meeting stock water quality standards although this was not a relinquishment criteria.
- Poorer than expected vegetation growth on a portion of Content Waste Rock Dump.
- The presence of Calotrope on the Mining Lease.

3.3 2003-2006 RECLAMATION HISTORY

No further reclamation work took place during this period. Placer Dome and Barrick have continued with the original environmental monitoring programme and annual reporting regime. In the latter half of 2006 Barrick undertook a brief field inspection of the site by a panel international mine closure experts and initiated the process that has led to the development of this EMP.

3.4 REGULATORY FRAMEWORK

Table 3.1 summarises regulatory conditions considered to be relevant to the current Project. These are detailed further in Appendices A and B.

Table 3.1
Existing Conditions and Relinquishment Criteria

MINING LEASE CONDITION	RELINQUISHMENT CRITERIA
The Lessee shall at all times cause all steps and things to be taken and done to prevent mineralised or impure water or sludge or mining debris resulting from mining operations within the lease boundary from unlawfully polluting, obstructing, damaging or interfering with any water course, lake, reservoir or land.	Surface water discharges should meet ANZECC Livestock watering guidelines or 115% of background surface water quality. Groundwater quality in the Slaughteryard Creek area must maintain existing water quality as measured during the 1990-93 monitoring period.
The Lessee shall grade or contour the mined area, overburden and waste rock dumps progressively so that: <ul style="list-style-type: none"> Final voids are landscaped to meet best practical landuse. Rock and overburden dumps are contoured to conform as is practicable to the adjoining landforms in terms of slopes and slope lengths. All disturbed areas are stabilised against the natural forces of erosion. 	Pit Lake water quality and that of the groundwater in the immediate vicinity of the pits does not need to meet any set criteria. Landform surface stability and infiltration should be trending towards that which is measured at control sites. The integrity of waste dump slope banks and troughs will be maintained. Erosion gullies and rills will not exceed 300 mm in depth.
All re-shaped and contoured areas should be covered with top soil or an appropriate regrowth medium. Measures should be taken to stabilize the area sufficiently to ensure the regrowth of vegetation during the term of the lease.	The capture and decomposition of leaf litter is occurring. Vegetation structural complexity, compositional complexity and habitat complexity are trending towards control sites.
Any overburden or waste rock dumps that react with water to produce substances toxic to animal or plant life should be covered by an approved layer of inert material.	Potentially Acid Producing material will be classified >0.25% The clay fill capping layer on a dump surface should be 600mm thick and have a permeability <10 ⁻⁸ m/s The clay fill capping layer on a dump slope should be 450mm thick and have a permeability <10 ⁻⁸ m/s Rock fill surface protection layers should have a thickness of 400 mm.
All fences on the lease shall be kept intact during the period of the lease.	
The Lessee shall maintain the lease area in a tidy state and prior to the termination of the lease remove all machinery and plant unless otherwise approved.	

Any EA issued by the EPA resulting from lodgement of this EMP will supersede the above conditions except in the case where they are Mining Lease conditions.

3.5 PROPOSED RECLAMATION ACTIVITIES

It is proposed that once the EA has been issued that a Plan of Operations be developed. The scope of the activities to be addressed in the Plan of Operations will include:

- Soil investigative work at the Content Waste Rock Dump and hardstand sites and further remediation and reclamation work at these areas as determined by the investigative work.

Rel

- Additional hydrogeological investigations/monitoring to confirm the conceptual hydrogeological model (Section 4.3.3) including the installation of additional monitoring bores..
- Restrict access to all pit lakes via the existing pit ramps.
- Ensure that all mine pit abandonment bunds provide adequate long term safety with regard to unauthorised access to the mine pit lakes.
- Negotiate the future land use of Golden Butterfly North Pit.
- Continue reclamation performance monitoring until such time as recovery trends can be adequately confirmed as complying with the relinquishment criteria.

4 ENVIRONMENTAL VALUES AND POTENTIAL IMPACTS

4.1 GENERAL

4.1.1 Proposed EA conditions

Financial assurance

- (A1-1) Provide a financial assurance in the amount and form required by the administering authority prior to the commencement of activities proposed under this environmental authority.
- (A1-2) The financial assurance is to remain in force until the administering authority is satisfied that no claim on the assurance is likely.

Maintenance of reclamation measures, plant and equipment

- (A2-1) The environmental authority holder must:
 - install measures, plant and equipment necessary to achieve compliance with the conditions of this environmental authority;
 - maintain such measures, plant and equipment in a proper condition;
 - operate such measures, plant and equipment in a proper manner; and
 - undertake regular inspections to maintain the measures, plant and equipment.

Monitoring

- (A3-1) Record, compile and keep for a minimum of five years all monitoring results required by this environmental authority and make available for inspection all or any of these records upon request by the administering authority.
- (A3-2) Where monitoring is a requirement of this environmental authority, ensure that a competent person(s) conducts all monitoring.

Storage and handling of flammable and combustible liquids

- (A4-1) Spillage of all flammable and combustible liquids must be contained within an on-site containment system and controlled in a manner that prevents environmental harm (other than trivial harm) and maintained in accordance with Section 5.9 of AS 1940 Storage and Handling of Flammable and Combustible Liquids of 1993.

Definitions

- (A5-1) Words and phrases used throughout this EA are defined in Attachment A – Definitions. Where a definition for a term used in this EA is sought and the term is not defined within this EA, the definitions in the *Environmental Protection Act, 1994*, its Regulations and Environmental Protection Policies must be used.

Mine Completion Criteria

- (A6-1) The current Croydon Mine Completion Criteria will be the version of the Criteria which the Administering Authority has notified Barrick in writing as being the current Croydon Mine Completion Criteria.

The Mine Completion Criteria are provided in Appendix C.

4.2 AIR

4.2.1 Environmental Value

The local air shed is of high quality and dust deposition rates are seasonally influenced with sustained wet and dry rainfall periods. The air environment is typical for that of a remote Gulf Country rural pastoral district.

4.2.2 Potential adverse / beneficial impacts

Air management is no longer considered a key issue as all mining activity has ceased. If any further reclamation work requiring earthworks is necessary this will be restricted to the Mining Lease area and be of very short duration. As such issues associated with odour or air borne contaminants should have no significant impact on regional air quality.

The site has been successfully re-vegetated and there is little evidence of wind erosion on/off any of the landforms.

4.2.3 Environmental protection commitments

To maintain adequate vegetation cover on all rehabilitated areas thereby minimizing wind erosion and production of excessive dust.

Any civil works that may be required as part of the reclamation programme will include dust suppression measures.

4.2.4 Proposed EA Conditions

- (B 1-1)** When requested by the administering authority, dust and particulate monitoring must be undertaken within a reasonable and practicable timeframe nominated by the administering authority to investigate any complaint (which is neither frivolous nor vexatious nor based on mistaken belief in the opinion of the authorised officer) of environmental nuisance at any sensitive or commercial place, and the results must be notified within 14 days to the administering authority following completion of monitoring.
- (B 1-2)** Exceedance in dust deposition of 120 milligrams per square metre per day, averaged over one month, when monitored in accordance with AS 3580.10.1 Methods for sampling and analysis of ambient air - Determination of particulates - Deposited matter - Gravimetric method of 1991 will necessitate management measures. This will involve immediate implementation of dust abatement measures so that emissions of dust from the activity does not result in further environmental nuisance.

4.3 WATER

4.3.1 Environmental Value

Surface Water

The highly seasonal nature of the rainfall means that all local creeks are ephemeral and the only permanent source of surface water on the Mining Lease, excluding the pit lakes is within the borrow pit located on Belmore Creek to the west of the Content Pit mining area. There is no hydrological flow gauging record for the Mining Lease area, but it is considered that runoff in local creeks and drainage lines ceases relatively soon after storm events. The relatively flat nature of much of the Mining Lease means that sheet flow is the dominant hydrological process during the short wet season.

The Mining Lease contains no springs or groundwater supported surface drainage features. Seasonal surface water runoff from the Mining Lease area does contribute some inflow to the surface water storage at Belmore Creek borrow pit, although the majority of the dam's catchment falls outside of the Mining Lease. In the south the "Golden Butterfly" drainage/creek contributes some flow to Slaughteryard Creek, but represents a relatively minor tributary to this drainage system. A small earth farm dam captures some local surface runoff to the immediate north of Golden Butterfly pit. Water quality in this dam is good and complies with ANZECC (2000) Stock Water Drinking Quality (Site SW4 in Table 4.1).

A surface water monitoring network was established in 1996 and is illustrated in Schedule I Map 1. A summary of surface water quality monitoring results for 2005 to 2006 is provided in Table 4.1 and a complete set of surface water monitoring is provided in Appendix D. Surface water monitoring results since the 2005/06 wet season show that all surface drainage from the Mining Lease is of a good quality and well within the ANZECC (2000) Stock Water Drinking Quality guidelines. The only area of concern is drainage in the area to the west-northwest of Content Waste Rock Dump. Drainage from this area is captured in a sediment (trap) dam in the north-west corner of the Mining Lease. Site SW5 in this sediment dam indicates acidic waters containing some metals. The water is however controlled within the Mining Lease boundary and monitoring at site SW6 indicates that the down stream stock watering point at Belmore Borrow Pit remains unaffected.

Groundwater

It is expected that the area covered by the Mining Lease is a "hardrock" geological terrain with groundwater hosted in the upper weathered rock horizon and deeper fractured rock aquifers associated with the mineral deposit. This is supported by the limited use of groundwater in the surrounding region for stockwatering. The aquifers are therefore not considered a potential resource. Groundwater quality is expected to reflect the mineralised nature of the country rock and bore yields are likely to be highly erratic due to the expected lack of hydrogeological interconnectivity between fractures. Regional groundwater levels are believed to be some 15m below ground surface and any groundwater exploration would have to target geological structures.

The only known use of groundwater in the surrounding area is the decommissioned Town Borefield located some 2km to the south-west of the Mining Lease. The Town Borefield which is likely to exploit an unconfined alluvial aquifer located along Slaughteryard Creek was decommissioned in 1995 when Lake Belmore was constructed as the permanent town water supply. Anecdotal evidence suggests that the groundwater quality in this aquifer is fresh but that bore yields are likely to be relatively low and highly dependent on local aquifer recharge within the creek sands.

A conceptual hydrogeological model has been developed for the Croydon Mining Lease area and surrounds (Figure 4.1). The conceptual hydrogeological model is based on currently available hydrogeological and groundwater quality information. A brief description of the conceptual groundwater model is provided below.

Fractured Rock Aquifers

Groundwater monitoring and pit lake recovery trends support the hypothesis that the deeper fractured rock aquifers are highly variable in water quality and have limited connectivity. Figure 4.1 shows the conceptualised hydrogeology in the Golden Butterfly Pit area. Groundwater levels on either side of the pit differ by up to 14 m (HLA-Envirosciences, 2001) and water qualities differ significantly (Bores BH1 and BH2 in Table 4.2). It is suggested, based on the available water quality data (Tables 4.2 and 4.4), that a major geological contact exists between bores GBMB2 and GBMB3 (Figure 4.1 and Schedule I, Map 1). This is borne out by the geology and totally different water quality found in Golden Butterfly North Pit (Table 4.3). Groundwater quality differences in Bores BH5, 6 & 7 (Table 4.2) illustrate the lack of interconnectivity between aquifers less than 20m apart. A summary of groundwater monitoring data is included in Appendix D.

All four pits (i.e. Golden Butterfly, Golden Butterfly North, Content and Lady Isabella) now contain pit lakes largely as a result of groundwater inflow at depth from expected fractured rock aquifers. Table 4-3 provides a summary of the water quality in the pit lakes. The differing pit water qualities reflect country rock geology and varying mineralisation within the ore deposit through which the groundwater is moving prior to entering the pits.

A hydrogeological study by HLA-Envirosciences (2001) showed that historic rainfall and evaporation data indicate a relatively large deficit (due to the short wet season and high evaporation during most of the year) and that even in the wettest years there is no risk of the pit lakes overflowing (Appendix E). A simple water balance indicates that the pit lakes are expected to act as groundwater sinks and have limited capacity to influence groundwater quality much beyond the immediate footprint of the pit. Water quality monitoring results support this with a change in water quality occurring with increased distance from the Golden Butterfly Pit (refer to water quality data in Tables 4.2 and 4.4).

Table 4.1
Surface Water Quality (2005 to 2006¹)

Parameter	Sample Site													
	SW1 [Lower Slaughteryard Ck]		SW2 [Slaughteryard Ck Tributary]		SW3 [Slaughteryard Ck Reference]		SW3a [Golden Butterfly WRD]		SW4 [stock water dam]		SW5 [NW sediment dam]		SW6 [Belmore Borrow Pit]	
	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
pH (pH units)	6.7	6.7	6.7	6.7	6.3	6.3	7.1 – 7.3	7.2	7.3 – 8.4	7.9	4.7 – 5.9	5.3	6.6 – 8.8	7.7
EC ($\mu\text{S}/\text{cm}$)	250 – 610	440	120 – 270	181	79 – 450	192	120 – 450	285	65 – 770	234	60 – 1,400	510	32 – 480	146
S04 (mg/L)	44 – 100	69	13 – 67	47	13 – 140	34	13 – 140	34	13 – 150	43	18 – 810	235	<2 – 22	17
Cu (mg/L)	<0.01 – 0.02	0.01*	<0.01 – 0.02	0.01*	<0.01 – 0.02	0.01	<0.01 – 0.01	0.01*	<0.01 – 0.10	0.01*	0.01 – 2.50	1.10*	<0.01 – 0.01	<0.01*
Pb (mg/L)	<0.002 – 0.002	<0.002*	<0.002 – 0.004	<0.002*	<0.0002 – 0.004	<0.002*	<0.002 – 0.004	0.004*	<0.002 – 0.011	<0.002*	<0.002 – 0.006	<0.002*	<0.002 – 0.009	0.004
Ni (mg/L)	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05 – 0.12	<0.05*	<0.05 – 1.00	0.11	<0.05	<0.05*
Al (mg/L)	0.09 – 2.30	0.76	0.14 – 2.80	0.92	0.10 – 3.50	0.77	1.4	1.4	0.12 – 11.00	1.63	0.60 – 77.00	17.21	0.74 – 27.00	6.51
Zn (mg/L)	0.008 – 0.068	0.032	0.007 – 0.070	0.044	0.005 – 0.170	0.035	0.019 – 0.021	0.020	<0.005 – 0.650	0.016*	0.011 – 6.000	1.640	<0.005 – 0.033	0.013*
Co (mg/L)	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	-	-	<0.05	<0.05*	0.17 – 0.44	0.32	<0.05	<0.05*
Cd (mg/L)	<0.0002 – <0.0005	<0.0002*	<0.0002 – 0.0002	<0.0002*	<0.0002 – 0.0003	<0.0002*	<0.0002 – 0.0002	0.0002*	<0.0002 – 0.0290	<0.0002*	<0.0002 – 0.2400	0.0083*	<0.0002	<0.0002*
Fe (mg/L)	0.33 – 0.78	0.50	0.27 – 0.78	0.53	0.73 – 5.20	1.89	0.33 – 1.20	0.77	0.12 – 5.10	1.09	0.08 – 1.90	0.54	0.39 – 2.70	1.51
Mn (mg/L)	<0.05 – 0.24	<0.05*	<0.05 – 0.14	0.05*	<0.05 – 1.90	<0.05*	<0.05 – 0.07	0.07*	<0.05 – 2.30	<0.05*	<0.05 – 10.00	3.10*	<0.05 – 0.10	<0.05*
As (mg/L)	<0.005 – 0.015	0.009*	<0.005 – 0.035	0.020*	<0.005 – 0.069	0.007*	0.005 – 0.012	0.009	<0.005 – 0.026	0.011*	<0.005 – 0.020	<0.005*	<0.005	<0.005*

¹ Sampling period after major reclamation works were conducted.

* Median

Source: Landline Consulting (2005 and 2006) and HLA-Envirosciences (2001).

Table 4.2
Groundwater Quality – Confined Fractured Rock Aquifer

Parameter	Sample Site																	
	BH1		BH2		BH3		BH4		BH5		BH6		BH7		GBMB1		GBMB2	
	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average	Range	Average
pH (pH units)	6.9 – 7.9	7.3	3.1 – 4.2	3.5	5.5 – 7.2	6.4	7.0 – 8.6	7.5	7.4 – 7.8	7.6	6.9 – 7.4	7.1	6.0 – 7.4	6.6	6.3 – 7.8	6.7	6.8 – 7.8	6.7
EC (µS/cm)	985 – 1,500	1,257	740 – 1,300	1,047	110 – 3,000	579	4,800 – 5,800	5,233	4,900 – 5,600	5,233	760 – 2,200	1,160	6,000 – 8,700	7,356	160 – 1045	726	260 – 4,000	2,285
SO ₄ (mg/L)	310 – 540	454	260 – 850	466	20 – 990	173	1,200 – 1,800	1,483	1,400 – 2,000	1,717	120 – 530	238	350 – 2,600	1,930	36 – 260	197	180 – 820	682
Cu (mg/L)	<0.01 – 0.01	<0.05*	<0.01 – 0.05	<0.05*	<0.01 – 0.01	<0.05*	<0.01 – 0.05	<0.01*	<0.01 – 0.01	<0.01	<0.01 – 0.02	0.01*	<0.01 – 0.01	<0.05*	<0.01 – 0.15	<0.05*	<0.01 – <0.05	<0.05*
Pb (mg/L)	<0.002 – 0.080	<0.05*	<0.05 – 0.4000	0.040*	<0.002 – 0.072	<0.05*	<0.002 – 0.006	<0.002*	<0.002 – <0.02	<0.0002*	<0.002 – 0.015	0.004*	<0.002 – 0.056	<0.005*	<0.002 – 1.400	0.008*	<0.001 – 0.300	<0.05*
Ni (mg/L)	<0.05	<0.05*	<0.05 – 0.09	0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*
Al (mg/L)	<0.05	<0.05*	1.40 – 2.60	1.90*	0.07 – 2.10	0.86	<0.05 – 0.37	0.05*	<0.05 – 0.29	0.06*	0.14 – 6.60	1.94	<0.05 – 0.16	<0.05*	<0.05 – 0.09	<0.05*	<0.05 – 0.21	<0.05*
Zn (mg/L)	<0.05 – 0.100	0.030*	0.230 – 0.510	0.340	<0.005 – 0.09	0.006*	0.008 – 0.040	0.020	<0.005 – 0.015	0.012*	0.005 – 0.029	0.016*	<0.05 – 0.160	0.040*	<0.05 – 0.240	0.019*	<0.05 – 0.280	0.028*
Co (mg/L)	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*
Cd (mg/L)	<0.0002 – 0.0008	<0.0002*	<0.0005 – 0.0028	0.0007*	<0.0002 – 0.0009	<0.0002*	<0.0002 – 0.0003	<0.0002*	<0.0002 – 0.0002	<0.0002*	<0.0002 – 0.0002	<0.0002*	<0.002 – 0.0020	0.0005*	<0.0002 – 0.0091	0.0013*	<0.0002 – 0.0082	<0.0002*
Fe (mg/L)	<0.05 – 3.20	0.09*	<0.05 – 27.00	1.30*	<0.05 – 1.75	0.26*	<0.05	<0.05*	<0.05	<0.05*	0.06 – 3.10	1.16*	<0.05 – 0.82	<0.05*	<0.05 – 11.00	1.40*	<0.05 – 2.8	0.075*
Mn (mg/L)	<0.05 – 0.11	0.05*	0.95 – 1.20	1.05	<0.005 – <0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05 – 0.68	<0.05*	<0.05 – 0.08	<0.05*	0.26 – 1.8	1.36	<0.05 – 1.5	0.83*
As (mg/L)	<0.02 – 0.080	0.020*	<0.005 – 0.120	<0.005*	<0.005 – 0.030	<0.02*	<0.005 – <0.05	<0.005*	<0.005 – 0.006	0.006*	0.013 – 0.048	0.027	<0.005 – 0.100	<0.02*	<0.005 – 0.034	0.009*	<0.005 – 0.023	<0.005*

* Median

Source: Landline Consulting (2005 and 2006) and HLA-Envirosciences (2001).

Table 4.3
Pit Lake Water Quality

Parameter	Sample Site							
	Golden Butterfly		Golden Butterfly North		Content		Lady Isabella	
	Range	Average	Range	Average	Range	Average	Range	Average
pH (pH units)	2.1 – 3.4	2.4	5.8 – 8.3	7.4	2.9 – 4.2	3.3	3.2 – 4.3	3.5
EC (µS/cm)	4,500 – 7,500	6,396	220 – 360	272	1,200 – 1,900	1,426	650 – 1,300	917
SO₄ (mg/L)	670 – 8,400	6,386	39 – 90	63	520 – 1,000	710	270 – 680	448
Cu (mg/L)	14.00 – 35.00	25.00	<0.01 – 0.11	<0.05*	0.09 – 0.93	0.42	0.70 – 1.70	1.10
Pb (mg/L)	<0.002 – 0.003	<0.005*	<0.001 – 8.300	<0.002*	<0.001 – 0.003	<0.002*	<0.005 – 0.005	0.003*
Ni (mg/L)	3.40 – 8.70	6.90	<0.005 – 0.07	<0.05*	0.23 – 0.59	0.36	0.29 – 0.77	0.51
Al (mg/L)	0.48 – 700.00	490.00	0.08 – 0.73	0.25	2.9 – 6.2	5.1	11 – 20	15
Zn (mg/L)	12 – 51	26	<0.005 – 0.220	<0.05*	0.75 – 1.90	1.20	2.3 – 6.9	4.0
Co (mg/L)	4.00 – 4.40	4.20	<0.01 – <0.05	<0.05*	0.21 – 0.23	0.22	0.33 – 0.34	0.34
Cd (mg/L)	0.1600 – 0.6000	0.27	<0.0002 – 0.0087	<0.0002*	0.0028 – 0.0450	0.0160	0.0110 – 0.3650	0.1300
Fe (mg/L)	67.00 – 1,100.00	576.00	<0.05 – 820	<0.05*	0.69 – 6.60	2.37	0.06 – 1.30	0.34
Mn (mg/L)	7.8 – 140.0	73.0	<0.05 – 820.0	<0.05*	3.3 – 6.2	4.4	2.4 – 52.0	5.7
As (mg/L)	0.34 – 48.00	3.20	<0.005 – 0.04	<0.02	<0.01 – 0.23	0.03*	<0.005 – 0.01	<0.02*

* Median

Source: Landline Consulting (2005 and 2006) and HLA-Envirosciences (2001).

Table 4.4
Groundwater Quality – Unconfined Alluvial Aquifer

Parameter	Sample Site							
	GBMB3		GBMB4		GBMB5		GBMB6	
	Range	Average	Range	Average	Range	Average	Range	Average
pH (pH units)	5.2 – 6.4	5.9	5.4 – 7.1	6.0	5.2 – 7.8	5.9	5.2 – 7.1	5.9
EC (µS/cm)	38 – 160	85	185 – 520	284	68 – 490	96	66 – 580	120
SO₄ (mg/L)	2 – 27	8	17 – 43	32	<2 – 13	2	<0.05 – 20	3.5
Cu (mg/L)	<0.0002 – 0.01	<0.05*	<0.01 – <0.05	<0.05*	<0.01 – <0.05	<0.05*	<0.01 – 0.01	<0.01*
Pb (mg/L)	<0.05 – 0.28	0.005	<0.001 – 0.300	<0.05*	<0.001 – 0.100	<0.05*	<0.001 – 0.049	<0.05*
Ni (mg/L)	<0.05 – 0.09	<0.05*	<0.05 – 0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*
Al (mg/L)	0.29 – 4.8	2	<0.05 – 0.29	<0.05*	<0.05 – 0.05	<0.05*	<0.05 – 0.69	<0.05*
Zn (mg/L)	<0.05 – 0.19	0.07*	<0.05 – 0.63	0.08*	<0.05 – 0.41	0.08*	<0.005 – 0.37	0.05*
Co (mg/L)	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*	<0.05	<0.05*
Cd (mg/L)	<0.0002 – 0.0080	<0.0002*	<0.0002 – 0.0042	<0.0002*	<0.0002 – 0.0029	<0.0002*	<0.0002 – 0.0420	<0.0002*
Fe (mg/L)	<0.01 – 8.00	2.20*	<0.05 – 6.60	<0.05*	<0.05 – 0.65	<0.05*	<0.01 – 30.00	<0.05*
Mn (mg/L)	<0.05 – 0.28	0.005*	<0.05 – 0.05	<0.05*	<0.05 – 0.26	<0.05*	<0.002 – 0.37	0.05*
As (mg/L)	<0.005 – 7.000	0.008*	<0.005 – 0.020	<0.005*	<0.005 – 0.091	<0.005*	<0.005 – 0.150	<0.01*

* Median

Source: Landline Consulting (2005 and 2006) and HLA-Envirosciences (2001).

Unconfined Alluvial Aquifer – Slaughteryard Creek

The Slaughteryard Creek unconfined alluvial aquifer previously exploited by the original Croydon town water supply borefield is located off the Mining Lease and some 2km from the Golden Butterfly Pit (Figure 4.1). Although there are no bore logs for the town borefield, it is believed that it utilised the shallow unconfined alluvial aquifer associated with Slaughteryard Creek. It is expected that the unconfined alluvial aquifer is locally recharged by surface water flow within the creek. As previously stated the surface water recharge component that can be attributed to the Mining Lease catchment is relatively small and any hydrogeological linkage to the Golden Butterfly Pit lake most unlikely. This has been confirmed by groundwater monitoring over the past 10 years (Tables 4.2, 4.3 & 4.4).

4.3.2 Potential adverse / beneficial impacts

Surface Water

Potential sources of contamination that could impact on local surface resources includes seepage and possible leaching of salts and AMD from waste rock dumps and original hardstand areas.

Table 4-1 summarises surface water quality at the surface water monitoring sites. Improvement of water quality over time suggests that any earlier surface water contamination that may have occurred in the Slaughteryard Creek catchment has been rectified. During the 1990's Goldfields dealt with contaminant source areas and in addition removed contaminated sediments within downstream drainage lines.

However monitoring point SW5 (Figure Schedule I Map 1), located in a sediment dam on the north-western Mining Lease boundary, has shown low pH and raised levels of sulphate and metals. The source of this contamination is likely the Content hardstand to the immediate west of Content Waste Rock Dump. An initial inspection of the area (in late 2006) suggested that although the northern end of the Content Waste Rock Dump suffered some surface ponding and gully formation along the dump crest, there appeared little evidence of leaching or seepage from the Content Waste Rock Dump. The accumulation of salts to the immediate west of the Content Waste Rock Dump appears to be linked to the original Content hardstand area, however this will require further investigative work for confirmation. During mining operations this area was in-filled with waste rock to form a level platform on which a crushing plant was located and ore stockpiled.

A total of 44,950 m³ of material was removed from this site during the 1996 reclamation work (Fawcett, 2001). It would however appear that material was only excavated to the original ground surface and that a level of residual contamination may occur in the underlying subsurface material. The area now forms a slight depression in the local topography and during the wet season a degree of ponding occurs which with evaporation may result in surface salting. The ponding effect is exacerbated by a number of old drainage bunds that have been constructed to divert surface runoff towards the sediment dam. This area will be investigated and remediation and rehabilitation completed. In order to minimise environmental risk it may be found necessary to construct a subsurface drain that discharges into Content Pit. As part of this investigative works at least three (3) new shallow monitoring bores will be installed in this area once reclamation is completed. These works are described in Section 4.3.3.

Inspection of Golden Butterfly Waste Rock Dump foot trench and monitoring bores indicates that this waste rock dump is not causing any adverse impacts on surface water quality (Landline Consulting, 2007).

Groundwater

The potential impact on local groundwater resources (i.e. surrounding aquifers) from water contained in the confined fractured rock aquifers and pit lakes is considered to be of minimal risk. This is due to the limited migration of pit water and groundwater contained in the confined fractured rock aquifers to surrounding aquifers. As described in Section 4.3.1, groundwater quality monitoring data from existing monitoring bores believed to be located in the unconfined alluvial aquifer (i.e. GBMB3 to GBMB6) indicate there is no evidence of movement of groundwater from the confined fractured rock aquifers to the unconfined alluvial aquifer (i.e. the aquifers are unlikely to be connected).

Mine Pit Lakes

Pit lakes are often considered as potential surface water resources by local landowners, construction companies/contractors and shire councils. The lakes are seen as storage receptors rather than potential environmental 'impactors'. This is particular true for Croydon where both Golden Butterfly North and Content pit lakes have been unofficially used as water supply sources.

All four pits at Croydon will remain groundwater sinks and as such may be expected to, over time, become more saline. Surface water inflow to the pits is restricted largely to direct precipitation with only Golden Butterfly North receiving any surface runoff from an adjacent subcatchment. The arid climatic conditions ensure that natural evapoconcentration within the pit lakes slowly increases salinity and this can only be countered by periodic flushing of the lakes with significant volumes of fresh water. It is therefore unlikely that the lake water quality in at least three of the pits (Content, Lady Isabella and Golden Butterfly) could be maintained at ANZECC (2000) Stock Water Drinking Quality.

4.3.3 Environmental protection commitments

The key objectives are to:

- Preserve the existing uses of local surface waters, both within the Mining Lease and at receiving water sites for stock watering purposes.
- Restrict use of the pit lakes to that of a wildlife habitat.

These objectives are based on the following considerations:

- Local surface water resources are currently used for stock watering purposes.
- The conceptual hydrogeological model outlined in Section 4.3.1.
- The pit lakes act as hydrogeological sinks and that slow salinisation occurs through natural evapoconcentration with limited diversion of surface water runoff into the pits to provide periodic flushing and adequate dilution to maintain water quality at ANZECC (2000) Stock Water Drinking Quality.
- The site has been monitored for ten years since the 1996/97 follow-up reclamation work. Water quality trends have been established and reclamation performance confirmed.

To achieve the above objectives Barrick commits to manage all mine generated landforms/structures such that seepage from and erosion of these landforms does not significantly impact on water resources deemed necessary to sustain post mining land use.

In addition to the above, Barrick commits to the following:

- Draining all excess surface runoff off Content Waste Rock Dump upper surface to the Content Pit
- Conducting a contaminated land investigation of the Content Hardstand area and, if required, appropriate remediation measures will be implemented.
- Conducting monitoring of the entire site in accordance with the EA conditions.
- Constructing additional monitoring bores to the west of Content Waste Rock Dump (BH10 and BH11) and between Golden Butterfly North Pit and the adjacent Golden Butterfly Waste Rock Dump (BH8 and BH9).
- Conducting additional investigations/monitoring to confirm the conceptual hydrogeological model described in Section 4.3.1, including:
 - Obtaining additional hydrogeological information (e.g. geological information, bore and pit water levels).
 - Investigating the existence of existing groundwater quality data from the town water supply bores.

- Installing an additional deep monitoring bore (SY1) between the Golden Butterfly Pit and Slaughteryard Creek to supplement the existing monitoring network.
- Surveying of pit lake water levels and erection of water level gauging stages.
- Including the latest information obtained from the additional hydrogeological investigations/monitoring in subsequent amendments to this EMP.
- Developing a site-wide Stormwater Management Plan (implemented as part of the Closure Plan).

Works associated with the above will be detailed in the Plan of Operations for the site.

4.3.4 Proposed EA Conditions

In order to achieve the water management objectives outlined above it is suggested that the following EA conditions be adopted:

- (C1-1)** Receiving waters affected by the release of stormwater runoff from mining landforms such as waste rock dumps and hardstand areas will be monitored at the locations and frequencies defined in the Croydon Mine Completion Criteria.
- (C1-2)** The holder of this environmental authority will comply with the receiving water quality guidelines defined in the Croydon Mine Completion Criteria.
- (C1-3)** All mine pit lakes (pit void receiving waters) will be monitored for water quality and water levels as per the locations and frequencies defined in the Croydon Mine Completion Criteria.
- (C1-4)** All water quality samples will be analyzed in a NATA registered laboratory for the range of parameters listed in the Croydon Mine Completion Criteria.
- (C2-1)** All groundwater monitoring sites will be sampled for water quality and measured for groundwater levels as defined in the Croydon Mine Completion Criteria.
- (C2-2)** The method of water sampling required by this environmental authority must comply with that set out in the latest edition of the Environmental Protection Agency's Water Quality Sampling Manual.
- (C2-3)** Monitoring bores will be constructed and surveyed as detailed in the Croydon Mine Completion Criteria.

4.4 NOISE AND VIBRATION

4.4.1 Environmental Value

Noise and vibration is not considered an issue on the Mining Lease as the Lessee is no longer active on the lease area.

4.4.2 Potential adverse / beneficial impacts

Mining activities on the Mining Lease area has long since ceased and the noise and vibration associated with maintenance and monitoring activities will not exceed the level of other activities in the surrounding Croydon Township.

4.4.3 Environmental protection commitments

None required.

4.4.4 Proposed EA Conditions

None proposed.

4.5 WASTE

4.5.1 Environmental Value

The Mining Lease area has been cleared of all mining related wastes that were introduced during the 1988 - 1993 mining operations. This includes all mine plant, fuels and containers. All wastes have been either removed from the Mining Lease or buried in designated landfills within the waste rock dumps. There is no visual evidence of waste materials having been indiscriminately dumped in mine pits.

4.5.2 Potential adverse / beneficial impacts

There will be little if any waste material introduced to the Mining Lease area during monitoring and reclamation activities. If at all, it would be classified as general litter.

4.5.3 Environmental protection commitments

Monitoring crews will remove any litter that they may introduce during their brief site visits. This material will be disposed of at the nearby Croydon refuse station.

4.5.4 Proposed EA Conditions

None proposed.

4.6 LAND MANAGEMENT

4.6.1 Environmental Value

The Mining Lease area lies just within the northern section of the Gulf Plains Bioregion and no regional ecosystem mapping is yet available for the area. The mix of tree and shrub species present on the Mining Lease area is similar to that found in adjacent regional ecosystems in the Einasleigh Upland Bioregion and most are widely distributed within the local area. The area has been continually disturbed for more than a century and it is most unlikely that any regional ecosystems of concern are to be found in the area. The conservation significance of the Mining Lease area in terms of biodiversity is considered to be low. The vegetation density and diversity over most of the Mining Lease area appears to be similar to other areas in the vicinity of Croydon Township. The dominant tree species is *Eucalyptus chartaboma*, with a sub dominant population of *Corymbia erythrophoia* and understorey layer of mainly *Acacia sp* (Landline Consultants, 2007).

The key environmental values that need to be considered are:

- The geotechnical stability of the landforms.
- Aesthetics (matching the surrounding environment).
- Safety risk relating to future landuse.

4.6.2 Potential adverse / beneficial impacts

The disturbance associated with mining has in the past adversely impacted on the ecosystems of the Mining Lease area. The area has however since been fully rehabilitated and the remaining mine related landforms offer an increased diversity of habitat for plants and wildlife. The area has a history of use for low intensity grazing and stock watering purposes.

The Golden Butterfly and Content Waste Rock Dump landforms have been re-profiled, surface drainage engineered and erosion control measures introduced to provide both long term stability and to ensure that the structures mimic the surrounding relief. Both waste dumps blend well into the local topography. The reclamation performance of Golden Butterfly and Content Waste Rock Dumps has been monitored for more than 10 years and except for a small section of Content Waste Rock Dump meets the current relinquishment criteria (Appendix B). The upper surface of the northern most end of Content Waste Rock Dump experiences a degree of ponding during high rainfall periods and exhibits some initial gully formation along the crest of the dump. This requires early intervention to avoid any significant long term erosion risk.

All four mine pits have perimeter earthen abandonment bunds and exclusion fencing has been erected to limit access by humans and domesticated animals. After ten years the mine pit walls remain intact as stable rock faces. Most mine benches that occur above the pit lake water level have naturally revegetated, providing additional stability. The surrounding land surface has been completely revegetated with the result that the pits are no longer visible from any public roads. The access ramps within the pits have been maintained as per the Mining Lease conditions (Appendix A). Notwithstanding local contractors appear to, from time to time, draw water from Content Pit. The Croydon Shire Council also regularly enters Golden Butterfly North Pit and maintains water pumps at the base of the access ramp.

The Croydon-Normanton Railway line lies in proximity to the Golden Butterfly North pit. Although fenced off there is clear evidence that this has become a tourist stop. It is proposed a more secure (diamond mesh) fence and additional signage be installed to prohibit any access beyond the existing Mining Lease boundary fence.

4.6.3 Environmental protection commitments

The following land management environmental protection objectives are proposed:

- Maintain and enhance where possible the diversity of natural habitats and land use in the area.
- Create post-mining landforms that are geotechnically and erosionally stable and consistent with the post mine land use.
- Minimise the potential for long-term land degradation.

To achieve these objectives Barrick commit to the following:

The land will be rehabilitated to re-establish a stable, sustainable ecosystem and beneficial land use in the area consistent with the proposed post mine land use of cattle grazing.

This commitment translates into the following:

- With the exception of the open pit voids all disturbed areas will be rehabilitated to a land use that can support low intensity grazing or bushland.
- Detail the management of the Golden Butterfly Waste Rock Dump in a site-wide Stormwater Management Plan (implemented as part of an overall Closure Plan).
- Undertake contaminated land assessment/investigation into the Content Waste Rock Dump and Content hardstand area. Contingent on the findings of the contaminated land assessment/investigation, a monitoring piezometer may be installed adjacent the Content Waste Rock Dump.
- Drain the surface of the Content Waste Rock Dump to Content Pit and fill low-lying areas on the Content Waste Rock Dump.

- All slopes once battered will be covered with a regrowth medium and where necessary rock mulch such that it will support vegetation regrowth and limit erosion.
- Import additional regrowth medium to the Content Waste Rock Dump to potentially improve revegetation.
- Revegetation of remaining disturbed areas will be completed across the site where monitoring indicates vegetation vigour is inadequate. This will further enhance the ecological amenity of the site through the production of natural habitat and grazing lands.
- Ground cover will be maintained by controlling grazing and the soil fertility status. This will entail the maintenance of Mining Lease boundary fences and gates in good order to control stock access, monitoring of soil fertility and implementation of weed control measures on an ongoing basis.
- Continue monitoring vegetation status at existing transects (Schedule I – Map 3) on rock dumps and install new vegetation transects on general disturbance areas of the Mining Lease. Monitor in early dry season.
- Revegetation monitoring to include groundcover, species composition, tree cover and tree height.
- Undertake a weed survey and implement any identified necessary controls.
- Install fencing and signage to prevent access to the Golden Butterfly North Pit from the railway line. In addition the perimeter earthen abandonment bund will be relocated back from the Golden Butterfly North Pit.
- Maintain existing mine pit perimeter fences and gates in good order to control unauthorized human entry and stock access.
- A contaminated land site investigation and, if required, remediation will be conducted in accordance with the *Draft Guidelines for the Assessment and Management of Contaminated Land* (EPA, 1998).

4.6.4 Proposed EA Conditions

In order to achieve the land management environmental protection objectives outlined in the previous section it is suggested that the following EA's be adopted:

- (F1-1) All surface areas significantly disturbed by mining activities will be rehabilitated in accordance with the Croydon Mine Completion Criteria.
- (F1-2) All infrastructure, linked to mining or reclamation activities, must be removed from the site prior to mining lease surrender, except where agreed to in writing by the post mining land owner/holder.
- (F1-3) Residual voids should not cause any serious environmental harm to land, surface waters or any recognized groundwater aquifer, other than the environmental harm constituted by the existence of the residual void itself and subject to any other condition within this environmental authority.
- (F1-4) All reasonable and practicable erosion protection measures and sediment control procedures must be implemented and maintained to minimize erosion and the release of sediment.
- (F1-5) Annual monitoring of vegetation status on all rehabilitated mine landforms as per the transects listed in Schedule I – Map 3. Monitoring to take place early in the dry season.

4.7 COMMUNITY

4.7.1 Environmental Value

The Mining Lease adjoins the town of Croydon and is considered an integral part of the town surrounds. Available mapping data show a number of roads, town blocks and a block of freehold aboriginal land within the boundaries of the Mining Lease area. No residences have been constructed on this land so an ownership search of these blocks was required to ensure that all stakeholders were identified and consulted about management of the area. The Croydon-Normanton Road also passes through the southern end of the Mining Lease area.

The entire Mining Lease area has been used for grazing since the early settlement of the area. The south-eastern portion of the Mining Lease (Lot 1 Ap5928) is part of the Croydon Town Common and has been grazed heavily for many years.

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Tourism at the site is associated with the historic mining artefacts that remain on the site. The Mining Lease area, like the entire Croydon District, contains items of mining heritage value. Most of the old excavations within the Mining Lease area have been impacted by more recent mining, but there are items of old mining equipment located at the eastern and western ends of the Mining Lease. The Croydon Shire Council has walking tracks and signage to the major heritage items close to the town, at the eastern end of the Mining Lease. The original Content mine at the western boundary of the Mining Lease was operated from 1896 to 1917 and is listed in the Queensland Heritage Register.

A water tower and associated pipelines that for many years formed part of the town water supply is located just outside the Mining Lease, to the east of the Golden Butterfly pit. This infrastructure was used when water was pumped from town bores along Slaughteryard Creek, downstream from the Mining Lease area. This borefield was decommissioned with the introduction of Belmore Dam as the town water supply. In late 2005, however, water levels in Belmore Dam dropped to such an extent that Croydon Shire Council commenced drawing town water supplies from the Golden Butterfly North Pit. This continued until good rains occurred in March 2006.

4.7.2 Potential adverse / beneficial impacts

The Mining Lease area has potential to enhance the lifestyle and economic well being of the community. Benefits may include: the existence of mining heritage items on the site; potential for low intensity grazing; and increased wildlife habitat.

The issue of potential contamination of the surrounding environment has been addressed in previous sections of this EMP.

There will always be a degree of public safety risk in the vicinity of the open cut pits. Most of these can be managed through bunding and restricting access with fencing. It is also proposed that all access to pit lakes be denied by decommissioning of the pit access ramps. The pit lakes are not visible from any of the public roads and will become secluded wildlife habitats.

The Croydon-Normanton Railway line lies in proximity to the Golden Butterfly North pit. Although fenced off there is clear evidence that this has become a tourist stop. It is proposed a more secure (diamond mesh) fence and additional signage be installed to prohibit any access beyond the fence.

There are a number of historic mine shafts and adits within the Mining Lease area which are not individually listed in the MINOCC database. The GPS locations of these have been recorded as and when discovered. Appropriate management measures to minimise their risk to public safety is proposed. All known significant mining heritage items within the Mining Lease are in locations where they will not be affected by further reclamation works. The mining equipment at the eastern end of the Mining Lease is afforded some level of protection due to its close proximity to the town.

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4.7.3 Environmental protection commitments

Barrick commit to enter and maintain consultation with local and state governments and local landholders with a view to maximizing the potential community benefit from the Mining Lease and sustainable land use for the area following lease relinquishment.

This will include:

- Cooperation with the State Government and Croydon Shire Council to undertake any actions deemed necessary to protect significant cultural heritage items within the Mining Lease boundaries. GPS details of any historic mine shafts and adits within the Mining Lease area will be provided for inclusion in the MINOCC database.
- Implementing all necessary safety measures to deny human and stock access to the mine pits prior to relinquishment.
- Install fencing and signage to prevent access to the Golden Butterfly North Pit from the railway line. In addition the perimeter earthen abandonment bund will be relocated back from the Golden Butterfly North Pit.
- Development of a grazing management plan.
- Implementing and maintaining a complaints handling register to respond to (and investigate if required) any formal complaints received from the community. Any such complaints will be reported to both EPA and Croydon Shire Council.

4.7.4 Proposed EA Conditions

- (G1-1)** All complaints received must be recorded including details of complainant, reasons for the complaint, investigations undertaken, conclusions formed and actions taken. This information must be made available for inspection by the administering authority on request.
- (G1-2)** A 4-strand barbed wire fence and locked gate will be maintained surrounding all open cut pits. Adequate signage will be placed on all fences warning the public not to enter the enclosed area.

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FIGURES

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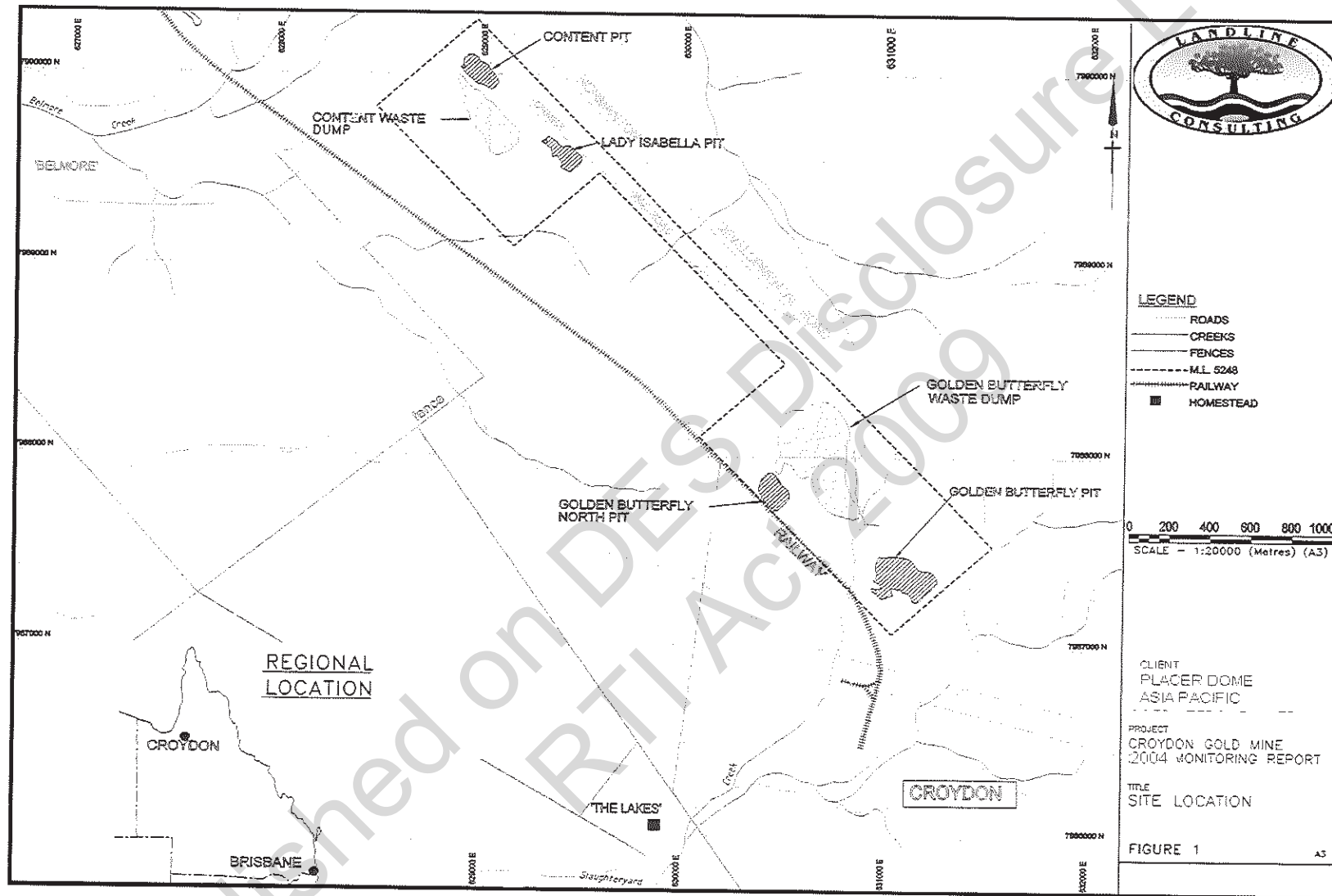
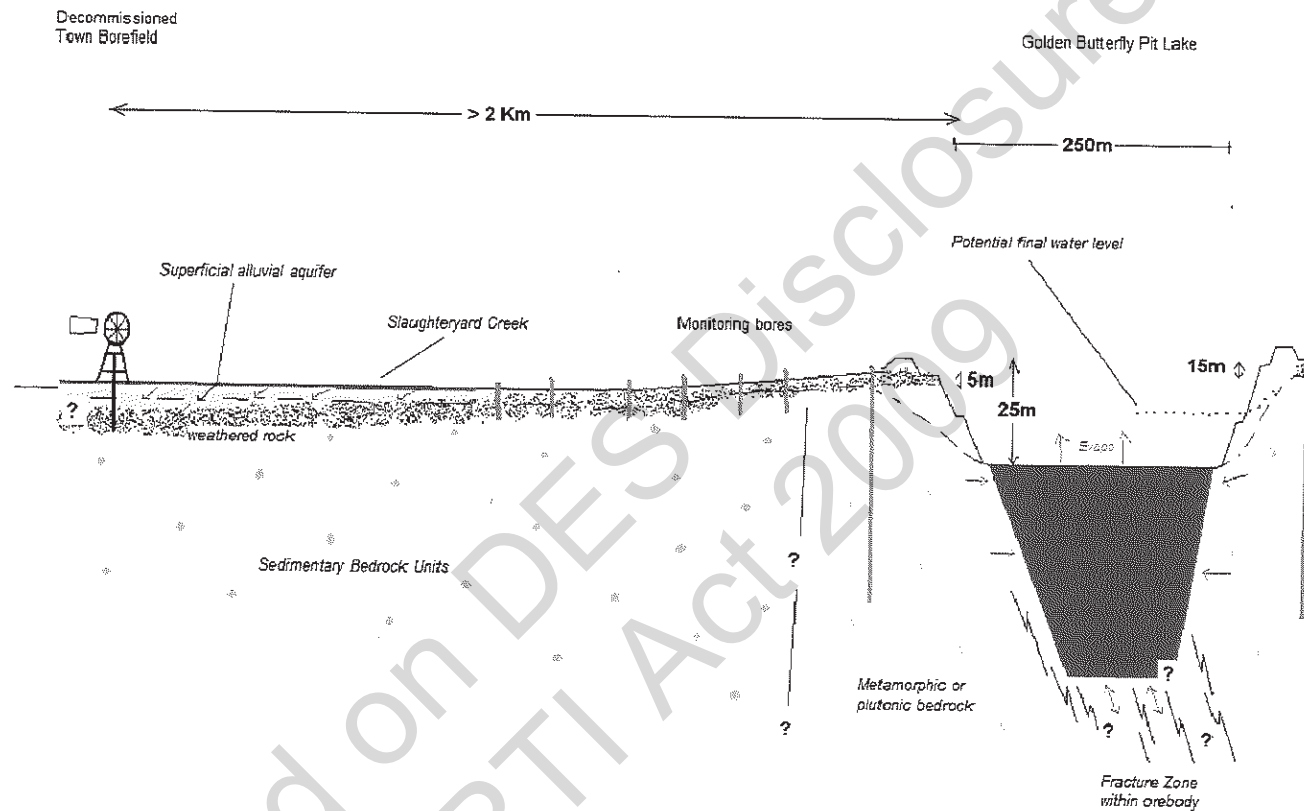


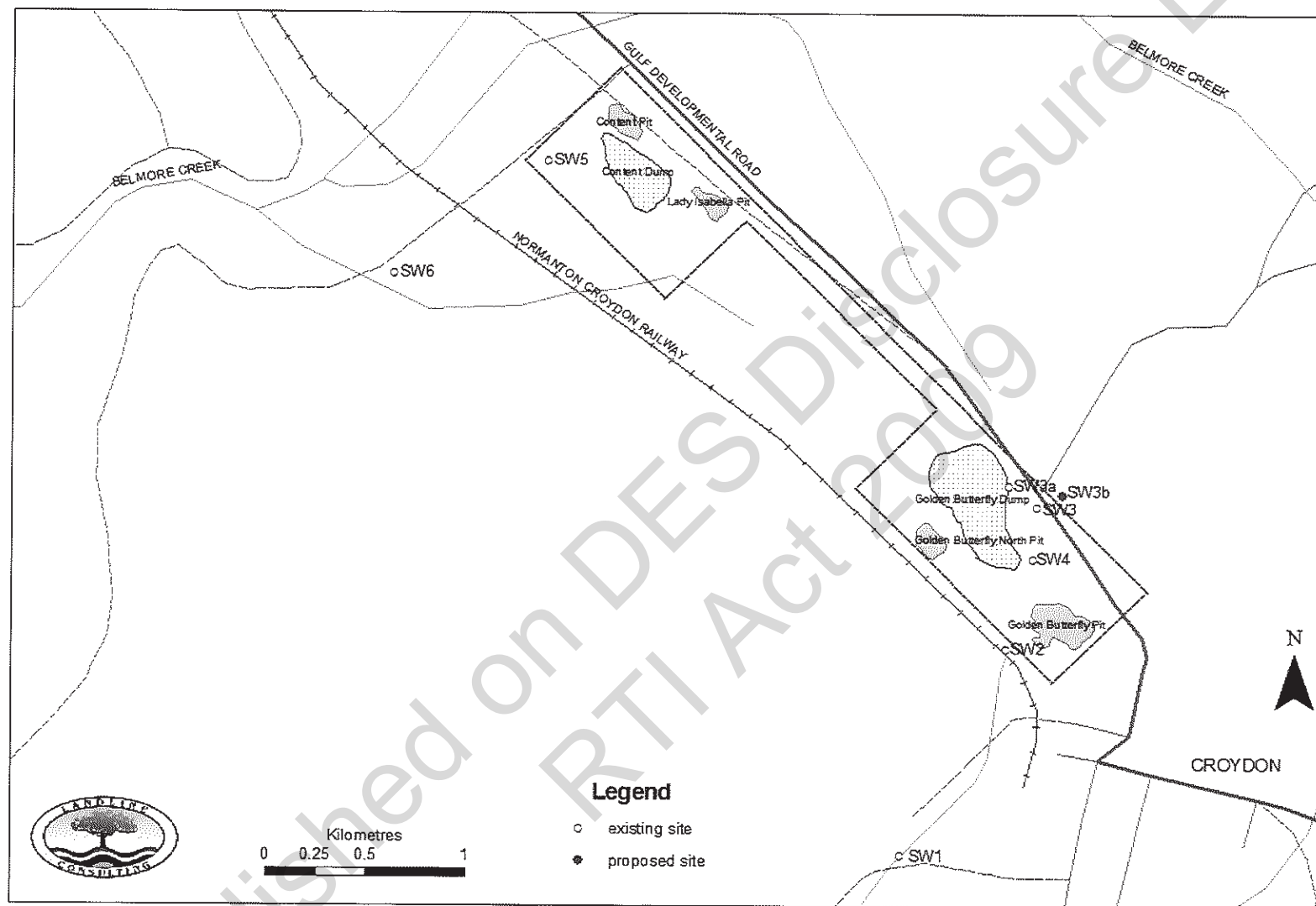
Figure 2-1 Location Plan showing remaining Croydon Gold Mine infrastructure and the ML5248 lease boundary



Golden Butterfly Pit - Old Town Borefield

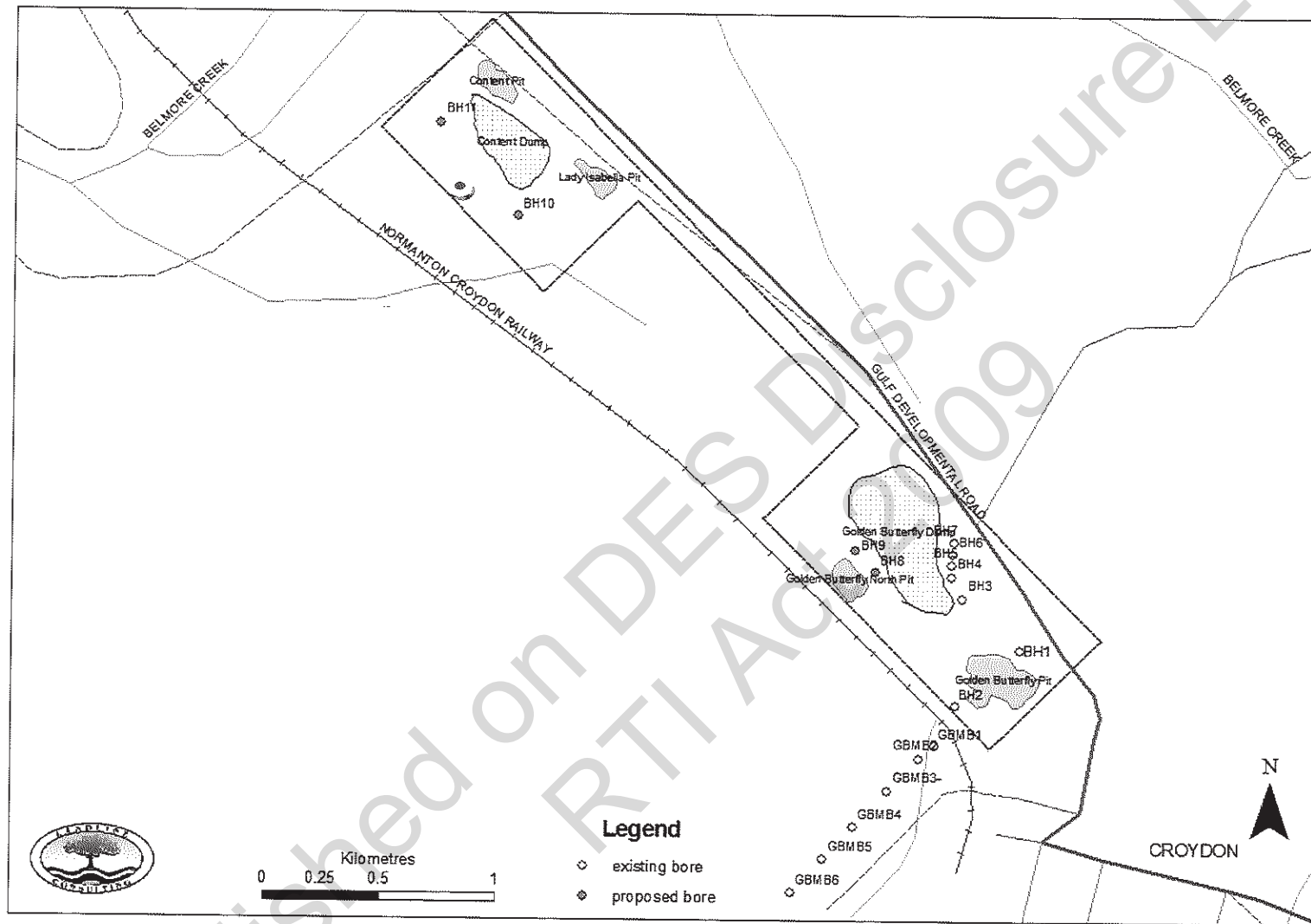
Conceptualised hydrogeology





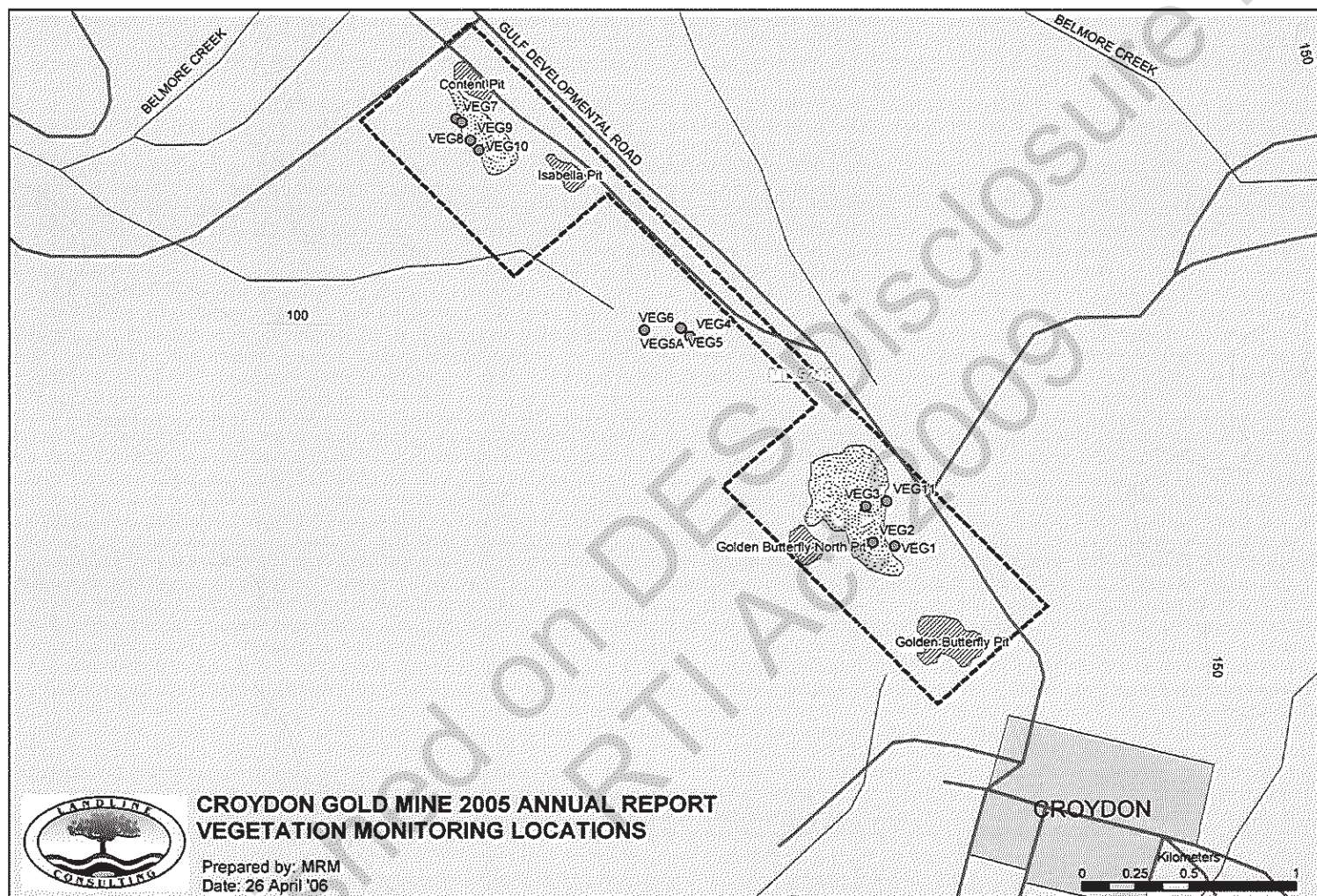
Schedule I Map 1. Surface water monitoring sites

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Schedule I Map 2. Groundwater monitoring sites

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Schedule I Map 3. Vegetation monitoring sites

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APPENDIX A

SPECIAL CONDITIONS CONTAINED IN ORIGINAL MINING LEASE

From HLA-Envirosciences (2001)

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COMMITMENT
Identify background landholder requirements regarding rehabilitation of ML 3248.
Prepare and implement an upgraded and enhanced site environmental monitoring program.
Review environmental monitoring program annually in consultation with the DME to ensure the continued effectiveness of the program.
Golden Butterfly Waste Dump - Clay fill covering and rock fill surface protection of the entire waste dump surface and construction of a cut-off key around the dump perimeter.
Content Waste Dump - Reprofile batter slopes (other than western batter). Clay fill covering and rock fill surface protection of the entire waste dump surface.
Identify, remove and dispose of potentially acid producing material from the Golden Butterfly hardstand area.
Identify, remove and dispose of contaminated sediments in Slaughteryard Creek adjacent to the Golden Butterfly waste dump.
Revegetate waste dump surfaces, former hardstand areas and other disturbed areas with native woodland tree species.

COMMITMENT
Pit water quality monitoring data will be reviewed annually, with any deterioration analysed and possible related impacts assessed.
Groundwater quality monitoring will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 3248.
GBMB series groundwater monitoring bores - maintain water quality within the range of water quality data collected for these bores over the period 1990 to 1993.
BH series groundwater monitoring bores - water quality monitoring data will be reviewed annually, with any deterioration analysed and possible related impacts assessed.
Monitoring data will be collated, interpreted and reported to the DME on an annual basis together with an audit of compliance status against commitments.
An annual lease inspection will be carried out by Goldfields.
Where practicable runoff water will be diverted away from voids via diversion bunds.
Safety bunding and fencing will be erected around open pits.

COMMITMENT
Revegetation performance will be monitored on an annual basis.
Generation of sediment will be limited by: <ul style="list-style-type: none"> (i) diversion of upstream runoff and, (ii) sediment traps will be constructed where necessary.
The effectiveness of sediment control measures will be monitored on a regular basis.
Erosion monitoring on the waste dump surfaces will be undertaken on a regular basis.
Water monitoring of creek sites will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 3248.
Water quality at monitoring sites SW1, (Golden Butterfly catchment) & SW3 (Content/Lady Isabella catchment) will comply with ANZECC (1992) Water Quality Guidelines for livestock watering (cattle), or not exceed 11.3% of background whichever is greater. Background will be measured at sites SW3 & SW4.
Water quality monitoring within open pits will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 3248.

COMMITMENT
Warning signs will be placed in strategic sites around the lease.
Abandoned shafts will be identified and backfilled.
Exploration drill holes will be located, plugged and covered over.
The lease will be monitored for the outbreak of noxious weeds, any outbreaks will be controlled by DPI recommended methods.
Submit to the DME a Final Rehabilitation Report.

APPENDIX B

1996 DME RELINQUISHMENT CRITERIA

From HLA-Envirosciences (2001)

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Category	Location	Parameters	Relinquishment Criteria
Surface Water	SW Series	pH, TDS, EC, Calcium, Magnesium, Sodium, Sulphate, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Nickel, Zinc	Livestock watering guidelines - beef cattle (ANZECC, 1992) or 113% of background surface water quality.
	Open pits	pH, TDS, EC, Calcium, Magnesium, Sodium, Sulphate, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Nickel, Zinc	No criteria
Groundwater	GBMB Series Bore	pH, TDS, EC, Calcium, Magnesium, Potassium, Sodium, Sulphate, Chloride, Arsenic, Cadmium, Copper, Iron, Lead, Manganese, Nickel, Zinc	Maintain existing water quality measured during the period 1990 to 1993.
	BH Series Bore	pH, TDS, EC, Sulphate, Iron	No criteria
Vegetation	Golden Butterfly and Centent Waste Dumps and adjacent revegetated areas	<ul style="list-style-type: none"> • Landscape Function Analysis (LFA) • Vegetation Measures <ul style="list-style-type: none"> - Species richness - Species frequency - Species density - Growth rate 	<ul style="list-style-type: none"> • Capture and decomposition of leaf litter is occurring • Vegetation structural complexity trending towards control sites • Vegetation compositional complexity trending towards control sites • Habitat complexity trending towards control sites • No criteria
Erosion	Golden Butterfly and Centent Waste Dumps	<ul style="list-style-type: none"> • LFA SSCC <ul style="list-style-type: none"> - surface stability - infiltration - nutrient cycling • Integrity of bank and trough systems on waste dump sloping • Erosion stability and depth 	<ul style="list-style-type: none"> • trending towards control site • Maintained • Erosion depth not > 300 mm

APPENDIX C

MINE COMPLETION CRITERIA

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**CROYDON GOLD MINE PROJECT
MINE COMPLETION CRITERIA**

**PREPARED BY
RESOURCE STRATEGIES PTY LTD**

**FEBRUARY 2008
Project No. BAR-06-01
Document No. CRY-MCP-02**

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1 INTRODUCTION

The Croydon Gold Mine Project (the Project) is located to the west of Croydon township in Northern Queensland. Barrick Gold Australia (Barrick) is the holder of Mining Lease (ML) 5248 for the Project. The ML 5248 forms part of the original Project that was mined between 1987 and 1990. The mine was decommissioned in 1993 and rehabilitated according to a Decommissioning Plan submitted to the Queensland Department of Minerals and Energy. Ownership of the lease has since passed to Goldfields Limited (later AurionGold) in 1995, Placer Dome Asia Pacific in 2003 and finally to Barrick in 2006.

1.1 AIM

The aim of this document is to provide a summary of the Croydon Gold Mine Project Mine Completion Criteria (MCC). The criteria contained within this document are provided as detail required by relevant Environmental Authority (EA) conditions.

1.2 PURPOSE

Relinquishment of Barrick's obligations under the *Environmental Protection Act, 1994* will culminate with the surrender of the Project EA. Surrender conditions relevant to aspects of land and water management are addressed in the MCC. Further review and revision of the MCC may be undertaken in consultation with the Environmental Protection Agency (EPA). Where this is the case, any proposed amendments will be formalised in consultation with the EPA and documented in the form of a revised MCC. The EA conditions relevant to MCC are reproduced in Table 1.

Table 1
Environmental Authority Conditions Relevant to the Mine Completion Criteria

Proposed Environmental Authority Condition	Section Addressed in this Document
A6-1 <i>The current Croydon Mine Completion Criteria will be the version of the Criteria which the Administering Authority has notified Barrick in writing as being the current Croydon Mine Completion Criteria.</i>	Section 1.2
C1-1 <i>Receiving waters affected by the release of stormwater runoff from mining landforms such as waste rock dumps and hardstand areas will be monitored at the locations and frequencies defined in the Croydon Mine Completion Criteria.</i>	Section 2.1
C1-2 <i>The holder of this environmental authority will comply with the receiving water quality guidelines defined in the Croydon Mine Completion Criteria.</i>	Section 2.1
C1-3 <i>All mine pit lakes (pit void receiving waters) will be monitored for water quality and water levels as per the locations and frequencies defined in the Croydon Mine Completion Criteria.</i>	Section 2.3
C1-4 <i>All water quality samples will be analyzed in a NATA registered laboratory for the range of parameters listed in the Croydon Mine Completion Criteria.</i>	Section 2
C2-1 <i>All groundwater monitoring sites listed in the Croydon Mine Completion Criteria will be sampled for water quality and measured for groundwater levels.</i>	Section 2.2
C2-3 <i>Monitoring bores will be constructed and surveyed as detailed in the Croydon Mine Completion Criteria.</i>	Section 2.2
F1-1 <i>All surface areas significantly disturbed by mining activities will be rehabilitated in accordance with the Croydon Mine Completion Criteria.</i>	Section 3

2 WATER

2.1 SURFACE WATER

Receiving waters affected by the release of stormwater runoff from mining landforms such as waste rock dumps and hardstand areas will be monitored at the locations and frequencies defined in Figure 1 and Table 2.

Table 2
Receiving Water Monitoring Locations and Frequency

Monitoring Point	Northing ¹	Easting ¹	Monitoring Frequency
SW1 (Lower Slaughteryard Creek)	7986405	630350	Twice yearly in January/February and May
SW2 (Slaughteryard West Tributary at the ML boundary)	7987640	630197	Twice yearly in January/February and May
SW3a (Golden Butterfly WRD toe drain)	7988253	630913	Twice yearly in January/February and May if discharging
SW3b (new Reference point for Slaughteryard creek)	7988220	613208	Twice yearly in January/February and May
SW4 (Stock water dam)	7987892	631049	Twice yearly in January/February and May if discharging
SW5 (sediment dam at lease boundary)	7990012	628691	Twice yearly in January/February and May
SW6 (Belmore Creek borrow pit / stock dam).	7989454	627908	Twice yearly in January/February and May

¹ MGA (GDA 94)

The surface water quality samples will be analysed in a NATA registered laboratory for the range of parameters listed in Table 3. Monitoring results will be reported to the administering authority on an annual basis.

Table 3
Water Quality Parameters to be Analysed

Analytical Suite	Parameters
Basic and Major Ions	TDS, SO ₄ , F
Metals	Al, As, B, Cd, Cr, Cu, Co, Hg, Mo, Ni, Pb, Se, Zn

If receiving waters at the site(s) defined in Table 2, do not comply with the criteria in Table 4, the EA holder will:

- complete an investigation in accordance with the ANZECC (2000) methodology, into the potential for environmental harm;
- provide a written report to the administering authority within 3 months of the date of the original exceedance, outlining:
 - details of the investigations carried out; and
 - actions taken to prevent environmental harm.

Table 4
Surface Water Quality Criteria

Parameter	Units	Criteria
Total Dissolved Solids	mg/L	4,000 ¹
Sulphate	mg/L	1,000 ¹
Aluminium	mg/L	5 ¹
Arsenic	mg/L	0.5 ¹
Boron	mg/L	5 ¹
Cadmium	mg/L	0.01 ¹
Chromium	mg/L	1 ¹
Cobalt	mg/L	1 ¹
Copper	mg/L	1 ¹
Fluoride	mg/L	2 ¹
Lead	mg/L	0.1 ¹
Mercury	mg/L	0.002 ¹
Molybdenum	mg/L	0.15 ¹
Nickel	mg/L	1 ¹
Selenium	mg/L	0.02 ¹
Zinc	mg/L	20 ¹

¹ ANZECC (2000) Livestock Drinking Water Guidelines.

2.2 GROUNDWATER

The groundwater monitoring sites defined in Table 5 will be sampled for water quality and measured for groundwater levels.

All groundwater monitoring sites listed in Table 5 will be sampled for water quality and measured for groundwater levels. The groundwater quality samples will be analysed in a NATA registered laboratory for the range of parameters listed in Table 3. Monitoring results will be reported to the administering authority on an annual basis.

The monitoring bores outlined in Table 5 will be constructed and surveyed by the end of 2008.

Table 5
Groundwater Monitoring Locations and Frequency

Monitoring Point	Northing ¹	Easting ¹	Elevation (surface RL)	Monitoring Frequency
BH1 (west of Golden Butterfly Pit)	7987673	631270	TBA ²	Annually during the dry season
BH2 (east of Golden Butterfly Pit)	7987444	630985	TBA ²	Annually during the dry season
BH3 (east of Golden Butterfly Waste Rock Dump)	TBA ²	TBA ²	TBA ²	Annually during the dry season
BH5 (east of Golden Butterfly Waste Rock Dump)	7988051	630987	TBA ²	Annually during the dry season
BH7 (east of Golden Butterfly Waste Rock Dump)	7988150	631000	TBA ²	Annually during the dry season
BH8 (east of Golden Butterfly Waste Rock Dump)	TBA ³	TBA ³	TBA ³	Annually during the dry season
BH9 (east of Golden Butterfly Waste Rock Dump)	TBA ³	TBA ³	TBA ³	Annually during the dry season
BH10 (west of Content Waste Rock Dump)	TBA ³	TBA ³	TBA ³	Annually during the dry season
BH11 (west of Content Waste Rock Dump)	TBA ³	TBA ³	TBA ³	Annually during the dry season
BH12 (west of Content Waste Rock Dump at lease boundary)	TBA ³	TBA ³	TBA ³	Annually during the dry season
GBMB1 (Slaughteryard Creek)	7987274	630894	TBA	Annually during the dry season
GBMB3 (Slaughteryard Creek)	7987087	630685	TBA	Annually during the dry season
GBMB6 (Slaughteryard Creek)	7986656	630257	TBA	Annually during the dry season
SY1 (Slaughteryard Creek)	TBA ³	TBA ³	TBA ³	Annually during the dry season

¹ MGA (UTM GDA 94).

² Coordinates and elevation to be determined during next sampling visit.

³ Coordinates and elevation to be determined once the proposed bores have been constructed.

2.3 PIT LAKES

All mine pit lakes (pit void receiving waters) (Figure 1) will be monitored for water quality and water levels as per the locations and frequencies defined in Table 6.

Table 6
Pit Lake Waters - Monitoring Locations and Frequency

Monitoring Point	Northing ¹	Easting ¹	Monitoring Frequency
Golden Butterfly Pit	7987525	631140	Annually at end of wet season (May)
Golden Butterfly North Pit	7987921	630545	Annually at end of wet season (May)
Lady Isabella Pit	7990023	629473	Annually at end of wet season (May)
Content Pit	7990435	629048	Annually at end of wet season (May)

¹ MGA (GDA 94)

The pit lake water quality samples will be analysed in a NATA registered laboratory for the range of parameters listed in Table 3. Monitoring results will be reported to the administering authority on an annual basis.

3 LAND MANAGEMENT

All surface areas significantly disturbed by mining activities will be rehabilitated in accordance with Table 7.

4 REFERENCES

ANZECC (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australian and New Zealand Environment and Conservation Council, October 2000

Table 7
Final Landform Design and Use

Landform	Surface Area	Proposed Land Use	Relinquishment Criteria		
			Safety	Stability	Visual Appearance
Pit Voids	10.5 ha	Wildlife Habitat	<ul style="list-style-type: none"> Abandonment bund of competent rock. Fenced with signage. 	<ul style="list-style-type: none"> Unstable zones in upper wall battered to $<45^{\circ}$. 	<ul style="list-style-type: none"> Abandonment bund screened by vegetation. Pit benches ripped to encourage natural seeding.
Waste Rock Dumps	21.5 ha	Low Intensity Grazing	<ul style="list-style-type: none"> Top accessible by 4x4 vehicles. Slope angle $<1:2$. 	<ul style="list-style-type: none"> Gullies not to exceed 300mm depth & $1:10\text{m}^2$ density. 	<ul style="list-style-type: none"> 60% of analogue site vegetation cover.
Hardstands	2.5 ha	Low Intensity Grazing	<ul style="list-style-type: none"> No exposed metal or concrete footings. 	<ul style="list-style-type: none"> Contoured to dovetail with local relief. 	<ul style="list-style-type: none"> 60% of analogue site vegetation cover.
Sediment Dams	1.5 ha	Stock Watering	<ul style="list-style-type: none"> Slope of dam floor $<30^{\circ}$. 	<ul style="list-style-type: none"> Embankments exceeding 2m height require spillways. 	<ul style="list-style-type: none"> No rubbish dumped in dam.
Roads/tracks	3.5 ha	Low Intensity Grazing	<ul style="list-style-type: none"> Mining Lease entrance blocked off and road banded at regular intervals. 	<ul style="list-style-type: none"> Contoured to dovetail with local relief. 	<ul style="list-style-type: none"> 60% of analogue site vegetation cover.

FIGURES

Figure 2
Groundwater Monitoring Locations

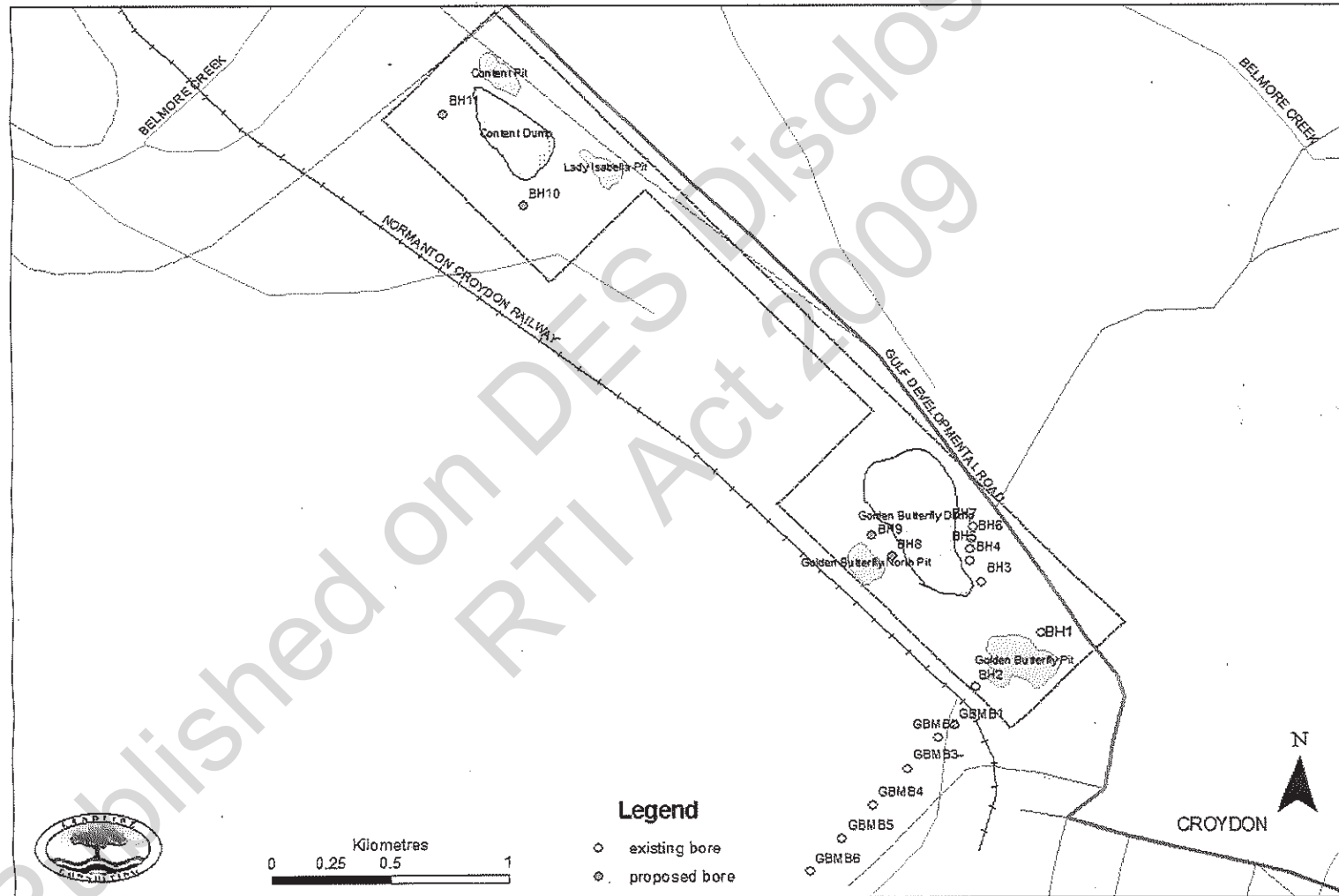
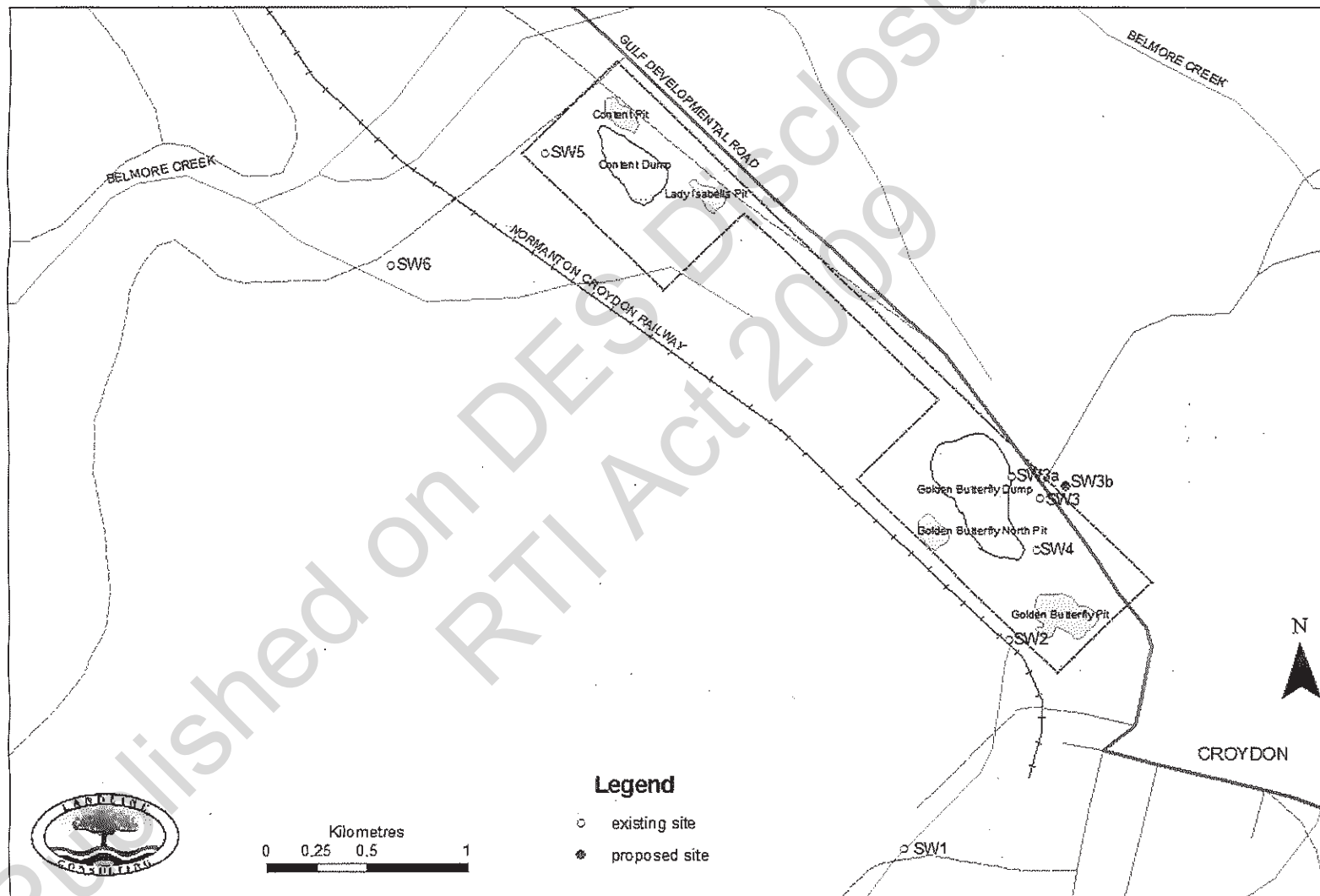


Figure 1
Surface Water Monitoring Locations



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APPENDIX D

WATER QUALITY MONITORING DATA

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Croydon Gold Mine

Water Quality Monitoring Data

Surface Water Monitoring Sites															
Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
SW1	28-Jan-96	-	3.9	200	<0.02	-	0.0051	0.38	1.9	<0.005	0.37	0.13	0.45	<0.1	-
SW1	06-Dec-96	-	5.1	33	<0.02	-	<0.0005	<0.05	5	0.022	0.14	<0.05	0.08	<0.05	-
SW1	31-Dec-96	-	6.3	17	<0.02	-	0.0024	<0.05	3.5	0.013	0.92	<0.05	<0.05	<0.05	-
SW1	28-Feb-97	370	5	190	<0.01	-	0.0019	0.06	0.08	<0.002	0.09	0.06	0.28	-	-
SW1	01-Dec-97	110	7.9	27	<0.005	-	<0.0005	<0.05	2.5	0.015	0.58	<0.05	<0.05	-	-
SW1	31-Dec-97	260	6.1	76	<0.005	-	0.0009	<0.05	0.13	<0.002	<0.05	<0.05	0.15	-	-
SW1	15-Jan-98	140	6.8	32	<0.005	-	<0.0005	<0.05	1.5	0.005	<0.05	<0.05	0.05	-	-
SW1	31-Jan-98	250	7	62	<0.005	-	<0.0005	<0.05	0.68	<0.002	0.09	<0.05	<0.05	-	-
SW1	15-Feb-98	160	6.7	43	<0.005	-	<0.0005	<0.05	2.2	0.007	0.09	<0.05	0.06	-	-
SW1	01-Mar-98	150	6.6	36	<0.005	-	<0.0005	<0.05	0.64	0.003	<0.05	<0.05	<0.05	-	-
SW1	15-Mar-98	180	6.9	44	<0.005	-	<0.0005	<0.05	0.97	0.003	-	<0.05	<0.05	-	-
SW1	01-Jan-99	110	6.8	22	0.008	-	<0.0002	<0.05	2.3	0.004	0.11	<0.05	0.034	-	-
SW1	15-Jan-99	100	6.8	25	<0.005	-	<0.0002	<0.05	0.4	0.004	<0.05	<0.05	0.02	-	-
SW1	15-Feb-99	320	7.2	79	0.008	-	<0.0002	<0.05	1.2	<0.001	0.31	<0.05	0.065	-	-
SW1	01-Mar-99	150	6.8	33	0.007	-	<0.0002	<0.05	0.72	0.004	<0.05	<0.05	0.016	-	-
SW1	15-Jan-00	190	6.5	50	0.005	-	<0.0002	<0.05	1.4	0.003	<0.05	<0.05	0.029	-	-
SW1	15-Feb-00	170	6.7	32	0.008	-	<0.0002	<0.05	1.6	0.003	<0.05	<0.05	0.01	-	-
SW1	29-Feb-00	200	6.8	48	0.012	-	<0.0002	<0.05	1.2	0.002	<0.05	<0.05	<0.005	-	-
SW1	15-Dec-00	140	6.2	32	0.007	-	<0.0002	<0.05	0.77	0.005	<0.05	<0.05	0.034	-	-
SW1	04-Jan-01	180	7.5	44	0.026	-	<0.0002	<0.05	1.3	0.002	0.06	<0.05	0.009	-	-
SW1	15-Feb-01	190	7.3	46	0.029	-	<0.0002	<0.05	2.7	0.003	0.06	<0.05	0.024	-	-
SW1	01-Mar-01	200	7.5	44	0.033	-	<0.0002	<0.05	1.9	0.002	<0.05	<0.05	0.013	-	-
SW1	15-Mar-01	140	7.2	28	0.021	-	<0.0002	<0.05	1.7	0.003	0.07	<0.05	0.013	-	-
SW1	01-Apr-01	160	7.5	27	0.019	-	<0.0002	<0.05	1.8	0.002	<0.05	<0.05	0.009	-	-
SW1	15-Dec-01	170	6.6	48	0.007	-	<0.0002	<0.05	1.9	0.004	0.26	<0.05	0.042	-	-
SW1	15-Jan-02	200	7.1	42	0.011	-	<0.0002	<0.01	1.4	<0.002	<0.05	<0.05	0.02	-	-
SW1	01-Feb-02	200	7.2	39	0.024	-	<0.0002	<0.01	3.5	0.005	<0.05	<0.05	0.016	-	-
SW1	15-Feb-02	200	7.3	34	0.017	-	<0.0002	<0.01	2.5	0.003	<0.05	<0.05	0.01	-	-
SW1	02-Mar-02	210	7	39	0.014	-	<0.0002	<0.01	1.7	0.002	<0.05	<0.05	0.033	-	-
SW1	15-Mar-02	290	7.7	39	0.051	-	<0.0002	<0.01	0.55	0.002	<0.05	<0.05	0.022	-	-
SW1	Jan-05	360	6.7	62	0.015	1.4	<0.0002	0.01	-	<0.002	<0.05	<0.05	0.026	-	-
SW1	26-Jan-06	550	6.9	75	0.007	-	<0.0002	0.01	0.78	-	0.24	<0.05	0.068	-	-
SW1	14-Feb-06	610	9.1	93	0.012	0.24	<0.0002	0.01	0.33	<0.002	<0.05	<0.05	0.018	<0.05	-
SW1	27-Mar-06	250	7.7	44	0.007	0.35	<0.0005	0.02	0.64	<0.002	<0.05	<0.05	0.022	<0.05	<0.05
SW1	19-Apr-06	310	9.2	58	0.009	0.09	<0.0002	<0.01	0.44	<0.002	<0.05	<0.05	0.019	<0.05	-
SW1	13-Jul-06	550	7.5	52	0.007	0.16	<0.0002	0.01	0.33	<0.002	<0.05	<0.05	0.008	<0.05	-
SW1	13-Dec-06	450	6.6	100	<0.005	2.3	<0.0002	0.01	-	0.002	-	<0.05	0.063	<0.05	<0.05

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

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Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
SW2	28-Jan-96	-	2.8	950	0.05	-	0.024	2.06	23	<0.005	-	0.66	2.2	<0.1	-
SW2	05-Mar-96	-	3.8	9600	0.5	-	0.18	22	197	<0.1	-	7.2	19	<0.1	-
SW2	06-Nov-96	-	6.2	620	<0.02	-	0.0045	<0.05	<0.05	<0.005	1.7	0.07	<0.05	<0.05	-
SW2	06-Dec-96	-	3.9	340	<0.02	-	0.0051	0.31	0.6	<0.005	3.1	0.27	0.7	<0.05	-
SW2	31-Dec-96	-	4	220	<0.02	-	0.0076	0.13	<0.05	<0.005	2	0.14	0.44	<0.05	-
SW2	28-Feb-97	1000	4	570	<0.01	-	0.01	0.45	0.12	0.002	4.8	0.29	1.3	-	-
SW2	31-Dec-97	520	4.2	220	<0.005	-	0.0042	0.09	<0.05	<0.002	2	0.1	0.69	-	-
SW2	15-Jan-98	240	4.2	76	<0.005	-	0.0028	0.1	0.12	<0.002	0.72	0.06	0.62	-	-
SW2	31-Jan-98	420	4.3	170	<0.005	-	0.0023	0.09	0.12	<0.002	0.88	<0.05	0.56	-	-
SW2	15-Feb-98	190	5.2	57	<0.005	-	0.0014	<0.05	0.19	<0.002	0.61	<0.05	0.25	-	-
SW2	01-Mar-98	250	4.6	75	<0.005	-	0.0016	0.05	0.12	<0.002	0.78	0.05	0.45	-	-
SW2	15-Mar-98	190	4.8	66	<0.005	-	0.0009	<0.05	0.08	<0.002	0.33	<0.05	0.4	-	-
SW2	01-Jan-99	400	4.7	140	<0.005	-	0.0018	<0.05	0.13	<0.001	1.3	0.08	0.31	-	-
SW2	15-Jan-99	180	6.8	49	<0.005	-	0.0003	<0.05	0.14	<0.001	0.36	<0.05	0.024	-	-
SW2	15-Feb-99	570	4.4	260	0.008	-	0.0045	0.2	0.63	<0.001	3.1	0.16	0.98	-	-
SW2	01-Mar-99	360	4.6	140	<0.005	-	0.0044	0.13	0.23	<0.002	1.7	0.11	0.67	-	-
SW2	15-Mar-99	310	6.5	120	0.005	-	0.0005	0.05	0.19	<0.002	0.82	<0.05	0.12	-	-
SW2	15-Feb-00	170	6.8	51	0.01	-	<0.0002	<0.05	0.76	0.003	0.19	<0.05	0.031	-	-
SW2	29-Feb-00	190	6.6	68	0.006	-	0.0002	<0.05	0.51	<0.002	0.23	<0.05	0.031	-	-
SW2	15-Dec-00	200	6.4	63	0.009	-	<0.0002	<0.05	1.8	0.005	0.06	<0.05	0.046	-	-
SW2	15-Feb-01	110	6.7	42	0.015	-	<0.0002	<0.05	0.55	0.004	0.06	<0.05	0.033	-	-
SW2	01-Mar-01	110	7.2	58	0.014	-	<0.0002	<0.05	0.71	<0.002	<0.05	<0.05	0.027	-	-
SW2	15-Mar-01	100	7.3	32	0.016	-	<0.0002	<0.05	1	0.003	<0.05	<0.05	0.027	-	-
SW2	01-Apr-01	140	6.9	42	0.015	-	<0.0002	<0.05	1.2	<0.002	<0.05	<0.05	0.016	-	-
SW2	15-Dec-01	260	5.1	100	<0.005	-	0.0007	<0.05	0.26	<0.002	0.61	<0.05	0.13	-	-
SW2	15-Jan-02	120	7.2	55	0.012	-	<0.0002	<0.01	0.87	<0.002	<0.05	<0.05	0.018	-	-
SW2	01-Feb-02	170	6.8	59	0.016	-	<0.0002	<0.01	0.67	0.002	0.22	<0.05	0.05	-	-
SW2	15-Feb-02	170	7	49	0.01	-	<0.0002	0.01	0.53	<0.002	<0.05	<0.05	0.02	-	-
SW2	02-Mar-02	190	7	57	0.011	-	0.0002	0.01	0.79	<0.002	0.15	<0.05	0.026	-	-
SW2	Jan-05	230	6.7	43	0.035	2.8	<0.0002	0.02	-	<0.002	0.05	<0.05	0.038	-	-
SW2	26-Jan-06	270	6.9	67	0.02	-	0.0002	0.01	0.78	0.002	0.14	<0.05	0.05	-	-
SW2	14-Feb-06	140	7.5	13	<0.005	0.22	<0.0002	0.01	0.73	<0.002	<0.05	<0.05	0.007	<0.05	-
SW2	27-Mar-06	130	7.2	41	0.014	0.7	<0.0002	0.02	0.33	<0.002	0.08	<0.05	0.067	<0.05	<0.05
SW2	19-Apr-06	140	9.1	44	0.021	0.14	<0.0002	<0.01	0.27	<0.002	<0.05	<0.05	0.028	<0.05	-
SW2	13-Jul-06	120	5.7	57	0.007	0.78	0.0002	0.01	-	<0.002	-	<0.05	0.07	<0.05	<0.05
SW2	13-Dec-06	240	6.1	63	0.019	0.86	0.0002	0.02	-	0.004	-	<0.05	0.049	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosiences (2001)

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Croydon Gold Mine
Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
SW3	28-Jan-96	-	6.6	35	<0.02	-	0.0006	<0.05	0.84	<0.005	<0.05	<0.05	<0.05	<0.1	-
SW3	05-Mar-96	-	6.5	53	<0.02	-	<0.0005	<0.05	1.53	<0.1	0.09	<0.05	<0.05	<0.1	-
SW3	06-Dec-96	-	6	20	<0.02	-	<0.0005	<0.05	6.5	0.006	<0.05	<0.05	<0.05	<0.05	-
SW3	31-Dec-96	-	6.5	36	<0.02	-	0.0008	<0.05	1.5	0.006	<0.05	<0.05	<0.05	<0.05	-
SW3	28-Feb-97	120	6.4	39	<0.01	-	<0.0005	<0.05	0.2	<0.002	<0.05	<0.05	<0.05	-	-
SW3	31-Dec-97	150	6.6	40	<0.005	-	<0.0005	<0.05	0.92	0.004	<0.05	<0.05	<0.05	-	-
SW3	15-Jan-98	78	6.3	15	0.007	-	<0.0005	<0.05	0.94	<0.002	<0.05	<0.05	<0.05	-	-
SW3	31-Jan-98	92	8.7	16	<0.005	-	<0.0005	<0.05	2.2	<0.002	<0.05	<0.05	<0.05	-	-
SW3	15-Feb-98	100	7.1	22	<0.005	-	<0.0005	<0.05	2.6	0.002	<0.05	<0.05	<0.05	-	-
SW3	01-Mar-98	90	6.6	26	<0.005	-	<0.0005	<0.05	1.3	<0.002	<0.05	<0.05	<0.05	-	-
SW3	15-Mar-98	69	7.8	13	<0.005	-	<0.0005	<0.05	0.88	<0.002	-	<0.05	<0.05	-	-
SW3	01-Apr-98	100	6.9	21	<0.005	-	<0.0005	<0.05	0.31	<0.002	-	<0.05	<0.05	-	-
SW3	01-Jan-99	61	6.5	14	<0.005	-	<0.0002	<0.05	0.69	0.003	<0.05	<0.05	0.014	-	-
SW3	15-Jan-99	57	6.7	15	<0.005	-	<0.0002	<0.05	0.49	0.003	<0.05	<0.05	0.017	-	-
SW3	15-Feb-99	170	7.2	36	0.023	-	<0.0002	<0.05	4.6	0.001	<0.05	<0.05	0.017	-	-
SW3	01-Mar-99	100	6.9	27	<0.005	-	<0.0002	<0.05	1.6	0.002	<0.05	<0.05	<0.005	-	-
SW3	15-Feb-00	240	6.7	76	<0.005	-	<0.0002	<0.05	0.26	<0.002	0.28	<0.05	0.007	-	-
SW3	29-Feb-00	120	6.9	36	<0.005	-	<0.0002	<0.05	0.95	<0.002	<0.05	<0.05	<0.005	-	-
SW3	15-Dec-00	66	6.4	22	<0.005	-	<0.0002	<0.05	0.63	0.006	<0.05	<0.05	0.02	-	-
SW3	01-Mar-01	100	7.6	21	0.009	-	<0.0002	<0.05	1.9	0.002	<0.05	<0.05	0.008	-	-
SW3	15-Mar-01	84	7.5	21	0.012	-	<0.0002	<0.05	3.2	<0.002	<0.05	<0.05	0.008	-	-
SW3	15-Jan-02	120	7	33	0.008	-	<0.0002	<0.01	1.6	<0.002	<0.05	<0.05	0.012	-	-
SW3	01-Feb-02	110	6.8	25	0.014	-	<0.0002	<0.01	1.6	0.004	<0.05	<0.05	0.022	-	-
SW3	15-Feb-02	100	7.1	23	0.006	-	<0.0002	<0.01	1.9	0.004	<0.05	<0.05	0.013	-	-
SW3	02-Mar-02	110	7.2	22	0.008	-	<0.0002	<0.01	2	<0.002	<0.05	<0.05	0.009	-	-
SW3	15-Mar-02	98	7.6	18	0.007	-	<0.0002	<0.01	0.95	<0.002	<0.05	<0.05	0.008	-	-
SW3	Jan-05	140	6.3	27	0.008	0.1	<0.0002	<0.01	-	<0.002	<0.05	<0.05	0.018	-	-
SW3	26-Jan-06	110	7.1	22	0.012	-	<0.0002	<0.01	0.79	0.002	<0.05	<0.05	0.023	-	-
SW3	14-Feb-06	140	7.5	13	<0.005	0.22	<0.0002	0.01	0.73	<0.002	<0.05	<0.05	0.007	<0.05	-
SW3	6-Mar-06	430	7.2	24	0.069	3.5	<0.0002	0.01	5.2	0.004	1.9	<0.05	0.033	<0.05	-
SW3	27-Mar-06	80	7.1	16	<0.005	0.35	<0.0002	0.02	1.1	<0.002	<0.05	<0.05	0.012	<0.05	-
SW3	19-Apr-06	79	7.3	13	0.01	0.1	<0.0002	<0.01	2.3	<0.0002	<0.05	<0.05	0.011	<0.05	-
SW3	17-May-06	110	7.2	15	0.005	0.21	<0.0002	<0.01	1.2	<0.002	<0.05	<0.05	0.005	<0.05	-
SW3	13-Jul-06	450	6.2	140	0.005	0.89	0.0003	0.02	-	0.002	-	<0.05	0.17	<0.05	<0.05

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW3a	28-Jan-96	-	2.5	1450	0.4	-	0.037	3.66	90	<0.005	380	0.91	2.7	<0.1	-
SW3a	05-Mar-96	-	2.8	10600	5.4	-	0.18	26	630	<0.1	3.6	6.3	18	<0.1	-
SW3a	30-Mar-96	-	2	18200	12.5	-	0.295	56	1100	<0.05	8.1	13	42	<0.1	-
SW3a	03-May-96	-	1.7	240	80	-	4.4	340	4850	<0.05	2.7	80	235	<0.1	-
SW3a	06-Dec-96	-	4	420	<0.02	-	0.0063	0.23	0.52	0.005	2.6	0.29	0.58	<0.05	-
SW3a	28-Feb-97	1400	4.2	880	<0.01	-	0.017	0.49	<0.05	0.004	1.3	0.4	0.96	-	-
SW3a	15-Jan-98	830	4.3	370	<0.005	-	0.0079	0.11	0.09	<0.002	10	0.19	0.36	-	-
SW3a	01-Mar-98	710	4.5	280	<0.005	-	0.005	0.17	0.12	<0.002	<0.05	0.19	0.44	-	-
SW3a	15-Jan-99	460	5.4	190	<0.005	-	0.0034	<0.05	<0.05	<0.001	-	<0.05	0.06	-	-
SW3a	15-Feb-99	2300	4.3	1300	0.005	-	0.035	0.34	0.14	0.004	-	0.49	0.89	-	-
SW3a	15-Feb-00	86	6.9	22	0.005	-	<0.0002	<0.05	0.56	<0.002	-	<0.05	0.007	-	-
SW3a	26-Jan-06	450	7.1	99	0.005	-	0.0002	<0.01	0.33	<0.002	0.07	<0.05	0.021	-	-
SW3a	14-Feb-06	120	7.3	27	0.012	1.4	<0.0002	0.01	1.2	0.004	<0.05	<0.05	0.019	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Released

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW4	03-May-96	-	7.3	58	0.02	-	<0.0005	<0.05	0.8	<0.05	<0.05	<0.05	0.14	<0.1	-
SW4	30-Jun-96	-	7.8	76	<0.02	-	<0.0005	<0.05	0.67	<0.05	<0.05	<0.05	<0.05	<0.1	-
SW4	01-Aug-96	-	7.6	72	<0.02	-	<0.0005	<0.05	0.15	<0.05	0.05	<0.05	0.08	<0.1	-
SW4	02-Sep-96	-	8.3	78	<0.02	-	0.0008	<0.05	0.5	<0.05	<0.05	<0.05	<0.05	<0.1	-
SW4	30-Oct-96	-	7.5	170	<0.02	-	<0.0005	<0.05	1.3	<0.005	0.13	<0.05	0.16	<0.05	-
SW4	30-Nov-96	-	7	140	<0.02	-	<0.0005	<0.05	0.76	<0.05	0.18	<0.05	<0.05	<0.05	-
SW4	31-Dec-96	-	6.8	68	0.05	-	0.003	<0.05	2.7	0.006	0.12	<0.05	<0.05	<0.05	-
SW4	28-Feb-97	150	6.6	66	<0.01	-	<0.0005	<0.05	0.38	0.002	<0.05	<0.05	<0.05	-	-
SW4	31-Mar-97	160	6.8	73	<0.01	-	<0.0005	<0.05	0.5	0.003	<0.05	<0.05	<0.05	-	-
SW4	04-Oct-97	820	7.9	260	0.01	-	<0.0005	<0.05	1.5	0.003	0.58	<0.05	<0.05	-	-
SW4	01-Dec-97	330	7.5	88	<0.005	-	<0.0005	<0.05	1.1	0.008	0.05	<0.05	<0.05	-	-
SW4	15-Dec-97	300	7.5	72	0.007	-	<0.0005	<0.05	0.98	0.008	<0.05	<0.05	<0.05	-	-
SW4	31-Dec-97	120	6.7	36	0.006	-	<0.0005	<0.05	0.41	0.004	<0.05	<0.05	<0.05	-	-
SW4	15-Jan-98	56	6.2	14	<0.005	-	<0.0005	<0.05	0.47	0.005	<0.05	<0.05	<0.05	-	-
SW4	31-Jan-98	99	7.3	20	<0.005	-	<0.0005	<0.05	1.5	0.002	<0.05	<0.05	<0.05	-	-
SW4	15-Feb-98	79	7	20	<0.005	-	<0.0005	<0.05	1.9	0.007	<0.05	<0.05	<0.05	-	-
SW4	01-Mar-98	82	6.6	22	<0.005	-	<0.0005	<0.05	0.92	0.002	<0.05	<0.05	<0.05	-	-
SW4	15-Mar-98	84	7.1	19	<0.005	-	<0.0005	<0.05	0.34	<0.002	<0.05	<0.05	<0.05	-	-
SW4	01-Apr-98	100	7.1	21	0.005	-	<0.0005	<0.05	0.34	<0.002	<0.05	<0.05	<0.05	-	-
SW4	21-Sep-98	420	8.4	73	0.011	-	<0.0002	<0.05	0.52	<0.001	<0.05	<0.05	0.007	-	-
SW4	01-Dec-98	410	8.5	96	0.016	-	<0.0002	<0.05	1.3	0.003	0.07	<0.05	0.013	-	-
SW4	01-Jan-99	160	7.3	31	0.005	-	<0.0002	<0.05	1.3	0.005	<0.05	<0.05	0.03	-	-
SW4	15-Jan-99	93	7.1	22	<0.005	-	<0.0002	<0.05	0.69	0.003	<0.05	<0.05	0.015	-	-
SW4	31-Jan-99	110	7.2	24	0.01	-	<0.0002	<0.05	3.8	0.003	<0.05	<0.05	0.2	-	-
SW4	15-Feb-99	130	7.3	30	0.012	-	<0.0002	<0.05	2.2	0.001	<0.05	<0.05	0.013	-	-
SW4	01-Mar-99	120	6.9	27	<0.005	-	<0.0002	<0.05	0.8	<0.002	<0.05	<0.05	0.005	-	-
SW4	15-Mar-99	140	9.2	36	0.012	-	<0.0002	<0.05	0.69	0.006	<0.05	<0.05	0.009	-	-
SW4	01-Apr-99	140	8.9	36	0.017	-	<0.0002	<0.05	0.76	0.004	<0.05	<0.05	0.006	-	-
SW4	15-Apr-99	150	7.9	39	0.014	-	<0.0002	<0.05	1.1	0.004	<0.05	<0.05	0.012	-	-
SW4	01-Jan-00	130	6.7	30	0.006	-	<0.0002	<0.05	1	0.003	<0.05	<0.05	0.022	-	-
SW4	15-Jan-00	100	7	28	0.007	-	<0.0002	<0.05	1.2	0.003	<0.05	<0.05	0.037	-	-
SW4	01-Feb-00	120	9.3	33	0.014	-	<0.0002	<0.05	0.72	0.002	0.07	<0.05	0.016	-	-
SW4	15-Feb-00	130	7	33	0.015	-	<0.0002	<0.05	0.69	<0.002	<0.05	<0.05	0.01	-	-
SW4	29-Feb-00	120	7	35	<0.005	-	<0.0002	<0.05	0.66	<0.002	<0.05	<0.05	<0.005	-	-
SW4	15-Mar-00	130	7.9	27	0.011	-	<0.0002	<0.05	0.81	<0.002	<0.05	<0.05	0.028	-	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW4	01-Apr-00	150	8.6	32	0.017	-	<0.0002	<0.05	0.63	<0.002	<0.05	<0.05	0.024	-	-
SW4	01-Dec-00	390	7.2	110	0.018	-	<0.0002	<0.05	6.4	0.008	<0.05	<0.05	0.02	-	-
SW4	15-Dec-00	160	6.5	45	0.008	-	<0.0002	<0.05	2.4	0.006	<0.05	<0.05	0.01	-	-
SW4	04-Jan-01	120	6.8	43	0.01	-	<0.0002	<0.05	1.6	0.003	<0.05	<0.05	0.01	-	-
SW4	15-Jan-01	170	8.6	43	0.013	-	<0.0002	<0.05	1.6	0.002	<0.05	<0.05	0.031	-	-
SW4	01-Feb-01	170	8.3	43	0.013	-	<0.0002	<0.05	1.6	<0.002	<0.05	<0.05	0.006	-	-
SW4	15-Feb-01	73	7.1	23	0.01	-	<0.0002	<0.05	0.55	0.002	<0.05	<0.05	0.014	-	-
SW4	01-Mar-01	86	7.3	25	0.01	-	<0.0002	<0.05	1.1	0.003	0.05	<0.05	0.014	-	-
SW4	15-Mar-01	88	7.5	22	0.011	-	<0.0002	<0.05	0.96	0.003	<0.05	<0.05	0.032	-	-
SW4	01-Apr-01	100	7.4	20	0.009	-	<0.0002	<0.05	1.2	0.003	<0.05	<0.05	0.026	-	-
SW4	15-Apr-01	110	7.4	23	0.01	-	<0.0002	<0.05	1.7	0.002	<0.05	<0.05	<0.005	-	-
SW4	15-Jan-02	120	7.1	29	0.012	-	<0.0002	<0.01	0.94	<0.002	<0.05	<0.05	0.006	-	-
SW4	01-Feb-02	130	7.2	34	0.018	-	<0.0002	<0.01	0.73	0.002	<0.05	<0.05	0.02	-	-
SW4	15-Feb-02	130	7.2	29	0.01	-	<0.0002	<0.01	0.54	<0.002	<0.05	<0.05	0.006	-	-
SW4	02-Mar-02	94	7.1	20	0.009	-	<0.0002	<0.01	1.1	0.002	<0.05	<0.05	<0.005	-	-
SW4	03-Jul-04	290	8.3	72	0.009	1.1	<0.0002	<0.01	-	0.007	<0.05	<0.05	0.008	<0.05	-
SW4	Jan-05	170	7.6	26	0.012	0.5	<0.0002	0.01	-	0.002	<0.05	<0.05	0.052	<0.05	-
SW4	Feb-05	200	7.3	25	0.012	11	<0.0002	<0.01	-	0.002	<0.05	<0.05	0.034	<0.05	-
SW4	Jun-05	410	8.4	40	0.022	0.6	<0.0002	<0.01	-	<0.002	<0.05	<0.05	0.013	<0.05	-
SW4	Aug-05	770	8.4	150	0.005	-	<0.0002	0.02	-	0.007	<0.05	<0.05	0.037	-	-
SW4	26-Jan-06	120	7.1	28	0.015	-	<0.0002	0.01	1.2	0.003	<0.05	<0.05	0.046	-	-
SW4	14-Feb-06	360	4.5	140	<0.005	2.4	0.029	0.1	0.12	<0.002	2.8	0.12	0.65	<0.05	-
SW4	6-Mar-06	180	7.4	39	0.016	1.8	<0.0002	0.01	5.1	0.011	0.05	<0.05	0.04	<0.05	<0.05
SW4	27-Mar-06	65	7.2	16	0.005	0.2	<0.0002	0.01	0.46	<0.002	<0.05	<0.05	0.016	<0.05	<0.05
SW4	19-Apr-06	83	7.5	14	0.01	0.14	<0.0002	<0.01	0.81	<0.002	<0.05	<0.05	0.013	<0.05	-
SW4	17-May-06	120	8	13	0.018	0.12	<0.0002	<0.01	0.73	<0.002	<0.05	<0.05	0.006	<0.05	-
SW4	14-Jun-06	120	8	19	0.013	0.15	<0.0002	<0.01	0.51	<0.002	<0.05	<0.05	<0.005	<0.05	-
SW4	13-Jul-06	150	7.4	25	0.01	1.2	<0.0002	0.01	-	<0.002	-	<0.05	0.005	<0.05	<0.05
SW4	28-Aug-06	210	7.5	33	0.006	1.2	<0.0002	0.01	0.42	<0.002	<0.05	<0.05	0.016	<0.05	-
SW4	13-Sep-06	270	8.9	41	0.026	2	<0.0002	0.01	-	0.01	-	<0.05	0.005	<0.05	<0.05
SW4	16-Oct-06	360	8.1	46	<0.005	0.59	<0.0002	<0.01	0.48	<0.002	0.14	<0.05	0.007	<0.05	-
SW4	13-Dec-06	160	7.1	29	0.01	0.87	<0.0002	0.01	-	0.004	-	<0.05	0.03	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine
Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW5	06-Dec-96	-	6	24	<0.02	-	<0.0005	0.05	6.2	0.024	0.22	<0.05	<0.05	<0.05	-
SW5	31-Dec-96	-	6	42	<0.02	-	0.0012	0.05	4	0.023	0.51	<0.05	0.05	<0.05	-
SW5	28-Feb-97	130	5.7	50	<0.01	-	<0.0005	<0.05	0.3	0.003	0.12	<0.05	<0.05	-	-
SW5	31-Mar-97	650	5.4	420	<0.01	-	0.0046	<0.05	<0.05	<0.001	1.9	<0.05	0.2	-	-
SW5	01-Dec-97	140	7.1	47	<0.005	-	<0.0005	<0.05	0.28	0.005	0.51	<0.05	<0.05	-	-
SW5	15-Dec-97	150	6.7	39	<0.005	-	<0.0005	<0.05	2.7	0.007	0.15	<0.05	<0.05	-	-
SW5	31-Dec-97	440	4.4	190	<0.005	-	0.014	0.11	0.07	<0.002	2.1	0.11	0.6	-	-
SW5	15-Jan-98	400	4	170	<0.005	-	0.046	0.37	0.19	0.003	1.6	0.16	0.92	-	-
SW5	31-Jan-98	990	3.9	500	<0.005	-	0.14	0.86	0.12	0.005	7.6	0.47	2.5	-	-
SW5	15-Feb-98	890	3.8	560	0.056	-	0.15	1.9	0.62	0.007	6.1	0.63	2.6	-	-
SW5	01-Mar-98	790	3.6	400	<0.005	-	0.1	1.3	0.67	0.005	3.8	0.45	2.1	-	-
SW5	15-Mar-98	1700	3.2	1300	<0.005	-	0.21	4.3	2.4	0.016	8.1	1.1	4	-	-
SW5	01-Apr-98	2800	3.2	2200	<0.01	-	0.35	6.3	0.87	0.05	22	2	8.5	-	-
SW5	01-Jan-99	170	4.6	61	<0.005	-	0.0043	0.05	<0.05	<0.001	0.84	0.06	0.17	-	-
SW5	15-Jan-99	260	4.2	120	<0.005	-	0.013	0.24	<0.05	<0.001	2.1	0.09	0.41	-	-
SW5	31-Jan-99	860	3.8	450	0.014	-	0.054	0.57	0.36	0.004	6.9	0.36	1.3	-	-
SW5	15-Feb-99	320	4.2	140	<0.005	-	0.012	0.21	0.29	<0.001	2.3	0.08	0.46	-	-
SW5	01-Mar-99	340	4	140	<0.005	-	0.016	0.22	0.16	<0.002	2.7	0.15	0.54	-	-
SW5	15-Mar-99	740	3.8	400	<0.005	-	0.042	0.73	0.28	0.009	5.5	0.35	1.3	-	-
SW5	01-Apr-99	640	3.8	330	<0.005	-	0.033	0.49	0.13	0.004	5.3	0.3	0.92	-	-
SW5	15-Apr-99	1000	4.2	660	0.026	-	0.061	0.82	0.15	0.007	12	0.58	1.9	-	-
SW5	01-Jan-00	280	4	110	<0.005	-	0.011	0.15	0.08	<0.002	2.1	0.11	0.37	-	-
SW5	15-Jan-00	400	4.2	180	<0.005	-	0.018	0.21	0.07	<0.002	2.4	0.14	0.49	-	-
SW5	01-Feb-00	430	4.1	200	0.005	-	0.014	0.18	<0.05	<0.002	3.2	0.18	0.58	-	-
SW5	15-Feb-00	130	4.4	43	<0.005	-	0.0038	0.05	<0.05	<0.002	0.84	<0.05	0.12	-	-
SW5	29-Feb-00	480	3.8	210	<0.005	-	0.046	0.43	0.27	0.004	3.2	0.22	0.83	-	-
SW5	15-Mar-00	780	3.7	390	<0.005	-	0.046	0.53	0.1	0.005	5.6	0.37	1.2	-	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
SW5	01-Apr-00	1200	3.5	610	0.01	-	0.069	0.69	0.1	0.005	9.8	0.57	1.9	-	-
SW5	01-Dec-00	260	4.1	96	<0.005	-	0.0099	0.12	<0.05	<0.002	2.2	0.08	0.37	-	-
SW5	15-Dec-00	170	4	56	<0.005	-	0.0044	0.1	<0.05	<0.002	1	0.06	0.2	-	-
SW5	04-Jan-01	300	4	120	<0.005	-	0.017	0.11	<0.05	<0.002	1.8	0.12	0.55	-	-
SW5	15-Jan-01	440	4	170	<0.005	-	0.024	0.19	0.07	<0.002	2.9	0.18	0.69	-	-
SW5	01-Feb-01	480	4	190	<0.005	-	0.024	0.19	0.05	<0.002	3.6	0.19	0.68	-	-
SW5	15-Feb-01	310	4.2	130	<0.005	-	0.018	0.23	0.08	0.002	1.8	0.13	0.65	-	-
SW5	01-Mar-01	640	3.9	330	<0.005	-	0.046	0.62	0.22	0.004	4.4	0.35	1.4	-	-
SW5	15-Mar-01	350	4.3	160	<0.005	-	0.021	0.25	0.18	0.003	2.6	0.19	0.68	-	-
SW5	01-Apr-01	530	3.9	250	<0.005	-	0.022	0.38	0.24	0.003	4.4	0.32	0.94	-	-
SW5	15-Apr-01	670	3.9	330	<0.005	-	0.029	0.44	0.19	0.003	6.8	0.44	1.2	-	-
SW5	15-Jan-02	360	4.1	180	<0.005	-	0.029	0.34	0.23	<0.002	2.5	0.17	0.74	-	-
SW5	01-Feb-02	280	4.1	100	<0.005	-	0.02	0.21	0.08	<0.002	2.2	0.16	0.57	-	-
SW5	15-Feb-02	310	4.1	130	<0.005	-	0.017	0.2	0.11	<0.002	1.9	0.13	0.56	-	-
SW5	02-Mar-02	480	4	220	<0.005	-	0.047	0.44	0.16	0.004	2.7	0.27	1.1	-	-
SW5	15-Mar-02	630	3.7	280	<0.005	-	0.041	0.49	0.15	0.007	3.8	0.32	1.3	-	-
SW5	Jan-05	230	5.9	47	0.014	0.9	0.0017	0.04	-	<0.002	0.6	<0.05	0.058	<0.05	-
SW5	Feb-05	340	4.7	74	0.02	0.6	0.0036	0.04	-	<0.002	1.6	<0.05	0.14	<0.05	-
SW5	26-Jan-06	92	6.2	25	<0.005	-	0.0022	0.01	0.26	<0.002	0.31	<0.05	0.078	-	-
SW5	14-Feb-06	60	7.1	18	<0.005	2.9	<0.0002	0.01	1.9	0.005	<0.05	<0.05	0.011	<0.05	-
SW5	6-Mar-06	770	5.5	300	<0.005	2.3	0.039	0.04	0.08	<0.002	6	0.22	1.2	<0.05	0.35
SW5	27-Mar-06	660	4.1	310	<0.005	21	0.13	0.92	0.36	0.003	4.6	0.43	2.9	<0.05	0.44
SW5	19-Apr-06	940	4	510	0.005	44	0.17	1.7	0.22	0.005	6.2	0.67	4.4	<0.05	-
SW5	17-May-06	1400	3.5	810	0.007	77	0.24	2.5	0.39	0.006	10	1	6	<0.05	-
SW5	13-Jul-06	380	4	190	<0.005	4.3	0.071	0.51	-	<0.002	-	0.16	1.3	<0.05	0.17
SW5	13-Dec-06	230	4.1	64	<0.005	1.9	0.013	0.09	-	<0.002	-	0.05	0.32	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envisciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SW6	07-Jun-98	76	7.5	8	<0.005	-	<0.0005	<0.05	1.1	0.009	<0.05	<0.05	<0.05	-	-
SW6	01-Jan-99	120	7.7	2	<0.005	-	<0.0002	<0.05	2	0.019	0.06	<0.05	0.058	-	-
SW6	15-Jan-99	85	6.5	26	<0.005	-	0.0014	<0.05	0.59	<0.001	0.34	<0.05	0.054	-	-
SW6	15-Feb-99	46	6.1	13	<0.005	-	<0.0002	<0.05	0.63	<0.001	0.14	<0.05	0.019	-	-
SW6	01-Mar-99	98	6.9	23	<0.005	-	0.0007	<0.05	1.9	0.005	0.21	<0.05	0.03	-	-
SW6	01-Apr-99	89	6.8	18	<0.005	-	0.0005	<0.05	1	0.004	<0.05	<0.05	0.039	-	-
SW6	01-Jan-00	110	7.2	16	<0.005	-	<0.0002	<0.05	2.9	0.004	<0.05	<0.05	0.049	-	-
SW6	15-Jan-00	110	7.2	4	<0.005	-	<0.0002	<0.05	3.5	0.007	0.08	<0.05	0.047	-	-
SW6	01-Feb-00	110	9	25	<0.005	-	<0.0002	<0.05	1.4	0.006	0.13	<0.05	0.042	-	-
SW6	15-Feb-00	93	6.6	24	<0.005	-	0.0004	<0.05	2	0.004	0.19	<0.05	0.042	-	-
SW6	29-Feb-00	84	6.6	25	<0.005	-	0.0003	<0.05	0.74	0.003	0.05	<0.05	0.026	-	-
SW6	15-Mar-00	80	7.8	5	<0.005	-	<0.0002	<0.05	0.96	0.013	<0.05	<0.05	0.027	-	-
SW6	01-Apr-00	88	7.2	6	<0.005	-	<0.0002	<0.05	0.65	0.006	<0.05	<0.05	0.024	-	-
SW6	15-Dec-00	56	5.3	19	<0.005	-	0.0003	<0.05	0.29	<0.002	<0.05	<0.05	0.024	-	-
SW6	04-Jan-01	100	7.1	25	<0.005	-	<0.0002	<0.05	4	0.007	0.08	<0.05	0.014	-	-
SW6	15-Jan-01	100	7.4	26	<0.005	-	<0.0002	<0.05	3.8	0.007	<0.05	<0.05	0.009	-	-
SW6	01-Feb-01	110	7.8	27	<0.005	-	<0.0002	<0.05	3.7	0.007	<0.05	<0.05	0.006	-	-
SW6	15-Feb-01	63	7.2	20	<0.005	-	<0.0002	<0.05	0.66	0.003	<0.05	<0.05	0.012	-	-
SW6	01-Mar-01	66	7	19	<0.005	-	<0.0002	<0.05	0.95	0.003	<0.05	<0.05	0.016	-	-
SW6	15-Mar-01	50	7.4	16	<0.005	-	<0.0002	<0.05	0.76	0.004	0.07	<0.05	0.021	-	-
SW6	01-Apr-01	68	7.2	15	0.009	-	<0.0002	<0.05	2.9	0.004	0.07	<0.05	0.006	-	-
SW6	15-Apr-01	88	7.5	12	0.011	-	<0.0002	<0.05	3.8	0.008	0.1	<0.05	0.012	-	-
SW6	15-Jan-02	92	6.9	12	0.014	-	<0.0002	<0.01	2.9	0.004	0.06	<0.05	0.023	-	-
SW6	01-Feb-02	72	7	12	0.015	-	<0.0002	<0.01	2.3	0.008	0.07	<0.05	0.037	-	-
SW6	15-Feb-02	110	6.4	33	<0.005	-	0.0005	0.01	0.82	0.004	0.17	<0.05	0.064	-	-
SW6	02-Mar-02	70	5.7	14	<0.005	-	0.0002	<0.01	1.2	0.006	0.07	<0.05	0.022	-	-
SW6	03-Jul-04	340	8.4	43	0.01	350	<0.0002	<0.01	-	0.047	0.14	<0.05	0.026	<0.05	-
SW6	Jan-05	200	8.4	17	<0.005	5.4	<0.0002	0.01	-	0.008	<0.05	<0.05	0.015	<0.05	-
SW6	Feb-05	230	7.8	21	<0.005	17	<0.0002	0.01	-	0.008	0.08	<0.05	0.015	<0.05	-
SW6	Aug-05	480	8.8	15	<0.005	-	<0.0002	0.01	2.7	0.006	<0.05	<0.05	0.019	-	-
SW6	Sep-05	390	8.5	9	<0.005	5.1	<0.0002	0.01	-	0.009	0.1	<0.05	0.016	<0.05	-
SW6	26-Jan-06	160	7.8	18	<0.005	-	<0.0002	<0.01	2.1	0.003	0.06	<0.05	0.012	-	-
SW6	14-Feb-06	60	7.1	18	<0.005	2.9	<0.0002	0.01	1.9	0.005	<0.05	<0.05	0.011	<0.05	-
SW6	6-Mar-06	77	7.3	16	<0.005	2.5	<0.0002	0.01	2.4	0.003	<0.05	<0.05	0.009	<0.05	<0.05
SW6	27-Mar-06	32	6.6	18	<0.005	27	<0.0002	<0.01	0.63	0.002	<0.05	<0.05	0.009	<0.05	<0.05
SW6	19-Apr-06	56	7.1	22	<0.005	2.1	<0.0002	<0.01	1.6	0.003	<0.05	<0.05	0.033	<0.05	-
SW6	17-May-06	63	7.5	21	<0.005	0.82	<0.0002	<0.01	0.39	0.002	<0.05	<0.05	0.013	<0.05	-
SW6	14-Jun-06	63	7.8	10	<0.005	0.74	<0.0002	<0.01	0.57	<0.002	<0.05	<0.05	<0.005	<0.05	-
SW6	13-Jul-06	71	7	9	<0.005	3.2	<0.0002	<0.01	-	0.002	-	<0.05	0.013	<0.05	<0.05
SW6	28-Aug-06	91	7.8	11	<0.005	14	<0.0002	0.01	1.1	0.003	<0.05	<0.05	0.013	<0.05	-
SW6	13-Sep-06	98	7.9	10	<0.005	4.2	<0.0002	<0.01	-	0.004	-	<0.05	0.011	<0.05	-
SW6	16-Oct-06	130	7.8	<2	<0.005	3.3	<0.0002	<0.01	1.7	0.004	<0.05	<0.05	0.016	<0.05	-
SW6	13-Dec-06	140	7.5	17	<0.005	2.9	<0.0002	<0.01	-	0.006	-	<0.05	0.016	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envisciences (2001)

Release

Croydon Gold Mine

Water Quality Monitoring Data

Groundwater Monitoring Sites															
Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
BH1	01-Mar-96	985	7.9	520	0.08	-	<0.0005	<0.05	1.08	<0.1	-	-	0.1	-	-
BH1	31-May-96	1195	7.2	430	0.04	-	0.0008	<0.05	<0.05	<0.05	-	-	<0.05	-	-
BH1	23-Sep-96	1100	7	350	<0.02	-	<0.0005	<0.05	0.6	0.08	-	-	0.05	-	-
BH1	02-Jan-97	1000	7	370	<0.02	-	<0.0005	<0.05	0.32	0.065	-	-	0.07	-	-
BH1	31-Mar-97	1100	7.4	410	-	-	-	-	0.16	-	-	-	-	-	-
BH1	24-Jun-97	1100	7.5	310	-	-	-	-	<0.05	-	-	-	-	-	-
BH1	04-Oct-97	1300	6.9	440	-	-	-	-	2	-	-	-	-	-	-
BH1	05-Dec-97	1500	6.9	480	-	-	-	-	3.2	-	-	-	-	-	-
BH1	18-Mar-98	1300	7.5	430	0	-	-	-	0.4	-	-	-	-	-	-
BH1	07-Jun-98	1300	6.9	430	-	-	-	-	<0.05	-	-	-	-	-	-
BH1	21-Sep-98	1300	7.2	420	-	-	-	-	0.14	-	-	-	-	-	-
BH1	06-Dec-98	1200	7.2	470	-	-	-	-	0.12	-	-	-	-	-	-
BH1	01-Apr-99	1300	6.9	490	-	-	-	-	0.13	-	-	-	-	-	-
BH1	28-Jun-99	1200	7.4	460	-	-	-	-	0.19	-	-	-	-	-	-
BH1	20-Sep-99	1200	6.9	430	-	-	-	-	0.11	-	-	-	-	-	-
BH1	01-Jan-00	1300	7.2	440	-	-	-	-	0.07	-	-	-	-	-	-
BH1	01-Mar-00	1300	7.4	460	-	-	-	-	<0.05	-	-	-	-	-	-
BH1	28-Jun-00	1300	7.2	470	-	-	-	-	0.13	-	-	-	-	-	-
BH1	29-Sep-00	1300	7.3	470	-	-	-	-	<0.05	-	-	-	-	-	-
BH1	07-Jan-01	1400	7.5	450	-	-	-	-	<0.05	-	-	-	-	-	-
BH1	15-Mar-01	1300	7.8	450	-	-	-	-	2	-	-	-	-	-	-
BH1	11-Jun-01	1300	7.4	480	-	-	-	-	0.08	-	-	-	-	-	-
BH1	11-Jun-01	1300	7.4	480	-	-	-	-	0.08	-	-	-	-	-	-
BH1	24-Sep-01	1300	7.3	440	-	-	-	-	<0.05	-	-	-	-	-	-
BH1	13-Dec-01	1200	7.5	490	-	-	-	-	1.7	-	-	-	-	-	-
BH1	02-Mar-02	1300	7.6	540	-	-	-	-	0.21	-	-	-	-	-	-
BH1	02-Jul-02	1400	7.2	490	-	-	-	-	0.09	-	-	-	-	-	-
BH1	03-Jul-04	1300	7.4	470	0.022	<0.05	<0.0002	<0.01	-	<0.002	0.1	<0.05	0.036	<0.05	-
BH1	01-Sep-05	1200	7.1	500	0.013	<0.05	<0.0002	0.01	<0.05	<0.002	<0.05	<0.05	0.032	<0.05	-
BH1	01-Mar-06	1400	7	450	0.012	<0.05	<0.0002	<0.01	0.06	<0.002	0.05	<0.05	0.072	<0.05	-
BH1	01-Jun-06	1200	7.4	470	0.016	<0.05	<0.0002	<0.01	<0.05	0.002	<0.05	<0.05	0.032	<0.05	<0.05
BH1	01-Aug-06	1300	7.3	460	0.015	<0.05	<0.0002	<0.01	0.09	<0.002	0.11	<0.05	0.023	<0.05	-
BH1	01-Dec-06	1300	7.1	530	0.017	<0.05	<0.0002	<0.01	-	<0.002	-	<0.05	0.042	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Released

Croydon Gold Mine
Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
BH2	01-Mar-96	797	4.2	520	0.07	-	<0.0005	<0.05	12	0.4	-	-	0.34	-	-
BH2	31-May-96	1082	3.3	460	<0.02	-	0.0028	<0.05	0.95	0.06	-	-	0.37	-	-
BH2	23-Sep-96	950	3.1	370	0.03	-	<0.0005	<0.05	17	<0.05	-	-	0.23	-	-
BH2	02-Jan-97	900	3.3	420	0.12	-	<0.0005	<0.05	27	0.022	-	-	0.27	-	-
BH2	31-Mar-97	1300	3.4	850	-	-	-	-	2.8	-	-	-	-	-	-
BH2	24-Jun-97	970	3.5	370	-	-	-	-	1	-	-	-	-	-	-
BH2	04-Oct-97	1200	3.4	480	-	-	-	-	11	-	-	-	-	-	-
BH2	05-Dec-97	1200	3.4	480	-	-	-	-	0.54	-	-	-	-	-	-
BH2	18-Mar-98	1300	3.3	570	-	-	-	-	1.3	-	-	-	-	-	-
BH2	07-Jun-98	1300	3.3	550	-	-	-	-	1.3	-	-	-	-	-	-
BH2	21-Sep-98	1100	3.3	430	-	-	-	-	0.5	-	-	-	-	-	-
BH2	06-Dec-98	1100	3.8	500	-	-	-	-	6.9	-	-	-	-	-	-
BH2	01-Apr-99	1200	3.5	620	-	-	-	-	6.5	-	-	-	-	-	-
BH2	28-Jun-99	1200	3.5	540	-	-	-	-	0.19	-	-	-	-	-	-
BH2	20-Sep-99	1000	3.7	440	-	-	-	-	12	-	-	-	-	-	-
BH2	01-Jan-00	920	3.8	380	-	-	-	-	11	-	-	-	-	-	-
BH2	01-Mar-00	1100	3.5	480	-	-	-	-	0.73	-	-	-	-	-	-
BH2	28-Jun-00	980	3.8	440	-	-	-	-	8.9	-	-	-	-	-	-
BH2	29-Sep-00	1100	3.6	490	-	-	-	-	3.3	-	-	-	-	-	-
BH2	07-Jan-01	1000	3.5	400	-	-	-	-	6.9	-	-	-	-	-	-
BH2	15-Mar-01	1200	3.7	540	-	-	-	-	0.47	-	-	-	-	-	-
BH2	11-Jun-01	1200	3.5	520	-	-	-	-	0.3	-	-	-	-	-	-
BH2	24-Sep-01	1200	3.4	520	-	-	-	-	4.1	-	-	-	-	-	-
BH2	13-Dec-01	950	3.9	470	-	-	-	-	15	-	-	-	-	-	-
BH2	02-Mar-02	1200	3.6	600	-	-	-	-	0.11	-	-	-	-	-	-
BH2	02-Jul-02	1200	3.4	530	-	-	-	-	0.92	-	-	-	-	-	-
BH2	03-Jul-04	890	3.6	360	<0.005	1.4	0.0007	<0.01	-	0.007	1.2	0.09	0.36	<0.05	-
BH2	01-Sep-05	740	3.5	310	<0.005	1.6	0.0007	0.05	0.21	0.1	1	0.05	0.51	<0.05	-
BH2	01-Mar-06	820	3.7	260	<0.005	2.3	0.0005	<0.01	0.07	0.053	1	0.05	0.28	<0.05	-
BH2	01-Jun-06	750	3.6	320	<0.005	1.6	0.0007	0.01	<0.05	0.057	0.95	0.05	0.37	<0.05	<0.05
BH2	01-Aug-06	830	3.7	350	<0.005	2.6	0.0007	0.02	0.11	0.011	1.1	0.05	0.37	<0.05	-
BH2	01-Dec-06	820	3.6	350	<0.005	1.7	0.0006	<0.01	-	0.016	-	<0.05	0.34	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envisciences (2001)

Croydon Gold Mine
Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
BH3	31-May-96	928	7.2	260	0.03	-	0.0009	<0.05	1.75	<0.05	-	-	<0.05	-	-
BH3	23-Sep-96	3000	6.8	990	0.03	-	<0.0005	<0.05	0.3	<0.05	-	-	<0.05	-	-
BH3	02-Jan-97	170	5.6	54	<0.02	-	<0.0005	<0.05	0.82	0.072	-	-	0.09	-	-
BH3	31-Mar-97	210	6.1	66	-	-	-	-	0.36	-	-	-	-	-	-
BH3	24-Jun-97	300	6.4	79	-	-	-	-	0.38	-	-	-	-	-	-
BH3	04-Oct-97	730	6.6	180	-	-	-	-	0.54	-	-	-	-	-	-
BH3	05-Dec-97	820	7.1	210	-	-	-	-	0.5	-	-	-	-	-	-
BH3	18-Mar-98	1100	5.9	310	-	-	-	-	<0.05	-	-	-	-	-	-
BH3	07-Jun-98	960	6	260	-	-	-	-	<0.05	-	-	-	-	-	-
BH3	21-Sep-98	1200	6.6	330	-	-	-	-	<0.05	-	-	-	-	-	-
BH3	06-Dec-98	1400	6.9	420	-	-	-	-	<0.05	-	-	-	-	-	-
BH3	01-Apr-99	270	5.8	84	-	-	-	-	0.16	-	-	-	-	-	-
BH3	28-Jun-99	310	6.4	95	-	-	-	-	0.44	-	-	-	-	-	-
BH3	20-Sep-99	800	6.9	210	-	-	-	-	0.13	-	-	-	-	-	-
BH3	01-Jan-00	180	5.5	47	-	-	-	-	0.16	-	-	-	-	-	-
BH3	01-Mar-00	130	5.8	47	-	-	-	-	<0.05	-	-	-	-	-	-
BH3	28-Jun-00	230	6.2	76	-	-	-	-	0.47	-	-	-	-	-	-
BH3	29-Sep-00	360	6.9	100	-	-	-	-	0.18	-	-	-	-	-	-
BH3	07-Jan-01	110	5.9	220	-	-	-	-	0.54	-	-	-	-	-	-
BH3	15-Mar-01	120	6.3	63	-	-	-	-	0.22	-	-	-	-	-	-
BH3	11-Jun-01	270	6.7	73	-	-	-	-	0.86	-	-	-	-	-	-
BH3	24-Sep-01	370	6.8	100	-	-	-	-	0.58	-	-	-	-	-	-
BH3	13-Dec-01	730	7.1	200	-	-	-	-	0.25	-	-	-	-	-	-
BH3	02-Mar-02	110	5.8	20	-	-	-	-	0.15	-	-	-	-	-	-
BH3	02-Jul-02	370	6.6	74	-	-	-	-	<0.05	-	-	-	-	-	-
BH3	01-Mar-06	340	5.8	130	<0.005	0.07	<0.0002	0.01	<0.05	<0.002	<0.05	<0.05	0.015	<0.05	-
BH3	01-Jun-06	230	6.4	64	<0.005	0.81	<0.0002	<0.01	0.26	0.003	<0.05	<0.05	<0.005	<0.05	<0.05
BH3	01-Aug-06	800	6.7	210	0.009	2.1	<0.0002	0.01	0.28	<0.002	<0.005	<0.05	0.006	<0.05	-
BH3	01-Dec-06	250	6	49	<0.005	0.46	<0.0002	<0.01	-	0.007	-	<0.05	0.019	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
BH4	03-Jul-04	4800	7.2	1400	<0.005	<0.05	<0.0002	<0.01	-	<0.002	<0.05	<0.05	0.04	<0.05	-
BH4	01-Sep-05	5200	8.6	1400	<0.005	0.19	<0.0002	0.05	<0.05	0.006	<0.05	<0.05	0.028	<0.05	-
BH4	01-Mar-06	5100	7.4	1200	<0.005	<0.05	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.008	<0.05	-
BH4	01-Jun-06	4800	7.8	1600	<0.005	0.37	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.008	<0.05	<0.05
BH4	01-Aug-06	5700	7	1800	<0.005	0.05	0.0003	<0.01	<0.05	<0.002	<0.05	<0.05	0.02	<0.05	-
BH4	01-Dec-06	5800	7	1500	<0.05	<0.05	<0.002	<0.01	-	<0.02	-	<0.05	0.015	<0.05	-
BH5	03-Jul-04	4900	7.4	1700	0.006	<0.05	0.0002	<0.01	-	<0.002	<0.05	<0.05	<0.005	<0.05	-
BH5	01-Sep-05	5000	7.7	1600	<0.005	0.06	<0.0002	0.01	<0.05	<0.002	<0.05	<0.05	0.01	<0.05	-
BH5	01-Mar-06	5400	7.5	1400	<0.005	<0.05	<0.0002	0.01	<0.05	<0.002	0.05	<0.05	0.01	<0.05	-
BH5	01-Jun-06	5100	7.8	1800	0.006	0.29	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.008	<0.05	<0.05
BH5	01-Aug-06	5400	7.6	2000	0.006	0.06	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.014	<0.05	-
BH5	01-Dec-06	5600	7.5	1800	<0.05	<0.05	<0.002	<0.01	-	<0.02	-	<0.05	0.015	<0.05	-
BH6	03-Jul-04	1300	7.4	270	0.028	0.14	<0.0002	<0.01	-	0.004	<0.05	<0.05	0.005	<0.05	-
BH6	01-Sep-05	2200	6.9	530	0.013	0.14	0.0002	0.01	0.06	<0.002	0.68	<0.05	0.019	<0.05	-
BH6	01-Mar-06	980	7	160	0.021	2.1	<0.0002	0.02	0.72	0.004	0.19	<0.05	0.013	<0.05	-
BH6	01-Jun-06	860	7.2	210	0.048	0.33	<0.0002	<0.01	0.76	0.004	<0.05	<0.05	0.006	<0.05	<0.05
BH6	01-Aug-06	760	7	120	0.024	6.6	<0.0002	0.02	3.1	0.009	<0.05	<0.05	0.029	<0.05	-
BH6	01-Dec-06	860	7.3	140	0.028	2.3	<0.0002	0.01	-	0.015	-	<0.05	0.021	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
BH7	31-May-96	6530	6.3	2000	0.1	-	0.0016	<0.05	<0.05	<0.05	-	-	0.07	-	-
BH7	23-Sep-96	6000	6.2	350	<0.1	-	<0.003	<0.05	0.52	<0.05	-	-	<0.05	-	-
BH7	02-Jan-97	6100	6	1900	<0.02	-	0.0014	<0.05	0.82	0.056	-	-	0.16	-	-
BH7	31-Mar-97	7400	6.1	2300	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	24-Jun-97	6700	6.3	1600	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	04-Oct-97	7100	6.3	2000	-	-	-	-	0.24	-	-	-	-	-	-
BH7	05-Dec-97	7600	6.6	1900	-	-	-	-	0.07	-	-	-	-	-	-
BH7	18-Mar-98	6600	7.4	1700	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	07-Jun-98	7100	6.9	1900	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	21-Sep-98	7500	6.7	1900	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	06-Dec-98	7600	6.5	2300	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	01-Apr-99	7500	6.4	2000	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	28-Jun-99	7300	6.6	1900	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	20-Sep-99	7500	6.6	2000	-	-	-	-	0.14	-	-	-	-	-	-
BH7	01-Jan-00	7500	6.4	780	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	01-Mar-00	7800	6.4	2000	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	28-Jun-00	7600	6.6	2300	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	29-Sep-00	8000	6.6	2300	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	07-Jan-01	8000	6.8	2200	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	15-Mar-01	7900	7	2200	-	-	-	-	0.06	-	-	-	-	-	-
BH7	11-Jun-01	8300	6.7	2300	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	24-Sep-01	8000	6.8	2400	-	-	-	-	0.1	-	-	-	-	-	-
BH7	13-Dec-01	8100	7.1	2600	-	-	-	-	0.27	-	-	-	-	-	-
BH7	02-Mar-02	8700	6.5	2200	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	02-Jul-02	8100	6.6	1900	-	-	-	-	<0.05	-	-	-	-	-	-
BH7	03-Jul-04	7400	6.8	2100	<0.01	0.16	0.0009	<0.01	-	<0.005	<0.05	<0.05	0.052	<0.05	-
BH7	01-Sep-05	6600	7.1	1600	<0.005	0.05	0.0005	<0.01	<0.05	<0.002	<0.05	<0.05	0.081	<0.05	-
BH7	01-Mar-06	7000	7	1400	<0.05	<0.05	0.0004	0.01	<0.05	<0.002	<0.05	<0.05	0.034	<0.05	-
BH7	01-Jun-06	6400	7	1800	<0.005	<0.05	0.0005	<0.01	<0.05	<0.002	<0.05	<0.05	0.029	<0.05	<0.05
BH7	01-Aug-06	7000	6.8	2100	<0.005	<0.05	0.0006	0.01	0.09	<0.002	0.08	<0.05	0.04	<0.05	-
BH7	01-Dec-06	7100	6.7	1900	<0.05	<0.05	<0.002	<0.01	-	<0.02	-	<0.05	0.05	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosiences (2001)

Released

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
GBMB1	01-Mar-96	805	7.8	200	<0.02	-	0.0005	<0.05	1.96	0.9	1	-	0.15	-	-
GBMB1	31-May-96	1045	7.4	180	0.03	-	0.0013	0.08	0.86	<0.05	1.6	-	0.05	-	-
GBMB1	23-Sep-96	800	6.6	240	<0.02	-	0.0009	<0.05	11	1.4	1.8	-	0.24	-	-
GBMB1	02-Jan-97	760	6.5	220	<0.02	-	<0.0005	0.15	3.9	0.13	1.6	-	0.09	-	-
GBMB1	31-Mar-97	810	6.9	200	<0.01	-	<0.0005	<0.05	1.6	0.018	1.6	-	<0.05	-	-
GBMB1	24-Jun-97	770	6.6	190	<0.005	-	<0.0005	<0.05	2.5	0.051	-	-	<0.05	-	-
GBMB1	04-Oct-97	810	6.6	240	0.025	-	0.0051	<0.05	3.4	0.21	-	-	0.08	-	-
GBMB1	05-Dec-97	860	6.7	220	0.022	-	<0.0005	<0.05	2.8	0.008	-	-	<0.05	-	-
GBMB1	07-Jun-98	790	6.4	220	0.024	-	0.0041	<0.05	3.6	0.13	-	-	<0.05	-	-
GBMB1	21-Sep-98	760	6.6	230	0.013	-	0.005	<0.05	0.16	0.008	1.6	-	0.042	-	-
GBMB1	06-Dec-98	700	6.8	260	0.007	-	0.0091	<0.05	0.14	0.006	1.6	-	0.045	-	-
GBMB1	28-Jun-99	710	6.6	230	0.005	-	0.0045	<0.05	0.2	0.013	1.6	-	0.019	-	-
GBMB1	20-Sep-99	710	6.3	210	<0.005	-	0.0023	<0.05	0.63	0.006	1.1	-	0.011	-	-
GBMB1	01-Jan-00	720	6.3	240	0.019	-	0.0069	<0.05	3.8	0.035	1.8	-	0.031	-	-
GBMB1	28-Jun-00	690	6.6	250	<0.01	-	0.0042	<0.05	3.5	0.05	1.7	-	0.012	-	-
GBMB1	29-Sep-00	700	6.6	190	0.006	-	0.0038	<0.05	1.2	0.12	1.4	-	0.016	-	-
GBMB1	Aug-05	750	6.7	150	0.034	-	0.0067	0.01	0.08	<0.002	1.4	<0.05	0.047	-	-
GBMB1	01-Mar-06	160	6.4	36	0.009	<0.05	0.0005	<0.01	<0.05	<0.002	0.26	<0.05	0.014	<0.05	-
GBMB1	01-Jun-06	450	6.6	91	0.023	<0.05	0.0006	<0.01	<0.05	<0.002	0.46	<0.05	0.026	<0.05	<0.05
GBMB2	31-May-96	2220	7.5	680	<0.02	-	0.0082	<0.05	0.06	<0.05	<0.05	-	<0.05	-	-
GBMB2	23-Sep-96	2000	7.3	640	<0.02	-	0.0012	<0.05	0.19	<0.05	1.3	-	0.07	-	-
GBMB2	02-Jan-97	1900	7.2	660	<0.02	-	0.0005	<0.05	0.53	0.022	1	-	<0.05	-	-
GBMB2	31-Mar-97	2100	7.2	800	<0.01	-	<0.0005	<0.05	0.2	0.014	0.69	-	<0.05	-	-
GBMB2	24-Jun-97	2100	7.8	600	<0.005	-	0.0013	<0.05	0.16	0.01	-	-	<0.05	-	-
GBMB2	04-Oct-97	2400	6.9	680	<0.005	-	<0.0005	<0.05	2.8	0.022	-	-	0.07	-	-
GBMB2	05-Dec-97	2700	6.9	670	<0.005	-	<0.0005	<0.05	0.82	0.003	-	-	0.07	-	-
GBMB2	07-Jun-98	2400	7	680	<0.005	-	<0.0005	<0.05	0.16	<0.001	-	-	0.17	-	-
GBMB2	21-Sep-98	4000	7.2	670	<0.005	-	0.0002	<0.05	0.09	0.002	0.58	-	0.28	-	-
GBMB2	06-Dec-98	2300	7.2	780	<0.005	-	<0.0002	<0.05	<0.05	<0.001	0.38	-	0.085	-	-
GBMB2	01-Apr-99	2400	6.8	680	<0.005	-	<0.0002	<0.05	0.1	<0.002	0.37	-	0.078	-	-
GBMB2	28-Jun-99	2300	7	720	<0.005	-	<0.0002	<0.05	<0.05	<0.002	0.43	-	0.12	-	-
GBMB2	20-Sep-99	2400	6.8	690	<0.005	-	<0.0002	<0.05	0.13	<0.002	1.5	-	0.019	-	-
GBMB2	01-Jan-00	2400	7	690	0.006	-	<0.0002	<0.05	<0.05	0.004	1.4	-	0.018	-	-
GBMB2	01-Mar-00	2300	6.8	580	<0.005	-	<0.0002	<0.05	<0.05	<0.002	1.3	-	0.007	-	-
GBMB2	28-Jun-00	2200	7.2	820	<0.005	-	<0.0002	<0.05	0.1	<0.002	1.2	-	0.047	-	-
GBMB2	29-Sep-00	2300	7.2	720	<0.005	-	<0.0002	<0.05	<0.05	<0.002	1.1	-	0.01	-	-
GBMB2	07-Jan-01	2400	7.5	730	<0.005	-	<0.0002	<0.05	<0.05	<0.002	1.2	-	0.025	-	-
GBMB2	11-Jun-01	2400	7.4	740	<0.005	-	<0.0002	<0.05	<0.05	<0.002	1	-	0.011	-	-
GBMB2	03-Jul-04	260	7	790	<0.005	<0.05	<0.0002	<0.01	-	0.002	0.82	<0.05	0.034	<0.05	-
GBMB2	Aug-05	2300	7.5	180	<0.005	-	0.0003	<0.01	<0.05	0.007	0.84	<0.05	0.041	-	-
GBMB2	01-Mar-06	2600	7.3	760	<0.005	0.05	<0.0002	<0.01	<0.05	0.002	0.77	<0.05	0.014	<0.05	-
GBMB2	01-Jun-06	2200	7.7	710	0.023	0.21	<0.0002	<0.01	<0.05	0.02	0.67	<0.05	0.056	<0.05	<0.05
GBMB2	01-Aug-06	2500	7.5	700	<0.005	<0.05	<0.0002	<0.01	<0.05	<0.002	0.83	<0.05	0.03	<0.05	-
GBMB2	01-Dec-06	2700	7.2	630	<0.005	<0.05	<0.0002	<0.01	-	<0.002	-	<0.05	0.019	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
GBMB3	02-Jan-97	88	5.6	<5	<0.02	-	0.0005	<0.05	5.8	0.07	0.15	-	0.15	-	-
GBMB3	31-Mar-97	89	6	27	<0.01	-	<0.0005	<0.05	3.3	0.041	<0.05	-	<0.05	-	-
GBMB3	24-Jun-97	89	6.2	12	<0.005	-	<0.0005	<0.05	2.4	0.029	<0.05	-	<0.05	-	-
GBMB3	04-Oct-97	150	6	23	0.016	-	0.0011	<0.05	3.8	0.043	-	-	0.11	-	-
GBMB3	05-Dec-97	160	6.3	13	0.008	-	0.0007	<0.05	1.5	0.018	-	-	0.11	-	-
GBMB3	17-Mar-98	38	5.7	3	<0.005	-	<0.0005	<0.05	1.7	0.014	-	-	<0.05	-	-
GBMB3	07-Jun-98	150	5.5	2	<0.005	-	<0.0005	<0.05	1.2	0.018	-	-	0.15	-	-
GBMB3	21-Sep-98	71	5.6	4	0.018	-	<0.0002	<0.05	1.4	0.017	<0.05	-	0.12	-	-
GBMB3	06-Dec-98	83	5.9	11	0.022	-	<0.0002	<0.05	1.9	0.012	0.08	-	0.13	-	-
GBMB3	01-Apr-99	68	5.2	4	0.016	-	<0.0002	<0.05	1.5	0.037	<0.05	-	0.19	-	-
GBMB3	28-Jun-99	71	5.7	6	0.013	-	<0.0002	<0.05	2.2	0.012	<0.05	-	0.11	-	-
GBMB3	20-Sep-99	82	5.7	13	0.018	-	<0.0002	<0.05	3.1	0.008	<0.05	-	0.1	-	-
GBMB3	01-Jan-00	120	5.9	13	0.011	-	<0.0002	<0.05	3	0.013	0.16	-	0.044	-	-
GBMB3	01-Mar-00	82	5.8	16	0.006	-	<0.0002	<0.05	2	0.013	0.05	-	0.071	-	-
GBMB3	28-Jun-00	66	5.8	13	<0.01	-	<0.0002	<0.05	2.3	0.014	0.05	-	0.13	-	-
GBMB3	29-Sep-00	65	5.8	16	0.008	-	<0.0002	<0.05	2.1	0.006	0.05	-	0.11	-	-
GBMB3	07-Jan-01	83	6.4	11	0.009	-	<0.0002	<0.05	2.2	0.014	0.14	-	0.11	-	-
GBMB3	15-Mar-01	72	5.9	8	0.01	-	<0.0002	<0.05	3	0.008	0.09	-	0.094	-	-
GBMB3	11-Jun-01	69	5.7	7	0.012	-	<0.0002	<0.05	1.6	0.006	<0.05	-	0.048	-	-
GBMB3	02-Jul-02	80	5.5	11	7	-	0.008	<0.0002	<0.01	1.7	0.005	0.09	0.069	-	-
GBMB3	Aug-05	94	6.2	8	0.007	-	<0.0002	<0.01	2.3	0.009	0.12	<0.05	0.052	<0.05	-
GBMB3	01-Mar-06	110	6.3	13	0.008	4.8	<0.0002	<0.01	2.5	0.018	0.15	<0.05	0.069	<0.05	-
GBMB3	01-Jun-06	58	6.2	6	0.006	0.29	<0.0002	<0.01	1.4	0.004	<0.05	<0.05	0.043	<0.05	<0.05
GBMB3	01-Aug-06	64	6.4	3	<0.005	0.63	<0.0002	0.01	0.93	0.005	<0.05	<0.05	0.056	<0.05	-
GBMB3	01-Dec-06	64	6	3	<0.005	2.3	<0.0002	<0.01	-	0.008	-	<0.05	0.017	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
GBMB4	31-Mar-97	240	5.8	34	<0.01	-	0.0005	<0.05	0.22	0.028	<0.05	-	<0.05	-	-
GBMB4	24-Jun-97	240	6	26	<0.005	-	0.0005	<0.05	0.31	0.029	<0.05	-	<0.05	-	-
GBMB4	04-Oct-97	270	5.7	35	<0.005	-	<0.0005	<0.05	0.72	0.031	-	-	0.09	-	-
GBMB4	05-Dec-97	280	5.9	33	<0.005	-	<0.0005	<0.05	0.1	0.005	-	-	0.32	-	-
GBMB4	17-Mar-98	260	6	29	<0.005	-	<0.0005	<0.05	<0.05	0.002	-	-	0.05	-	-
GBMB4	07-Jun-98	520	5.6	31	<0.005	-	<0.0005	<0.05	<0.05	<0.001	-	-	0.11	-	-
GBMB4	21-Sep-98	290	5.8	33	<0.005	-	<0.0002	<0.05	<0.05	<0.001	<0.05	-	0.63	-	-
GBMB4	06-Dec-98	270	5.9	42	<0.005	-	<0.0002	<0.05	0.05	<0.001	<0.05	-	0.15	-	-
GBMB4	01-Apr-99	280	5.6	34	<0.005	-	<0.0002	<0.05	<0.05	0.005	<0.05	-	0.48	-	-
GBMB4	28-Jun-99	280	6	37	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.12	-	-
GBMB4	20-Sep-99	290	5.9	37	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.1	-	-
GBMB4	01-Jan-00	290	5.9	35	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.1	-	-
GBMB4	01-Mar-00	280	6.2	43	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.076	-	-
GBMB4	28-Jun-00	280	5.9	39	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.25	-	-
GBMB4	29-Sep-00	280	5.9	43	<0.005	-	0.0003	<0.05	<0.05	<0.002	<0.05	-	0.12	-	-
GBMB4	07-Jan-01	290	6	38	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.18	-	-
GBMB4	15-Mar-01	270	6.4	35	0.007	-	<0.0002	<0.05	6.6	0.008	<0.05	-	0.079	-	-
GBMB4	11-Jun-01	290	6.1	38	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.05	-	-
GBMB4	Aug-05	270	6.1	26	<0.005	0.29	<0.0002	<0.01	0.09	0.003	<0.05	<0.05	0.06	<0.05	-
GBMB4	01-Mar-06	320	6.3	17	<0.005	<0.05	<0.0002	<0.01	0.53	0.006	<0.05	<0.05	0.042	<0.05	-
GBMB4	01-Jun-06	320	6.5	20	<0.005	0.12	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.5	0.006	<0.05	<0.05
GBMB4	01-Aug-06	330	6	26	<0.005	<0.05	0.0018	<0.01	<0.05	0.002	0.05	<0.05	0.028	<0.05	-
GBMB4	01-Dec-06	350	6	32	<0.005	<0.05	<0.0002	<0.01	-	<0.002	-	0.05	0.02	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosiences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
GBMB5	31-Mar-97	71	5.9	<5	<0.01	-	0.0006	<0.05	<0.05	0.011	<0.05	-	<0.05	-	-
GBMB5	24-Jun-97	73	5.8	<5	<0.005	-	<0.0005	<0.05	0.1	0.006	<0.05	-	<0.05	-	-
GBMB5	04-Oct-97	88	5.7	<5	<0.005	-	0.0009	<0.05	0.44	0.1	-	-	0.29	-	-
GBMB5	05-Dec-97	84	5.9	<5	<0.005	-	<0.0005	<0.05	0.18	0.005	-	-	0.13	-	-
GBMB5	17-Mar-98	77	6.4	<2	<0.005	-	<0.0005	<0.05	<0.05	0.002	-	-	0.1	-	-
GBMB5	07-Jun-98	130	5.5	2	<0.005	-	<0.0005	<0.05	<0.05	<0.001	-	-	0.1	-	-
GBMB5	21-Sep-98	80	5.6	<2	<0.005	-	<0.0002	<0.05	<0.05	<0.001	<0.05	-	0.41	-	-
GBMB5	06-Dec-98	74	5.7	4	<0.005	-	<0.0002	<0.05	<0.05	<0.001	<0.05	-	0.11	-	-
GBMB5	01-Apr-99	77	5.4	2	0.006	-	<0.0002	<0.05	<0.05	0.008	<0.05	-	0.067	-	-
GBMB5	28-Jun-99	77	5.7	4	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.046	-	-
GBMB5	20-Sep-99	78	5.6	<2	<0.005	-	<0.0002	<0.05	0.11	<0.002	<0.05	-	0.061	-	-
GBMB5	01-Jan-00	78	5.6	3	0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.019	-	-
GBMB5	01-Mar-00	78	6.1	3	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.047	-	-
GBMB5	28-Jun-00	80	5.8	<2	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.11	-	-
GBMB5	29-Sep-00	79	5.7	8	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.07	-	-
GBMB5	07-Jan-01	80	5.9	4	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.087	-	-
GBMB5	15-Mar-01	80	6	3	<0.005	-	<0.0002	<0.05	<0.05	0.004	<0.05	-	0.075	-	-
GBMB5	11-Jun-01	78	6	2	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.07	-	-
GBMB5	03-Jul-04	490	7.1	13	0.091	<0.05	<0.0002	<0.01	-	<0.002	0.26	<0.05	0.01	<0.05	-
GBMB5	Aug-05	73	5.9	2	<0.005	<0.05	<0.0002	<0.01	<0.05	0.004	<0.05	<0.05	0.072	<0.05	-
GBMB5	01-Mar-06	87	6.1	<2	<0.005	<0.05	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.15	<0.05	-
GBMB5	01-Jun-06	80	6.1	<2	<0.005	0.05	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.14	<0.05	<0.05
GBMB5	01-Aug-06	88	5.7	<2	<0.005	<0.05	<0.0002	0.01	<0.05	<0.002	<0.05	<0.05	0.096	<0.05	-
GBMB5	01-Dec-06	100	5.9	2	<0.005	<0.05	<0.0002	<0.01	-	<0.002	-	<0.05	0.087	<0.05	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
GBMB6	31-Mar-97	80	5.7	<5	<0.01	-	0.0013	<0.05	<0.05	0.016	<0.05	-	<0.05	-	-
GBMB6	24-Jun-97	85	5.8	<5	<0.005	-	0.0026	<0.05	0.18	0.034	<0.05	-	<0.05	-	-
GBMB6	04-Oct-97	84	5.4	<5	<0.005	-	<0.0005	<0.05	0.16	0.049	-	-	<0.05	-	-
GBMB6	05-Dec-97	79	5.5	<5	<0.005	-	<0.0005	<0.05	0.16	0.003	-	-	<0.05	-	-
GBMB6	17-Mar-98	69	6.1	<2	<0.005	-	<0.0005	<0.05	<0.05	<0.002	-	-	<0.05	-	-
GBMB6	07-Jun-98	120	5.7	2	<0.005	-	<0.0005	<0.05	<0.05	<0.001	-	-	0.37	-	-
GBMB6	21-Sep-98	80	5.6	3	<0.005	-	<0.0002	<0.05	<0.05	<0.001	<0.05	-	0.2	-	-
GBMB6	06-Dec-98	78	5.8	6	<0.005	-	<0.0002	<0.05	<0.05	<0.001	<0.05	-	0.081	-	-
GBMB6	01-Apr-99	79	5.5	3	<0.005	-	<0.0002	<0.05	<0.05	0.003	<0.05	-	0.051	-	-
GBMB6	28-Jun-99	76	5.7	4	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.024	-	-
GBMB6	20-Sep-99	82	5.8	2	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.045	-	-
GBMB6	01-Jan-00	100	5.8	8	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.023	-	-
GBMB6	01-Mar-00	140	6	20	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.051	-	-
GBMB6	28-Jun-00	150	6.1	19	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.26	-	-
GBMB6	29-Sep-00	90	5.9	9	0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.06	-	-
GBMB6	07-Jan-01	92	6	7	0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.055	-	-
GBMB6	15-Mar-01	90	6.2	5	0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.091	-	-
GBMB6	11-Jun-01	85	6	3	0.006	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	0.029	-	-
GBMB6	03-Jul-04	66	6.8	5	0.014	<0.05	<0.0002	<0.01	-	0.002	<0.05	<0.05	0.008	<0.05	-
GBMB6	Aug-05	84	5.8	4	<0.005	<0.05	<0.0002	<0.01	<0.05	0.011	<0.05	<0.05	0.058	<0.05	-
GBMB6	01-Mar-06	580	7.1	18	0.006	0.69	<0.0002	<0.01	0.39	0.004	0.11	<0.05	0.025	<0.05	-
GBMB6	01-Jun-06	430	6.8	19	0.15	0.06	<0.0002	<0.01	30	<0.002	0.37	<0.05	<0.005	<0.05	<0.05
GBMB6	01-Aug-06	100	6.3	3	<0.005	<0.05	<0.0002	0.01	<0.05	<0.002	<0.05	<0.05	0.056	<0.05	-
GBMB6	01-Dec-06	100	5.9	<0.05	<0.005	<0.05	<0.0002	-	<0.01	-	<0.002	-	<0.05	-	-

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine
Water Quality Monitoring Data

Pit Lake Monitoring															
Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
Content Pit	05-Mar-96	-	4.2	870	0.03	-	0.019	0.86	2.04	<0.1	5	0.48	1.66	<0.1	-
Content Pit	30-Mar-96	-	3	850	<0.02	-	0.044	0.83	1.83	<0.05	5.2	0.48	1.61	<0.1	-
Content Pit	03-May-96	-	3.1	1000	0.05	-	0.045	0.78	4.82	<0.05	5.3	0.46	1.65	<0.1	-
Content Pit	30-Jun-96	-	3.2	850	0.11	-	0.0275	0.75	6.6	<0.05	5.1	0.46	1.6	<0.1	-
Content Pit	01-Aug-96	-	3.1	770	0.08	-	0.025	0.8	4.1	<0.05	6.2	0.5	1.7	<0.1	-
Content Pit	02-Sep-96	-	3.1	840	0.05	-	0.025	0.76	4.4	<0.05	6.2	0.45	1.9	<0.1	-
Content Pit	30-Oct-96	-	2.9	960	<0.02	-	0.026	0.93	4.3	<0.005	5.8	0.54	1.9	<0.05	-
Content Pit	30-Nov-96	-	3	960	0.03	-	0.03	0.9	4.2	<0.05	6	0.59	1.9	<0.05	-
Content Pit	31-Dec-96	-	3.1	1000	0.02	-	0.024	0.82	3.8	<0.005	5.2	0.55	1.8	<0.05	-
Content Pit	31-Mar-97	1700	3.3	1000	<0.01	-	0.018	0.6	4.3	0.003	5.1	0.38	1.5	-	-
Content Pit	24-Jun-97	1700	3.3	810	0.12	-	0.017	0.55	6.3	0.002	5.5	0.46	1.6	-	-
Content Pit	04-Oct-97	1800	3.1	890	0.09	-	0.026	0.52	5.9	<0.002	-	0.48	1.6	-	-
Content Pit	01-Dec-97	1900	3.3	890	0.23	-	0.022	0.59	3.8	<0.005	-	0.47	1.8	-	-
Content Pit	15-Mar-98	1300	3.3	540	0.015	-	0.0085	0.31	1.8	<0.002	3.3	0.27	0.92	-	-
Content Pit	07-Jun-98	1400	3.2	570	0.013	-	0.011	0.33	1.9	<0.001	3.3	0.31	0.99	-	-
Content Pit	21-Sep-98	1400	3.3	570	0.039	-	0.011	0.42	1.4	<0.001	4.2	0.34	1.1	-	-
Content Pit	01-Dec-98	1400	3.4	660	0.017	-	0.013	0.45	1.2	<0.001	4.2	0.33	1.2	-	-
Content Pit	01-Mar-99	1700	3.3	640	0.019	-	0.013	0.33	0.8	<0.002	3.8	0.35	1.1	-	-
Content Pit	28-Jun-99	1300	3.4	610	0.086	-	0.0097	0.29	1.5	<0.002	3.8	0.34	0.99	-	-
Content Pit	20-Sep-99	1400	3.4	570	0.024	-	0.011	0.29	1.6	<0.002	3.9	0.29	0.99	-	-
Content Pit	01-Jan-00	1400	3.3	600	0.029	-	0.013	0.28	1.3	<0.002	3.8	0.29	0.89	-	-
Content Pit	01-Mar-00	1300	3.3	560	0.011	-	0.023	0.26	1.1	<0.002	3.6	0.26	0.9	-	-
Content Pit	28-Jun-00	1300	3.5	590	0.058	-	0.0086	0.23	1.2	<0.002	3.6	0.27	0.93	-	-
Content Pit	29-Sep-00	1300	3.5	600	0.031	-	0.0072	0.22	1.2	<0.002	3.9	0.26	0.89	-	-
Content Pit	04-Jan-01	1300	3.4	550	0.012	-	0.011	0.21	0.78	<0.002	3.8	0.27	0.86	-	-
Content Pit	15-Mar-01	1200	3.7	540	0.022	-	0.009	0.2	1.2	<0.002	3.6	0.27	0.85	-	-
Content Pit	11-Jun-01	1200	3.6	560	0.038	-	0.0089	0.17	0.79	<0.002	3.6	0.25	0.78	-	-
Content Pit	24-Sep-01	1300	3.5	610	0.048	-	0.0067	0.21	1.2	<0.002	3.9	0.25	0.83	-	-
Content Pit	13-Dec-01	1300	3.5	610	0.013	-	0.008	0.21	0.81	<0.002	3.9	0.32	0.81	-	-
Content Pit	27-Mar-02	1200	3.4	520	0.061	-	0.01	0.17	0.88	<0.002	3.3	0.23	0.75	-	-
Content Pit	02-Jul-02	1300	3.5	560	0.048	-	0.011	0.16	0.71	<0.002	3.5	0.25	0.76	-	-
Content Pit	03-Jul-04	1400	3.5	700	0.035	5.8	0.0028	0.18	-	<0.002	4.6	0.3	0.95	<0.05	-
Content Pit	Sep-05	1500	3.4	600	0.045	2.9	0.0079	0.22	1.1	<0.002	5.2	0.32	1.1	<0.05	-
Content Pit	Mar-06	1800	3.4	720	0.012	6.2	0.0085	0.18	0.98	<0.002	4.9	0.28	0.92	<0.05	-
Content Pit	Jun-06	1300	3.5	600	0.039	6.2	0.0058	0.17	0.69	<0.002	4.2	0.25	0.79	<0.05	0.23
Content Pit	Dec-06	1400	3.6	780	-	4.4	0.0077	0.09	-	<0.002	-	0.24	0.8	<0.05	0.21

Source: Landline Consulting (2005 and 2006) and HLA Envirosiences (2001)

Rele

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
Golden Butterfly North Pit	05-Mar-96	-	8.2	72	0.04	-	<0.0005	<0.05	0.13	<0.1	<0.05	0.07	<0.05	<0.1	-
Golden Butterfly North Pit	30-Mar-96	-	7.7	69	0.02	-	<0.0005	0.11	0.12	<0.05	<0.05	<0.05	<0.05	<0.1	-
Golden Butterfly North Pit	03-May-96	-	7.2	57	0.02	-	<0.0005	<0.05	0.14	<0.05	<0.05	<0.05	0.1	<0.1	-
Golden Butterfly North Pit	30-Jun-96	-	7.6	64	<0.02	-	<0.0005	<0.05	0.13	<0.05	<0.05	<0.05	<0.05	<0.1	-
Golden Butterfly North Pit	01-Aug-96	-	8	60	<0.02	-	<0.0005	<0.05	0.05	<0.05	<0.05	<0.05	0.07	<0.1	-
Golden Butterfly North Pit	02-Sep-96	-	7.9	67	<0.02	-	<0.0005	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	-
Golden Butterfly North Pit	30-Oct-96	-	7.6	72	<0.02	-	<0.0005	<0.05	<0.05	<0.005	0.29	<0.05	0.07	<0.05	-
Golden Butterfly North Pit	30-Nov-96	-	7.7	72	<0.02	-	<0.0005	0.1	0.1	<0.05	<0.05	<0.05	0.22	<0.05	-
Golden Butterfly North Pit	31-Dec-96	-	7.2	59	<0.02	-	0.0087	<0.05	0.52	<0.005	<0.05	<0.05	<0.05	<0.05	-
Golden Butterfly North Pit	31-Mar-97	270	7.3	68	<0.01	-	<0.0005	<0.05	<0.05	<0.001	<0.05	<0.05	<0.05	-	-
Golden Butterfly North Pit	24-Jun-97	290	8.2	56	<0.005	-	<0.0005	<0.05	<0.05	<0.002	-	<0.05	<0.05	-	-
Golden Butterfly North Pit	04-Oct-97	350	8.3	59	<0.005	-	<0.0005	<0.05	<0.05	<0.002	-	<0.05	<0.05	-	-
Golden Butterfly North Pit	01-Dec-97	360	7.2	64	<0.005	-	<0.0005	<0.05	0.2	<0.005	<0.05	<0.05	<0.05	-	-
Golden Butterfly North Pit	15-Mar-98	220	8	39	0.01	-	<0.0005	<0.05	<0.05	<0.002	<0.05	<0.05	<0.05	-	-
Golden Butterfly North Pit	07-Jun-98	250	7.6	39	0.017	-	<0.0005	<0.05	<0.05	<0.001	<0.05	<0.05	<0.05	-	-
Golden Butterfly North Pit	21-Sep-98	250	7.9	40	0.009	-	<0.0002	<0.05	<0.05	<0.001	<0.05	<0.05	0.007	-	-
Golden Butterfly North Pit	01-Dec-98	230	8.1	55	0.006	-	<0.0002	<0.05	0.1	<0.001	<0.05	<0.05	0.008	-	-
Golden Butterfly North Pit	01-Mar-99	230	7.6	47	0.006	-	<0.0002	<0.05	0.16	<0.002	<0.05	<0.05	<0.005	-	-
Golden Butterfly North Pit	28-Jun-99	230	7.7	45	0.014	-	<0.0002	<0.05	<0.05	<0.002	<0.05	<0.05	0.006	-	-
Golden Butterfly North Pit	20-Sep-99	250	6.3	59	0.006	-	<0.0002	<0.05	<0.05	<0.002	<0.05	<0.05	0.01	-	-
Golden Butterfly North Pit	01-Jan-00	250	6.9	56	0.008	-	<0.0002	<0.05	0.24	0.003	<0.05	<0.05	0.012	-	-
Golden Butterfly North Pit	01-Mar-00	230	5.8	61	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	<0.05	<0.005	-	-
Golden Butterfly North Pit	28-Jun-00	260	5.9	60	0.007	-	<0.0002	<0.05	0.11	<0.002	0.25	<0.05	0.01	-	-
Golden Butterfly North Pit	29-Sep-00	260	7.2	64	0.006	-	<0.0002	<0.05	<0.05	<0.002	0.11	<0.05	0.006	-	-
Golden Butterfly North Pit	04-Jan-01	260	7.2	62	<0.005	-	<0.0002	<0.05	0.07	<0.002	<0.05	<0.05	<0.005	-	-
Golden Butterfly North Pit	15-Mar-01	230	7.7	59	<0.005	-	<0.0002	<0.05	0.18	<0.002	<0.05	<0.05	0.007	-	-
Golden Butterfly North Pit	24-Sep-01	260	6.8	70	0.008	-	<0.0002	<0.05	<0.05	<0.002	0.06	<0.05	0.018	-	-
Golden Butterfly North Pit	13-Dec-01	270	6.8	62	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	<0.05	0.017	-	-
Golden Butterfly North Pit	27-Mar-02	260	6.6	63	<0.005	-	0.0002	0.01	0.21	<0.002	<0.05	<0.05	0.016	-	-
Golden Butterfly North Pit	02-Jul-02	270	6.6	67	0.007	-	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.007	-	-
Golden Butterfly North Pit	03-Jul-04	310	7.4	86	0.008	0.08	<0.0002	<0.01	-	<0.002	<0.05	<0.05	0.01	<0.05	-
Golden Butterfly North Pit	Sep-05	350	7.1	88	<0.005	0.15	<0.0002	<0.01	<0.05	<0.002	<0.05	<0.05	0.017	<0.05	-
Golden Butterfly North Pit	Mar-06	330	6.7	65	<0.005	0.73	<0.0002	<0.01	0.13	<0.002	<0.05	<0.05	0.006	<0.05	-
Golden Butterfly North Pit	Jun-06	260	6.9	81	<0.005	0.13	<0.0002	<0.01	0.07	<0.002	<0.05	<0.05	<0.005	<0.05	<0.05
Golden Butterfly North Pit	Dec-06	340	6.4	90	<0.005	0.15	0.0002	<0.01	-	<0.002	-	<0.05	0.05	<0.05	<0.05

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC	pH	SO4	Arsenic	Aluminium	Cadmium	Copper	Iron	Lead	Manganese	Nickel	Zinc	Molybdenum	Cobalt
		uS/cm	units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Golden Butterfly Pit	05-Mar-96	-	3.4	8000	1.75	-	0.19	24.4	640	<0.1	140	5.6	21	<0.1	-
Golden Butterfly Pit	30-Mar-96	-	2.1	6840	2.1	-	0.21	26	680	<0.05	82	5.8	22.4	<0.1	-
Golden Butterfly Pit	03-May-96	-	2.2	6600	2.9	-	0.275	32	640	<0.05	7.8	6.8	27.8	<0.1	-
Golden Butterfly Pit	30-Jun-96	-	2.3	5500	4.5	-	0.6	33.8	1100	<0.05	69	7.7	27	<0.1	-
Golden Butterfly Pit	01-Aug-96	-	2.2	7600	48	-	0.3	34	1000	<0.05	88	7.8	28	<0.1	-
Golden Butterfly Pit	02-Sep-96	-	2.1	7400	3.5	-	0.32	34	860	<0.05	89	7.2	30	<0.1	-
Golden Butterfly Pit	30-Oct-96	-	2.1	7900	4.4	-	0.32	34	940	<0.025	79	8.7	30	<0.05	-
Golden Butterfly Pit	30-Nov-96	-	2.2	8400	3.4	-	0.33	35	890	<0.05	67	8.5	29	<0.05	-
Golden Butterfly Pit	31-Dec-96	-	2.3	7900	3.1	-	0.16	31	760	<0.005	79	8.1	28	<0.05	-
Golden Butterfly Pit	31-Mar-97	6700	2.3	7400	3.2	-	0.27	26	67	<0.01	93	4.4	22	-	-
Golden Butterfly Pit	24-Jun-97	7100	2.5	670	2.6	-	0.31	30	820	0.003	81	7.6	28	-	-
Golden Butterfly Pit	04-Oct-97	7400	2.2	7400	3	-	0.32	30	840	<0.01	34	8.4	30	-	-
Golden Butterfly Pit	01-Dec-97	7500	2.5	8300	1.6	-	0.32	33	780	<0.005	54	8.3	32	-	-
Golden Butterfly Pit	15-Mar-98	4500	2.3	3500	1.4	-	0.41	14	320	<0.002	-	3.4	12	-	-
Golden Butterfly Pit	07-Jun-98	6000	2.3	5100	2.9	-	0.21	22	500	<0.005	-	5.2	20	-	-
Golden Butterfly Pit	21-Sep-98	6900	2.3	6200	2.4	-	0.25	28	630	<0.005	73	7.1	27	-	-
Golden Butterfly Pit	01-Dec-98	6900	2.4	7400	2.6	-	0.27	30	630	<0.005	85	7.9	29	-	-
Golden Butterfly Pit	01-Mar-99	5500	2.3	5000	1	-	0.18	18	400	<0.004	54	5.2	19	-	-
Golden Butterfly Pit	28-Jun-99	6300	2.3	7200	1.8	-	0.27	27	700	<0.002	78	7.6	29	-	-
Golden Butterfly Pit	20-Sep-99	6800	2.3	6600	1.8	-	0.29	28	710	<0.002	84	7.6	31	-	-
Golden Butterfly Pit	01-Jan-00	5600	2.3	5300	1.5	-	0.21	19	450	<0.005	65	5.2	17	-	-
Golden Butterfly Pit	01-Mar-00	5400	2.3	4800	1.1	-	0.21	18	400	<0.002	56	5	18	-	-
Golden Butterfly Pit	28-Jun-00	6300	2.4	6700	1.7	-	0.26	24	520	<0.01	74	7.1	26	-	-
Golden Butterfly Pit	29-Sep-00	6700	2.4	7000	1.6	-	0.27	24	500	<0.004	76	7.2	27	-	-
Golden Butterfly Pit	04-Jan-01	6100	2.3	5600	1.3	-	0.23	20	440	<0.004	74	6.3	23	-	-
Golden Butterfly Pit	15-Mar-01	5500	2.6	5200	1	-	0.21	18	370	<0.005	56	6.5	19	-	-
Golden Butterfly Pit	11-Jun-01	6400	2.4	6400	1.3	-	0.24	21	450	<0.002	72	6.9	23	-	-
Golden Butterfly Pit	24-Sep-01	6600	2.4	7100	1.3	-	0.27	24	480	<0.005	82	7.4	26	-	-
Golden Butterfly Pit	13-Dec-01	6400	2.4	6600	1.2	-	0.28	21	440	<0.004	76	8.7	25	-	-
Golden Butterfly Pit	27-Mar-02	6200	2.3	5600	1.1	-	0.23	20	350	<0.002	65	5.9	51	-	-
Golden Butterfly Pit	02-Jul-02	6600	2.4	7300	1.1	-	0.26	21	430	<0.005	74	7.3	26	-	-
Golden Butterfly Pit	03-Jul-04	6900	2.4	7400	0.97	640	0.28	22	-	<0.005	84	7.6	22	<0.05	-
Golden Butterfly Pit	Sep-05	7000	2.3	6700	0.65	700	0.34	23	360	<0.002	89	8.5	31	<0.05	-
Golden Butterfly Pit	Mar-06	6900	2.4	5700	0.54	560	0.24	18	260	<0.002	67	7.3	25	<0.05	-
Golden Butterfly Pit	Jun-06	5500	2.4	4700	0.34	550	0.21	15	240	<0.002	60	5.9	20	<0.05	4
Golden Butterfly Pit	Dec-06	7000	2.5	6900	0.64	0.48	0.21	16	-	<0.002	-	6	22	<0.05	4.4

Source: Landline Consulting (2005 and 2006) and HLA Envisciences (2001)

Croydon Gold Mine

Water Quality Monitoring Data

Site	Analyte	EC uS/cm	pH units	SO4 mg/L	Arsenic mg/L	Aluminium mg/L	Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Nickel mg/L	Zinc mg/L	Molybdenum mg/L	Cobalt mg/L
Lady Isabella Pit	05-Mar-96	-	4.3	680	<0.02	-	0.155	1.36	0.76	<0.1	5.5	0.6	4.5	<0.1	-
Lady Isabella Pit	30-Mar-96	-	3.4	660	<0.02	-	0.185	1.38	0.62	<0.05	6.4	0.59	4.6	<0.1	-
Lady Isabella Pit	03-May-96	-	3.4	670	<0.02	-	0.365	1.45	0.32	<0.05	5.6	0.57	4.99	<0.1	-
Lady Isabella Pit	30-Jun-96	-	3.5	550	<0.02	-	0.19	1.53	0.31	<0.05	7.1	0.64	4.7	<0.1	-
Lady Isabella Pit	01-Aug-96	-	3.3	490	<0.02	-	0.15	1.58	0.3	<0.05	6.7	0.6	4.85	<0.1	-
Lady Isabella Pit	02-Sep-96	-	3.4	480	<0.02	-	0.09	1.6	0.23	<0.05	6.1	0.64	5.9	<0.1	-
Lady Isabella Pit	30-Oct-96	-	3.2	660	<0.02	-	0.22	1.7	0.92	<0.005	5.5	0.74	6.9	<0.05	-
Lady Isabella Pit	30-Nov-96	-	3.3	600	<0.02	-	0.21	1.5	0.91	<0.05	4.2	0.73	6.6	<0.05	-
Lady Isabella Pit	31-Dec-96	-	3.4	520	<0.02	-	0.02	1.4	1.3	<0.005	4.5	0.67	4.8	<0.05	-
Lady Isabella Pit	31-Mar-97	990	3.5	580	<0.01	-	0.16	1	0.46	0.005	4.5	0.43	3.5	-	-
Lady Isabella Pit	24-Jun-97	1000	3.6	450	<0.005	-	0.16	1.1	0.32	0.005	4.8	0.53	3.9	-	-
Lady Isabella Pit	04-Oct-97	1100	3.4	490	<0.005	-	0.15	1	0.48	0.004	2.4	0.53	3.8	-	-
Lady Isabella Pit	01-Dec-97	1100	3.5	530	<0.005	-	0.17	1.2	0.3	0.004	2.5	0.57	4.4	-	-
Lady Isabella Pit	15-Mar-98	730	3.5	280	<0.005	-	0.091	0.7	0.29	0.002	-	0.29	2.3	-	-
Lady Isabella Pit	07-Jun-98	750	3.5	270	<0.005	-	0.11	0.77	0.17	0.002	-	0.34	2.6	-	-
Lady Isabella Pit	21-Sep-98	810	3.5	310	0.005	-	0.094	0.91	0.11	0.003	3.2	0.37	3.1	-	-
Lady Isabella Pit	01-Dec-98	790	3.7	360	0.008	-	0.11	0.97	0.18	0.002	3.2	0.41	3.4	-	-
Lady Isabella Pit	01-Mar-99	790	3.5	330	<0.005	-	0.1	0.85	0.11	0.004	2.9	0.41	3.1	-	-
Lady Isabella Pit	28-Jun-99	800	3.5	330	<0.005	-	0.011	0.95	0.12	0.003	3.3	0.45	3.2	-	-
Lady Isabella Pit	20-Sep-99	850	3.5	340	<0.005	-	0.11	1	0.12	0.003	3.5	0.44	3.6	-	-
Lady Isabella Pit	01-Jan-00	890	3.5	370	0.013	-	0.11	0.98	0.11	0.003	3.5	0.44	3.1	-	-
Lady Isabella Pit	01-Mar-00	830	3.4	330	<0.005	-	0.12	0.9	0.06	0.003	3.2	0.4	3.2	-	-
Lady Isabella Pit	28-Jun-00	830	3.6	360	0.008	-	0.1	0.92	0.24	0.003	3.3	0.42	3.3	-	-
Lady Isabella Pit	29-Sep-00	890	3.6	380	0.005	-	0.12	0.96	0.1	0.003	3.7	0.43	3.3	-	-
Lady Isabella Pit	04-Jan-01	890	3.5	350	<0.005	-	0.11	0.95	0.1	0.003	3.6	0.44	3.3	-	-
Lady Isabella Pit	15-Mar-01	650	3.8	330	<0.005	-	0.1	0.88	0.23	0.003	3.3	0.44	3.4	-	-
Lady Isabella Pit	11-Jun-01	840	3.6	360	0.006	-	0.1	0.89	0.15	0.004	3.4	0.45	3.1	-	-
Lady Isabella Pit	24-Sep-01	890	3.6	390	0.008	-	0.11	0.99	0.38	0.002	3.8	0.46	3.4	-	-
Lady Isabella Pit	13-Dec-01	890	3.6	430	<0.005	-	0.1	1	0.21	0.003	3.9	0.6	3.4	-	-
Lady Isabella Pit	27-Mar-02	850	3.4	330	<0.005	-	0.098	0.77	0.36	0.005	3.2	0.4	3	-	-
Lady Isabella Pit	02-Jul-02	880	3.5	340	<0.005	-	0.1	0.81	0.12	0.005	3.3	0.44	3	-	-
Lady Isabella Pit	03-Jul-04	1100	3.5	610	0.005	16	0.13	1.2	-	0.003	52	0.62	4.8	<0.05	-
Lady Isabella Pit	Sep-05	1300	3.4	490	0.006	20	0.19	1.4	0.46	0.002	6.3	0.77	5.8	<0.05	-
Lady Isabella Pit	Mar-06	1300	3.4	570	0.006	16	0.14	1.1	0.66	0.003	5.6	0.61	4.5	<0.05	-
Lady Isabella Pit	Jun-06	910	3.6	390	<0.005	14	0.09	0.79	0.21	0.002	4	0.46	3.6	<0.05	0.33
Lady Isabella Pit	Dec-06	1100	3.6	530	<0.005	11	0.094	0.77	-	0.003	-	-0.48	3.6	<0.05	0.34

Source: Landline Consulting (2005 and 2006) and HLA Envirosciences (2001)

APPENDIX E

WATER LEVEL ANALYSIS OF GOLDEN BUTTERFLY PIT CROYDON GOLD MINE

From HLA-Envirosciences (2001)

Rel

Water Level Analysis of Golden Butterfly Pit Croydon Gold Mine

Prepared for

Goldfields Limited

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15 May 2001

This document was prepared for the sole use of Goldfields Limited and the regulatory agencies that are directly involved in this project, the only intended beneficiaries of our work. No other party should rely on the information contained herein without the prior written consent of HLA-Envirosciences Pty Limited and Goldfields Limited.

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F1715-3/EC, BE:ec
15 May 2001

1.0 INTRODUCTION

Goldfields Limited requested HLA-Envirosciences review the available meteorology and groundwater data for the area around the Golden Butterfly Pit and Waste Dump at the Croydon Mine in Northwest Queensland. The purpose of the review was to determine the likelihood of the pit overflowing in extreme weather conditions.

Goldfields Kalgoorlie Limited (formerly Pancontinental Mining Limited) is holder of ML 5248, just west of Croydon township in Northwest Queensland. ML 5248 was mined between 1987 to 1990. In 1993 a Decommissioning Plan was accepted by the Department of Minerals and Energy and decommissioning commenced.

The data reviewed for this study included the following:

- Rainfall and Evaporation data from Bureau of Meteorology Station 029012 – Croydon Township. Rainfall data commenced in 1889 and evaporation data commenced in 1972.
- Groundwater levels from two monitoring wells for 19 monitoring events from March 1996 through January 2001.

2.0 PRECIPITATION AND EVAPORATION

2.1 Average Monthly Precipitation and Evaporation

The Croydon Mine is located in Northwest Queensland, which is subject to very distinct monsoonal wet and dry seasons. Table 1 shows that on average, 85% of the rainfall falls from December to March, but the evaporation is spread relatively evenly throughout the year.

Month	Rainfall (mm/month)	Evap (mm/month)
Jan	218.8	202
Feb	177.0	158
Mar	115.0	189
Apr	23.1	195
May	8.2	177
Jun	8.5	147
Jul	3.4	161
Aug	2.8	198
Sep	5.7	243
Oct	14.0	279
Nov	44.5	267
Dec	111.4	248
12 Month Total	732.4	2464
Dec to Mar Total	622.2	797
Dec to Mar %	85%	31%
Apr to Nov Total	110.2	1667

Table 1 also shows that between December and March average rainfall exceeds average evaporation by only 175 mm. In a wet year, rainfall will exceed evaporation as described in the next section. During the dry months, April to November evaporation exceeds precipitation by about 1.5 metres. This means that there is no real significance to a sequence of wet or dry years. Each year will have a wet season and a dry season. In a sequence of wet years, the dry season would still cause evaporation to exceed rainfall. For this reason there is no reason to analyse a series of wet years.

2.2 Wet Season Rainfall

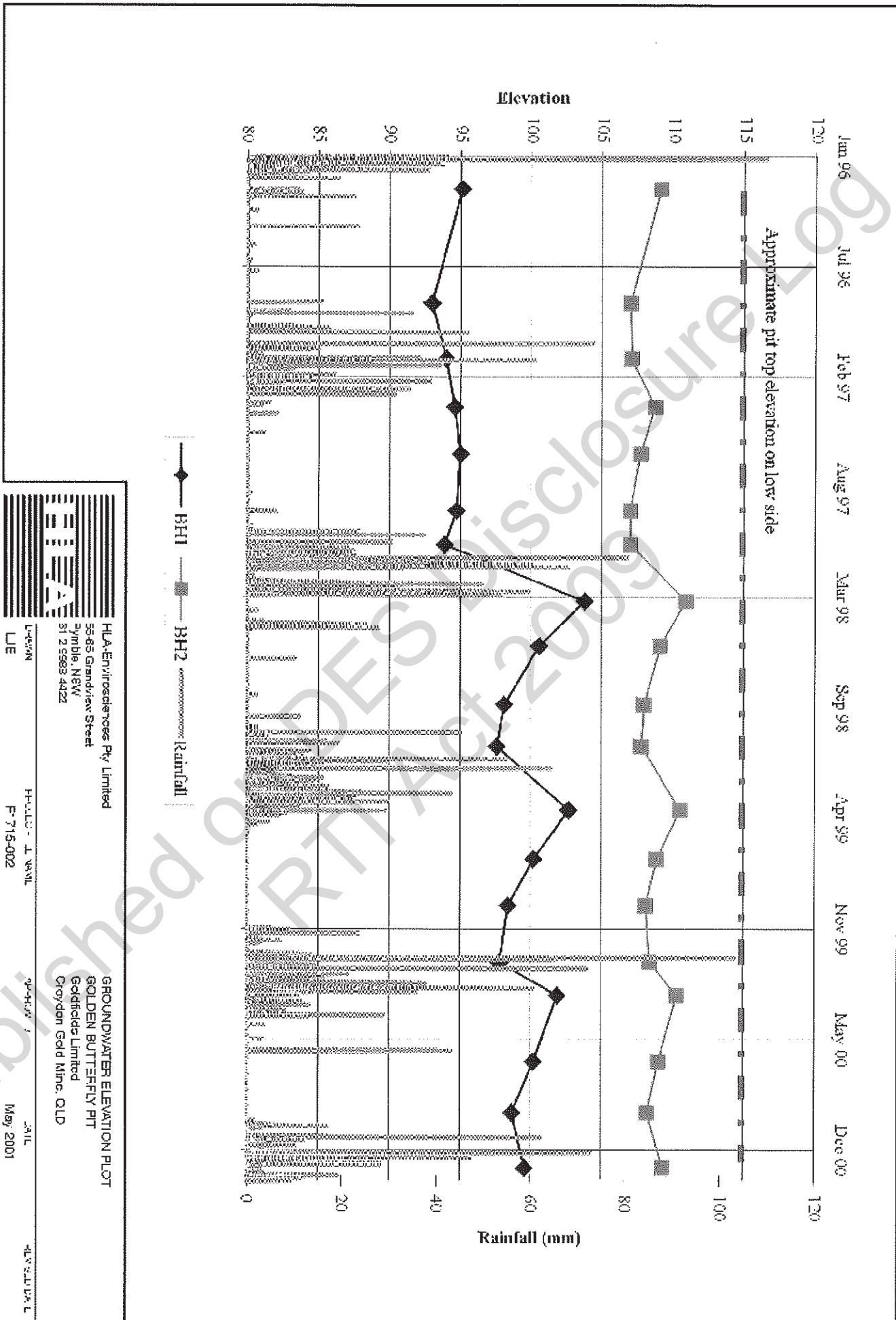
Table 2 – Ranked Rainfall from December to March, Croydon			
Wet Year	rank / 112	Year	Rainfall Dec-Mar (mm)
Wettest	1/112	1974	1611
90%	11/112	1922	942.2
80%	22/112	2001	823.8
50%	56/112	1927	647.7
20%	90/112	1926	431.3
10%	101/112	1978	378.8
Driest	112/112	1952	192.6
Average Wet Season Evaporation			797

The rainfall records at Croydon Met Station have been recorded for 112 years. **Table 2** shows that during the 80 percentile or wetter year there will be more rainfall than the average evaporation in the wet season from December to March (as shown in **Table 1**). The net additional rainfall is very small (between 0 and 0.8 m) compared to the evaporation during the dry months, when a net loss of water on the order of 1.5 metres of water is likely.

3.0 GROUNDWATER

Groundwater levels for two monitoring wells located adjacent to the Golden Butterfly Pit were evaluated for change over time and magnitude of change with rainfall. Monitoring Well BH1 is located approximately 60 metres northeast of the pit and BH2 is located approximately 50 metres southwest of the pit. The water level dataset includes 19 monitoring events from March 1996 through January 2001.

Figure 1 presents a plot of water levels in BH1 and BH2 over time, as well as daily rainfall for the period (March 1996 through January 2001). The data show a good correlation with rainfall. Water levels show a marked increase in 1998, which was the 8th wettest year on record over a 112 year period. The overall trend in groundwater levels appears to be increasing very slightly over this 5 year period. It is possible that the increase is cyclical and related to series of wet years. The rainfall in the years following 1998 were also above the mean (1999 – 0.2%; 2000 – 7.4%). The plot also shows that the equivalent water elevation in BH1 ranges from 7 to 14 metres deeper than in BH2, even though BH1 is considered to be the up gradient well.



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Figure 2 presents a southwest to northeast cross section through the pit and the monitoring wells. It shows the relative difference between the water levels in BH1 and BH2. Because the depth of the pit and the water level in the pit are not known, it is not possible to quantify the effect of the change in the pit water level has on the monitoring well levels, hence the groundwater levels surrounding the pit.

As discussed above, the historic rainfall and evaporation data indicate a relatively large deficit because of the high evaporation during 7 to 8 months of the year. Assuming that the bund surrounding the pit does not allow surface run off to enter the pit and that groundwater flows into and out of the pit at the same rate, direct rainfall would be the only source of water into the pit. There is also the possibility that the pit could be acting as a groundwater sink due to the surrounding geology and the significant amounts of water removed by evaporation. **Table 3** shows the impact of rainfall and evaporation in the wet and dry seasons and how the pit level and freeboard in the pit is affected.

Table 3 – Summary of Estimated Pit levels and Freeboard under wet and dry conditions

Wet Year	mm added by Rainfall	mm removed by Evap	Change in Pit Level	Approx Free-board [#]	mm added by Rainfall	mm removed by Evap	Change in Pit Level	Approx Free-board [#]
	December to March			1 st Apr	April to November			1 st Dec
90%	942mm	563mm	+0.4m	3.7m	84mm	1424mm	-1.3m	5.0m
50%	648mm	662mm	0.0m	4.1m	57mm	1381mm	-1.3m	5.4m
10%	379mm	1011mm	-0.6m	4.7m	56mm	1841mm	-1.8m	6.5m

[#] - assumes starting pit water level of RL110.9 (worst case of all readings, BH2 18 march 1998) and lowest pit top level of RL115.0 (based on Woodward-Clyde Plan dated July 1996)

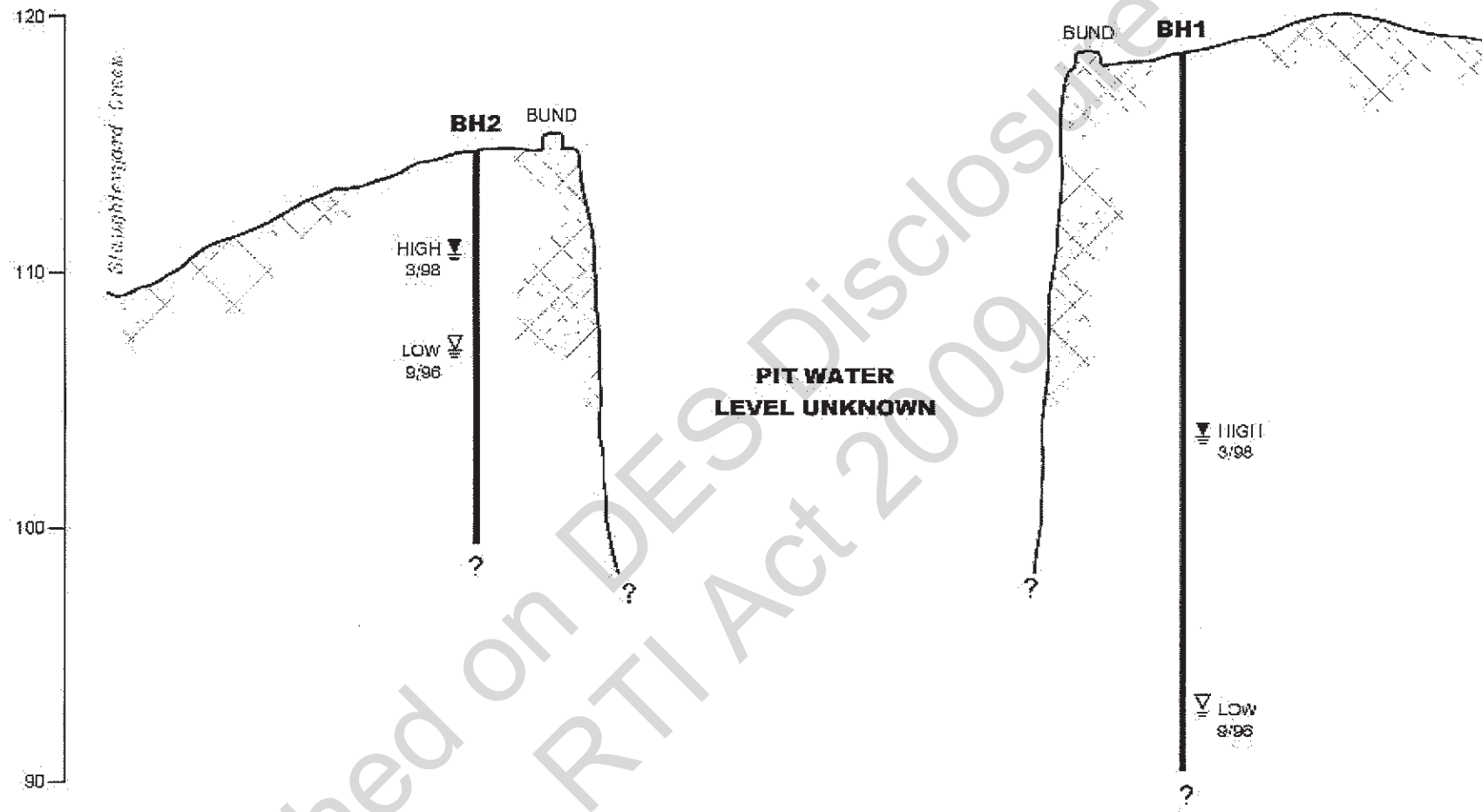
Table 3 shows that even in a very wet year the pit water level will drop by 0.9m without any inflow of groundwater, assuming that runoff from surrounding catchments is kept out of the pit.

Although it would be useful if the data used to make the conclusions were more complete, the existing data points very strongly toward the conclusion that the net evaporation can only decrease the pit level, as long as surface runoff is kept out of the pit. If pit levels increase, then there would have to be inflow from groundwater. No water levels for the pit have been recorded, so it will be difficult to test this theory with data over a long period. No construction details are available for the wells, so there may be some inconsistencies in the way that the wells can accept groundwater from all the strata over the full depth of the well. Wellhead elevations were estimated based on a drawing entitled “Golden Butterfly Pit and Waste Dump Plan of Existing Layout” by Woodward-Clyde, dated July 1996.

Additional monitoring wells are located adjacent to Slaughteryard Creek to the southwest of the pit. Water levels in these wells were not evaluated due to their proximity to the creek. It is considered that the

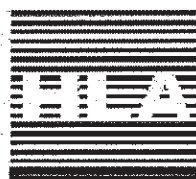
Salmon West

North East



LEGEND

- ▼ HIGHEST WATER LEVEL DURING MONITORING PERIOD
- ▽ LOWEST WATER LEVEL DURING MONITORING PERIOD



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CROSS SECTION THROUGH GOLDEN BUTTERFLY PIT
Goldfields Limited
Croydon Gold Mine, QLD

FIGURE

2

DRAWN	PROJECT - II - NAME	APPROVED	DATE	REVISION DATA
LJE	F1715-001		May 2001	

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Croydon ML 5248

Monitoring Report

November 2005

Prepared for: Placer Dome Australia Limited

Author:

CTPI 49-Sch4

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1.0 SUMMARY

Monitoring of surface and ground waters, as well as vegetation and soil was undertaken in July 2004 and resampled in June 2006. In November 2003, Placer Dome Australia limited inherited the lease as part of its acquisition of AurionGold Limited. A Plan of Operations expired when the previous owner held the lease. An EMP, Plan of Operations and EA are currently being developed for the project.

Water samples were collected from the lease in July 2004 and June 2005, and will be undertaken on a regular basis as part of the ongoing monitoring program for the site. The results are presented in this report with the historical data dating back to 1999. The results show that the only location with poor quality water (low pH and elevated cadmium) is site SW5, which is located immediately to the west of the Content waste dump, at a former seepage point. The source of the seepage has been directed to the open pit via a subsurface flow through drain that was constructed in 2001.

The ground water adjacent to the Golden Butterfly pit has low pH, though monitoring at bores located further to the south of the pit indicate no contamination. The shallow bores to the north of the Golden Butterfly waste dump show elevated sulphate levels, but no increased acidity or heavy metals.

With the exception of the Golden Butterfly North pit, all the pits have acid water and elevated cadmium. The poorest quality was recorded in the Golden Butterfly pit, which is highly acid, and has high levels of arsenic, aluminium, cadmium, copper, nickel and zinc.

The vegetation on the rehabilitation areas on the Golden Butterfly and the Content waste dumps show a good cover. However, the vegetation has low vigour and biomass (140-275 kg/ha) and appears to be in decline, with trees and shrubs dying (38% mortality on the Golden Butterfly waste dump). Low soil fertility is considered to be the cause of the poor vegetation vigour, associated with recent drought years.

The former hardstand area to the west of the Content waste dump, which was contaminated with cadmium, was resampled, and there is now no evidence of heavy metal contamination. Although soil fertility analyses are not available for the site, the soil on the hardstand has elevated salt levels and is slightly acidic which will contribute to the lack of vegetation on this area.

There was substantial compliance with commitments made in the Decommission Plan for the site. The development of an EMP, Plan of Operations and Environmental Authority will establish the environmental conditions and activities for the site for the post 2005 period.

2.0 INTRODUCTION

Placer Dome Australia Ltd is the holder of ML 5248, which was obtained as a result of the acquisition of AurionGold Limited in November 2003. The mining lease is located immediately to the west of the Croydon Township in far north Queensland (Figure 1). Mining of the Croydon Gold Project took place in the period 1987 to 1993, and rehabilitation was undertaken according to a Decommissioning Plan approved by the then Department of Minerals and Energy.

During a period of ownership under Goldfields Limited from 1995 onwards, the Decommissioning Plan was amended to conduct further rehabilitation works on the Golden Butterfly dump. The amended Plan detailed relinquishment criteria, a monitoring program, and committed to the preparation of an annual monitoring report to measure performance against relinquishment criteria (Appendix 2).

Landline Consulting was engaged to conduct monitoring activities at the site and prepare the annual monitoring report in 2004. Monitoring activities comprises surface and ground water monitoring, vegetation and soil monitoring and an assessment of weed status and management.

3.0 BACKGROUND

A monitoring report was completed in 1999 - 2000. (HLA) The report indicated the surface water on the lease is of reasonable quality except for drainage from the Content waste rock dump, which was acid due to oxidation and seepage from one location on the western side of the dump. As a result the water quality at monitoring location SW5 is poor due to elevated cadmium levels. In 2002, Auriongold Limited capped the small seepage area and cut a trench from the seepage point to direct the seepage into the pit. The trench was filled with coarse gravel to facilitate the free flow of the seepage.

There are four pits on the lease, namely the Golden Butterfly, Golden Butterfly North, Lady Isabella and Content pits. Water in the pits is derived mainly from rainfall and groundwater inflow, as there is no catchment flow into the bunded pits. Water quality is acid in the three open pits, but is particularly low in the Golden Butterfly pit, which also has elevated metal levels. The Golden Butterfly North pit has good quality water.

The groundwater monitoring program focused on the surrounds of the Golden Butterfly waste dump area and downstream. Unfortunately, the 2000 report does not provide a complete set of the groundwater monitoring data. Downstream groundwater bores have near neutral pH, electrical conductivity, sodium and sulphate. An exception is GBMB3 with pH in the range 5.7 - 5.9. The bores immediately adjacent to the dump generally have low pH.

The report states that in 1999, the tree density decreased and herb density and tree height increased. The mine site was trending towards the control sites in terms of tree density and height, and species richness. Species frequency remained stable. Two

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sites (2 and 6) were performing poorly due to a fire at site 2 (causing tree deaths) and localised seepage at site 6 on the Content waste dump.

Surface soil stability and infiltration data derived from LFA (Landscape Functional Analysis) trended towards those of the control site.

4.0 METHODS

4.1 Water Quality

The water-monitoring program involves the sampling and analysis of surface waters from a range of surface water locations (SW1-7) on and downstream of the mining lease, as well as the open pits (Figure 1). Sampling frequency is bimonthly for surface waters (when flowing) and bi-annually for the open pits and groundwater bores.

Seven surface-water sampling locations have been established within and around the lease area. These are labelled SW1 to SW7 and shown in Figure 2, and described in Table 1.

Table 1. Location of surface water monitoring points on and around the mining lease.

Location	Description
SW1	Slaughteryard Creek, 1.5 km downstream of lease boundary
SW2	Junction of Slaughteryard Creek and lease boundary
SW3	Slaughteryard Creek, upstream of Golden Butterfly waste dump
SW4	Eastern side of Golden Butterfly dump in a drainage channel
SW5	Slaughteryard Creek, in a water storage dam 200 m downstream of SW3
SW6	West of the Content Dump area in a drainage channel
SW7	South of SW6, the discharge point of the borrow pit dam on Belmore Station

The downstream compliance points for ML 5248 are located at SW1 and SW7. The background surface water location is SW3

Water quality is monitored at the base of the ramp at each of the four open pits (Golden Butterfly, Golden Butterfly North, Lady Isabella and Content).

Groundwater is monitored at a range of locations (Figure 2) adjacent to the Golden Butterfly pit (BH1-2), Golden Butterfly waste dump (BH3-7 to assess shallow groundwater impacts) and downstream of those structures running parallel to Slaughteryard Creek (GBMB1-6) (Figure 3). Sampling frequency is bi-annually at end of wet season and end of dry season.

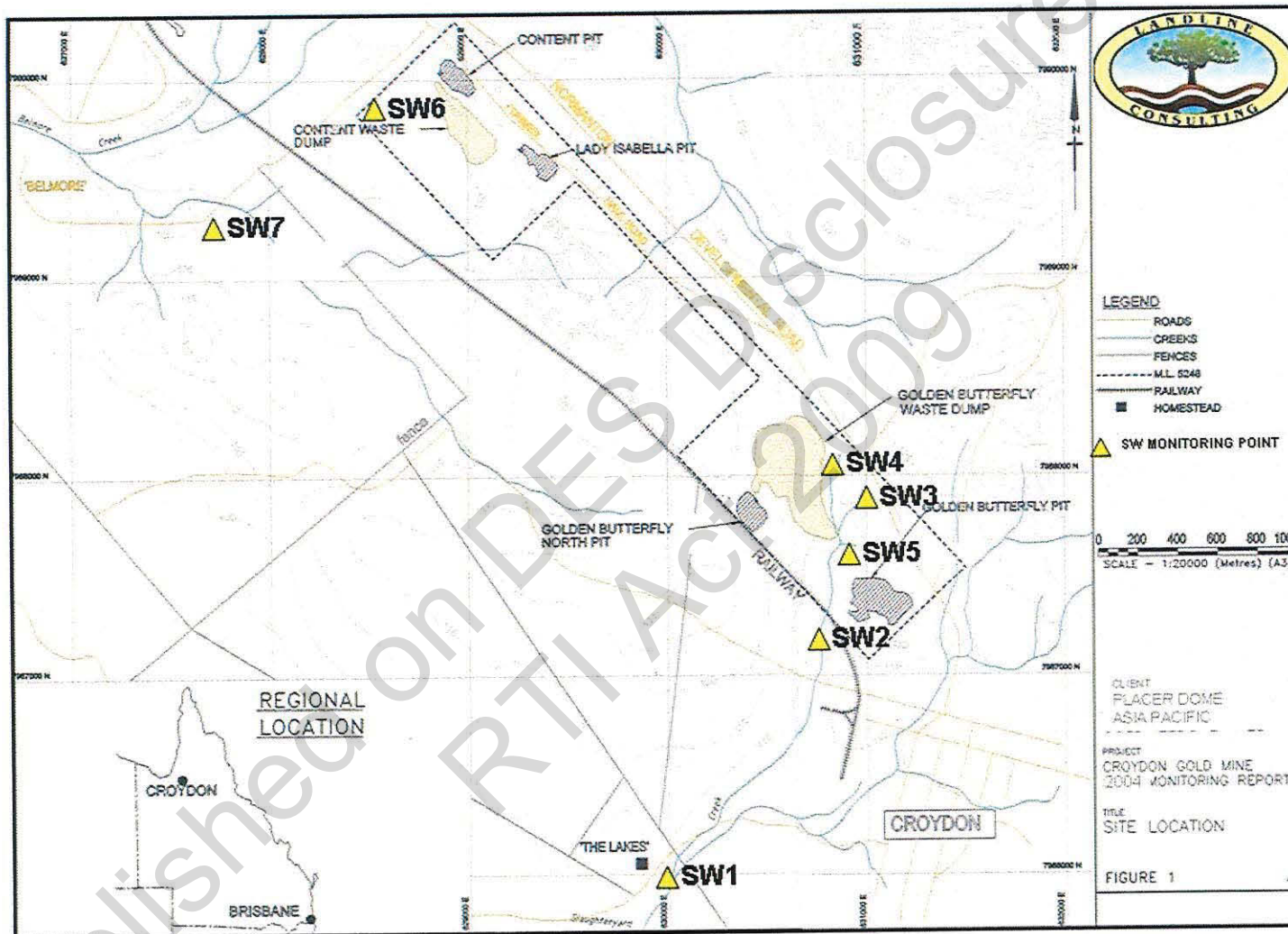


Figure 1. Surface water monitoring locations on the Croydon project area.

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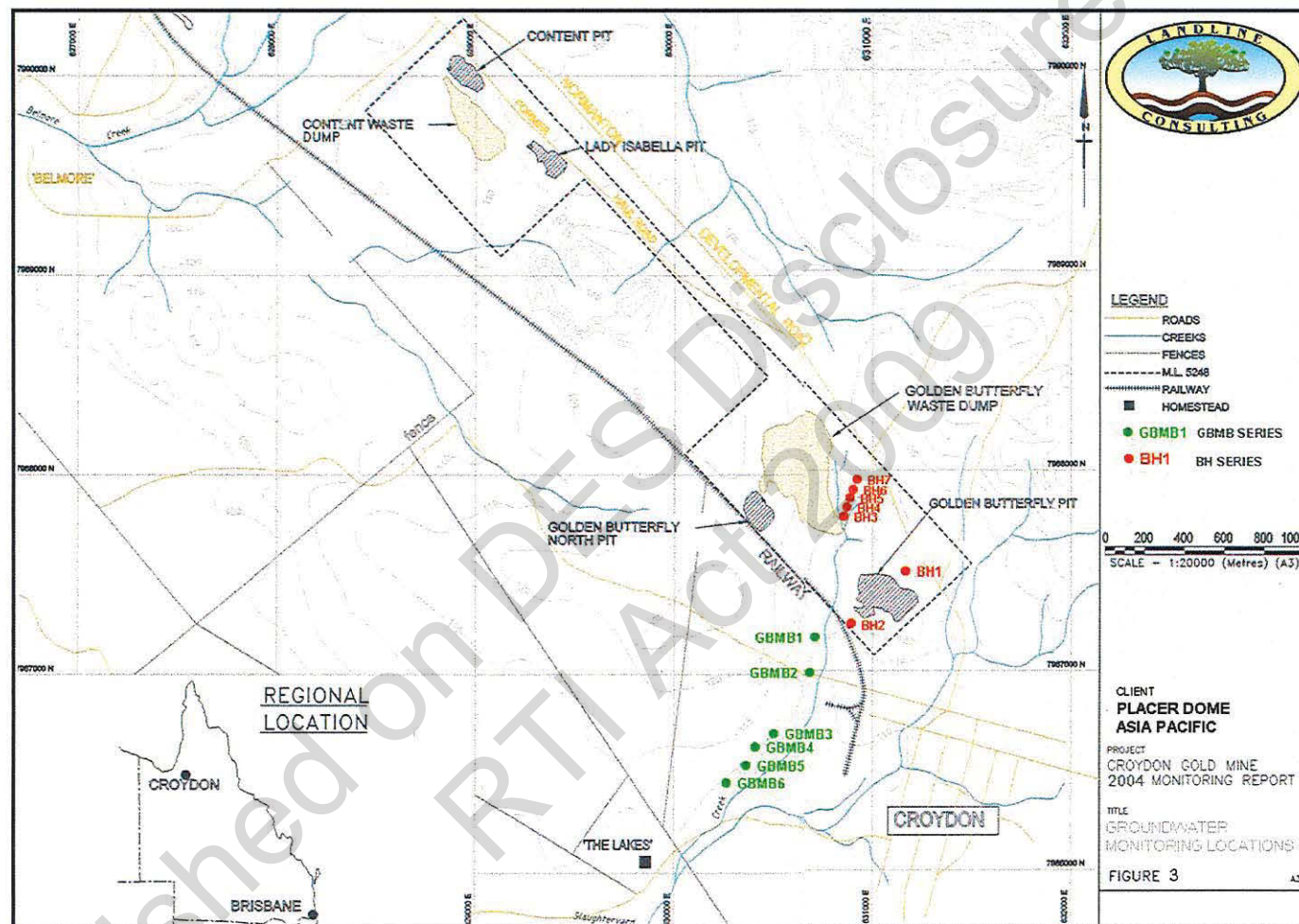


Figure 2. Ground water monitoring locations on the Croydon project area.

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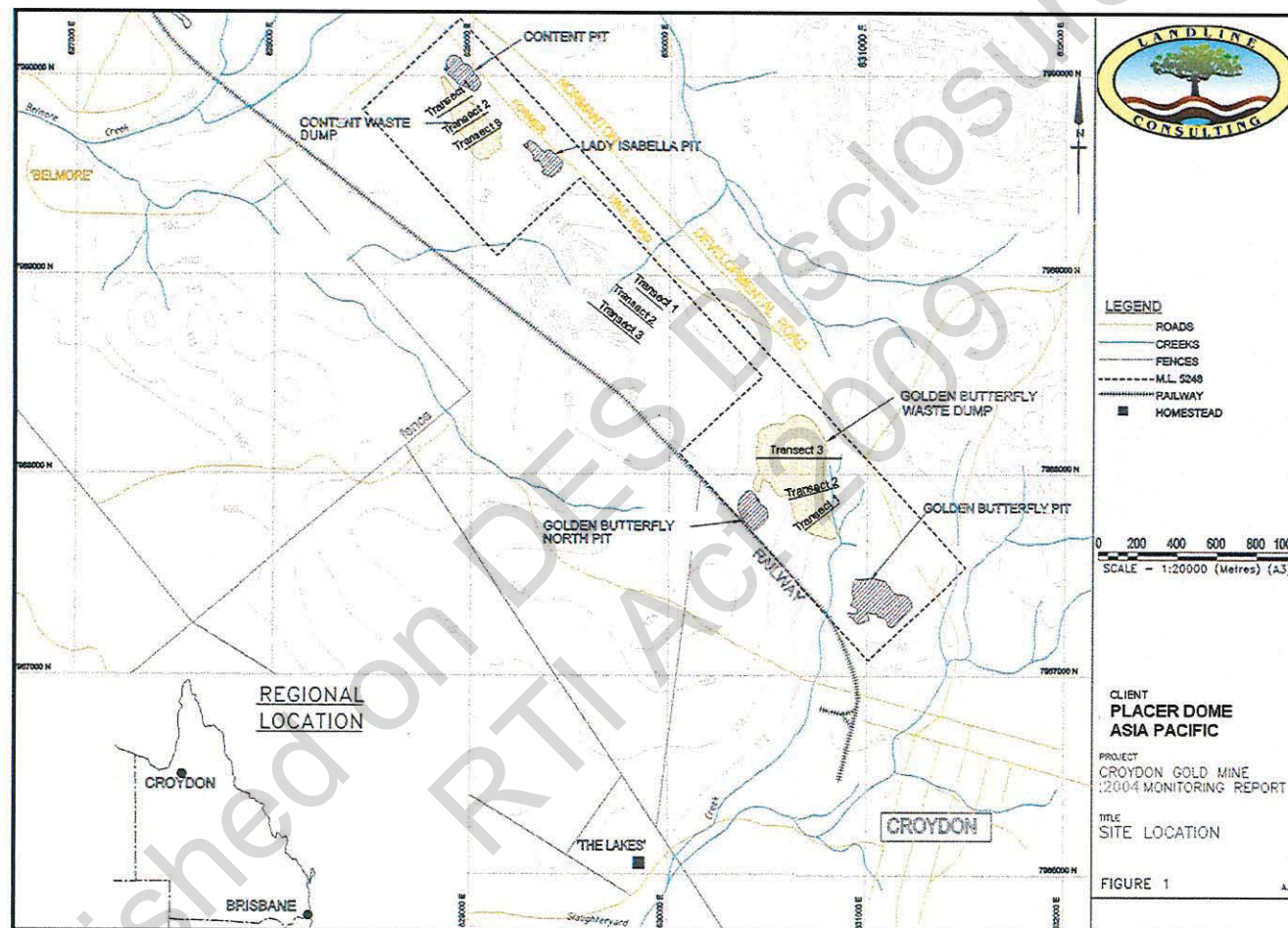


Figure 3. Vegetation monitoring locations in the Croydon project area.

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4.2 Vegetation and Soil

The objective of the rehabilitation program was to develop a stable vegetation cover on disturbed areas of the mining lease. Vegetation monitoring has previously been based on the LFA technique developed by Tongway and Hindley (1995). Based on a number of subjective measurements, the technique was considered to measure how well a rehabilitated landscape is using water and nutrients, its ability to resist erosion, and progress towards a stable self-sustaining unit in comparison with selected control sites.

In 1999-2000 the monitoring program found that "tree densities have decreased, herb densities have generally increased and tree heights have increased in all sites. The rehabilitation sites are trending towards the control site in terms of tree heights and densities, herb densities and species richness."

The LFA measurements indicated, "Surface stability and infiltration results trended towards those of the control site at most sites. There is no evidence that the nutrient cycling in the rehabilitation sites is trending towards that of the control site."

For the 2004 monitoring program, a set of simple vegetation measurements were made on the Golden Butterfly and Content waste rock dumps, and the analogue site located between the two waste rock dumps (Figure 3). Measurements were made of tree density, height and species composition, number of live and dead trees, pasture biomass, cover and species composition on three 250 m transects across the flat, the waste rock batters and top bench (Figure 4). A photographic record was taken of each transect.

Three surface soil samples (0-10 cm) were collected from the hardstand area to the southwest of the Content waste dump to assess contaminant levels. For each composite sample, soil was taken from 10 locations within a 20-metre radius. Samples were sent to Australian Laboratory Services in Brisbane for analysis of pH, sulphate, arsenic, cadmium, chromium, copper, lead, molybdenum, nickel and zinc.

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4.3 Relinquishment Criteria

The relinquishment criteria for surface and groundwater are shown in Table 2.

Table 2 Desirable criteria for water quality of surface, pit and ground waters.

Parameter	Units	Surface water ¹	Pit water & groundwater
pH		4 - 9	4 - 9
EC	µS/cm	6000	6000
SO ₄	mg/L	1000	1000
As	mg/L	0.5	0.5
Cd	mg/L	0.01	0.01
Cu	mg/L	1	1
Fe	mg/L	-	-
Pb	mg/L	0.1	0.1
Mn	mg/L	-	-
Ni	mg/L	1	1
Zn	mg/L	20	20

¹ ANZECC (2000) Livestock drinking water.

Relinquishment criteria for the vegetation have not been defined previously, and so they will be developed over the next twelve months, based on vegetation parameters measured at the analogue site, immediately adjacent to the lease.

5.0 RESULTS & DISCUSSION

5.1 Climate

Rainfall at Croydon has been extremely variable in the period 2000-2004. Rainfall was above average in 2000 and 2001, but well below average in subsequent years. The dry years have imposed a marked stress on the vegetation, and this has been particularly evident with the trees and shrubs in the rehabilitation areas.

Table 3. Monthly rainfall records (mm) at Croydon Township.

	2000	2001	2002	2003	2004	Average
Jan	151.8	87	197.4	4.7	160.4	215.6
Feb	271	305	239.4	151.2	135.8	178
Mar	41.2	155	36.2	186.8	62	114.9
Apr	56.4	10.2	0	0	24.3	22.6
May	3.2	0	0	0	0	7.9
Jun	100.8	0	0	0	0	8.3
Jul	0	0	0	0	0	3.3
Aug	0	0	0	0	0	2.8
Sep	0	0	0	0	0	5.5
Oct	36	32	0	0	6	14.1
Nov	117.2	46.2	0	0	24	44.4
Dec	251.8	202.8	44.2	83.6	173.6	112.6
Year	1029.4	838.2	517.2	426.3	586.1	729.9

5.2 Surface water quality

Although there was little surface water available for sampling prior to July 2004, monitoring indicated little change to the water quality recorded in 2000 (Table 4). At SW5 immediately to the west of the Content pit, the water is acid (pH 3.5 – 4.4) and has had elevated levels of cadmium. Due to the site being dry, some sample locations were unable to be sampled in June 2005.

5.3 Pit water quality

Water quality is poor in the Golden Butterfly, Isabella and Content pits (Table 4). These pits have acid water and elevated levels of cadmium. The Golden Butterfly pit has the poorest quality of all the pits with pH of 2.3, and highly elevated electrical conductivity, arsenic, cadmium, copper, nickel, zinc and sulphate. Water quality in the Golden Butterfly North pit is of good quality and is suitable for livestock drinking water. During the 1990s water from the Golden Butterfly North pit was used as a source of water for the nearby township. The township now derives its water from a dam to the north however, has approached PDAP to access this pit as a backup for town Raw Water should the dam levels drop.

5.4 Groundwater quality

Water quality in the shallow groundwater bores adjacent to the Golden Butterfly waste dump and pit varies considerably (Table 5). The bore (BH1) on the northern side of the Golden Butterfly pit has good water quality. The bore (BH2) to the south of the pit has low pH (3.5-3.8), but low metal levels. Three of the shallow bores to the north of the Golden Butterfly waste dump have elevated sulphate levels (1400-2300 mg/L) but low metal levels.

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Water quality in the downstream groundwater bores along Slaughteryard Creek is generally good (Table 6). There is minor evidence of an impact on sulphate only in groundwater in the two bores closest to the pit and the waste dump. At bores GBMB1 and 2, sulphate levels are in the range 210-820 mg/L compared with 2-43 mg/L further downstream from the minesite. There is however some evidence of an impact on sulphate levels at GBMB1 and GBMB2, which are the two bores closest to the pit and waste dump. In these two bores sulphate levels are in the range 210-820mg/L, in comparison with values of 2-43mg/L further downstream from the mine site.

Table 4. Surface water quality at a range of locations on and around the Croydon mining lease (using ANZECC 2000 Livestock Water guideline*).

		pH	EC	TDS	As	Al	Cd	Cu	Fe	Pb	Mn	Mo	Ni	SO ₄	Zn
Location	Date/Units		uS/cm	mg/L											
SW1	15-01-00	6.5	190	160	0.005	-	<0.0002	<0.05	1.40	0.003	<0.05	-	<0.05	50	0.029
SW1	29-02-00	6.8	200	170	0.012	-	<0.0002	<0.05	1.20	0.002	<0.05	-	<0.05	48	<0.005
SW2	15-02-00	6.8	170	260	0.01	-	<0.0002	<0.05	0.76	0.003	0.19	-	<0.05	51	0.031
SW2	29-02-00	6.6	190	170	0.006	-	0.0002	<0.05	0.51	<0.002	0.23	-	<0.05	68	0.031
SW3	15-02-00	6.7	240	240	<0.005	-	<0.0002	<0.05	0.26	<0.002	0.28	-	<0.05	76	0.007
SW3	29-02-00	6.9	120	130	<0.005	-	<0.0002	<0.05	0.95	<0.002	<0.05	-	<0.05	36	<0.005
SW3A	15-02-00	6.9	86	100	0.005	-	<0.0002	<0.05	0.56	<0.002	<0.05	-	<0.05	22	0.007
SW4	15-02-00	7.0	130	170	0.015	-	<0.0002	<0.05	0.69	<0.002	<0.05	-	<0.05	33	0.010
SW4	01-04-00	8.6	150	140	0.017	-	<0.0002	<0.05	0.63	<0.002	<0.05	-	<0.05	32	0.024
SW4	03-07-04	8.3	290	-	0.009	1.1	<0.0002	<0.01	-	0.007	<0.05	<0.05	<0.05	72	0.008
SW4	09-06-05	8.4	410	-	0.005	0.6	<0.0002	<0.01	-	<0.002	<0.05	<0.05	<0.05	40	0.013
SW5	01-01-00	4.0	280	180	<0.005	-	0.0110	0.15	0.08	<0.002	2.10	-	0.11	110	0.370
SW5	15-02-00	4.4	130	90	<0.005	-	0.0038	0.05	<0.05	<0.002	0.84	-	<0.05	43	0.120
SW5	01-04-00	3.5	1200	940	0.01	-	0.0690	0.69	0.10	0.005	9.80	-	0.57	610	1.900
SW6	01-01-00	7.2	110	700	<0.005	-	<0.0002	<0.05	2.90	0.004	<0.05	-	<0.05	16	0.049
SW6	15-02-00	6.6	93	300	<0.005	-	0.0004	<0.05	2.00	0.004	0.19	-	<0.05	24	0.042
SW6	03-07-04	8.4	340	-	0.01	350	<0.0002	<0.01	-	0.047	0.14	<0.05	<0.05	43	0.026
SW6	09-06-05	8.5	390	-	<0.005	5.1	<0.0002	0.01	-	0.009	0.10	<0.05	<0.05	9	0.016
*Guideline		5.5-8.5	1500	4000	0.5	5	0.01	1	-	0.1	-	0.15	1	1000	20

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Table 5. Pit water quality in the four pits on the Croydon mining lease (using ANZECC 2000 Livestock Water guideline*).

		pH	EC	TDS	As	Al	Cd	Cu	Fe	Pb	Mn	Mo	Ni	SO4	Zn
Location	Date/Units		uS/cm	mg/L											
Golden Butterfly	20-09-99	2.3	6800	10000	1.800	-	0.2900	28	710	<0.002	84	-	7.60	6600	31.00
	01-01-00	2.3	5600	7600	1.500	-	0.2100	19	450	<0.005	65	-	5.20	5300	17.00
	01-03-00	2.3	5400	7400	1.100	-	0.2100	18	400	<0.002	56	-	5.00	4800	18.00
	28-06-00	2.4	6300	9900	1.700	-	0.2600	24	520	<0.01	74	-	7.10	6700	26.00
	03-07-04	2.4	6900		0.970	640	0.2800	22	-	<0.005	84	<0.05	7.60	7400	22.00
	16-06-05	2.4	6900	11000	0.77	-	0.29	23	380	<0.002	95	-	8.0	7200	28
G'Butterfly North	20-09-99	6.3	250	150	0.006	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	<0.05	59	0.01
	01-01-00	6.9	250	170	0.008	-	<0.0002	<0.05	0.24	0.003	<0.05	-	<0.05	56	0.01
	28-06-00	5.9	260	150	0.007	-	<0.0002	<0.05	0.11	<0.002	0.25	-	<0.05	60	0.01
	03-07-04	7.4	310		0.008	0.08	<0.0002	<0.01	-	<0.002	<0.05	<0.05	<0.05	86	0.01
	09-06-05	7.2	370	-	<0.005	0.07	<0.0002	<0.01	-	<0.002	0.05	<0.05	<0.05	88	0.011
Isabel	20-09-99	3.5	850	690	<0.005	-	0.1100	1.00	0.12	0.003	3.5	-	0.44	340	3.60
	01-01-00	3.5	890	710	0.013	-	0.1100	0.98	0.11	0.003	3.5	-	0.44	370	3.10
	01-03-00	3.4	830	690	<0.005	-	0.1200	0.90	0.06	0.003	3.2	-	0.40	330	3.20
	28-06-00	3.6	830	680	0.008	-	0.1000	0.92	0.24	0.003	3.3	-	0.42	360	3.30
	03-07-04	3.5	1100		0.005	16	0.1300	1.20	-	0.003	52.0	<0.05	0.62	610	4.80
	16-06-05	3.4	1200	1200	0.006	17	0.16	1.3	-	0.007	5.9	-	0.70	480	5.3
Content	20-09-99	3.4	1400	1000	0.024	-	0.0110	0.29	1.6	<0.002	3.9	-	0.29	570	0.99
	01-01-00	3.3	1400	1100	0.029	-	0.0130	0.28	1.3	<0.002	3.8	-	0.29	600	0.89
	01-03-00	3.3	1300	1000	0.011	-	0.0230	0.26	1.1	<0.002	3.6	-	0.26	560	0.90
	28-06-00	3.5	1300	1000	0.058	-	0.0086	0.23	1.2	<0.002	3.6	-	0.27	590	0.93
	03-07-04	3.5	1400	-	0.035	5.8	0.0028	0.18	-	<0.002	4.6	<0.05	0.30	700	0.95
	16-06-05	3.4	1600	1300	0.05	-	0.0072	0.20	1.5	<0.002	4.9	-	0.30	540	1.1
*Guideline		5.5-8.5	1500	4000	0.5	5	0.01	1	-	0.1	-	0.15	1	1000	20

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Table 6. Groundwater quality adjacent to the Golden Butterfly waste dump and pit on the Croydon mining lease (ANZECC 2000 Livestock Water guideline*).

		pH	EC	TDS	As	Al	Cd	Cu	Fe	Pb	Mn	Mo	Ni	SO4	Zn
Location	Date	Units	uS/cm	mg/L											
BH1	20-09-99	6.9	1200	970	-	-	-	-	0.11	-	-	-	-	430	-
	01-01-00	7.2	1300	1000	-	-	-	-	0.07	-	-	-	-	440	-
	01-03-00	7.4	1300	1100	-	-	-	-	<0.05	-	-	-	-	460	-
	28-06-00	7.2	1300	1100	-	-	-	-	0.13	-	-	-	-	470	-
	03-07-04	7.4	1300	-	0.022	<0.05	<0.0002	<0.01	-	<0.002	0.1	<0.05	<0.05	470	0.036
	09-06-05	7.1	1300	-	0.013	<0.05	<0.0002	0.01	-	0.35	<0.05	<0.05	<0.05	380	0.057
BH2	20-09-99	3.7	1000	830	-	-	-	-	12.00	-	-	-	-	440	-
	01-01-00	3.8	920	730	-	-	-	-	11.00	-	-	-	-	380	-
	01-03-00	3.5	1100	890	-	-	-	-	0.73	-	-	-	-	480	-
	28-06-00	3.8	980	800	-	-	-	-	8.90	-	-	-	-	440	-
	03-07-04	3.6	890	-	<0.005	1.40	0.0007	<0.01	-	0.007	1.2	<0.05	0.09	360	0.360
	09-06-05	3.6	830	-	<0.005	2.1	0.0004	0.02	-	0.15	1.1	<0.05	0.05	270	0.34
BH3	20-09-99	6.9	800	500	-	-	-	-	0.13	-	-	-	-	210	-
	01-01-00	5.5	180	150	-	-	-	-	0.16	-	-	-	-	47	-
	01-03-00	5.8	130	130	-	-	-	-	<0.05	-	-	-	-	47	-
	28-06-00	6.2	230	250	-	-	-	-	0.47	-	-	-	-	76	-
BH4	03-07-04	7.2	4800	-	<0.005	<0.05	<0.0002	<0.01	-	<0.002	<0.05	<0.05	<0.05	1400	0.040
BH5	03-07-04	7.4	4900	-	0.006	<0.05	0.0002	<0.01	-	<0.002	<0.05	<0.05	<0.05	1700	<0.005
	09-06-05	7.3	4900	-	<0.005	<0.05	<0.0004	0.03	-	0.24	0.06	<0.05	<0.05	1500	0.017
BH6	03-07-04	7.4	1300	-	0.028	0.14	<0.0002	<0.01	-	0.004	<0.05	<0.05	<0.05	270	0.005
	09-06-05	7.1	1100	-	0.038	1.2	<0.0002	0.02	-	0.056	0.18	<0.05	<0.05	170	0.011
BH7	20-09-99	6.6	7500	5700	-	-	-	-	0.14	-	-	-	-	2000	-
	01-01-00	6.4	7500	5800	-	-	-	-	<0.05	-	-	-	-	780	-
	01-03-00	6.4	7800	6000	-	-	-	-	<0.05	-	-	-	-	2000	-
	28-06-00	6.6	7600	6100	-	-	-	-	<0.05	-	-	-	-	2300	-
	03-07-04	6.8	7400	-	<0.01	0.16	0.0009	<0.01	-	<0.005	<0.05	<0.05	<0.05	2100	0.052
	09-06-05	6.7	7400	-	<0.005	<0.05	0.0009	0.03	-	0.35	0.08	<0.05	<0.05	1700	0.14
*Guideline		5.5-8.5	1500	4000	0.5	5	0.01	1	-	0.1	-	0.15	1	1000	20

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Table 7. Groundwater quality downstream of the Golden Butterfly waste dump and pit on the Croydon mining

		pH	EC	TDS	As	Al	Cd	Cu	Fe	Pb	Mn	Mo	Ni	SO ₄	Zn
Location	Date/Units		uS/cm	mg/L											
GBMB1	20-09-99	6.30	710	590	<0.005	-	0.0023	<0.05	0.63	0.006	1.10	-	-	210	0.011
	01-01-00	6.30	720	590	0.019	-	0.0069	<0.05	3.80	0.035	1.80	-	-	240	0.031
	28-06-00	6.60	690	590	<0.01	-	0.0042	<0.05	3.50	0.05	1.70	-	-	250	0.012
GBMB2	20-09-99	6.80	2400	1700	<0.005	-	<0.0002	<0.05	0.13	<0.002	1.50	-	-	690	0.019
	01-01-00	7.00	2400	1700	0.006	-	<0.0002	<0.05	<0.05	0.004	1.40	-	-	690	0.018
	01-03-00	6.80	2300	1700	<0.005	-	<0.0002	<0.05	<0.05	<0.002	1.30	-	-	580	0.007
	28-06-00	7.20	2200	1700	<0.005	-	<0.0002	<0.05	0.10	<0.002	1.20	-	-	820	0.047
	03-07-04	7.00	260	-	<0.005	<0.05	<0.0002	<0.01	-	0.002	0.82	<0.05	<0.05	790	0.034
GBMB3	20-09-99	5.70	82	180	0.018	-	<0.0002	<0.05	3.10	0.008	<0.05	-	-	13	0.100
	01-01-00	5.90	120	250	0.011	-	<0.0002	<0.05	3.00	0.013	0.16	-	-	13	0.044
	01-03-00	5.80	82	180	0.006	-	<0.0002	<0.05	2.00	0.013	0.05	-	-	16	0.071
	28-06-00	5.80	66	150	<0.01	-	<0.0002	<0.05	2.30	0.014	0.05	-	-	13	0.130
GBMB4	20-09-99	5.90	290	250	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	37	0.100
	01-01-00	5.90	290	250	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	35	0.100
	01-03-00	6.20	280	240	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	43	0.076
	28-06-00	5.90	280	250	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	39	0.250
GBMB5	20-09-99	5.60	78	97	<0.005	-	<0.0002	<0.05	0.11	<0.002	<0.05	-	-	<2	0.061
	01-01-00	5.60	78	96	0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	3	0.019
	01-03-00	6.10	78	96	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	3	0.047
	28-06-00	5.80	80	96	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	<2	0.110
	03-07-04	7.10	490	-	0.091	<0.05	<0.0002	<0.01	-	<0.002	0.26	<0.05	<0.05	13	0.010
GBMB6	20-09-99	5.80	82	110	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	2	0.045
	01-01-00	5.80	100	120	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	8	0.023
	01-03-00	6.00	140	140	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	20	0.051
	28-06-00	6.10	150	150	<0.005	-	<0.0002	<0.05	<0.05	<0.002	<0.05	-	-	19	0.260
	03-07-04	6.80	66	-	0.014	<0.05	<0.0002	<0.01	-	0.002	<0.05	<0.05	<0.05	5	0.008
	09-06-05	6.2	110	-	<0.005	<0.05	<0.0002	0.02	-	0.31	<0.05	<0.05	<0.05	7	0.089
Guideline*		5.5-8.5	1500	4000	0.5	5	0.01	1	-	0.1	-	0.15	1	1000	20

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5.5 Vegetation

Groundcover

The groundcover vegetation on the waste rock dumps and adjacent flat areas is generally stressed and appears to be performing poorly (see photographs in Appendix 1). However, growth on the control site is also poor, which is an indication of the low soil fertility in the area (Table 8). The poor growth and stress could also be related to the poor rainfall experienced during the last 3 years of drought. The level of cover including rock is high, though variable, on the Golden Butterfly dump (82 %) and the Content dump (74%), compared with the control site (94%). Rock (18-35%) and litter (15-18%) are major contributors to the cover on the dumps and the control site. The high levels of cover can impact on the rate of soil erosion. Generally there is a negative exponential relationship between cover and soil erosion, with minimal erosion where soil cover is greater than 70%.

The vegetation on rehabilitation sites and analogue sites is growing poorly with biomass yields of between 140 and 275 kg/ha. The ability of this biomass to extract water is severely limited. Field studies by Hall (1978) showed that pasture yields of 2,500 kg/ha can be achieved using fertiliser in the Croydon area, providing there are good soils. Apparently the contractor did not use fertiliser when rehabilitation works were conducted on the site. Studies have shown that the soils in the area are deficient in phosphorus, sulphur, potassium and zinc (Webb 1975). For the purpose of developing a sustainable cover on the disturbed areas it is recommended that fertiliser be applied to boost vegetation biomass and improve the turnover of nutrients in the soil. It will also reduce the degree of rainfall infiltration through the dump covers. The use of legumes such as *Seca stylo* will also improve the nitrogen economy within the vegetation/soil system. Placer Dome undertook a revised seeding and fertilisation program in January 2005, to supplement vegetation.

Shrubs and Trees

The upper storey vegetation including shrubs and trees appears not to have changed in the past 5 years based on observations of the site by the author. Nutrient and water deficiency will have restricted growth severely. Tree density is reasonable for the area in the range 300-500 live stems per hectare (Table 9). However, there are a substantial number of tree deaths particularly on the Golden Butterfly waste dump (303 stems/ha), which indicates a longer-term decline in the tree population in the rehabilitation areas. A similar situation applies to the control site located between the two waste dumps. The control site has been disturbed by mining activities in the past as is evidenced by the presence of acacia.

The dominant species on the control site is *Eucalyptus miniata*, which is well adapted to the low hills of the area, and a range of *Acacia* species. There is also a significant component of Calatope (*Calatropis procera*) and Rubber vine (*Cryptostegia grandifolia*) on the control site, but little infestation in the rehabilitation areas.

5.6 Soil Contaminant Levels

The hardstand area was previously contaminated by seepage from the Content waste dump, and the soil is salted with no vegetation growth. Analysis of the three composite samples taken from the hardstand site reveals no metal contamination (Table 10). The absence of any vegetation on the hardstand area is assumed to result from high acidity and salt levels in the area.

Table 10. Contaminant levels in the surface soil collected from the hardstand area immediately to the west of the Content waste dump.

Parameter	Handstand sample			Investigation Levels	
	1	2	3	EIL*	HIL*
Arsenic	4	24	45	20	200
Cadmium	<1	<1	<1	3	40
Chromium	4	3	5	50	200
Copper	25	21	11	60	2000
Lead	3	7	15	300	600
Molybdenum	<1	<1	1	-	-
Nickel	12	2	4	60	600
Zinc	24	9	57	200	14000

*EIL and HIL refer to the Environmental Investigation Limit and the Health-based Investigation Limit for open space etc., respectively.

6.0 Compliance

There are a lack of compliance documents for this mining site, and this report will be used by Placer Dome Australia to review the issues associated with the mining lease 5248 and develop a EMP and EA in consultation with the regulatory authority for the site. The intention is to manage the risks associated with the site and develop suitable controls.

An assessment against the closure plan has been completed in Appendix 2 and details progress against the commitments.

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Tredwell, D., Grigg, A. and Page, M. *et al.* (2003). Comparison of LFA and empirical measures of ecosystem function: a case study from Kidston Gold Mine, Queensland.

Webb, A.A. (1975). Plant nutrient status of soils of the Mayvale Land System, North Queensland. Queensland Journal of Agricultural and Animal Sciences 32 (1): 19 - 25.

Tongway, D. and Hindley, N. (1995). Manual for Assessment of Soil Condition of Tropical Grasslands, CSIRO, Division of Wildlife and Ecology, Canberra.

Hall (1978) Cloncurry buffel grass (*Cenchrus pennisetiformis*) in north-western Queensland. Tropical Grasslands 12 (1): 10-19

HLA, (2000), Croydon Gold Mine, 1999-2000 Monitoring Report.

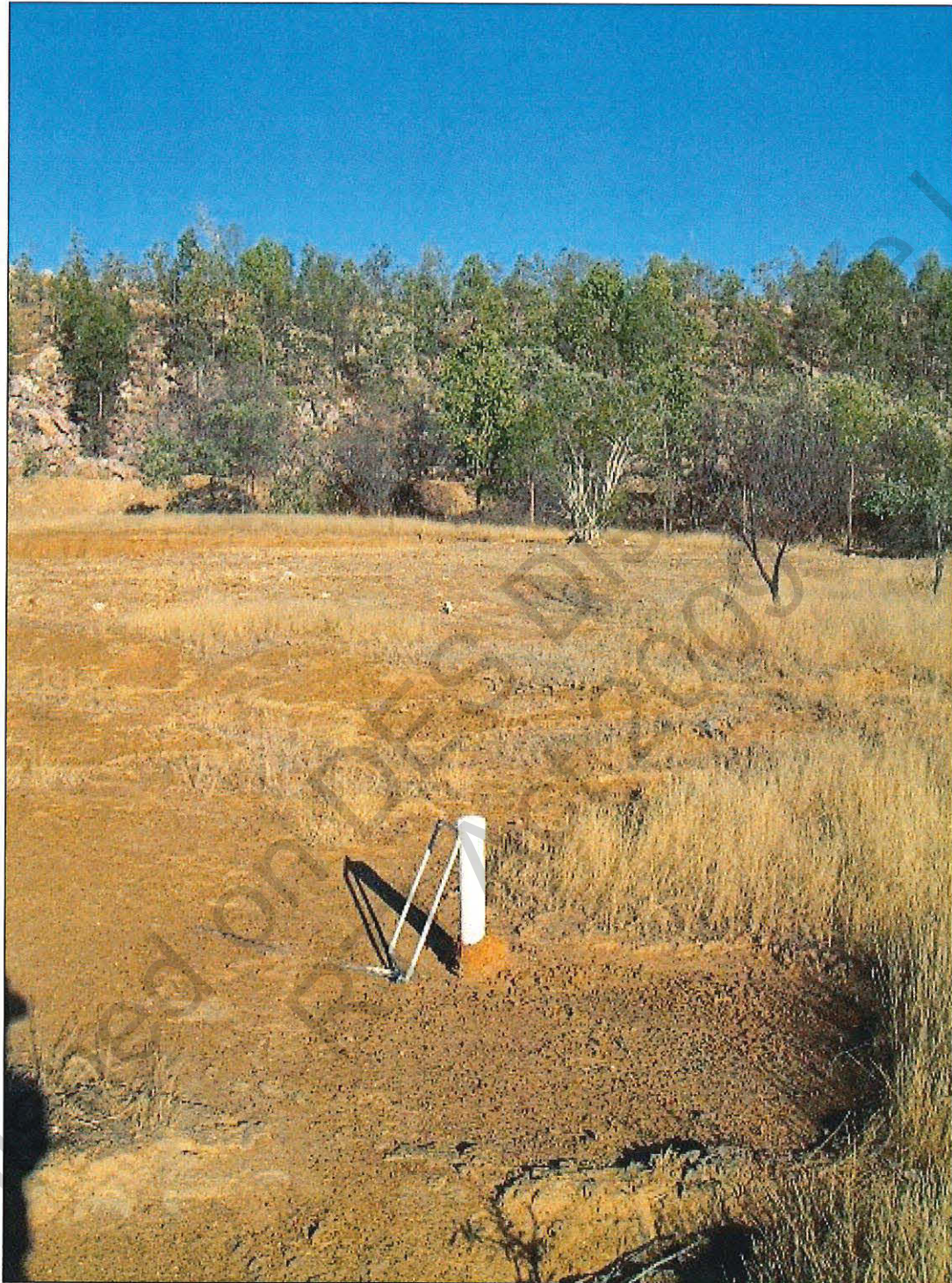
APPENDIX 1

Photographs of the Vegetation Transects

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Golden Butterfly Waste Dump (Transect 1)



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Content Waste Dump (Transect 1)

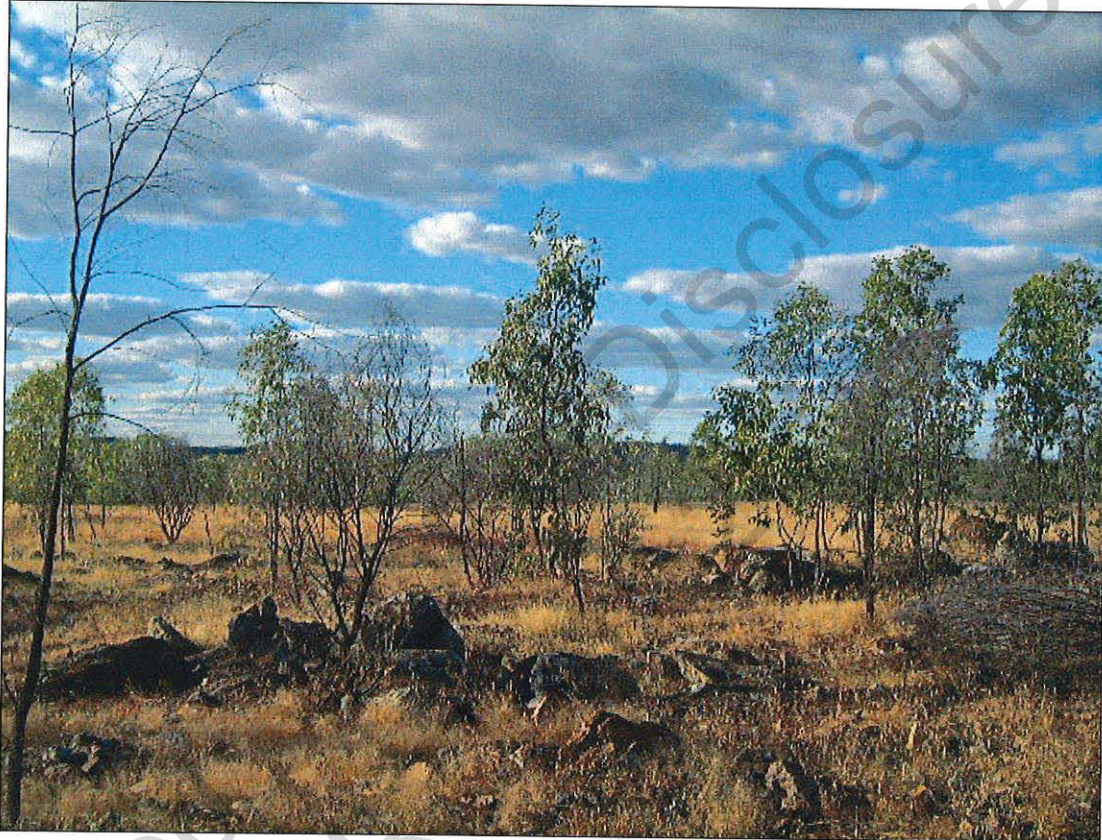


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Control Site (Transect 1)



Content Dump Top



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Content Dump Hardstand area in Jan 2005



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APPENDIX 2

COMPLIANCE WITH CLOSURE PLAN

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Commitment	Compliance Status	Comments
Identify background landholder requirements regarding rehabilitation of ML 5248	In compliance.	Completed – detailed in the decommissioning Plan
Prepare and implement an upgraded and enhanced site environmental monitoring program	In compliance, but amendment required.	Environmental monitoring program will be incorporated in an EMOS, Plan of Operations and EA for the project
Review environmental monitoring program annually in consultation with the DME to ensure the continued effectiveness of the program	In compliance	Review required with Regulatory Authority
Golden Butterfly Waste Dump – clay fill covering and rock fill surface protection of the entire waste dump surface	Compliance	Completed November 1996
Identify, remove and dispose of potentially acid producing material from the Golden Butterfly hardstand area	Compliance	Completed November 1996. Some maintenance fertilizer required.
Identify, remove and dispose of contaminated sediments in Slaughteryard Creek adjacent to the Golden Butterfly waste dump	Compliance	Completed November 1996. Validation sampling required in 2005
Revegetate waste dump surfaces, former hardstand areas and other disturbed areas with native woodland tree species	Compliance	Completed November 1996. Maintenance fertilizer applied in 2004/5 wet season
Revegetation performance will be monitored on an annual basis	Compliance	Monitored in 2000 and 2004.
Generation of sediment will be limited by (i) Diversion of upstream runoff and, (ii) Sediment traps will be constructed where necessary	Partial Compliance	Some works completed in 1993, some in 1996 and 2004. Ongoing maintenance required till fully vegetated.

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The effectiveness of sediment control measures will be monitored on a regular basis	Partial compliance	Will be inspected during regular water monitoring program.
Water monitoring of creek sites will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 5248	Partial compliance	Monitoring program now in place
Water quality at monitoring sites SW1, (Golden Butterfly catchment) & SW5 (Content/Lady Isabella catchment) will comply with ANZECC (1992) Water Quality Guidelines for livestock watering (cattle), or not exceed 115% of background whichever is greater. Background will be measured at sites SW3 and SW4	Partial compliance	Water quality at SW1 was in compliance, however many cadmium concentrations at SW5 were above the relinquishment criteria during the monitoring period. Note that the text of the 1996 Decommissioning Report specifies that SW1 is the nominated compliance point but that compliance is aimed at for SW2 and SW5.
Water quality monitoring within open pits will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 5248	Partial compliance	Monitoring program now in place
Pit water quality monitoring data will be reviewed annually, with any deterioration analysed and possible related impacts assessed	Partial compliance	Monitoring program now in place
Groundwater quality monitoring will be undertaken at the locations and on the frequencies detailed in the Water Monitoring Schedule for ML 5248	Partial compliance	Monitoring program now in place
GBMB series groundwater monitoring bores – maintain water quality within the range of water quality data collected for these bores over the period 1990 to 1993	Partial compliance	Monitoring program now in place
BH series groundwater monitoring bores – water quality monitoring data will be reviewed annually	Partial compliance	Monitoring program now in place

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with any deterioration analysed and possible related impacts assessed		
Monitoring data will be collated, interpreted and reported to the DME on an annual basis together with an audit of compliance status against commitments	Partial compliance	Will be conducted on annual basis
An annual lease inspection will be carried out by RGC	To be completed	Will be conducted on annual basis
Where practicable runoff water will be diverted away from voids via diversion bunds	Compliance	Has been completed
Safety bunding and fencing will be erected around open pits	Partial compliance	Fences and gates require maintenance
Warning signs will be placed in strategic sites around the lease	Compliance	Completed, but maintenance required
Abandoned shafts will be identified and backfilled	-	To be assessed in 2005
Exploration drill holes will be located, plugged and covered over	Compliance	To be assessed in 2005
The lease will be monitored for the outbreak of noxious weeds, any outbreaks will be controlled by DPI recommended methods	Non compliance	To be completed in 2005
Submit to the DME a Final Rehabilitation Report	To do	-

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