5000_2_v6
October 2007

Kanmantoo Copper Project Mining Lease Proposal

Appendices
Volume 3

HILLGROVE RESOURCES

enesar peopleandplace

Kanmantoo Copper Project

Mining Lease Proposal

Appendices

Volume 3

October 2007
5000_2_v6

Prepared by:
Enesar Consulting Pty Ltd
Level 1, 2-3 Greenhill Road Wayville South Australia 3510
p 61-8-7221 3588 **f** 61-8-7221 3510
e office@enesar.com.au **www** enesar.com.au

Project Director	David Browne
Project Manager	Tara Halliday
Version/s:	**Distribution:**
CR 5000_2_v6 October 2007	Hillgrove – 4 copies Enesar – 4 copies South Australian Agencies and other project stakeholders – 30 copies

Summary Information

Mine owner:	Hillgrove Copper Pty Ltd and Kelaray Pty Ltd
Mine operator:	Hillgrove Copper Pty Ltd
Contact person:	Marty Adams Project Manager
Contact details:	Hillgrove Resources Limited Callington Project Office 42 Back Callington Road Callington SA 5254 Telephone: 08 8538 5100 Email: martya@hillgroveresources.com.au
Tenements:	MC 3510, MC 3833, MC 3834, MC 3835, MC 3836
Name of mining operation:	Kanmantoo Copper Project
Commodity to be mined:	Copper, gold, silver and garnet
MLP date:	October 2007

Appendices

12 Kanmantoo Copper Project Integrated Waste Landform Design

Appendix 12

Kanmantoo Copper Project Integrated Waste Landform Design

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

INTEGRATED WASTE LANDFORM (IWL) DESIGN DOCUMENT KANMANTOO PROJECT, SOUTH AUSTRALIA

MWP00335AA-A -IWL Design Report Rev 2

8 October 2007

Coffey Mining Pty Ltd ABN 52 065 481 209
1162 Hay Street West Perth WA 6005 Australia

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

8 October 2007

Hillgrove Copper Pty Ltd
42 Back Callington Road
Callington SA 5254

Attention: Marty Adams

Dear Sir

RE: INTEGRATED WASTE LANDFORM (IWL) DESGIN DOCUMENT KANMANTOO PROJECT, SOUTH AUSTRALIA

This document presents the details for the Bankable Feasibility Study for the tailings storage facility (TSF) within the integrated waste landform (IWL) for the Kanmantoo Project, South Australia.

One (1) hard copy and one (1) electronic copy (CD) of this report has been sent to Dale Ferguson at the Hillgrove Copper Pty Ltd office in Perth, and a separate hard copy and electronic copy of this document has been sent direct to Richard Jewell.

For and on behalf of Coffey Mining Pty Ltd

Christopher Lane

Senior Principal

DOCUMENT INFORMATION

Status	Final
Version	Rev 2
Print Date	8 October 2007
Approval State	
Author(s)	Christopher Lane
Reviewed By	
Path Name	F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\WP Docs\MH00335AA-AB -IWL Design Report Rev 2.doc
File Name	MH00335AA-AB -IWL Design Report Rev 2.doc
Project No	MWP00335AA
Distribution	One (1) hard copy and one (1) electronic copy (CD) – Hillgrove Copper Pty Ltd Perth; one (1) hard copy and one (1) electronic copy (CD) – Richard Jewell and one (1) hard copy and one (1) electronic copy (CD) – Coffey Mining Pty Ltd Library.

DOCUMENT CHANGE CONTROL

Version	Description (section(s) amended)	Author(s)	Date
1	Executive summary (ii) amended and Section 7.0 amended	CL	21 September 2007
2	Executive summary amended, Section 7.0 amended and Section 9.0 amended	CL	8 October 2007

DOCUMENT REVIEW AND SIGN OFF

Name	Position	Role	Signature	Date Issued
Ian Grieve	Principal	Reviewer		6 August 2007
Chris Hogg	Principal	Reviewer		31 August 2007

CONTENTS

CONTENTS

CONTENTS

ATTACHMENTS

Figures

Appendices

EXECUTIVE SUMMARY

Hillgrove Copper Pty Ltd (Hillgrove) are proposing to develop their Kanmantoo Project, which is located in the Mount Lofty Ranges, 55 kilometres southeast of Adelaide in South Australia. This is a brownfields development with an existing mine and some infrastructure from previous mining operations at the site. The throughput of the processing plant has been advised at approximately 2,000,000 tonnes per annum (tpa), with a projected mine life of 8 years. Concentrate produced from the plant feed is approximately 96,000 tpa, with tailings produced as a waste product of the process, totalling 1,904,000 tpa (approximately 238 tonnes per hour). The tailings can be potentially acid forming and need to be contained.

The tailings storage facility (TSF) option examined, as part of a range of TSF options for the Definitive Feasibility Study (DFS) is an integrated waste landform (IWL). The IWL is simply defined as a tailings storage facility (TSF) that is located inside the waste rock storage. It is formed by placing controlled, compacted, earthworks to form a containment embankment to retain the tailings. Mine waste is placed around the outer edge of this containment embankment such that a void is formed inside the storage. This void allows for further controlled, compacted, earthworks around the circumference of the void to form a perimeter containment boundary between the tailings and the mine waste. One of the advantages of this structure is that continued staged construction is in the downstream direction, that is, each lift is laid back against the surrounding mine waste rock storage and is placed over previously placed mine waste. Construction of future embankment lifts does not rely on the strength of the deposited tailings and, as such, the rate of rise and strength of the tailings do not impact on construction considerations. Other features of the TSF for the Kanmantoo Project comprise:

(i) A compacted clay liner, 0.75 m thick, over a minimum of 1.0 m of insitu clay in the base of the TSF.

(ii) An extensive underdrainage system, in the base of the TSF, is placed over the compacted clay liner to capture water which percolates through the tailings stack during the operation of the facility. The underdrainage system has a total design flow capacity estimated at approximately 1,075 L/sec. Because the capacity of the underdrainage system is in excess of the seepage rate through the tailings bed, the underdrainage system effectively has zero (0) piezometric head at the location of each underdrainage line. With piezometric head of zero (0) at each underdrainage line on the compacted clay liner the flow of fluids from the tailings stack is into the underdrainage and there is effectively negligible probability for seepage to penetrate the through the compacted clay liner on the floor of the TSF. On this basis there is no need for an artificial liner (rubber, plastic or similar) for the floor of the TSF.

(iii) A system of gravity decants, two (2) temporary decant and one (1) permanent decant are installed in the IWL to facilitate surface water recovery. Each decant system has a separate outfall and the design flow from the decant outfall pipework ranges from 11,232 m^3/day to 12,960 m^3/day at the starting level of each decant. In addition to recovery of slurry water discharged into the TSF, estimated at approximately 4,268 m^3/day, the pipework is designed to handle storm water flows for extreme storm events.

(iv) A high density polyethylene (HDPE) lined water storage with a capacity of 125,000 m^3 to contain water recovered by the decant and underdrainage system and handle storm water flows for extreme rainfall events.

(v) At closure, the surface of the TSF will be “domed”, with an HDPE liner, 0.75 mm, placed over the tailings and a layer of regolith placed over the HDPE liner. Grasses and shrubs will be planted in the regolith. The incorporation of the HDPE liner will minimise the potential for moisture and air entry to the tailings bed thereby reducing the risk of the tailings oxidising and producing an acidic leachate. The underdrainage and decant systems are fitted with airlocks to prevent entry of air into the base of the tailings stack at closure. Once the tailings have drained and the flow from the pipes is significantly reduced the outfall pipes will be capped, sealed and buried.

The following documents have been used in the design of the TSF:

(i) EPA/PIRSA Guideline *‘Tailings and Tailings Storage Facilities’* Draft issued May 2007, but dated 15/06/2007.

(ii) The Australian National Committee on Large Dams (ANCOLD) document titled, ‘*Guidelines on Tailings Dam Design, Construction and Operations*,’ dated October 1999.

(iii) The Western Australian Department of Industry and Resources (DoIR) document titled, ‘*Guidelines on the Safe Design and Operating Standards for Tailings Storage*’, dated May 1999.

For risk assessment purposes, the TSF has been assigned a hazard rating of Significant, Category 1, based on classification criteria outlined in Table 1 and Figure 1 of the DoIR Guideline.

The site selected for the IWL was based on the results of prefeasibility studies for a number of waste storage options and configurations. The final site selected for the IWL will minimise the impact on flora and fauna as the area proposed for the IWL has been used for grazing, with mine waste from previous mining operations located to the east of the site. The IWL is situated clear of remnant native vegetation which are located to the northeast and north west of this structure. The IWL is also located such that the potential impact of noise and dust on the local community is minimised and it is in close proximity to the planned processing plant and the pit.

The results of geotechnical investigations undertaken have been used to develop the design concept. A geotechnical assessment of the proposed storage area has been undertaken by Coffey Geotechnics Pty Ltd (Coffey Geotechnics) *‘Geotechnical Investigation of Proposed Tailings Storage Facility and Borrow Investigation - Factual Report, Kanmantoo Project.’* (Ref MH00335AA-AC dated June, 2007, in order to assess any ground conditions and identify constraints on the design and operation of the facility.

The geotechnical investigation works were supplemented by hydrogeological work on the site undertaken by Resource and Environmental Management (REM), groundwater consultants to Hillgrove. The results of insitu testing undertaken by REM determined that hydraulic conductivity of the insitu rock is variable, with investigations focused in the fractured rock in the vicinity of the TSF giving an hydraulic conductivity in the range of 0.01 m/day to 1.5 m/day (1.16×10^{-7} m/sec to 1.74×10^{-5} m/sec). REM preliminary hydrogeological modelling indicates rock mass permeability in the order of 0.01 m/day (1.16×10^{-7} m/sec).

It should be noted that this modelling has not been completed and indications are that the rock mass permeability could be as low as 0.001 m/day (1.0 x 10^{-8} m/sec). Advice from Alan Moon (Coffey Geotechnics Pty Ltd, Adelaide-based Senior Principal Engineering Geologist) who has many years experience with the investigations for various dams, including dams in the Adelaide Hills indicates that: *"I would expect in the folded and faulted rocks in the Adelaide Hills that in a weathered rock mass many of the crushed seams (faults consisting of crushed rock) will include clayey material and clay will also occur in other defects. If the weathered rock mass has not been affected by mechanical loosening (eg by stress relief, root jacking or slope movements) I would expect the permeability to be very low – typically in the range 10^{-8} to 10^{-9} metres/second. In a fresh rock mass I would expect permeability to be higher because some of the crushed seams will be more permeable and there will be less clay in the rock mass. If undisturbed by mechanical loosening I would expect permeability to be typically in the range of 10^{-7} to 10^{-8} metres/second but it will be locally higher in places (eg in fault zones)."* On the basis of the foregoing a rock mass permeability of 1.0 x 10^{-8} m/sec has been adopted for seepage modeling purposes for the TSF. The TSF proposed for the Kanmantoo Project is therefore effectively underlain by a 0.75 m compacted clay liner a minimum of approximately 1 m of insitu clay, which in some locations is up to 2 m thick, weathered rock and fresh rock with the depths of weathering ranging between 8 m and 27 m. In order to limit the potential seepage through the floor of the TSF an underdrainage system has been incorporated into the design.

Studies of the seepage from the TSF have been undertaken using computer modelling (SEEPW) as part of the current design work. Pressure heads (phreatic surface) have been simulated for a number of models, with each model having a base profile, equivalent to the natural topography (slopes), and the average hydraulic head, representing the final tailings level contained within the proposed Kanmantoo TSF area, appropriate to that section TSF. During the modelling process the underdrainage spacing was adjusted within each model to achieve effectively zero seepage from the base of the TSF. The underdrainage spacing determined from the modelling was then applied to the final drawings.

After deposition of tailings, seepage of fluids into the natural ground is not expected since the surface of the tailings will be covered with HDPE to prevent water and air entry to the tailings bed. Drainage of fluids through the tailings stack and into the underdrainage is predicted to continue for a period of up to 3 years following the cessation of tailings deposition and covering of the tailings stack with the 0.75 mm HDPE liner and regolith.

Waste rock from the prestripping operation of the open pit will be utilised to construct the downstream zone of the IWL with the clay liner and upstream zone constructed from compacted clay selected from the IWL footprint and adjacent borrow areas.

The perimeter containment embankments of the TSF will comprise a starter embankment (Stage 1) constructed using compacted clay to RL215 mAHD (1215 m in the mine co-ordinate system). Future lifts will be undertaken in stages to raise the embankment level using the downstream construction method to a level of RL240 mAHD (1240 m in the mine co-ordinate system). Clayey mine waste materials will be used for these staged embankment lifts. The TSF is circular with a nominal diameter of 630 m (radius 315 m), occupying a storage surface area of approximately 31 ha.

The starter embankments have been designed to provide an initial storage capacity of 12 months, based on an assumed initial average tailings dry density of 1.50 t/m^3, with a nominal height varying between 1 m where the starter embankment is parallel to the ground in the northwestern corner of the TSF and 35 m on the southern side of the site due to the site topography.

It is currently proposed to undertake several staged lifts, which will provide further storage capacity, with a final waste embankment at RL240 mAHD and tailings at RL235 MAHD with the height of tailings generally varying between 19 m on the north west side of the TSF and 60 m on the southern side of the TSF. The design storage life is 8 years however consolidation of the tailings is likely to result in the average dry density of the tailings increasing, which will either result in a lower final height assuming no increase in the total tonnes of tailings being generated; or an increased storage capacity to accommodate additional tailings should the tonnes of ore available for processing increase.

The results of geochemical testing of the tailings samples, metallurgical testing and from tailings recovered from drilling and sampling of the existing tailings facility (from the previous mining operations) have been taken into account during the design. The geochemical testing and evaluation was undertaken by Graeme Campbell & Associates and reference should be made to the documents titled *'Geochemical Characterisation of Process-Tailings-Slurry Sample [Static testwork] Implications for Process-Tailings Management'* dated January 2007 and *'Geochemical Characterisation of Tailings – Profile Samples from Existing Tailings-Storage Facility'* dated July 2007. In summary, the results of this work indicate that within the operating TSF, sulphide-oxidation should be minimal, due to spigot rotations, programmed to be weeks rather than months, which will maintain moist surface conditions on the tailings beaches.

High moisture contents will also be maintained within the tailings bed during the tailings deposition as a result of random segregation and sedimentation during the tailings deposition process with the fine fraction of the tailings (materials less than 75 microns) deposited as a series of lenses with irregular horizontal and vertical spacing giving rise to impeding bands of low hydraulic conductivity (low K_{sat}). This random pattern of irregular horizontal and vertical lenses will increase in frequency away from the tailings-discharge points, towards the centre of the TSF. Within the surface-zone of the tailings-bed, sulphide-oxidation could be rapid, but because of the planned rapid cycling of the active spigot points limited oxygen (O_2)-penetration into the tailings-bed is likely. Although modest in amount, soluble-alkalinity forms in the "fresh" incoming tailings-slurry will at least partly neutralise any acidity locally generated within the surface-zone of any dormant tailings-beaches. Although difficult to quantify, soluble-Fe(II) forms should occur in the tailings-pore-fluids, but overall unlikely to be beyond the 10 m/L range, when due account is taken of localised sulphide-oxidation within the surface-zone, and mixing/dilution with tailings-pore-fluids derived from the incoming, freshly-deposited-tailings. Since anoxic conditions should prevail at depth within the tailings-bed, formation of scale within the underdrainage system is considered unlikely, though this is again difficult to quantify. The underdrainage-water reporting from the underdrainage system is anticipated to have a pH above 5 with low amounts of latent-acidity in the form of soluble Fe(II) forms. The Al concentrations should be low (e.g. near-mg/L range possibly), due to the anticipated pH regime. The Cu concentrations may be within the range 1-10 mg/L. The latent-acidity in the form of soluble Fe(II) forms means that the water could acidify to pH 4 (+/-) upon "day lighting", and ageing in contact with air although this will be offset by decant water which is discharged in larger quantities at a pH which is likely to be similar to the pH at discharge, ie pH in the range 8 to 9. Some form of neutralisation treatment may therefore be required as part of the water conditioning process before the tailings water is returned to the process circuit. It is emphasised that because of the paucity of carbonate-minerals, and the presence of reactive-sulphides, albeit in trace amounts, an accurate projection of pH regime and metal-solubility behaviour is difficult for this Project. Monitoring is needed to confirm / refine the above anticipated chemistry of the underdrainage-water and routine sampling is recommended at the discharge point of both the underdrainage and decant.

The results of the assessments for the development of the conceptual design of the TSF within the IWL indicate that the tailings storage facility can be safely operated on the basis that:

(i) Liberated water is continually removed from the surface of the tailings.

(ii) The underdrainage and decant systems are continuously operated to remove water from the top and base of the tailings stack.

(iii) Tailings deposition is regularly cycled around the circumference embankment to maximise tailings density and therefore the storage volume of the facility. The sloped tailings beaches that are developed will concentrate water in the centre of the facility.

(iv) The storage is operated in accordance with the details contained in the Operating Manual.

(v) The safe operation of the storage relies upon the implementation of the tailings operation, management inspection and maintenance procedures.

The minimum embankment freeboard (operational freeboard) to be maintained between the tailings beach and the embankment crest to prevent tailings spillage is 300mm. The total freeboard volume (ANCOLD 1999) based on the AEP storm event of 1 in 10,000 year 72 hour duration for the Kanmantoo TSF is approximately 135,000 m^3 or approximately 42% of the total volume of the depressed cone contained within the TSF based on an average beach slope of 1%.

For a beach slope of 2% the volume occupied by based on the AEP storm event of 1 in 10,000 year 72 hour duration will be closer to 21% of the volume in the depressed cone.

It should be further noted that, at maximum height, the TSF's will be surrounded by the waste rock storage, which will stand well above the TSF crest level in some areas. The probability of embankment failure during the life of the tailings disposal has been assessed as being low provided the construction and operation guidelines are adhered to.

At this stage, the final top surface of the TSF is to be domed, using tailings with the lowest level of the tailings being RL235 mAHD adjacent to the perimeter embankment which will have a height of RL240 mAHD. The tailings deposition will be reversed during the final year of operation such that tailings are deposited through a series risers constructed on wing walls from the decant to create the domed tailings surface. An HDPE liner, 0.75 mm thick, will be placed over the tailings and covered with regolith, source from waste rock and stored surrounding the TSF, supplemented with soil to form a growth medium. The regolith will be seeded with grasses and shrubs only. No large trees are to be planted on this surface.

In the event of premature closure the doming will have to be undertaken using spigotting of tailings to initiate the dome and earthmoving equipment if the final months of operation are not sufficient to create a final domed surface, prior to placement of the HDPE cover and regolith.

A detailed rehabilitation / decommissioning plan will be prepared prior to decommissioning of the TSF.

Hillgrove, as operator of the project, make the following commitments:

(i) The TSF will be constructed in accordance with the specifications and drawings. Construction will be supervised and monitored by personnel with experience in this type of construction. Details of construction will be provided in a construction report.

(ii) The TSF will be managed and operated in general accordance with the Operation Manual, which will be reviewed on an annual basis and updated as required. Independent audits will be performed on an annual basis.

(iii) A groundwater monitoring programme will be initiated around the TSF and reference should be made to the reports by REM.

(iv) All investigation boreholes, groundwater and sterilisation holes drilled in the area of the TSF will be backfilled and sealed.

* * * * *

1 INTRODUCTION

This document presents details for the proposed Tailings Storage Facility (TSF) for the Kanmantoo Project, which is located in the Mount Lofty Ranges 55 kilometres southeast of Adelaide in South Australia, Figure 1.

The following documents have been used in the design of the TSF:

(i) EPA/PIRSA Guideline[1] *'Tailings and Tailings Storage Facilities'* Draft issued May 2007, but dated 15/06/2007.

(ii) The Australian National Committee on Large Dams (ANCOLD)[2] document titled, '*Guidelines on Tailings Dam Design, Construction and Operations*,*'* dated October 1999.

(iii) The Western Australian Department of Industry and Resources (DoIR)[3] document titled, '*Guidelines on the Safe Design and Operating Standards for Tailings Storage*', dated May 1999.

From the outset it must be noted that this document has been prepared as part of the MRG Guideline 2: Preparation of a Mining Lease Proposal for the Kanmantoo Project and this Design Document must be read as part of the document titled *'Mining Lease Proposal Kanmantoo Copper Project'*[4], dated September 2007, hereafter referred to as the Kanmantoo Mining Lease Proposal. This document must not be read without reference to the Kanmantoo Mining Lease Proposal since the site characterisation information, as listed in the EPA/PIRSA Guideline, is covered within the Mining Lease Proposal and is not repeated within this Design Document. For ease of cross referencing the location of the site characterisation information within the Mining Lease Proposal is detailed as follows:

- Local community, refer to Section 8.0 - Stakeholder Consultation to date, and that proposed for the future of the Mining Lease Proposal[4];
- Land use, refer to Sections 5.4 and 9.2 of the Mining Lease Proposal[4];
- Proximity to housing and infrastructure, refer to Section 5.14 and 9.14 Infrastructure and Transport of the Mining Lease Proposal[4];
- Amenity, refer to Section 5.3 - Topography, Landscape and Visual Amenity and Section 9.13 – Landscape and Visual Amenity, of the Mining Lease Proposal[4];
- Ambient Air Quality, Odour and Noise Levels, refer to Sections 5.2 of the Mining Lease Proposal[4],
- Air Quality, Noise and Vibration and Greenhouse Gas Emissions, refer to Section 9..5, 9.6 and 9.7 of the Mining Lease Proposal[4],
- Climate, refer to Section 5.1 of the Mining Lease Proposal[4];
- Geohazards, refer to Sections 5.6 and Section 11.6 of the Mining Lease Proposal[4];
- Surface Water, refer to Sections 5.7 and 9.3 of the Mining Lease Proposal[4];
- Groundwater, refer to Sections 5.8 and 9.4 of the Mining Lease Proposal[4];
- Vegetation, weeds and plant pathogens, refer to Section 5.9 – Flora, of the Mining Lease Proposal[4];

- Fauna, refer to Section 5.10 of the Mining Lease Proposal[4];
- Topsoil and sub soil, refer to Section 5.5 – Geology and Soils, of the Mining Lease Proposal[4];
- Heritage, refer to Sections 5.13 and 5.14 – Non-Indigenous and Indigenous Cultural Heritage, of the Mining Lease Proposal[4]; and
- Pre-existing site contamination and disturbance, refer to Sections 5.4, 5.5 and 5.8 – Land Uses, Geology and Soils and Groundwater, of the Mining Lease Proposal[4].

Details of the TSF design, not listed in the EPA/PIRSA Guideline[1], which enable the reader to understand the design of the TSF are provided in Section 2 of this document as background information.

2 BACKGROUND INFORMATION

2.1 Development of TSF Design

The tailings storage facility (TSF) option examined, as part of a range of TSF options for the Definitive Feasibility Study (DFS) is an integrated waste landform (IWL). The IWL is simply defined as a tailings storage facility (TSF) that is located inside a waste rock storage. It is formed by placing controlled, compacted, earthworks to form a containment embankment to retain the tailings. Mine waste is placed around the outer edge of this containment embankment such that a void is formed inside the storage. This void allows for further controlled, compacted, earthworks around the circumference of the void to form a perimeter containment boundary between the tailings and the mine waste. Figure 2 shows the general arrangement incorporating the design concept for the IWL.

For risk assessment purposes, the TSF has been assigned a hazard rating of Significant, Category 1, based on classification criteria outlined in Table 1 and Figure 1 of the DoIR Guideline[3].

2.2 Appended Documents

The following Figures and Appendices complete this design document.

- Figure 1 – Site Location.
- Figure 2 – General Arrangement.
- Figure 3 – Distribution of Earthquake Epicentres of South Australia
- Figure 4 – Earthquake Hazard Map of South Australia
- Appendix A – Drawings (A1 size).
- Appendix B – Scope of Works.
- Appendix C - Operation Manuals for Plant Staff.
- Appendix D - Geotechnical Investigation Reports.
- Appendix E – Seepage Analysis.
- Appendix F – Stability Analysis
- Appendix G – Risk Assessment

- Appendix H – Geochemical Characterisation

2.3 Location

The site is located at Kanmantoo located in the Mount Lofty Ranges, 55 kilometres southeast of Adelaide in South Australia. The proposed TSF is located within the mining lease application (MLA) and the approximate centre of TSF (Australian Map Grid co-ordinates) is 316,900 mE 6,115,550 mN. For the purposes of calculation of bonds, the area of disturbance of the TSF is approximately 31 ha, but does not include any area occupied by the surrounding waste rock storage.

2.4 Ownership

Hillgrove Resources Limited is the project proponent and will develop the project under a joint venture agreement with Keleray Pty Ltd (a fully owned subsidiary of Argonaut Resources).

2.5 Brief History

The Kanmantoo Project is situated within the Kanmantoo Trough, which is an axial zone hosting numerous former base metal and copper-gold mines and has been the subject of sporadic mining activity of both vein and replacement style deposits since the mid 1800's.

The Kanmantoo Mine operated from 1970 to 1975. Overburden removal for mining commenced in August 1970 and ore treatment began in October 1971[5]. Mining ceased in 1975 and the mine was placed on care and maintenance in 1976. The mine produced a total of 4.1 million tonnes of copper ore. Operations ceased on 30 June 1976 due to low copper prices, a high exchange rate and increasing costs.

In April 2004, Hillgrove exercised the option to acquire Mining lease 5776. Since that time ongoing exploration of the deposit and completion of various studies have been undertaken. More detailed information on the history of the site is presented in Section 5.0 of the Mining Lease Proposal[4].

2.6 Processing Information

The proposed treatment route is a conventional copper flotation plant. Metallurgical test work has indicated that recoveries of copper from the ore will be in the order or 95%. The concentrates produced will be high quality with low impurities. The process engineers have determined that the tailings discharge will be thickened to 55% solids, by weight, to assist in increasing water recoveries at the plant.

Water recovery from the TSF would comprise supernatant, or surface water (bleed water from the tailings), and run-off from rainfall collected within the catchment of the TSF. In addition an underdrainage system will be installed to recover water percolating through the tailings.

All water recovered (supernatant and underdrainage) would be collected in a double lined return water pond and pumped back to the process plant for reuse in the processing of ore.

The processing plant has been designed for a plant feed of approximately 2,000,000 tonnes of ore per annum with concentrate recovery of approximately 96,000 tonnes per annum and tailings of approximately 1,904,000 tonnes per annum. At this stage the project has a life of approximately 8 years.

More detailed information on the process type is presented in Section 6.5 of the Mining Lease Proposal[4].

3 TAILINGS PROPERTIES

3.1 Engineering Properties

Testing of tailings as part of this study comprised:

- particle size distribution test;
- plasticity index test;
- soil particle density test;
- air drying test;
- undrained settling test; and
- drained settling test.

The results of the tailings testing have been incorporated into the design and the details of this testwork is presented with the Geotechnical information in Appendix D The implications from the test results in respect to the design and operation of the tailings storage can be summarised as follows:

(i) The tailings are predominantly sand with non plastic fines. This means that the tailings will settle rapidly, releasing water for return via a decant system, as they will readily "bleed", resulting in free water discharge. The tailings will also "self drain", resulting in water percolation into the tailings stack and underlying underdrainage system. The water recovery will be a function of the slope of the tailings beaches which develop, the efficiency of the gravity decant system and the efficiency of the underdrainage system. Water recovery from the decant and underdrainage systems is expected to be high given the settling characteristics of the tailings.

(ii) Depending on the deposition velocity the tailings could form a relatively steep initial beach slope, a concave surface towards the decant. Overall beach slopes are anticipated to be in the range of 1% to 2%.

(iii) The tailings mass as a whole is expected to form a low permeability (Terzaghi and Peck 1967) tailings stack as a result of random horizontal and vertical, segregation and sedimentation of the non plastic fine fraction of the tailings. This should ensure that the tailings bed remains saturated during the operational life of the TSF.

(iv) The air drying tests indicate that between 5 and 7 days is needed to dry the tailings at temperatures of 45^{o} to 50^{o} C in the laboratory and seasonal variations in temperature will significantly impact on drying times in the field. However, given the geochemical characteristics of the Kanmantoo tailings total drying is not desirable and rapid rotation of the tailings deposition around the perimeter, within the time constraints identified by the geochemical testwork, ie weeks rather than months, is preferred.

(v) Consolidation of the tailings will be important to maximise the dry density of the tailings stack. Given the tailings are predominantly sand with non plastic fines, consolidation by self weight loading will be the primary consolidation mechanism. The average dry density of the tailings deposited subaerially are expected to be in the range of 1.65 t/m^3 possibly up to 1.80 t/m^3.

(vi) Moisture contents within the deposited tailings will vary in accordance with tailings segregation and sedimentation of the fines fraction of the tailings during the deposition process. It can reasonably be expected, depending on the number of spigots operating, that tailings lenses of finer tailings will occur within the outer section of the tailings beach with the centre of the tailings storage containing a mixture of fines (materials finer than 75 microns) and finer sands of variable thickness and moisture content, as a function of consolidation and drying conditions prevailing at the time of operation.

(vii) Prior to closure the deposition system will be changed to allow for the creation of a domed tailings surface. Stability of the tailings stack at high percentage solids is unlikely to be an issue as the bleed water from the tailings stack is expected to be maximised and the tailings drain rapidly. Multiple spigots may be required to allow tailings stack positions to be alternated to achieve the final desired shape.

The tailings parameters and characteristics adopted in the design are:

! Soil Particle density (SG)	3.1.
! Average slurry density ex-plant	55% solids (thickened).
! Tailings density (average)	1.50t/m^3 (for planning purposes)
! Tailings density (final average)	up to 1.80t/m^3.
! Particle size distribution	15% passing 75 microns.
! Unified soils classification	SM (Silty Sand)
! Hydraulic Conductivity (minimum assumed)	10^{-5} m/sec with minimal overburden loading and minimal consolidation.
! Hydraulic Conductivity (final assumed)	10^{-6} m/sec with overburden loading and consolidation.

An impermeable final surface cover will be required to limit the development of oxidation after tailings deposition has ceased to prevent the post closure entry of moisture and air into the tailings stack thereby minimising the potential for development of an oxide surface layer and acidic leachate.

3.2 Geochemistry

3.2.1 Tailings Slurry

The geochemical testing and evaluation of the tailings slurry from metallurgical testing and from the existing tailings was undertaken by Graeme Campbell & Associates and reference should be made to the documents titled *'Kanmantoo Copper Project Geochemical Characterisation of Process-Tailings-Slurry Sample [Static testwork] Implications for Process-Tailings Management'*[6] dated January 2007.

The results of geochemical characterisation testwork for the tailings slurry from the metallurgical testing indicate that:

- the tailings solids are classified PAF (potentially acid forming), short lag;
- the tailings solids are moderately enriched with Ag, Bi and Se; and
- the tailings slurry water is circum neutral and of potable salinity with very low concentrations of minor elements.

3.2.2 Tailings Analogue

The existing tailings facility from the previous mining operations at Kanmantoo is an analogue which, as part of this study, been subjected to investigation and geochemical testing to obtain an understanding of its performance and provide information for the design of the new TSF for the proposed Kanmantoo Project by Hillgrove Copper Pty Ltd.

The existing tailings were first deposited when processing operations commence in October 1971 and deposition ceased with the mine being placed on care and maintenance in 1976 (Coffey[5]). Topsoil is reported (Coffey[7]) to have been progressively laid over the surface of the existing TSF starting from the main (eastern embankment), with the level sections being done in two halves, the first in the spring of 1976 and the second a year later. For each section the upper surface of the tailings was scarified and mixed with lime and a topsoil layer placed and seeded. The topsoil on the sloping surface has been placed progressively over the time from 1975 to 1985 (to control dust problems) without lime treatment or seeding. Some catch dams had been constructed to intercept runoff from surrounding slopes onto the tailings deposit.

Investigation of the existing tailings was undertaken by Coffey Geotechnics Pty Ltd (Adelaide) in May 2007. The results of investigation of the existing tailings, presented in Appendix D, indicate that:

(i) The tailings solids are oxidised to a relatively shallow depth, 1.2 m at the western end of the existing TSF and 2.6 m and 3.6 m at the eastern end of the existing TSF.

(ii) Percentage fines vary through the tailings profile indicating random segregation and sedimentation during the tailings deposition process.

(iii) Water is present in the existing tailings profile with the depth to water ranging from 3.2 m to 8.5 m. It should be noted that given the time of the investigation, May 2007, the water levels recorded are likely to represent the lower bound, pre-winter recharge water levels.

Geochemical testing of the tailings samples from the existing TSF was undertaken by Graeme Campbell & Associates and reported in the document titled *'Geochemical Characterisation of Tailings – Profile Samples from Existing Tailings-Storage Facility'*[8] dated July 2007. This document is presented in Appendix H.

The implication from this geochemical testwork indicate that within the operating TSF, sulphide-oxidation should be minimal, provided spigot rotations are programmed to be in weeks, rather than months, which will maintain moist surface conditions on the tailings beaches. High moisture contents will also be maintained within the tailings bed during the as a result of random segregation and sedimentation during the tailings deposition process with the fine fraction of the tailings (materials less than 75 microns) deposited as a series of lenses with irregular horizontal and vertical spacing giving rise to impeding bands of low hydraulic conductivity (low K_{sat}). This random pattern of irregular horizontal and vertical lenses will increase in frequency away from the tailings-discharge points, towards the centre of the TSF.

Within the surface-zone of the tailings-bed, sulphide-oxidation could be rapid, but because of rapid cycling of the spigotting limited oxygen (O_2)-penetration into the tailings-bed is likely. Although modest in amount, soluble-alkalinity forms in the "fresh" incoming tailings-slurry will at least partly neutralise any acidity locally generated within the surface-zone of any dormant tailings-beaches.

Although difficult to quantify, soluble-Fe(II) forms should occur in the tailings-pore-fluids, but overall likely not beyond the 10 mg/L range when due account is taken of localised sulphide-oxidation within the surface-zone, and mixing/dilution with tailings-pore-fluids derived from the incoming, freshly-deposited-tailings. Since anoxic conditions should prevail at depth within the tailings-bed, scaling of the underdrainage system is considered unlikely, though this is again difficult to quantify. The underdrainage-water reporting from the underdrainage system is anticipated to have a pH above 5 with low amounts of latent-acidity in the form of soluble Fe(II) forms. The Al concentrations should be low (e.g. near-mg/L range possibly), due to the anticipated pH regime. The Cu concentrations may be within the range 1-10 mg/L. The latent-acidity in the form of soluble Fe(II) forms means that the water could acidify to pH 4 (+/-) upon 'day lighting', and ageing in contact with air although this will be offset by decant water which is discharged in larger quantities at a pH which is likely to be similar to the pH at discharge, ie pH in the range 8 to 9. Some form of neutralisation treatment may therefore be required as part of the water conditioning process before the tailings water is returned to the process circuit. It is emphasised that because of the paucity of carbonate-minerals, and the presence of reactive-sulphides, albeit in trace amounts, accurate projection of pH regime and metal-solubility behaviour is difficult for this Project. Monitoring is needed to confirm / refine the above anticipated chemistry of the underdrainage-water and routine sampling is recommended at the discharge point of both the underdrainage and decant.

The results of the geochemical testing have been incorporated into the design and operation of the TSF and reference should be made to the drawings, which show the various features incorporated into the design to minimise the impact of the potential for the tailings to acidify and operations manual for plant staff which indicate the timing of the changes to the tailings deposition and spigot rotation around the TSF.

4 SITE SELECTION

4.1 Background Information

The site selected for the TSF was based on the results of various technical and environmental studies undertaken during the prefeasibility study, the DFS, and includes the various consultations with the local community and PIRSA. The Mining Lease Proposal[4] contains the relevant environmental aspects of the site selection process. The technical components of the site selection comprise the various geotechnical, geochemical and hydrogeological studies which are appended to this document.

In summary, the current design will create a facility which offers the optimum solution from environmental, geotechnical, hydrogeological, economic and environmental perspectives and will provide a minimum of 8 years storage capacity.

4.2 Landform

The project area is characterised by low lying gently sloping ground, with surface elevations between RL 160 mAHD and RL 230m AHD, which is the existing waste dump from the previous mining operations.

Vegetation cover typically consists of grasses in the pastoral areas, shrubs and remnant woodland vegetation. More detailed information on the topography, landscape and amenity is presented in Section 5.3 of the Mining Lease Proposal[4].

4.3 Seismicity

In the last 100 years, South Australia has experienced 10 earthquake of magnitude larger than 5, the most recent being in 1986. The largest earthquake of magnitude 6.5 experienced in the region was in 1897. The focal depths of most earthquakes are relatively shallow, being confined to the upper crust. Distribution of epicentres with in the region of various magnitudes is shown on Figure 3.

The region is largely influence by active fault zones trending north and north east direction within close proximity to the site. The greatest concentration of earthquakes in the region occurs in northern part of Flinders Range of the Adelaide Geosynclines. In the Flinders Range it would appear that the earthquakes are scattered widely and do not cluster along the faults as shown on Figure 3.

Kanmantoo TSF is located within the southern part of Flinders Range where comparatively lesser densities of seismic activities are distributed. On 05 March 1997, an earthquake of magnitude 5 occurred some 130 km north of the Kanmantoo TSF site (LAT 35, LON 139).

According to AS 1170.4, horizontal acceleration coefficient of 0.09g, 10% chance of exceedance in 50 years (1:500 AEP, annual exceedance probability), is estimated around Kanmantoo TSF site as shown on Figure 4.

A probability based assessment of seismic risk at TSF site has been carried out using seismic data recorded in the region between 1883 and 2006.

Analysis of seismic data indicates that the occurrence of an earthquake of 6.2 magnitude in the region has a probability of 1 in 10,000. (AEP 1:10,000). The peak ground acceleration (PGA) anticipated versus annual exceedance probability (AEP) is presented in Table 1. Based on the analyses undertaken the PGA, 0.106g at the site, corresponds to 1:1,000 AEP.

TABLE 1 PGA VS AEP AT TSF 1 SITE.

Annual Exceedance of Probability (AEP)	Peak Ground Acceleration (PGA) (g)	Comments
1:100	0.071	
1:500	0.090	OBE
1:1,000	0.106	MDE
1:10,000	0.158	

*OBE – Operating Basis Earthquake. + MDE Maximum Design Earthquake.

According to ANCOLD[2], a TSF with a hazard rating of "Significant", should be designed for an AEP of 1:1,000. However, the design should be based on the maximum level of ground motion, which will be produced by a MDE (ANCOLD[2]).

4.4 Geology and Soils

4.4.1 General

Ground conditions at the site of the TSF generally comprise:

- Shallow overburden depth of soil (1 m thick) comprising mixtures of silty sand (SM), sandy clay (CL/CI) having low to medium plasticity; overlying
- Residual soil, primarily extremely weathered rock, which is defined as silty or sandy clay with medium to high plasticity; overlying.
- Highly to moderately weathered schist.

Within the area of the Kanmantoo mine the general trend for the rock is north-south strike with foliation steeply dipping to the east with remnant bedding dipping and striking in a similar direction to the foliation.

The results of the geotechnical investigations for the Kanmantoo TSF are presented in Appendix D.

More detailed information on the soils and geology of the project area is presented in Section 5.5 of the Mining Lease Proposal[4].

4.4.2 Liquefaction Potential - Soils

Liquefaction is a soil behaviour phenomenon in which a saturated soil loses strength due to high excess pore-water pressure generated by strong earthquake ground shakes. The initial liquefaction is the situation when the effective stress of the soil mass momentarily is zero.

A number of fundamental soil characteristics affect the liquefaction susceptibility, as identified by previous case histories and laboratory studies, eg. Fell et al, 2005[9] and ANCOLD, 1998[10]. Australian earthquakes are of a magnitude to cause liquefaction ANCOLD (1998)[10]. The primary factors affecting the susceptibility for liquefaction includes groundwater level or saturation of the soils, the composition and classification of the soils and relative density. The following sections discusses some screening techniques used as a general guideline for evaluation of liquefaction potential for TSF 1 using techniques outlined in ANCOLD (1998)[10].

Soil Properties

Sand and silty sands are particularly susceptible for liquefaction. Generally the presence of fines (silt and clay size particle passing 0.075mm sieve) reduces the susceptibly to liquefaction.

- Clay content > 15%;
- Liquid Limit > 35%; or
- Moisture content < 0.9 x Liquid Limit (LL).

ML and SM soils, which have plasticity index less than 7%, may be susceptible to liquefaction, even if not all criteria above are met.

The majority of the soils investigated at the site have a Liquid Limit in excess of 35% but may not all have a clay content in excess of 15% and therefore it is assessed that the susceptibly of the insitu soils to liquefaction is low.

It should be noted that the majority of the soils beneath the TSF and the waste storage which forms the IWL will be compacted either as part of the construction process, such as in the clay subgrade beneath the floor of the TSF prior to construction of the compacted clay liner, or will be removed for use in construction prior to placement of waste.

The moisture content of 90% of the liquid limit of the soil beneath the TSF could only occur as a result of significant saturation if the underdrainage system were to become totally blocked or accidentally closed. The probability of this happening is considered low if the construction and operation of the TSF is in accordance with the design requirements.

Saturation

In order to be susceptible to liquefaction, a potential liquefiable soil must be fully saturated or nearly saturated. This condition could only exist if the underdrainage system were to become totally blocked or accidentally closed and the soils beneath the TSF were to be come saturated. The probability of this happening is considered low of the construction and operation of the TSF is in accordance with the design requirements.

Stratification

Liquefiable soil of limited thickness and limited lateral extent may not create a liquefaction risk. But relatively thin seams of liquefiable soils, if laterally continuous over sufficient areas, can represent potentially hazardous weak planes of sliding. In general, liquefaction hazards are most severe in the upper 15 m of the ground surface (ANCOLD 1998[10]) within deeper weathered profiles.

The soil profile beneath the TSF at Kanmantoo is relatively shallow and will following TSF and IWL construction be limited in lateral extent therefore stratification is not considered as impacting on the liquefaction potential of the TSF.

Particle Size Distribution

ANCOLD (1998)[10] states that saturated sands, silty sands, silts and gravely sands are susceptible to liquefaction and gives particle size envelopes for potentially liquefiable soil and most liquefiable soil (Figure 11, ANCOLD, 1998)[8]. However later experience has shown that even soils with small amounts of clay may liquefy.

Given the insitu soils are predominantly mixtures of silty sand (SM), sandy clay (CL/CI) having low to medium plasticity, and these will be removed from beneath the outer embankment section of the IWL during construction if the construction and operation of the TSF is in accordance with the design requirements, then the potential for liquefaction as a function of material particle size distribution is considered to be low.

Soil Composition and Classification

All cohesionless soils may be considered potentially liquefiable, while cohesive soils that contain more than about 15% of clay and a Liquid Limit (LL) of >35 % generally are considered non-liquefiable, Seed Bolton *et al*, (1983)[11]. The percentage fines of the insitu soils exceed 15% and therefore the potential for liquefaction as a function of soil composition and classification is considered to be low.

4.4.3 Assessment of Liquefaction Potential – Tailings

A preliminary assessment of the liquefaction potential of tailings has been undertaken with regard to the screening techniques discussed in Section 4.3.2 above, and the material to be stored within TSF a non plastic silty sand and is considered to be potentially liquefiable. The physical properties of the tailings and the potential for liquefaction are summarised below in Table 2.

TABLE 2 SUMMARY OF LABORATORY TEST RESULTS

Parameter	Tailings Characteristic
Liquid Limit (LL)	Non Plastic
Plastic (PL)	Non Plastic
Plasticity Index (PI)	Non Plastic
Granular Content, sand fraction	85%
Classification	SM (silty sand)
Potential for liquefaction	High

The tailings are predominately coarse grained (silty sandy) with 85% passing 75 microns. Particle size distribution envelopes for the various materials, which show liquefaction potential under seismic loading, indicates that the tailings plot within the envelopes for soils with potential for liquefaction. Reference should be made to the plots in Appendix D. For the materials to liquefy as the result of seismic loading, the following criteria must be met:

- the material must be liquefiable; and
- the material must be saturated, that is, lying within the water table, be it perched or otherwise.

Estimation of Cyclic Resistance Ratio (CRR)

The CRR defines the capacity of the soil to resist liquefaction. In the absence of SPT data for the tailings, the CRR is estimated using an assumed range of values for the tailing based on available physical properties. The values assumed in the analysis are shown in Table 3. Lower bound values of $(N_1)_{60}$ for tailings material is considered for the analysis.

TABLE 3 ASSUMED $(N_1)_{60}$ VALUE FOR THE MATERIAL

Material Type	$(N_1)_{60}$ Upper bound value	$(N_1)_{60}$ Lower bound value
Tailings	12	8

The Cyclic Stress Ratio (CSR_{liq}) of the tailings required to generate liquefaction are obtained from Figure 18 of (ANCOLD 1998)[10], based on assumed lower bound values.

Table 4 shows the derivation of CSR and CRR for the determination of a factor of safety against liquefaction for 1 in 1,000 AEP (Average Exceedance Probability) earthquake with a corresponding peak ground acceleration of 0.106g, as determined from the seismicity analysis, refer to Section 4.3.

Results of Liquefaction Assessment

TABLE 4 FACTOR OF SAFETY AGAINST LIQUEFACTION - TAILINGS

Depth (m)	Assumed Value for $(N_1)_{60}$	$CRR_{7.5}$	CSR (Fully Saturated Condition)	Factor of Safety CRR/CSR	
				MSF* = 1.76	MSF*=2.1
Tailings					
2	8	0.13	0.1676	1.2678	1.5127
5	8	0.13	0.1360	1.4664	1.7496
10	8	0.13	0.1160	1.6822	2.0072
20	8	0.13	0.0948	2.4140	2.8803

Notes: MSF = Magnitude scaling factor – lower bound is 1.76 and upper bound is 2.1

Summary

The figures in the above table show that the tailings have factors of safety against liquefaction above 1 and are thus considered to be non liquefiable during Maximum Design Earthquake (MDE) of AEP 1:1,000, PGA 0.106g, as determined from the seismicity analysis, refer to Section 4.3..

Further analyses were carried out lowering the phreatic surface within the coarse tailings. The analyses indicate that factor of safety of the coarse tailing above the phreatic surface are well above 2 for the entire depth range under MDE.

4.5 Hydrogeology

Hydrogeological studies have been undertaken by Resource and Environmental Management (REM)[11] and the results of their investigations are presented in Section 5.8 of the Mining Lease Proposal.

The results of the REM investigations indicate that the groundwater system beneath the Kanmantoo site area comprises a fractured rock aquifer, with groundwater predominantly occurring within discrete fracture zones within mineralised and un-mineralised fresh bedrock units of the Kanmantoo Group. The overlying shallower weathered bedrock profiles tend to form a confining unit to this aquifer, and the shallow Quaternary sediments associated with drainage lines, if saturated, would be too thin to form useful aquifers but may form perched aquifers that support remnant vegetation. At least on a local scale, the groundwater flow would be heterogeneous and fracture-flow dominated and may also be compartmentalised into separate strip aquifers across the site. The existing open-pit currently acts as a groundwater sink, with general radial flow of groundwater towards the pit. With further mining the pit is expected to continue to act as a groundwater sink, both during and following mining.

Five monitoring wells (KMB004 and KMB016 to KMB019) and one groundwater supply investigation well (KMB006) were installed in the vicinity of the proposed IWL and the results of the localised hydrogeological investigations indicates that:

(i) The results of insitu testing, slug and pump testing of the fracture zones investigated, as part of the groundwater supply investigation works determined that hydraulic conductivity of the insitu rock is variable. Hydraulic conductivity in the fractured rock in the vicinity of the TSF are in the range of 0.01 m/day to 1.5 m/day (1.16×10^{-7} m/sec to 1.74×10^{-5} m/sec).

(ii) Groundwater levels from the six wells ranged from 8 m to 27 m below ground and are considered to be representative of the typical depths to groundwater below most of the IWL area.

(iii) Groundwater sampled from the bores reported elevated concentrations of selenium (KMB016 and KMB019), cadmium (KMB017 and KMB019), manganese (KMB017 and KMB018), copper (KMB019) and zinc (KMB017). All reported levels are marginally above the SA EPA (2003) water quality criteria. These concentrations are most likely 'natural concentrations' of metals indicative of the mineralisation of the parent rock.

Preliminary hydrogeological modelling by REM indicates that the rock mass permeability is in the order of 0.01 m/day (1.16×10^{-7} m/sec). It should be noted that this modelling has not been completed and indications are that the rock mass permeability could be as low as 0.001 m/day (1.0×10^{-8} m/sec).

Advice from Alan Moon (Coffey Geotechnics Pty Ltd, Adelaide based Senior Principal Engineering Geologist) who has many years experience with the investigations for various dams, including dams in the Adelaide Hills indicates that: *"I would expect in the folded and faulted rocks in the Adelaide Hills that in a weathered rock mass many of the crushed seams (faults consisting of crushed rock) will include clayey material and clay will also occur in other defects. If the weathered rock mass has not been affected by mechanical loosening (eg by stress relief, root jacking or slope movements) I would expect the permeability to be very low – typically in the range 10^{-8} to 10^{-9} metres/second. In a fresh rock mass I would expect permeability to be higher because some of the crushed seams will be more permeable and there will be less clay in the rock mass. If undisturbed by mechanical loosening I would expect permeability to be typically in the range of 10^{-7} to 10^{-8} metres/second but it will be locally higher in places (eg in fault zones)."*

On the basis of the foregoing a rock mass permeability of 1.0×10^{-8} m/sec has been adopted for seepage modeling purposes for the TSF.

4.6 Hydrological Characteristics

4.6.1 Surface Water

The IWL is located in an area of 'sheet' flow with drainage lines for ephemeral stream flow to the south of the site. There is no defined drainage lines within the northern half of the IWL footprint. There are no permanent streams within the IWL footprint. With the exception of one drainage line to the west of the site, the majority of the drainage lines within the IWL footprint will be covered during initial construction and operation.

Incident rainfall into the TSF will be captured and discharged to the return water storage for use in the process plant. The return water storage facility to the south of the IWL also stores water recovered from the decant and underdrainage system. The return water storage has a capacity of approximately 125,000 m^3.

The major drainage line from the west of the IWL will be initially be diverted into a diversion drain during the first stage construction works and will discharge direct to the culvert under the rail line. As the southern section of the waste rock storage footprint extends to the south, the drainage from this catchment will be captured in a water storage and spilled via a lined diversion channel, during overflow periods, direct to the culvert under the rail line.

4.6.2 Design Floods

As the TSF will be an integrated landform type facility, watershed into the TSF will only occur from incident rainfall within the TSF catchment. The total height of water plus allowances based on the AEP (Annual Exceedance Probability) storm event 1 in 10,000 year 72 hour rainfall event (ANCOLD 1999)[2] for this TSF is 300 mm. When this is converted to an equivalent volume it occupies approximately 135,000 m^3.

Therefore for practical purposes, the stormwater freeboard capacity of the return water pond for the TSF is close to, but slightly less than the ANCOLD[2] design requirements. The AEP storm event (1 in 10,000 year 72 hour duration) for the Kanmantoo TSF is approximately 42% of the total volume of the depressed cone contained within the TSF based on an average beach slope of 1%, if retained on the TSF. This is equivalent to a pond area of approximately 17.4 hectares.

For a beach slope of 2% the volume occupied by based on the AEP storm event of 1 in 10,000 year 72 hour duration will be closer to 21% of the volume in the depressed cone, if retained on the TSF. This is equivalent to a pond area of 10.0 hectares. If the runoff from the 1 in 10,000 AEP were to be retained on the TSF it would take approximately 100 days to remove.

The actual volume formed within the impoundment area by the tailings beaches, which slope at 1% towards the centre of the TSF to form an inverted cone is likely to be approximately 32.7 hectares.

The design also provides for an operational freeboard, defined as the vertical distance between that tailings beach and the adjacent embankment crest, of 300mm (minimum). The operational freeboard is to prevent overtopping of the embankments by tailings deposition and is in addition to stormwater freeboard.

Sufficient freeboard adjacent to the perimeter embankment will need to be retained at the end of tailings deposition for Stage 7, prior to completion of the final cover placement. Once the final tailings cover is in place excess runoff from the regolith will be discharged into the non-acid forming waste (NAF) which surrounds the TSF.

4.6.3 Water Balance Analysis

Preliminary water balance studies have been undertaken for the TSF design as part of this study. Rainfall data for the water balance analyses were obtained from the Bureau of Meteorology (BoM) for the town of Callington which has rainfall records from 1883 to 2007. Evaporation data for the site is not available and the evaporation data for the water balance was BoM records for Wellington Pumping Station, approximately 40 km from the site.

For the purposes of these water balance analyses **only**, the following assumptions were made:

- Initial TSF area 310,000 m^2, final TSF area 450,000 m^2;
- A fixed pool* area of 10,000 m^2;
- Fixed running beaches of 10,000 m^2;
- Underdrainage recovery fixed at 1,062 m^3 per day;
- Seepage losses constrained at 1.0 x 10^{-10} m/sec; and
- Retained moisture fixed at 35%.

*It should be noted that for practical operation purposes there is to be no pooling of water on the surface of the TSF and the incorporation of the extensive underdrainage should result in no seepage losses through the floor of the TSF.

The results of the water balance analyses, based on a slurry density of 55% solids, using average rainfall conditions and average evaporation for the initial TSF area (Case 1) and for the 9th Decile (90% of the rainfall) and average evaporation for the final TSF area (Case 2) are:

(i) For Case 1, the potential water available for water recovery for average rainfall (380 mm) and average evaporation (1,469 mm) has been estimated at approximately 2,408 m^3/day up to 2,645 m^3/day from decant, with the maximum flow through the underdrainage estimated to be approximately 1,062 m^3/day.

(ii) For Case 2 the potential water return for 9th Decile monthly rainfall and average evaporation conditions is approximately 2,525 m^3/day up to 2,835 m^3/day from decant with the maximum flow through the underdrainage estimated to be approximately 1,062 m^3/day.

The actual water which is available for return to the plant may vary considerably from the figures presented in these water balance analyses, since water available for return to the plant will be a function of:

- the actual slurry density at the time of operation;
- thickener operation;
- continuity of tailings discharge;
- distance of the discharge point on the perimeter embankment to the decant or decant pond, if any, since it is expected the majority of any supernatant water will move towards the gravity decant and be discharged to the water return storage pond, together with water recovered by the underdrainage,
- weather conditions prevailing at the time of operation; and
- the efficiency of the underdrainage and decant when operating.

Water should not be permanently stored on the TSF for long periods of time. The TSF should be the prime resource for harvesting water for use in the processing operation under normal operating conditions and especially following large rainfall events. Optimising the operation of the thickener to boost fine tailings slurry densities above 55% solids will have a significant benefit in recovering water at the plant. Water recovered from the TSF facility will be returned to the processing plant and make up water, as required, will be added to the circuit.

The underdrainage is designed to recover water from the base of the deposited tailings stack and assist with consolidation of the tailings. The presence of the underdrainage, coupled with the practically impermeable compacted clay liner, underlying the underdrainage, will effectively preclude vertical seepage from the TSF. It should also be noted that the impact of the consolidation of the tailings maybe a reduction in the volume of water flow through the underdrainage system to an amount which is less than the full design flow capacity of the underdrainage. If the results of this consolidation constrain the seepage to a rate which is lower than, say 1.0 x 10^{-6} m/sec, then the water available for recovery through the underdrainage would decrease. This reduction in flow through the underdrainage does not imply that seepage through the clay liner will occur.

Water recovered from the facility (decant and underdrainage) will be returned to the processing plant via the return water storage with make up water added to the circuit in the raw water tanks.

The return water storage pond has a volume of approximately 125,000 m^3, which is sufficient to accommodate the 1 in 100 72 hour ARI (average recurrence interval) storm event which would generate 53,000 m^3 in addition to normal water return.

5 TAILINGS DISPOSAL FACILITY

The site selected for the TSF was based on the results of work undertaken during the prefeasibility study, consultation with PIRSA, consultation with the local community and land ownership constraints. The different types of tailings storages options that have been assessed for the Kanmantoo Project comprised:

(i) Inpit Tailings Storage, was considered but no pits are available for this option at this point in time.

(ii) Conventional stand alone Paddock Type Storage with upstream or centreline and downstream construction.

(iii) Valley Type Storage.

(iv) Central Thickened / Paste Discharge (cone disposal).

(v) Integrated Waste Landform, which comprises a TSF located within a waste rock storage.

An economic ranking and risk ranking was undertaken on each type of facility and the results of this ranking is presented in Table 5.

TABLE 5 TSF OPTIONS

TSF Option	Economic Ranking+	Risk Ranking*	Comment
In-pit TSF	1	1	Requires pits to be available for tailings storage. This option is generally not available to start up projects. Progressive rehabilitation is not possible. Post closure erosion risk is negligible. Mine voids are filled.
Paddock (upstream raising using tailings)	2	3	Progressive rehabilitation of outer embankment is possible. Post closure erosion has a high risk of uncontrolled release of tailings unless the cover design is adequate to reduce the risk erosion.
Paddock (upstream raising using mine waste)	2	2	Progressive rehabilitation of outer embankment is possible. Some post closure erosion potential but this is limited where the composition of the downstream cover design is carefully considered at the time of construction and maintenance or design changes are implemented during operation to reduce the risk of erosion. Post closure erosion risks could be negligible.
Paddock centreline or downstream raising using mine waste	3	2	Progressive rehabilitation is not possible. Post closure erosion potential unless the composition of the downstream cover design is carefully considered at the time of construction and is adequate to reduce the risk of erosion.
Valley storage	2	2 - 3	Progressive rehabilitation of outer embankment is possible. Depending on the size and location of the valley TSF the risk ranking will generally remain in the medium to high category, depending on the consequences of embankment failure. This type of facility may require on going management, post closure, to maintain the operation of spillways etc.
CTD and Paste tailings to surface storage	3	1	Progressive rehabilitation of outer embankment is possible. CTD has the attraction of low overall height in terms of stability but the tailings occupy a large area which can give rise to water management problems during operation. On large projects the costs of rehabilitation are as much as 33% of the whole of life costs. Post closure erosion risks are negligible.
IWL	2	1	Progressive rehabilitation is possible. Post closure erosion possible but this is limited where the composition of the downstream cover design is carefully considered at the time of construction and maintenance or design changes are implemented during operation to reduce the risk of erosion. Post closure release of tailings eliminated due to encapsulation within the waste rock storage.

Notes

+ Economic ranking is based on whole of life costs, where 1 = low whole of life cost, 2 = medium whole of life cost, 3 = high whole of life cost.

* Risk ranking is based on operational and post closure risks, where 1 = low risk both during operation and post operation, 2 = medium risk both during operation and post operation, 3 = high risk both during operation and post operation.

The sighting, design and operational of the IWL has been aimed at:

(i) Minimising the impact of the Kanmantoo Project on the native vegetation.

(ii) Minimising the impact on the local community.

(iii) Optimising the removal of surface water for return to the processing plant.

(iv) Optimising the recovery of water percolating through the tailings stack for return to the processing plant and minimising the potential for seepage through the floor of the TSF.

(v) Maximising tailings density and storage capacity by undertaking cyclic deposition.

(vi) Minimising environmental impact creating an IWL which incorporates the TSF within the waste rock storage.

The following considerations have been incorporated into the tailings storage design.

(i) A compacted clay liner in the floor of the TSF.

(ii) Central decants to recovery supernatant water for reuse in the process plant.

(iii) Extensive underdrainage system to recover water percolating through the tailings stack during operation and post closure.

(iv) Starter embankments from compacted clay placed against mine waste.

(v) Mine waste from the open pit will be used in the construction of the embankments to support the compacted clay.

(vi) A seepage cut-off and underdrainage system is incorporated into the design to limit potential seepage losses from the site and recover seepage for reuse in the process plant.

(vii) Staged embankment construction will be undertaken utilising the downstream construction method. Staged construction will provide additional capacity on an as required basis, generally aimed at providing an additional 1 year storage capacity with each lift.

(viii) The storage life has been estimated based on a production rate of 1,904,000 tonnes of tailings per annum for an 8 year mine life.

(ix) Tailings in the form of a slurry will be discharged subaerially and spirally around the storage. Tailings will be deposited in discrete layers from one or more discharges at 55% solids to promote low velocity discharge. The active discharge points will be regularly moved to ensure that an even development of the tailings beach is achieved with the rotation of the entire perimeter completed in 30 days to minimise the oxidisation of the tailings on the tailings beach.

(x) Tailings discharge or spigotting will be carried out such that the sloped beaches that are formed will be controlled to ensure that any surface water pond, which is formed from the liberation of water from the deposited tailings slurry, is maintained around the central decant structure which has a gravity outfall to the return water storage.

(xi) Beach slopes are expected to be in the range of 1% to 2% and in the event steeper beach slopes form there is sufficient mine waste to either create finger walls, perpendicular to the perimeter embankment, to allow tailings deposition to extend further into the facility and thus maximise the use of the storage volume within the depressed cone formed in the centre of the facility or raised the perimeter embankments.

(xii) The tailings storage area will assume the form of a truncated prism with a depressed cone in the top surface. The facility will have the potential to contain a considerable body of water during a rainstorm. The minimum operational freeboard is 300 mm. The minimum total freeboard within the inverted cone could range from 312,000 m^3 for a 1% beach slope to 650,000 m^3 for a 2% beach slope, which will be adequate to contain a 72 hour 1 in 10,000 year AEP (Annual Exceedance Probability) rainfall event, 135,000 m^3 in the event of emergencies.

(xiii) On decommissioning, the TSF will remain a permanent feature of the landscape but completely enclosed in a waste rock storage forming the IWL. The tailings will drain to an increasingly stable mass. Only the top surface will require rehabilitation as the facility will be encased (surrounded) by mine waste. This provides a significant long term environmental advantage to conventional paddock style TSFs where a relatively thin veneer of waste is usually used to cover the sides of the TSF.

(xiv) The current plan, at this stage, for the final top surface of the TSF is that it is to be domed, using tailings, with the tailings deposition pattern reversed during the final year of operation such that tailings are deposited through a series risers constructed on wing walls from the decant to create the domed tailings surface. An HDPE liner, 0.75 mm, will then be placed over the tailings and covered with regolith, from waste stored surrounding the TSF supplemented with soil to form a growth medium. The regolith will be seeded with grasses and shrubs only. No large trees are to be planted on this surface. In the event of premature closure the doming will have to be undertaken using spigotting of tailings to initiate the dome and earthmoving equipment if the final months of operation are not sufficient to create a final domed surface, prior to placement of the HDPE cover and regolith

(xv) A detailed rehabilitation / decommissioning plan will be prepared prior to decommissioning of the TSF and the rehabilitation and decommissioning plans developed at this point in time are located in Section 11 of the Kanmantoo Mining Lease Proposal by Enesar.

5.1 Drawings

The following drawings are provided:

Title	Drawing No.	Rev
General Arrangement	MH00335AA-01	B
TSF Plan Stage 1 Earthworks (Clay Blanket and Internal Embankment)	MH00335AA-02	C
TSF Section Stage 1 Earthworks (Clay Blanket and Internal Embankment)	MH00335AA-03	C
TSF Underdrainage and Decant Pipework Plan	MH00335AA-04	C
Sections and Details - Decant	MH00335AA-05	B
Sections and Details - Underdrainage	MH00335AA-06	C
Return Water Storage - Plans and Sections	MH00335AA-07	D
Water Storage dam and Diversion – Plans and Sections	MH00335AA-08	D
Underdrainage Protection Plan	MH00335AA-09	C
Underdrainage Protection Sections	MH00335AA-10	C
TSF Plan – Stage 6	MH00335AA-11	B
TSF Sections – Stages 2 to 6	MH00335AA-12	C
Stage 7 Plan and Sections – Final Deposition	MH00335AA-13	B
Staging of Final Cover Deposition	MH00335AA-14	A
Process Water Pond Plan and Sections	MH00335AA-15	A

A general arrangement drawing is presented at A3 size immediately following the text as Figure 2. All drawings are presented at A1 size in Appendix A.

5.2 Construction Method

The perimeter embankment of the TSF's will comprise a starter embankment constructed using compacted clay which will be formed against the adjacent waste rock storage. The clay materials will be sourced from the areas which will be covered by the waste rock storage, and other areas to be developed as part of the project.

The design concept also incorporates water recovery systems comprising an underdrainage and a gravity feed decant.

The underdrainage is designed to recover water from the base of the deposited tailings stack and assist with consolidation of the tailings. The presence of the underdrainage, coupled with the practically impermeable compacted clay liner, underlying the underdrainage, will effectively preclude vertical seepage from the TSF.

The decant system comprises a decant access and a centrally located decant structure comprising slotted concrete well sections stacked vertically on one another and surrounded by select filter rock. This structure will be raised along with the perimeter embankments as part of any staged construction works.

A detailed description of the construction requirements and procedures for construction of the TSF perimeter embankments, underdrainage and decant is presented in Appendix B, Scope of Works. This document, together with the drawings and geotechnical investigation works will be provided as part of the tender and contract packages that will be prepared for the construction of the TSF.

Typical construction requirements for the TSF implementation include the following:

- Inspection of the underdrainage pipework and outfall sump.
- Inspection of the seepage cut off and the alignment of the embankment.
- Compliance testing of seepage cut off and perimeter embankment to ensure:

  Moisture content at the time of placement is within -2%, +2% of the optimum moisture content as determined from laboratory test 5.1.1 of AS1289 with moisture curing of materials as required during embankment construction.

  Compaction is to achieve a density ratio greater than 98% of standard maximum dry density, as determined from laboratory test AS 1289.5.1.1.

  Materials used in the embankment construction shall comprise clayey material having a fines content (material finer than 75 microns) in excess of 40% for the compacted clay liner.

5.3 Area

The tailings storage footprint area, based on an inside radius of 315 m is 31 ha. The surface area will increase slightly at the Stage 1 crest level and further increase as the perimeter walls are raised to their final design height. At the final stage crest level, the surface area is expected to be 45 ha. This increase in area will NOT affect any undisturbed ground as construction will be out and over the existing waste rock storage.

5.4 Depth

The embankment height of the Stage 1 starter embankment will typically vary from nominally 1 m above the natural ground in the northwestern corner of the TSF to 35 m on the southern embankment due to the sloping nature of the natural ground surface. At the final design height, the depth of tailings will generally vary from approximately 19 m to 60 m.

5.5 Capacity

The potential storage capacity has been assessed at 15,232,000 tonnes, or 10,154,670 m^3 at a minimum density of 1.50 t/m^3.

Due to the slope of the tailings beach, there will be a reduction in the total available storage volume. At a beach slope of 1 in 100, the fall will be approximately 3.15 m from the circumference perimeter embankment to the decant based on a radius of approximately 315 m.

5.6 Wall Angles

The embankments will have design slopes of 1:1.5 (vertical to horizontal) for the inner slope. The outer or downstream slope will be formed by the waste rock storage, which is likely to initially be at its natural angle of repose, assumed to be approximately 1:1.5 (V:H), until such time as reshaping is undertaken to achieve the final design slopes for rehabilitation.

5.7 Water Recovery System

5.7.1 Decant

A system of gravity decants, two (2) temporary decant and one (1) permanent decant are installed in the IWL to facilitate surface water recovery. Each decant system has a separate outfall and the design flow from the decant outfall pipework is in the range of 11,232 m^3/day to 12,960 m^3/day at the start level of each decant.

In addition to recovery of slurry water discharged to the TSF, estimated at approximately 4,268 m^3/day, the pipework is designed to handle storm water flows for extreme storm events. Recovered surface water will flow by gravity to the return water storage from where it will be pumped back to the processing plant for use in processing.

Each decant comprises slotted concrete pipes which will be surrounded by ‘clean’ rock fill, which allows for safe access to the structure for pump installation and maintenance purposes.

Access to the actual decant structure for light vehicles and maintenance equipment will be via a decant access roadway constructed from mine waste.

As the decants are raised, and collars added to the internal riser, scats or gravel will be added to the annulus between the collars and the slotted concrete pipe.

5.7.2 Underdrainage

The underdrainage is designed to recover water from the base of the deposited tailings stack and assist with the rate of consolidation of the tailings.

The presence of the underdrainage, coupled with the practically impermeable compacted clay liner underlying will effectively preclude vertical seepage from the TSF.

5.8 Liners

A compacted clay cut-off and a compacted clay liner, 0.75 m thick, in the floor of the TSF and compacted clay perimeter embankments, 6.0 m thick minimum, have been incorporated into the design of the TSF. Please note that the compacted clay liner is in addition to the 1.0 m, minimum, of insitu clay.

The presence of an intensive underdrainage system which is designed to create “zero piezometric pressure” above the compacted clay liner in the floor of the TSF and to capture the flow of fluids from the tailings stack such that there is negligible probability for seepage through the compacted clay liner and insitu clay on the floor of the TSF.

The practically impermeable (Terzaghi and Peck 1967) compacted clay liner which is acting as a confinement layer beneath the underdrainage can effectively preclude vertical seepage from the TSF.

6 GEOTECHNICAL INVESTIGATIONS

Geotechnical investigations for the proposed TSF and the preliminary borrow areas required for the TSF construction have been carried out by Adelaide based Coffey Geotechnics Pty Ltd. The results of these investigations are provided in Appendix D. Brief details of the results of these investigations are presented in Section 4.4.

Geotechnical investigations have also been carried out in the existing tailings storage facilities and the results of these investigations are also presented in Appendix D.

7 SEEPAGE ANALYSES

7.1 Method of Analysis

Seepage analyses have been undertaken for the proposed embankment design concept to RL 1240 m with the final tailings surface approximately 2 m below the embankment at the perimeter. The analyses were undertaken using a 2D steady state seepage analysis computer programme SEEPW. This computer programme utilises the finite element method for the purposes of calculation. It should be noted that 2D modelling is a simplistic approach, which does not take into account 3D effects.

Given the variable topography of the site the analyses were undertaken by:

(i) Grouping the natural topography into slope groups.

(ii) Calculating the head variations between the final tailings surface and the topography.

(iii) Setting up a series of models in SEEPW for representative slope and head groups and analysing the spacing of the underdrainage pipes to determine the distance between underdrainage pipes to achieve negligible (effectively zero) seepage through the compacted clay liner.

No seepage is a state which cannot be practically achieved even with HDPE liners. Each case analysed the tailings surface at RL 1238 m with the water level on the tailings surface. This is assumed to be the worst case scenario. Figure E1 shows the grouped topographic slopes and total head contours. The modelling for variable TSF floor gradients of 7%, 10%, 20%, 30% and 40% were carried out since these gradients are representative of the various topographic slopes within the entire TSF floor area. The base case value of tailings permeability, 8.5×10^{-6} m/s was adopted based on laboratory testing, the results of which are presented in the tailings testwork report in Appendix D. Table 6 below shows the permeability values adopted for the materials.

TABLE 6 PERMEABILITY VALUES ADOPTED

Material Zone	Base Case
Deposited tailings	8.5×10^{-6}
Compacted clay liner (0.75 m thick)	1.0×10^{-9}
Insitu clay below compacted clay liner (1.0 m min)	1.0×10^{-8}
Clay liner (perimeter embankment to RL 1225m)	1.0×10^{-8}
Clay liner (perimeter embankment from RL 1225m to RL 1240m)	1.0×10^{-8}
Mine waste	1.0×10^{-3}
Foundation (weathered rock)	1.0×10^{-8}

Table 7 shows the cases analysed using the base case permeability values as shown in Table 6, and the underdrainage spacing required to achieve negligible (effectively zero) seepage.

TABLE 7 SEEPAGE ANALYSES CASES

Case	Model Conditions
Case 1	Topography gradient 7% with underdrainage spacing 25 m.
Case 2	Topography gradient 10% with underdrainage spacing 30 m.
Case 3	Topography gradient 20% with underdrainage spacing 30 m.
Case 4	Topography gradient 30% with underdrainage spacing 30 m.
Case 5	Topography gradient 40% with underdrainage spacing 30 m.

7.2 Model Assumptions

The finite element ground water seepage module in SEEPW is a numerical model which mathematically simulates the real physical process of water flow through the medium being analysed. The seepage model of for the Kanmantoo TSF has been developed for 200 m sections of the TSF floor area, with the total head and topographic slopes appropriate to each section. ***The main objective of the modelling was to optimise the underdrainage spacing to achieve negligible (effectively zero) seepage through the floor of the TSF.*** For simplicity, the model is assumed to have a boundary at depth beneath the TSF. The ratio of vertical and horizontal permeability of the material in the model assumed to be equal to 1. It should not be interpreted or otherwise construed that the maximum depth of the tailings as shown against the left axis for those models with steeper gradients is indicative of the actual depth of the tailings.

Nor should it be interpreted or construed that the "end effects" are part of the modelling. The readers focus is drawn to the centre of the model since the objective of the modelling was to optimise the spacing of the underdrainage lines.

7.3 Model Geometry and Boundary Conditions

The geometry of the models is representative of the floor gradients and total heads within the proposed TSF. A four noded rectangular finite element mesh was set up for gradient model for the purposes of the analyses. The model boundary conditions were defined with flow and pressure boundaries based on the model geometry and various conditions of the analysis. The upper boundary condition comprised a constant total head equal to the level of the supernatant pond on the tailings surface. Zero total heads (P=0) were set up at nodes in the underdrainage. A process of trial and error was then undertaken to determine the underdrainage spacing which would result in negligible (effectively zero) seepage through the compacted clay liner.

7.4 Modelling Results

Material parameters, boundary condition, computed total head and the pore water pressure distribution for each case are presented in Figures E2 to E6 in Appendix E. Table 8 presents the results of the seepage analysis in terms of the computed seepage rates into the underdrainage, underdrainage spacing, estimated seepage through the liner based on the predicted pore pressures, the estimated time for seepage to penetrate to the underside of the clay liners (0.75 m compacted clay and 1.0 m of insitu clay).

TABLE 8 RESULTS OF SEEPAGE ANALYSES

Case	Slope	Approximate area within TSF that the slope applies (m^2)	Average Head (m)	Effective Drainage Spacing (m)	Estimated flow through compacted clay liner (m/sec)	Time for seepage front to penetrate the compacted clay liner (years)	Estimate seepage through compacted clay liner (m^3/m^2/year) after penetration to underside of clay liner	Estimated seepage over sloped area (after penetration to underside of clay liner) (m^3/year
1	7%	130,000	24	25	1.29×10^{-9}	28	0.041	5,300
2	10%	60,000	25	30	1.33×10^{-9}	34	0.042	2,500
3	20%	75,000	35	30	1.50×10^{-9}	40	0.047	3,500
4	30%	16,000	47	30	8.99×10^{-10}	12	0.028	450
5	40%	30,000	42	30	9.95×10^{-10}	10	0.031	950

The underdrainage system has a great influence in controlling passage of seepage through the entire TSF foundation and the embankment.

Drainage of fluids through the tailings stack and into the underdrainage is predicted to continue for a period of up to 3 years following the cessation of tailings deposition and covering of the tailings stack with the 0.75 mm HDPE liner and regolith.

It should be noted that blockage of underdrainage will raise the phreatic surface within the facility. However, the provision of a multiple filter system within underdrainage and multiple underdrainage outlets reduces the potential risk of blockage. Figure E7 shows the proposed layout of the underdrainage as determined by the modelling. Drainage of fluids through the tailings stack and into the underdrainage is predicted to continue for a period of up to 3 years following the cessation of tailings deposition and covering of the tailings stack with the 0.75 mm HDPE liner and regolith. Figure E8 shows the time for seepage, for various heads, to penetrate the compacted clay liner in the event to entire underdrainage system were to be disabled.

7.5 Impact of Overburden on Underdrainage

The proposed underdrainage system for Kanmantoo TSF consists of 300/450 Megaflo Ultra wrapped with geotextile and covered with component, 10 mm to 14 mm coarse aggregate which is designed to protect the entire Megaflo Ultra underdrainage system, in accordance with generally accepted practice in mining[14]. The underdrainage system will experience stresses from the deposited tailings although the aggregate over the underdrainage will impact on the vertical stresses through a process known as soil arching. The basic concept of soil arching is that a part of the weight of the tailings is transferred to the underlying compacted clay liner through the aggregate which is curved over the Megaflo Ultra. The soil arch load more closely represents the actual tailings load. Analysis of the effective overburden stress on the Megaflo Ultra, placed in both the horizontal and vertical orientation, with a competent 10 mm to 14 mm coarse aggregate has been undertaken using two dimensional explicit Finite Element Program, FLAC Version 5.

The analysis was undertaken with zero (0) pore pressure in the underdrainage, ie the underdrainage was flowing, and the effective stress model for the 56 m maximum height of tailings with pore pressures within the tailings stack accounted for in accordance with the pore pressure profile determined from the seepage analysis.

The results of the analysis for the effective overburden stress were compared with manual calculations. The results of the analysis are summarised below:

- Effective Stress without soil arching above Megaflo Ultra drainage = 962 kPa (J. Boussinesq).
- Effective Stress with soil arching above Megaflo Ultra drainage (horizontal orientation) = 240 kPa
- Effective Stress with soil arching above Megaflo Ultra drainage (vertical orientation) = 340 kPa Effective Stress without soil arching above Megaflo Ultra drainage = 500 kPa (FLAC)

Total vertical displacement at inner crown of the arch surrounding the Megaflo Ultra derived from the FLAC analyses was estimated at 7 mm. Figure E8 shows the modeling and the results of the modeling.

In view of the above result, and based on advice from Geofabrics Pty Ltd in respect of recent testing of the Megaflo Ultra the vertical load from the tailings can be accommodated by Megaflo Ultra.

8 STABILITY ANALYSES

8.1 Background

Stability analyses have been carried out for TSF to the design crest level of RL 240 m (RL 1240 m Mine Datum) using the computer based modelling programme, SLIDE. The computer models analysed the stability of potential circular slip planes within the mass of the facility by Bishop's simplified method.

The design earthquake load for the TSF embankment (Maximum Design Earthquake, MDE or Operational Basis Earthquake, OBE) is determined by consideration of the hazard category of the tailings storage and is selected as an earthquake with a given AEP. ANCOLD (1998)[10] gives the guidance in selecting the Annual Exceedance Probability (AEP) of the OBE.

Since the Kanmantoo TSF is considered as 'Significant' Hazard category tailings storage (ANCOLD[10]), the MDE has been selected as an AEP 1 in 1000 years.

According to the AS 1170.40, a horizontal acceleration coefficient of 0.09g, with 10% chance of exceedance in 50 years (1:500 AEP), is estimated for the Kanmantoo TSF site, as shown on Figure 4. The Peak Ground Acceleration (PGA) of 0.09g corresponds to OBE of 1:500 AEP. A probability assessment of seismic loading has been then considered for the analyses. In the light of this, AEP 1:1000 is considered for the design of Kanmantoo TSF under seismic loading of Peak Ground Acceleration (PGA) 0.1g (MDE). It has a 5% chance of exceedance in 50 years. The phreatic surface adopted in all cases was based on the seepage analyses, refer to Section 7.

8.2 Method of Analysis

The analyses were carried out for downstream embankment construction technique for RL 1215 m and RL 1240 m. Four cases were examined for each stage in the stability analysis for design embankments as follows.

(i) Case 1: Downstream failure: Normal Condition.

(ii) Case 2: As for case 1, but with PGA of 0.1g (MDE) corresponds to AEP 1:1000.

(iii) Case 3: Upstream Failure: Normal Condition.

(iv) Case 4: As for case 3, but with PGA of 0.1g (MDE) corresponds to AEP 1:1000.

8.3 Parameters

Parameters adopted for the embankment fill materials in the analyses were based on assumed parameters for the mine waste starter embankment and coarse tailings. The parameters for the tailings and embankment foundation materials were assumed based on the recent investigation works. Parameters for mine waste were assumed and are believed to be conservative. The parameters assumed in the analysis are shown in Table 10.

TABLE 10 MATERIAL PARAMETERS

Material Type	Bulk Density (kN/m^3)	Effective Strength Parameter	
		Cohesion c$^/$ (kPa)	Friction Angle "$^/$ (degrees)
Deposited Tailings	17	0	35
Compacted Clay (Foundation)	17	5	28
Compacted Clay (Upstream face)	16	5	25
Mine Waste	25	0	40
Foundation (rock)	22	20	40

8.4 Results of the Stability Analyses

The results of the stability analyses for the various cases examined are summarised in Tables 11 and 12, with the SLIDE computer printouts presented in Appendix F.

TABLE 11 RESULTS OF STABILITY ANALYSIS - RL 1215 m

Case	Factor of Safety	Recommended Minimum Factors of Safety*
1	2.19	1.5
2	1.74	1.3
3	2.02	1.5
4	1.64	1.3

Table 12 - STABILITY ANALYSIS RESULTS - RL 1240 m

Case	Factor of Safety	Recommended Minimum Factors of Safety*
1	2.14	1.5
2	1.68	1.3
3	1.86	1.5
4	1.53	1.3

Notes: * Recommended factors of safety in accordance with ANCOLD (1999)[2].

The stability analyses indicate that the design has adequate factors of safety when compared with the recommended minimum factors of safety in ANCOLD (1999)[2] for the cases examined.

The factor of safety against a deep seated failure through the embankments is greatly influenced by the position of the phreatic surface. The containment embankment provides temporary water storage following extreme storm events and any water retained will either evaporate or be recovered through the decant or report to the underdrainage collection system.

8.5 Probabilistic Stability Analyses

In addition to the deterministic stability analyses carried out above, probabilistic stability analyses were also performed using Slide. The probabilistic stability analyses were performed in order to assess the level of confidence in the design parameters adopted in the analyses for the long term cases. The probabilistic stability analyses were carried out using the Bishop's method with probabilities of failure estimated using Monte Carlo methods. The material parameters, phreatic surface etc were as per the deterministic analyses (refer Section 8.3). The standard deviations adopted for the Monte Carlo trials were based on generally accepted values typical of the materials used in the analyses. The material parameters are detailed on the computer printouts presented in Appendix F of this report. A copy of the computer printouts showing the results of the analyses are presented in Appendix F and summarised in Tables 13 and 14.

TABLE 13 RESULTS OF THE PROBABILISTIC STABILITY ANALYSES – RL 1215 m

Case Number	Factor of Safety*	Probability of `Slope Instability' *	Probability of Earthquake Event (ie trigger event)	Estimated Annual Probability of Slope failure
1	2.19	$< 10^{-4}$	-	$<10^{-5}$
2	1.74	$< 10^{-4}$	$1x10^{-3}$	$<10^{-6}$
3	2.02	$< 10^{-4}$	-	$<10^{-5}$
4	1.64	$< 10^{-4}$	$1x10^{-3}$	$<10^{-6}$

** Probability of FOS <1 .0 base on standard deviations adopted.*

TABLE 14 - RESULTS OF THE PROBABILISTIC STABILITY ANALYSES – RL1240 m

Case Number	Factor of Safety*	Probability of `Slope Instability' *	Probability of Earthquake Event (ie trigger event)	Estimated Annual Probability of Slope failure
1	2.14	$< 10^{-4}$	-	$<10^{-5}$
2	1.68	$< 10^{-4}$	$1x10^{-3}$	$<10^{-6}$
3	1.86	$< 10^{-4}$	-	$<10^{-5}$
4	1.53	$< 10^{-4}$	$1x10^{-3}$	$<10^{-6}$

** Probability of FOS <1 .0 base on standard deviations adopted.*

The highest annual probability of failure is an upstream failure into the facility which will not lead to release of tailings to the environment. The probabilities for all other cases were less than 1×10^{-6} which is the normally accepted societal risk criteria.

8.6 General Comments in Respect to Stability

Stability is significantly influenced by the position of the phreatic surface within the deposited tailings and confining embankment. Under extreme operating conditions, where the phreatic surface was higher than that determined by the seepage analyses, actual factors of safety would be lower than the factors of safety outlined in Section 8.4 above. However, the assumptions that the supernatant pond can reach, and remain at the embankments long enough to allow full saturation of the tailings to occur, under extreme rainfall conditions is an event with a very low probability of occurrence. The stability analyses indicate that under correct operational conditions the TSF has adequate factors of safety against failure.

The tailings storage should be operated in such a manner as to ensure that the supernatant pond is kept to an absolute minimum size and the phreatic surface is maintained below that used in the worst case scenario analysis. Details of appropriate management practices are provided in the Operations Manual, refer to Appendix C.

9 QUALITATIVE RISK ASSESSMENT

9.1 General

A qualitative risk assessment of the TSF was undertaken utilising the risk management process outlined in AS/NZS 4360:1999[15] and AS/NZS 4360:2004[16]. A summary of the major issues which involve the embankment integrity addressed in the risk assessment are attached in Appendix G. The qualitative risk analysis matrix is also attached in Appendix G.

The risk assessment involved a process of:

- Hazard Identification
- Failure mechanism resulting from hazard
- Potential consequences in terms of both safety and operating/business
- Likelihood
- Risk
- Action

9.2 Surrounding Environment

The TSF is located adjacent to and upstream of the process plant, the main Adelaide to Melbourne railway line and the local community of Cannington. A major failure of the TSF could lead to flow of water and tailings into the plant or down local drainage lines and into surrounding areas with the environmental consequences downstream.

The TSF is also located in the Murray River catchment and poses a risk in terms of potential for ground water pollution.

9.3 Examination of Major Hazards

The following major hazards have been identified as part of the risk assessment for the TSF design:

(i) Embankment failure (Seismic): Embankment deformation, loss of freeboard, loss of water and tailings from the storage.

(ii) Embankment failure (Overtopping – storm water): Embankment failure due to overtopping as a result of excess water from rainfall with loss of water from the storage.

(iii) Embankment Failure (Overtopping - operational): Embankment failure due to overtopping as a result of excess water from operations, with loss of water and tailings from the storage.

(iv) Piping (Internal embankment erosion): Erosion leading to embankment failure and loss of water and tailings from the storage.

(v) Foundation sliding: Embankment failure, and loss of water and tailings from the storage.

(vi) Embankment failure (high water level / phreatic surface): Embankment failure and loss of water and tailings from the storage.

(vii) Tailings line failure: Erosion leading to embankment failure, and loss of water and tailings from the storage.

(viii) Combination failure: A combination of more than one of the above at the same time resulting in embankment failure, and loss of water and tailings from the storage.

It should be noted issues associated with construction of the embankments, positioning of the waste storages which surround the TSF and operation of the TSF have been considered as part of the risk assessment.

Failure of the gravity decant has not been considered in detail since a pump can be retrofitted into the decant tower in the event of failure of the internal pipework, to maintain discharge to the external sump. If there is a pump installed into the decant it will need to be correctly sized to meet the design water return requirements as the return water is critical to the operation of the process plant.

The operation of this pump equipment is no different from failure of any other piece of mechanical equipment within the plant where access to maintenance and or pump replacement is part of the normal day to day operation.

9.4 Groundwater Pollution

There is a potential risk of ground water pollution as a result of seepage from the TSF. The magnitude of that risk is a function of the factors which impact on the veracity of the results predicted by the seepage modelling, refer to Section 7.0. The factors which influence the actual performance of the TSF versus the predicted performance from the modelling are:

- Material parameters used in the models.
- Risks associated with the modeling.
- Construction risk; and

! Operational risk

The seepage analyses, refer to Section 7.0, demonstrate that if it is assumed that a full hydraulic head can be maintained, beyond the current projected project life, then seepage will penetrate the clay liner system at the time periods as outlined in Table 8. This could occur if the life of the project is such that the depth of tailings exceeds the hydraulic heads used in the seepage analyses. The risk of the hydraulic head being maintained once the final tailings cover is in place is negligible since excess runoff from the regolith will be discharged into the non-acid forming waste (NAF) which surrounds the TSF. Analyses also indicate that with the proposed design there is risk of seepage from the TSF, within the project life, if the underdrainage were to be disabled.

The impact of seepage, as predicted in Section 7.0, is being assessed by REM.

9.4.1 Material Parameters

The material parameters adopted in the models are based on currently available data. Of all the parameters used in the seepage modelling the parameters which might appear to have some uncertainty are the permeability of the compacted clay liner and the permeability of the weathered rock and fresh rock foundation.

The compacted clay liner permeabilities are based on the results of laboratory testwork. It is acknowledged that there is literature available, from research done in the 1980's and 1990's which demonstrates that in comparisons between laboratory and field testing permeabilities of up to 2 orders of magnitude higher have been recorded in the laboratory when compared to the field results. However, this research is based on lower levels of compaction than have been specified in the TSF design, that is compaction to achieve 95% dry density ratio determined from standard compaction versus compaction to achieve 98% dry density ratio determined from standard compaction as specified by the TSF design. Furthermore, the research does take into account:

(i) The development and use of heavy compaction plant such as Caterpillar 825 compaction equipment which can achieve a more effective mixing, kneading and compaction of cohesive materials during construction, than equipment used at the time of the research. It is not uncommon to achieve insitu dry density ratios of 100% of the maximum dry density when this heavy equipment is used in conjunction with good quality construction practices.

(ii) The benefits of consolidation on compacted clay liners, as most loads on clay liners are relatively small since clay liners are principally used for effluent ponds and the like. It should be noted that the compacted clay liner and insitu clay will be under significant loading imposed by the tailings overburden, maximum effective stress is estimated at 962 kPa, and the effect of this overburden loading will be an increase in the density of the liner as a result of settlement through consolidation and thus a reduction in the permeability of the compacted clay liner and insitu clay as a result of increased density.

In addition to further investigations of borrow materials, refer to the recommendations in the geotechnical report in Appendix D, permeability testing of the proposed construction materials and insitu clay materials under the proposed overburden loads should be considered in the next phase of the design work.

In respect to the permeability of the weathered rock foundation, modelling is currently being undertaken by REM to assess the impact of the predicted seepage from the floor of the TSF upon the underlying groundwater system. As the existing permeability testing in the TSF area is biased towards known fracture zones, it is reasonable to assume that the rock mass permeability will fall within the range as specified, typically in the range 10^{-8} to 10^{-9} m/sec for weathered rock and typically in the range of 10^{-7} to 10^{-8} m/sec in fresh rock which has not been disturbed by mechanical loosening. In addition, the reader is reminded that any potential seepage impacts may be constrained by the lateral influence of open-pit dewatering, which is predicted to partially project into the TSF area. Natural attenuation by the insitu materials is also being examined as part of the further seepage impact studies by REM.

9.4.2 Modelling Risks

The seepage analysis performed for the base of the TSF, as part of the TSF design, has limited risk since the parameters are currently known and the seepage model is relatively simple.

More complex modelling of the site hydrogeology has risk associated with the model setup and material parameters selected as input to the models. This risk can be reduced through increased knowledge of the site, particularly the geology, its structural features and hydraulic parameters.

The Kanmantoo site has an existing tailings dam with a long seepage history. If this is investigated further, the field results could be used as a benchmark analogue for modelling of the proposed TSF.

Once the hydrogeological modelling is completed a detailed groundwater monitoring plan can be prepared for implementation during the operational phase of the project.

9.4.3 Construction Risk

Construction risk can be minimised by implementing a strict construction quality control and quality assurance (QA/AC) program to ensure construction is undertaken to meet the requirements of the design.

9.4.4 Operational Risk

Operational risk can be managed by:

- Ensuring the tailings management is in accordance with the deign and the operations manual;
- Ensuring a strict construction quality control and quality assurance program is in place for subsequent embankment construction works;
- Implementing the groundwater monitoring plan and regularly reviewing the groundwater monitoring results and assessing how those results compare with the model predictions.

9.5 Consequence Assessment

The consequence of a major failure examined three basic aspects, namely:

- Safety
- Environment
- Operations/Business

For each of the hazards identified in Section 9.3 above, the consequence of failure was assessed. The results of the risk assessment are summarised in tabular form and presented in Appendix G. The results of the risk assessment indicated that each hazard generally has a high risk. Controls and actions to mitigate the risks are outlined in Section 9.5.

9.6 Controls and Actions to Mitigate Risk

Controls and actions to mitigate the risk identified by this assessment are:

(i) Ensuring that management controls are in place to achieve the design objectives during construction. This means ensuring that the QA/QC procedures are in place to effectively monitor construction to ensure that each element of the TSF and IWL are constructed through all stages to meet the design parameters.

(ii) Ensuring that management controls are in place to achieve the design objectives and compliance with the requirements of the Operations Manual, eg daily inspections by the designated plant staff and monthly inspections by plant management, with logs completed after each inspection and the annual engineering inspection. These inspections include ensuring that tailings deposition and water recovery are in accordance with good operating practice. This means constant monitoring to ensure supernatant water can access the decant systems and that the operation of the underdrainage system is monitored to ensure its performance meets expectations.

(iii) Ensuring that management controls are in place to monitor the rate of tailings rise and ensure that the future embankment construction is keeping place with, and is ahead of the projected tailings storage requirements.

10 OPERATING PROCEDURES

Operations Manual for the IWL for the plant staff is presented in Appendix C.

11 GEOCHEMICAL CHARACTERISATION

Geochemical testing of the tailings has been carried out by Graeme Campbell and Associates and reference should be made to the comments presented in Section 3.1and the reports dated January 2007 and July 2007 in Appendix H.

Geochemical testing mine waste has been carried out by EGI, refer to document ref: 2042/771, dated June 2007.

12 INSTRUMENTATION AND MONITORING

Approximately seven (7) groundwater monitoring bores will be located at some distance from the TSF due to the presence of the waste rock storage. Where appropriate, existing bores will be used for monitoring purposes. Experience has shown that bores/piezometers placed close to the TSF (ie in the active waste) storage are usually quickly destroyed by the large mining equipment used to construct the storages.

It should be noted that the TSF will be located partially within the significant influence zone of the pit dewatering system and reference should be made to the comments in Section 4.5 of this report.

Bores that are installed will be sampled prior to TSF construction and then monitored at least on a quarterly basis after commissioning. Locations of the monitoring bores will be confirmed by the project hydrogeologists.

A monitoring program will be established including water level readings and the taking of water samples for water quality testing purposes from the bores around the TSF. Collected information will be reviewed regularly and reported in an annual TSF audit.

This monitoring program will also need to include water level readings and the taking of water samples for water quality testing purposes from the leak detection systems from the return water storage and process water storage.

13 EMERGENCY ACTION PLAN

An emergency action plan has been developed specifically for the IWL, and is included as part of the Operations Manuals, presented in Appendix C. Due to the presence of the large waste rock storage surrounding the facility the likelihood of any likely failure impacts are considered to be negligible.

14 REHABILITATION

At this stage, the final top surface of the TSF is to be domed, using tailings, with the tailings deposition pattern reversed during the final year of operation such that tailings are deposited through a series risers constructed on wing walls from the decant to create the domed tailings surface. An HDPE liner, 0.75 mm, will be placed over the tailings and covered with regolith, from waste stored surrounding the TSF supplemented with soil to form a growth medium. Reference should be made to Drawing No MH00335AA-13 in Appendix A which provides the design concept (plan and sections) for the final TSF surface.

The regolith will be seeded with grasses and shrubs only. No large trees are to be planted on this surface. The final cover aspects are planned to be further assessed as part of normal operating conditions when representative materials are being produced. Topsoil either removed from the IWL areas prior to construction, or sourced from other salvage operations at the site, will be redeployed over the prepared top surface. The downstream slopes will be concave in shape with upper slopes of 25^{o} and lower slopes of 14^{o}. More detailed information on the rehabilitation TSF is presented in Section 11 of the Mining Lease Proposal[4].

Recommendations for rehabilitation of this structure will be researched and reviewed during the life of the project and will be under the direction of personnel from Kanmantoo's environmental team. A detailed rehabilitation / decommissioning plan will be prepared prior to decommissioning of the IWL.

15 REFERENCES:

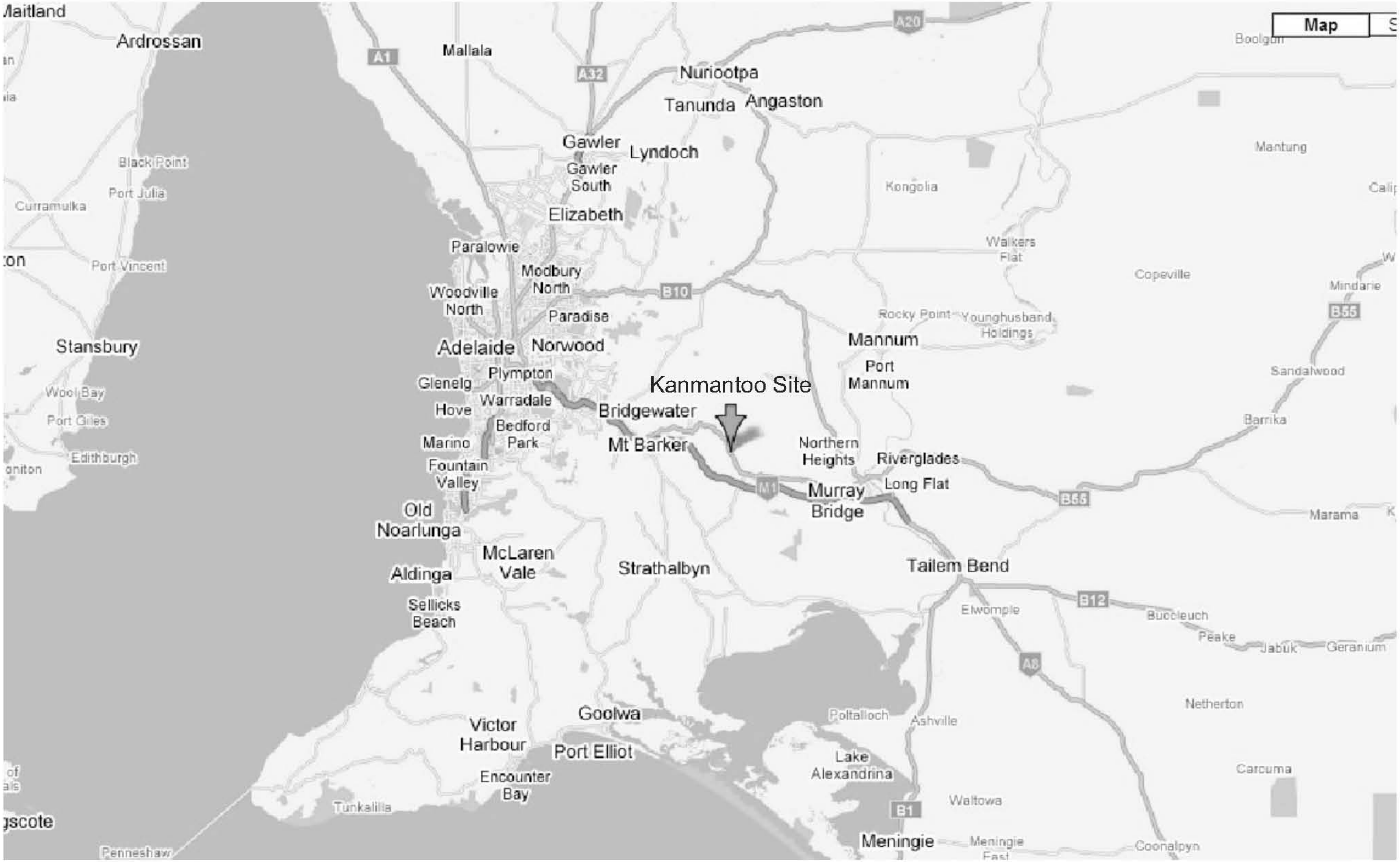
The following standards and references were used in the preparation of this report.

1. EPA/PIRSA, (2007) DRAFT Guideline *'Tailings and Tailings Storage Facilities'.*
2. ANCOLD (1999), *'Guidelines on Tailings Dam Design, Construction and Operation'*.
3. DoIR (1999), *'Guidelines on Safe Design and Operating Standards for Tailings Storage'*.
4. Enesar (2007), *'Mining Lease Proposal – Kanmantoo Copper Project'*.

5. Coffey (1989), *'A.M. & S. Mining Ltd Kanmantoo Mine – Kanmantoo Consolidated Report of Rehabilitation of Tailings Dam'*.
6. Graeme Campbell & Associates (2007) *'Kanmantoo Copper Project Geochemical Characterisation of Process-Tailings-Slurry Sample [Static testwork] Implications for Process-Tailings Management'*.
7. Coffey (1985), *'A.M. & S. Mining Ltd Preliminary Report on Kanmantoo Mine Rehabilitation'*.
8. Graeme Campbell & Associates (2007) *'Geochemical Characterisation of Tailings –Profile Samples from Existing Tailings-Storage Facility'*
9. Fell, R., MacGregor, P., Stapledon, D., (2005), *'Geotechnical Engineering of Embankment Dams'*, Balkema, Rotterdam, Chapter 15 pp488-502.
10. ANCOLD (1998), '*Guidelines for Design of Dams fortr Earthquake*'.
11. Seed, Bolton (1983), *'Evaluation of Liquefaction Potential Using Field Performance Data',* ASCS, J. Geotechnical Engineering, 109(3), 458 – 482.
12. Resource and Environment Management (2007), *'Kanmantoo Copper Project Groundwater Impact Assessment'*.
13. Lupo, J. F. and Morrison K. F. (2005) *'Innovative Geosynthetic Liner Design Approaches and Construction in the Mining Industry'*.
14. Standards Australia (1999) *'Risk Management AS/NZS 4360:1999'*.
15. Standards Australia (2004) *'Risk Management AS/NZS 4360:2004'*.

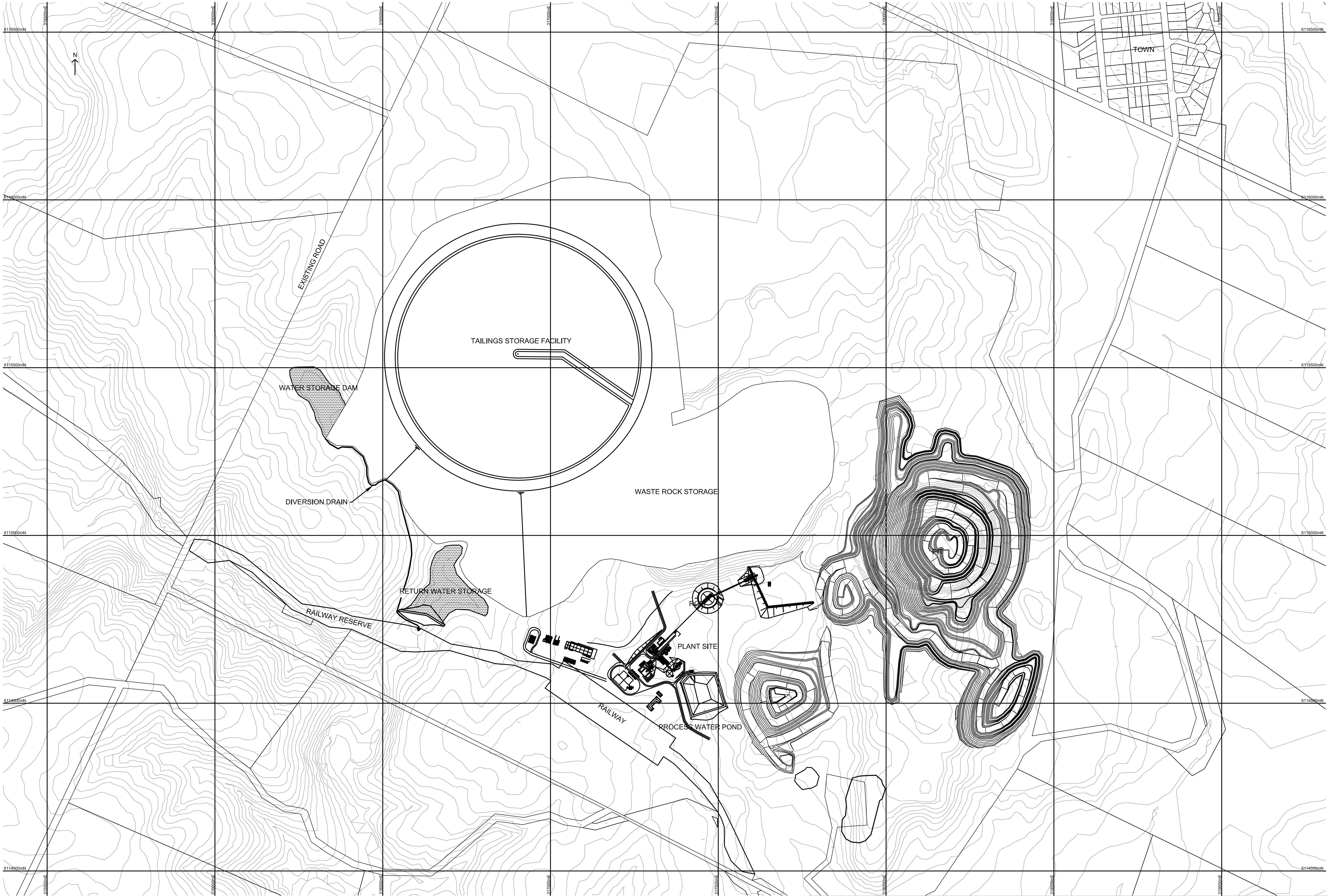
* * * * *

Figures



20km

coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	CFF	HILLGROVE COPPER PTY LTD KANMANTOO COPPER PROJECT SITE LOCATION PLAN	Original Size	A3
	Approved	PP		Project no:	MH00335AA
	Date	03/08/07		Figure	1
	Scale	N/A			



REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-01 Rev B.dwg

Rev No	Revision Note	Date	Approved
B	MINOR CHANGES	17/07/07	CL
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

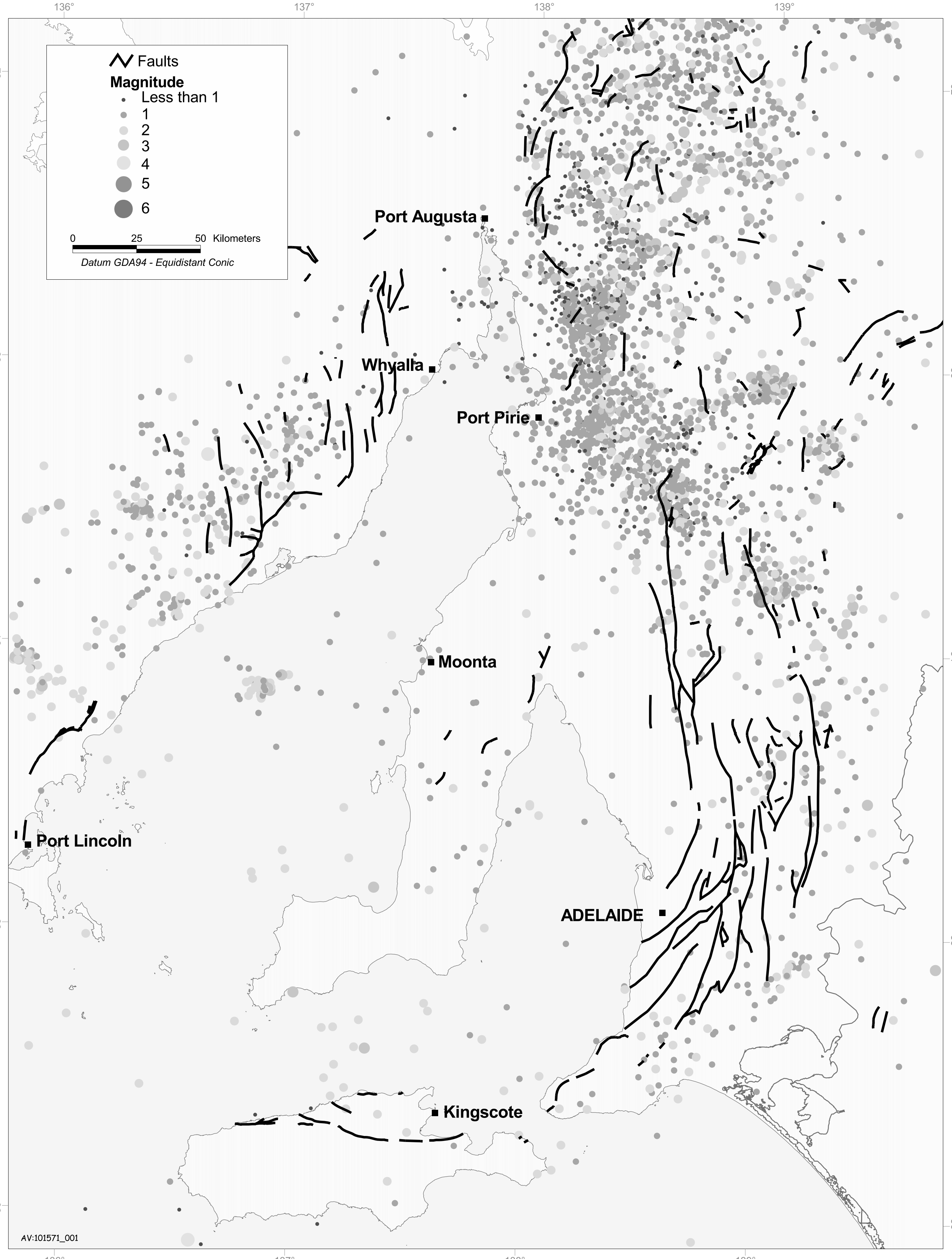
coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

GENERAL ARRANGEMENT

Original Size	A1
Project no:	MH00335AA
Drawing	**FIGURE 2**



Earthquakes from 1980 to 2001. Epicentres are widely spread and do not follow any narrow zones. Large earthquakes can occur anywhere.

101571

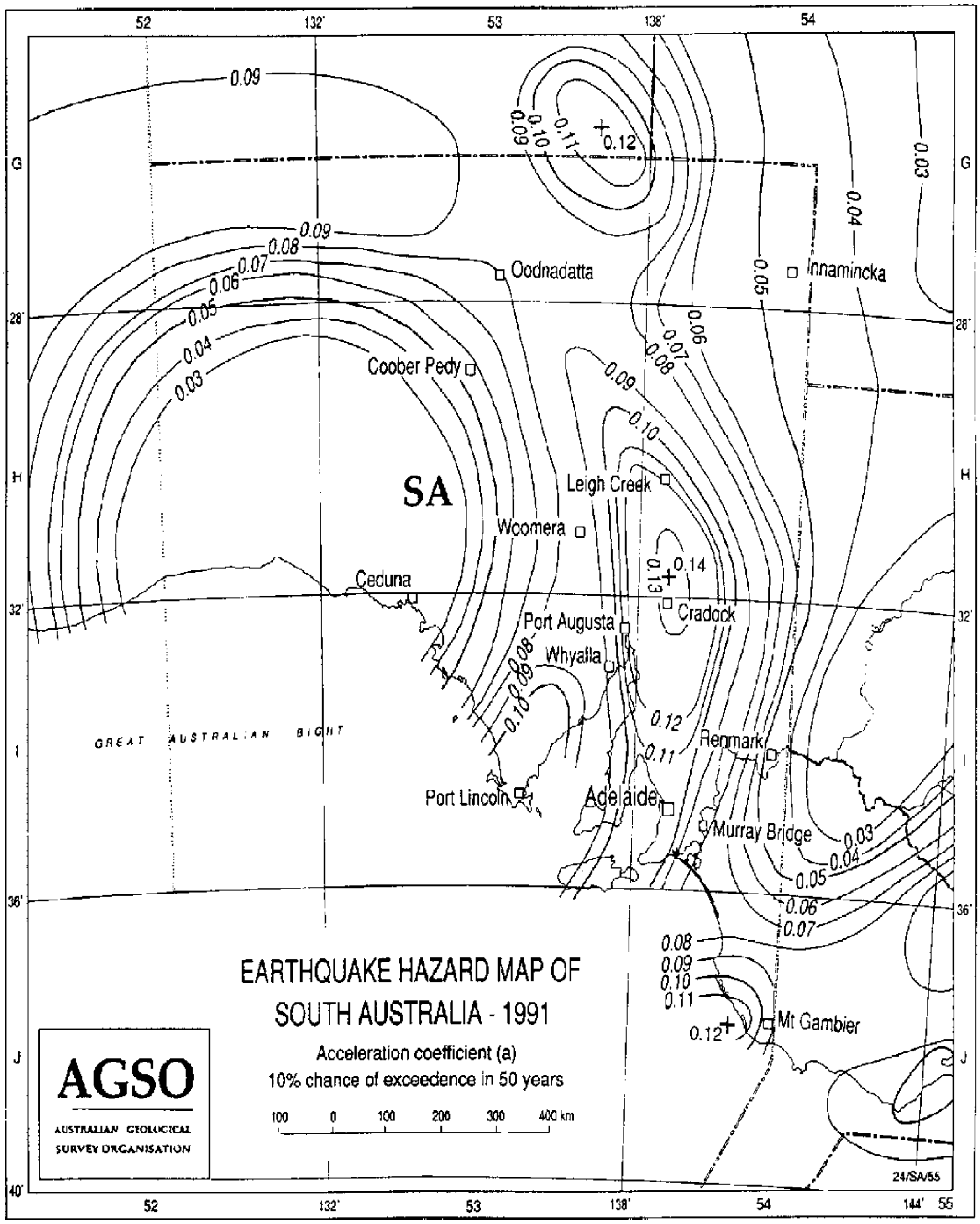


FIGURE 4 ACCELERATION COEFFICIENT MAP OF SOUTH AUSTRALIA

Appendix A

Drawings

Rev No	Revision Note	Date	Approved
B	MINOR CHANGES	17/07/07	CL
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

GENERAL ARRANGEMENT

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-01

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-01 Rev B.dwg

LEGEND

Clay Blanket

Rev No	Revision Note	Date	Approved
C	MINOR CHANGES	17/07/07	CL
B	THICKNESS OF CLAY BLANKET REVISED	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

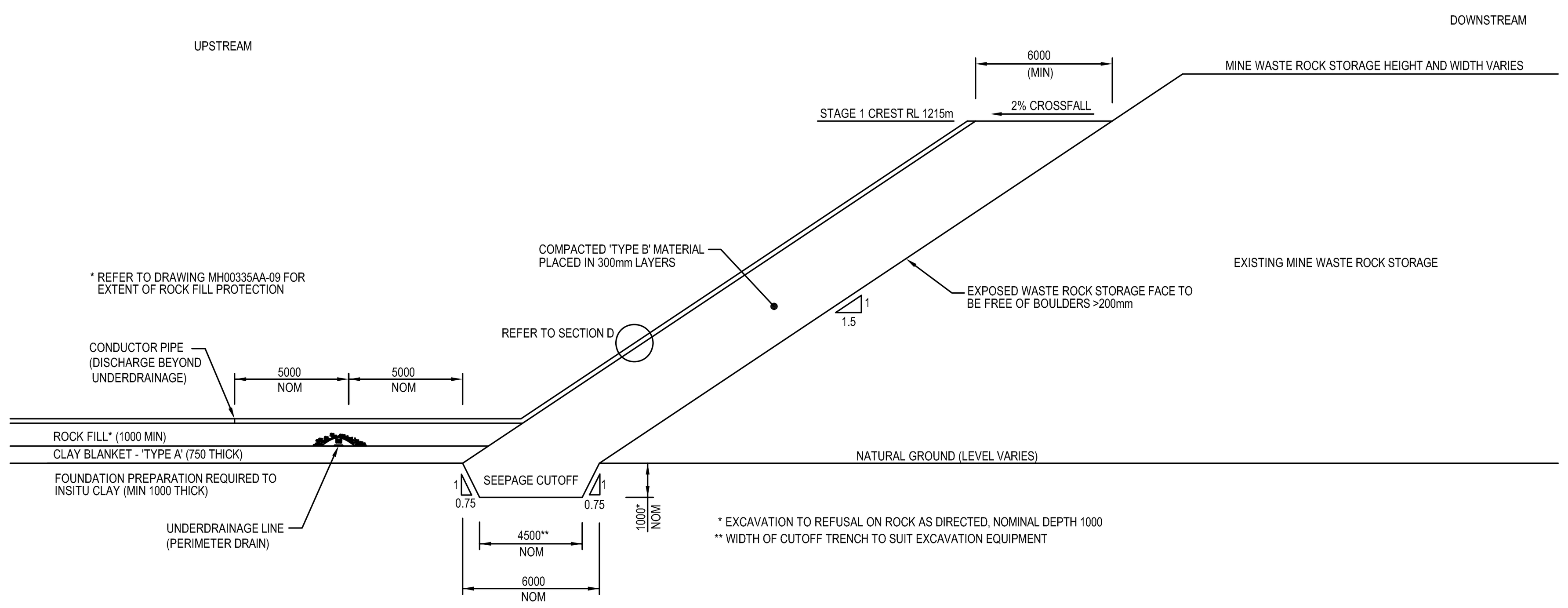
Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

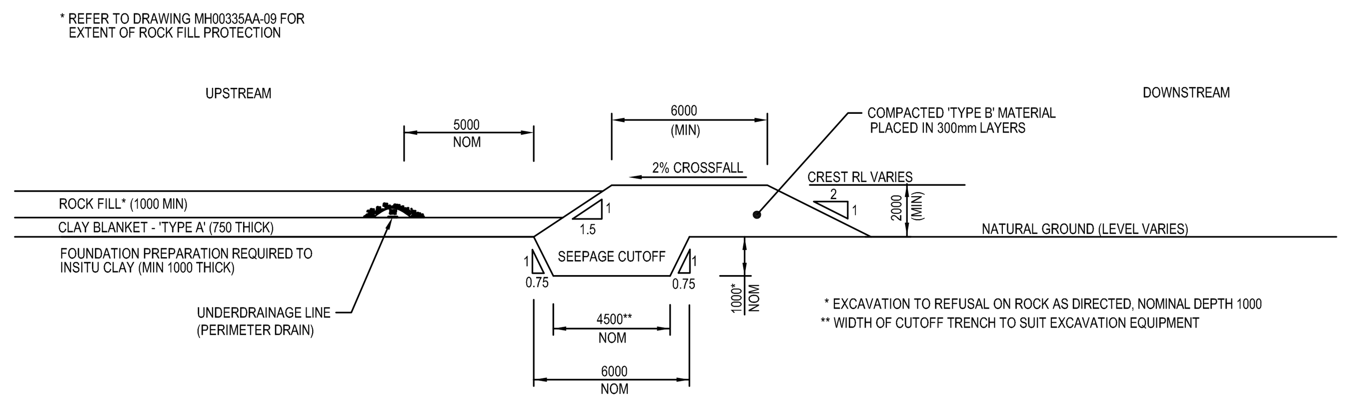
TSF PLAN - STAGE 1 EARTHWORKS
(CLAY BLANKET AND INTERNAL EMBANKMENT)

Original Size	A1
Project no:	MH00335AA
Drawing	**MH00335AA-02**

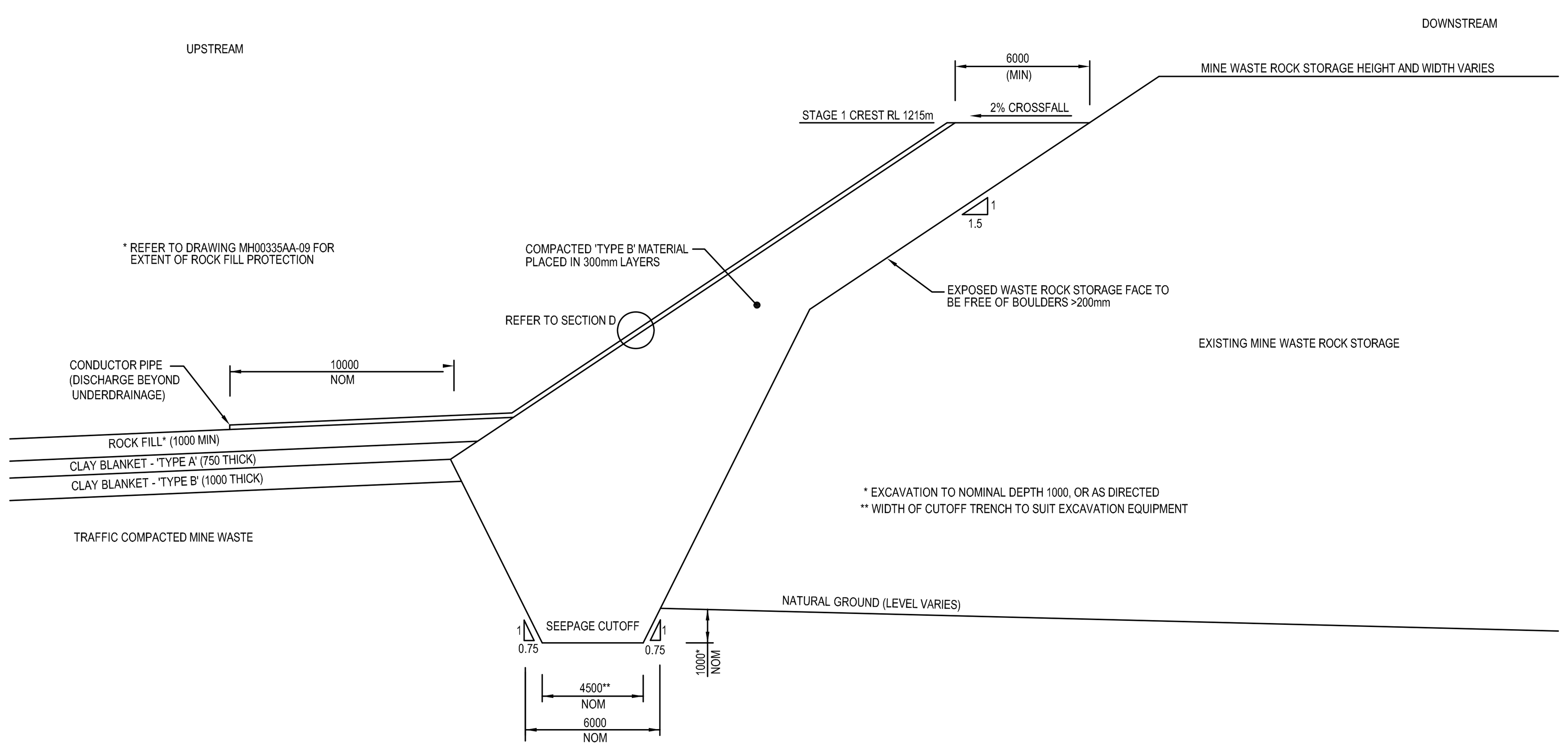
REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-02 Rev C.dwg



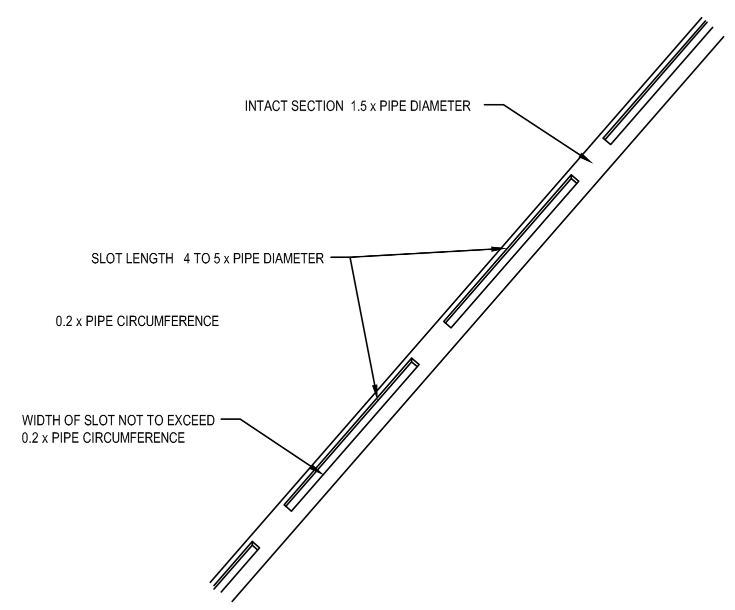
A/2 PERIMETER EMBANKMENT - STAGE 1
TYPICAL SECTION
SCALE 1:250



B/2 PERIMETER EMBANKMENT EXTENSION - STAGE 1
TYPICAL SECTION
SCALE 1:250



C/2 PERIMETER EMBANKMENT - NORTH EAST CORNER
TYPICAL SECTION
SCALE 1:250



D/- CONDUCTOR PIPE
TYPICAL DETAIL
SCALE 1:20

Rev No	Revision Note	Date	Approved
C	MINOR CHANGES	17/07/07	CL
B	REVISED THICKNESS OF CLAY BLANKET	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	12/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	17/07/07
Scale	AS SHOWN

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

TSF SECTION - STAGE 1 EARTHWORKS
(CLAY BLANKET AND INTERNAL EMBANKMENT)

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-03

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-03 Rev C.dwg

LEGEND

- 300 Megaflo Ultra
- 450 Megaflo Ultra
- Slotted 200OD HDPE Pipe / Solid Outfall Pipe
- Decant Outfall

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-04 Rev D.dwg

Rev No	Revision Note	Date	Approved
C	MINOR CHANGES	17/07/07	CL
B	REVISED UNDERDRAINAGE LAYOUT	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

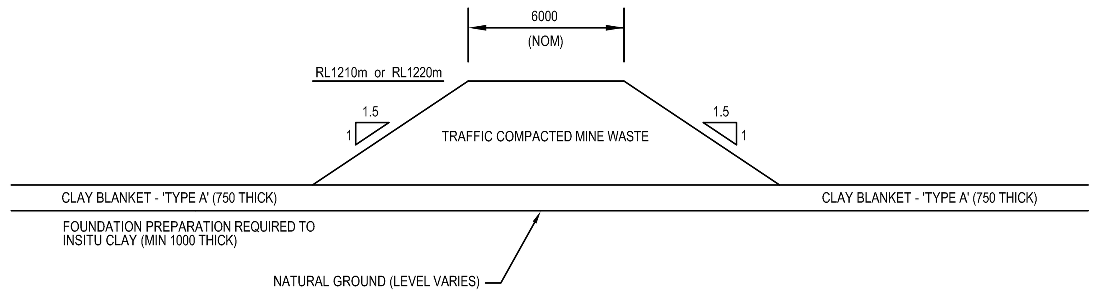
coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

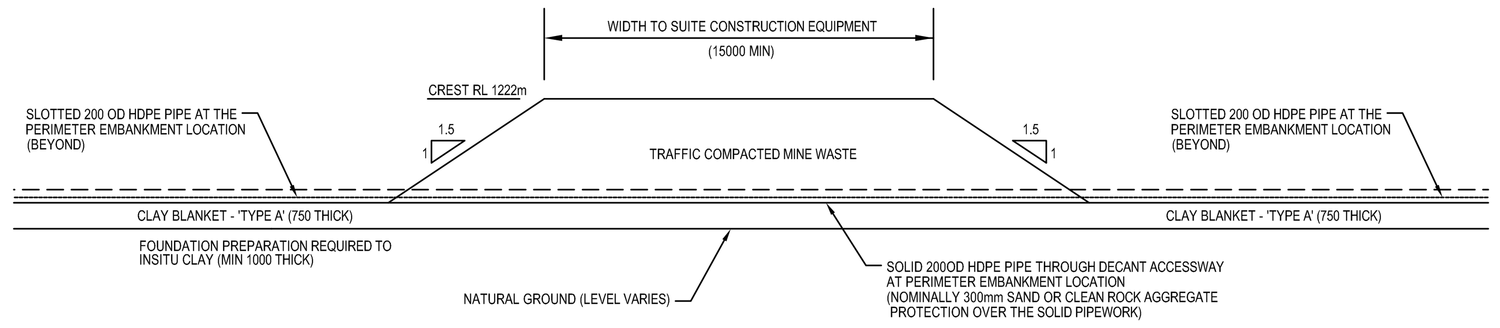
HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

TSF UNDERDRAINAGE AND DECANT PIPEWORK PLAN

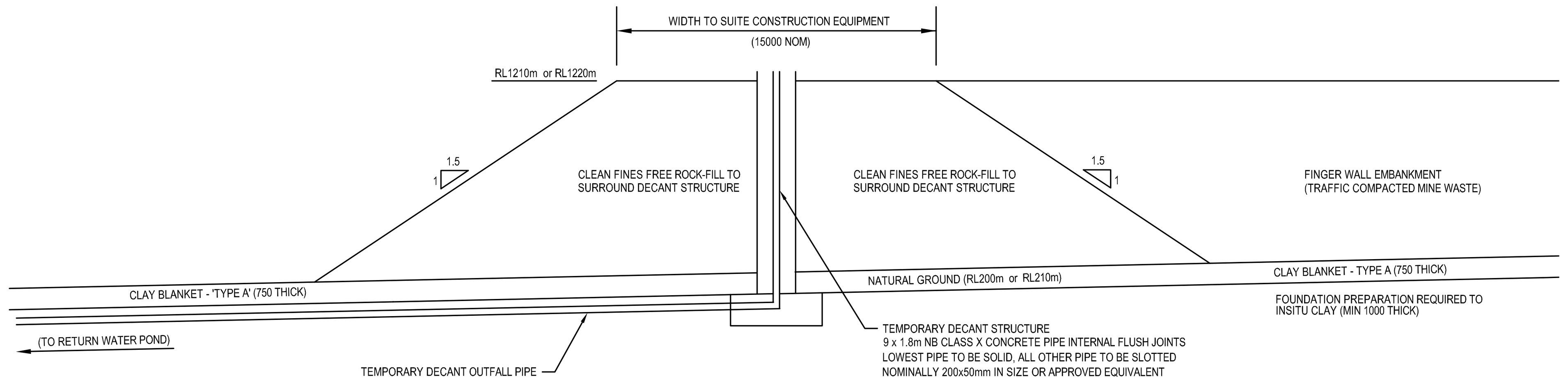
Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-04



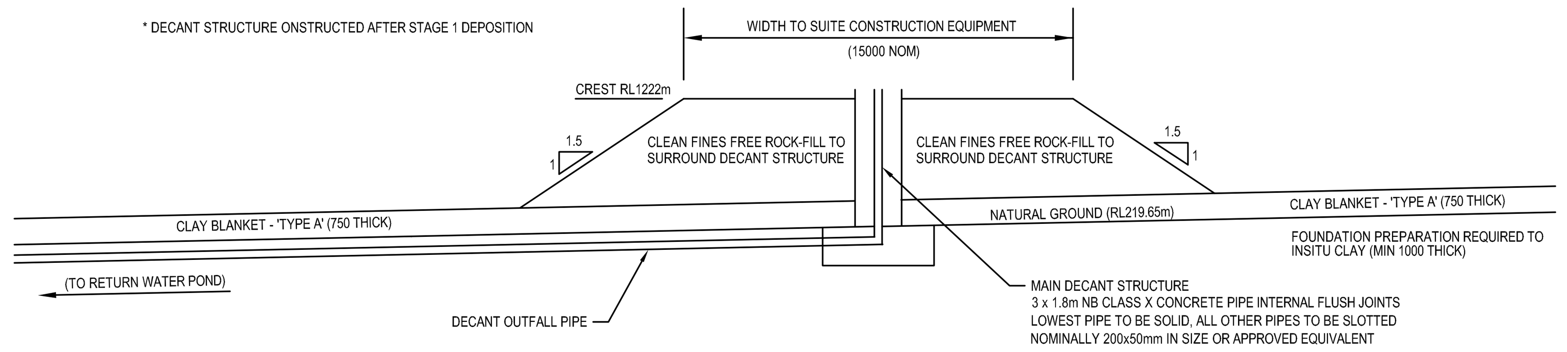
A/4 FINGER EMBANKMENT
TYPICAL SECTION
SCALE 1:250



C/4 DECANT ACCESSWAY - STAGE 1
SECTION
SCALE 1:250



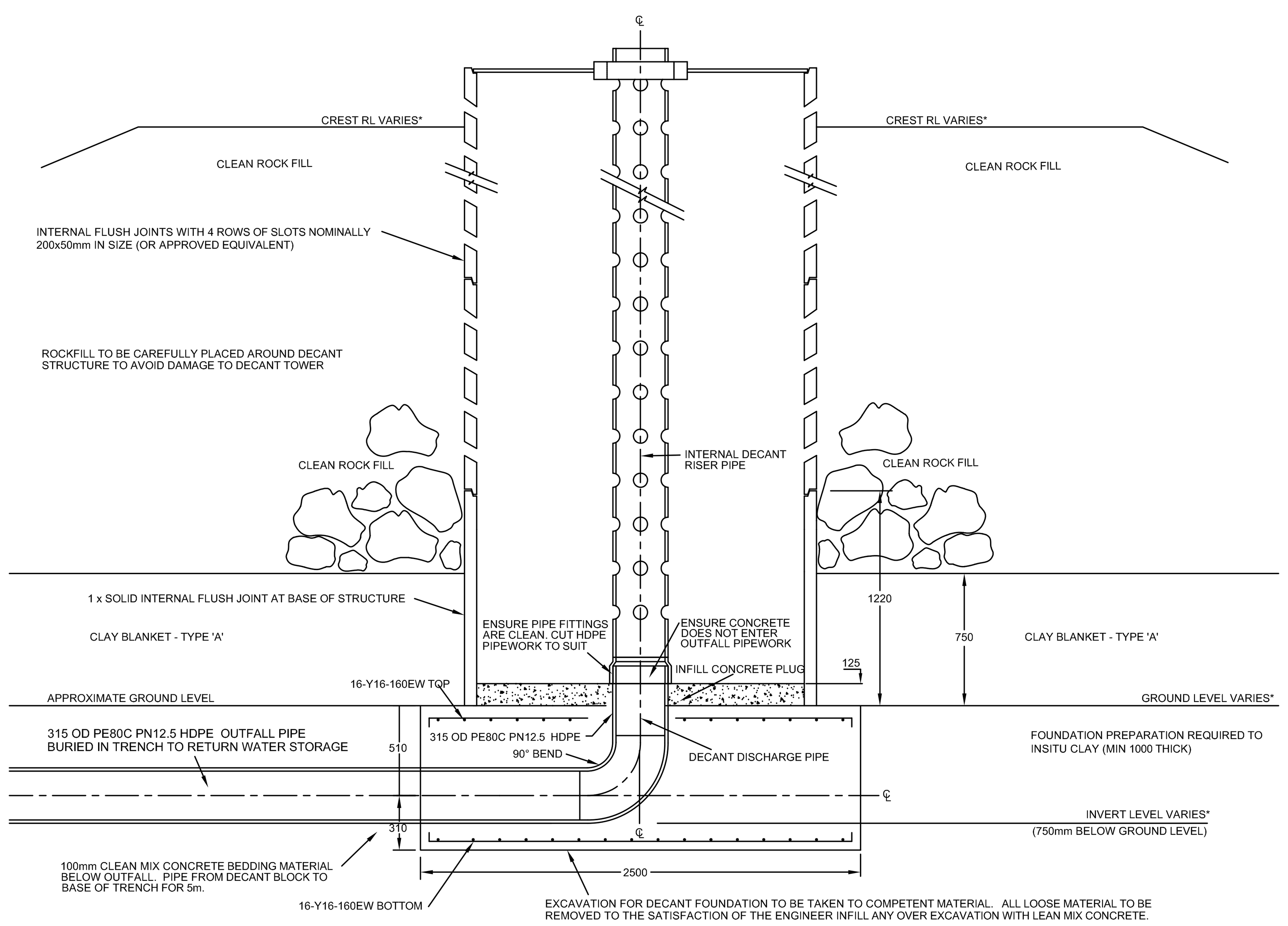
B/4 TEMPORARY DECANT STRUCTURE
TYPICAL SECTION
SCALE 1:250



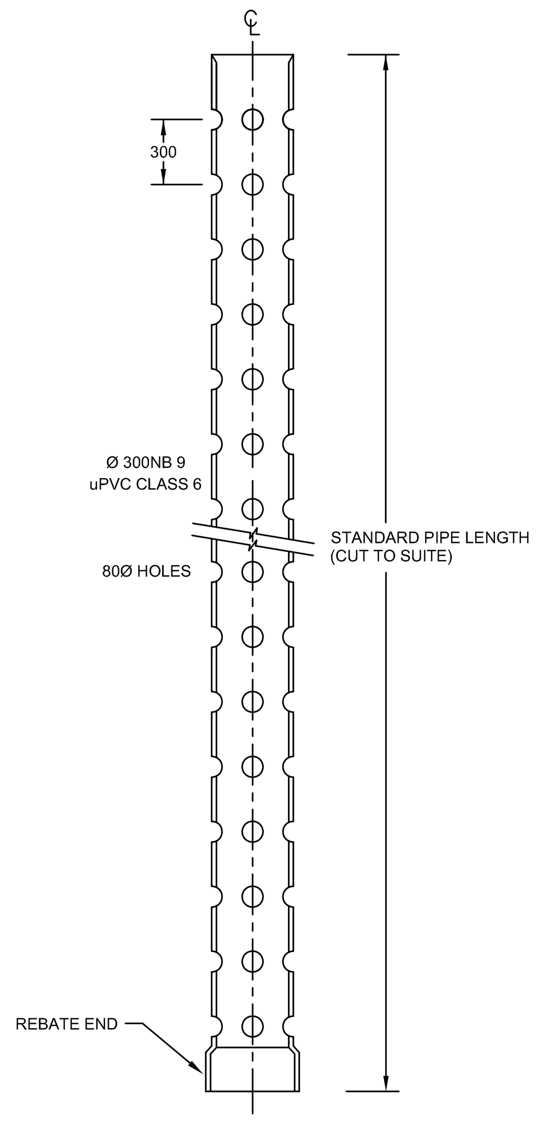
D/4 MAIN DECANT STRUCTURE - STAGE 1
SECTION
SCALE 1:250

* APPROXIMATE LEVELS FOR DECANT STRUCTURES

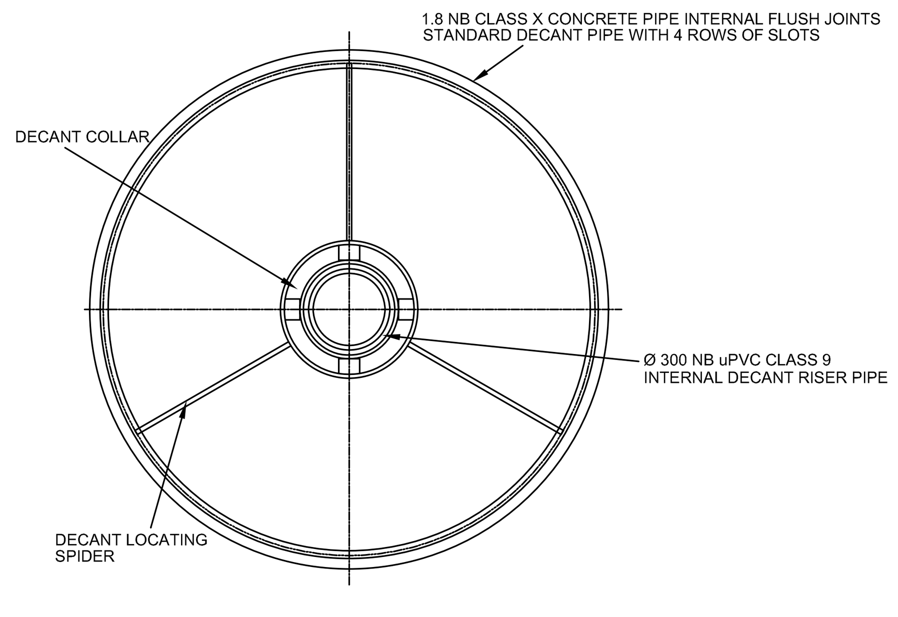
DECANT	INVERT RL	GROUND RL	CREST RL
TEMP DECANT 1	1199.35	1200.00	1210.00
TEMP DECANT 2	1209.35	1210.00	1220.00
MAIN DECANT	1219.00	1219.65	1222.00



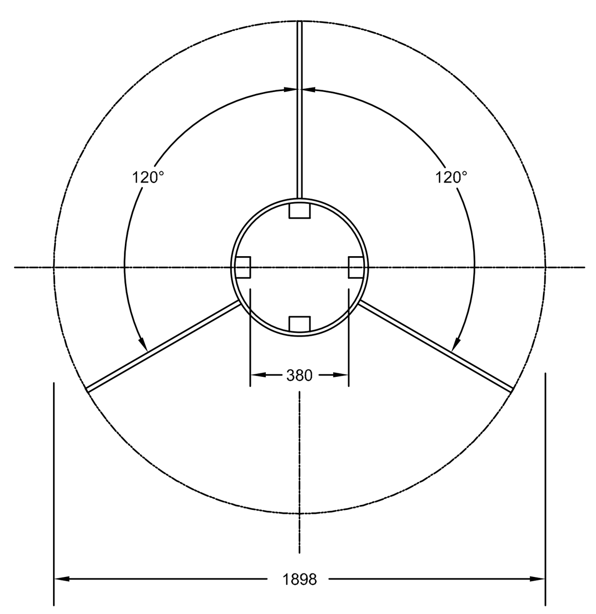
E DECANT STRUCTURE
DETAIL
SCALE 1:30



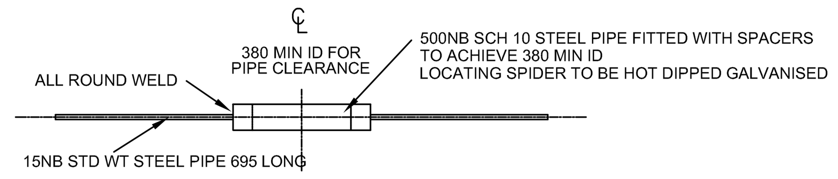
F INTERNAL DECANT RISER PIPE
DETAIL
SCALE 1:30



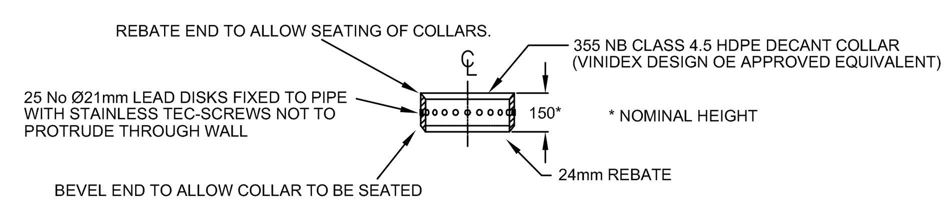
G INTERNAL RISER SUPPORT
PLAN
SCALE 1:25



H LOCATING SPIDER
PLAN
SCALE 1:25



I DECANT COLLAR
PLAN
SCALE 1:25



J DECANT COLLAR
ELEVATION
SCALE 1:25

Rev No	Revision Note	Date	Approved
B	REVISED THICKNESS OF CLAY BLANKET	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	12/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

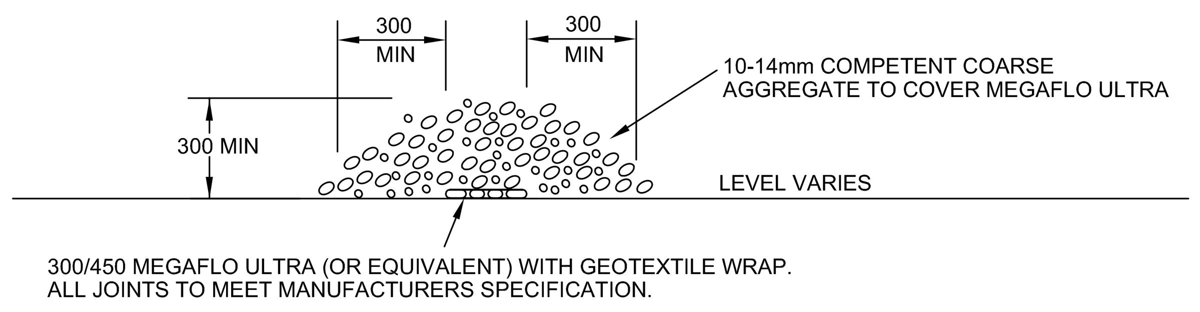
Drawn	PP
Approved	CL
Date	12/06/07
Scale	AS SHOWN

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

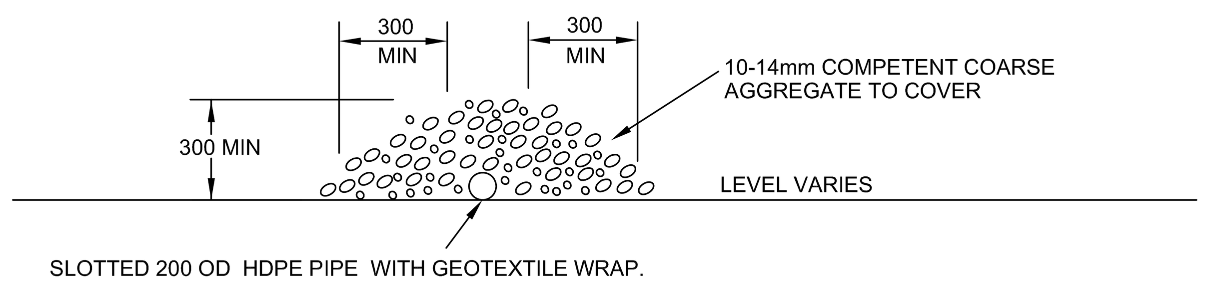
SECTIONS AND DETAILS - DECANT

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-05

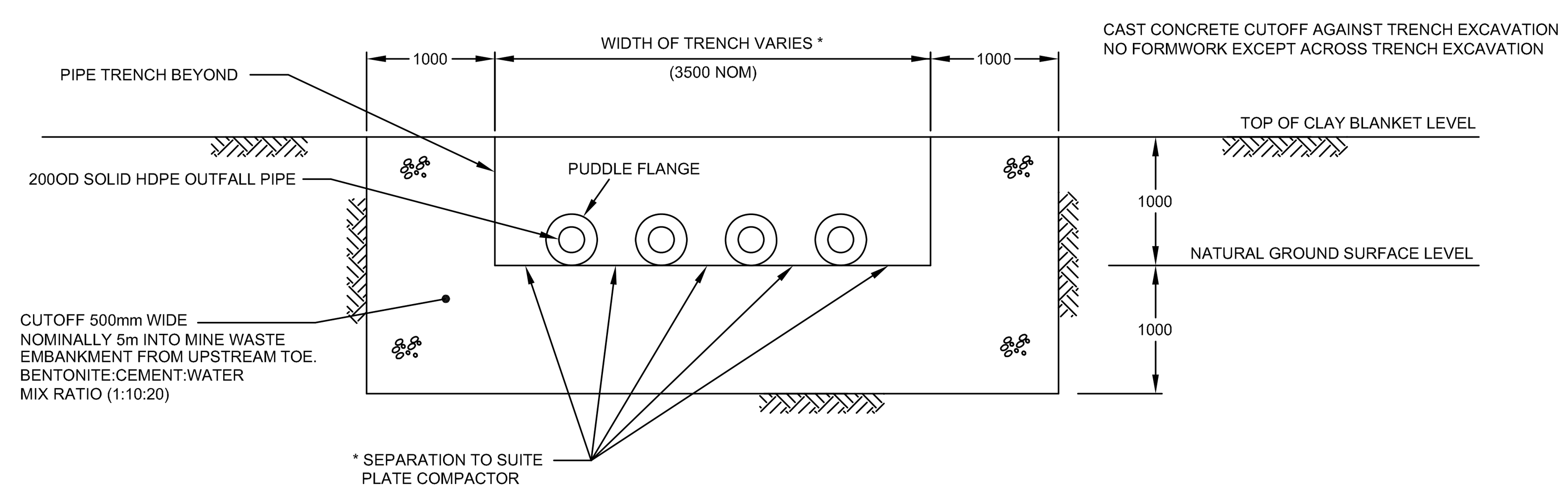
REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-05 Rev B.dwg



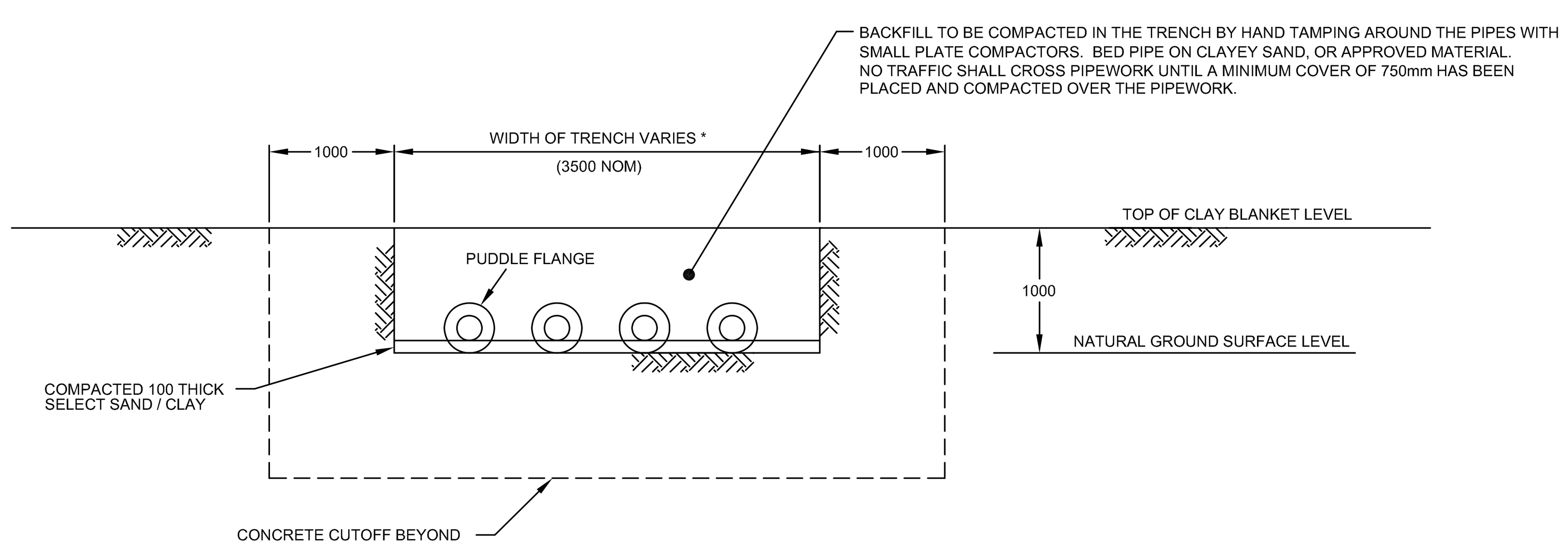
E/4 MEGAFLO ULTRA UNDERDRAINAGE DETAIL
NOT TO SCALE



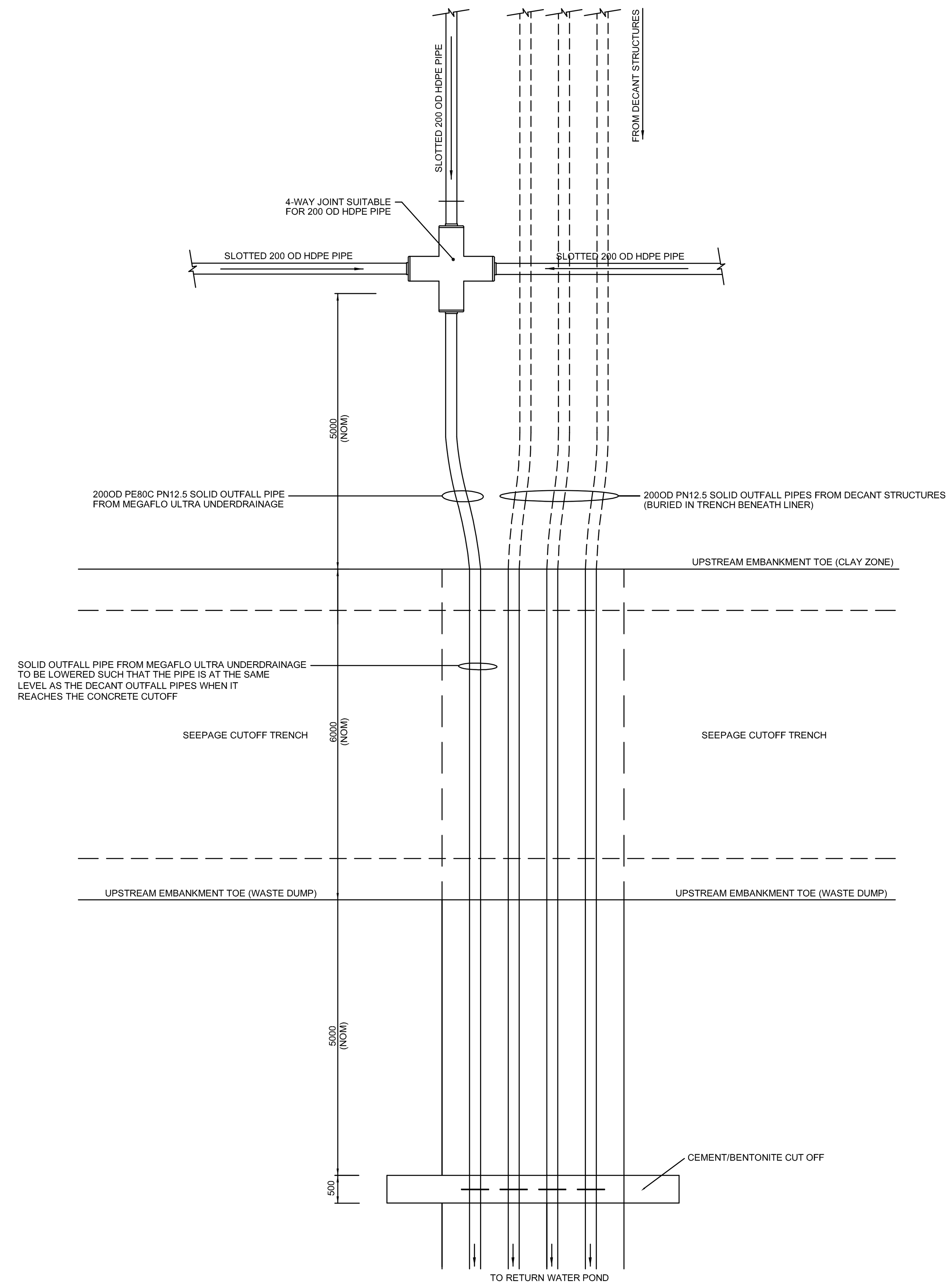
F/4 MEGAFLO ULTRA UNDERDRAINAGE DETAIL
NOT TO SCALE



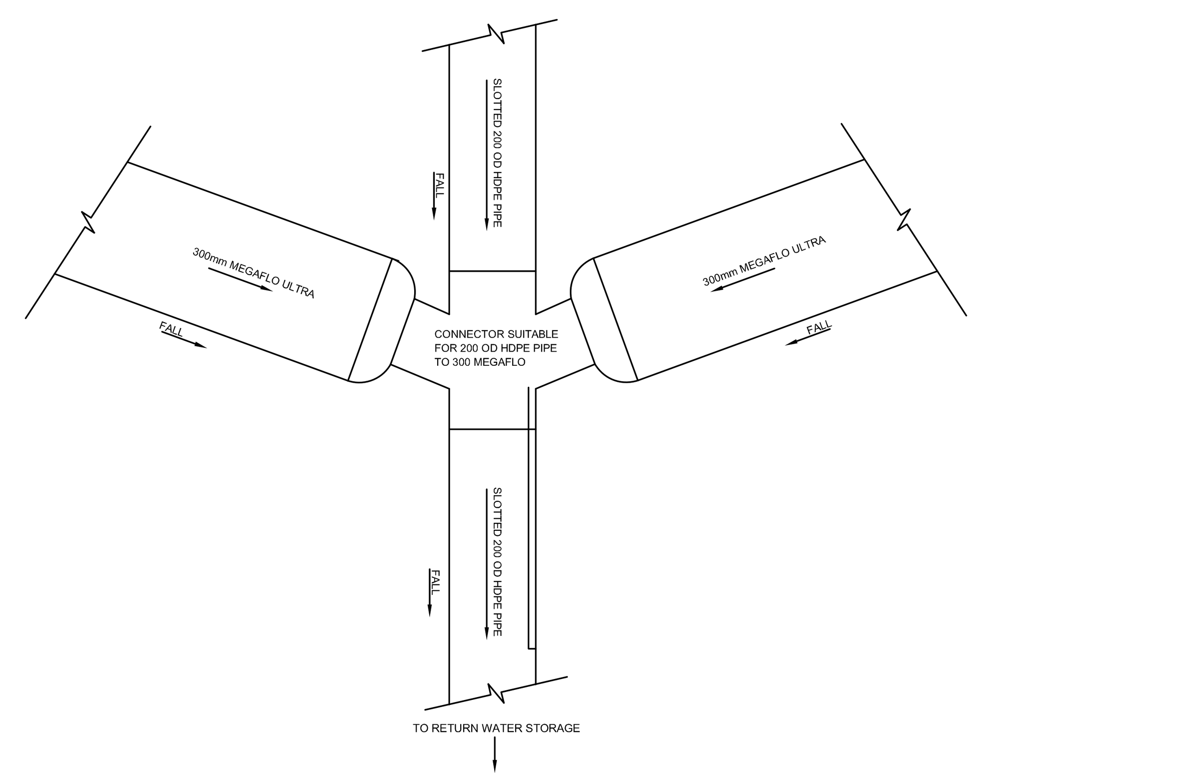
G/4 CEMENT/BENTONITE CUTOFF ELEVATION
SCALE 1:50



H/4 OUTFALL PIPE TRENCH DETAIL
SCALE 1:50



I/4 OUTFALL PIPEWORK AND CONCRETE CUTOFF PLAN
SCALE 1:75



J/4 MEGAFLO ULTRA UNDERDRAINAGE JOINT (HERRINGBONE SYSTEM) DETAIL
SCALE 1:15

Rev No	Revision Note	Date	Approved
C	MINOR CHANGES	17/07/07	CL
B	REVISED UNDERDRAINAGE SECTIONS	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	12/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

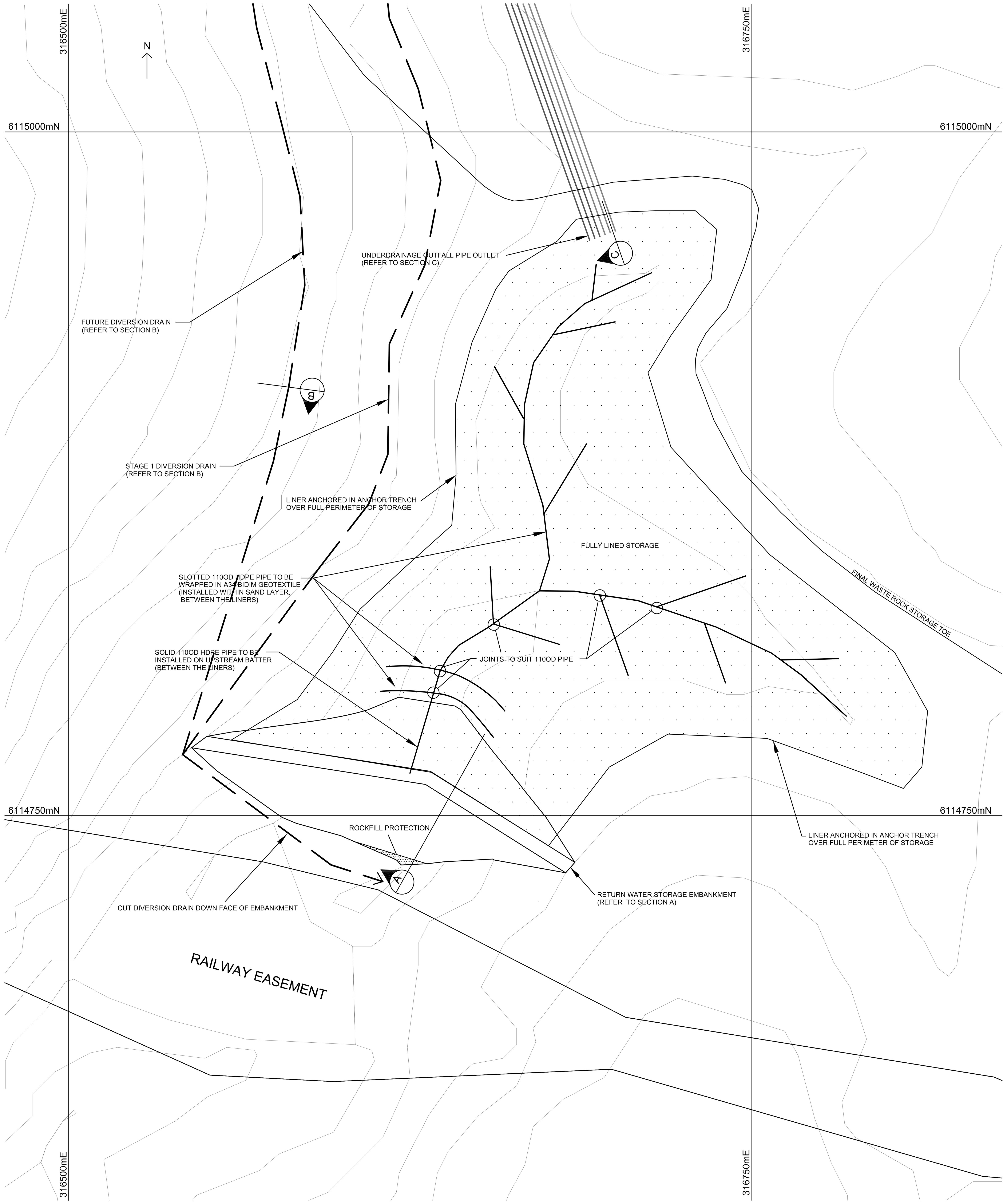
Drawn	PP
Approved	CL
Date	17/07/07
Scale	AS SHOWN

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

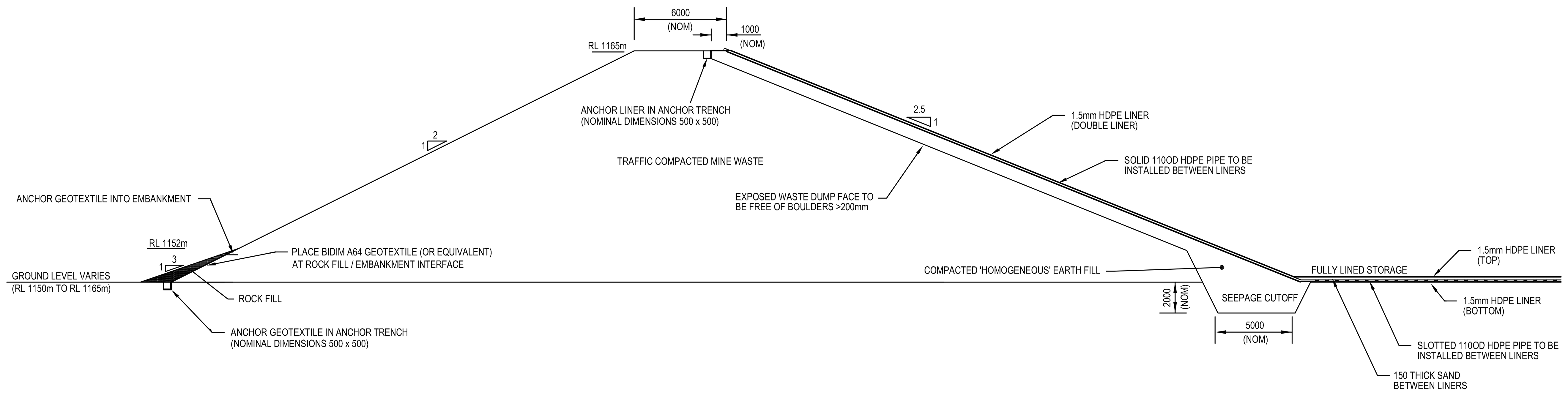
SECTIONS AND DETAILS - UNDERDRAINAGE

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-06

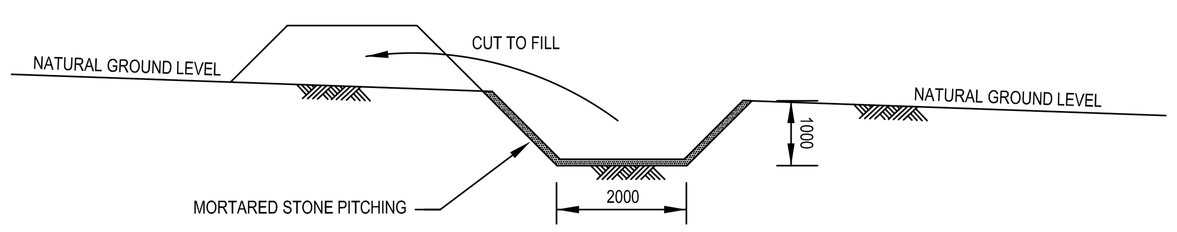
REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-06 Rev C.dwg



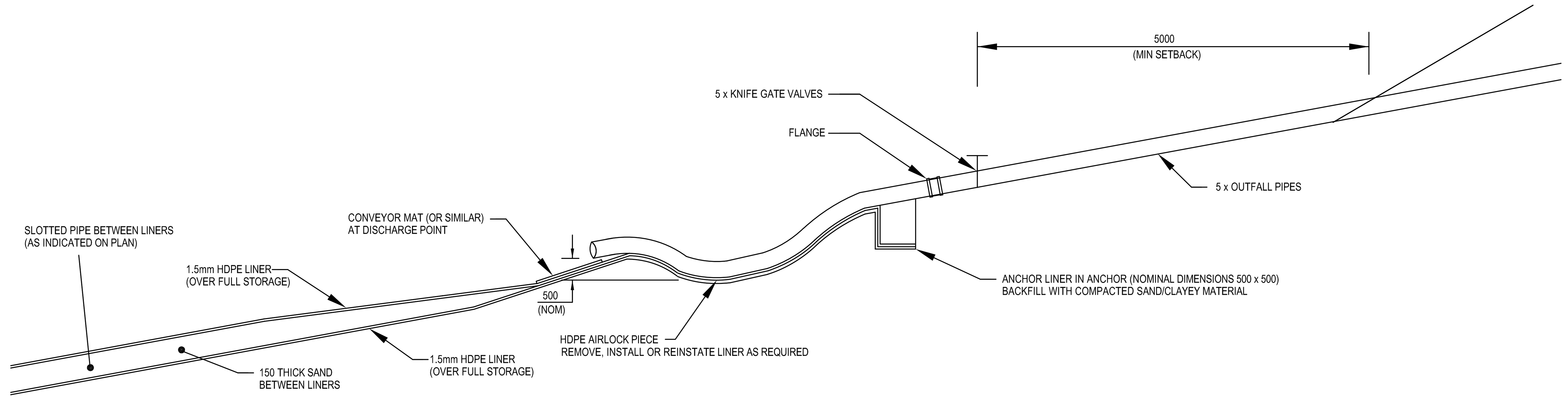
RETURN WATER STORAGE
PLAN
SCALE 1:1000



A RETURN WATER STORAGE EMBANKMENT
TYPICAL SECTION
SCALE 1:250



B DIVERSION DRAIN
TYPICAL SECTION
SCALE 1:100



C OUTFALL PIPEWORK OUTLET
TYPICAL SECTION
SCALE 1:50

LEGEND
Underdrainage Outfall
Decant Outfall

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-07 Rev D.dwg

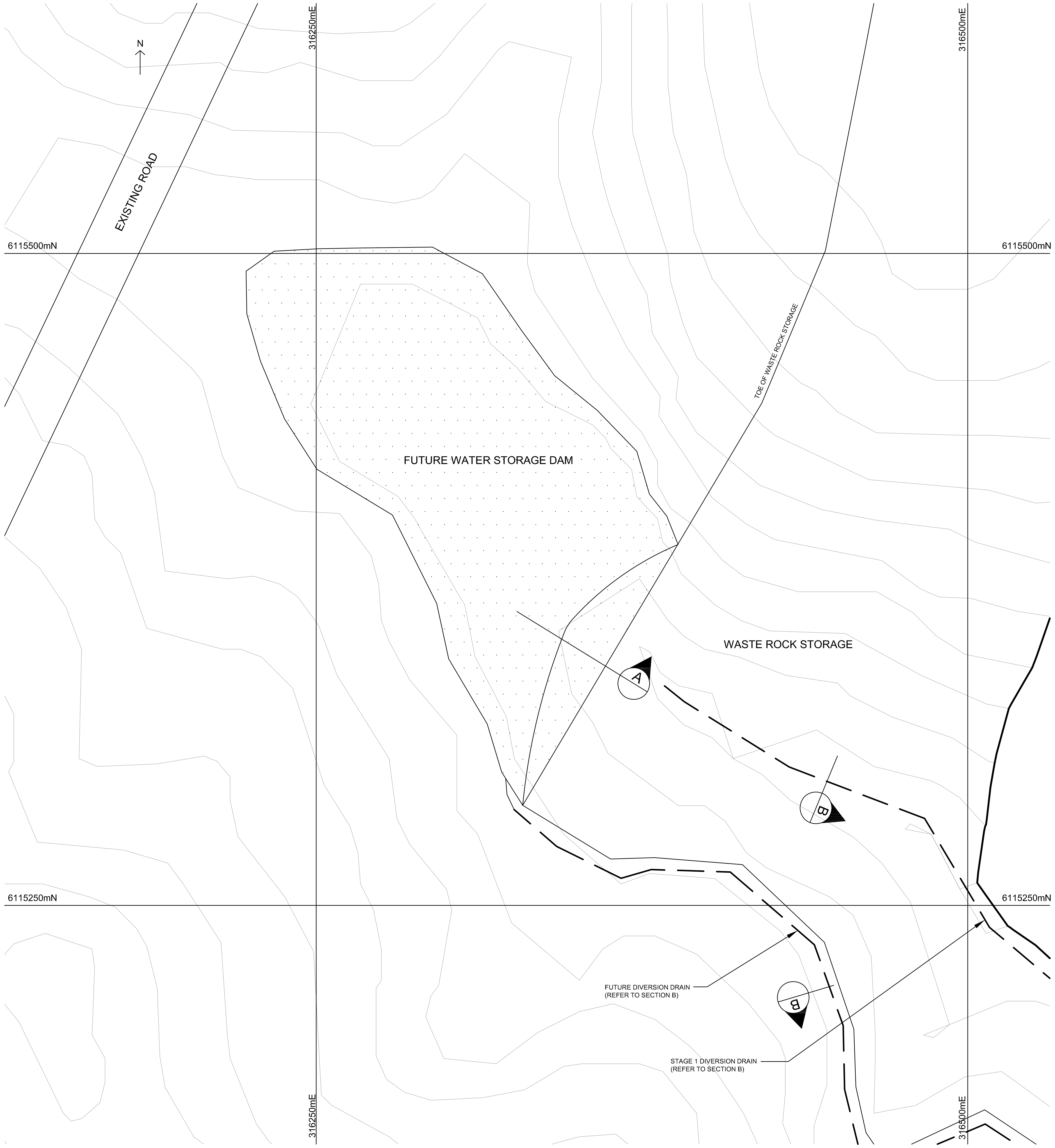
Rev No	Revision Note	Date	Approved
D	MINOR CHANGES	17/07/07	CL
C	DOUBLE LINER ADDED	09/07/07	CL
B	SEEPAGE CUTOFF ADDED	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

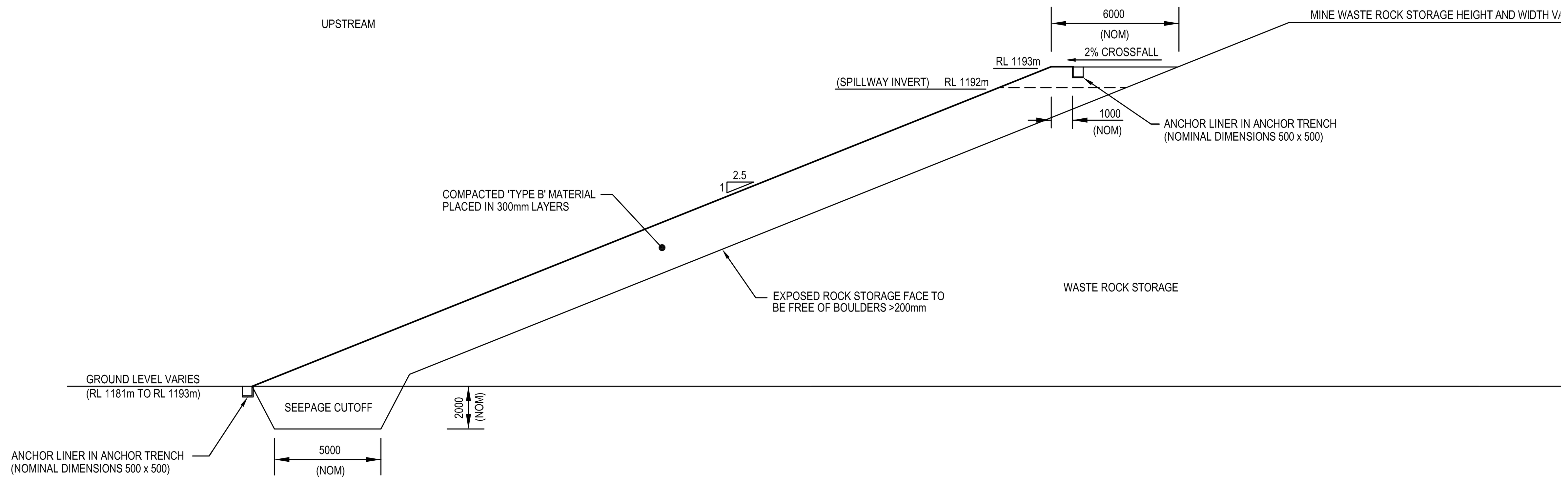
Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY
RETURN WATER STORAGE - PLAN AND SECTIONS

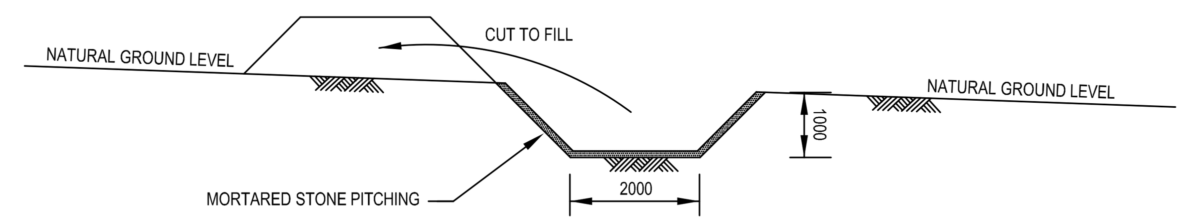
Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-07



FUTURE WATER STORAGE DAM AND DIVERSION
PLAN
SCALE 1:1000



A FUTURE WATER STORAGE DAM - EMBANKMENT
TYPICAL SECTION
SCALE 1:200



B DIVERSION DRAIN
TYPICAL SECTION
SCALE 1:100

Rev No	Revision Note	Date	Approved
D	MINOR CHANGES	17/07/07	
C	MINOR CHANGES	16/07/07	CL
B	SEEPAGE CUTOFF ADDED	09/07/07	CL
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

WATER STORAGE DAM AND DIVERSION - PLAN AND SECTIONS

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-08

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-08 Rev D.dwg

LEGEND

- 300 Megaflo Ultra
- 450 Megaflo Ultra
- Slotted 200OD HDPE Pipe / Solid Outfall Pipe
- Decant Outfall
- Rock Fill Protection Layer

Rev No	Revision Note	Date	Approved
C	REVISED ROCK PROTECTION	17/07/07	
B	REVISED UNDERDRAINAGE LAYOUT	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

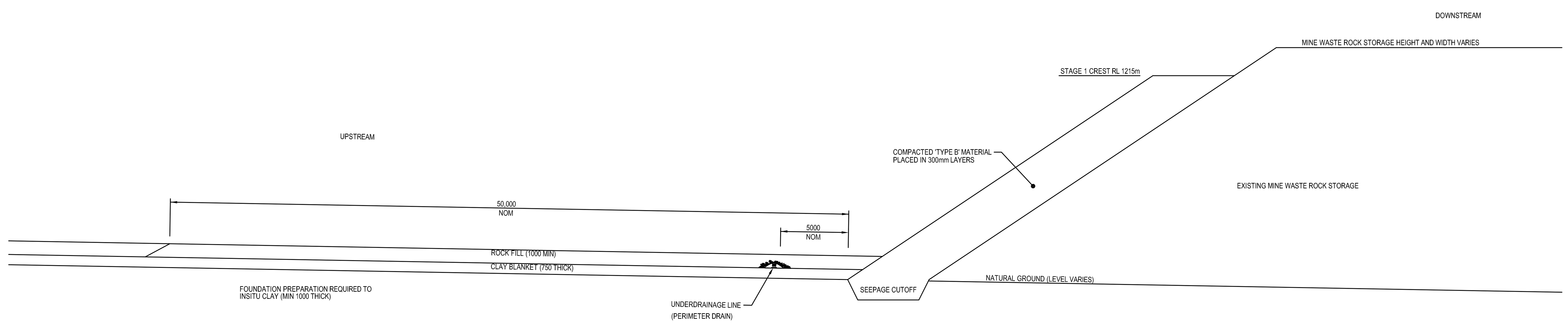
Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

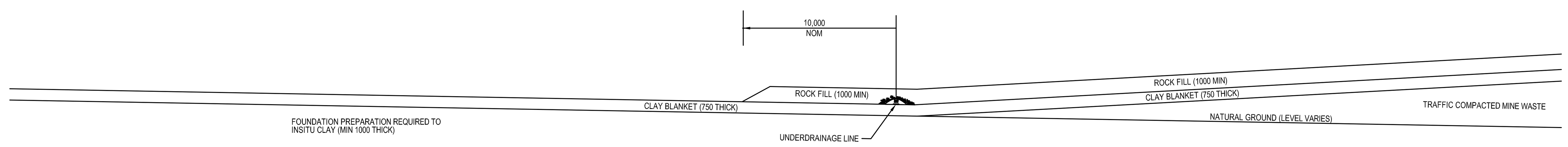
UNDERDRAINAGE PROTECTION PLAN

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-09

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-09 Rev C.dwg



A/9 UNDERDRAINAGE PROTECTION - PERIMETER EMBANKMENT
TYPICAL SECTION
SCALE 1:250



B/9 UNDERDRAINAGE PROTECTION - INTERNAL
TYPICAL SECTION
SCALE 1:250

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-10 Rev C.dwg

Rev No	Revision Note	Date	Approved
C	REVISED ROCK FILL PROTECTION	17/07/07	
B	CONDUCTOR PIPE DETAILS ADDED	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	12/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	17/07/07
Scale	AS SHOWN

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

UNDERDRAINAGE PROTECTION SECTIONS

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-10

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-11 Rev B.dwg

Rev No	Revision Note	Date	Approved
B	MINOR CHANGES	17/07/07	
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

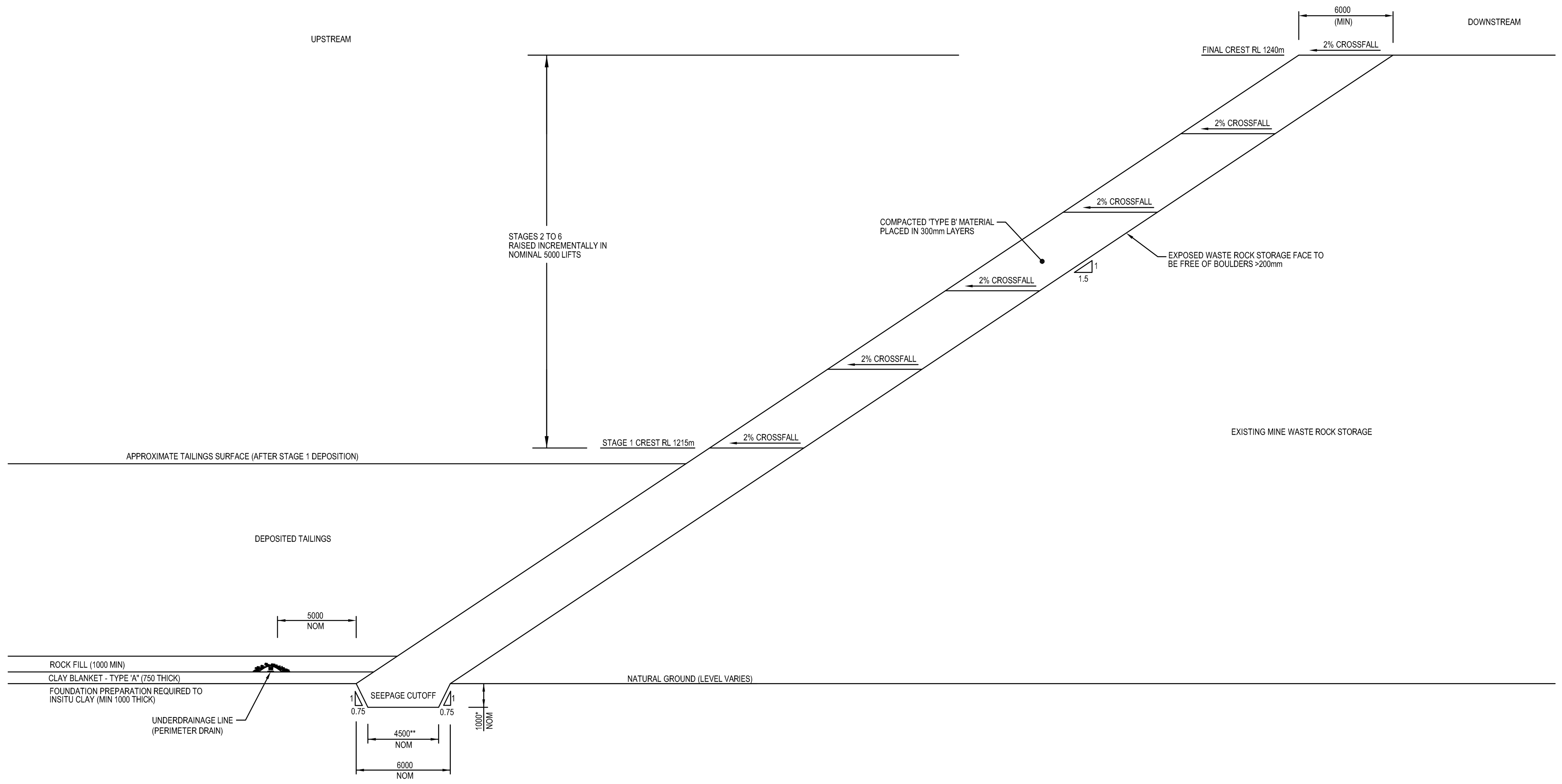
coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	17/07/07
Scale	1:2000

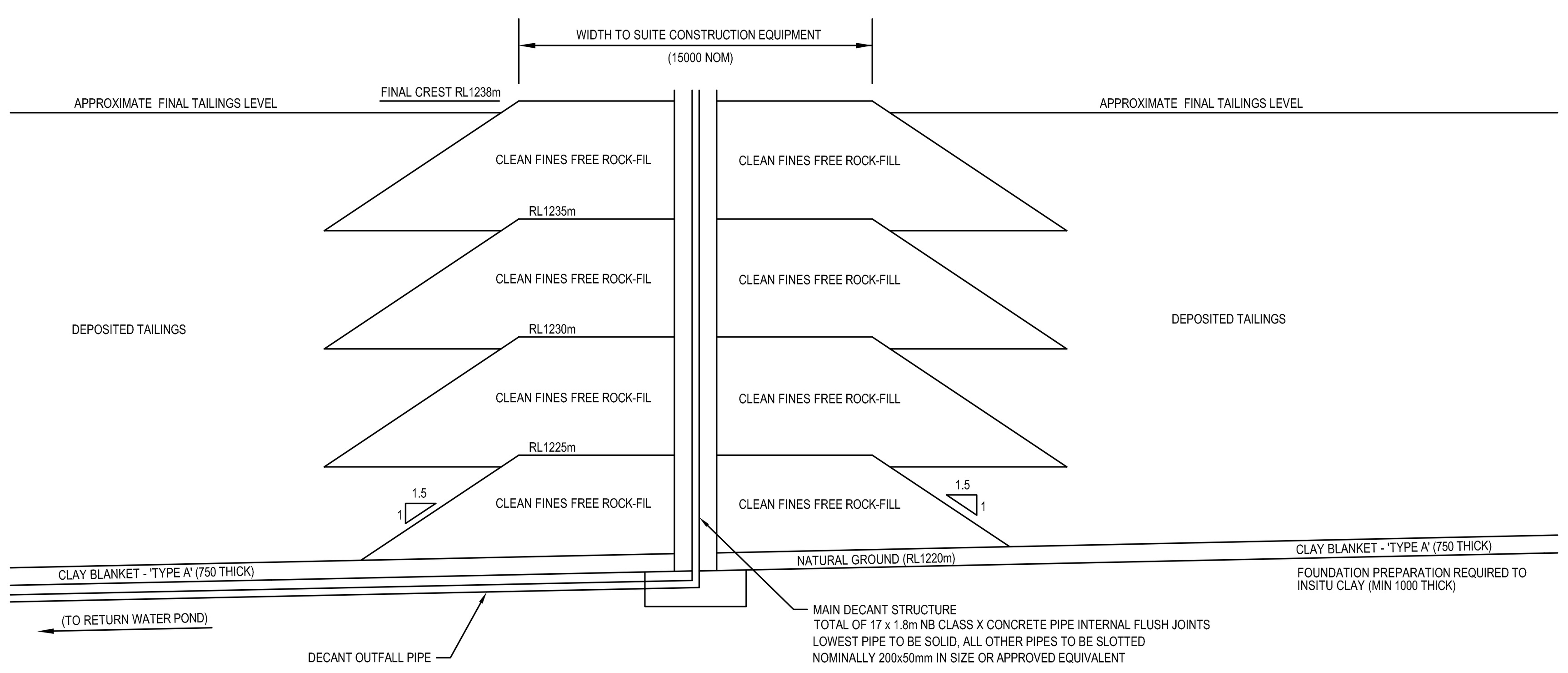
HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

TSF PLAN - STAGE 6

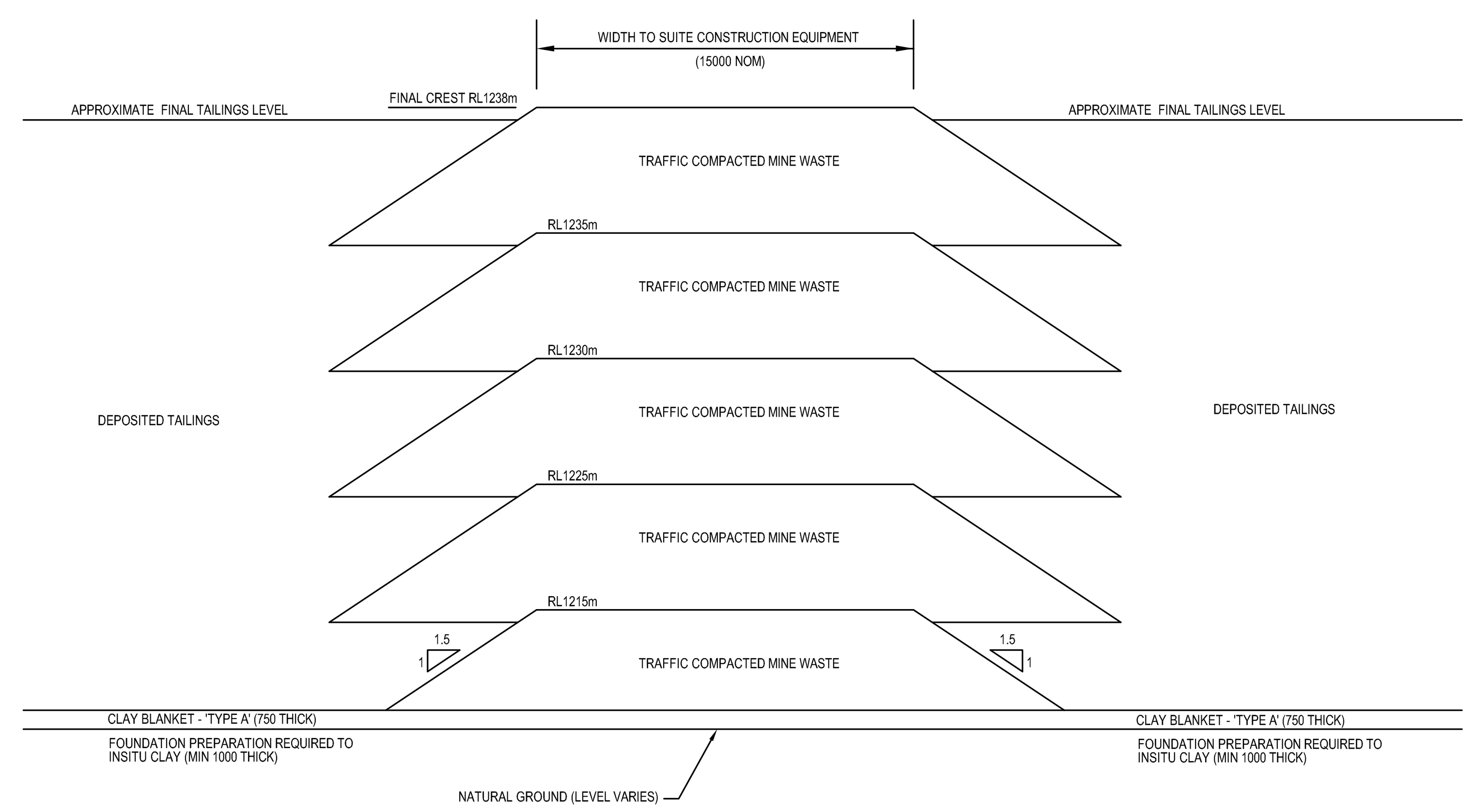
Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-11



PERIMETER EMBANKMENT - STAGES 2 TO 6
TYPICAL SECTION
SCALE 1:250



MAIN DECANT STRUCTURE - FINAL
SECTION
SCALE 1:250



DECANT ACCESSWAY - FINAL
TYPICAL SECTION
SCALE 1:250

Rev No	Revision Note	Date	Approved
C	MINOR CHANGES	17/07/07	
B	REVISED THICKNESS OF CLAY BLANKET	04/07/07	CL
A	ISSUED FOR CLIENT REVIEW	12/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

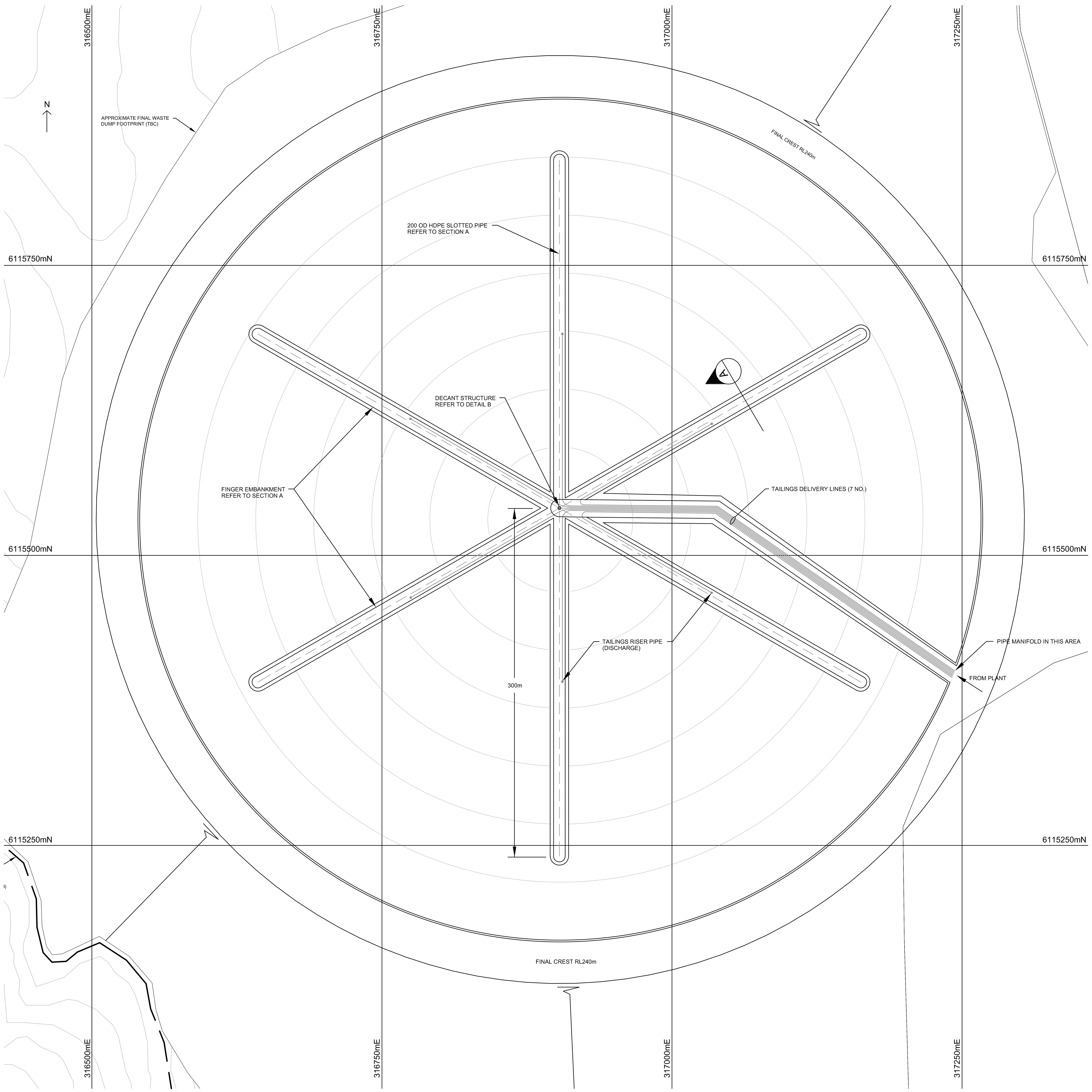
Drawn	PP
Approved	CL
Date	17/07/07
Scale	AS SHOWN

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

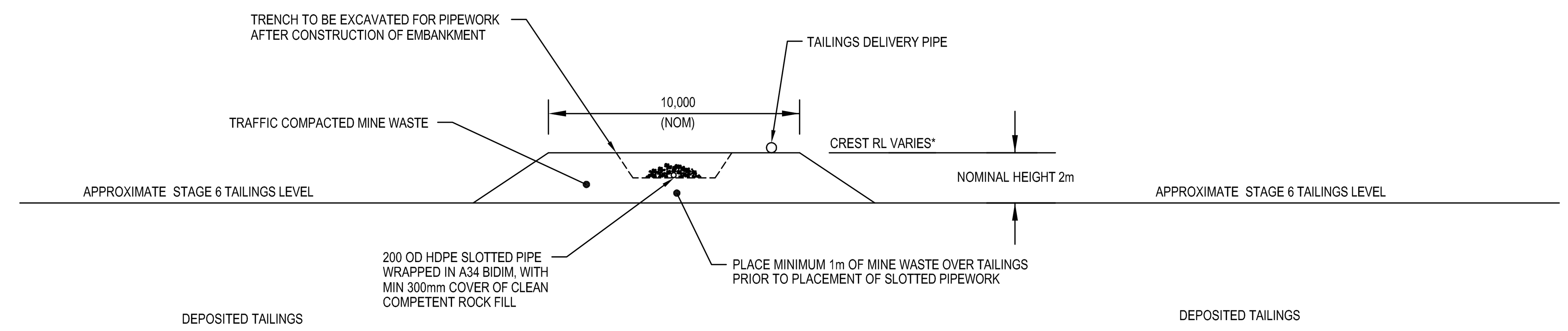
TSF SECTIONS - STAGES 2 TO 6

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-12

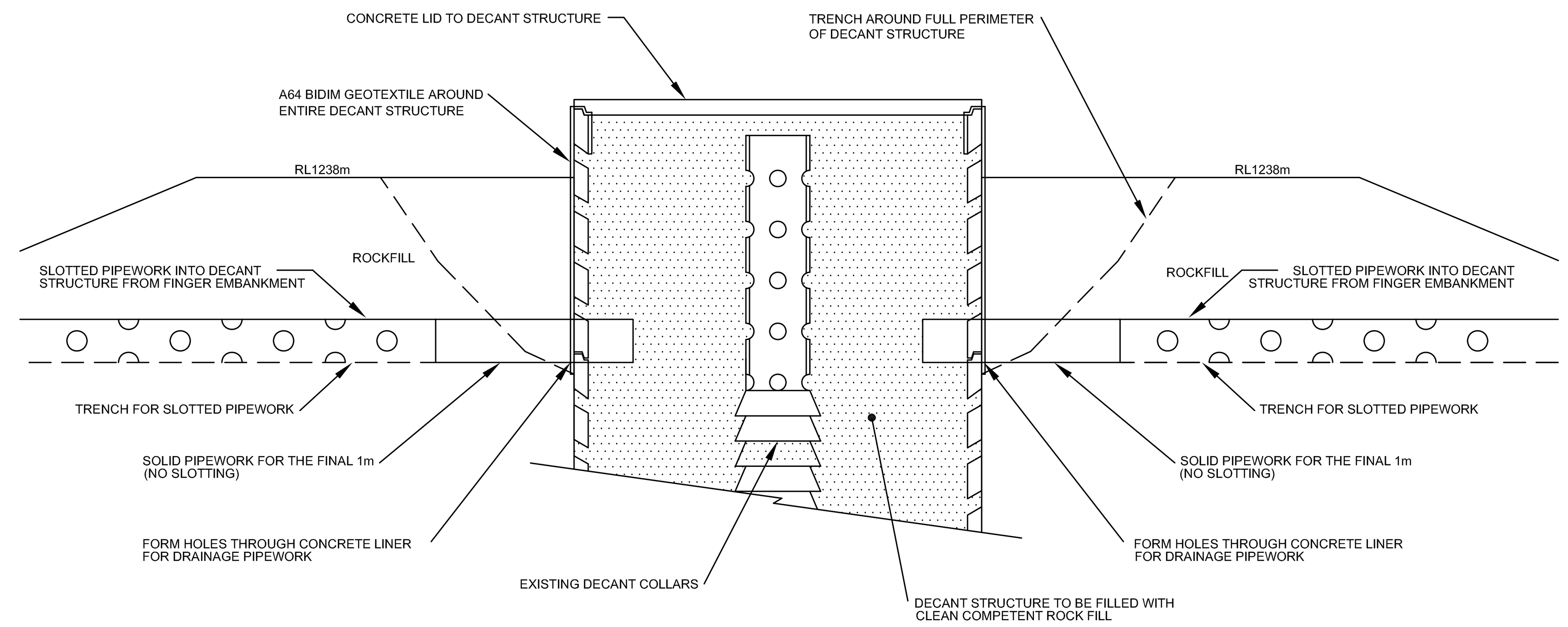
REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-12 Rev C.dwg



STAGE 7 - FINAL DEPOSITION
PLAN
SCALE 1:2000



A FINGER EMBANKMENT
TYPICAL SECTION
SCALE 1:200



B DECANT STRUCTURE
DETAIL
NOT TO SCALE

Rev No	Revision Note	Date	Approved
B	TAILINGS RISER PIPE MOVED	24/07/07	CL
A	ISSUED FOR CLIENT REVIEW	20/06/07	CL

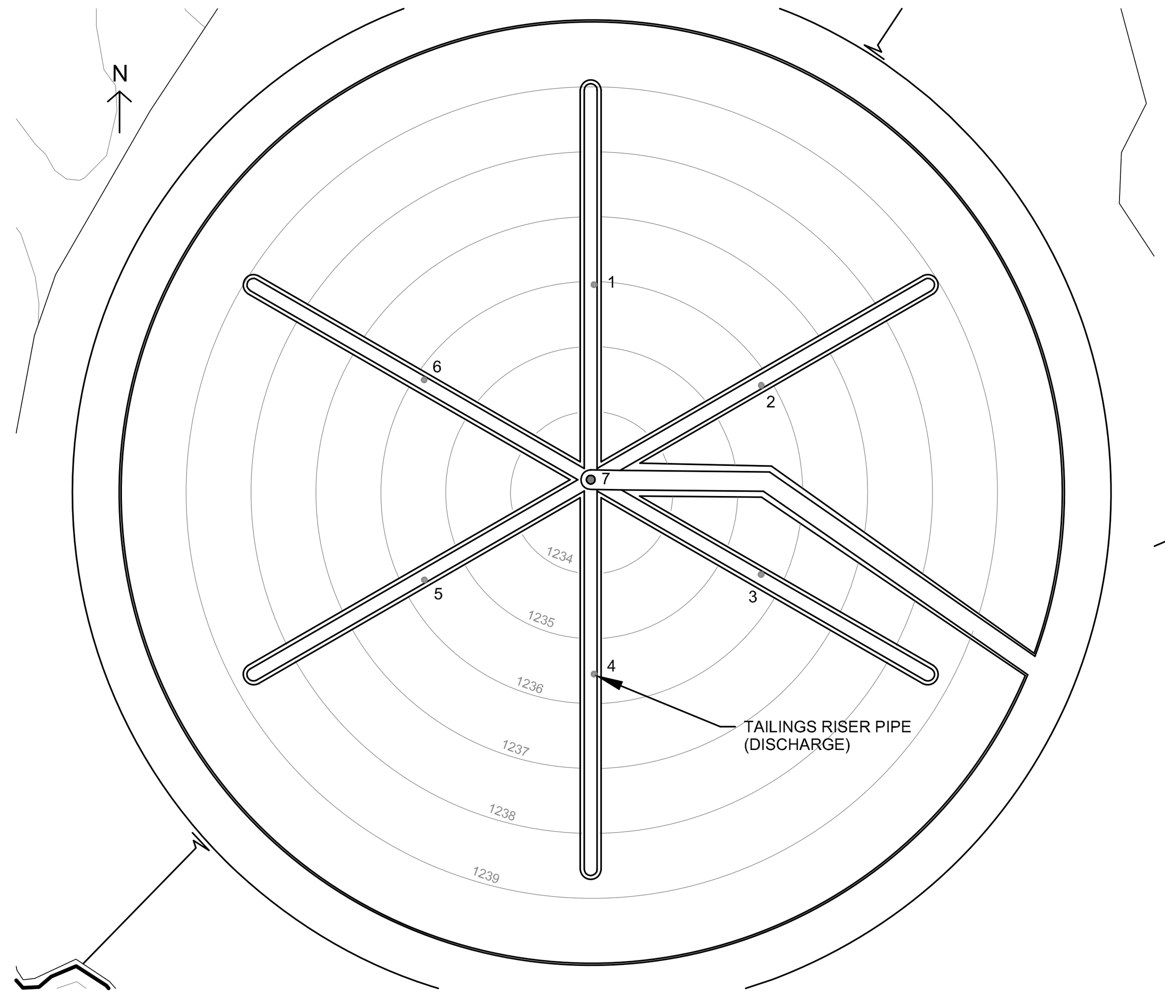
coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	24/07/07
Scale	AS SHOWN

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY
STAGE 7 PLAN AND SECTIONS - FINAL DEPOSITION

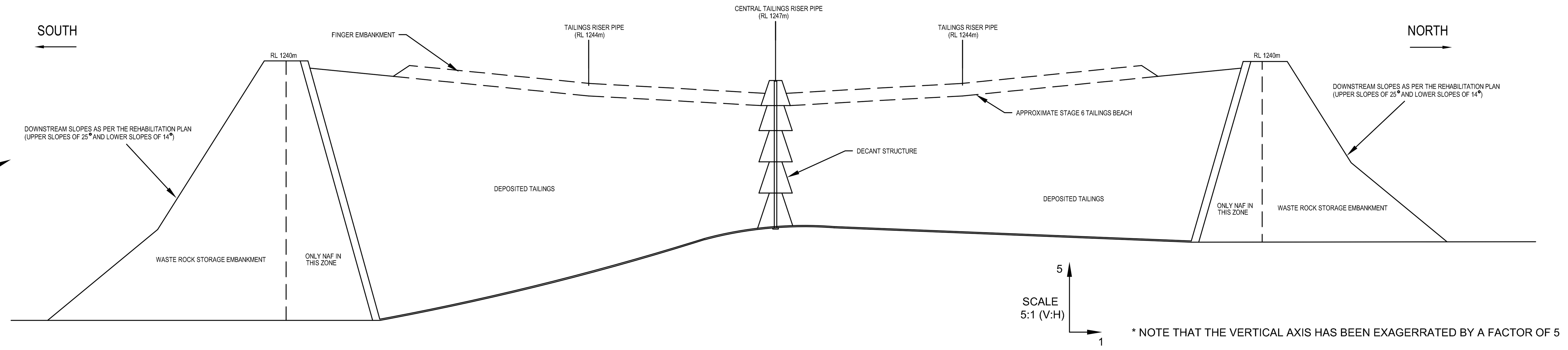
Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-13

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-13 Rev B.dwg

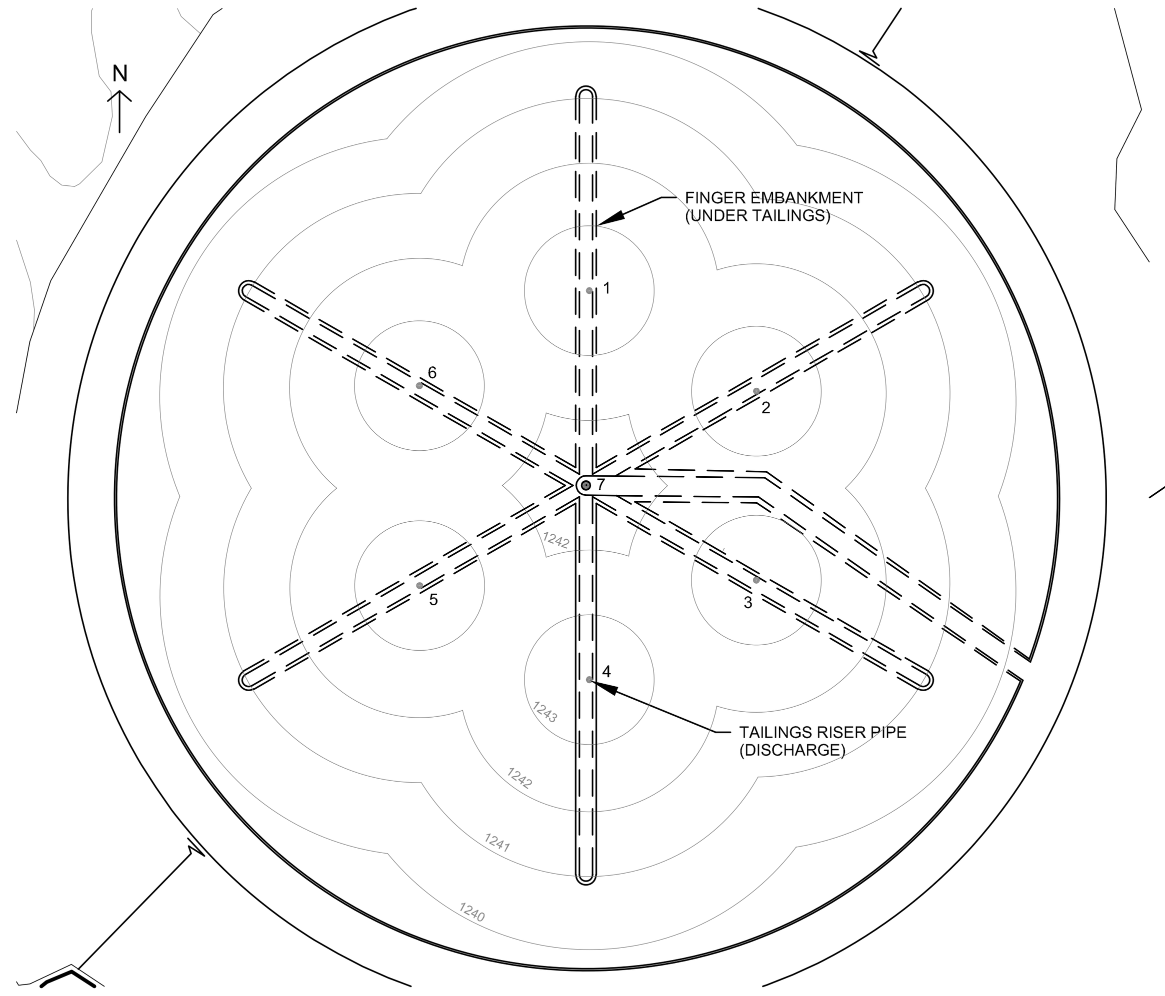


DEPOSITION PLAN - PRIOR TO COVER DEPOSITION
PLAN
NOT TO SCALE

REFER TO SECTION

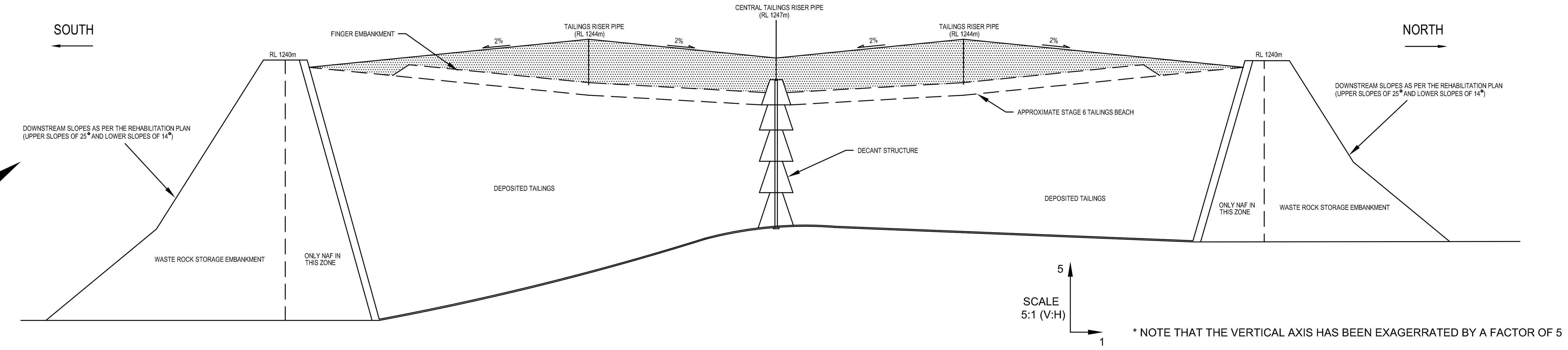


DEPOSITION PLAN - PRIOR TO COVER DEPOSITION
TYPICAL SECTION
NOT TO SCALE

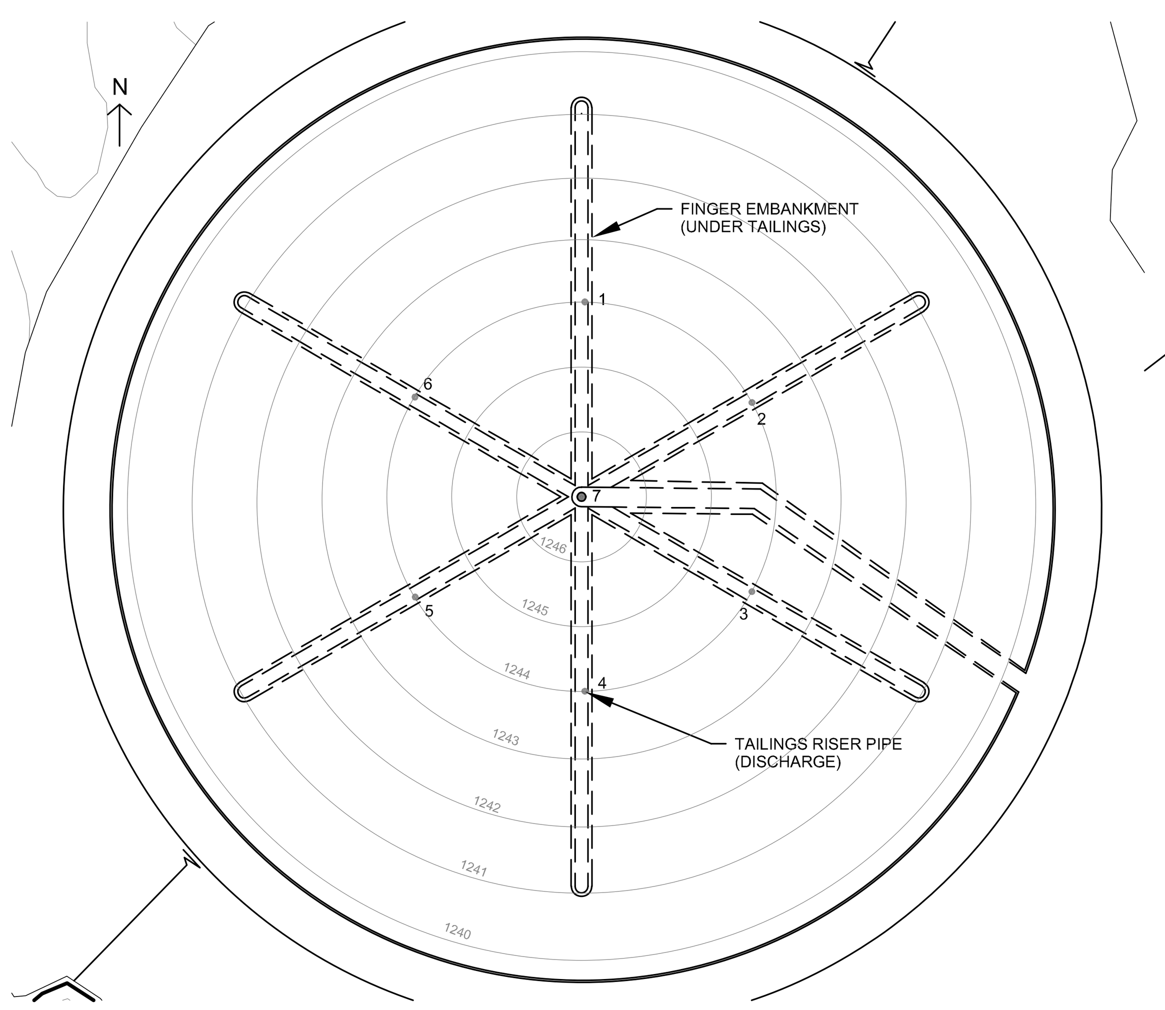


DEPOSITION PLAN - INTIAL COVER DEPOSITION
PLAN
NOT TO SCALE

REFER TO SECTION

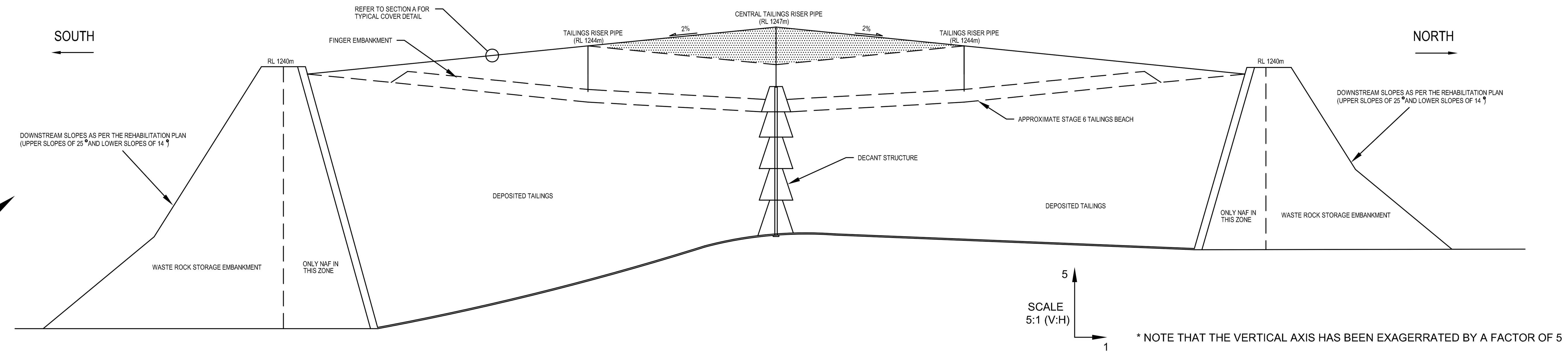


DEPOSITION PLAN - INTIAL COVER DEPOSITION
TYPICAL SECTION
NOT TO SCALE

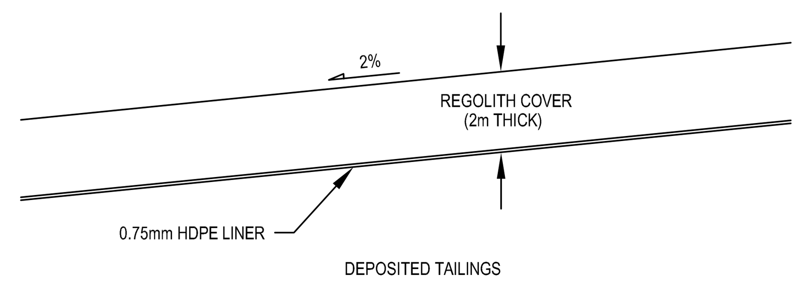


DEPOSITION PLAN - FINAL COVER DEPOSITION
PLAN
NOT TO SCALE

REFER TO SECTION



DEPOSITION PLAN - FINAL COVER DEPOSITION
TYPICAL SECTION
NOT TO SCALE



A
FINAL COVER
TYPICAL DETAIL
SCALE 1:1000

Rev No	Revision Note	Date	Approved
A	ISSUED FOR CLIENT REVIEW	24/07/07	CL

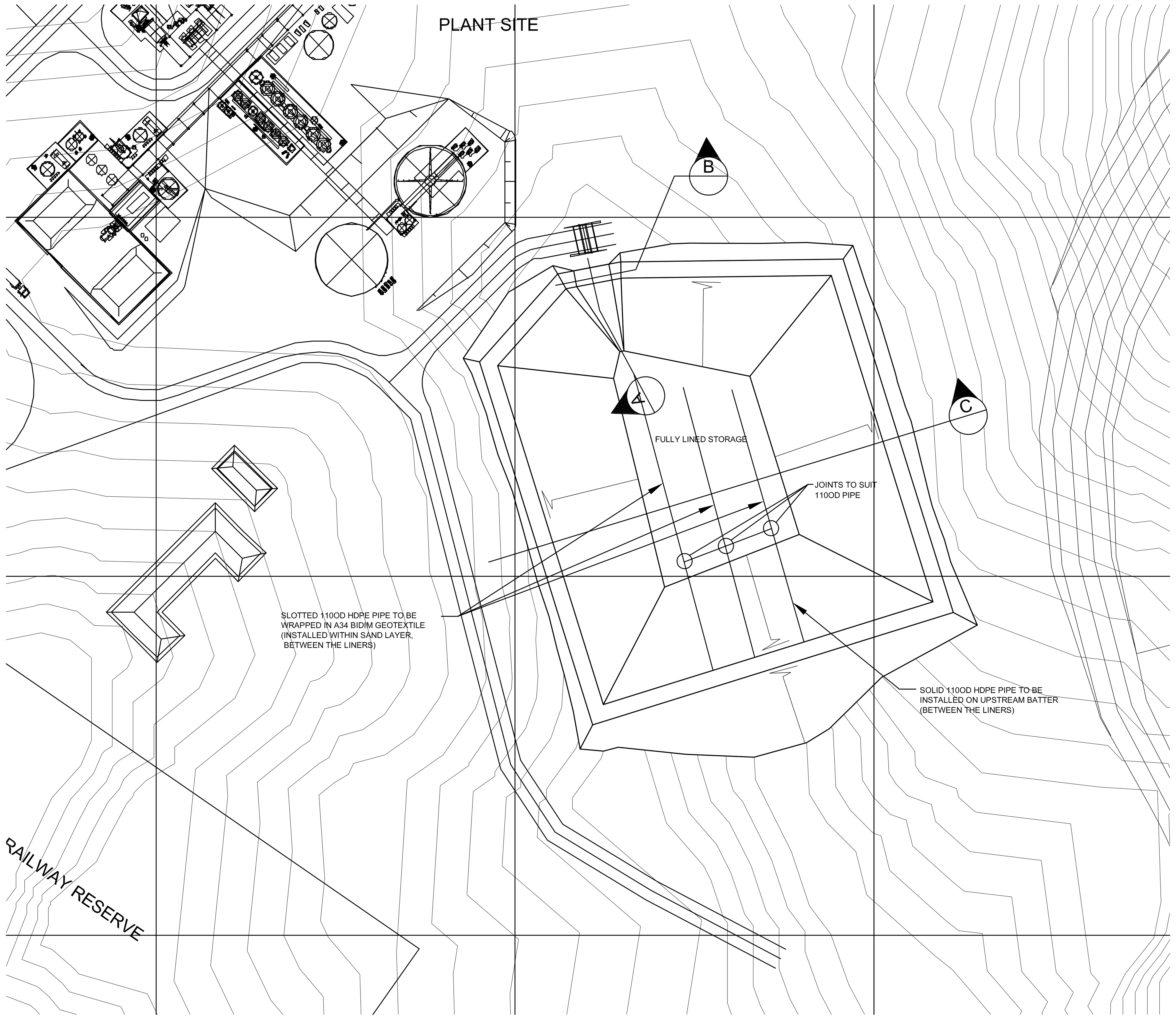
coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	24/07/07
Scale	AS SHOWN

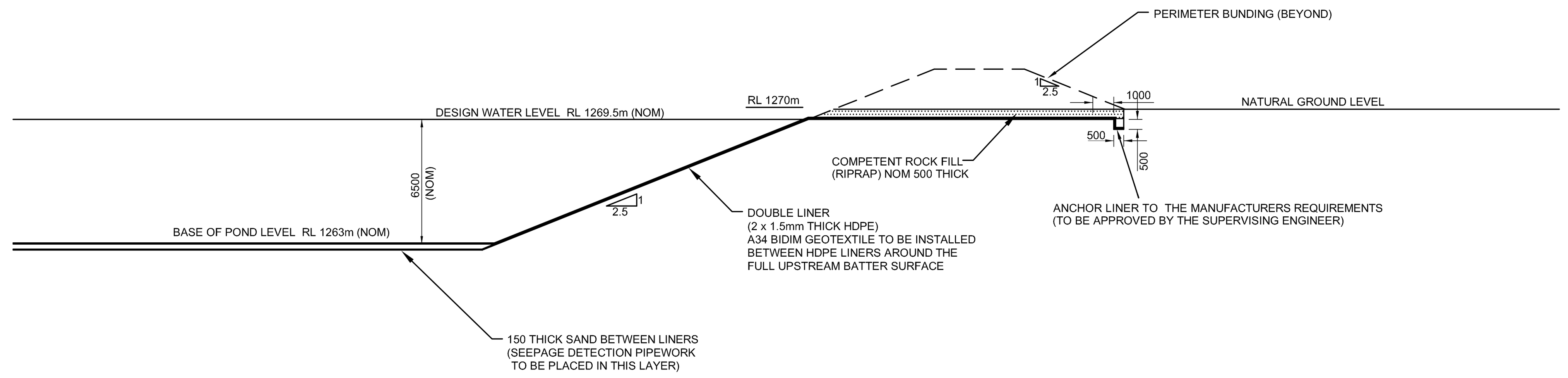
HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY
STAGING OF FINAL COVER DEPOSITION

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-14

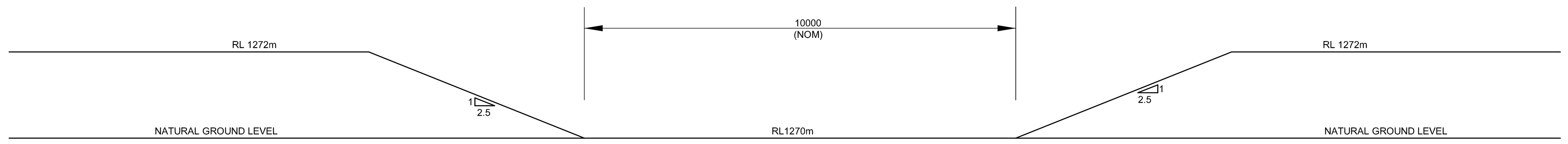
REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-14 Rev A.dwg



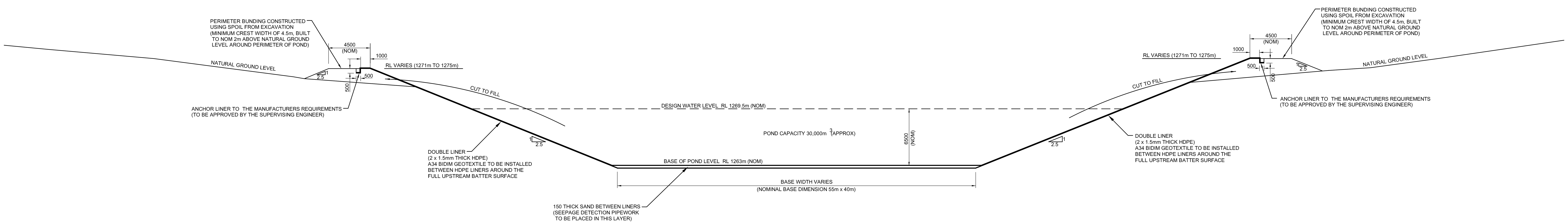
PROCESS WATER POND
PLAN
SCALE 1:1000



A PROCESS WATER POND - INLET
TYPICAL SECTION
SCALE 1:250



B PROCESS WATER POND - INLET
LONGITUDINAL SECTION
SCALE 1:100



C PROCESS WATER POND
TYPICAL SECTION
SCALE 1:250

Rev No	Revision Note	Date	Approved
A	ISSUED FOR CLIENT REVIEW	30/07/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	30/07/07
Scale	AS SHOWN

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

PROCESS WATER POND - PLAN AND SECTIONS

Original Size	A1
Project no:	MH00335AA
Drawing	MH00335AA-15

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-15 Rev A.dwg

Appendix B

Scope of Works

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

SCOPE OF WORKS KANMANTOO COPPER PROJECT, SOUTH AUSTRALIA

MH00335AA-AE Scope of Works Rev D

5 October 2007

Coffey Mining Pty Ltd ABN 52 065 481 209
24 Hasler Road Herdsman WA 6017 Australia

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

21 September2007

Hillgrove Copper Pty Ltd
Level 41, 264-278 George Street
Sydney NSW 2000
AUSTRALIA

Attention: Marty Adams

Dear Sir

RE: SCOPE OF WORKS KANMANTOO PROJECT, SOUTH AUSTRALIA

Please find attached the Scope of Works for the construction of the tailings storage facility at Kanmantoo.

For and on behalf of Coffey Mining Pty Ltd

Christopher Lane

Senior Principal

DOCUMENT INFORMATION

Status	Not approved for construction
Version	Rev D
Print Date	5 October 2007
Approval State	
Author(s)	Christopher Lane
Reviewed By	Ian Grieve
Path Name	F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\WP Docs\MH00335AA-AE Scope of Works Rev D.doc
File Name	MH00335AA-AE Scope of Works Rev D.doc
Project No	MH00335AA
Distribution	

DOCUMENT CHANGE CONTROL

Version	Description (section(s) amended)	Author(s)	Date

DOCUMENT REVIEW AND SIGN OFF

Name	Position	Role	Signature	Date Issued
Ian Grieve	Principal		IG	June 2007

CONTENTS

CONTENTS

CONTENTS

ATTACHMENTS

Tables

Schedule of Quantities - Stage 1 RL 215 mAHD (Local RL 1215 m)

Separate Drawings and Scope of Works are required for construction of Stages 2 to 6

Schedule of Quantities - Stage 2 RL 222 mAHD (Local RL 1222 m)

Schedule of Quantities - Stage 3 RL 227 mAHD (Local RL 1227 m)

Schedule of Quantities - Stage 4 RL 232 mAHD (Local RL 1232 m)

Schedule of Quantities - Stage 5 RL 237 mAHD (Local RL 1237 m)

Schedule of Quantities - Stage 6 RL 240 mAHD (Local RL 1240 m)

Schedule of Quantities – Stage 7 Final Surface Cover

1 INTRODUCTION

This Scope of Work covers the construction of the Tailings Storage Facility (TSF) and associated facilities for the Kanmantoo Copper Project, South Australia.

The works mainly involve bulk earthworks to excavate the seepage cutoff, construction of the clay liner, clay starter embankments, decant accessway, return water storage, water storage facility, water diversion and diversion spillway. Other works associated with the project include construction of the underdrainage system, decant facility including decant outfall pipes and HDPE liner to the return water sump. All details presented herein are to be read in conjunction with the drawings.

The Scope of Work shall comprise the provision of all material, construction plant, equipment, labour, supervision, tools, services, warehousing if required, testing equipment, and each and every item of expense necessary for the construction, acceptance testing and preparing of "as built" drawings and documents for work shown in the drawings schedules and Specifications forming part of the Construction of the TSF for the Kanmantoo Copper Project.

All works shall be constructed complete and operational except as specifically excluded, and shall include all necessary auxiliary works, accessories and the incorporation of all miscellaneous material, minor parts and other such items, whether or not the items are specified, where it is clearly the intent of the design that they should be supplied, or where they are obviously required and necessary to complete and commission the work.

The Contractor must fully co-operate with other contractors and at all times co-ordinate activities to ensure the TSF is constructed in accordance with the intent of the design. The protection of all active and non-active pipework and instrumentation which is in place is paramount. The Mine Superintendent shall be immediately notified of any damage to pipework or instrumentation no matter how minor.

1.1 Drawings

The following drawings complete this Scope of Work:

Title	Drawing No.	Rev
General Arrangement	MH00335AA-01	A
TSF Plan Stage 1 Earthworks (Clay Blanket and Internal Embankment)	MH00335AA-02	B
TSF Section Stage 1 Earthworks (Clay Blanket and Internal Embankment)	MH00335AA-03	B
TSF Underdrainage and Decant Pipework Plan	MH00335AA-04	B
Sections and Details - Decant	MH00335AA-05	B
Sections and Details - Underdrainage	MH00335AA-06	B
Return Water Storage - Plans and Sections	MH00335AA-07	C
Water Storage dam and Diversion – Plans and Sections	MH00335AA-08	C

Title	Drawing No.	Rev
Underdrainage Protection Plan	MH00335AA-09	B
Underdrainage Protection Sections	MH00335AA-10	B
Process Water Pond Plan and Sections	MH00335AA-15	A

It should be noted that Stages 2 to 6 will require the preparation of detailed drawings (Plan and Section Drawings) for the construction of each embankment lift, separately prepared with the design for each new lift based on the details from the 'as built drawings' from the previously constructed stage. Similarly, a Scope of Work document will need to be prepared to ensure that only those details relevant to the construction are provided for the construction works. The following drawings show the concept for construction of Stages 2 to 6.

Title	Drawing No.	Rev
TSF Plan – Stage 6	MH00335AA-11	A
TSF Sections – Stages 2 to 6	MH00335AA-12	B

Stage 7 will require the preparation of detailed drawings (Plan and Section Drawings) for the construction of final tailings surface and cover with the design based on the details from the 'as completed Stage 6 tailings beach'. Similarly, a Scope of Work document will need to be prepared for Stage 7 to ensure that only those details relevant to the construction are provided for the construction works. The following drawings show the concept for construction of Stage 7.

Title	Drawing No.	Rev
Stage 7 Plan and Sections – Final Deposition	MH00335AA-13	A
Staging of Final Cover Deposition	MH00335AA-14	A

1.2 Code of Practice

Unless otherwise specified or shown on the drawings, all materials and the work shall be in accordance with the latest revisions of the relevant Australian Standard Codes, or alternative standards approved by the designer (Coffey Mining Pty Ltd). All work shall be performed strictly in accordance with the following Specifications, Drawings and other documents, which by this reference forms part of this Contract, unless expressly noted otherwise.

AS 1289 Methods of testing soils for engineering purposes.

AS 1726 Geotechnical site investigations.

AS 3798 Guidelines on earthworks for commercial and residential developments.

The Works shall be carried out to comply with the latest revision of the Drawings, Codes and Standards specified, or where no standards are specified, to Australian Standards, or to the appropriate British or other recognised Standards.

Before making any change in any work to comply with any revisions to the relevant codes and standards, written notice shall be given to the designer specifying the reason and requesting their direction thereon. The designer shall decide whether a change is necessary and issue a written order accordingly.

1.3 Site Inspection

The Contractor shall inspect the site and must allow for the following factors in their price:

(i) The nature and requirements of the work to be done.

(ii) All conditions on and adjacent to the site.

(iii) Access to the site.

(iv) The types of soil and vegetation present on the site.

(v) The expected or known water table.

(vi) The nearest sources of suitable fill material which complies with this Specification.

(vii) The source of water for construction purposes.

Attention is drawn to the availability of a geotechnical report for the Kanmantoo Copper Mine Project.

1.4 Safety

The Contractor shall:

(i) Carry out the works in a safe manner.

(ii) Conform to all relevant Acts or Statutes of Parliament, Regulations, By-Laws or Orders relating to the safety of persons and property on or about the site.

1.5 Site Location and Description

The site is approximately 31 hectares in total area and is located to the west of the existing waste dump from the previous mining operations. The proposed TSF, with time, will be encapsulated within the new waste dump that will be formed as part of the future mining operations.

2 DESCRIPTION OF WORK - SPECIFIC

The Scope of Work shall include, but is not necessarily limited to the following:

2.1 General

The Contractor shall:

- Attend a specific site induction before the commencement of works to ensure they fully understand the requirements of the design, and site protocols.
- Carry out all works indicated or implied in the Drawings or in the Specification.

- Supply all labour, plant and materials (except those indicated as being supplied by the Principal) necessary for completion of the works.
- Maintain all works as required by the design documents and for the period stated therein.

All construction shall be to the minimum lines and grades shown on the drawings or as required by the designers as work progresses.

During the progress of the works, the designers may find it necessary to revise the lines, levels and grades of any part of the works because of the conditions revealed by the works.

Some delays may occur due to inspection and checking of any part of the works to determine grades and levels.

2.2 Survey

The Contractor shall:

- Perform all ground surveys using conventional and agreed surveying techniques.
- Survey and setting out of the works based on the datum points provided.
- Be responsible for the protection of all permanent and temporary beacons or bench marks.
- Be wholly responsible for the setting out of his works in accordance with the terms of the specification. Setting out shall be checked from time to time, such checking will not relieve the construction personnel of full responsibility for the accuracy of such setting out.
- Carry out surveys prior to the commencement of the item of work and at the completion of the item of work.
- Carry out a post construction survey by licensed surveyor of the works to verify that the works were constructed within the specified tolerances and submit to the designers.
- Submit survey data and calculations to the designers.
- Ensure initial and/or final surveys are undertaken and approved by the designers prior to the removal or placement of any material, especially where such action will destroy or cover the surface just surveyed. All survey checks or quantity measurements must be supplied to the designers, suitable time must be given to the designers to allow such calculations to be checked and approved prior to the works being covered or removed.

The Owners Representative may undertake their own survey of any item, either in conjunction with the Contractor, or separately.

The Contractor and Owners Representative shall agree on the results of measurement surveys that are carried out prior to any works being covered up or within seven (7) days of a survey being undertaken. Should agreement not be reached, the difference shall be documented such that the matter can be later decided without disruption to the construction programme.

The maximum permissible horizontal deviation from the finished lines or zone boundaries shall be -0m to +0.5m.

Vertical deviation shall be -0m to +0.2m, provided no abrupt changes in slope or level are present on any finished surface.

2.3 Establishment Works

The Contractor shall, as appropriate:

- Submit details of the proposed access road(s), haul road(s) and or ramp(s) to the Principal for approval prior to the commencement of construction.
- Construct only approved access road(s), haul road(s) and or ramp(s), as appropriate, between the designated borrow or waste dump(s) and the TSF, as appropriate to enable the fill materials to be recovered.

2.4 Clearing Works

The Contractor shall, as appropriate:

- Clear and stockpile trees, standing or fallen, brush, shrubs and other vegetation from the footprint area of the TSF impoundment area, including the internal perimeter embankment, return water storage, water storage facilities and associated diversion works.
- Clear the agreed routes of all haul roads of all vegetation standing and fallen. Push this vegetation into heaps as approved by the Owners Representative.
- Do all things necessary to form and maintain haul roads linking the mine waste dump / borrow areas to the site and other haul roads necessary for the works and which are approved by the Owners Representative.
- Keep all haul roads sprayed and wetted to totally prevent the generation of airborne dust during the course of road construction and usage, subject to direction by the Principal.
- Seal all investigation boreholes, groundwater and sterilisation holes within the storage area of the proposed TSF facility and keep an accurate record of all holes filled.
- Prepare a quality assurance and quality control programme to cover all aspects of work included within this Construction Specification for the designers approval.
- Provide all things necessary to implement the approved QA/QC programme.

2.5 Topsoil Stripping

The Contractor shall, as appropriate:

- Strip and stockpile topsoil from within the TSF foundation area, return water storage and water storage to a nominal depth of 150mm below the natural ground surface. Stockpiling of topsoil shall be in areas nominated by the Owners Representative. Stockpiles shall have a maximum height of 2.0m and side slopes of 1 (vertical) to 1.5 (horizontal).

2.6 Foundation Preparation

The Contractor shall, as appropriate:

- Excavate the internal base of the TSF to the design depth as directed. Clayey soil meeting the requirements for the clay liners or embankment fill, shall be separately stockpiled as directed. Material not meeting the relevant requirements shall be separately stockpiled outside the works area.

- Tyne, moisture condition and proof compact the surface of the excavation to a minimum density ratio of 98% of standard compaction.
- Grade the surface of the excavation to be consistent with the design fall of the clay liner.
- Any filling required to replace soft or excessively deflecting areas, or to raise the level of the excavation shall be placed in layers and compacted to a minimum density ratio of 98% of standard compaction.
- The final surface shall be dense, smooth and homogenous, free of gravel protrusions.
- Allow for keeping water from the foundation by pumping, dewatering, or other suitable means, and adequately dispose of it clear of the works.

2.7 Earthworks

2.7.1 Construction Materials - Liners

The Contractor shall, as appropriate:

- Construct the clay liners to the tailings storage floor and embankments using selected approved clay materials sourced from the designated areas, as detailed on Figure 1.
- Use only materials complying with the following requirements in the areas designated for Type A Clay Fill:
  - The materials shall have 100% by weight passing 19 mm.
  - The materials shall have a minimum of 40% by weight passing 0.075 mm.
  - The material shall be free of organic or any other deleterious inclusions.
  - The material shall have a liquid limit of not less than 30%; and
  - The material shall have a plasticity index of more than 20%.
- Use only materials complying with the following requirements in the areas designated for Type B Clay Fill:
  - The materials shall have 100% by weight passing 19 mm.
  - The materials shall have a minimum of 30% by weight passing 0.075 mm.
  - The material shall be free of organic or any other deleterious inclusions.
  - The material shall have a liquid limit of not less than 20%; and
  - The material shall have a plasticity index of more than 8%.
- Ensure all materials shall be stockpiled, transported and placed in such a manner as to minimise segregation.
- Adjust the moisture content of the borrow material, approved for use in the perimeter embankment construction. Moisture condition the borrow to within the range of -2%, +2% of the optimum moisture content as determined from laboratory test 5.1.1 of AS1289 (1993). The borrow materials shall be cured to ensure the moisture is thoroughly mixed and evenly spread through all materials proposed for embankment construction.

- Place all fill material comprising the perimeter embankment in homogeneous horizontal layers not exceeding 300 mm loose lift thickness. Each layer shall be compacted to achieve a minimum density ratio of not less than 98% of the maximum dry density - standard compaction as determined from laboratory test AS 1289.5.1.1. Placement should be continuous. If a break in fill placement allows the exposed surface to dry, it should be lightly tyned, watered and compacted prior to fill placement recommencing.
- The surface of the compacted clay liner shall be graded to the design slope
- Carry out testing to comply with the Specification and QA/QC procedures.
- Allow for keeping water from the works during construction.
- Allow for maintaining the borrow areas free of large accumulations of water.
- Construct any internal access road(s) over the compacted clay liner using construction techniques and materials, approved by Principal, so as not to damage the compacted clay liner.

2.7.2 Earthfill Embankment

The Contractor shall, as appropriate:

- Construct the earthfill to embankments using selected approved material sourced from the borrow areas.
- Use only materials complying with the following requirements in the areas designated for earthfill:
  - The materials shall have 100% by weight passing 37.5 mm.
  - The materials shall have a minimum of 25% by weight passing 0.075 mm.
  - The material shall be free of organic or any other deleterious inclusions.
  - The material shall have a liquid limit of not less than 15%; and
  - The material shall have a plasticity index of more than 5%.
- Materials shall be stockpiled, transported and placed in such a manner as to minimise segregation.
- Adjust the moisture content of the borrow material, approved for use in the perimeter embankment construction. Moisture condition the borrow to within the range of -2%, +2% of the optimum moisture content as determined from laboratory test 5.1.1 of AS1289 (1993). The borrow materials shall be cured to ensure the moisture is thoroughly mixed and evenly spread through all materials proposed for embankment construction.
- Place all fill material comprising the perimeter embankment in homogeneous horizontal layers not exceeding 300 mm loose lift thickness. Each layer shall be compacted to achieve a minimum density ratio of not less than 98% of the maximum dry density - standard compaction as determined from laboratory test AS 1289.5.1.1. Placement should be continuous. If a break in fill placement allows the exposed surface to dry, it should be lightly tyned, watered and compacted prior to fill placement recommencing.
- The surface of the compacted clay liner shall be graded to the design slope
- Carry out testing to comply with the Specification and QA/QC procedures.

- Allow for keeping water from the works during construction.
- Allow for maintaining the borrow areas free of large accumulations of water.

2.7.3 Internal Decant Accessways

The Contractor shall, as appropriate:

- Construct the internal decant accessways using selected mine waste material sourced from the waste dump located west of storage.
- Prior to construction of any internal access road(s) over the compacted clay liner the Contractor shall submit details of the proposed construction techniques and materials to the Principal for approval. The construction of internal access roads shall be such so as not to damage the compacted clay liner.

2.7.4 Decant Structure(s)

The Contractor shall:

- Survey the position of the decant structures.
- Excavate the decant foundation to the design level or as directed and provide a 'smooth' base for the placement of the blinding layer to the satisfaction of the Principal.
- Load, haul and place spoil excavated from the decant foundation to the position of the decant accessway as directed.
- Supply and place reinforcement and concrete for the decant structure base as noted on the Drawings.
- Allow the decant base to cure for a minimum period of three days prior to the placement of concrete pipes or rockfill.
- Supply and install all materials to construct the decant structure as shown on the Drawings.
- Win, load, haul and place decant filter rock from the designated source and place around the decant structure as shown on the drawings (from nominated stockpiles at the mine waste dump)

Only clean approved competent rock with a low fines content shall be placed around the decant structure. All rock shall be carefully placed to ensure the concrete pipes are not dislodged or damaged. Any damaged pipes shall be reported to the Principal and repaired and replaced by the contractor at their cost.

2.8 Pipework

2.8.1 General

The Contractor shall:

- Transport all pipe, underdrainage pipe and associated items to site.

- Install, test and commission all pipework to the grades and levels shown on the drawings and noted in this scope of work.
- Excavate a trench through the embankment to take the outfall pipework.
- Excavate for the concrete cutoff within the embankment and provide formwork within the trench as noted.
- Supply and place concrete for the concrete cutoff.
- Backfill, fill and bed items as noted with approved earthfill as shown on the drawings and noted in this scope of work.
- Cover and stake all pipework to prevent floating.

2.8.2 Decant Outfall Pipework

All gravity decant outflow pipework shall be installed on a prepared surface free from projections with an **even** fall towards the outlet point. The pipe grade shall not deviate greater than 1/3 the diameter of the pipework from the design grade.

The pipework in the vicinity of the decant structure rock mound shall be thoroughly protected. Similarly, rock in the vicinity of the pipe shall be placed with care to prevent damage.

Backfill placed around the pipes located adjacent to the decant structure(s) shall be backfilled with cement stabilised backfill (1 part Portland Cement : 20 parts approved earthfill free of cobbles, boulders or rocks).

The main trench through the mine waste embankment for the decant and underdrainage outfall pipes shall have an approximate width of 4000 mm and shall be excavated prior to the placement of the compacted clay liner. Material excavated from the trench shall be stockpiled for re-use in other parts of the construction where the materials meet the specified requirements for that part of the construction.

Once excavated, select backfill free of cobbles, boulders or rocks shall be placed in compacted layers of 100 mm and shaped to provide full support for the barrel of the pipe.

Prior to trench backfilling, a cutoff comprising a bentonite:cement:water mix (1:10:20) is to be installed to reduce the potential for any seepage flow along the outfall pipe trench. The cutoff is to be formed against and into either natural ground or well compacted fill, no formwork is to be used except across the trench excavation.

Once the pipes have been pressure tested, and the concrete cut off installed backfilling with overburden waste shall be undertaken, with 100 mm thick layers being hand tamped from the pipe invert level to 100 mm above the top of the pipe around the pipe, and small plate compactors used in the area between the pipes and trench sides as appropriate.

The remainder of the trench shall be carefully backfilled with overburden waste to the surrounding ground level. Extreme care shall be taken to avoid any damage to the installed pipework when backfilling and compacting around and above the pipes.

Normal embankment construction can recommence once the trench has been backfilled to the surrounding construction level.

Any pipes which are not laid to line, level or grade, or are damaged or displaced during backfilling or other operations by the Contractor in the course of the works, shall be removed and replaced at the Contractor's expense. The Contractor shall be responsible for any excavation of backfilling necessary for the removal and replacement of any pipe.

The contractor shall ensure that all other pipework is placed in accordance with the appropriate recommendations of the manufacturer.

On completion of pipe laying and testing, the decant lines shall be covered with a minimum 1m earthfill which is free of cobbles, boulders or rocks, to prevent floating during the initial stages of tailings deposition. The valves near the return water sump should be closed and the decant pipes filled with water to prevent floating during initial tailings deposition.

2.9 Underdrainage

2.9.1 General

The base of the TSF will be covered by a compacted clay liner over which a herringbone Megaflo Ultra underdrainage system will be installed.

2.9.2 Underdrainage Pipework

The Contractor shall, as appropriate:

- Transport all pipe, underdrainage pipe and associated items to site.
- Install, test and commission all pipework to the grades and levels shown on the drawings and noted in this scope of work.
- Backfill, cover and bed items as noted with sand as shown on the drawings and noted in this scope of work.
- Ensure that areas to receive pipework / underdrainage are smooth and be free of any rock, cobbles and other deleterious materials that could damage the pipework, and that there is an **even** fall towards the outlet point.
- Construct any internal access road(s) over the compacted clay liner using construction techniques and materials, approved by Principal, so as not to damage the liner.
- Carefully lay the Megaflo Ultra directly over the compacted clay liner. Care must be taken to avoid damaging the underlying liner.
- Place clean (no fines) fine aggregate (10mm to 14mm nominal size), as shown on the drawings.
- Allow for keeping water from excavations by pumping, dewatering, or other suitable means, and adequately dispose of it clear of the works.

2.9.3 Underdrainage Fine Aggregate

The Contractor shall:

- Ensure that Fine Aggregate materials for the underdrainage, both herringbone Megaflo Ultra and slotted HDPE, shall conform with the following requirements:
    - The fine aggregate shall be component, durable, and derived from crushed fresh rock.
    - The fine aggregate shall have a minimum particle size of 10 mm and a maximum particle size of 14 mm.
    - The fine aggregate shall contain not more than (3% by weight) of fractions finer than 0.075mm.

  - ! The fine aggregate shall be free of organic or any other deleterious inclusions.
  - ! The fine aggregate shall have a plasticity index of 0% (ie non plastic).
- Ensure that the fine aggregate shall be placed in horizontal layers to the specified thickness within the underdrainage system.
- Ensure all materials are carefully placed so as not to damage any geotextile or pipework.
- Construct access roads and or ramp(s), as appropriate, to the designated stockpiles or borrow areas appropriate to enable the sand materials to be recovered. The details of the proposed ramps should be submitted to the Owners Representative prior to the commencement of construction.

2.9.4 Underdrainage Outfall Pipework

All underdrainage outflow pipework shall be installed on a prepared surface free from projections with an **even** fall towards the outlet point. The pipe grade shall not deviate greater than 1/3 the diameter of the pipework from the design grade.

The pipework in the vicinity of the embankment and as marked on the drawings shall be thoroughly protected. Similarly, rock in the vicinity of the underdrainage pipe shall be placed with care to prevent damage.

The main trench through the mine waste embankment for the decant and underdrainage outfall pipes shall have an approximate width of 4000 mm and shall be excavated prior to the placement of the compacted clay liner. Material excavated from the trench shall be stockpiled for re-use in other parts of the construction where the materials meet the specified requirements for that part of the construction.

Once excavated, select backfill free of cobbles, boulders or rocks shall be placed in compacted layers of 100 mm and shaped to provide full support for the barrel of the pipe.

Prior to trench backfilling, a cutoff comprising a bentonite:cement:water mix (1:10:20) is to be installed to reduce the potential for any seepage flow along the outfall pipe trench. The cutoff is to be formed against and into either natural ground or well compacted fill, no formwork is to be used except across the trench excavation.

Once the pipes have been pressure tested, and the concrete cut off installed backfilling with overburden waste shall be undertaken, with 100 mm thick layers being hand tamped from the pipe invert level to 100 mm above the top of the pipe around the pipe, and small plate compactors used in the area between the pipes and trench sides as appropriate.

The remainder of the trench shall be carefully backfilled with overburden waste to the surrounding ground level. Extreme care shall be taken to avoid any damage to the installed pipework when backfilling and compacting around and above the pipes.

Normal embankment construction can recommence once the trench has been backfilled to the surrounding construction level.

Any pipes which are not laid to line, level or grade, or are damaged or displaced during backfilling or other operations by the Contractor in the course of the works, shall be removed and replaced at the Contractor's expense. The Contractor shall be responsible for any excavation of backfilling necessary for the removal and replacement of any pipe.

The contractor shall ensure that all other pipework is placed in accordance with the appropriate recommendations of the manufacturer.

On completion of pipe laying and testing, the underdrainage lines shall be covered as shown on the drawings to prevent floating during the initial stages of tailings deposition. The valves near the return water sump should be closed and the underdrainage outfall pipes filled with water to prevent floating during initial tailings deposition.

2.10 Return Water Storage and Water Storage

2.10.1 General

The contractor shall construct the return water storage and water storage dam in the location and to the details shown on the drawings. The shape of the storages may vary on site, as directed by the Owners Representative, to suit excavation conditions. All surplus excavated material shall be removed to spoil.

The Contractor shall:

- Excavate the Pond and place material to form the surrounding bunds.
- Spoil any excess material from within the sump as directed.
- Supply and place sand bedding under the artificial liner.
- Install, join, anchor, test and commission the artificial liner as shown on the drawings and to the manufacturers requirements.
- Install all pipework and penetrations.

2.10.2 Preparatory Earthworks

The Contractor shall:

- Prepare the subgrade surface to accept the liner. The subgrade shall be compacted to 95% of the standard maximum dry density for a depth of 200mm.
- The finished subgrade surface shall be smooth and free of projections (eg cobbles, roots etc) that could damage the HDPE liner.

2.10.3 HDPE Liner

The Contractor shall install the HDPE Liner in accordance with the design drawings and in accordance with the manufacturers recommendations.

The liner material shall comprise 1.5mm thick Class 16 HDPE liner. The liners shall have ultra violet protection. The liner shall be free of holes, blisters, undispersed raw materials or any sign of contamination by foreign matter. The manufacturing process shall provide a smooth surface with a regular thickness of material. The liner shall be “defect free” and shall contain no more than one repairable damage per 450m^2 upon unrolling at site. The Contractor shall submit the manufacturer’s test certificates for the liner prior to delivery to site for approval by the Owner’s Representative.

The Contractor constructing the liner shall ensure that:

- The liner shall be installed, joined, site welded and anchored in accordance with the manufacturer’s recommendations. Details shall be provided for approval by the Owner’s Representative.

- The liner shall be quality control tested (both destructive and non destructive) in accordance with the manufacturer's recommendations. On a daily basis a weld specimen destructive test shall be performed. All liner welds shall be tested for integrity using the vacuum box method or similar approved. Details of test procedures, all test reports and all quality assurance reports are to be submitted to the Owner's Representative.
- At the time of tender, the contractor shall advise the name of the supplier and installer of the HDPE liners. In addition, a description of processes to be adopted, equipment to be utilised and all necessary documentation in regard to QA/QC shall be provided.

The Contractor constructing the liner shall supply the following information with their tender:

- Liner Specification
- Manufacturer's sampling and testing
- Inspection, supervision and installation methodology
- Proposed supervision and installation personnel proving experience on a similar size project
- Quality Assurance plan including checking for defects prior to installation, weld testing etc
- Installation methodology
- As built sheet layout drawing showing sheet numbers

Any defective liner will be rejected and replaced at the Contractor's cost.

2.10.4 HDPE Liner Testing Plans

The Contractor installing the liner shall provide not later than seven (7) days after Award of Contract a certified Testing Programme.

The Testing Programme shall include details of Procedures, Standards and acceptance levels and conform to the requirements of Specifications forming part of the Contract documentation and shall include details of testing of the HDPE liner installation.

The details of testing of the HDPE liner installation shall comprise the following, as appropriate:

- Raw material testing
- Geomembrane production testing
- Geomembrane roll report
- Daily operating control report
- Pre weld test certificate
- Daily weld test report (vacuum box method or similar approved)
- Daily weld specimen destructive test report
- Weld layout drawings

The Contractor shall advise the qualifications of the personnel involved with liner testing.

2.10.5 Leak Detection Pipework

The Contractor shall, as appropriate:

- Transport all pipe for the leak detection pipework and associated items to site.
- Install, test and commission all pipework to the grades and levels shown on the drawings and noted in this scope of work.
- Backfill, cover and bed items as noted with sand as shown on the drawings and noted in this scope of work.
- Carefully lay the pipework directly over the HDPE liner. Care must be taken to avoid damaging the underlying liner.
- Place clean sand (no fines) or geotextile (Bidim A34) as shown on the drawings.
- Allow for keeping water from excavations by pumping, dewatering, or other suitable means, and adequately dispose of it clear of the works.

2.10.6 Underdrainage Sand

The Contractor shall:

- Ensure that sand materials for the leak detection pipework shall conform with the following requirements:
  - The sand shall have a maximum particle size of 5mm with 80% by weight passing 2mm.
  - The sand shall contain not any (0% by weight) of fractions finer than 0.075mm.
  - The sand shall be free of organic or any other deleterious inclusions.
  - The sand shall have a plasticity index of 0% (ie non plastic).
- Ensure that the sand shall be placed in horizontal layers to the specified thickness within the leak detection system.
- Ensure all materials are carefully placed so as not to damage any geotextile, pipework, instrumentation or instrumentation cabling.
- Construct access roads and or ramp(s), as appropriate, to the designated stockpiles or borrow areas appropriate to enable the sand materials to be recovered. The details of the proposed ramps and ramps should be submitted to the Owners Representative prior to the commencement of construction.

2.11 Diversion Channel - Mortared Stone Pitching

Mortared stone pitching shall be placed to the extents, as shown on the drawings or as directed, in the diversion channel.

Mortared stone pitching shall comprise spalls of hard durable rock with no dimension less than 200mm. The stones shall be hand placed so that they are firmly bedded in layers. Mortared stone pitching shall be placed against prepared surfaces.

The stones shall be grouted with cement mortar. The cement mortar shall consist of 1 part cement to 3 parts clean sand with potable water to form a workable mixture. The mortar shall be worked into the interstices of the stone pitching to a depth of at least 100mm from the surface (from the base upwards). The mortar shall be cured for at least 48 hours.

Any defective mortar shall be removed and any loose stones re-grouted.

2.12 Completion

The Contractor shall:

- Batter down the sides of any borrow pits, as appropriate, for stability on completion of the work. Materials not considered suitable for use in the works shall be evenly spread over the borrow pit surface. The finished surface profile of the borrow shall comply with best practice Guidelines for rehabilitation of mine waste dumps.
- Clean up all rubbish, remove all plant and supply materials, trim all banks neatly, spread all excavated material not specified to be removed from the site and leave the site in a clean and tidy condition.
- Topsoil and vegetable matter removed from the embankment footprint prior to embankment construction shall be respread on the downstream face of the dam. Topsoil shall be redeployed in a thickness similar to that removed from the embankment footprint.

2.13 Construction Sequence

The Contractor shall liaise with the mining team, other contractors and the Owner/Principal to agree a sequence for the works. The Contractor and other contractor shall endeavour to complete the external embankments in the sequence agreed.

2.14 Limits of the Contract

The limits of the Contract are as shown on the Drawings.

3 PRINCIPAL SUPPLIED ITEMS

3.1 Survey

The Principal will provide co-ordinates and levels of survey marks within the vicinity of the storage. The Contractor and other contractors shall set out all lines and levels using the survey marks provided.

3.2 Materials

The Principal will supply mine waste for construction of the works from designated sources.

3.3 Water

Water will be made available. Supply will be from a standpipe located near the site. Access to the standpipe will not be exclusive to the Contractor. The Contractor shall determine the type and suitability of the water supplies for use in the works.

The Contractor shall make their own arrangements for loading and hauling of water.

4 QUALITY CONTROL AND QUALITY ASSURANCE

The required quality standards for implementation of this Scope of Work are the AS/NZS ISO 9001:2001 Standard Series and the Contractor and other contractors shall comply with the requirements of these standards.

The Contractor shall provide not later than seven (7) days after notification of the start date fully documented details of the Quality systems and procedures to be utilised together with reference details for implementation of the stated system and procedures on previous similar projects.

5 INSPECTION AND TESTING

5.1 Inspection Requirements

The Owners Representative will be entitled, at all times to inspect, examine and test the materials and workmanship provided under the Scope of Works. Such inspection, examination or testing, if made, shall not release the Contractor from any obligation to complete the works as per the design.

The Contractor shall co-operate with and provide full opportunity to the Owners Representative to monitor regularly the progress of the Works to the detailed extent necessary to satisfy progress relative to the Construction and Mining Programs.

All pertinent information to enable the Owners Representative to determine the adequacy of the advance planning for material procurement, machine and manpower resources to meet the Construction Program shall be made freely available to the Owners Representative.

These requirements shall be incorporated in orders placed with Subcontractors.

5.2 Testing Plans

The Contractor shall provide, not later than seven (7) days after Award of Contract, a certified Testing Programme.

The Testing Programme shall include details of Procedures, Standards and acceptance levels and conform to the requirements of Specifications forming part of the Contract documentation.

Compliance tests shall be carried out to such a degree as to satisfy the Owners Representative that the criteria on materials, moisture content and compaction are met. All compliance tests shall be carried out by a qualified technician from a NATA registered laboratory employed by the Contractor.

The Contractor shall, at their own expense, rework or replace materials which do not meet the compaction or moisture content requirements.

Compliance testing of field density (compaction) shall be at the rate of not less than 1 test per layer per material type per 1,500m^2. Compliance testing (% fines and plasticity index tests) of construction materials shall be at the rate of not less than 1 test per material type per 2,500m^3.

The Contractor shall, at his own expense, rework or replace materials which do not meet the compaction requirements.

6 PERMITS, LICENCES AND APPROVALS

Further to the General Conditions of Contract, the Principal will obtain all Government Approvals relevant to the works. All other necessary permits, licenses and approvals shall be obtained by the Contractor.

7 SUBSTITUTIONS

The Contractor shall:

- Not substitute any alternative to the equipment and materials included in the Works without the prior written consent of the designer.
- Make diligent efforts to utilise the specified Materials to be incorporated into the Works but where the Contractor considers there are commercial or other advantages to be derived by the Principal, the Contractor may submit a proposal for a substitute material for approval by the Principal prior to commencement of the work. Such proposal for substitution shall be in writing and state reasons for and (if applicable) advantages of the substitute material. The Principal shall determine whether the substitute material will be permitted and such determination shall be binding and conclusive.

8 SHIPMENT (GENERAL)

The Contractor shall be responsible for transporting the Plant and Equipment to the site and shall maintain full responsibility for loading, unloading, handling, site storage and insurance of the Plant and Equipment during transportation.

Notice of dispatch shall be sent by the Contractor to the Principal at the time of dispatch of all consignments of Plant. Such notice shall contain the method and date of dispatch and date of arrival on site.

9 CO-OPERATION WITH OTHER CONTRACTORS AND OPERATIONS

It is inevitable that at times other Contractors or Operations personnel may be working in very close proximity to the Contractor during the execution of the Works. The Contractor shall at times, co-operate to the fullest extent with other Contractors and Operations and shall be deemed to have made full allowance in the Contract Sum for any costs which could be incurred as a result of such co-operation up to a maximum of two (2) hours for each incident.

The Contractor shall make allowances for the following:

- inconvenience of working around other contractors and operations
- need to relocate to another work area if the area is considered unsafe by the Principal due to activities of other contractors and Operations
- restrictions on access due to activities of others
- the need to use temporary and incomplete access ways and platforms.

10 TEMPORARY SERVICES AND FACILITIES

10.1 Furnished by Contractor

The Contractor shall, as part of the Scope of Work, supply, install, properly maintain, and remove all temporary construction facilities and utilities necessary for full and complete performance of the works. Such items shall include, but not necessarily be limited to, those listed below.

The type of facilities, mobilisation and demobilisation dates, and locations of job site shall be subject to, and in accordance with, the review and approval of the Principal.

- Access roads around and within the site to the approval of the Principal.
- All temporary office, cribroom and buildings required for use during the execution of the works.
- All sanitary consumables (toilet paper and hand cleaner).
- First line first aid facilities at work Site including a First Aid Officer.
- Fuels and lubricants.
- Compressed air and gases.
- Construction electric power distribution at the work Site to the approval of the Principal from existing supply points.
- Transportation facilities on site.
- Communications activities, including telephone and facsimile (Contractor shall liaise with telecommunications suppliers direct).
- Maintenance of laydown, storage and work areas and roads within such areas.
- All cranes and other necessary equipment for lifting and moving equipment.
- All small tools and testing equipment.
- Temporary lighting.
- Road and traffic signs
- Any items specified or implied in other sections of the Contract documents.
- Site clean-up and removal of rubbish to tip at an interval not exceeding one week.

10.2 Furnished by Principal

This section provides a list of Principal furnished Services. Any services or materials not specifically identified as being provided by the Principal shall be provided by the Contractor.

10.2.1 Utility Services

Where the work is at an existing Plant, the Principal may be able to provide from existing outlets, electric power, water, and plant air at an agreed charge. These utility services are not guaranteed and may be withdrawn or terminated by the Principal at any time and for any duration without notice.

Should the Contractor be required to extend water, electric power or plant air from the existing outlets, such extensions shall only be carried out with the written approval of the Principal and shall be at the Project's cost.

All installations are to be built and maintained in accordance with relevant regulations and to the Principal's requirements.

The Contractor shall take all necessary steps to prevent waste of utility services.

11 DATA REQUIREMENTS

The Contractor shall submit as built drawings, testing results for construction within 7 days of completion of each stage of the works in addition to the data requirements detailed elsewhere in this Specification to the Principal as part of the Work.

The Contractor shall show the reference Project Number and identifying item numbers, if applicable, on all data submitted.

12 CONSTRUCTION PROGRAMME

The Contractor shall provide a construction programme and indicate the following milestone dates.

Notice to proceed with Stage 1

Scheduling programme for each item of works

Principal completion date for each stage.

Final Completion Date

* * * * * * * * * * *

Tables

Schedule of Quantities Stage 1

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**
CLIENT	**: HILLGROVE COPPER PTY LTD**
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 1 - RL1215 (215 mAHD)**

Date	21/09/2007
Job No	MH00335AA
File	
Subject	costing
Revision	C

Item	Description	Unit	Quantity	Rate	Amount
1.00	**EARTHWORKS**				
1.1.0	Clearing tailings storage floor area	m^2	310,000		$ -
1.1.1	Strip soil from beneath waste dump aera adjacent to TSF Stage 1	m^2	200,000		$ -
1.1.2	Strip soil from beneath return water storage	m^2	50,000		$ -
1.1.3	Strip soil from beneath pipework corridor	m^2	10,000		$ -
1.1.4	Borrow, moisture condition, transport, place and compact fill to clay	m^3	232,500		$ -
1.1.5	Fill north eastern corner of storage area with mine waste	m^3	100,000		$ -
1.1.6	Excavate seepage cutoff	m^3	40,000		$ -
1.1.7	Borrow, moisture condition, transport, place and compact fill to seepage	m^3	40,000		$ -
1.1.8	Borrow, moisture condition, transport, place and compact fill to internal	m^3	105,000		$ -
1.1.9	Borrow, transport, place, and traffic compact fill to decant accessway and finger embankments	m^3	125,000		$ -
1.1.10	Transport and place decant rockfill	m^3	3,500		$ -
1.1.11	Excavate decant blocks	m^3	24		$ -
1.1.12	Excavate underdrainage outfall pipe trench through embankment	m^3	1,800		$ -
1.1.13	Form and place cutoff to outfall pipes	m^3	7		$ -
1.1.14	Backfill over and around pipes through embankment	m^3	1,800		$ -
1.1.15	Borrow, moisture condition, transport, place and compact fill to return water storage embankment	m^3	16,500		$ -
1.1.16	Borrow, moisture condition, transport, place and compact fill to water storage embankment	m^3	6,000		$ -
1.1.17	Construct water diversion drain, including mortared stone pitching	m	800		$ -
1.1.18	Place gravel sheeting to internal perimeter embankment	m^2	13,000		$ -
1.1.19	Borehole Sealing	item	-		$ -
	ITEM 1.0 TOTAL				$ -

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	7/10/2007
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	C
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 1 - RL1215 (215 mAHD)**		

Item	Description	Unit	Quantity	Rate	Amount
2.00	**DECANT AND PIPEWORK**				
2.1.0	Reinforced concrete base for decants	m^3	24		$ -
2.1.1	Solid decant pipe NB1.8 Class X concrete internal flush joints	no.	3		$ -
2.1.2	Slotted decant pipe NB1.8 Class X concrete internal flush joints	no.	18		
2.1.3	90 degree Elbow	no.	3		$ -
2.1.4	Reducer from Elbow to Internal Riser	no.	3		$ -
2.1.5	Internal Riser	no.	3		$ -
2.1.6	Locating Spider	no.	3		$ -
2.1.7	HDPE butt welded decant outfall pipe	no.	3		$ -
2.1.8	HDPE Decant Sleeves	no.	100		$ -
2.1.9	Concrete plug to base of decant	m^3	1		$ -
2.1.10	Decant outfall pipe 315OD (total for 3 x lines to return water storage)	m	1,900		$ -
	ITEM 2.0 TOTAL				$ -
3.00	**UNDERDRAINAGE**				
3.1.1	Supply and install 300mm Megaflo Ultra	m	12,600		$ -
3.1.2	Supply and install 400mm Megaflo Ultra	m	900		$ -
3.1.3	Supply and install slotted 200 OD HDPE pipe (within storage area)	m	2,600		$ -
3.1.4	Underdrainage outfall pipes (to return water storage)	m	1,900		$ -
3.1.5	Aggregate to underdrainage	m^3	4,000		$ -
3.1.6	Underdrainage protection (rock fill)	m^3	90,000		$ -
	ITEM 3.0 TOTAL				$ -
4.00	**RETURN WATER STORAGE, WATER STORAGE AND DIVERSION**				
4.1.1	Supply and install 1.5mm HDPE liner to return water storage	m^2	52,000		$ -
4.1.2	Haul and place 150mm thick sand between liners	m^3	8,000		$ -
4.1.3	Supply and install slotted 110 OD HDPE pipe to sand layer (between liner	m	550		$ -
4.1.4	Supply and install solid 110 OD HDPE pipe to sand layer (on upstream ba	m	50		$ -
4.1.5	Supply and install 1.5mm HDPE liner to water storage dam	m^2	1,000		$ -
	ITEM 4.0 TOTAL				$ -

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**			Date	30/07/2007
				Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**			File	
				Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**			Revision	C
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 1 - RL1215 (215 mAHD)**				

Item	Description	Unit	Quantity	Rate	Amount
5.00	**PROCESS WATER POND**				
5.1.1	Excavate process water pond	m^2	28,000		$ -
5.1.2	Borrow, moisture condition, transport, place and compact fill to perimeter e	m^3	16,000		$ -
5.1.3	Supply and install 1.5mm HDPE liner to process water pond	m^2	25,000		$ -
5.1.4	Haul and place 150mm thick sand between liners	m^3	375		$ -
5.1.5	Supply and install solid 110 OD HDPE pipe to sand layer	m	250		$ -
	ITEM 5.0 TOTAL				$ -

Tables

For Information Only - Schedule of Quantities Stages 2 to 7

Separate Drawings / Scope of Works are required for constructing Stages 2 to 7

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	21-Sep-07
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	A
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 2 - RL1222 (222 mAHD)**		

Item	Description	Unit	Quantity	Rate	Amount
1.00	**EARTHWORKS**				
1.1.0	Strip soil from beneath waste dump area adjacent to TSF Stage 2	m^2	590,000		$ -
1.1.1	Remove gravel sheeting	m^2	13,000		$ -
1.1.2	Prepare foundation	m^2	13,000		$ -
1.1.3	Borrow, moisture condition, transport, place and compact fill to internal embankment	m^3	65,000		$ -
1.1.4	Borrow, transport, place, and traffic compact fill to decant access for Decant 1	m^3	0		$ -
1.1.5	Transport and Place Decant Rockfill	m^3	0		$ -
1.1.6	Replace gravel sheeting	m^2	13,250		$ -
	ITEM 1.0 TOTAL				$ -
2.00	**DECANT AND PIPEWORK**				
2.1.1	Decant Pipe NB1.8 Class X Concrete Internal Flush Joints 24 slots	no.	0		$ -
2.1.2	Internal Riser	m	0		$ -
2.1.3	HDPE Decant Sleeves	no.	0		$ -
	ITEM 2.0 TOTAL				$ -
	COST ESTIMATE TOTAL				$ -

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	30-Jul-07
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	A
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 3 - RL1227 (227 mAHD)**		

Item	Description	Unit	Quantity	Rate	Amount
1.00	**EARTHWORKS**				
1.1.1	Remove gravel sheeting	m^2	13250		$ -
1.1.2	Prepare foundation	m^2	13250		$ -
1.1.3	Borrow, moisture condition, transport, place and compact fill to internal embankment	m^3	55000		$ -
1.1.4	Borrow, transport, place, and traffic compact fill to decant access for Decant 1	m^3	36000		$ -
1.1.5	Transport and Place Decant Rockfill	m^3	1500		$ -
1.1.6	Replace gravel sheeting	m^2	13500		$ -
	ITEM 1.0 TOTAL				$ -
2.00	**DECANT AND PIPEWORK**				
2.1.1	Decant Pipe NB1.8 Class X Concrete Internal Flush Joints 24 slots	no.	4		$ -
2.1.2	Internal Riser	m	5		$ -
2.1.3	HDPE Decant Sleeves	no.	34		$ -
	ITEM 2.0 TOTAL				$ -
	COST ESTIMATE TOTAL				$ -

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	30-Jul-07
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	A
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 4 - RL1232 (232 mAHD)**		

Item	Description	Unit	Quantity	Rate	Amount
1.00	**EARTHWORKS**				
1.1.1	Remove gravel sheeting	m^2	13500		$ -
1.1.2	Prepare foundation	m^2	13500		$ -
1.1.3	Borrow, moisture condition, transport, place and compact fill to internal embankment	m^3	65000		$ -
1.1.4	Borrow, transport, place, and traffic compact fill to decant access for Decant 1	m^3	36000		$ -
1.1.5	Transport and Place Decant Rockfill	m^3	1500		$ -
1.1.6	Replace gravel sheeting	m^2	13800		$ -
	ITEM 1.0 TOTAL				$ -
2.00	**DECANT AND PIPEWORK**				
2.1.1	Decant Pipe NB1.8 Class X Concrete Internal Flush Joints 24 slots	no.	4		$ -
2.1.2	Internal Riser	m	5		$ -
2.1.3	HDPE Decant Sleeves	no.	34		$ -
	ITEM 2.0 TOTAL				$ -
	COST ESTIMATE TOTAL				$ -

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	30-Jul-07
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	A
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 5 - RL1237 (237 mAHD)**		

Item	Description	Unit	Quantity	Rate	Amount
1.00	**EARTHWORKS**				
1.1.1	Remove gravel sheeting	m^2	13800		$ -
1.1.2	Prepare foundation	m^2	13800		$ -
1.1.3	Borrow, moisture condition, transport, place and compact fill to internal embankment	m^3	70000		$ -
1.1.4	Borrow, transport, place, and traffic compact fill to decant access for Decant 1	m^3	36000		$ -
1.1.5	Transport and Place Decant Rockfill	m^3	1500		$ -
1.1.6	Replace gravel sheeting	m^2	14000		$ -
	ITEM 1.0 TOTAL				$ -
2.00	**DECANT AND PIPEWORK**				
2.1.1	Decant Pipe NB1.8 Class X Concrete Internal Flush Joints 24 slots	no.	4		$ -
2.1.2	Internal Riser	m	5		$ -
2.1.3	HDPE Decant Sleeves	no.	34		$ -
	ITEM 2.0 TOTAL				$ -
	COST ESTIMATE TOTAL				$ -

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	30-Jul-07
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	A
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 6 - RL1240 (240 mAHD)**		

Item	Description	Unit	Quantity	Rate	Amount
1.00	**EARTHWORKS**				
1.1.1	Remove gravel sheeting	m^2	14000		$ -
1.1.2	Prepare foundation	m^2	14000		$ -
1.1.3	Borrow, moisture condition, transport, place and compact fill to internal embankment	m^3	40000		$ -
1.1.4	Borrow, transport, place, and traffic compact fill to decant access for Decant 1	m^3	19000		$ -
1.1.5	Transport and Place Decant Rockfill	m^3	1500		$ -
1.1.6	Replace gravel sheeting	m^2	14100		$ -
	ITEM 1.0 TOTAL				$ -
2.00	**DECANT AND PIPEWORK**				
2.1.1	Decant Pipe NB1.8 Class X Concrete Internal Flush Joints 24 slots	no.	2		$ -
2.1.2	Internal Riser	m	2		$ -
2.1.3	HDPE Decant Sleeves	no.	20		$ -
	ITEM 2.0 TOTAL				$ -
	COST ESTIMATE TOTAL				$ -

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	30-Jul-07
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	costing
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	A
SUBJECT	**: COSTING OF TAILINGS STORAGE CONSTRUCTION - STAGE 7 - REHABILITATION COVER**		

Item	Description	Unit	Quantity	Rate	Amount
1.00	**TSF COVER**				
1.1.1	Reshape tailings beach	m^2	410,000		$ -
1.1.2	Supply and install HDPE liner over final tailings beach	m^2	410,000		$ -
1.1.3	Regolith cover (nominally 2m thick)	m^3	820,000		$ -
	ITEM 1.0 TOTAL				$ -
	COST ESTIMATE TOTAL				$ -

Appendix C

Operations Manual

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

INTEGRATED WASTE LANDFORM, KANMANTOO PROJECT, TAILINGS STORAGE FACILITY OPERATIONS MANUAL PLANT STAFF

MH00335AA-AD OM-Staff Rev B

27 July 2007

Coffey Mining Pty Ltd ABN 52 065 481 209
1162 Hay Street West Perth WA 6005 Australia

DOCUMENT INFORMATION

Status	Draft
Version	Rev B
Print Date	27 July 2007
Approval State	DRAFT
Author(s)	Christopher Lane
Reviewed By	
Path Name	C:\Documents and Settings\chris_lane\My Documents\Coffey Projects\MH00335AA Kanmantoo Project\MH00335AA-AD OM-Staff Rev A.doc
File Name	MH00335AA-AD OM-Staff Rev B.doc
Project No	MH00335AA
Distribution	HILLGROVE COPPER PTY LTD

DOCUMENT CHANGE CONTROL

Version	Description (section(s) amended)	Author(s)	Date

DOCUMENT REVIEW AND SIGN OFF

Name	Position	Role	Signature	Date Issued

CONTENTS

ATTACHMENTS

Figures

Appendices

1 INTRODUCTION

This document presents the Operations Manual for Plant Staff for the Tailings Storage Facility (TSF) which is part of the Integrated Waste Landform (IWL) at the Kanmantoo Project. This document describes the day to day operating procedures for the TSF for which the Plant Staff will be responsible.

The provisions of the Operations Manual must be strictly adhered to by the Owner and the storage must be operated strictly in accordance with its provisions. Coffey Mining Pty Ltd (Coffey Mining) shall not be liable in any respect whatsoever for any damage to or failure in the operations of the tailings storage resulting from failure of the Owner, its servants or agents to comply with the provisions of this Operations Manual.

The Operations Manuals for the TSF are divided into 2 two separate documents, Operations Manual for Plant Management and Operations Manual for Plant Staff.

1.1 Operations Manual for Plant Staff

The Operations Manual for Plant Staff (this document), is for the use of staff who have the responsibility for the general day to day activities associated with the operation of the storage facility such as inspecting the perimeter embankments; tailings delivery and tailings distribution lines; changing the spigot discharge location points; the operation of the decant system; and inspecting the discharge from the decant system and underdrainage system at the return water storage facility.

The Operations Manual for Plant Staff (this document), sets out details of the components of the storage facility which are influenced by the general day to day activities. Each of these components are part of the overall operation of the storage facility and attention must be paid to each component to ensure the storage facility is operated to achieve the design objectives.

The components which are influenced by the general day to day activities include:

(i) Tailings deposition.

(iii) Routine inspections and maintenance.

(iv) Emergency action plan.

1.2 Operations Manual for Plant Management

The second document (Ref: MH00335AA-AC OM-Management Rev A), which is to be prepared during the detailed design phase of the Kanmantoo Project, is for the use of the process plant management who have the responsibility for:

(i) Ensuring the storage facility is operated and monitored to achieve the design objectives.

(ii) Ensuring the facility is operated in accordance with the parameters which have been provided by the clients Project Team for use in the design of the tailings storage facility.

Where changes in the parameters are proposed, the process plant management must advise the designers in order that the impact of the changes can be fully assessed.

The Operations Manual for Plant Management sets out, in broad terms, the technical details associated with the design of the storage and the technical requirements for operating the storage facility including:

(i) Tailings Storage Management

- Spigotting (tailings discharge);
- Staging of construction, embankment raising; and
- Operation of the water recovery from the return water storage to the process plant.

(ii) Objectives and requirements of the monitoring programme.

1.3 Design Objectives

The design objectives, which are set out in the Design Document (Ref: MH00335AA-AC IWL Design Rev A), dated June 2007 are summarised as follows:

(i) Allow the tailings storage to function with minimal daily input, whilst maximising water recovery.

(ii) Maintaining stability of the perimeter embankments.

(ii) Maximise storage capacity in the tailings storage facility.

2 SUMMARY OF OPERATIONAL PROCEDURES

The following is a summary of operational procedures:

(i) The tailings will be deposited subaerially (exposed to air) via discrete spigots (discharge points) into conductor pipes. On a daily basis, when the plant is operating, and as detailed in Section 3.0, the active discharge locations must be moved to ensure even development of the tailings beaches. The length of time between successive depositions (i.e. beaching and draining time) on any one area should be **maximised**.

(ii) Tailings should be discharged at the **lowest possible velocity through discrete spigot** locations. The number of spigots which can be opened will be determined through the commissioning period.

(iii) The fundamental objective is to allow the tailings to beach, and remove as much water from the tailings storage as possible, by decant combined with the operation of the underdrainage system to collect seepage through the deposited tailings mass to maximise water return to the process plant. Some water loss will occur by evaporation. The supernatant water ('bleed' from the deposited tailings) and ponding from rainfall runoff should be maintained at the smallest practical size, with the pond size maintained at no more than 10,000 m^2 to optimise water recovery. This water will be collected in the gravity decant system.

It should be noted that the phreatic surface within the perimeter embankment is the single, most important influence on the stability of the perimeter embankments. Keeping any temporary freewater pond to a minimum size will have the effect of maximising water recovery, controlling the phreatic surface within the tailings mass and hence maximising the factor of safety of the perimeter embankment against failure.

(iv) Frequent inspections (a minimum of once per production shift on a daily basis) should be made of the perimeter embankments; tailings delivery and discharge lines; discharge points; size of the supernatant pond and the position of the supernatant pond in relation to the perimeter embankment; decant and underdrainage flow to the return water storage and water level in the return water storage. If seepage is observed at the toe of the downstream embankment particular attention should be paid to the embankment in the vicinity of this seepage and advice sought from the design engineer.

Only by regular inspection and appropriate remedial action can the performance of the tailings system be optimised and operational problems be avoided.

(v) Operation, safety and environmental aspects should be periodically reviewed during an inspection by a suitably experienced and qualified engineer. This inspection should be done at least once every year.

3 COMPONENTS OF TAILINGS STORAGE OPERATIONAL PROCEDURES

3.1 Deposition of Tailings

The method of deposition of tailings into the storage is one of the major controlling factors in achieving high insitu density. The following details are provided to enable an efficient tailings disposal system to be operated:

(i) The tailings should be deposited subaerially, ideally in layers to form an inverted cone with relatively even, sloped beaches, ensuring that hollows, which might allow free water to pond against the perimeter embankment, do not develop.

The deposited tailings should be allowed to drain and desiccate (by solar drying) for a period of no more than 6 weeks before being covered with the next layer of tailings.

ii) At any one time tailings deposition into the storage area should be from discrete spigot points. At this stage only one spigot point will be opened. During commissioning it will be determined if additional spigot points can be opened.

Discharge of tailings into the storage should be in such a manner as to prevent erosion of either the embankment or the tailings beaches.

Lower velocity discharge promotes the deposition of some of the coarser fraction of the slurry adjacent to the discharge point, with finer material progressively deposited towards the edge of the cone within the storage area. Apart from minor deposition of sand at the spigot location the tailings slurry should not segregate.

Tailings discharged at a high velocity erodes previously deposited tailings by forming a channel as it flows directly to the centre of the storage.

(iii) The tailings will be discharged from the perimeter embankment and in discrete layers in a cyclic manner around the perimeter of the storage area. Construction of future embankment lifts should be undertaken such that as the tailings approach a level nominally within 300mm of the perimeter embankment crest the subsequent stage of the embankment is under construction and above the previous embankment crest level.

In order to further understand the tailings deposition requirements a detailed knowledge of the components of the tailings system is required. These components include:

- Tailings Pipework
- Spigotting Process
- Tailings Line Flushing

3.1.1 Tailings Pipework

The tailings delivery line comprises a 200NB steel pipeline with a polyethylene liner. The delivery line is split near the decant access to form the southern and northern tailings distribution lines. The distribution line comprises 225 mm OD HDPE pipe and has tee pieces and spigots located at 36 m centres on each distribution line to allow tailings discharge from the line. Slotted conductor pipes located against the perimeter embankment batter slope will allow the tailings to be discharged at the toe of the embankment.

3.1.2 Spigotting Process

General

Tailings should be deposited over the exposed beaches, at low velocity. This is best achieved by discharging the tailings sequentially through discrete spigot points. Some experimentation will be required during the commissioning operation of the plant to determine the optimum number of spigots to be opened based on the proposed tailings production rates and the slurry density. The number of spigots should be sufficient to achieve low velocity uniform discharge whilst still maintaining sufficient pressure from the tailings pipeline to ensure the spigots are discharging evenly. Tailings should not be discharged so as to erode the soil embankments. Use of the conductor pipes will minimise the potential for embankment erosion.

It is recommended that all spigot locations be individually numbered. The spigot numbering will be assigned by the commissioning team with reference to the split in the tailings distribution point and the northern and southern branches of the tailings distribution line.

Initial Tailings Deposition

At the start of tailings deposition the southern distribution line will be used predominantly until such time as the level of the tailings beach, adjacent to the perimeter embankment, reaches RL 1212 (212 mAHD) when each distribution point on the northern distribution line will be commissioned. A preliminary deposition numbering sequence is presented on Figure 1.

This means that the tailings will initially be discharged into the deepest section of the tailings storage first with the deposition points moved east and west between spigot locations 6S and 17S, then gradually the deposition will extend out to locations 26S. After each deposition run along the southern distribution line, the tailings deposition will be moved to location 7N on the northern tailings distribution line, long enough for the southern deposition line to be flushed such that tailings deposition can recommence on that line.

Once the southern section and north eastern section of the TSF have been filled to RL 1215 (215 mAHD), approximately 12 months after tailings deposition starts, the tailings deposition will be extended around the embankment perimeter with tailings deposition being alternated between the northern and southern tailings distribution lines until the tailings cover the entire surface of the TSF.

Full Perimeter Tailings Deposition

After the full number of tailings deposition points has been commissioned the spigots will be routinely changed on a 12 hour shift basis when the plant is operating and thus it will take approximately 30 days to complete one cycle of the entire TSF.

3.1.3 Tailings Line Flushing

At the completion of the sequential deposition on each distribution line, the distribution line should be flushed with water until it is clean.

Flushing proceeds in the same sequential manner as tailings spigotting, with the adjacent spigots nearest the valves opened first. As clear water flows from each spigot, the spigot is closed, the water turned off and the final spigot closed such that the tailings line is left filled with clean water.

3.2 Decant Water Recovery System

A gravity decant system has been incorporated into the TSF design and all decant water will flow to the HDPE lined return water storage, located on the southern side of the TSF, from where it will be pumped directly back to the plant for reuse as process water.

The gravity decant system comprises 2 temporary decants and 1 permanent decant. Water should enter the decants, after the TSF is commissioned, as follows:

(i) Decant 1 (temporary) within 1 month of the commencement of tailings deposition.

(ii) Decant 2 (temporary) within 9 months of the commencement of tailings deposition.

(iii) Decant 3 within 18 months of the commencement of tailings deposition.

When water enters Decant 2, Decant 1 will be shut down and decommissioned, similarly when water enters Decant 3, Decant 2 will be shut down and decommissioned. Decommissioning involves closing the valve at the downstream end of the pipe, at the return water storage, and sealing the upstream section of the decant. Airlocks are to be fitted to all decant pipes at the completion of the project.

The only routine maintenance requirements for the decant system are the addition of the collars over the internal riser as the tailings level rises. Earthworks construction on Decant 3 and the associated access will require the addition of decant pipes and the raising of the rock fill around this decant as the perimeter embankments are raised. Decants 1 and 2 are constructed to their final height and will not be raised.

The location of any supernatant pond which develops will be controlled by the tailings discharge sequence employed. The process of tailings deposition is aimed at ensuring that any temporary pond which develops within the TSF is captured by the decant.

Under normal operations the water pond should never be allowed to build up on the storage such that the pond extends a size of approximately 10,000 m^2. Temporary water build up from extreme storm events should be removed as quickly as possible. Ten (10) days has been allowed for the removal of the design storm which equates to approximately 5,800 m^3/day. In the event that a water build up on the storage is noted the Services Foreman is to be immediately notified.

The size of any supernatant pond which develops will be largely governed by the following controlling factors:

- the efficiency of the decant pumps and pipework;
- evaporation from the surface of the pond;
- input of tailings water (percent solids);
- rainfall;
- difference in permeability between the tailings and the underlying soil types; and
- the ratio of horizontal to vertical permeability of the tailings.

3.3 Underdrainage Water Recovery System

All water recovered from the underdrainage system will flow directly to the return water storage from where it will be pumped to the plant site for reuse as process water.

Daily inspections of the underdrainage outfall pipes are required to ensure flow is clean and is discharging to the return water pond. There are no maintenance requirements for the underdrainage system other than routine maintenance to the pump which returns the water to the plant. Airlocks are to be fitted to all underdrainage pipes at the return water storage at the completion of the project.

In the event that a water build up on the return water storage is noted the Services Foreman is to be immediately notified. The volume of flow from the underdrainage will be largely governed by the following controlling factors:

- evaporation from the surface of the TSF and supernatant pond;
- input of tailings water (percent solids);
- rainfall;
- difference in permeability between the tailings and the underlying soil types; and
- the ratio of horizontal to vertical permeability of the tailings.

3.4 Routine Inspections and Maintenance

The following routine inspection and maintenance procedures are to be carried out for the various components of the system.

Pro formas are presented in Appendix A of the *Operating Manual for Process Plant Management*.

During each production shift the following inspection activities are to be undertaken by an operator or shift supervisor.

A log book is to be signed by the person allocated to undertake the inspection on that shift to ensure the requirements have been undertaken. Inspection forms are to be filled out on a daily basis.

The inspection covers:

- tailings pipelines to the TSF and around the perimeter embankment;
- the decant system
- decant and underdrainage outfall pipes;
- water return lines from the decant and underdrainage return water pond;
- pumps;
- spigots and valves;
- location and size of the supernatant water pond;
- crest of the perimeter embankment to check the general integrity of the embankment, i.e. any cracking; and
- downstream toe of the waste dump to check the general integrity of the embankment, i.e. any cracking or seepage.

3.4.1 Tailings, Water return and Underdrainage Lines

The tailings, water return and underdrainage pipelines are to be inspected a minimum of once per shift, preferably twice. The record of each inspection is to be entered into the log book.

All tailings delivery lines and water lines from the water return storage must be bunded. The HDPE tailings distribution lines on the embankment crests, water return lines and underdrainage lines, are sensitive to temperature and the expansion and contraction of these lines can cause leaks and, in extreme situations, failure of the pipeline. Any leaks or failures of the tailings, water return and underdrainage pipelines should be immediately reported to the following personnel or project equivalents.

- *Metallurgy Manager*
- *Mill Foreman*
- *Metallurgical Person on Call*

3.4.2 Decant System

The position and size of the pond, in relation to the decant, should be inspected at the same time as the tailings and water return pipelines are inspected. Any abnormalities should be reported immediately to the following personnel or project equivalents:

- *Metallurgy Manager*
- *Mill Foreman*
- *Metallurgical Person on Call*

3.5 Embankments

Part of the general activities of the *Shift Supervisor,* when visiting the storage facilities, shall be to inspect the embankments, including embankment crest, any berms downstream slopes and toe areas.

The inspection shall note any cracking or other features, such as seepage, embankment erosion or scour (caused by tailings deposition or rainfall runoff) or any other obvious changes or problems. Any problems must be reported to the metallurgical manager.

4 EMERGENCY ACTION PLAN

4.1 Response Actions

To enable the emergency action plan to be implemented and to allow a safe and timely response to be instigated the *Metallurgy Manager* shall be responsible for assembly points and contact names. Contractors shall also be made familiar with the location of the assembly point and be made aware of their reporting responsibilities and to whom they shall report to.

Relevant contact details of staff associated with the tailings storage, senior site responsible staff, safety officers and emergency services should be kept.

All personnel who are associated with the facilities are also required to sign a form as evidence that they have been inducted and are aware of assembly points and reporting procedures.

4.2 Tailings Lines and Return Water Lines

The tailings lines from the process plant to the tailings storage and the return water lines from the return water storage are to be bunded to contain any spillage of materials resulting from lines which develop leaks or burst during operation.

In the event of pipeline failure the *Shift Supervisor* is to be notified and the affected pipeline is to be shut down until repaired and the spilled materials collected and/or pumped, as appropriate, and deposited in the tailings storage.

4.3 Tailings Storage

The embankments of the tailings storage facilities has been designed with an adequate factor of safety against failure under normal operating conditions and under seismic load conditions appropriate for the location of the storage. Normal operating conditions refer to a relatively small water pond with no free water ponding against the perimeter embankments with a resultant low phreatic surface within the embankment.

Given the adoption of the tailings deposition philosophy, good decant operation, routine inspections and maintenance practices set out in the Operations Manual and that the embankment construction has been or should be carried out in accordance with the design the probability of embankment failure during normal operations is very low.

However, in the unlikely event of embankment failure, the flow of tailings from the storage will be controlled by the degree of saturation of the tailings at the time of failure.

Action to control a **small** scale embankment failure and to limit environmental damage would include:

(i) Assess the requirement to shut down of the process plant, or reduce process plant throughput.

(ii) Diversion of tailings deposition to areas not affected by the small scale embankment failure.

(iii) Construction of bunds by earthmoving equipment to divert and contain the tailings.

(iv) Contact a suitably qualified geotechnical organisation for technical assistance.

(v) Deployment of pumps to recover tailings water and return it either to the storage if structurally sound or to the return water pond.

(vi) Prior to the commencement of any repairs undertake a thorough inspection of the area with or without a specialist dependent on the scale of the failure.

(vii) Undertake remedial and repair work of the damaged embankment or affected area.

(viii) Clean up of tailings as soon as practical after embankment repairs have been completed and the storage is considered to be in a safe condition.

(ix) Prepare an incident report, detailing all factors prior to the incident and the situation after cleanup. The report should identify causes of the problem and what actions will be taken to prevent a similar occurrence. This report should detail the ongoing monitoring programme to fully assess the impact of the incident.

(x) Advise all appropriate government departments as necessary of the incident, review conditions of licence in respect to the timing and reporting criteria.

Action to control **large** scale embankment failure and to limit environmental damage would include:

(i) Assess the requirement to shut down of the process plant or reduce throughput.

(ii) Construction of bunds by earthmoving equipment to divert and contain the tailings.

(iii) Contact a suitably qualified geotechnical organisation for technical assistance.

(iv) Advise the relevant government departments.

(v) Deployment of pumps to recover tailings water and return it either to the storages if structurally sound or to the return water pond.

(vi) Prior to the commencement of any repairs undertake a thorough inspection of the area with the assistance of a geotechnical specialist.

(vii) Repair the damaged embankment.

(viii) Clean up of tailings as soon as practical after the embankment repairs have been completed.

(ix) Prepare an incident report, detailing all factors prior to the incident and the situation after cleanup. The report should identify causes of the problem and what actions will be taken to prevent a similar occurrence. This report should detail the ongoing monitoring programme to fully assess the impact of the incident.

(x) Advise all appropriate government departments as necessary of the incident, review conditions of licence in respect to the timing and reporting criteria.

It must be stressed however, that the safe operation of the tailings storage facility relies upon the implementation of operational procedures which include tailings deposition, decant operation and routine inspections and maintenance, as set out in the Operations Manual to minimise the potential for a catastrophic event such as a failed embankment.

5 INCIDENT REPORTING

The undertaking of regular inspections and monitoring is aimed at identifying any problems prior to them causing a major impact on the operation or integrity of the storage facility. The inspections may result in the identification of an event that may require reporting to senior staff and in some cases to relevant government departments.

In addition to incidents that require reporting under various legislative requirements the following events or occurrences also need to be reported within 7 days or sooner following identification of an incident/problem or likely incident/problem. PIRSA (Primary Industries and Resources South Australia) conditions of licence should also be reviewed in respect to the timing and detail required for incident reports.

Typical reporting events include:

(i) Any fauna death on or near the IWL (not road kill).

(ii) Any uncontrolled release of tailings slurry or return water and the cause (pipe break, overtopping, pump malfunction, automatic switch malfunction, operator error).

(iii) Embankment cracking and or slumping.

(iv) Impact from seepage (vegetation distress, soil contamination, water quality changes).

(v) Defects to the tailings storage facility covering such things as the decant facilities.

(v) Changes in water quality that exceed prescribed conditions of licence criteria.

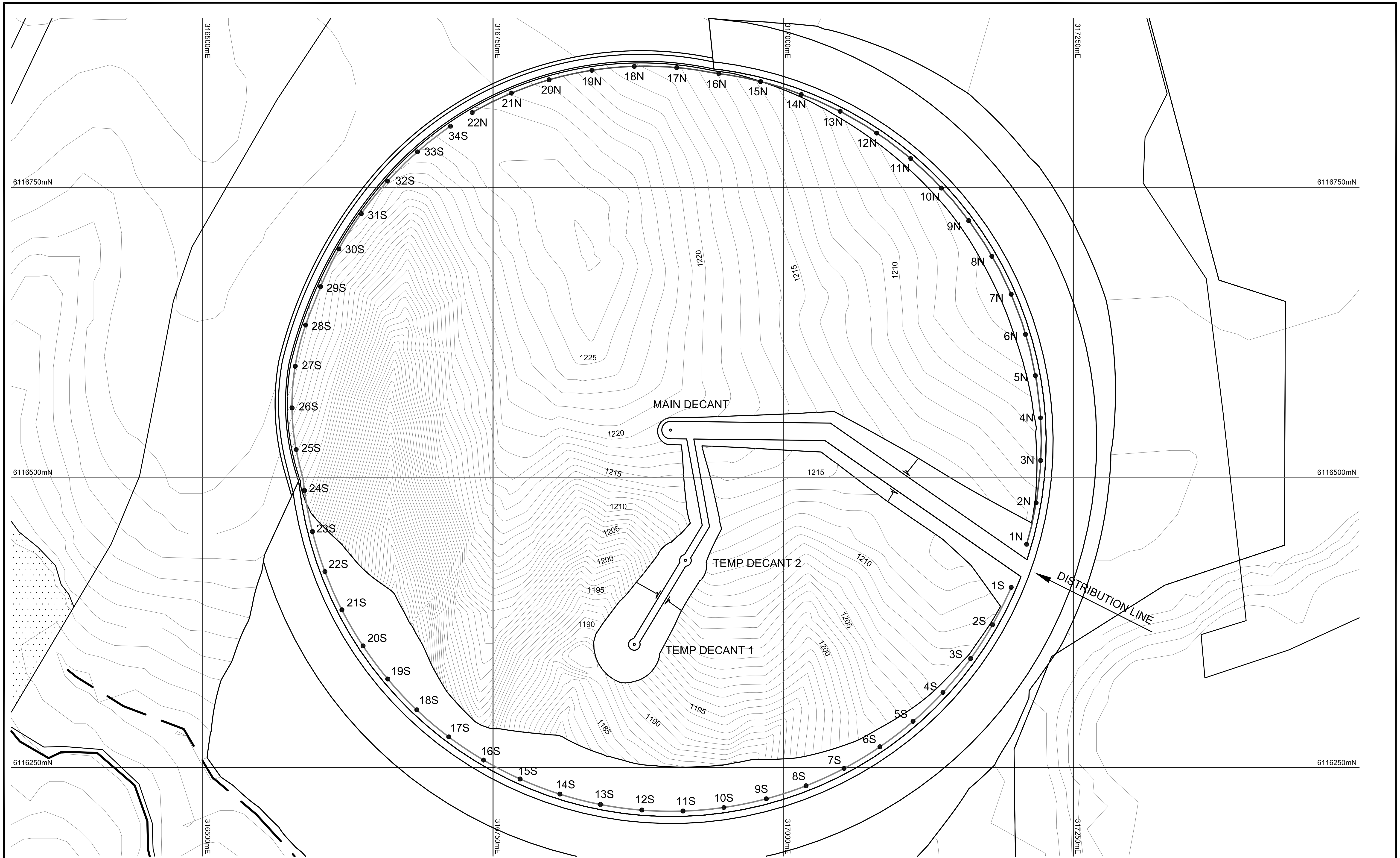
(vi) Increases in production tonnages.

It is recommended that prior to submitting an incident report, that an initial assessment be undertaken to confirm the nature, type and impact of the incident by either senior site staff or an independent organisation. If an incident requires reporting to the regulatory authorities standard incident forms as well as any other reporting requirements should be used.

* * * * *

Figures

Spigot Numbering



coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE					
Drawn	PP	**INTEGRATED WASTE LANDFORM KANMANTOO PROJECT**	Original Size	A3
Approved	CL	**OPERATIONS MANUAL**	Project no:	MH00335AA
Date	30/07/07			
Scale	1:3000	**SPIGOT NUMBERING**	Figure	**1**

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-OM-FIG1.dwg

Appendix A

Inspection Proformas

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	30-Jul-07
CLIENT	**: HILLGROVE COPPER PTY LTD**	Job No	MH00335AA
		File	
		Subject	
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	0
SUBJECT	**: DAILY INSPECTION LOG SHEET**	**PF1**	sheet 1 of 1

Date: **Shift Supervisor:**	**Time:** **Inspection by:**	**Nominate Active TSF** **(North TSF or South TSF)**

Item	Criteria	Operating/Defective Yes/No		Comments
		Night Shift	Day Shift	
Roadways	Condition			
Downstream areas	Any seepage/wet areas			
	Any spillages			
Return water	Pumps operating			
	Pipeline Integrity			
Seepage	Any new seepage. If so, where?			
	Existing seepage any change in flow or water quality			
Decant structure	Integrity			
	Water clarity			
Freeboard	Pond position			
	Depth (estimate)			
	Operational freeboard (at wall)			
Tailings discharge	Location? Spigots operating?			
	Pipeline Integrity			
Embankments	Any distress? Any cracking?			
Fauna	Any deaths			
Flora	Any new distress			
Monitoring	Damage to instruments			

NOTES :
Please provide any comments or notes relating to the tailings storage facility especially relating to new occurrences

Last Updated : 30/07/2007 ref : 0

PROJECT	**: INTEGRATED WASTE LANDFORM, KANAMATOO COPPER PROJECT**	Date	30-Jul-07
		Job No	MH00335AA
CLIENT	**: HILLGROVE COPPER PTY LTD**	File	
		Subject	
LOCATION	**: KANMANTOO, SOUTH AUSTRALIA**	Revision	1
SUBJECT	**: MONTHLY INSPECTION LOG AND MONITORING SHEET- PROCESS PLANT MANAGEMENT**	**PF 2**	sheet 1 of 1

Date: **Shift Supervisor:**	**Time:** **Inspection by:**	**Cell No.**

Item	Description of Inspection Activity	Comments	Remedial Works Start	Remedial Works Finish
1.0	**Embankments**			
	Is cracking present on the crest of the embankment? If yes, is it new cracking or an existing cracking. If existing, has it got larger?			
	Is staining or discoloration present on any of the downstream batter slopes of the embankments?			
	Is water ponding at the downstream toe of any of the embankments?			
	Is there water flow from the downstream toe of any of the embankments?			
	Is the freeboard in excess of the designated level? (Based on DoIR criteria that is 675mm)			
	Have the water levels in the monitoring bores been measured and data entered to the appropriate sheet?			
2.0	**Spigotting**			
	Is the distribution of the tailings on the beaches as required by the operations manual?			
3.0	**Decant System**			
	Is the supernatant water positioned around the decant facility?			
	Is the supernatant surface (within the storage) as planned, or is there excess water on the storage?			
	Can the decant system handle storm runoff in addition to the reclaim water efficiently?			
4.0	**Process Plant Information**			
	Ore processed for the month (tonnes)			
	Average tailings slurry density, measured in percentage solids			
	Water return from the tailings storage to the process water pond (in tonnes and m3)			
5.0	**Water Balance**			
	Has the data in 4.0 above been entered into the water balance?			
6.0	**Water Quality Data**			
	Has the water quality data from the monitoring bores adjacent to the TSFs been checked and data entered into the			
	Have water quality measurments for known seepage areas been taken and recorded at the required frequency?			
7.0	**Climatic Data**			
	Has the rainfall been entered daily and the monthly total be given to the Metallurgical Department?			
8.0	**Other Aspects**			
	Comments			

Appendix D

Geotechnical Investigations Reports

FACTUAL REPORT OF MATERIAL SEARCH FOR PROPOSED TAILINGS STORAGE FACILITY

Justin Burke

Kanmantoo, Callington SA

MINEHERD00335AA_RE01_V01

23 July 2007

Coffey Mining Pty Ltd ABN 52 065 481 209
14B Henley Beach Road Mile End SA 5031 Australia

23 July 2007

HILLGROVE COPPER PTY LTD
Level 41, 264-278 George Street,
Sydney, NSW 2000

Attention: Mr. Marty Adams

Project Manager

Dear Sir

RE: FACTUAL REPORT OF MATERIAL SEARCH FOR PROPOSED TAILINGS STORAGE FACILITY

This letter presents the factual report of material search for a proposed Tailings Storage Facility for the Kanmantoo Copper Project at Callington, SA.

If you have any questions related to the report or we can be of further assistance, please do not hesitate to contact Mr Justin Burke in our Adelaide office (08 8352 1744).

For and on behalf of Coffey Mining Pty Ltd

Justin Burke

Justin Burke

Geotechnical Engineer

DOCUMENT INFORMATION

Status	Draft
Version	v01
Print Date	23 July 2007
Approval State	
Author(s)	Justin Burke
Reviewed By	Chris Lane
Path Name	F:\MINING\mineHERD\00335AA Ktoo TSF\REPORTS\MINEHERD00335AA_RE01_V01_Material Search Factual.doc
File Name	MINEHERD00335AA_RE01_V01_Material Search Factual
Project No	MINEHERD00335AA_RE01_V01
Distribution	3 copies HILLGROVE COPPER PTY LTD 1 copy Coffey Mining Pty Ltd Library Original Coffey Mining Pty Ltd 1 electronic PDF copy HILLGROVE COPPER PTY LTD on CD

DOCUMENT CHANGE CONTROL

Version	Description (section(s) amended)	Author(s)	Date

DOCUMENT REVIEW AND SIGN OFF

Name	Position	Role	Signature	Date Issued
Justin Burke	Geotechnical Engineer	Author		23 July 2007
Chris Lane	Senior Principal Engineer	Reviewer		

CONTENTS

Figures

Appendices

1 INTRODUCTION

A geotechnical investigation has been undertaken by Coffey Mining Pty Ltd (Coffey) for a proposed Tailings Storage Facility (TSF) for the Kanmantoo Copper Project at Callington, SA.

The aim of the investigation is to provide information on the subsurface conditions in selected places across the site, identifying materials suitable for use in lining for the proposed TSF.

The investigation was commissioned by Hillgrove Copper Pty Ltd. The scope of work undertaken was broadly consistent with that outlined in a proposal prepared by Coffey dated 27 January 2007 (reference: MINEHERD00335AA-AA-P).

This factual report describes:

- the geotechnical investigation undertaken,
- summarises the subsurface conditions encountered,
- the results of the testing undertaken, and
- estimates the volumes of suitable materials.

2 OUTLINE OF THE INVESTIGATION

2.1 Field Investigation

The field investigation was carried out between 27 February and 10 March 2007 and comprised:

- excavating 40 test pits (denoted A1 to A10, B1 to B15, C1 to C10 and D1 to D5) to depths ranging between about 0.4 m and 3.2 m below the existing ground surface in the area of the ore body footprint;
- excavating 38 test pits (denoted P1 to P38) to depths ranging between about 0.6 m and 2 m below the existing ground surface in the area of the proposed process plant footprint;
- excavating 14 test pits (denoted R1 to R14) to depths ranging between about 1.1 m and 3.9 m below the existing ground surface in the area of the proposed ROM Pad; and
- excavating 111 test pits (denoted T1 to T108, T2/3, T10/11, T35/43) to depths ranging between about 0.3 m and 2.6 m below the existing ground surface at selected locations across the proposed mine site.

The test pits were excavated using a Komatsu PC200 20 tonne excavator fitted with a 0.6m wide toothed bucket.

Refusal was met in the majority of the test pits.

The test pit locations were selected by Coffey Mining in order to provide a broad coverage of the site at locations where earthworks are proposed. The test pit locations are shown approximately in Figure 1.

The field investigation was undertaken in the presence of a Senior Technical Officer from Coffey who was responsible for logging the soil profile encountered and recovering samples for subsequent laboratory testing.

The soil profile encountered in the test pits is summarised in Section 3.2 and the summary excavation logs in Appendix A.

2.2 Laboratory Testing

Laboratory testing was undertaken on selected samples recovered from the field investigation in Coffey Geotechnics Pty Ltd NATA registered Adelaide laboratory and comprised:

- Atterberg limits (18 tests);
- particle size distribution (18 tests);
- Standard compaction (15 tests)
- permeability (18 tests).

The permeability testing was undertaken on samples remoulded at optimum moisture content to a target dry density ratio of 98% relative to Standard compaction (AS1289 5.1.1). Selected samples were also blended with either 5%, 10% or 15% bentonite prior to compaction.

The results of laboratory testing are summarised in Section 4 and presented on the laboratory test results sheets in Appendix B.

3 SITE CONDITIONS

3.1 Surface Conditions

The site consists of number of terrains including;

- Existing mine infrastructure and remanent areas such as the existing open pit waste rock dump and tailings storage facility. Non of these areas were considered suitable for matrail and not investigated.
- Generally the site was undulating with some steeper gullies and rocky outcrops.
- Suitable materials were generally found on the undulating areas,
- steep or rocky outcrop areas were investigated on a limited basis due to limited excavatable material cover

Generally the site was cleared of trees in the area investigated, with a lightly wooded area in the north west of the site.

The area around the homestead at the western base of the waste rock dump was investigated on a limited basis due to limited access.

3.2 Subsurface Conditions

Field descriptions of the main geological units encountered in the test pits have been summarised in Table 1. The field descriptions were based on a visual assessment of the excavated material, combined with remoulding the material under finger pressure using water.

The depth range of the geological units in each test pit is summarised in the summary excavation logs in Appendix A.

Table 1: Generalised Description of Main Geological Units Encountered

Unit Soil Descriptions	Description Summary Logs
Surface soils generally have root zones, and are slightly cemented. Described as Silty SAND (SM), fine to medium grained, grey or grey brown, dry and slightly cemented.	Unit 1A
Described as Sandy CLAY, low to medium plasticity, brown, sand fine to medium grained, dry / moist.	Unit 1B
Residual Soil, primarily extremely weathered Rock. Described as Silty or Sandy CLAY/CLAY generally medium to high plasticity, red brown, sand fine to medium grained, dry / moist.	Unit 1C
Distinct rock texture and structure. Described as mix of Gravelly Clayey SAND fine to medium grained, orange, some brown, gravel fine to coarse grained, fines of low plasticity, moist, gravel fragments highly weathered rock or Sandy GRAVEL, fine to coarse grained, brown with some silty fines. Generalised description extremely to highly weathered rock. Excavator can easily progress excavation. Vertical side walls generally stable.	Unit 2A
Schist, highly to moderately weathered brown and light grey, generally accepted as excavator refusal.	Unit 2B

Very high excavation resistance (and hence slow production rate) was generally encountered in the weathered schist, with the majority of the test pits meeting refusal. At the depth of refusal rock strength materials were encountered.

No groundwater was observed over the depth range of the investigation. Seasonal variations in groundwater must be anticipated.

4 RESULTS OF LABORATORY TESTING

Atterberg limits and particle size distribution testing was undertaken on selected disturbed samples recovered from the field investigation. The results of laboratory testing are summarised in Table 2 and presented on the test results sheets in Appendix B.

It should be noted that the laboratory test procedures involve mechanically breaking down the recovered samples and hence the results are not necessarily reflective of the in situ properties of the material.

Table 2: Summary of Atterberg Limits and Particle Size Distribution Test Results

Test Pit	Depth Range (m)	Atterberg Limits			Particle Size Distribution			Clay liner Type*	Unit#
		W_L (%)	I_P (%)	LS (%)	>2.36 mm (%)	Sand (%)	<75 µm (%)		
A9	1.0 to 1.5	27	9	4.0	5	47	48	B	2A
A9	2.0 to 2.5	29	12	4.0	5	48	47	B	2A
B6	0.1 to 0.4	51	32	14	26	16	58	A	1C
D4	0.2 to 0.7	37	23	10	16	38	46	A	1C
R10	1.0 to 1.5	29	17	6.0	8	45	47	B	1C
R13	0.5 to 1.0	20	2	0.5	7	60	33	N/S	1C
R14	0.5 to 1.0	30	16	5.5	14	48	38	B	2A
R14	1.0 to 1.5	28	12	4.0	23	46	31	B	2A
T2	0.5 to 1.0	36	24	11	10	48	42	A	2A
T11	0.2 to 0.5	35	20	10	6	43	51	A	1C
T30	0.2 to 0.5	62	45	15	2	25	73	A	1C
T30	0.5 to 1.0	49	34	11.5	3	44	53	A	2A
T30	1.0 to 1.4	33	8	4	9	56	35	B	2A
T35	1.3 to 1.7	62	44	15	2	27	71	A	1C
T55	0.1 to 0.4	47	28	9.5	25	37	38	A	1C
T55	0.4 to 0.9	55	41	13.5	5	25	70	A	2A
T79	0.6 to 1.0	41	27	12	16	33	51	A	1C
T89	0.1 to 0.5	36	20	10	9	35	56	A	1C
T35/43	0.1 to 0.5	46	29	12	2	27	71	A	1C

Note: W_L: Liquid Limit; I_P: Plasticity Index LS: Linear Shrinkage; NO: Not Obtainable; NP: Non Plastic.

* Classified according to Coffey report MINEHERD00335AA-AE Scope of works Rev A; N/S: Not suitable; # Unit defined in Table 1 above

Table 3: Summary of Standard Compaction and Permeability Testing

Test Pit	Unit*	Depth Range (m)	USC	k_{sat} (m/s)	Bentonite (%)
A9	2A	1.0 to 1.5	SC	2.0×10^{-8}	0
A9	2A	2.0 to 2.5	SC	2.8×10^{-9}	5
R13	1C	0.5 to 1.0	SM	2.5×10^{-8}	0
R14	2A	0.5 to 1.0	CL	2.1×10^{-9}	0
R14	2A	0.5 to 1.0	CL	6.6×10^{-10}	5
R14	2A	1.0 to 1.5	SC	1.5×10^{-10}	5
T35/43	1C	0.1 to 0.5	CL	2.5×10^{-9}	0
T30	2A	1.0 to 1.4	SC	2.1×10^{-8}	0
T30	2A	1.0 to 1.4	SC	1.5×10^{-10}	15
T30	2A	0.5 to 1.0	CL	1.7×10^{-10}	10
T55	1C	0.1 to 0.4	SC	4.2×10^{-9}	0
T55	2A	0.4 to 0.9	CH	9.8×10^{-10}	5
T55	2A	0.4 to 0.9	CH	3.1×10^{-11}	15

Where USC = Unified Soil Classification; OMC = Optimum Moisture Content;

MDD = Maximum Dry Density; k_{sat} = Coefficient of Permeability.

Notes: * Unit defined in Table 1 above

5 EARTHWORKS

The following section outlines the specification for the use of materials on site. The specifications are taken from Coffey Mining report MINEHERD00335AA-AE Scope of Works Rev A.

5.1 Construction Materials - Liners

The Contractor shall, as appropriate:

- Construct the clay liners to the tailings storage floor and embankments using selected approved clay materials sourced from the designated areas, as detailed on Figure 1.
- Use only materials complying with the following requirements in the areas designated for Type A Clay Fill:
  - The materials shall have 100% by weight passing 19 mm.
  - The materials shall have a minimum of 40% by weight passing 0.075 mm.
  - The material shall be free of organic or any other deleterious inclusions.
  - The material shall have a liquid limit of not less than 30%; and
  - The material shall have a plasticity index of more than 20%.
- Use only materials complying with the following requirements in the areas designated for Type B Clay Fill:
  - The materials shall have 100% by weight passing 19 mm.
  - The materials shall have a minimum of 30% by weight passing 0.075 mm.
  - The material shall be free of organic or any other deleterious inclusions.
  - The material shall have a liquid limit of not less than 20%; and
  - The material shall have a plasticity index of more than 8%.
- Ensure all materials shall be stockpiled, transported and placed in such a manner as to minimise segregation.
- Adjust the moisture content of the borrow material, approved for use in the perimeter embankment construction. Moisture condition the borrow to within the range of -2%, +2% of the optimum moisture content as determined from laboratory test 5.1.1 of AS1289 (1993). The borrow materials shall be cured to ensure the moisture is thoroughly mixed and evenly spread through all materials proposed for embankment construction.
- Place all fill material comprising the perimeter embankment in homogeneous horizontal layers not exceeding 300 mm loose lift thickness. Each layer shall be compacted to achieve a minimum density ratio of not less than 98% of the maximum dry density - standard compaction as determined from laboratory test AS 1289.5.1.1. Placement should be continuous. If a break in fill placement allows the exposed surface to dry, it should be lightly tyned, watered and compacted prior to fill placement recommencing.
- The surface of the compacted clay liner shall be graded to the design slope
- Carry out testing to comply with the Specification and QA/QC procedures.
- Allow for keeping water from the works during construction.
- Allow for maintaining the borrow areas free of large accumulations of water.
- Construct any internal access road(s) over the compacted clay liner using construction techniques and materials, approved by Principal, so as not to damage the compacted clay liner.

6 ESTIMATED VOLUMES

Based on the material classification, test pit locations and test pit logs volumes for Clay liner Type A and B have been estimated. Figure 1 illustrates the approximate locations of the borrow areas.

Generally the test results indicate that Clay liner Type A can be associate with Unit 1C and Clay liner Type B is generally associated with Unit 2A.

The volume of Clay liner Type A is calculated from the base of Unit 1C and Volume of Clay liner Type B is calculated from the base of Unit 2A. Both calculations include all material to the surface minus the top 0.1m which is assumed to be top soil containing organic material.

Table 4 below summarises the borrow area volumes; Appendix C is the estimated material volumes.

Table 4 Summary of Borrow Area Volumes

	Approximate Material Volume (m^3)	
Borrow Area	Type A	Type B
Area 1	212,158	786,234
Area 2	0	252,875
ROM	61,313	77,143
Plant Site	30,022	61,551
Access Road	172,000	172,000
TOTAL	475,493	1,349,803

7 FURTHER WORKS

The detailed design stage will require further investigation to define the locations of suitable construction materials (including controlled fill material). The detailed investigation would also be used (where possible) to increase the available borrow areas for Type A and B materials and materials for site rehabilitation.

The investigation should progress according to the following scope of works:-

- Fieldwork would require test pits on 50m by 50m grid across the site (including newly acquired areas)
- Classification of the material with laboratory analysis for particle size distribution (PSD), Atterberg Limits, maximum dry density (standard compaction) and permeability testing.
- Reporting and detailing the location of the materials.

Laboratory analysis is prescribed at the following rate

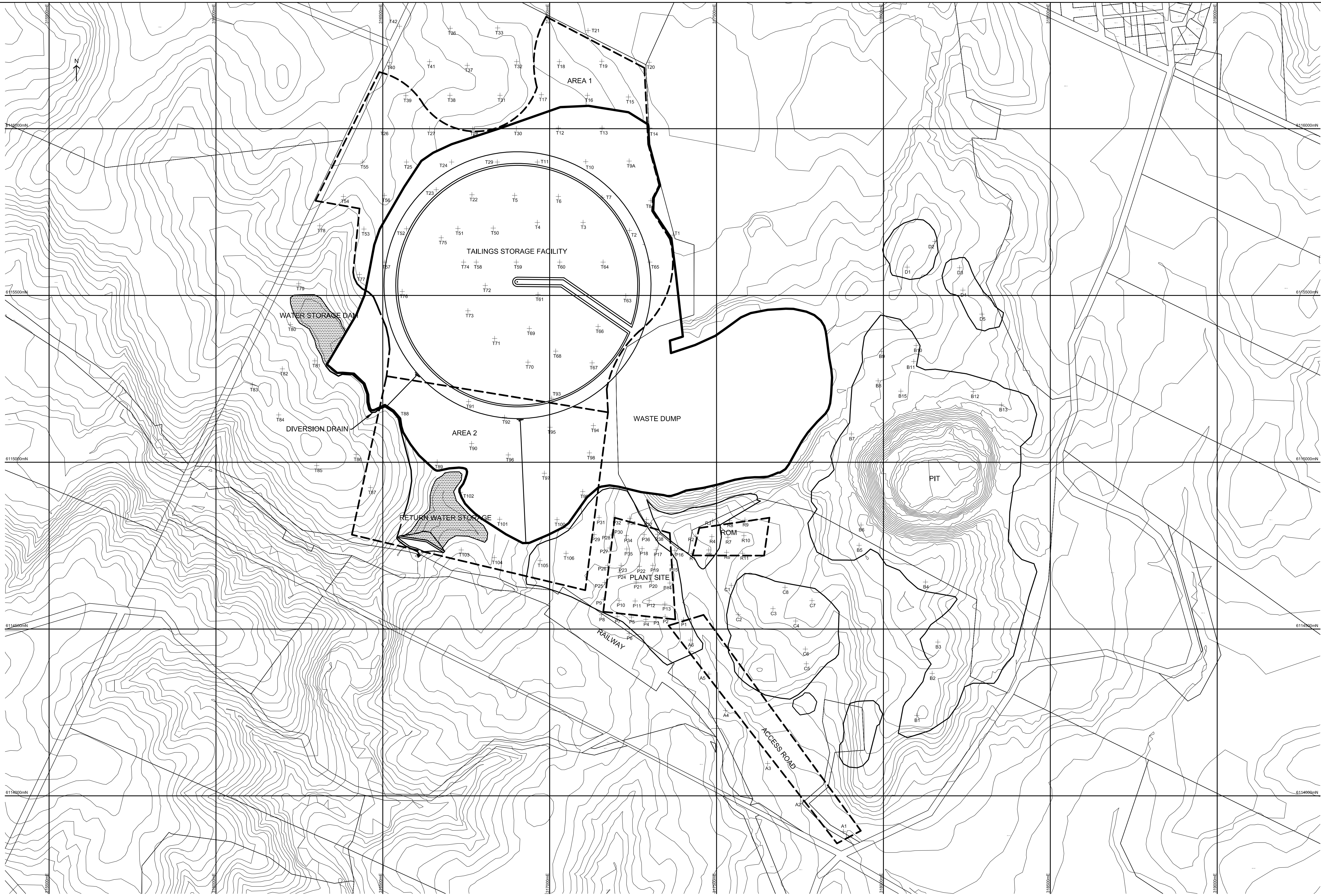
- PSD and Atterberg Limits – one test per two test pits,
- Maximum dry density and permeability testing – one per fifteen test pits

Based on the current site Coffey estimate approximately 25 days field work to conduct a suitable material search and classification with approximately 18 test pits per day an approximate costing is attached in Appendix D (totalling 450 test pits).

8 LIMITATIONS

The findings contained within this report are the result of limited investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

For and on behalf of
Coffey Mining Pty Ltd



LEGEND:

+ DENOTES APPROXIMATE LOCATION OF TEST PIT.

– – – DENOTES APPROXIMATE BOUNDARY OF BORROW AREA.

Rev No	Revision Note	Date	Approved
A	ISSUED FOR CLIENT REVIEW	13/06/07	CL

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	PP
Approved	CL
Date	13/06/07
Scale	1:2000

HILLGROVE COPPER PTY LTD COMPANY
KANMANTOO TAILINGS STORAGE FACILITY

BORROW AREA AND TEST PIT LOCATION

Original Size	A1
Project no:	MH00335AA
Drawing	FIGURE_1

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\17-05-07\MH00335AA-13-FIGURE1.dwg

Appendix A

Summary Excavation Logs

Client:	**Hillgrove Copper Pty Ltd**	**Job No.:**	**MINEHERD00335.AA**
Project:	**TSF Material Search**	**Date:**	
Location:	**Kanmantoo**	**Sheet**	**1 of 23**

SUMMARY EXCAVATION LOGS - EXCAVATOR

			A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
Location / ID	**TP No.**		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
	Co-ords	E	317880	317759	317653	317527	317477	317422				
		N	6113893	6113984	6114097	6114256	6114365	6114467				
Geological Units	**Unit**	1A	0.4	0.3	0.25	0.2	0.2	0.2		0.15	0.15	0.11
		1B	2.2	2	2.8	0.75	1.7					
		1C	3	2.8	2.9	1.4	3	0.5		0.6	0.3	0.7
	Unit	2A			3		3.2	1.9		0.75-1.1	2.5	1.8
		2B				1.5R		2.0R		1.3 R		2
	Unit											
Additional Info	**Water**											
	Photograph											
	Comments									light brown	light brown	light brown/orange
										roots to 0.15		

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	2 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

			B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Location / ID	TP No.		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
	Co-ords	E	318100	318146	318163	318126	317927	317933	317904	317984	317994	318098
		N	6114241	6114367	6114461	6114641	6114751	6114812	6115085	6115244	3115332	6115350
Geological Units	Unit	1A	0.1	0.1	0.1	0.05	0.05	0.05	0.05	0.05	0.1	0.05
		1B										
		1C	0.4	0.6	0.45	0.4	0.35	0.4	0.3	0.4	1.2	0.6
	Unit	2A		1.2	1.3	1	0.9	1.2	1.5	0.9	2.4	1.3
		2B	0.7R	1.4R	1.5R	1.15R	1.05R	1.4R	1.7R	1.1R	2.8VR	1.4R
	Unit											
Additional Info	Water											
	Photograph											
	Comments		cap rock 0.4-0.6		D0.7-1.0	surface cobbles / boulders		D0.1-0.4	cobbles and boulders	surface rocks	B 0.8-1.2, possible source	B 0.1-0.6

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd		Job No.:	MINEHERD00335.AA
Project:	TSF Material Search		Date:	
Location:	Kanmantoo		Sheet	3 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	TP No.		B11	B12	B13	B14	B15
	Co-ords	E	318091	318269	318354	318053	318052
		N	6115302	6115212	6115172	6115423	6115213
Geological Units	Unit	1A	0.1	0.05	<0.05	0.05	
		1B					
		1C	0.8	0.3	0.55	0.15	CL/CH 0.35
	Unit	2A	1.2VR		1.45R	0.6	cobbles 0.9
		2B		0.4R		0.65R	1
	Unit						
Additional Info	Water						
	Photograph					66	
	Comments		roots to 0.3m	surface boulder, rocks	D 1.2-1.4		surface boulders

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	**Hillgrove Copper Pty Ltd**	**Job No.:**	**MINEHERD00335.AA**
Project:	**TSF Material Search**	**Date:**	
Location:	**Kanmantoo**	**Sheet**	**4 of 23**

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		C1	C2	C3	C4	C5	C6	C7	C8	
	Co-ords	E	317544	317565	317669	317737	371769	317766	317786	317705	
		N	6114631	6114543	6114561	6114524	6114396	6114440	6114585	6114625	
Geological Units	**Unit**	1A	0.3	0.1	0.056	0.05	0.1	0.1	0.05	0.05	
		1B									
		1C		0.4	0.5	0.15	0.5	0.45	0.25	0.5	
	Unit	2A		0.8	0.7	0.6	0.9	0.85	0.8	0.6	
		2B	0.4R	1.0R	0.75R	0.65R	1.0R	0.9R	0.9R	0.6R	
	Unit										
Additional Info	**Water**										
	Photograph					28	27				
	Comments		outcrops	surface rocks		outcrops		outcrops		surface rocks	

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:		**Hillgrove Copper Pty Ltd**						**Job No.:**	**MINEHERD00335.AA**		
Project:		**TSF Material Search**						**Date:**			
Location:		**Kanmantoo**						**Sheet**	5	**of 23**	

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		D1	D2	D3	D4	D5					
	Co-ords	E	318071	318154	318228	318238	31895					
		N	6115585	6115662	6115583	6115516	6115444					
Geological Units	**Unit**	1A	0.1	< 0.05	0.1	0.1						
		1B										
		1C		0.25	CL/CM 0.5	0.7	0.5					
	Unit	2A	1.1	0.9	1.1	1.4	cobbles 1.0					
		2B	1.3VR	1.2R	1.3R	1.5R	1.05R					
	Unit											
Additional Info	**Water**											
	Photograph		65	64	62/63	61	60					
	Comments		rocks at surface	cobbles below 0.3	suitable to 1.0 as clay fill	D0.2-0.7 roots to gully	Cu ore outcrop surface fill					

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	6 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

			P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Location / ID	TP No.		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
	Co-ords	E	317401	317346		317291	317245	317238	317202	317154	317161	317208
		N	6114528	6114537		6114528	6114536	6114487	6114537	6114543	6114588	6114586
Geological Units	Unit	1A	0.15	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.05
		1B	0.4	0.4						0.7	0.95	
		1C	0.5	0.75	0.7	0.4	0.4	0.4	0.3	1.3		0.9
	Unit	2A	1.3	1.6	1.5	1	1.2	0.9	0.6	1.8	1.25	1.1
		2B	1.5R	1.8R	1.6R	1.2R	1.3R	1.95R	0.8R	1.9R	1.3R	1.2R
	Unit											
Additional Info	Water											
	Photograph											
	Comments											

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	7 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

			P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
Location / ID	TP No.		P11	P12	P13	P14	P15	P16	P17	P18	P19	P20
	Co-ords	E	317256	317298	317345	317360	317366	317375	317319	317277	317309	317305
		N	6114584	6114585	6114575	6114638	6114692	6114736	6114738	6114741	6114691	6114643
Geological Units	Unit	1A	0.1	0.2	0.15	0.1	0.1	0.1	0.1	0.1	0.15	0.1
		1B		1					0.3		0.5	
		1C	1	1.5	0.5	0.4	0.45	0.5	0.7	1.5	0.8	0.45
	Unit	2A	1.25	1.7	1	0.9	1.05	1.1	1.15	1.75	0.9R	0.7
		2B	1.3R	1.75R	1.05R	0.95R	1.1R	1.2R	1.2R	1.8R		1.05R
	Unit											
Additional Info	Water											
	Photograph											
	Comments			0.4-0.8	0.6-0.9					0.2-0.5		

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	8 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		P21	P22	P23	P24	P25	P26	P27	P28	P29	P30
	Co-ords	E	317259	317269	317214	317211	317165	317174	317179	317186	317133	317189
		N	6114641	6114688	6114691	611437	6114639	6117691	6114743	6114782	6114783	6114782
Geological Units	**Unit**	1A	0.05	0.1	0.01	0.05	0.15	0.01	0.05	0.05	0.01	0.05
		1B					0.55					
		1C	0.3	0.6	0.3	0.3	1.15	0.4	0.45	0.3	0.25	
	Unit	2A	0.6	1	0.5	0.8	1.4	1.4	1.2	1.5	1.05	0.5
		2B	0.8R	1.2R	1.4R	1.4R	1.5R	1.5R	1.4R	1.8R	1.35R	0.6R
	Unit											
Additional Info	**Water**											
	Photograph											65
	Comments										0.5-0.9	no residual soil rock out cropping
											1.1-1.3	

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:		Hillgrove Copper Pty Ltd					Job No.:	MINEHERD00335.AA		
Project:		TSF Material Search					Date:			
Location:		Kanmantoo					Sheet	9	of 23	

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	TP No.		P31	P32	P33	P34	P35	P36	P37	P38		
	Co-ords	E	317148	317196	317240	317230	317231	317283	317290	317323		
		N	6114834	6114833	6114832	6114780	6114740	6114783	6114828	6114784		
Geological Units	Unit	1A	0.05	0.1	0.1	0.1	0.1	0.05	0.1	0.05		
		1B										
		1C	0.1	0.4	0.5	0.4	0.6	0.15		0.25		
	Unit	2A	0.75	0.6	0.8	0.9	1	1	0.75	0.6		
		2B	0.9R	0.75R	0.85R	1.0R	1.1R	1.2R	0.9R	0.7R		
	Unit											
Additional Info	Water											
	Photograph		65	64	63	62	61	59	58			
	Comments		rock outcropping		surface rocks		adjacent to rock outcrops	rock outcrops extensive	rock outcrops roots to 0.5, adjacent telstra line	outcrop, boulders in top 500, near vent bedding		

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	**Hillgrove Copper Pty Ltd**	**Job No.:**	**MINEHERD00335.AA**
Project:	**TSF Material Search**	**Date:**	
Location:	**Kanmantoo**	**Sheet**	**10 of 23**

SUMMARY EXCAVATION LOGS - EXCAVATOR

			R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Location / ID	**TP No.**		R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
	Co-ords	E	317426	317438	317488	317486	317477	317530	317534	317539	317585	317582
		N	6114726	6114778	6114824	6114777	6114737	6114730	6114775	6114825	6114827	6114780
Geological Units	**Unit**	1A	0.3	0.1	0.2	0.2	0.2	0.2	0.25	0.1	0.1	0.2
		1B				0.7		0.5				
		1C	1.5	0.65	2.1	2.2	3.9	2	0.9	0.8	0.3	3.5
	Unit	2A	1.9	1	2.5	2.4R		2.1VR	1.5	1.3	1.0	
		2B	2.0R	1.1R	2.6VR				2.0VR	1.5R	1.2R	
	Unit											
Additional Info	**Water**											
	Photograph		55/54			50/49	48	46/47	44/45			
	Comments			surface rocks								

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	Facility Upgrade - Access Track	Date:	
Location:	Kanmantoo	Sheet	11 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	TP No.		R11	R12	R13	R14
	Co-ords	E	317578			
		N	6114727			
Geological Units	Unit	1A	0.05	0.1	0.1	0.15
		1B				
		1C	0.35	0.8	1.5	
	Unit	2A	1	1.3	2.1	2.4
		2B	1.2R	2.2 VR	2.3 VR	2.7
	Unit					
Additional Info	Water					
	Photograph					
	Comments		rock outcropping			high silt content, light

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	12 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

			T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Location / ID	**TP No.**		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
	Co-ords	E	317370	317239	317100	316963	316895	317026	317157	317303	317238	317108
		N	6115681	6115695	6115719	6115719	6115800	6115797	6115794	6115784	6115903	6115901
Geological Units	**Unit**	1A	0.05	0.15	0.15	0.1	0.15	0.15	0.05	< 0.05	0.15	0.1
		1B										
		1C	red brown 0.5 light brown 0.6	1.5	0.7	0.5	0.5	0.6	0.8	0.95	1.3	1
	Unit	2A	1.2	2.6	0.7-1.2 light brown 1.7 grey	1.6	1.1	1.5	1.6	2 solid	2.0	1.7
		2B	1.3R	E of pit in HW rock grey	1.8R	1.7R	1.25R	1.75R	1.65R	2.2VR	2.2VR	1.8VR
	Unit											
Additional Info	**Water**											
	Photograph		58	56/57	55	54	53	52	51	50	49/50	48
	Comments		rock outcrops roots to 0.4	grassed area rootholes to 2mm	B 1.0-1.5			roots to 0.5 blocky structure top 600			spoil no	tight from 0.5m pp > 400

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	13 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID												
	TP No.		T11	T12	T13	T14	T15	T16	T17	T18	T19	T20
	Co-ords	E	316963	317026	317157	317300	317236	317113	316975	317029	317156	317298
		N	6115900	6116002	6116002	6116002	6116045	6116100	6116102	6116201	6116202	6116199
Geological Units	Unit	1A	0.2	0.1SM	0.2	0.05	0.15	0.1	0.1	0.15	0.2	0.25
		1B										
		1C	0.6	0.7CL	0.5	0.3	0.75	0.45	0.5	0.6	0.6	0.9
	Unit	2A	1	1.4 SM/ML orange grey	0.9	0.6	1.2	0.9	1	1.0 light brown 1.4 grey brown	1	1.5
		2B	1.2R	1.5VR	1.0R	0.65R	1.3R	0.9R	1.15VR	1.7VR	1.1VR	1.7VR
	Unit											
Additional Info	Water											
	Photograph		47	46	45	44	43	42	41/40		35	34
	Comments		B 0.2-0.3		stones on surface		good soils to 1.0. B 0.3 - 1.0	rock outcrops	some rock cobbles/ boulders at edge of paddock	pasture	surface rocks	rocks across surface cnr of fence lines

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd				Job No.:	MINEHERD00335.AA	
Project:	TSF Material Search				Date:		
Location:	Kanmantoo				Sheet	14 of 23	

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	TP No.		T21	T22	T23	T24	T25	T26	T27	T28	T29	T30
	Co-ords	E	317115	316767	31666	316706	316571	316500	316640	316769	316843	316900
		N	6116294	6115802	6115817	6115900	6115900	6116000	6116000	6115999	6115900	6116000
Geological Units	Unit	1A	0.25	0.1 (SC)	0.1 (SC)	0.2	0.3SM	0.25	0.3	0.3	0.2	0.2
		1B										
		1C	0.9 with boulders	0.35	fissures 0.5	fissures 0.55	0.65	0.5	0.75	0.65	0.5	0.55
	Unit	2A	1.7	0.71 brown 1.5	0.71 brown 1.0	1.2 green grey	1.3 yellow grey	0.75 light brown 0.85	1.1 light brown 1.5	1.15	1.5	1.7
		2B	1.9R	1.8R	1.1R	1.35R	1.8VR grey	0.9R	1.7R	1.3R	1.9R	1.8R
	Unit											
Additional Info	Water									nil		
	Photograph		32/33	31	forgotten photo?	30	29	28	27	26	stockpile 25/24	23
	Comments		boulder near surface	top of hill line 1	surface stone	surface stone	block to 0.5	near top of hill	pasture	tree root at 0.25 15mmΦ	rocks at surface	D0.2-0.5 D0.6-0.9 top on ok for reuse
			Unsuitable as borrow material	Minimal usable clay	next to fence					Unit 2A less silt more clay		more sand below 1.0

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:		**Hillgrove Copper Pty Ltd**						**Job No.:**	**MINEHERD00335.AA**		
Project:		**TSF Material Search**						**Date:**			
Location:		**Kanmantoo**						**Sheet**	**15**	**of 23**	

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		T31	T32	T33	T34	T35	T36	T37	T38	T39	T40
	Co-ords	E	316851	316901	316844	316900	316771	316702	316753	316701	316569	316520
		N	6116100	3116201	6116302	6116395	6116400	6116301	6116190	6116100	6116099	6116198
Geological Units	**Unit**	1A	0.15	0.15	0.15	0.4	0.35	0.3	0.5	0.3	0.3	0.2
		1B									roots to 0.3	
		1C	0.45	0.4	0.35	0.9	0.8	0.6	0.4	0.5	0.6	0.6
	Unit	2A	1.1	1.2	0.7	1.5	1.8	1.4	0.7	0.8	1.2 yellow brown 1.8	yellow to 1.0 1.4
		2B	1.2R	1.35R	0.75R	1.7VR	1.95R	1.5R	1.05R	1.2R	2.2VR	1.6VR
	Unit										pasture	
Additional Info	**Water**		tree area								nil	
	Photograph		22	21	20	19	18/17	16	15/16			
	Comments			stone on surface	surface tree root	under a tree surface rocks	Unit 2A ok for use as clay	stone surface	tree roots to 20Φ	Unit 2A suitable	yellow brown Unit 2A ok	1.0m. Stones across surface

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	**Hillgrove Copper Pty Ltd**	**Job No.:**	**MINEHERD00335.AA**
Project:	**TSF Material Search**	**Date:**	
Location:	**Kanmantoo**	**Sheet**	**16 of 23**

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		T41	T42	T43	T44	T45	T46	T47	T48	T49	T50
	Co-ords	E	316640	316550	316647	316699	316850	317000	317149	317300	317450	316831
		N	6116201	6116307	6116442	6116550	6116551	6116550	6116550	6116550	6116550	6115702
Geological Units	**Unit**	1A	0.15	0.15	0.3	0.3	0.2	0.15	0.2	0.1	0.1	0.25
		1B			tree root to 30Φ							
		1C	0.4	0.55	0.6	0.9	0.6	0.6	0.65	0.55	0.5(CH)	0.5
	Unit	2A	1.3	1	1	1.5 light brown	0.7	1.2	1.4 blue grey	0.9	1.2 light brown	1.1
		2B	1.45R	1.3R	1.2R	1.65R grey	0.9R	1.3VR	1.6VR light grey	0.95R	1.35R	1.3R
	Unit											
Additional Info	**Water**											
	Photograph					66	65	64	63	62	61	59/60
	Comments		ok Unit 2A to 1.0m	wooded area	ok to 0.8/0.9	ok to 1.5 for reuse	erosion pathway	pasture	ok for reuse to approx. 1.1		grave/cobble pasture. Ok to	
						pasture						

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	17 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

			T51	T52	T53	T54	T55	T56	T57	T58	T59	T60
Location / ID	TP No.		T51	T52	T53	T54	T55	T56	T57	T58	T59	T60
	Co-ords	E	316725	316570	316441	316380	316440	316505	316506	316780	316900	317030
		N	6115701	6115700	6115699	6115800	6118900	6115800	6115600	6115600	6115600	6115600
Geological Units	Unit	1A	0.03	0.2	0.05	0.3	0.15	0.25	0.1	0.1	0.2	0.1
		1B										
		1C	0.2	0.55	0.45	0.6	0.4	0.5	0.5	0.25	0.65	0.4
	Unit	2A	0.4	1	0.7	1.4 (poor SM)	1.6 yellow brown 1.5	1.0 light brown 1.35	0.6	0.4	1.0 light brown ok	1.0 light brown ok
		2B	0.5R	1.05R	0.9	1.6R HW	1.7VR HW	1.5VR	0.7R	1.3VR HW	1.25R	1.2R
	Unit											
Additional Info	Water											
	Photograph		59 surface 57 pit	56	55			52	51	49	48	47
	Comments		top steep slope rock outcrops	surface stone		stones on surface	D0.7-1.3 pasture ok to 1.5	some stone across surface marginal use >0.5m	stone surface floaters to 0.5	outcrop surface photos boulders in clay matrix	pasture	surface stone

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:	**Hillgrove Copper Pty Ltd**	**Job No.:**	**MINEHERD00335.AA**
Project:	**TSF Material Search**	**Date:**	
Location:	**Kanmantoo**	**Sheet**	**18 of 23**

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		T61	T62	T63	T64	T65	T66	T67	T68	T69	T70
	Co-ords	E	316965	317099	317228	317160	317300	317145	317127	317018	316939	316925
		N	6115503	6115500	6115499	6115600	6115600	6115407	6115298	6115333	6115401	6115300
Geological Units	**Unit**	1A	0.25	0.1	0.1	0.2 (SM)	0.2	0.15	0.2	0.5	0.1	0.1
		1B								root zone to 0.45		
		1C	0.6	0.5	0.3	0.55 (CL)	0.5	0.5	0.5 CL/CH	minimal if any CL		
	Unit	2A	1.0 ok	0.7	1.25	0.7 light brown 0.9	0.8 light brown 1.15	0.7	0.9 ML ok	1.5	0.5	0.5
		2B	0.9R	1.45VR HW		1.05R	1.3R	0.75R	1.05VR	1.7VR HW	0.6R	0.65R
	Unit											
										usable to 1.5 m sandy root holes	boulders & cobble in clay sand matrix	surface rock outcrops
Additional Info	**Water**											
	Photograph		46	45	44	43	42	40/41			36/37	35 general site 34
	Comments		stony surface	stone surface				flash unit to compare	stone surface	outcrops on slopes B0.5-1.0	rock outcrops at surface	boulders in soil matrix
							some stone across surface	surface rocks		poor founding conditions	poor founding conditions	poor founding conditions

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Client:		**Hillgrove Copper Pty Ltd**						**Job No.:**	**MINEHERD00335.AA**		
Project:		**TSF Material Search**						**Date:**			
Location:		**Kanmantoo**						**Sheet**	**19**	**of 23**	

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		T71	T72	T73	T74	T75	T76	T77	T78	T79	T80
	Co-ords	E	316835	316807	316755	316742	316675	316580	316430	316311	316248	316223
		N	6115371	6115530	6115454	6115600	6115673	6115512	6115563	6115709	6115535	6115413
Geological Units	**Unit**	1A	0.4	0.1 SM/ML	0.2 SM/ML	0.25	0.1	0.1	0.1	0.25 SM/SL	0.3	0.1
		1B	1.0 orange brown SM/SC	0.6 boulder/ cobbles/gravel in matrix		EW rock			0.3 (3)		0.6 EW (SC)	
		1C	no clay	SC/SM brown gray		0.55	0.65 CL/SC EW rock			0.65 (CL)	1.0 EW (CL/SC)	0.35
	Unit	2A	1.5	1	0.4	1	1	0.4	0.6	1.2	2.0 brown	0.6
		2B	1.55VR	1.2VR HW	0.6 HW	1.2VR HW	1.3R HW	0.45R (HW)	0.7R	1.3VR HW	2.2 VR (HW)	0.8R
	Unit										roots to 0.4	
											D0.3-0.6 D0.6-1.0	
Additional Info	**Water**											
	Photograph		33	32	31	30	29 countryside 28 normal 27 flash	26	25	24	23	22
	Comments			surface outcrops		D 0-0.25 check % silt	roots to 0.15	no clay cobbles in ML/SM matrix brown	rock outcrops	rock outcrops close by		outcrops close vicinity
				poor founding conditions			outcrops to either side of gully		minimal surface cover	surface stone	adjacent reeds rock outcrops	minimal vegetation

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			(3) cobbles/boulder in SM/ML matrix brown (dry)

Client:	Hillgrove Copper Pty Ltd	Job No.:	MINEHERD00335.AA
Project:	TSF Material Search	Date:	
Location:	Kanmantoo	Sheet	20 of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	TP No.		T81	T82	T83	T84	T85	T86	T87	T88	T89	T90
	Co-ords	E	316296	316199	316109	316188	316302	316420	316463	316544	316663	316766
		N	6115304	6115280	61152326	6115142	6114990	6115023	6114924	6115134	6115001	6115056
Geological Units	Unit	1A	0.25 SM/SL	0.1	0.05	0.1	0.15	0.15	0.1	0.15	0.1	0.05
		1B	minimal EW rock primarily	0.25 (3)	0.3 (3)	0.35 (3)	0.3 SC/CL			0.6		
		1C	0.6	0.55				0.30 orange brown			0.5	0.45
	Unit	2A	0.9	0.8	0.4	0.55	1.0 light brown to 0.7 good	1.0	0.7	0.6	0.8	0.5
		2B	1.0 VR HW	1.0R	0.5R	0.65R HW	1.15R	1.2R	0.75R	0.75VR (HW)	0.7VR (HW)	0.7R
	Unit											
Additional Info	Water											
	Photograph							15	14	13	12	11
	Comments		rock outcrops	outcrops of rock	grass. Outcrops	stones on surface & outcrops	rock outcrops	rock outcrops	surface rock outcrops rootholes to 8mmΦ	rock outcrops	grassed bottom of slope	grassed area some stone
			minimal grass	Ok to reuse to 0.8								

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			(3) cobbles/boulder in SM/ML matrix brown (dry)

Client:	Hillgrove Copper Pty Ltd		Job No.:	MINEHERD00335.AA	
Project:	TSF Material Search		Date:		
Location:	Kanmantoo		Sheet	21	of 23

SUMMARY EXCAVATION LOGS - EXCAVATOR

			T91	T92	T93	T94	T95	T96	T97	T98	T99	T100
Location / ID	TP No.		T91	T92	T93	T94	T95	T96	T97	T98	T99	T100
	Co-ords	E	316757	316865	317006	317131	317001	316876	316984	317119	317099	317022
		N	6115182	6115135	6115192	6115110	6115105	6115022	6114967	6115028	6114912	6114828
Geological Units	Unit	1A	0.3	<0.05	<0.05	0.1	0.45	0.25	0.15	0.05	0.05	0.2
		1B	(SC/SM) root to 0.3				0.9					
		1C					primarily weathered SC/SM					
	Unit	2A	1	0.4	0.45 (SM/ML)	0.9	1.3	0.55	0.6 (3)	0.25 (3)	0.45 (3)	0.9 (3)
		2B	1.2R	0.55	0.7R	1.1R	1.4R grey	0.6R	0.65	0.3R	0.5R	1.0R
	Unit											
Additional Info	Water											
	Photograph		10	8		66	65					
	Comments		grassed area	rock outcrops	rock outcrops		root holes to 2 mmΦ. Root zone to 0.4. Rocks on surface	root holes	rock outcrops to west		surface rocks	rock outcrops roots to 0.3 / 0.4

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			(3): Cobbles / boulders in SM/ML matrix, brown

Client:	**Hillgrove Copper Pty Ltd**						**Job No.:**	**MINEHERD00335.AA**		
Project:	**TSF Material Search**						**Date:**			
Location:	**Kanmantoo**						**Sheet**	**22**	**of 23**	

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		T101	T102	T103	T104	T105	T106	T 107	T 108		
	Co-ords	E	316856	316733	316735	316834	316971	317049	316246	316633		
		N	6114829	6114910	6114737	6114714	6114705	6114727	6115493	6115086		
Geological Units	**Unit**	1A	0.4	0.25 (SM)	0.15	0.2 (SM)	0.05	0.2	0.2	0.2		
		1B	roots to 0.5		0.6				0.7	0.7		
		1C				0.9 (EW) low (CL)						
	Unit	2A	1.5	light brown 1.2 1.8	0.8	1.5	0.35	0.55	more EW	1.5		
		2B	1.6HW VR	1.9HW VR	0.85R	1.7 grey VR	0.45	0.7R	2.5 VR	1.6 VR		
	Unit											
Additional Info	**Water**											
	Photograph			57	56							
	Comments		D0.5-1.0 stable below 1.02. Unsuitable as fill	lower soils if ??? Ok for clayfill	rock outcrops close proximity poor material for core	Good material to > 1.2 m	no clay unsuitable as core stone surface	grassed area				

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal	
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey		
Unit 1C	Residual: CL/ML EW Schist				

Client:	**Hillgrove Copper Pty Ltd**				**Job No.:**	**MINEHERD00335.AA**
Project:	**TSF Material Search**				**Date:**	
Location:	**Kanmantoo**				**Sheet**	**23 of 23**

SUMMARY EXCAVATION LOGS - EXCAVATOR

Location / ID	**TP No.**		T 2/3	T10/11	T 35/43
	Co-ords	E			
		N			
Geological Units	**Unit**	1A	0.1	0.15	0.1
		1B			
		1C	0.25	0.5	0.6
	Unit	2A	0.6	0.8	0.7 VR
		2B	1.5 R	1.5 R	0.8
	Unit				
Additional Info	**Water**				
	Photograph				
	Comments				

Geological Unit Description:

Unit 1A	Topsoil: SM Silty SAND	**Unit 2A**	EW/HW Schist, grey/brown	R = Refusal
Unit 1B	Alluvial: CL/SC low plasticity fines	**Unit 2B**	HW/MW Schist, light grey	
Unit 1C	Residual: CL/ML EW Schist			

Appendix B

Laboratory Test Results

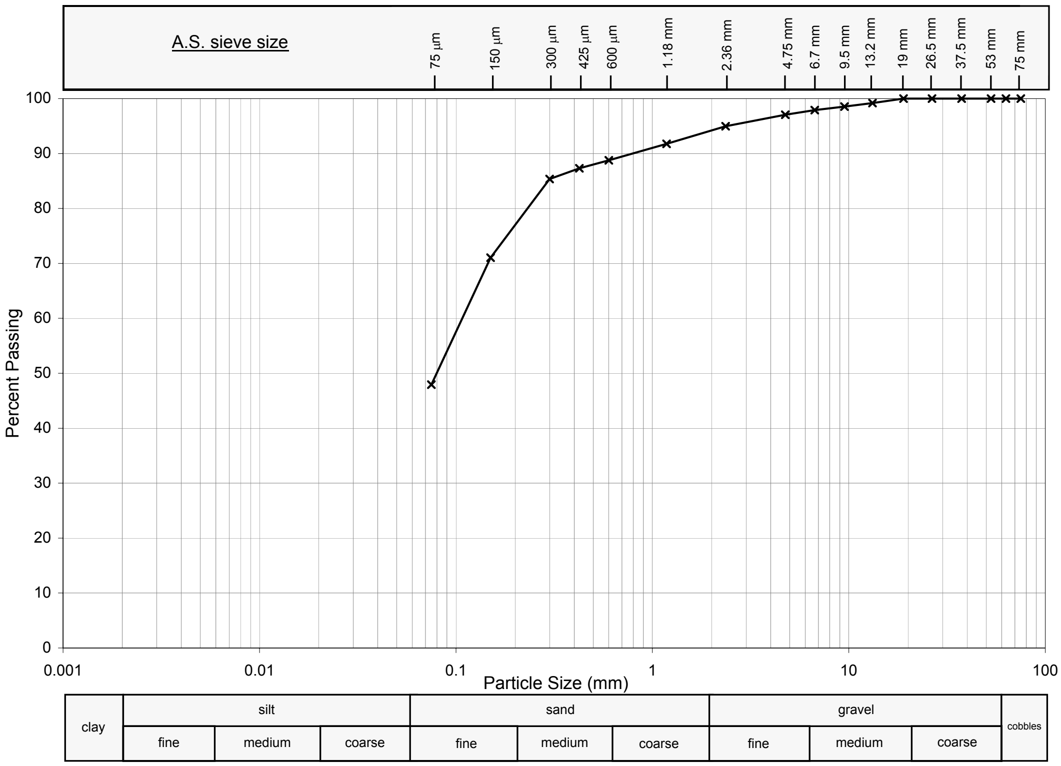
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R10
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2888	**Sample Identification:**	A9. 2A 1.0 1.5



Particle Size Distribution	AS1289 3.6.1	
Sieve Size	**% Passing**	**Specification**
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
9.5 mm	99	
6.7 mm	98	
4.75 mm	97	
2.36 mm	95	
1.18 mm	92	
600 um	89	
425 um	87	
300 um	85	
150 um	71	
75 um	48	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	27	
Plastic Limit	%	AS1289 3.2.1	18	
Plasticity Index	%	AS1289 3.3.1	9	
Linear Shrinkage	%	AS1289 3.4.1	4.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND, FINE TO COARSE, DARK BROWN, LOW PLASTICITY FINES, TRACE FINE TO MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431 Date:
Approved Signature:

W J FIELDHOUSE

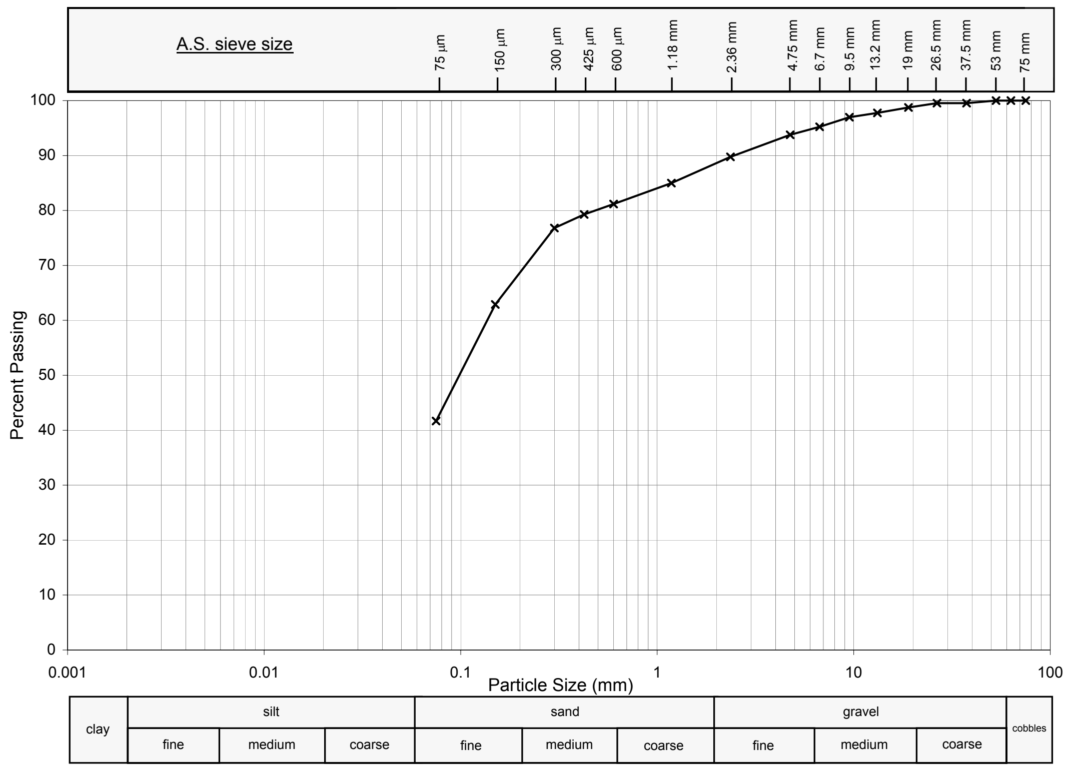
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R8
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02187	**Sample Identification:**	T2 0.5 - 1.0



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	99	
13.2 mm	98	
9.5 mm	97	
6.7 mm	95	
4.75 mm	94	
2.36 mm	90	
1.18 mm	85	
600 um	81	
425 um	79	
300 um	77	
150 um	63	
75 um	42	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	36	
Plastic Limit	%	AS1289 3.2.1	12	
Plasticity Index	%	AS1289 3.3.1	24	
Linear Shrinkage	%	AS1289 3.4.1	11.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND FINE - COARSE, BROWN, MEDIUM PLASTICITY FINES, TRACE FINE - COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431 Date:
Approved Signature:

W J FIELDHOUSE

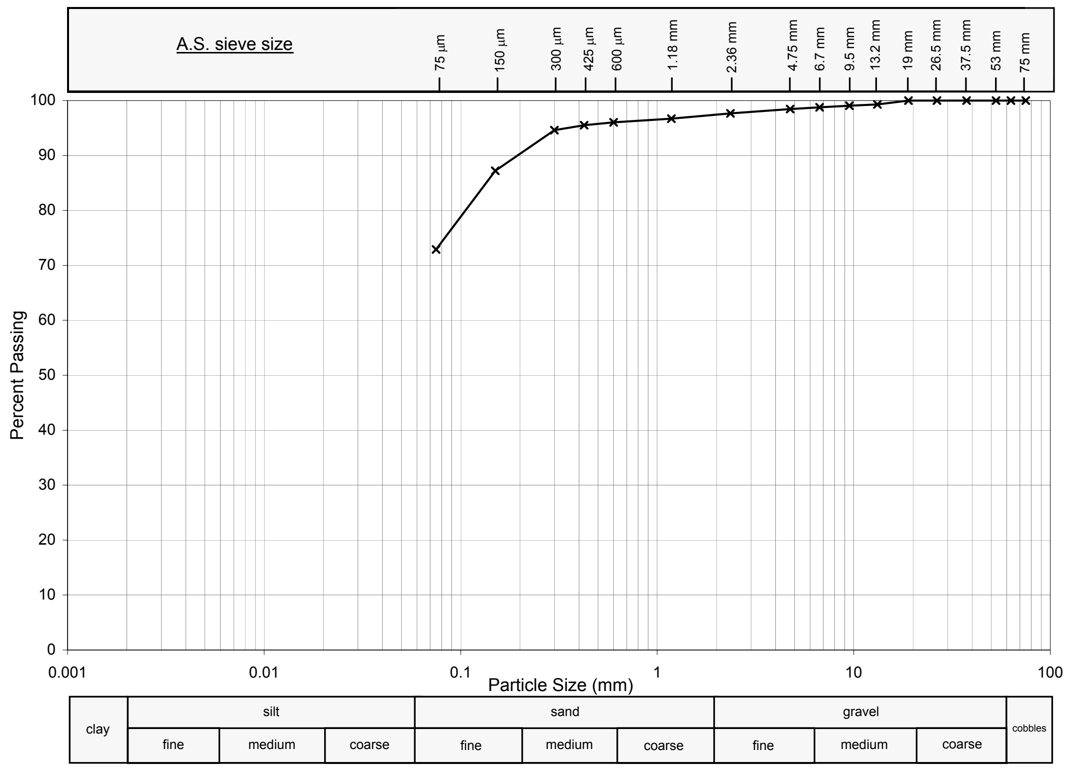
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R7
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02186	**Sample Identification:**	T30 0.2 - 0.5



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
9.5 mm	99	
6.7 mm	99	
4.75 mm	98	
2.36 mm	98	
1.18 mm	97	
600 um	96	
425 um	96	
300 um	95	
150 um	87	
75 um	73	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	62	
Plastic Limit	%	AS1289 3.2.1	17	
Plasticity Index	%	AS1289 3.3.1	45	
Linear Shrinkage	%	AS1289 3.4.1	15.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAY, HIGH PLASTICITY, BROWN, SOME FINE - COARSE SAND, TRACE FINE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431

Date:

Approved Signature:

W J FIELDHOUSE

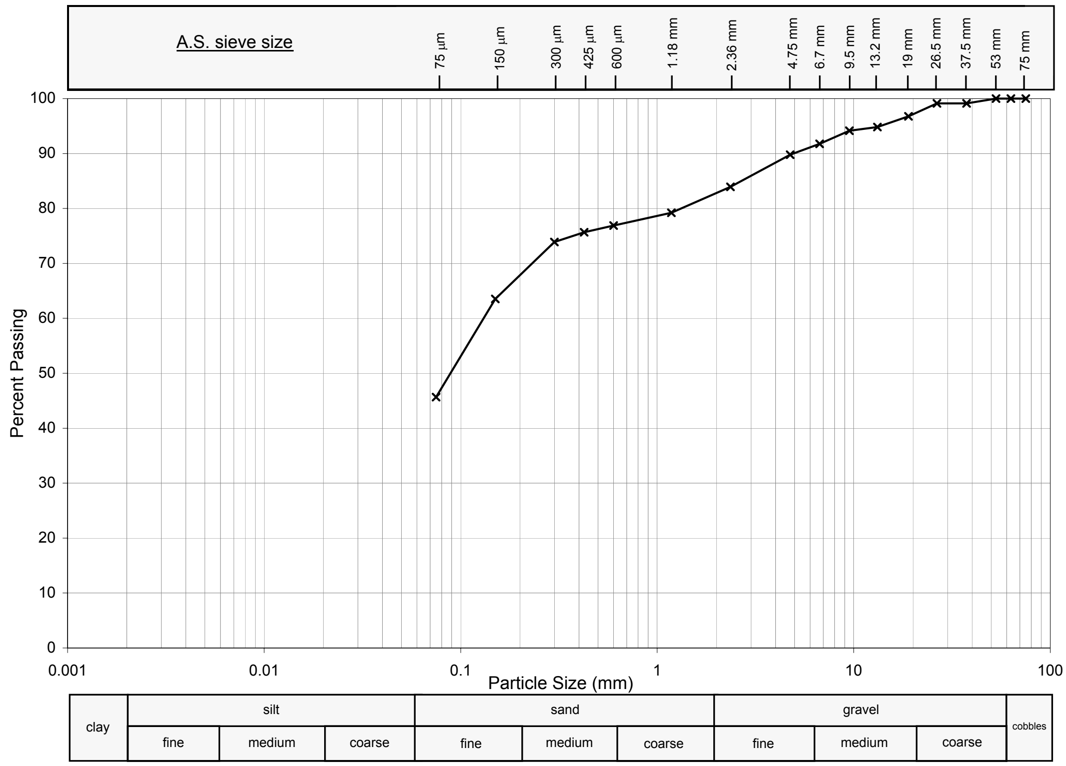
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R6
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02185	**Sample Identification:**	D4 0.2 - 0.7



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	99	
26.5 mm	99	
19.0 mm	97	
13.2 mm	95	
9.5 mm	94	
6.7 mm	92	
4.75 mm	90	
2.36 mm	84	
1.18 mm	79	
600 um	77	
425 um	76	
300 um	74	
150 um	64	
75 um	46	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	37	
Plastic Limit	%	AS1289 3.2.1	14	
Plasticity Index	%	AS1289 3.3.1	23	
Linear Shrinkage	%	AS1289 3.4.1	10.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND FINE - COARSE, BROWN, MEDIUM PLASTICITY FINES, TRACE FINE - COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431
Date:
Approved Signature:

W J FIELDHOUSE

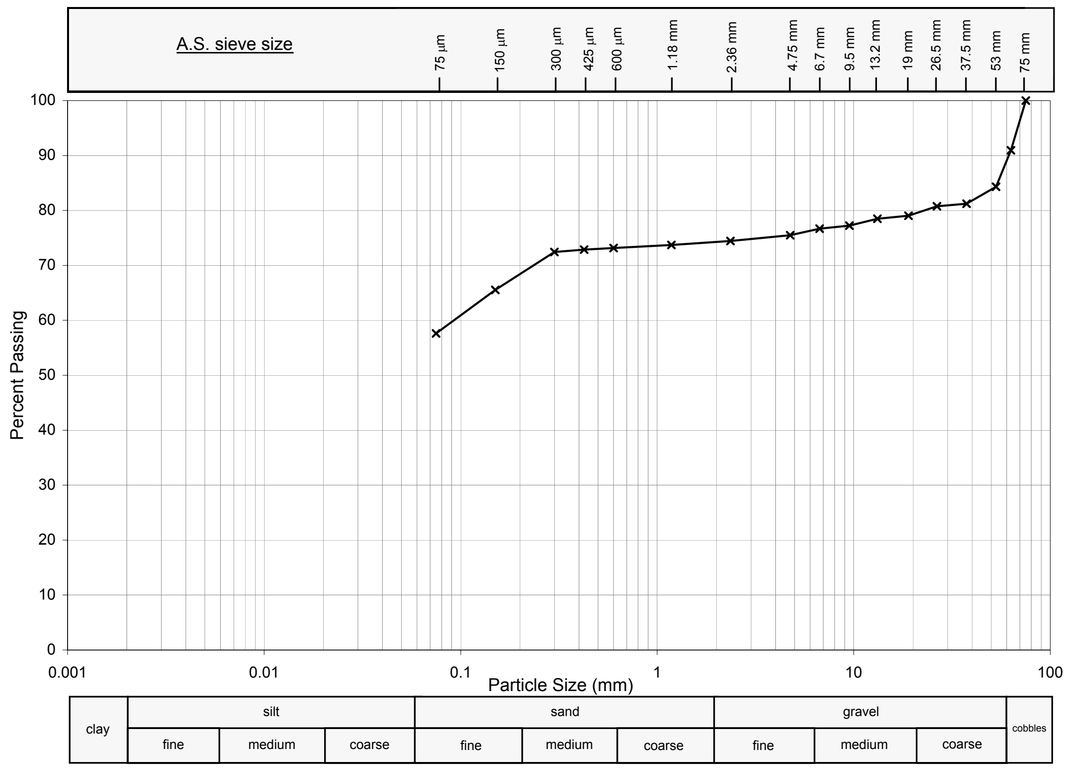
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R5
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02184	**Sample Identification:**	B6 0.1 - 0.4



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	84	
37.5 mm	81	
26.5 mm	81	
19.0 mm	79	
13.2 mm	78	
9.5 mm	77	
6.7 mm	77	
4.75 mm	75	
2.36 mm	74	
1.18 mm	74	
600 um	73	
425 um	73	
300 um	72	
150 um	66	
75 um	58	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	51	
Plastic Limit	%	AS1289 3.2.1	19	
Plasticity Index	%	AS1289 3.3.1	32	
Linear Shrinkage	%	AS1289 3.4.1	14.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, HIGH PLASTICITY, BROWN, SOME FINE - COARSE GRAVEL, SAND FINE - COARSE

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431
Date:
Approved Signature:

W J FIELDHOUSE

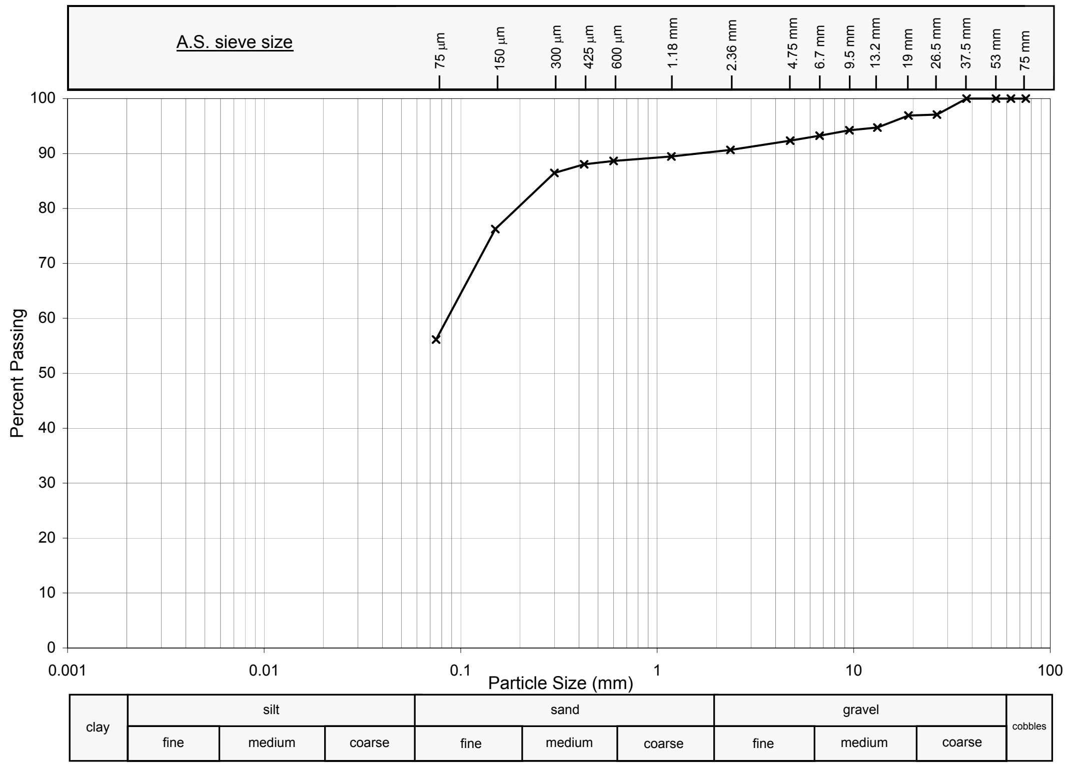
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R4
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02183	**Sample Identification:**	T89 0.1 - 0.5



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	97	
19.0 mm	97	
13.2 mm	95	
9.5 mm	94	
6.7 mm	93	
4.75 mm	92	
2.36 mm	91	
1.18 mm	89	
600 um	89	
425 um	88	
300 um	86	
150 um	76	
75 um	56	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	36	
Plastic Limit	%	AS1289 3.2.1	16	
Plasticity Index	%	AS1289 3.3.1	20	
Linear Shrinkage	%	AS1289 3.4.1	10.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, MEDIUM PLASTICITY, BROWN, FINE - COARSE SAND, TRACE FINE - COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431 Date:
Approved Signature:

W J FIELDHOUSE

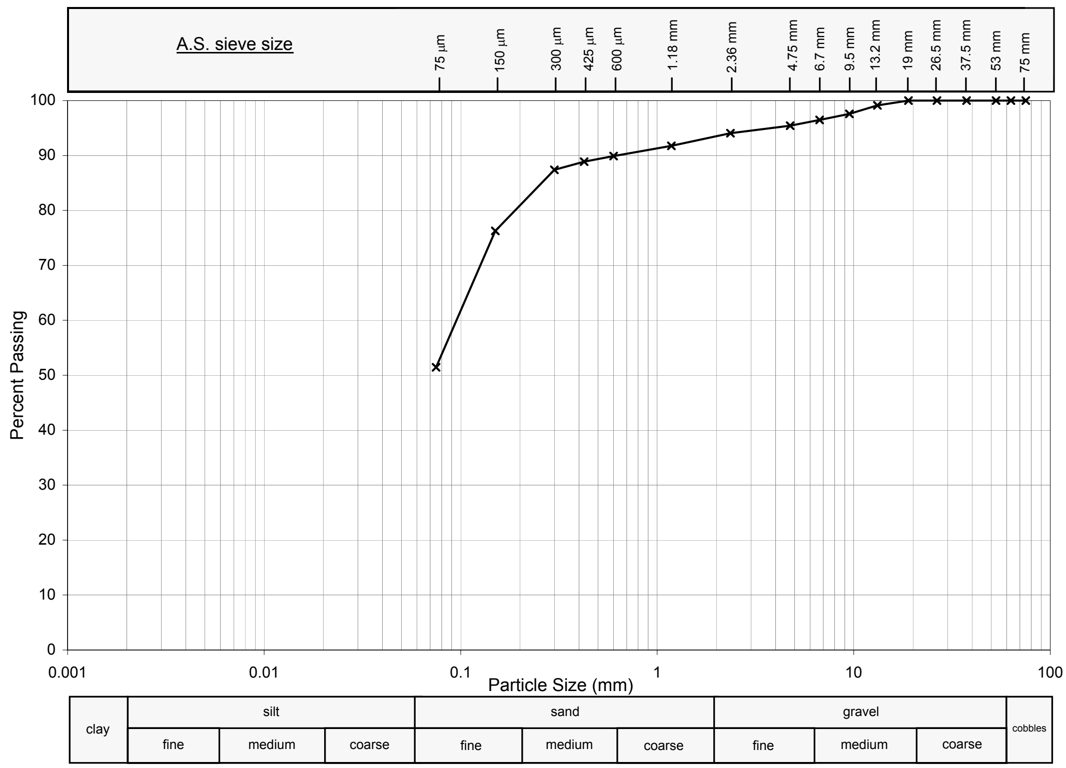
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R3
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02182	**Sample Identification:**	T11 0.2 - 0.5



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
9.5 mm	98	
6.7 mm	96	
4.75 mm	95	
2.36 mm	94	
1.18 mm	92	
600 um	90	
425 um	89	
300 um	87	
150 um	76	
75 um	51	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	35	
Plastic Limit	%	AS1289 3.2.1	15	
Plasticity Index	%	AS1289 3.3.1	20	
Linear Shrinkage	%	AS1289 3.4.1	10.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, MEDIUM PLASTICITY, BROWN, FINE - COARSE SAND, FINE - MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431

Date:

Approved Signature:

W J FIELDHOUSE

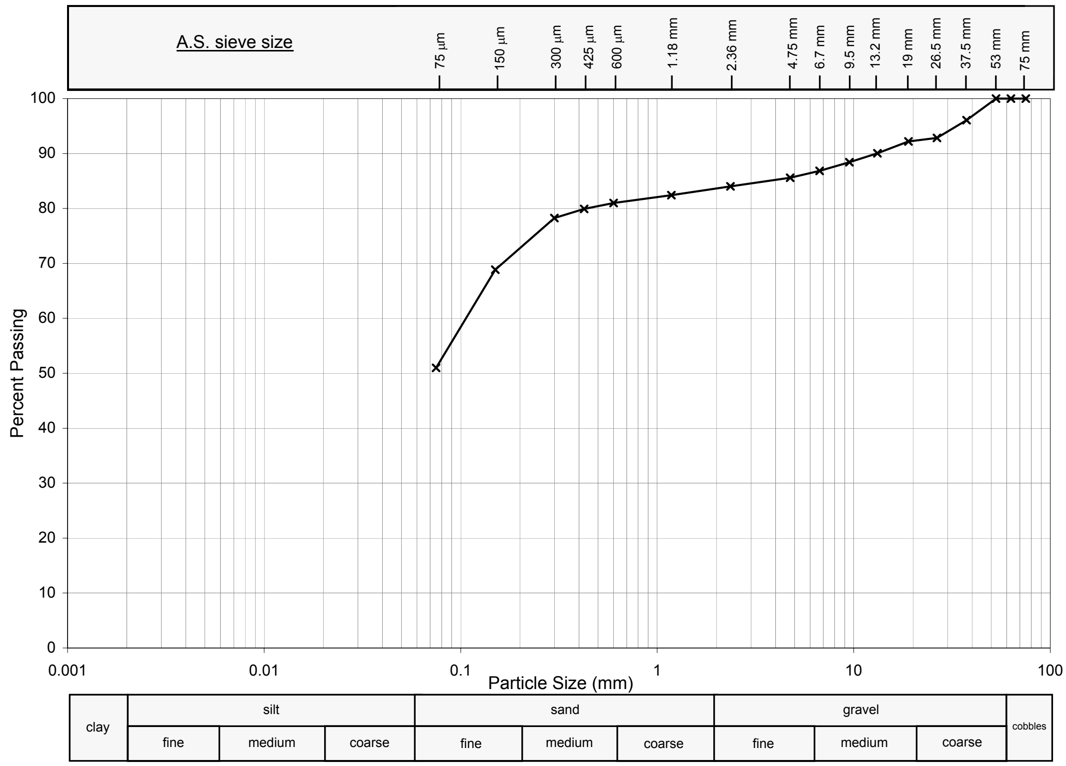
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R2
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02181	**Sample Identification:**	T79 0.6 - 1.0



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	96	
26.5 mm	93	
19.0 mm	92	
13.2 mm	90	
9.5 mm	88	
6.7 mm	87	
4.75 mm	86	
2.36 mm	84	
1.18 mm	82	
600 um	81	
425 um	80	
300 um	78	
150 um	69	
75 um	51	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	41	
Plastic Limit	%	AS1289 3.2.1	14	
Plasticity Index	%	AS1289 3.3.1	27	
Linear Shrinkage	%	AS1289 3.4.1	12.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, MEDIUM PLASTICITY, BROWN, FINE - COARSE SAND, FINE - COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431
Date:
Approved Signature:

W J FIELDHOUSE

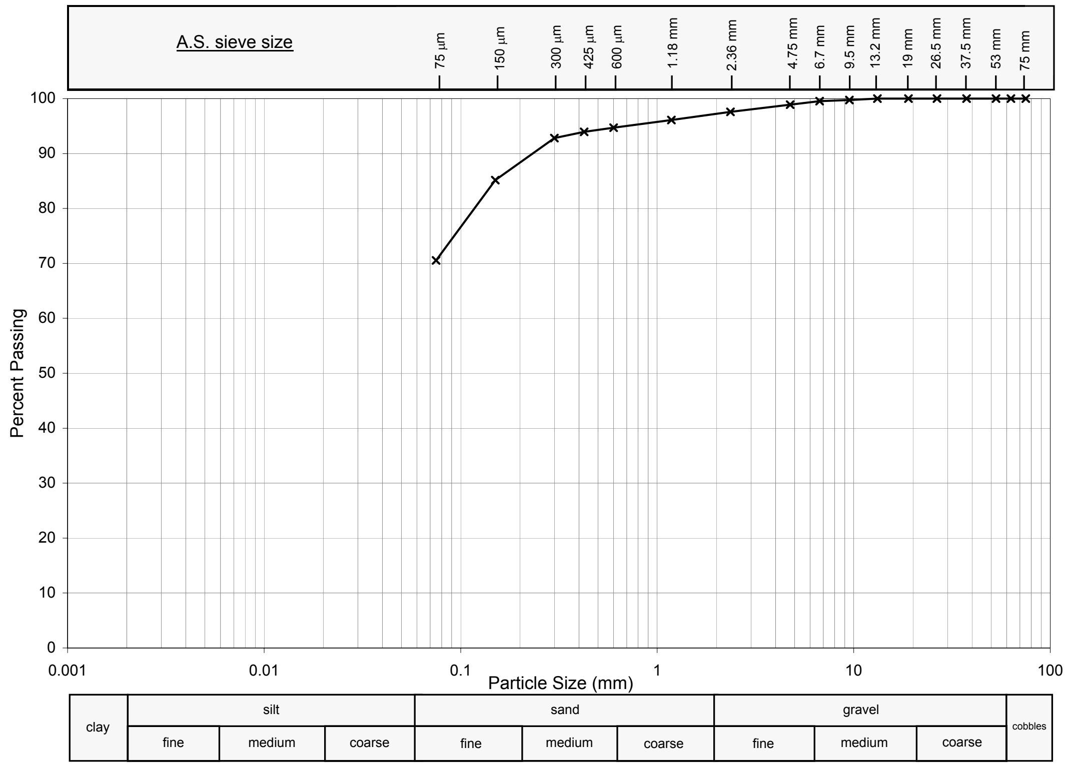
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R1
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02180	**Sample Identification:**	T35 1.3 - 1.7



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	100	
6.7 mm	100	
4.75 mm	99	
2.36 mm	98	
1.18 mm	96	
600 um	95	
425 um	94	
300 um	93	
150 um	85	
75 um	71	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	62	
Plastic Limit	%	AS1289 3.2.1	18	
Plasticity Index	%	AS1289 3.3.1	44	
Linear Shrinkage	%	AS1289 3.4.1	15.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAY, HIGH PLASTICITY, BROWN, SOME FINE - COARSE SAND, TRACE FINE - MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431
Date:
Approved Signature:

W J FIELDHOUSE

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

test results

client : *HILLGROVE RESOURCES*
CALLINGTON 42, BACK CALLINGTON ROAD 5254
job no : *00335/AA*
principal :
laboratory : *ADELAIDE*
project : *PROPOSED TAILING DAM*
report date : *June 06, 2007*
location : *KANMANTOO*
test report no. : *00335/AA-R22*
test procedure : *AS 1289 6.7.2, 2.1.1*
test date :

SAMPLE IDENTIFICATION	REMOULDED DRY DENSITY (t/m3)	REMOULDED MOISTURE CONTENT (%)	FIELD MOISTURE CONTENT (%)	COEFFICIENT OF PERMEABILITY (m/sec)
SAMPLE NO. 07S -2895	*1.64*	*18.5*	*14.4*	*1.7 X E - 10*
T30, 2A 0.5 - 1.0m				
SANDY CLAY, MEDIUM TO HIGH PLASTICITY, BROWN (WITH 10% BENTONITE ADDED)				
SAMPLE NO. 07S -2896	*1.61*	*18.8*	*14.0*	*4.2 X E - 9*
T55, 1C 0.1 - 0.4m				
CLAYEY SAND, FINE TO COARSE, BROWN				
SAMPLE NO. 07S -2897	*1.58*	*21.3*	*16.1*	*9.8 X E - 10*
T55, 2A 0.4 - 0.9m				
CLAY, HIGH PLASTICITY, BROWN (WITH 5% BENTONITE ADDED)				
SAMPLE NO. 07S -2897	*1.58*	*20.6*	*16.1*	*3.1 X E -11*
T55, 2A 0.4 - 0.9m				
(WITH 15% BENTONITE ADDED)				

remarks : *SAMPLES TESTED AS RECEIVED*
1. SAMPLES REMOULDED TO 98% OF MAXIMIM DRY DENSITY AT OPTIMUM MOISTURE CONTENT (STANDARD)
2. 100% OF MATERIAL PASSES THE 19mm SIEVE FOR EACH SAMPLE
3. SAMPLES WHERE REMOULDED IN 3 LAYERS

NATA
WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory No. 431
Date :
Approved Signatory:
WESTLEY FIELDHOUSE

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

test results

client :	HILLGROVE RESOURCES CALLINGTON 42, BACK CALLINGTON ROAD 5254	job no :	00335/AA
principal :		laboratory :	ADELAIDE
project :	PROPOSED TAILING DAM	report date :	June 06, 2007
location :	KANMANTOO	test report no. :	00335/AA-R21
test procedure :	AS 1289 6.7.2, 2.1.1	test date :	

SAMPLE IDENTIFICATION	REMOULDED DRY DENSITY (t/m3)	REMOULDED MOISTURE CONTENT (%)	FIELD MOISTURE CONTENT (%)	COEFFICIENT OF PERMEABILITY (m/sec)
SAMPLE NO. 07S -2892 R14, 2A 1.0 - 1.5m GRAVELLY CLAYEY SAND, FINE TO COARSE, BROWN (WITH 10% BENTONITE ADDED)	1.99	11.3	8.6	1.5 X E - 10
SAMPLE NO. 07S -2893 T35/43, 1C 0.1 - 0.5m SANDY CLAY, MEDIUM PLASTICITY, BROWN	1.59	19.3	15.2	2.5 X E - 9
SAMPLE NO. 07S -2894 T30, 2A 1.0 - 1.4m CLAYEY SAND, FINE TO COARSE, BROWN	1.72	15.5	8.1	2.1 X E - 8
SAMPLE NO. 07S -2894 T30, 2A 1.0 - 1.4m (WITH 15% BENTONITE ADDED)	1.74	17.3	8.1	1.5 X E - 10

remarks : SAMPLES TESTED AS RECEIVED
1. SAMPLES REMOULDED TO 98% OF MAXIMIM DRY DENSITY AT OPTIMUM MOISTURE CONTENT (STANDARD)
2. 100% OF MATERIAL PASSES THE 19mm SIEVE FOR EACH SAMPLE
3. SAMPLES WHERE REMOULDED IN 3 LAYERS

NATA Accredited Laboratory No. 431

Date :

Approved Signatory:

WESTLEY FIELDHOUSE

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

test results

client : *HILLGROVE RESOURCES CALLINGTON 42, BACK CALLINGTON ROAD 5254*
job no : *00335/AA*
principal :
laboratory : *ADELAIDE*
project : *PROPOSED TAILING DAM*
report date : *June 06, 2007*
location : *KANMANTOO*
test report no. : *00335/AA-R20*
test procedure : *AS 1289 6.7.2, 2.1.1*
test date :

SAMPLE IDENTIFICATION	REMOULDED DRY DENSITY (t/m3)	REMOULDED MOISTURE CONTENT (%)	FIELD MOISTURE CONTENT (%)	COEFFICIENT OF PERMEABILITY (m/sec)
SAMPLE NO. 07S -2888 A9, 2A 1.0 - 1.5m CLAYEY SAND, FINE TO COARSE, DARK BROWN	*1.87*	*9.7*	*7.1*	*2.0 x E - 8*
SAMPLE NO. 07S -2889 A9, 2A 2.0 - 2.5m CLAYEY SAND, FINE TO COARSE, DARK BROWN (WITH 5% BENTONITE)	*1.83*	*12.4*	*7.2*	*2.8 X E - 9*
SAMPLE NO. 07S -2890 R13, 1C 0.5 - 1.0m SILTY SAND, FINE TO COARSE, BROWN	*1.87*	*10.2*	*4.2*	*2.5 X E - 8*
SAMPLE NO. 07S -2891 R14, 2A 0.5 - 1.0m GRAVELLY CLAY, SAND FINE TO COARSE, BROWN	*1.93*	*11.3*	*8.1*	*2.1 X E - 9*
SAMPLE NO. 07S - 2891 R14, 2A 0.5 - 1.0m (WITH 5% BENTONITE ADDED)	*1.93*	*11.4*	*8.1*	*6.6 X E - 10*

remarks : *SAMPLES TESTED AS RECEIVED*
1. SAMPLES REMOULDED TO 98% OF MAXIMIM DRY DENSITY AT OPTIMUM MOISTURE CONTENT (STANDARD)
2. 100% OF MATERIAL PASSES THE 19mm SIEVE FOR EACH SAMPLE
3. SAMPLES WHERE REMOULDED IN 3 LAYERS

NATA Accredited Laboratory No. 431
Date :
Approved Signatory:
WESTLEY FIELDHOUSE

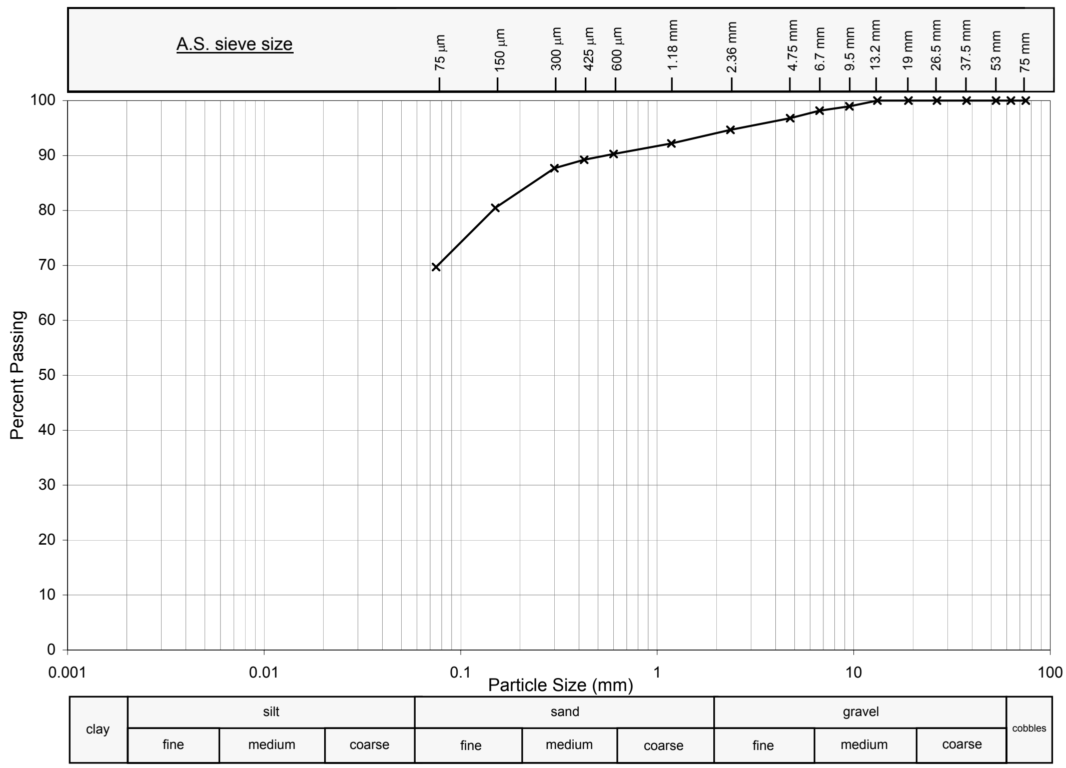
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R19
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2897	**Sample Identification:**	T55. 2A 0.4 - 0.9



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	99	
6.7 mm	98	
4.75 mm	97	
2.36 mm	95	
1.18 mm	92	
600 um	90	
425 um	89	
300 um	88	
150 um	80	
75 um	70	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	55	
Plastic Limit	%	AS1289 3.2.1	15	
Plasticity Index	%	AS1289 3.3.1	41	
Linear Shrinkage	%	AS1289 3.4.1	13.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAY, HIGH PLASTICITY, BROWN, SOME FINE - COARSE SAND, FINE TO MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431 Date:
Approved Signature:

W J FIELDHOUSE

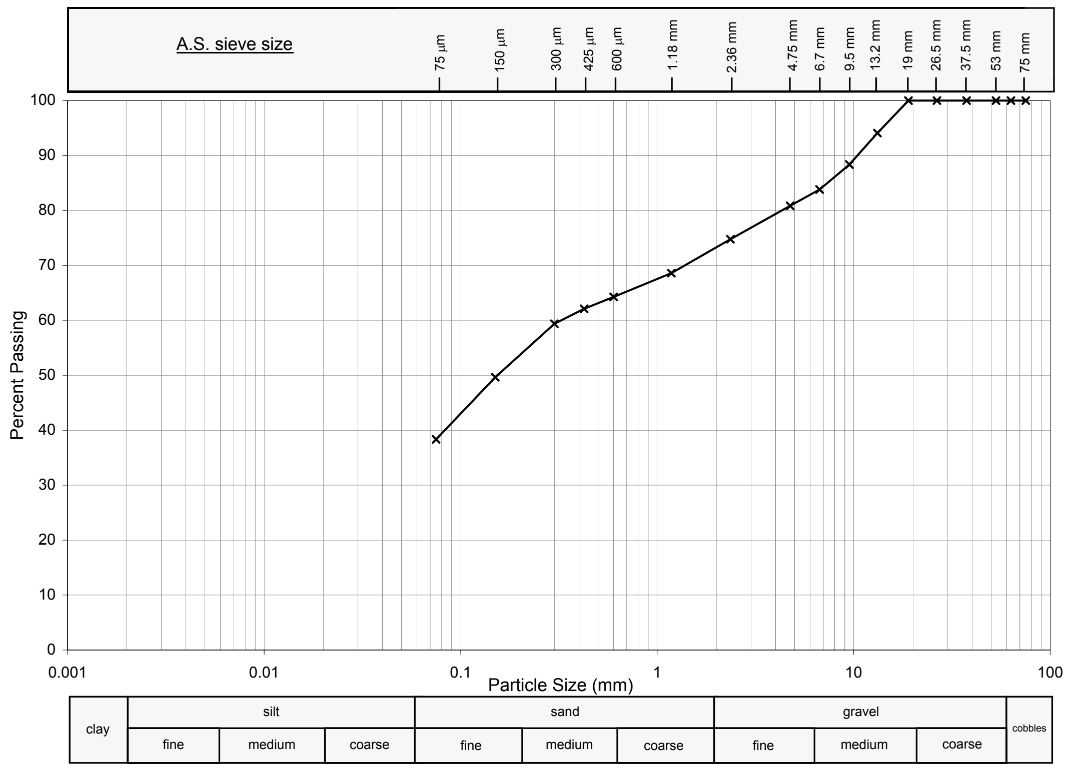
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R18
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2896	**Sample Identification:**	T55. 1C 0.1 - 0.4



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	94	
9.5 mm	88	
6.7 mm	84	
4.75 mm	81	
2.36 mm	75	
1.18 mm	69	
600 um	64	
425 um	62	
300 um	59	
150 um	50	
75 um	38	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	47	
Plastic Limit	%	AS1289 3.2.1	19	
Plasticity Index	%	AS1289 3.3.1	28	
Linear Shrinkage	%	AS1289 3.4.1	9.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND, FINE TO COARSE, LIGHT BROWN, MEDIUM PLASTICITY FINES, SOME FINE TO COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431

Date:

Approved Signature:

W J FIELDHOUSE

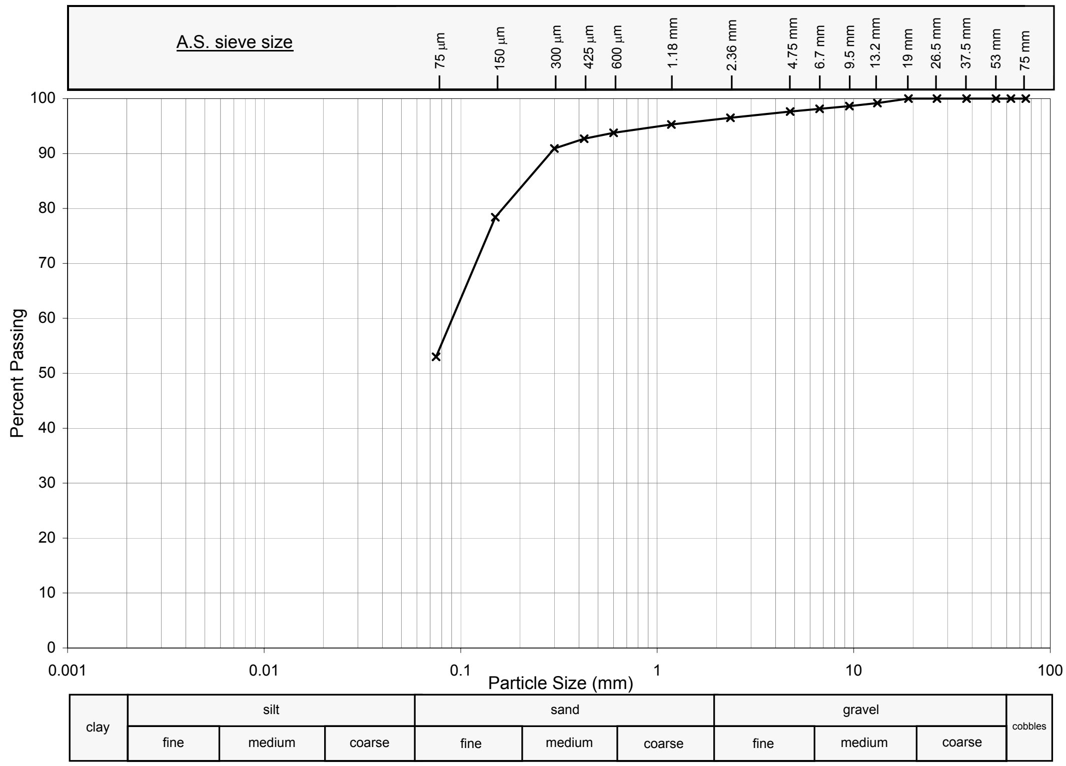
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R17
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2895	**Sample Identification:**	T30. 2A 0.5 - 1.0



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
9.5 mm	99	
6.7 mm	98	
4.75 mm	98	
2.36 mm	97	
1.18 mm	95	
600 um	94	
425 um	93	
300 um	91	
150 um	78	
75 um	53	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	49	
Plastic Limit	%	AS1289 3.2.1	15	
Plasticity Index	%	AS1289 3.3.1	34	
Linear Shrinkage	%	AS1289 3.4.1	11.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, MEDIUM TO HIGH PLASTICITY, BROWN, SAND FINE TO COARSE, TRACE FINE TO MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431 Date:
Approved Signature:

W J FIELDHOUSE

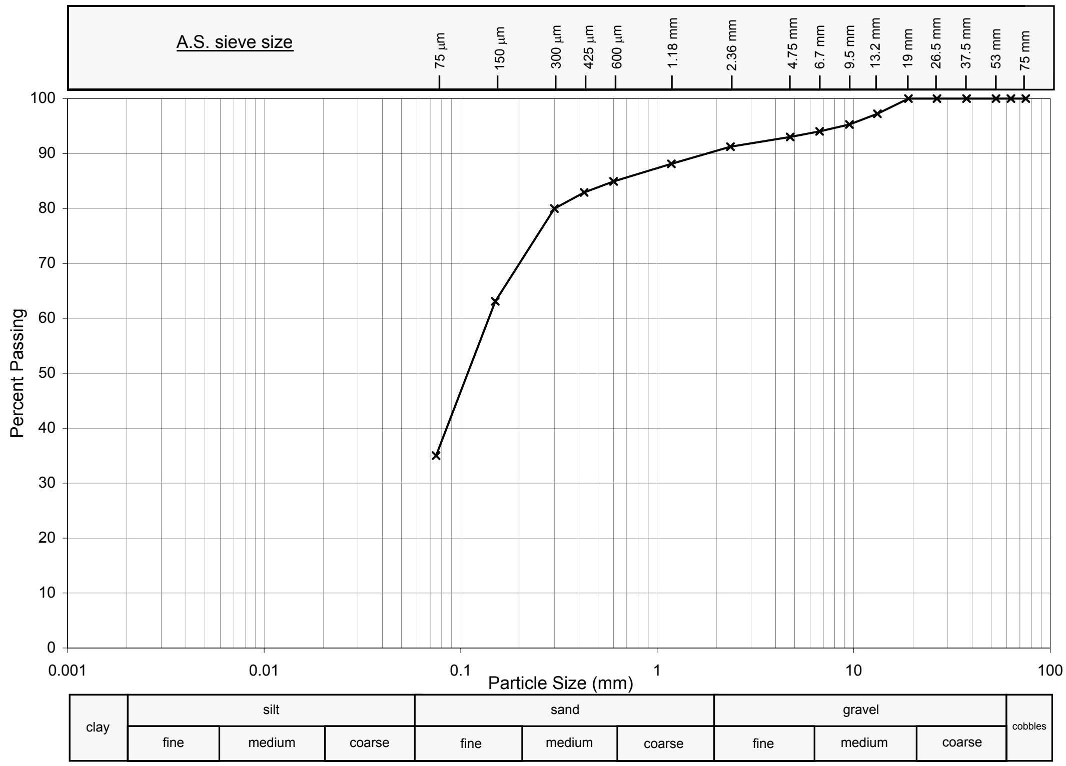
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R16
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2894	**Sample Identification:**	T30. 2A 1.0 - 1.4



Particle Size Distribution	AS1289 3.6.1	
Sieve Size	**% Passing**	**Specification**
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	97	
9.5 mm	95	
6.7 mm	94	
4.75 mm	93	
2.36 mm	91	
1.18 mm	88	
600 um	85	
425 um	83	
300 um	80	
150 um	63	
75 um	35	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	33	
Plastic Limit	%	AS1289 3.2.1	25	
Plasticity Index	%	AS1289 3.3.1	8	
Linear Shrinkage	%	AS1289 3.4.1	4.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND, FINE TO COARSE, BROWN, LOW PLASTICITY FINES, TRACE FINE TO COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431

Date:

Approved Signature:

W J FIELDHOUSE

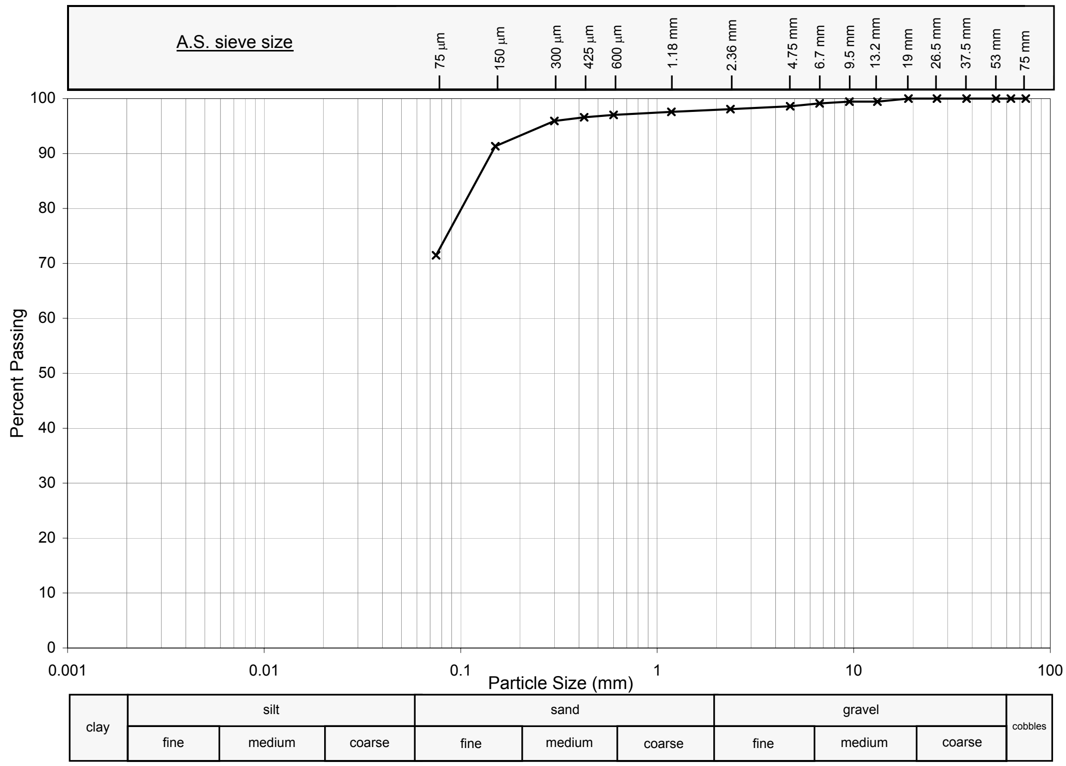
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R15
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2893	**Sample Identification:**	T35/43. 1C 0.1 - 0.5



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
9.5 mm	99	
6.7 mm	99	
4.75 mm	99	
2.36 mm	98	
1.18 mm	98	
600 um	97	
425 um	97	
300 um	96	
150 um	91	
75 um	71	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	46	
Plastic Limit	%	AS1289 3.2.1	17	
Plasticity Index	%	AS1289 3.3.1	29	
Linear Shrinkage	%	AS1289 3.4.1	12.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SANDY CLAY, MEDIUM PLASTICITY, BROWN, SAND FINE TO CORSE. TRACE FINE TO MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431

Date:

Approved Signature:

W J FIELDHOUSE

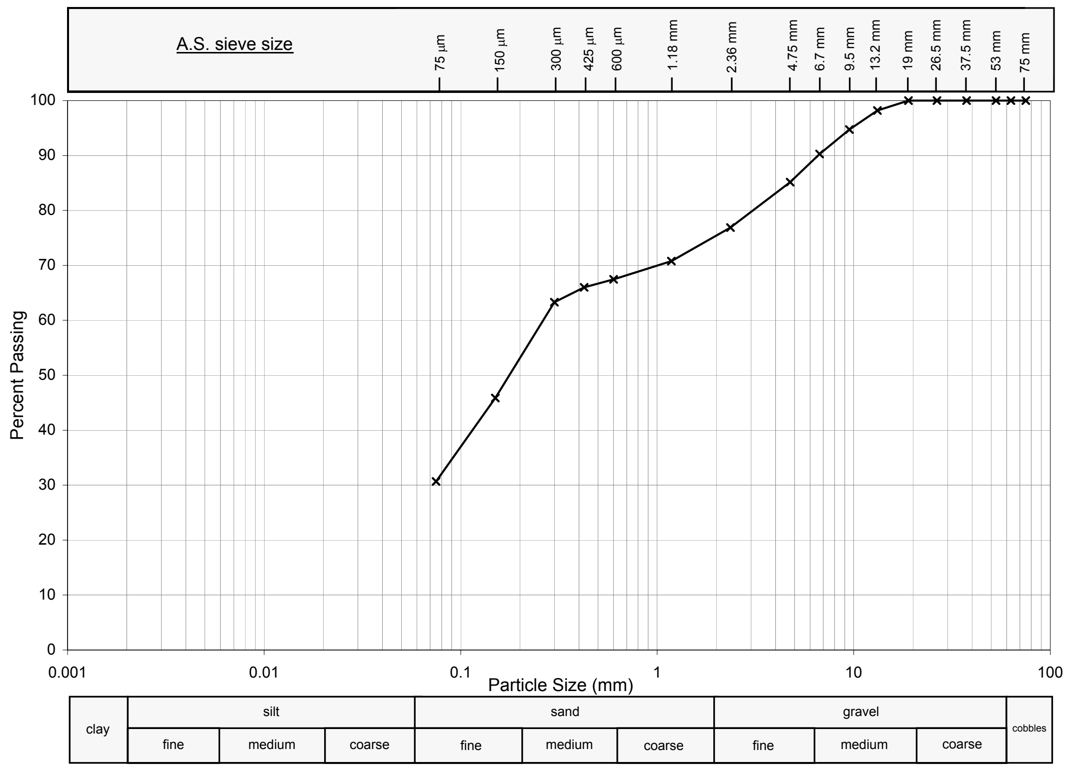
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R14
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2892	**Sample Identification:**	R14. 2A 1.0 - 1.5



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	98	
9.5 mm	95	
6.7 mm	90	
4.75 mm	85	
2.36 mm	77	
1.18 mm	71	
600 um	67	
425 um	66	
300 um	63	
150 um	46	
75 um	31	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	28	
Plastic Limit	%	AS1289 3.2.1	16	
Plasticity Index	%	AS1289 3.3.1	12	
Linear Shrinkage	%	AS1289 3.4.1	4.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
GRAVELLY CLAYEY SAND, FINE TO COARSE, BROWN, LOW PLASTICITY FINES, FINE TO COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

NATA Accredited Laboratory No. 431 Date:
Approved Signature:

W J FIELDHOUSE

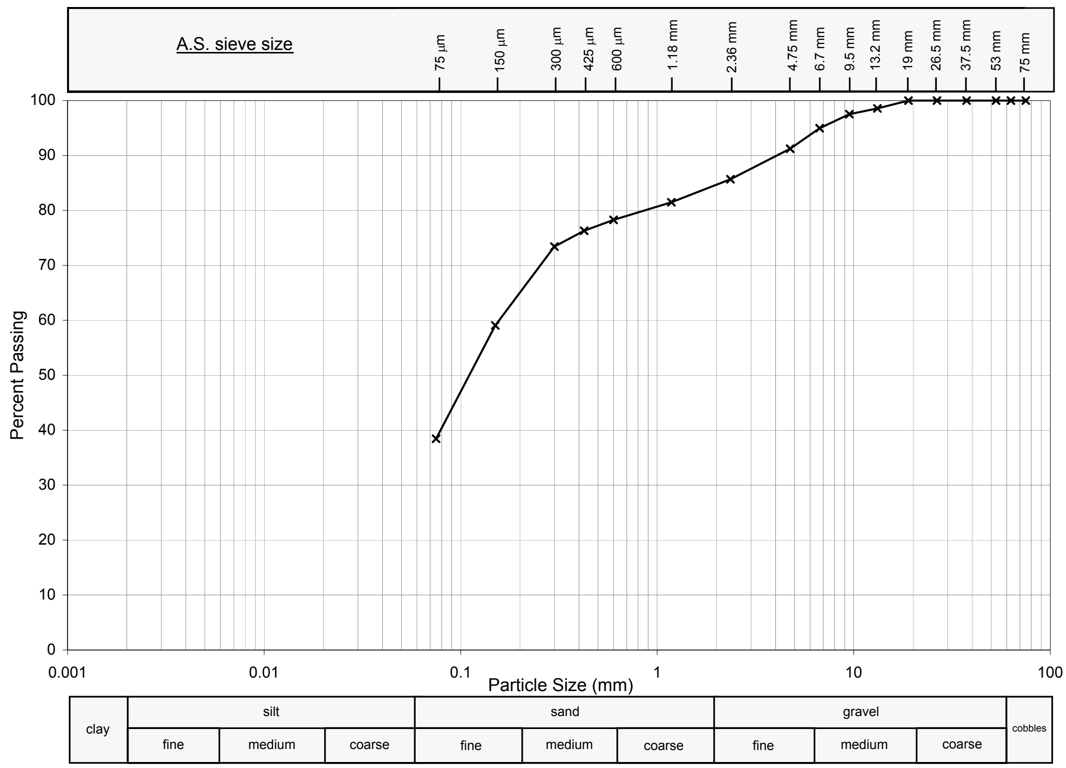
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R13
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2891	**Sample Identification:**	R14. 2A 0.5 - 1.0



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
9.5 mm	98	
6.7 mm	95	
4.75 mm	91	
2.36 mm	86	
1.18 mm	82	
600 um	78	
425 um	76	
300 um	73	
150 um	59	
75 um	38	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	30	
Plastic Limit	%	AS1289 3.2.1	14	
Plasticity Index	%	AS1289 3.3.1	16	
Linear Shrinkage	%	AS1289 3.4.1	5.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
GRAVELLY CLAYEY SAND, FINE TO COARSE, BROWN, LOW PLASTICITY FINES, FINE TO COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA Accredited Laboratory No. 431

Date:

Approved Signature:

W J FIELDHOUSE

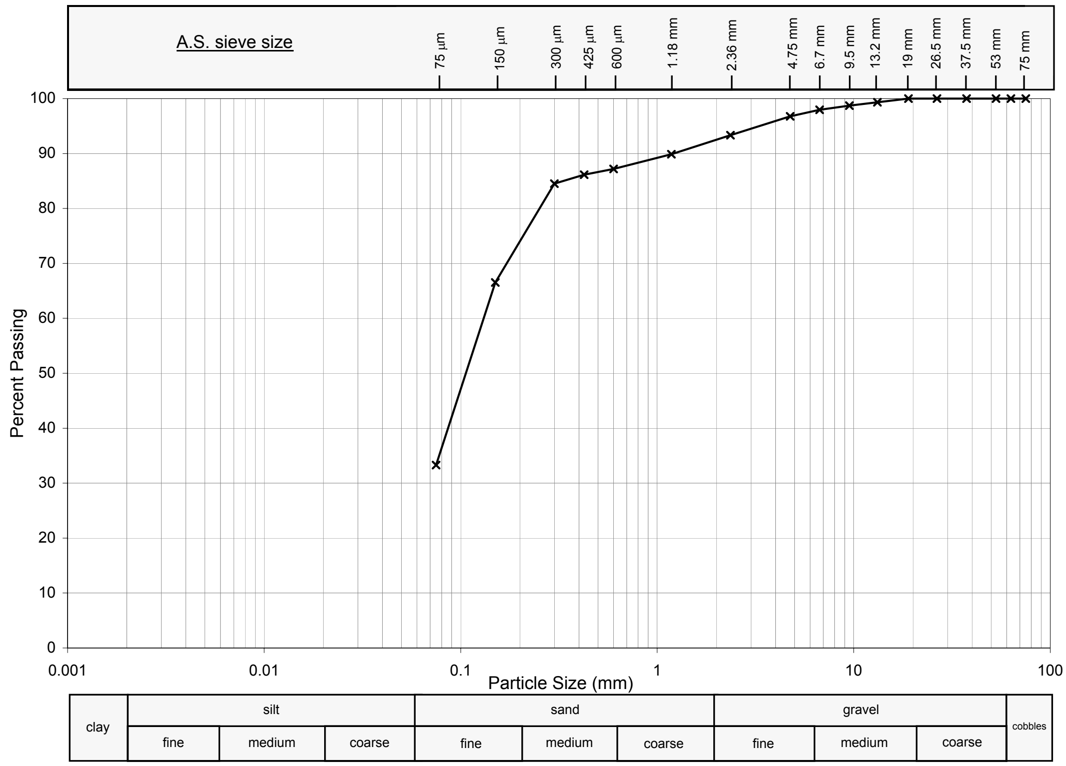
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R12
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2890	**Sample Identification:**	R13. 1C 0.5 - 1.0



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	99	
9.5 mm	99	
6.7 mm	98	
4.75 mm	97	
2.36 mm	93	
1.18 mm	90	
600 um	87	
425 um	86	
300 um	85	
150 um	67	
75 um	33	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	20	
Plastic Limit	%	AS1289 3.2.1	18	
Plasticity Index	%	AS1289 3.3.1	2	
Linear Shrinkage	%	AS1289 3.4.1	0.5	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
SILTY SAND, FINE TO COARSE, BROWN, LOW NON PLASTIC FINES WITH FINE TO MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431
Date:
Approved Signature:

W J FIELDHOUSE

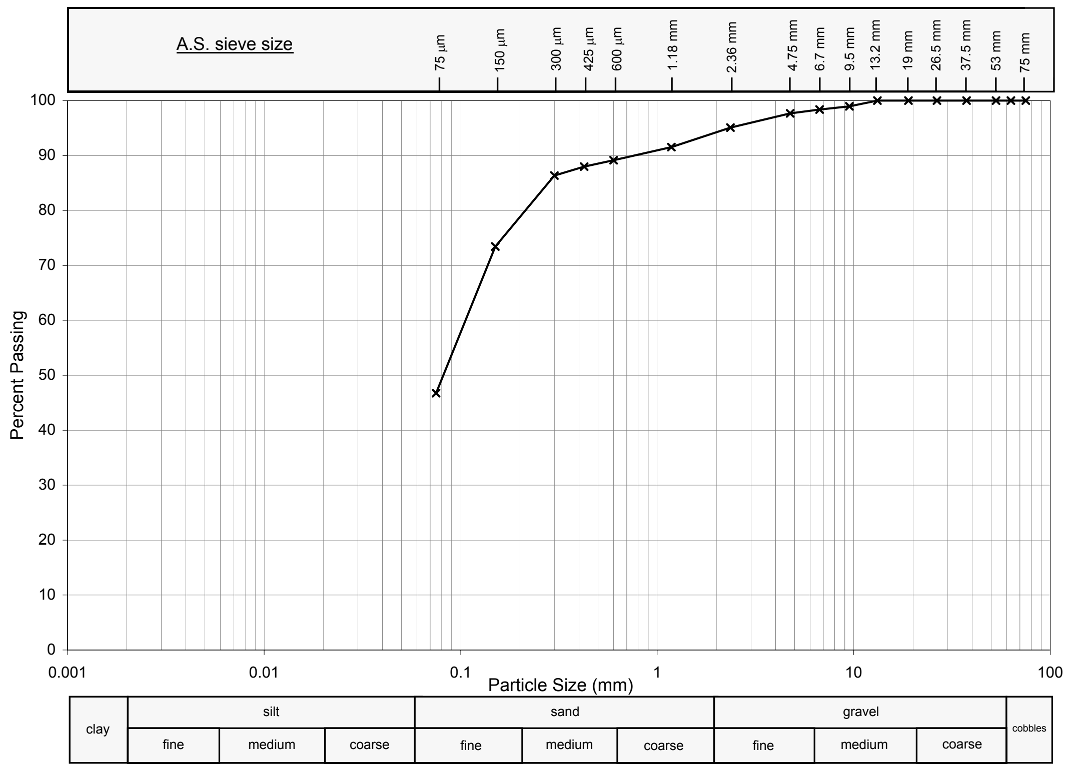
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	00335/AA
Address:	CALLINGTON 42, BACK CALLINGTON ROAD 5254	**Date:**	12-May-07
Principal:		**Report No.**	00335/AA.R11
Project:	PROPOSED TAILING DAM		
Location:	KANMANTOO		
Sample No.:	07S2889	**Sample Identification:**	A9. 2A 2.0 - 2.5



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	100	
19.0 mm	100	
13.2 mm	100	
9.5 mm	99	
6.7 mm	98	
4.75 mm	98	
2.36 mm	95	
1.18 mm	92	
600 um	89	
425 um	88	
300 um	86	
150 um	73	
75 um	47	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	29	
Plastic Limit	%	AS1289 3.2.1	17	
Plasticity Index	%	AS1289 3.3.1	12	
Linear Shrinkage	%	AS1289 3.4.1	4.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 254 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND, FINE TO COARSE, DARK BROWN, LOW PLASTICITY FINES, TRACE FINE TO MEDIUM GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431 Date:

Approved Signature:

W J FIELDHOUSE

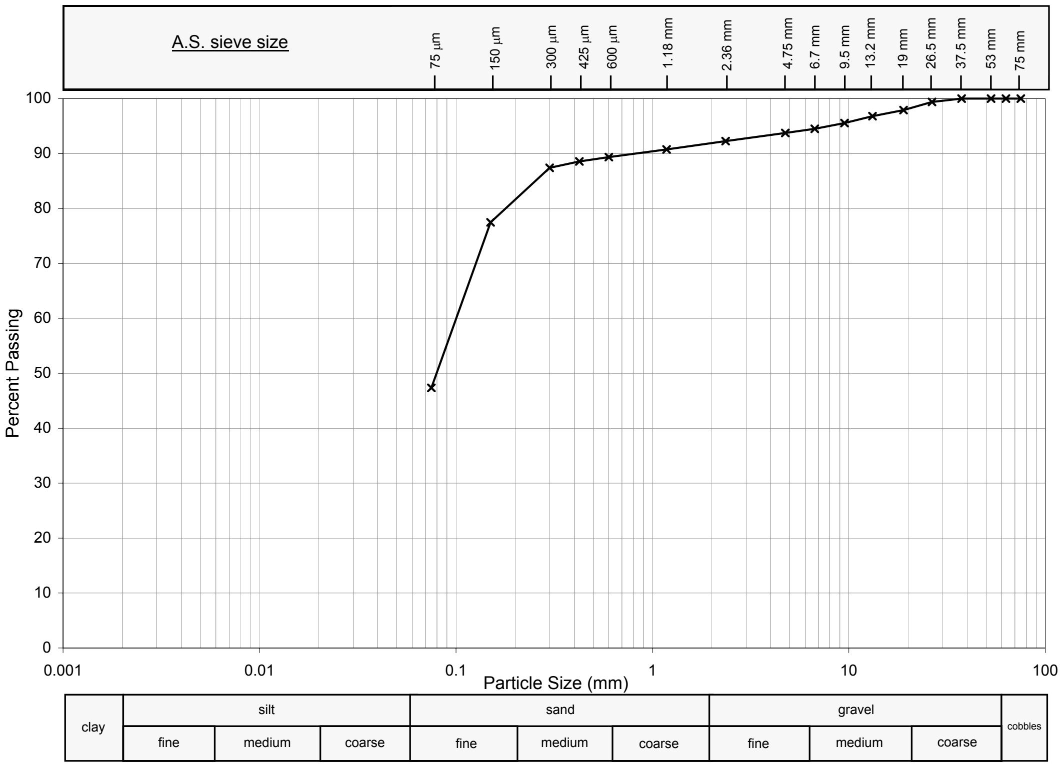
coffey geotechnics
SPECIALISTS MANAGING THE EARTH

A.C.N. 056 929 483

14B Henley Beach Road, Mile End, SA, 5031
Ph: (08) 8352 1744 Fax: (08) 8234 0932

Particle Size Distribution & Atterberg Limits

Client:	HILLGROVE RESOURCES	**Job No.**	MINEHERD00335AA
Address:	42 BACK CALLINGTON ROAD, CALLINGTON SA 5254	**Date:**	2-Apr-07
Principal:		**Report No.**	00335AA-R9
Project:	KANMANTOO TSF		
Location:	KANMANTOO		
Sample No.:	07S-02188	**Sample Identification:**	R10 1.0 - 1.5



Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm	100	
75 mm	100	
53mm	100	
37.5 mm	100	
26.5 mm	99	
19.0 mm	98	
13.2 mm	97	
9.5 mm	96	
6.7 mm	94	
4.75 mm	94	
2.36 mm	92	
1.18 mm	91	
600 um	89	
425 um	89	
300 um	87	
150 um	77	
75 um	47	

Atterberg Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	29	
Plastic Limit	%	AS1289 3.2.1	12	
Plasticity Index	%	AS1289 3.3.1	17	
Linear Shrinkage	%	AS1289 3.4.1	6.0	
Moisture Content	%	AS1289 2.1.1	ND	

Sample History: ☐ Natural State ☐ Air Dried ☑ Oven Dried
Preparation Method: ☑ Dry Sieved ☐ Wet Sieved
Linear shrinkage: ☐ Crumbling ☐ Curling
Mould Length: 250 mm

ND = not determined NO = not obtainable NP = non plastic

Classification:
CLAYEY SAND FINE - COARSE, BROWN, LOW PLASTICITY FINES, TRACE FINE - COARSE GRAVEL

SAMPLE TESTED AS RECEIVED

NATA

NATA Accredited Laboratory No. 431

Date:

Approved Signature:

W J FIELDHOUSE

Appendix C

Estimated Material Volumes

Appendix C Estimated Material Volumes

Area 1	Depth to base of 1C	Depth to base of 2A
1	0.4	1.2
2	1.2	2.6
3	0.6	1.7
4	0.4	1.6
5	0.4	1.1
6	0.5	1.5
7	0.7	1.6
8	0.4	2
9A	1.1	2
10	0.9	1.7
11	0.4	1
12	0.7	1.4
13	0.3	0.9
14	0.25	0.6
15	0.75	1.2
16	0.3	0.9
17	0.4	1
18	0.5	1.4
19	0.4	1
20	0.7	1.5
22	0.2	1.5
23	0.3	1
24	0.3	1.2
25	0.4	1.3
26	0.3	0.85
27	0.4	1.5
28	0.65	1.15
29	0.5	1.5
30	0.55	1.7
39	0.3	1.8
50	0.3	1.1
51	0.2	0.4
52	0.3	1
53	0.4	0.7
54	0.3	1.4
55	0.3	1..5
56	0.3	1.35
57	0.4	0.6
58	0.15	0.4
59	0.5	1
60	0.3	1
61	0.4	1
63	0.4	1.25
64	0.55	0.9
66	0.35	1.15
67	0.3	0.9
68	0	1.5
69	0	0.5
70	0	0.5
71	0	1.5
72	0	1
73	0	0.4
74	0.55	1
75	0.65	1
76	0	0.4
77	0	0.6
93	0	0.45
Average	0.383	1.150
Less top 0.1m	0.28333	1.050
Area (m^2)	748794	
Volume (m^3)	212158	786234

Area 2	Depth to base of 1C	Depth to base of 2A
86	0.3	1
87	0	0.7
88	0	0.6
89	0.5	0.8
90	0.45	0.5
91	0	1
92	0	0.4
94	0	0.9
95	0	1.3
96	0	0.55
97	0	0.6
98	0	0.25
99	0	0.45
100	0	0.9
101	0	1.5
102	0	1.8
103	0	0.8
104	0	1.5
105	0	0.35
106	0	0.55
Average	0.063	0.823
Less top 0.1m	0	0.723
L & W	700	500
Area (m^2)	350000	
Volume (m^3)	0	252875

Prep Plant	Depth to base of 1C	Depth to base of 2A
P1	0.1	1.3
P2	0.3	1.6
P3	0.6	1.5
P4	0.3	1
P5	0.3	1.2
P6	0.3	0.9
P7	0.3	0.6
P8	1.3	1.8
P10	0.9	1.1
P11	1	1.25
P12	1.5	1.7
P13	0.5	1
P14	0.4	0.9
P15	0.45	1.05
P16	0.5	1.1
P17	0.7	1.15
P18	1.5	0.175
P19	0.8	0.9
P20	0.45	0.7
P21	0.3	0.6
P22	0.6	1
P23	0.3	0.5
P24	0.3	0.8
P25	1.15	1.4
P26	0.4	1.4
P27	0.45	1.2
P28	0.3	1.5
P29	0.25	1.05
Average	0.580	1.085
Less top 0.1m	0.480	0.985
L & W	250	250
Area (m^2)	62500	
Volume (m^3)	30022	61551

Access Road	Depth to base of 1C	Depth to base of 2A
A1	3	
A2	2.8	
A3	2.8	
A4	1.4	
A5	3	
A6	0.5	As per 1C
Average	2.250	
Less top 0.1m	2.150	
L & W	100	800
Area (m^2)	80000	
Volume (m^3)	172000	

ROM	Depth to base of 1C	Depth to base of 2A
R1	1.2	1.9
R2	0.5	1
R3	2	2.5
R4	1.5	2.4
R5	3.5	
R6	1.5	2.1
R7	0.7	1.5
R8	0.8	1.3
Average	1.463	1.814
Less top 0.1m	1.363	1.714
L & W	300	150
Area (m^2)	45000	
Volume (m^3)	61312.5	77143

Total Volumes		
Unit (Type)	1C (A)	2A (B)
m^3	475493	1349803

Appendix D

Estimated Detail Design Stage Material Search Costs

CLIENT:	**HILLGROVE COPPER PTY LTD**	Date	23-Jul-07
PROJECT:	**KANMANTOO PROJECT -**	Job No	MH00335AA-RE01
LOCATION:	**KANMANTOO, via CALLINGTON**	Revision	
SUBJECT:	**ESTIMATE OF FEES AND COSTS DETAILED DESIGN STAGE**		

Item		Unit	Quantity	Rate	Amount
1.0	**PROJECT PLANNING**				
1.1.01	Senior Principal Engineering Geologist/Geotechnical Engineer	hour		$ 250.00	$ -
1.1.02	Geotechnical Engineer	hour	7.5	$ 130.00	$ 975.00
1.1.04	Vehicle kilometers	km	120	$ 0.85	$ 102.00
2.0	**FIELDWORK**				
2.1	**Fieldwork Direction and Logging**				
2.1.01	Senior Geotechnician (10hr day) - Mike Hilsberg	days	25	$ 1,050.00	$ 26,250.00
2.1.02	time in excess of 10hrs per day	hr		$ 105.00	$ -
2.1.03	Geotechnical Engineer - Paul Greenhalf	days		$ 1,250.00	$ -
2.1.04	time in excess of 10hrs per day	hr		$ 125.00	$ -
2.1.05	travel (per km)	km		$ 0.85	$ -
2.1.06	Field Equipment (Hand auger, penetrometer, Clegg Hammer)	days		$ 55.00	$ -
2.2	**Subcontract Services (cost plus 10.0%)**				
2.2.1	**Buried Services Location**				
2.2.1.01	Cable Locator	hr		$ 88.00	Rate only
2.2.3	**Boreholes for Site investigation (if required)**				
2.2.3.01	Geotechncial drilling rig and establishment	days		$ 1,250	$ -
2.2.4	**Testpitting**				
2.2.4.01	Backhoe/Excavator Hire	days	25	$ -	By client
2.2.5	**Surveying**				
2.2.5.01	Pick up test locations				By client
2.3	**Disbursements (cost plus 10%)**				
2.3.01	Airfares	no.		$ -	$ -
2.3.02	Vehicle Hire (incl fuel, insurance and excess kms)	days		$ 120.00	$ -
2.3.03	Sample / Equipment Freight	sum		$ -	$ -
2.3.04	Taxi fares, to / from airport	sum		$ -	$ -
2.3.05	Meals & Accommodation (Coffey)	days		$ -	$ -
	ITEMS 1.0 and 2.0 TOTAL				**$ 27,327.00**

CLIENT:	**HILLGROVE COPPER PTY LTD**	Date	23-Jul-07
PROJECT:	**KANMANTOO PROJECT -**	Job No	MH00335AA-RE01
LOCATION:	**KANMANTOO, via CALLINGTON**	Revision	
SUBJECT:	**ESTIMATE OF FEES AND COSTS DETAILED DESIGN STAGE**		

Item		Unit	Quantity	Rate	Amount
3.0	**LABORATORY TESTING**				
3.1	**Geotechnical testing (Coffey Geotechnics P/L Adelaide Laboratory)**				
3.1.01	Particle Size Distribution (<6mm Max. Particle Size)	no.		$ 75.00	$ -
3.1.02	Percentage Fines	no.	225	$ 40.00	$ 9,000.00
3.1.03	Atterberg Limits (4 point method incl linear shrinkage)	no.	225	$ 130.00	$ 29,250.00
3.1.04	Moisture Content	no.		$ 15.00	$ -
3.1.05	Shrink Swell Test	no.		$ 100.00	$ -
3.1.07	Maximum Dry Density (Standard Compaction)	no.	25	$ 70.00	$ 1,750.00
3.1.08	California Bearing Ratio (xcluding compaction test)	no.		$ 110.00	$ -
3.1.09	Emerson Class	no.		$ 50.00	$ -
3.1.10	Organic Content (LOI)	no.		$ 60.00	$ -
3.1.11	Point Load Strength Index	no.		$ 35.00	$ -
3.1.12	Unconsolidated Undrained Triaxial Test with pore pressure etc	no.		$ 700.00	$ -
3.1.13	Permeability Test (98% Standard compaction)	no.	25	$ 350.00	$ 8,750.00
	ITEM 3.0 TOTAL				**$ 48,750.00**
4.0	**EVALUATION, ANALYSIS AND REPORTING**				
	Factual report from investigations (4 copies)				$ 7,500.00
	Detailed design report (4 copies)				$ 10,000.00
4.01	Senior Principal Engineering Geologist/Geotechnical Engineer	hour		$ 250.00	$ -
4.02	Principal Geotechnical Engineer / Geologist	hour		$ 205.00	$ -
4.03	Associate Engineer / Geologist	hour		$ 180.00	$ -
4.04	Senior Engineering Geologist/Geotechnical/Civil Eng	hour		$ 160.00	$ -
4.05	Project Engineering Geologist/Geotechnical Engineer	hour		$ 120.00	$ -
4.06	Drafting	hour		$ 85.00	$ -
4.07	Word Processing	hour		$ 80.00	$ -
4.08	Report reproduction costs	copy		$ 150.00	estimate
	(photographs, plan / sepia printing, colour photocopying)				
	ITEM 4.0 TOTAL				**$ 17,500.00**
5.0	**PROJECT MANAGEMENT AND LIAISON**			estimate	$ 1,000.00
5.01	Senior Principal Engineering Geologist/Geotechnical Engineer	hour		$ 250.00	$ -
5.02	Principal Geotechnical Engineer / Geologist	hour		$ 205.00	
5.03	Senior Geotechnical Engineer	hour		$ 180.00	$ -
5.04	Expenses (travel, communications)	estimate			$ -
	ITEM 5.0 TOTAL				**$ 1,000.00**
	COST ESTIMATE TOTAL				**$ 94,577.00**
	GOODS AND SERVICES TAX (10%)				**$ 9,457.70**
	TOTAL COST INCLUSIVE OF GST				**$ 104,034.70**

Appendix E

Important information about your Coffey Mining report

Important information about your **Coffey** Mining Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey Mining to work with other project design professionals who are affected by the report. Have Coffey Mining explain the report implications to design professionals affected by them and then review plans and specifications produced to see how Coffey Mining's report findings have been incorporated.

Data should not be separated from the report*

The report as a whole presents the findings of the site or project assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field data and laboratory evaluation of field samples. This information should not, under any circumstances, be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey Mining for information relating to geoenvironmental issues.

Rely on Coffey Mining for additional assistance

Coffey Mining is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties involved with a project, from design through to development. It is common that not all approaches will necessarily be examined in your report due to concepts proposed at that time. If problems are encountered as the project progresses through design toward development, speaking with Coffey Mining about alternative approaches may be of genuine benefit both in terms of time and cost.

Third party and client data

Coffey Mining may have used or relied upon information provided by the client or by third parties. Unless specifically included in Coffey Mining's scope of services, Coffey Mining has not checked or verified the accuracy of such information.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion, and has a level of uncertainty attached to it that makes it far less exact than the design disciplines. This has often resulted in unfounded claims being lodged against consultants. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey Mining to other parties but are included to identify where Coffey Mining's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey Mining closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Constructions Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987

Important information about your **Coffey** Mining Report

These notes have been prepared by Coffey Mining to help you interpret and understand the limitations of your report. They are additional to any limitations noted within the report.

Your report is based on project specific criteria

Your report has been developed on the basis of Coffey Mining's understanding of your unique, project-specific requirements, and applies only to the project investigated. Project criteria typically include the general nature of the project; its size and configuration; geology and rock mass conditions; the location of any infrastructure on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. If there are any changes to the project subsequent to the date of the report, the report should not be used without first asking Coffey Mining to assess how the changes affect the report's recommendations. Coffey Mining cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time or rock mass conditions may change as a result of mining or other activity in the area. Because a report is based on conditions which existed at the time of the study, decisions should not be based on a report that may have been rendered inadequate by the passage of time. Consult Coffey Mining to be advised how time may have impacted on the project.

Interpretation of factual data

Rock mass assessment identifies actual subsurface conditions only at those points where samples are taken and only at the time of sampling. Data derived from literature and external data source reviews, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall rock mass conditions, their likely impact on proposed developments and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. Nothing can be done to change the actual rock mass conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey Mining throughout development stages, to identify variances, conduct additional testing if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations for proposed developments

Your report is based on the assumption that the rock mass conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. For proposed developments this assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey Mining is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey Mining cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey Mining before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

FACTUAL REPORT OF SAMPLING TAILINGS MATERIAL FROM EXISTING TAILING STORAGE FACILITY

Justin Burke

Kanmantoo, Callington SA

MINEMEND04511AA_RE01_V01

24 July 2007

Coffey Mining Pty Ltd ABN 52 065 481 209
14B Henley Beach Road Mile End SA 5031 Australia

24 July 2007

HILLGROVE COPPER PTY LTD
Level 41, 264-278 George Street,
Sydney, NSW 2000

Attention: Mr. Marty Adams

Project Manager

Dear Sir

RE: FACTUAL REPORT OF SAMPLING TAILINGS MATERIAL FROM EXISTING TAILING STORAGE FACILITY

This letter presents the factual report of sampling tailings material fro m the existing Tailings Storage Facility at the Kanmantoo Copper Project at Callington, SA.

If you have any questions related to the report or we can be of further assistance, please do not hesitate to contact Mr Justin Burke in our Adelaide office (08 8352 1744).

For and on behalf of Coffey Mining Pty Ltd

Justin Burke

Geotechnical Engineer

DOCUMENT INFORMATION

Status	Draft
Version	v00A
Print Date	24 July 2007
Approval State	
Author(s)	Justin Burke
Reviewed By	Chris Lane
Path Name	C:\Coffey Mining\04511AA Kantoo Old Tailings sampling\REPORTS\MINEMEND04511AA_RE01_V01_Tailings sampling factual.doc
File Name	MINEMEND04511AA_RE01_V01_Tailings sampling factual
Project No	MINEMEND04511AA_RE01_V01
Distribution	3 copies HILLGROVE COPPER PTY LTD 1 copy Coffey Mining Pty Ltd Library Original Coffey Mining Pty Ltd 1 electronic PDF copy HILLGROVE COPPER PTY LTD on CD

DOCUMENT CHANGE CONTROL

Version	Description (section(s) amended)	Author(s)	Date

DOCUMENT REVIEW AND SIGN OFF

Name	Position	Role	Signature	Date Issued
Justin Burke	Geotechnical Engineer	Author		24 July 2007
Chris Lane	Senior Principal Engineer	Reviewer		

Figures

Appendices

1 INTRODUCTION

Sampling of the existing tailings material at the Kanmantoo mine-site has been undertaken by Coffey Mining Pty Ltd (Coffey) for Hillgrove Resources Ltd (Hillgrove) for the Kanmantoo Copper project at Callington, SA.

The tailings material was sampled for geochemical analysis and to provide information on the oxidation profile. The samples were forwarded to Graeme Campbell and Associates Pty Ltd for geochemical analysis.

The investigation was commissioned by Hillgrove Copper Pty Ltd in purchase order number 3151 dated 7 May 2007. The scope of work undertaken was broadly consistent with that outlined in a proposal prepared by Coffey dated 26 April 2007 (reference: MINEMEND04511AA_FAX01_V001).

This factual report describes the fieldworks undertaken and summarises the subsurface conditions encountered.

2 OUTLINE OF THE INVESTIGATION

2.1 Fieldworks

The fieldwork was carried out on 17 May 2007 and comprised:

- Drilling 4 bore holes (designated BH1 to BH4) and recovering materials from each location for analysis;
- Installation of peizometers in 3 drills holes to assess groundwater conditions.

The boreholes were drilled with an Ezi probe rig mounted on a 4WD vehicle. Samples were recovered using push tube drilling technique.

Table 1 below summarises the boreholes details, depth, location and peizometer installation.

The boreholes were located to provide a range of tailings materials as deposited by the beaching effect of the tailings deposition. Each borehole location was measured with a hand held GPS with the co-ordinates recorded on the borehole log. The location of the boreholes is shown in Figure 1.

The field investigation was undertaken in the presence of a Senior Technical Officer from Coffey who was responsible for logging the tailings profile encountered and recovering samples for subsequent laboratory testing. Detailed logs of the boreholes is attached in Appendix A

3 SITE CONDITIONS

3.1 Surface Conditions

The surface of the existing tailings site consisted of gently sloping grassed area with no trees.

The retention dams were visible on the eastern and western drainage paths, marking the boundary of the original terrain. Generally the site was clear of trees in the area investigated,

3.2 Subsurface Conditions

Field descriptions of the main geological units encountered in the boreholes are summarised in Table 1. The field descriptions were based on a visual assessment of the recovered material.

The depth range of the geological units in each borehole is summarised in the detailed borehole logs in Appendix A.

The depth of oxidised tailings material is summarised in Table 2 below. The oxidised material was estimated from the colour of the tailings material; orange and brown defined as oxidised, grey defined as fresh/non oxidised tailings material.

The intent of each borehole was establish the depth of oxidation, groundwater and the depth to the natural material. BH3 did not intersect natural material nor groundwater within the 15m capacity of the drill rig. The walls of BH4 continually collapsed and could not be taken to further depth.

A summary of the peizometer installations are included in Table 3 below. All peizometers were installed with PVC slotted screen with solid PVC upper sections. The annulus of the wells was backfilled were possible with filter sand, capped with bentonite and concrete.

The peizometers were covered with lockable steel stand pipe gattics.

Table 1: Generalised Description of Main Geological Units Encountered

Depth range (m)	Unit Soil Descriptions	Summary Logs
0 to 0.4	Described as Sandy CLAY to Clayey SAND, low to medium plasticity, light brown, brown and orange, sand fine to medium grained, dry / moist	Surface capping
0.4 to >15	Tailings material described as Sandy SILT/Silty SAND/SILT, fine to medium grained sand, light grey to grey with some light brown to grey material near surface	Tailings
7.0 and 7.6. Not found in BH3 and BH4	Sandy CLAY generally medium to high plasticity, red brown, sand fine to medium grained, dry / moist.	Natural surface

Table 2: Summary of oxidation, natural surface and borehole depths.

Borehole	Estimated depth to base of oxidised tailings (m)	Depth to natural surface (m)	Total Depth (m)
BH1	**5.0**	**7.6**	**7.9**
BH2	**1.2**	**7.0**	**7.25**
BH3	**2.6**	**Not intersected**	**15.0**
BH4	**3.6**	**Not intersected**	**11.5**

Table 3: Summary of peizometer installation

Borehole	Depth to base of well screen (m)	Depth to base of solid (m)	Comments
BH1	7.70	0.2	Borehole collapse from 7.7 to 7.9m
BH2	7.25	0.8	
BH3	-	-	No well installed
BH4	10.55	1.8	Borehole collapse from 10.55 to 11.5m

3.3 Groundwater

Groundwater was encountered three boreholes (BH1, BH2 and BH4).

Table 4 below summarises the groundwater level below the surface.

Table 4 Summary of groundwater level below surface

Borehole	Groundwater level below surface (m)
BH1	6.0
BH2	3.2
BH3	No groundwater observed
BH4	8.5

4 LIMITATIONS

The findings contained within this report are the result of limited investigations conducted in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

For and on behalf of
Coffey Geotechnics Pty Ltd

Appendix A

Borehole logs

coffey geotechnics

Engineering Log - Borehole

Borehole No.	**BH1**
Sheet	1 of 1
Project No:	**MINEMEND04511AA**
Date started:	**17.5.2007**
Date completed:	**17.5.2007**
Logged by:	**MBH:rn**
Checked by:	

Client: **HILLGROVE RESOURCES LIMITED**

Principal:

Project: **EXISTING TAILINGS SAMPLING**

Borehole Location: **REFER TO FIGURE 1**

drill model and mounting:	EZIPROBE, 4WD	Easting:	317512	slope:	-90°	R.L. Surface:	
hole diameter:	60 mm	Northing	6116075	bearing:		datum:	NOT MEASURED

drilling information / **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency/density index	pocket penetrometer kPa (100 200 300 400)	structure and additional observations
Push Tube		Nil				0.0–0.2			**FILL: SANDY CLAY:** medium plasticity, brown, fine to medium grained sand.	M			FILL
						0.2–2.2			**FILL: SILTY SAND:** fine to medium plasticity, light grey.				TAILINGS
									becomes grey.				
						2.2–5.1			**FILL: SANDY SILT:** non plastic, dark brown, grey.				
									SAND and **SILT** layer, 0.05 m thick, fine to medium grained sand, and silt.				
						5.1–7.6			**FILL: SILT:** grey, non plastic.				
			▼ (6.0)							W (from 5.9)			
						7.6–7.9		CH	**SANDY CLAY:** medium plasticity, fine to medium grained sand, brown.				NATURAL
						7.9			Borehole BH1 terminated at 7.9m				

method		support	notes, samples, tests		classification symbols and soil description	consistency/density index	
AS	auger screwing*	M mud N nil	U_{50}	undisturbed sample 50mm diameter	based on unified classification system	VS	very soft
AD	auger drilling*	C casing	U_{63}	undisturbed sample 63mm diameter		S	soft
RR	roller/tricone	**penetration** 1 2 3 4	D	disturbed sample		F	firm
W	washbore	no resistance ranging to refusal	N	standard penetration test (SPT)		St	stiff
CT	cable tool		N*	SPT - sample recovered	**moisture**	VSt	very stiff
HA	hand auger	**water**	Nc	SPT with solid cone	D dry	H	hard
DT	diatube	10/1/98 water level on date shown	V	vane shear (kPa)	M moist	Fb	friable
B	blank bit		P	pressuremeter	W wet	VL	very loose
V	V bit	water inflow	Bs	bulk sample	Wp plastic limit	L	loose
T	TC bit	water outflow	E	environmental sample	W_L liquid limit	MD	medium dense
*bit shown by suffix			R	refusal		D	dense
e.g.	ADT					VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	*BH2*
Sheet	1 of 1
Project No:	*MINEMEND04511AA*
Client:	*HILLGROVE RESOURCES LIMITED*
Date started:	*17.5.2007*
Principal:	
Date completed:	*17.5.2007*
Project:	*EXISTING TAILINGS SAMPLING*
Logged by:	*MBH:rn*
Borehole Location:	*REFER TO FIGURE 1*
Checked by:	

drill model and mounting:	EZIPROBE, 4WD	Easting:	317658	slope:	-90°	R.L. Surface:	
hole diameter:	60 mm	Northing	6115942	bearing:		datum:	NOT MEASURED

drilling information / **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
Push Tube		Nil				0.0–0.2			**FILL: SANDY CLAY:** medium plasticity, light brown, fine to medium grained sand.	M			TAILINGS
						0.2–0.6			**FILL: SANDY SILT / SILTY SAND:** fine to medium grained, brown.				pyrite
			▼ (3.1) ► (6.0)			0.6–7.0			**FILL: SILTY SAND:** fine to medium grained, grey.	W (from 5.0), M (from 6.8)			
						7.0–7.2		CH / CL	**SANDY CLAY:** medium to high plasticity, brown.				NATURAL
						7.2			Borehole BH2 terminated at 7.2m				

method

AS	auger screwing*
AD	auger drilling*
RR	roller/tricone
W	washbore
CT	cable tool
HA	hand auger
DT	diatube
B	blank bit
V	V bit
T	TC bit

*bit shown by suffix e.g. ADT

support

M mud N nil
C casing

penetration

1 2 3 4 — no resistance ranging to refusal

water

▼ 10/1/98 water level on date shown
► water inflow
◄ water outflow

notes, samples, tests

U_{50}	undisturbed sample 50mm diameter
U_{63}	undisturbed sample 63mm diameter
D	disturbed sample
N	standard penetration test (SPT)
N*	SPT - sample recovered
Nc	SPT with solid cone
V	vane shear (kPa)
P	pressuremeter
Bs	bulk sample
E	environmental sample
R	refusal

classification symbols and soil description

based on unified classification system

moisture

D	dry
M	moist
W	wet
Wp	plastic limit
W_L	liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	**BH3**
Sheet	1 of 2
Project No:	**MINEMEND04511AA**
Date started:	**17.5.2007**
Date completed:	**17.5.2007**
Logged by:	**MBH:rn**
Checked by:	

Client: **HILLGROVE RESOURCES LIMITED**

Principal:

Project: **EXISTING TAILINGS SAMPLING**

Borehole Location: **REFER TO FIGURE 1**

drill model and mounting:	EZIPROBE, 4WD	Easting:	318062	slope:	-90°	R.L. Surface:	
hole diameter:	60 mm	Northing	6116131	bearing:		datum:	NOT MEASURED

drilling information / **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
Push Tube		Nil							**FILL: CLAYEY SAND:**medium plasticity, orange brown, fine to coarse granied sand.	D			TAILINGS no well installed
									FILL: SILTY SAND:fine to medium grained, light brown, grey.	M			
						1							
						2							
									becomes grey.				
						3							
									FILL: SAND:fine to medium grained, grey and purple garnets.				
						4							
						5							
						6							
						7							
						8							

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration
1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

BOREHOLE 04511.AA BH1 TO BH4.GPJ COFFEY.GDT 22.5.07

Form GEO 5.3 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Borehole

Borehole No.	BH3
Sheet	2 of 2
Project No:	MINEMEND04511AA
Client:	HILLGROVE RESOURCES LIMITED
Date started:	17.5.2007
Principal:	
Date completed:	17.5.2007
Project:	EXISTING TAILINGS SAMPLING
Logged by:	MBH:rn
Borehole Location:	REFER TO FIGURE 1
Checked by:	

drill model and mounting:	EZIPROBE, 4WD	Easting:	318062	slope:	-90°	R.L. Surface:	
hole diameter:	60 mm	Northing	6116131	bearing:		datum:	NOT MEASURED

drilling information / **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
Push Tube						9–15			**FILL: SAND:** fine to medium grained, grey and purple garnets. *(continued)*	M			
						15–17			Borehole BH3 terminated at 15m				

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration
1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey geotechnics

Engineering Log - Borehole

Borehole No.	**BH4**
Sheet	1 of 2
Project No:	**MINEMEND04511AA**
Client:	**HILLGROVE RESOURCES LIMITED**
Date started:	**17.5.2007**
Principal:	
Date completed:	**17.5.2007**
Project:	**EXISTING TAILINGS SAMPLING**
Logged by:	**MBH:rn**
Borehole Location:	**REFER TO FIGURE 1**
Checked by:	

drill model and mounting:	EZIPROBE, 4WD	Easting:	317805	slope:	-90°	R.L. Surface:	
hole diameter:	60 mm	Northing	6116057	bearing:		datum:	NOT MEASURED

drilling information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
Push Tube		Nil							**FILL: CLAYEY SAND:** fine to medium grained, low to medium plasticity clay, orange brown, dry.	D	L / MD		TAILINGS
									FILL: SILTY SAND / SANDY SILT: fine to medium grained, light brown and grey.				
						1							
						2							
						3				M			
						4			grey.				
						5							
						6							
						7							
									FILL: SANDY SILT: grey, fine to coarse grained sand.				
			▼			8							

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration
1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

coffey geotechnics

Engineering Log - Borehole

Client:	HILLGROVE RESOURCES LIMITED	Borehole No.	BH4
Principal:		Sheet	2 of 2
Project:	EXISTING TAILINGS SAMPLING	Project No:	MINEMEND04511AA
Borehole Location:	REFER TO FIGURE 1	Date started:	17.5.2007
		Date completed:	17.5.2007
		Logged by:	MBH:rn
		Checked by:	

drill model and mounting:	EZIPROBE, 4WD	Easting:	317805	slope:	-90°	R.L. Surface:	
hole diameter:	60 mm	Northing	6116057	bearing:		datum:	NOT MEASURED

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetro-meter kPa 100 200 300 400	structure and additional observations
Push Tube						9, 10, 11			**FILL: SANDY SILT:** grey, fine to coarse grained sand. *(continued)*	W	L / MD		
						12, 13, 14, 15, 16, 17			Borehole BH4 terminated at 11.5m				

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration
1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Appendix B

Important information about your Coffey Mining report

Important information about your **Coffey** Mining Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey Mining to work with other project design professionals who are affected by the report. Have Coffey Mining explain the report implications to design professionals affected by them and then review plans and specifications produced to see how Coffey Mining's report findings have been incorporated.

Data should not be separated from the report*

The report as a whole presents the findings of the site or project assessment and the report should not be copied in part or altered in any way. Logs, figures, drawings etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field data and laboratory evaluation of field samples. This information should not, under any circumstances, be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey Mining for information relating to geoenvironmental issues.

Rely on Coffey Mining for additional assistance

Coffey Mining is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties involved with a project, from design through to development. It is common that not all approaches will necessarily be examined in your report due to concepts proposed at that time. If problems are encountered as the project progresses through design toward development, speaking with Coffey Mining about alternative approaches may be of genuine benefit both in terms of time and cost.

Third party and client data

Coffey Mining may have used or relied upon information provided by the client or by third parties. Unless specifically included in Coffey Mining's scope of services, Coffey Mining has not checked or verified the accuracy of such information.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion, and has a level of uncertainty attached to it that makes it far less exact than the design disciplines. This has often resulted in unfounded claims being lodged against consultants. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey Mining to other parties but are included to identify where Coffey Mining's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey Mining closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Constructions Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987

Important information about your **Coffey** Mining Report

These notes have been prepared by Coffey Mining to help you interpret and understand the limitations of your report. They are additional to any limitations noted within the report.

Your report is based on project specific criteria

Your report has been developed on the basis of Coffey Mining's understanding of your unique, project-specific requirements, and applies only to the project investigated. Project criteria typically include the general nature of the project; its size and configuration; geology and rock mass conditions; the location of any infrastructure on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. If there are any changes to the project subsequent to the date of the report, the report should not be used without first asking Coffey Mining to assess how the changes affect the report's recommendations. Coffey Mining cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time or rock mass conditions may change as a result of mining or other activity in the area. Because a report is based on conditions which existed at the time of the study, decisions should not be based on a report that may have been rendered inadequate by the passage of time. Consult Coffey Mining to be advised how time may have impacted on the project.

Interpretation of factual data

Rock mass assessment identifies actual subsurface conditions only at those points where samples are taken and only at the time of sampling. Data derived from literature and external data source reviews, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall rock mass conditions, their likely impact on proposed developments and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. Nothing can be done to change the actual rock mass conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey Mining throughout development stages, to identify variances, conduct additional testing if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations for proposed developments

Your report is based on the assumption that the rock mass conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. For proposed developments this assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey Mining is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey Mining cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey Mining before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

30 July 2007

Hillgrove Copper Pty Ltd
42 Back Callington Road
Callington SA 5254

Attention: Marty Adams

Dear Sir

RE: TAILINGS TESTWORK - KANMANTOO COPPER PROJECT

1 INTRODUCTION

This letter presents the interpretation of the results of the tailings testwork carried out by Coffey Geotechnics Pty Ltd on the tailings supplied for the Kanmantoo Copper Project for Hillgrove Copper Pty Ltd.

2 BACKGROUND INFORMATION

Tailings were received in February 2007 from Amdel. The slurry density of the "as received tailings" was not provided. In the absence of the final slurry density the tailings testing was undertaken at the as received density determined to be 58.9% solids.

The laboratory testwork, completed by NATA registered Coffey Geotechnics Pty Ltd soil testing laboratories at 24 Hasler Road Herdsman, comprised:

- One particle size distribution;
- One plasticity index test;
- One soil particle density;
- One air-drying test;
- One undrained settling test; and
- One drained settling test.

Results of these tests are presented in Appendix A.

The laboratory testwork, completed by Tricon Testing soil testing laboratories at 5/8 Corbuster Place, Balcatta, comprised:

- One modified triaxial test; and
- Three permeability tests.

Results of these tests are presented in Appendix B.

3 DISCUSSION OF TESTWORK

3.1 Tailings Classification Tests

The results of the particle size distribution and plasticity index tests indicate the tailings are predominantly a fine to medium sand, with 15% fines (material finer than 75 microns) and are non plastic, with a unified soil classification of SM.

The soil particle density is 3.10.

3.2 Air-drying Test

The results of the air drying test of the tailings indicate that after a period of approximately 6 days the dry density of 1.396 t/m^3, with a residual moisture content of 9.68% was reached. Beyond 6 days the residual moisture dropped rapidly.

These air drying tests were undertaken at drying temperatures of 45^o to 50^o C and seasonal variation in temperature will significantly impact on drying times and retained moisture in the tailings.

3.3 Undrained Settling Tests

The undrained settling test typically simulates the conditions part way down the tailings beach, away from the tailings discharge point where segregation of the coarse fraction of the tailings typically occurs as a result of rapid drop in velocity.

Typically the tailings part way down the tailings beach near the centre of the storage are where drainage of tailings is limited by the nature of the underlying tailings and floor of the TSF. The objective of this test is to monitor the tailings settlement and the development of 'clear' supernatant water (surface water) in undrained conditions. By monitoring the percentage of supernatant, with respect to the initial water volume, an indication of the volume of water that will be available for recovery, and the speed at which this water is released as the tailings settle, can be assessed.

The laboratory results show the available supernatant water with respect to the total water discharged to the tailings storage. The points to note from the laboratory results for tailings at 58.9% solids are:

- The maximum water available from testing, approximately 43%, was achieved approximately 105 minutes after tailings deposition, under ideal conditions.
- The dry density of the tailings after 105 minutes was 1.379 t/m^3 in the undrained settling test.

It should be noted that if the tailings are deposited subaerially, then water recovery under field conditions is likely to match the results achieved in the laboratory, although given the coarse nature of the tailings seepage losses will occur into the tailings stack. Evaporation will have limited effect on the supernatant water if the beaching of the tailings is such that the decant recovery is maximised.

3.4 Drained Settling Test

The drained settling test is similar to the undrained settling test except that it typically simulates the conditions midway down the tailings beach and near the centre of the storage where drainage of tailings is not limited by the relatively impermeable nature of the underlying tailings and rock.

The objective of this test is also to monitor the tailings settlement and the development of 'clear' supernatant water and flow into any underdrainage in drained conditions. By monitoring the percentage of supernatant and underdrainage with respect to the initial water volume an indication of how much water could be available for recovery and the speed at which this water is released can also be assessed.

The points to note from the laboratory results for tailings at 58.9% solids are:

- The maximum water available from testing, approximately 50%, was achieved approximately 143 hours or 6 days after tailings deposition.
- The dry density of the tailings after 143 hours was 1.486 t/m^3 in the drained settling test.
- Supernatant water develops at a rate similar to that measured for the undrained test. However, the supernatant water development peaks within 15 minutes of deposition and then decreases.
- The impact of flow through the tailings stack occurs rapidly indicating that significant volumes of water could percolate through the tailings stack and the design should be based on full hydrostatic conditions. The actual volumes of flow through the tailings stack will be a function of the tailings beach slopes which develop and the efficiency of the decant system to remove the supernatant. Some movement of water may have occurred between the interface of the tailings and the wall of the cylinder however this is suspected to be minor given the predominantly sandy nature of the tailings.

It should be noted that if the tailings are deposited subaerially, then water recovery under field conditions is likely to match the results achieved in the laboratory, as evaporation is likely to have limited impact in removing water from the system other than where water is allowed to pond for long periods.

3.5 Modified Triaxial Testing

The results of the modified triaxial testing indicates that the dry density of the tailings is likely to be in the order of 1.65 t/m^3, minimum. For planning purposes a dry density of 1.50 t/m^3 is recommended. The final dry density could be up to 1.80 t/m^3.

3.6 Permeability Testing

The results of the permeability testing indicates that the permeability of the tailings is likely to be in the order of 10^{-5} m/sec during the initial placement and then reduce to 10^{-6} m/sec as the overburden loading increases.

4 IMPLICATIONS FOR TSF OPERATION

From a review of the test results, and from experience of performance of other tailings storage facilities, the following comments are made:

(i) The tailings are predominantly sand with non plastic fines. This means that the tailings will settle rapidly, releasing water for return via a decant system, as they will readily “bleed”, resulting in free water discharge. The tailings will also “self drain”, resulting in water percolation into the tailings stack and underlying underdrainage system. The water recovery will be a function of the slope of the tailings beaches which develop, the efficiency of the gravity decant system and the efficiency of the underdrainage system. Water recovery from the decant and underdrainage systems is expected to be high given the settling characteristics of the tailings.

(ii) Depending on the deposition velocity the tailings could form a relatively steep initial beach slope, a concave surface towards the decant. Overall beach slopes are anticipated to be in the range of 1% to 2%.

(iii) The tailings mass as a whole is expected to form a low permeability (Terzaghi and Peck 1967) tailings stack as a result of random horizontal and vertical, segregation and sedimentation of the non plastic fine fraction of the tailings. This should ensure that the tailings bed remains saturated during the operational life of the TSF.

(iv) The air drying tests indicate that between 5 and 7 days is needed to dry the tailings at temperatures of 45^{o} to 50^{o} C in the laboratory and seasonal variations in temperature will significantly impact on drying times in the field. However, given the geochemical characteristics of the Kanmantoo tailings total drying is not desirable and rapid rotation of the tailings deposition around the perimeter, within the time constraints identified by the geochemical testwork, ie weeks rather than months, is preferred.

(v) Consolidation of the tailings will be important to maximise the dry density of the tailings stack. Given the tailings are predominantly sand with non plastic fines, consolidation by self weight loading will be the primary consolidation mechanism. The average dry density of the tailings deposited subaerially are expected to be in the range of 1.65 t/m^3 possibly up to 1.80 t/m^3.

(vi) Moisture contents within the deposited tailings will vary in accordance with tailings segregation and sedimentation of the fines fraction of the tailings during the deposition process. It can reasonably be expected, depending on the number of spigots operating, that tailings lenses of finer tailings will occur within the outer section of the tailings beach with the centre of the tailings storage containing a mixture of fines (materials finer than 75 microns) and finer sands thickness and drying conditions.

(vii) Prior to closure the deposition system will be changed to allow for the creation of a domed tailings surface. Stability of the tailings stack at high % solids is unlikely to be an issue as the bleed water from the stack is expected to be maximised and the tailings drain rapidly. Multiple spigots may be required to allow tailings stack positions to be alternated to achieve the final desired shape.

5 CLOSURE

We trust the information contained in this letter report meets your requirements. Should you require clarification of any information or details, please do not hesitate to contact this office.

For and on behalf of Coffey Mining Pty Ltd

Christopher Lane

Senior Principal

Appendix A: Coffey Geotechnics Pty Ltd - Laboratory Test Certificates.

Appendix B: Tricon Testing - Laboratory Test Certificates.

Appendix A

Coffey Geotechnics Pty Ltd - Test Certificates

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

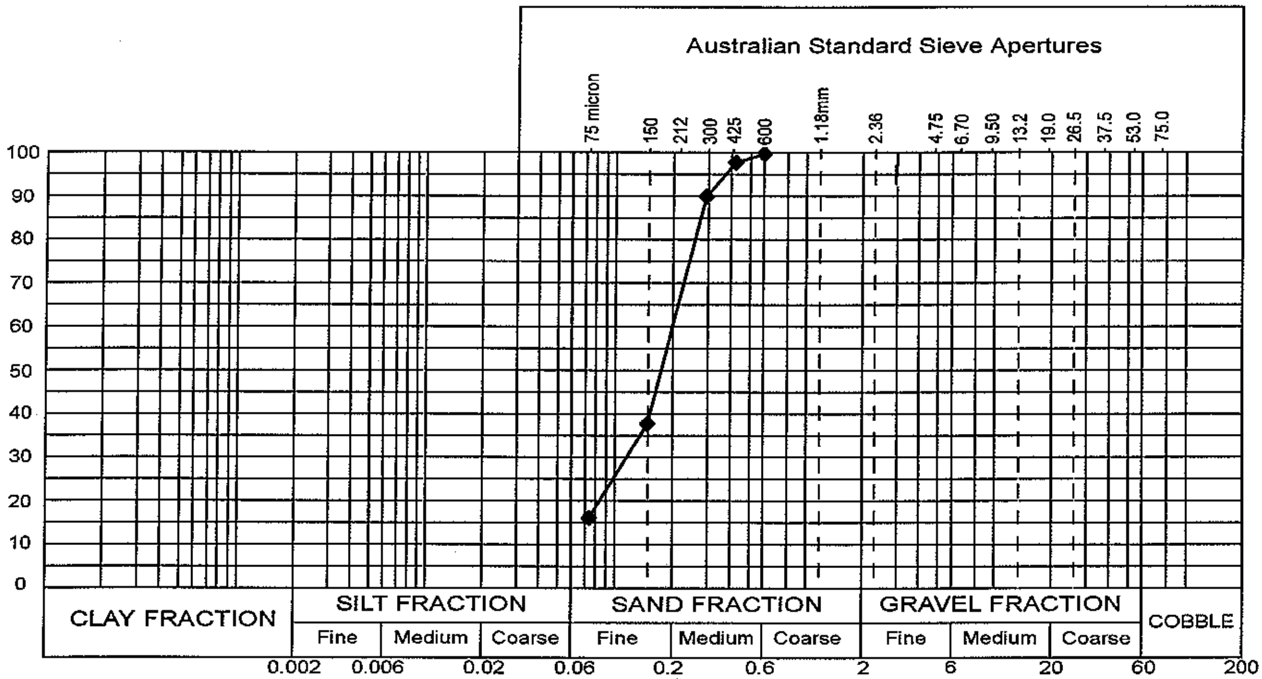
Coffey Geosciences Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

TEST CERTIFICATE

Client: Coffey Mining - MINEHERD00335AA **Report No.:** HERD07S-01235/3
Principal: -
Project: Kanmantoo **Job No.:** LABTHERD00148AA
Location: -
Sample ID: A10080/RG8261 **Date Tested:** 27.03.07

Particle Size Distribution & Atterberg Limits of a Soil

Partcle Size Distribution (AS1289 3.6.1)				**Atterberg Limits** (AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1)	
Sieve Size	% Passing	Sieve Size	% Passing		
150.0mm		1.18 mm		Liquid Limit (%)	Slips in Cup
75.0mm		600 micron	100	Plastic Limit (%)	Not Obtainable
37.5 mm		425 micron	98	Plasticity Index (%)	Non Plastic
19.0 mm		300 micron	90	Linear Shrinkage (%)	-
9.50 mm		150 micron	37	Nature Of Shrinkage	-
4.75 mm		75 micron	15	Sample History	Air Dried
2.36mm				Preparation Method	Dry Sieved



Remarks: Sampling Method/s - Submitted by client

NATA

This document is issued in accordance with NATA's Accreditation Requirements. Accredited for compliance with ISO/IEC 17025

Authorised Signature:

W Rozmianiec
Date: 11.04.07
NATA Acc. Laboratory No 431

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

TEST CERTIFICATE

Client: Coffey Mining - MINEHERD00335AA
Principal: -
Project: Kanmantoo
Location: -

Report No.: HERD07S-01235/4
Job No.: LABTHERD00148AA
Date Tested: 27.03.07

Soil Particle Density
AS 1289.3.5.1

Laboratory Number	HERD07S-01235
Sample Identification	A100800 RG8261
Temperature of Test C	19.0
Average Soil Particle Density -2.36mm t/m^3	3.10
Average Soil Particle Density +2.36mm t/m^3	-
Average Soil Particle Total Sample t/m^3	3.10

Remarks: Sampling Method/s - Submitted by client

W. Rozmianiec

Date: 11.04.07

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 000 F (+61) (8) 9347 0099
www.coffey.com.au

test certificate - air drying test

job no : LABTHERD00148AA
report no : HERD07S-01235

client :	Coffey Mining - MINEHERD00335AA	date :	20/03/2007
principal :	-	laboratory :	Perth
project :	Kanmantoo	tested by :	MJ
location :	-	checked by :	WR

Sample Identification: A10080/RG8261

PERCENT SOLIDS: 58.9 %

TEST CYLINDER

Diameter of Beaker	87.1	mm
Area of Beaker	5958.35	mm2
Mass of Beaker	180.7	g
Mass Beaker & Tailings	857.80	g
Mass of Tailings Wet	677.10	g
Mass of Tailings Dry	399.12	g

MOISTURE CONTENT AT TEST

Container No.	B11	
Mass Cont. & Tailings Wet	782.6	g
Mass Cont. & Tailings Dry	535.37	g
Mass Container	180.4	g
Moisture Content	69.65	%

AFTER TEST

Final Moisture Content		%
Mass Tailings Dry: *check*		g

Date & Time Test Commenced 13/03/2007 @ 0920hrs

Elapsed Time (hours)	Height of Tailings (mm)	Height of Water (mm)		Mass Beaker & Tailings (g)	Wet Mass (g)	Volume of Tailings (cm3)	Dry Density (t/m3)	Moisture Content of Slurry (%)
0	86	0		857.8	677.10	512.42	0.779	69.65
24	53	27		826.1	645.42	315.79	1.264	61.71
101	50	11		751.8	571.12	297.92	1.340	43.09
*144	48	0		618.5	437.76	286.00	1.396	9.68
168	48	0		580.8	400.10	286.00	1.396	0.25
176	48	0		580.8	400.10	286.00	1.396	0.25

Remarks: Sampling Method/s - Submitted by client
*Test sample placed in an Air drying oven with temperatures ranging between approximately 45 - 50C

Approved:(W.Rozmianiec)
Date: 20/03/2007

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Raod Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T(+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

test certificate - undrained settling test

job no : LABTHERD00148AA
report no : HERD07S-01235/1

client :	Coffey Mining - MINEHERD00335AB	date :	20/03/2007
principal :	-	laboratory :	Perth
project :	Kanmantoo	tested by :	MJ
location :	-	checked by :	WR

Sample Identification: A10080/RG8261

% Solids: 58.9 %

TEST CYLINDER

Diameter of Cylinder	63.4	mm
Area of Cylinder	3156.95	mm2
Mass of Cylinder	444.3	g
Mass Cylinder & Tailings	2290.5	g
Mass of Tailings Wet	1846.2	g
Mass of Tailings Dry	1088.25	g
Density of Liquor	1.0	g/cm3
Amount of Liquor in Sample	240.09	mm

MOISTURE CONTENT AT TEST

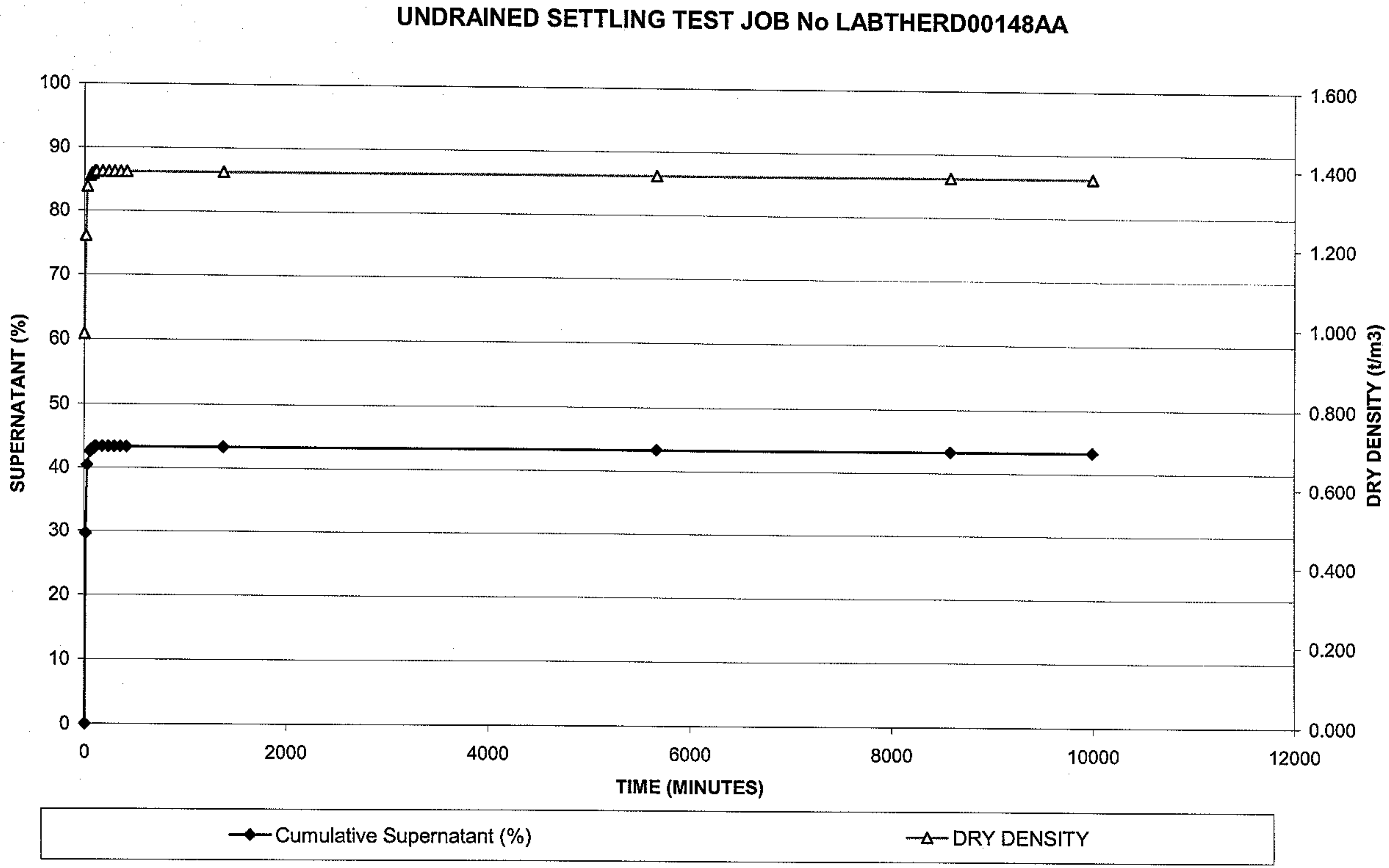
Container No.	B11	
Mass Cont. & Tailings Wet	782.6	g
Mass Cont. & Tailings Dry	535.37	g
Mass Container	180.4	g
Moisture Content	69.65	%

Date & Time Test Commenced 13/03/07 @ 0920hrs

					With respect to Initial Volume of Liquor			
Elapsed Time (minutes)	Height of Water (mm)			Height of Tailings (mm)	Cumulative Supernatant (%)			Dry Density (t/m3)
0	0			354	0.00			0.974
15	71			283	29.57			1.218
30	97			257	40.40			1.341
60	102			252	42.48			1.368
75	103			251	42.90			1.373
90	103			251	42.90			1.373
105	104			250	43.32			1.379
120	104			250	43.32			1.379
180	104			250	43.32			1.379
240	104			250	43.32			1.379
300	104			250	43.32			1.379
360	104			250	43.32			1.379
420	104			250	43.32			1.379
1380	104			250	43.32			1.379
5670	104			250	43.32			1.379
8580	104			250	43.32			1.379
9990	104			250	43.32			1.379

Remarks: Sampling Method/s - Submitted by client

Approved: W Rozmianiec
Date: 21/03/2007



UNDRAINED SETTLING TEST JOB No LABTHERD00148AA
SUPERNATANT (%)
DRY DENSITY (t/m3)
TIME (MINUTES)
0
10
20
30
40
50
60
70
80
90
100
0.000
0.200
0.400
0.600
0.800
1.000
1.200
1.400
1.600
0
2000
4000
6000
8000
10000
12000
Cumulative Supernatant (%)
DRY DENSITY

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

test certificate - drained settling test

job no : LABTHERD00148AA
report no : HERD07S-01235/2

client :	Coffey Mining - MINEHERD00335AA	date :	21/03/2007
principal :	-	laboratory :	Perth
project :	Kanmantoo	tested by :	MJ
location :	-	checked by :	WR

Sample Identification: A10080/RG8261

% Solids: 58.9

TEST CYLINDER

Diameter of Cylinder	63.9	mm
Area of Cylinder	3206.9	mm2
Mass of Cylinder	904.1	g
Mass Cylinder & Tailings	2520.7	g
Mass of Tailings Wet	1616.6	g
Mass of Tailings Dry	952.8	g

MOISTURE CONTENT CHECK

Container No.	B11	
Mass Cont. & Tailings Wet	782.6	g
Mass Cont. & Tailings Dry	535.33	g
Mass Container	180.4	g
Moisture Content	69.67	%

AFTER TEST

Mass Cylinder & Tailings	2185.9	g
Mass of Tailings Wet	1281.8	g
Mass of Tailings Dry	952.8	g
Amount of Liquor in Sample	207.0	mm
Amount of Liquor Drained	104.4	mm
Amount of Liquor Removed	0.0	mm
Remaining Liquor in Sample	102.59	mm

334.8 (g)

AFTER TEST

Final Moisture Content 34.5 %

Date & Time Test Commenced 13/03/07 @ 0920hrs

Density of Liquor: 1.0 g/cm3

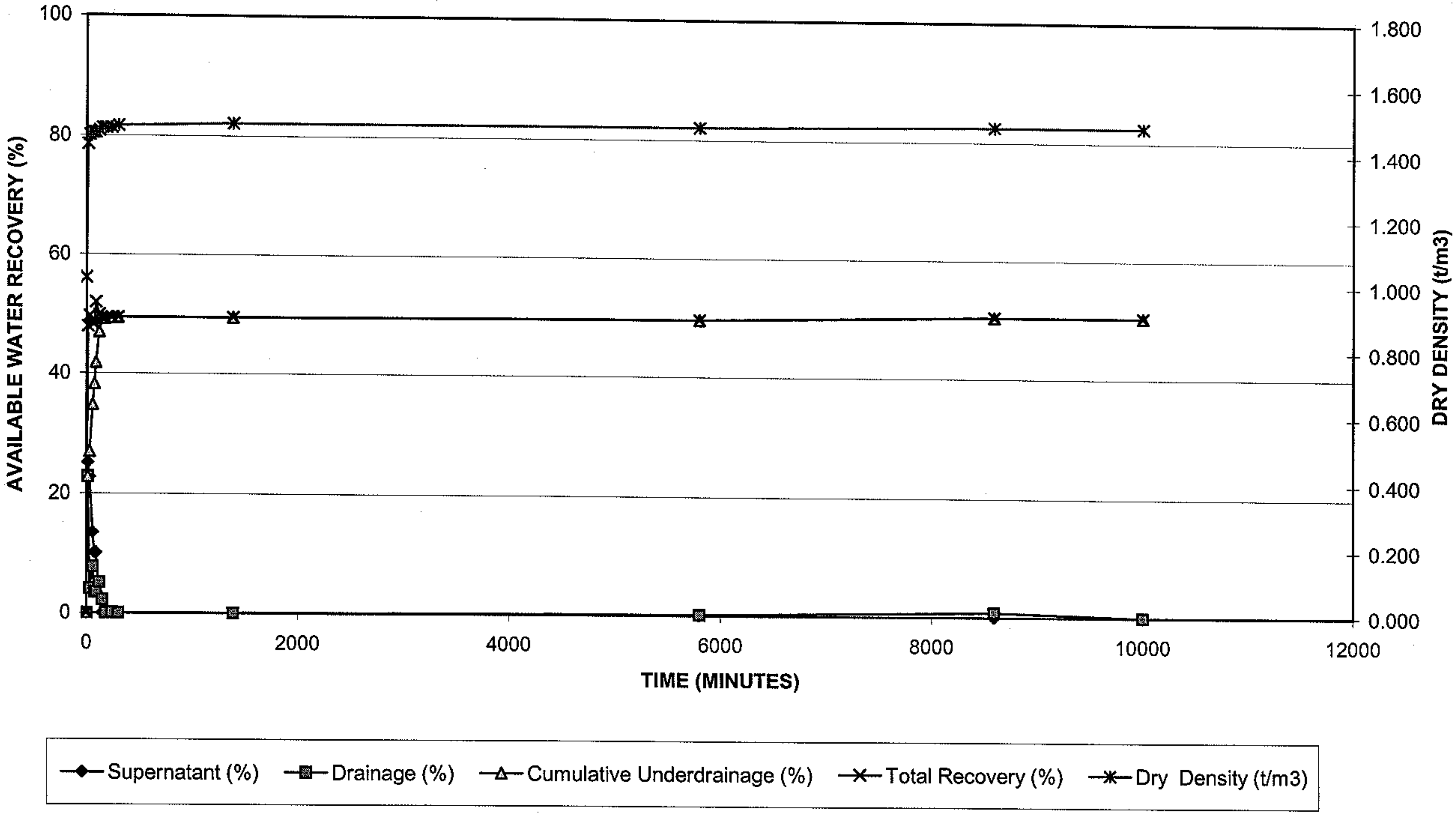
					With respect to Initial Volume of Liquor					
Elapsed Time (minutes)	Height of Liquor mm	Liquor Drained (g)	Liquor Drained (mm)	Height of Tailings (mm)	Supernatant (%)	Drainage (%)	Cumulative Underdrain (%)	Total Recovery (%)	Dry Density (t/m3)	Moisture Content of Slurry (%)
0	0	0.0	0.0	294	0.00	0.00	0.00	0.00	1.011	69.67
15	52	151.3	47.2	210	25.12	22.79	22.79	47.92	1.415	53.79
30	47	179.0	55.8	206	22.71	4.17	26.97	49.67	1.442	50.88
60	28	230.8	72.0	205	13.53	7.80	34.77	48.30	1.449	45.44
75	21	253.7	79.1	205	10.15	3.45	38.22	48.37	1.449	43.04
90	21	277.5	86.5	205	10.15	3.59	41.81	51.95	1.449	40.54
120	6	311.9	97.3	204	2.90	5.18	46.99	49.89	1.456	36.93
150	0	326.6	101.8	203	0.00	2.21	49.20	49.20	1.464	35.39
180	0	326.9	101.9	203	0.00	0.05	49.25	49.25	1.464	35.36
240	0	327.7	102.2	203	0.00	0.12	49.37	49.37	1.464	35.27
300	0	328.1	102.3	202	0.00	0.06	49.43	49.43	1.471	35.23
1390	0	328.4	102.4	201	0.00	0.05	49.47	49.47	1.478	35.20
5800	0	329.4	102.7	201	0.00	0.15	49.62	49.62	1.478	35.10
8590	0	334.8	104.4	200	0.00	0.81	50.44	50.44	1.486	34.53
10000	0	334.8	104.4	200	0.00	0.00	50.44	50.44	1.486	34.53

Remarks: Sampling Method/s - Submitted by client.

Approved: W Rozmianiec

Date: 21/03/2007

DRAINED SETTLING TEST JOB No LABTHERD00148AA



Appendix B

Tricon Testing – Test Certificates

TRICON TESTING

Geotechnical Engineering Laboratory

5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438

tricontest@optusnet.com.au Ph: (08) 9240 1444 Fax: (08) 9240 1044

TRIAXIAL CONSOLIDATION TEST

REPORT CERTIFICATE

CLIENT : Coffey Geotechnics Pty Ltd (Job # LTH 00148AA)

PROJECT : Kanmantoo Tailings (Coffey Mining MH 00335AA)

Sample Id : Kanmantoo Tailings, Sample No : H07w-03356

Test Type : Consolidated Isotropically Undrained , Multi-Stage

JOB NO : 0708108

LOCATION : Kanmantoo

Lab No. : TT06108001

Date Tested : 24-28/07/2007

Specimen Details :	**Placement**	**Final**
Length/Diameter (ratio) :	1.71	-
Dry Density (t/m^3) :	1.502	1.652
Moisture Content (%) :	11.0	23.2

Sample Description :
Medium Grey, Silty Sand (fine gr.)

Sampling Details : 70mm Ø remoulded sample

Remoulding Details : sample placed at moist conditions in 5 layer with minimal compaction

CONSOLIDATION TEST DATA

Effective Confining Pressure during Saturation : 6 kPa

Specimen Drainage Condition : One End Only

Stage No	**σ'_3** (kPa)	**$\Delta\sigma'_3$** (kPa)	**Volume** (cc)	**M_v** (m^2/MN)	**Dry Density** (t/m^3)
Initial	6	-	457.9	-	1.502
1	40	34	452.1	3.8×10^{-01}	1.521
2	80	40	446.6	3.0×10^{-01}	1.540
3	150	70	440.5	1.9×10^{-01}	1.561
4	300	150	432.8	1.2×10^{-01}	1.589
5	600	300	423.5	7.2×10^{-02}	1.624
6	900	300	416.2	5.7×10^{-02}	1.652

Notes : Sample supplied by client

Authorised Signatory : _ PRELIMINARY FINAL
(S. Brodie)

Date : ________________

Form No TXL/61/AA 05/1 R

TRICON TESTING
Geotechnical Engineering Laboratory
TRIAXIAL CONSOLIDATION TEST
REPORT CERTIFICATE

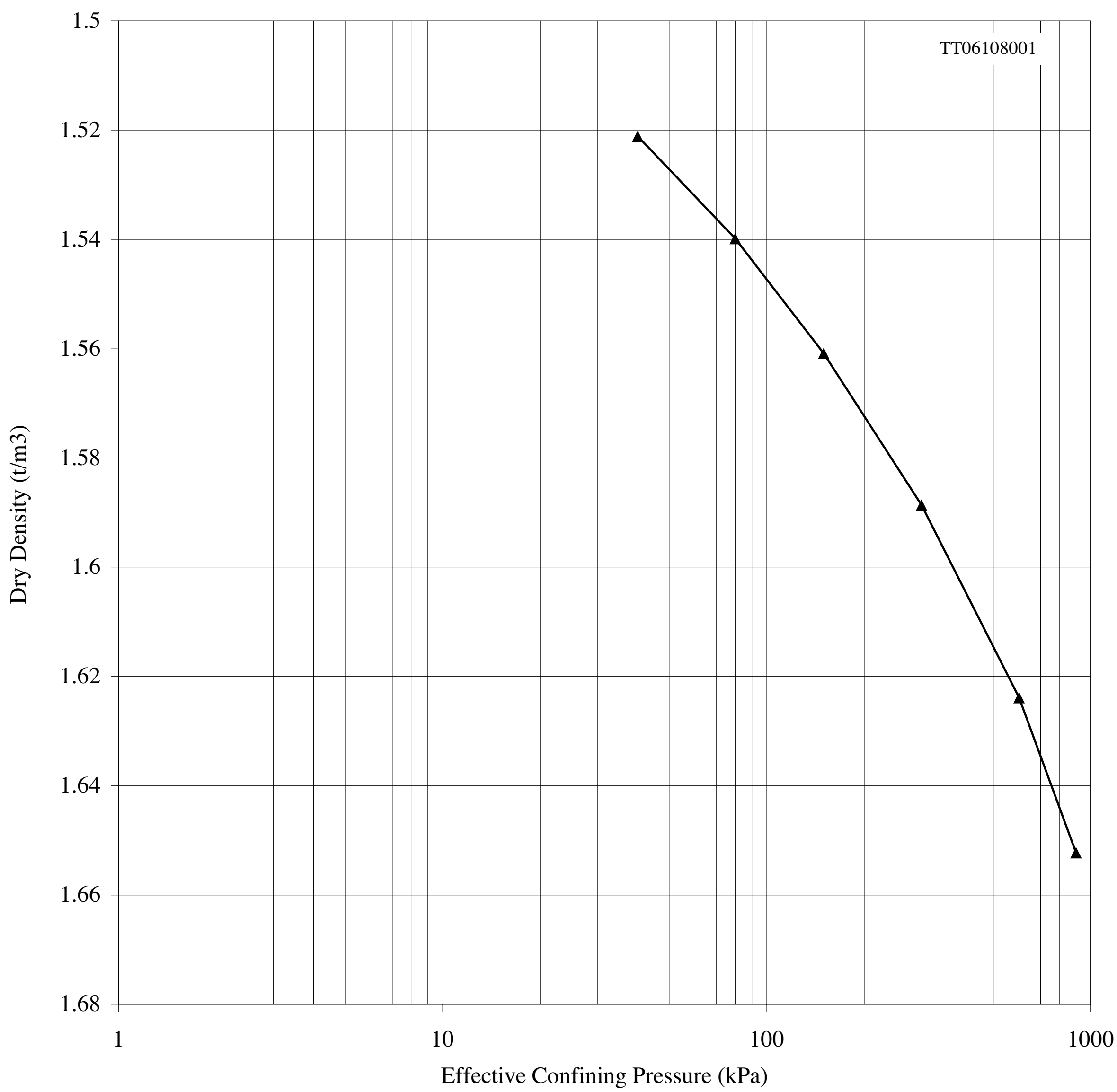
CLIENT :	Coffey Geotechnics Pty Ltd (Job # LTH 00148AA)		**JOB NO :**	0708108
PROJECT :	Kanmantoo Tailings (Coffey Mining MH 00335AA)		**LOCATION :**	Kanmantoo
Sample Id :	Kanmantoo Tailings, Sample No : H07w-03356		**Lab No. :**	TT06108001
Test Type :	Consolidated Isotropically Undrained , Multi-Stage		**Date Tested :**	24-28/07/2007

Specimen Details :	**Placement**	**Final**
Length/Diameter (ratio) :	1.71	-
Dry Density (t/m^3) :	1.502	1.652
Moisture Content (%) :	11.0	23.2

Sample Description :
Medium Grey, Silty Sand (fine gr.)

Sampling Details : 70mm Ø remoulded sample

DRY DENSITY Vs Effective CONFINING PRESSURE



Authorised Signatory : _PRELIMINARY FINAL
(S. Brodie)

Date : ________________

Form No TXL/61/AC 05/1 R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
tricontest@optusnet.com.au Ph: (08) 9240 1444 Fax: (08) 9240 1044

REPORT CERTIFICATE

Determination of Permeability of a Soil
Constant Head Method using a Flexible Wall Permeameter
-according to AS 1289.6.7.3 - 1999

CLIENT :	Coffey Geotechnics Pty Ltd (Job # LTH 00148AA)	**JOB NO :**	0708108
PROJECT :	Kanmantoo Tailings (Coffey Mining MH 00335AA)	**LOCATION :**	Kanmantoo
Sample Id :	Kanmantoo Tailings, Sample No : H07w-03356	**Lab No. :**	TT 06108001
Test Type :	Constant Head, Flexible Wall	**Date Tested :**	24-28/07/2007

SPECIMEN DETAILS

Sample Description : Medium Grey, Silty Sand (fine gr.)

Sample Type :	70mm Ø remoulded sample
Dry Density - Initial :	1.502 t/m^3
Moisture Content - Initial :	11.0 %
Dry Density - @ Test :	1.589 t/m^3
Moisture Content - Final :	23.2 %

TEST DETAILS

Specimen Diameter - @ Test :	68.6 mm
Length / Diameter Ratio - @ Test :	1.70
Filter Thickness (Bottom / Top) :	10 / 10 mm
Percolation Head of Water :	390 mm
Effective Confining Stress :	300 kPa
Permeant Used :	Distilled Water
Temperature at Test :	21 °C

TEST DETAILS

Coefficient of Permeability : 1.0×10^{-05} m / sec

Notes : Sample supplied by Client

Authorised Signatory : _ PRELIMINARY FINAL
(S. Brodie)

Date : ________________
Form No TXL/51/BA 06/1 R

TRICON TESTING
Geotechnical Engineering Laboratory
5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438
tricontest@optusnet.com.au Ph: (08) 9240 1444 Fax: (08) 9240 1044

REPORT CERTIFICATE

Determination of Permeability of a Soil
Constant Head Method using a Flexible Wall Permeameter
-according to AS 1289.6.7.3 - 1999

CLIENT :	Coffey Geotechnics Pty Ltd (Job # LTH 00148AA)	**JOB NO :**	0708108
PROJECT :	Kanmantoo Tailings (Coffey Mining MH 00335AA)	**LOCATION :**	Kanmantoo
Sample Id :	Kanmantoo Tailings, Sample No : H07w-03356	**Lab No. :**	TT 06108001
Test Type :	Constant Head, Flexible Wall	**Date Tested :**	24-28/07/2007

SPECIMEN DETAILS

Sample Description : Medium Grey, Silty Sand (fine gr.)

Sample Type :	70mm Ø remoulded sample
Dry Density - Initial :	1.502 t/m^3
Moisture Content - Initial :	11.0 %
Dry Density - @ Test :	1.624 t/m^3
Moisture Content - Final :	23.2 %

TEST DETAILS

Specimen Diameter - @ Test :	68.3 mm
Length / Diameter Ratio - @ Test :	1.69
Filter Thickness (Bottom / Top) :	10 / 10 mm
Percolation Head of Water :	380 mm
Effective Confining Stress :	600 kPa
Permeant Used :	Distilled Water
Temperature at Test :	21 ℃

TEST DETAILS

Coefficient of Permeability : 8.5×10^{-06} m / sec

Notes : Sample supplied by Client

Authorised Signatory : _ PRELIMINARY FINAL
(S. Brodie)

Date : _______________

Form No TXL/51/BA 06/1 R

TRICON TESTING

Geotechnical Engineering Laboratory

5 / 8 Corbusier Place, Balcatta, WA 6021 ABN 12 529 845 438

tricontest@optusnet.com.au Ph: (08) 9240 1444 Fax: (08) 9240 1044

REPORT CERTIFICATE

Determination of Permeability of a Soil
Constant Head Method using a Flexible Wall Permeameter

-according to AS 1289.6.7.3 - 1999

CLIENT :	Coffey Geotechnics Pty Ltd (Job # LTH 00148AA)	**JOB NO :**	0708108
PROJECT :	Kanmantoo Tailings (Coffey Mining MH 00335AA)	**LOCATION :**	Kanmantoo
Sample Id :	Kanmantoo Tailings, Sample No : H07w-03356	**Lab No. :**	TT 06108001
Test Type :	Constant Head, Flexible Wall	**Date Tested :**	24-28/07/2007

SPECIMEN DETAILS

Sample Description : Medium Grey, Silty Sand (fine gr.)

Sample Type :	70mm Ø remoulded sample
Dry Density - Initial :	1.502 t/m^3
Moisture Content - Initial :	11.0 %
Dry Density - @ Test :	1.652 t/m^3
Moisture Content - Final :	23.2 %

TEST DETAILS

Specimen Diameter - @ Test :	67.9 mm
Length / Diameter Ratio - @ Test :	1.69
Filter Thickness (Bottom / Top) :	10 / 10 mm
Percolation Head of Water :	310 mm
Effective Confining Stress :	900 kPa
Permeant Used :	Distilled Water
Temperature at Test :	21 ℃

TEST DETAILS

Coefficient of Permeability : 7.5×10^{-06} m / sec

Notes : Sample supplied by Client

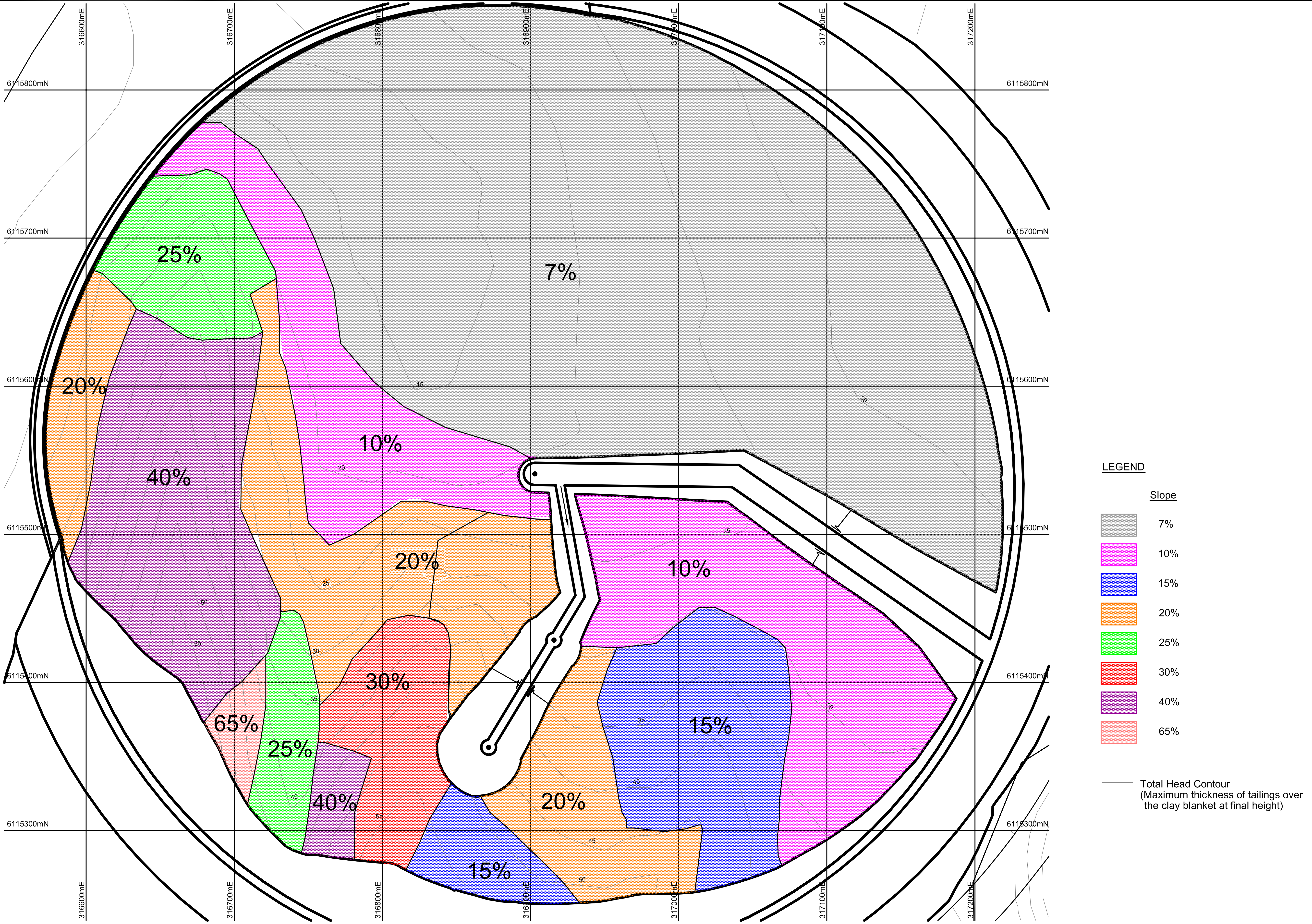
Authorised Signatory : _ PRELIMINARY FINAL
(S. Brodie)

Date : ________________

Form No TXL/51/BA 06/1 R

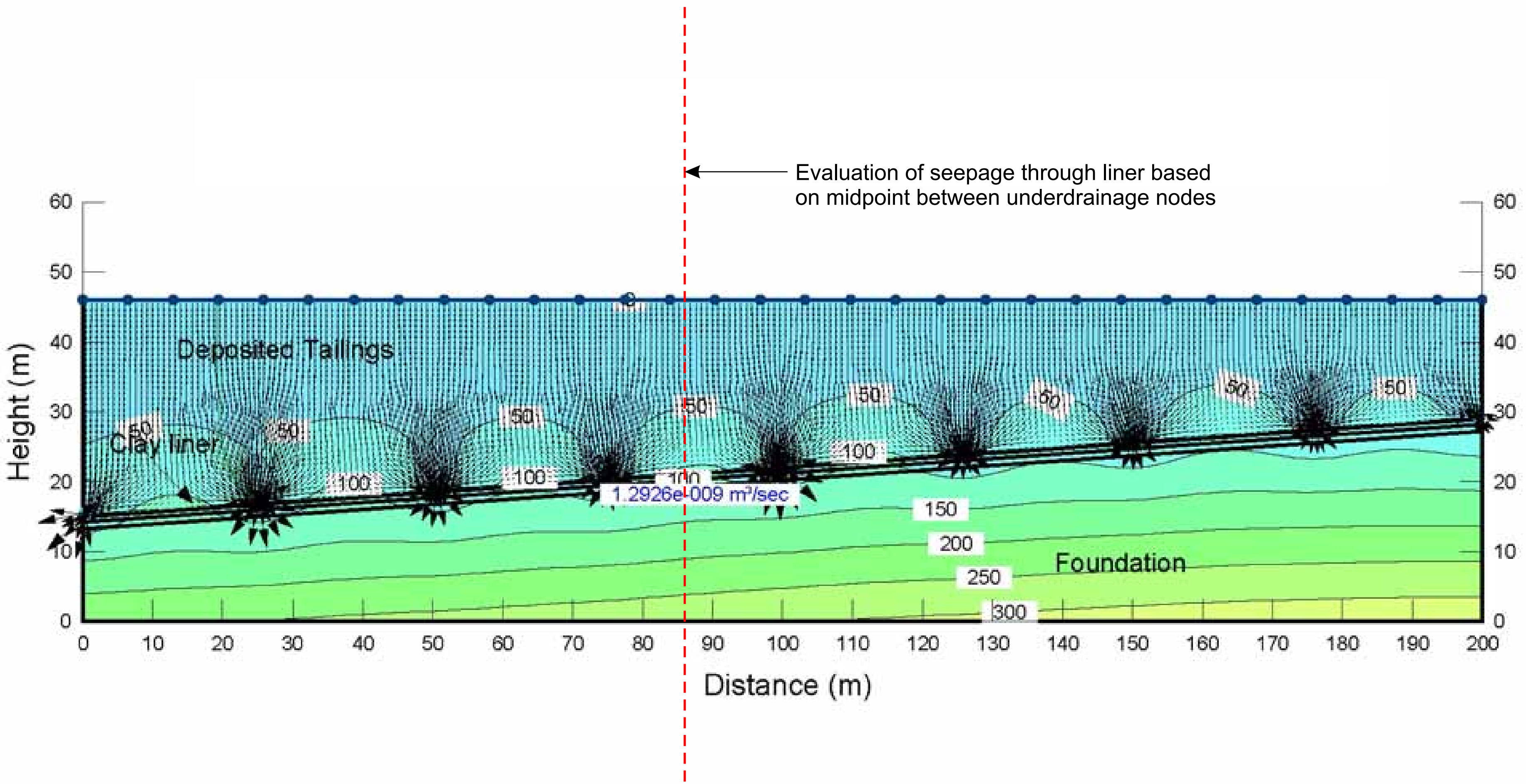
Appendix E

Seepage Analysis



coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	PP	HILLGROVE COPPER PTY LTD COMPANY		Original Size	A3
	Approved	CL	KANMANTOO TAILINGS STORAGE FACILITY		Project no:	MH00335AA
	Date	31/08/07				
	Scale	1:2500	TOPOGRAPHIC AND TOTAL HEAD CONTOUR PLAN		Figure	E1

REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-E1-7.dwg

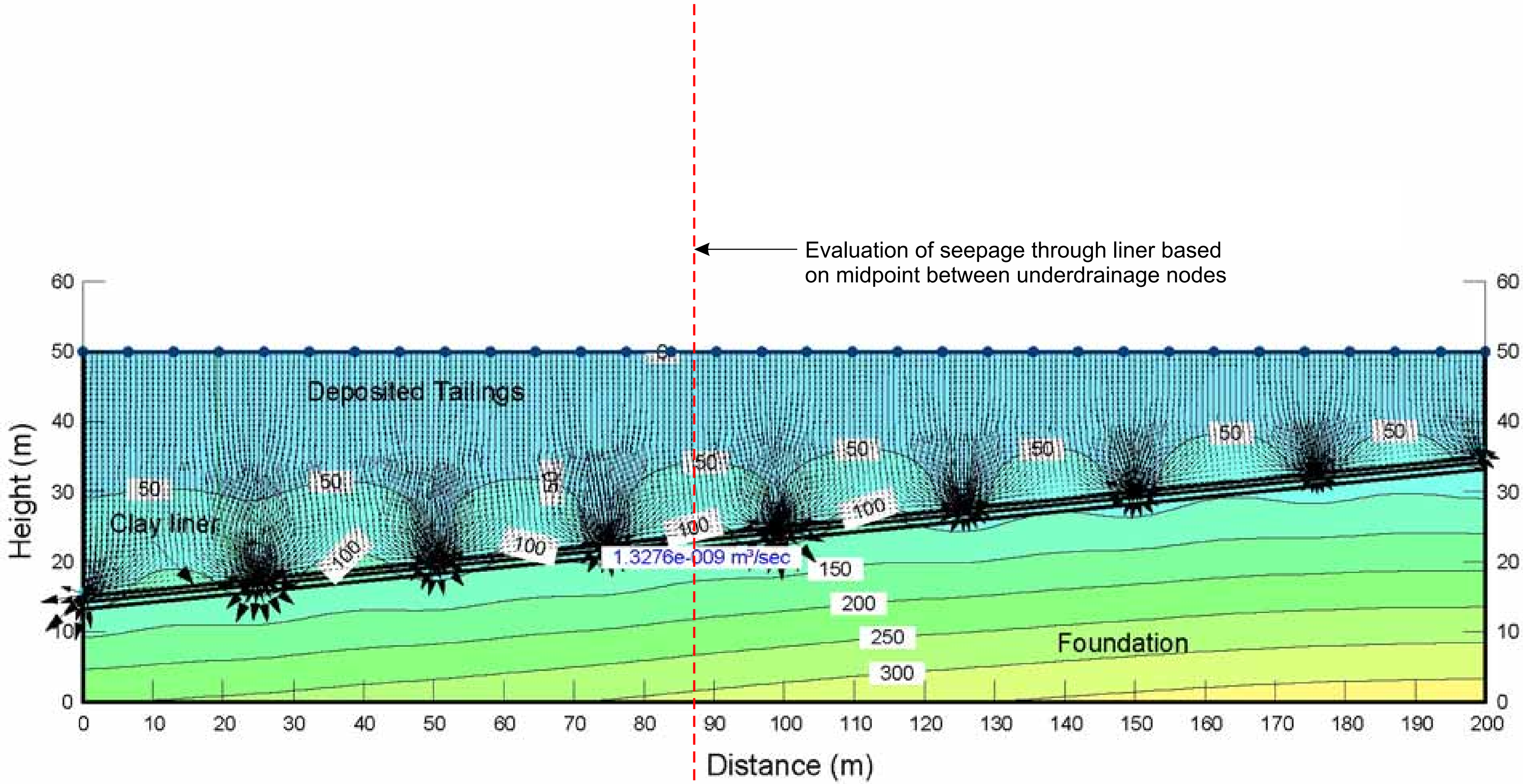


LEGEND

→ Denotes flow path of fluid particle

* Note that all pore pressure contours are in kPa

coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	CFF	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A4
	Approved	PP		Project no:	MH00335AA
	Date	20/09/2007	TAILINGS DRAINAGE FLOW NET PORE WATER PRESSURE CONTOURS (7% SLOPE)	Figure	E2
	Scale	AS SHOWN			



LEGEND

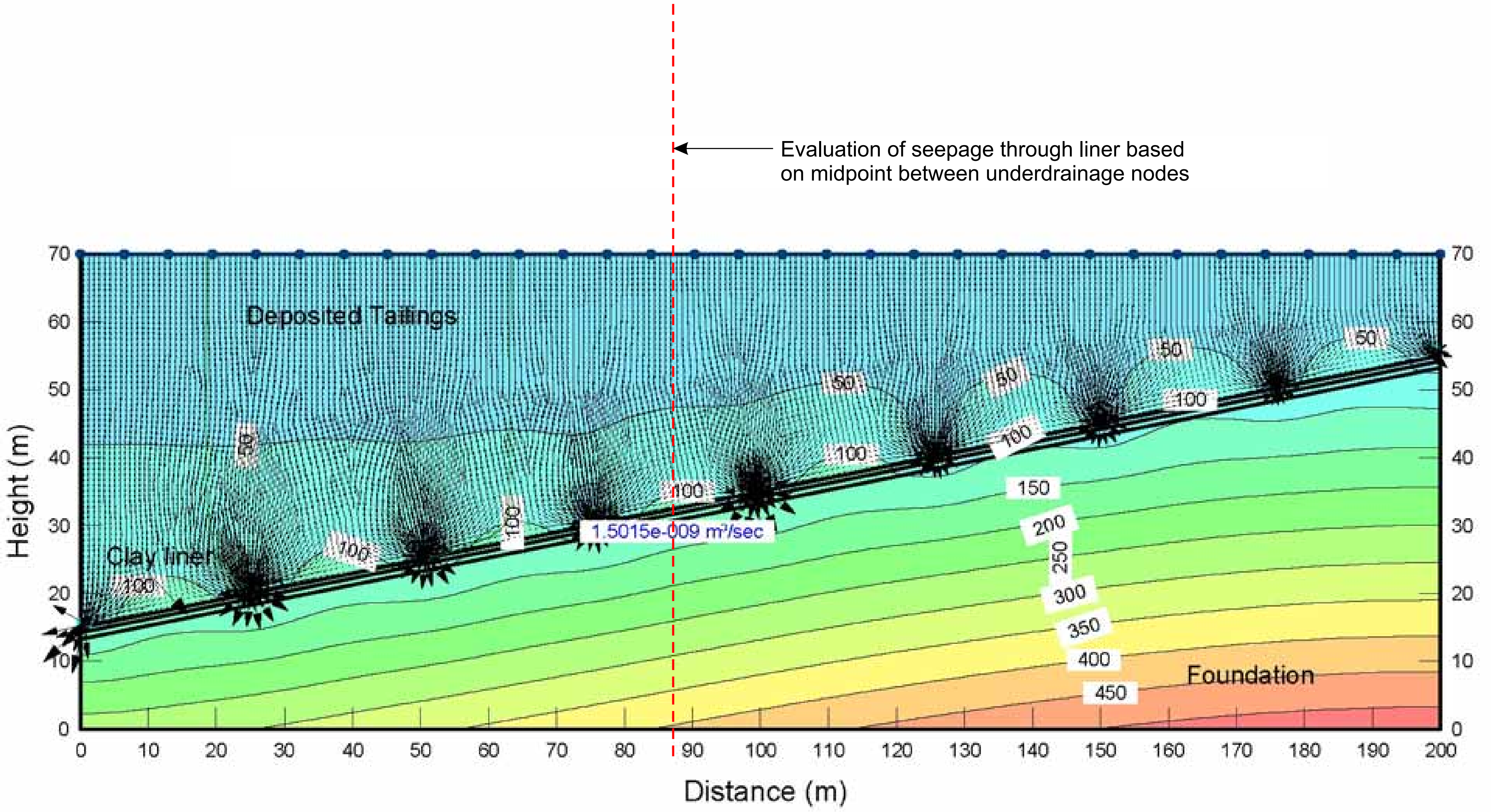
→ Denotes flow path of fluid particle

* Note that all pore pressure contours are in kPa

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	FAC	**HILLGROVE COPPER PTY LTD COMPANY** **KANMANTOO TAILINGS STORAGE FACILITY**	Original Size	A4
Approved	CL		Project no:	MH00335AA
Date	20/09/2007	**TAILINGS DRAINAGE FLOW NET** **PORE WATER PRESSURE CONTOURS (10% SLOPE)**	Figure	**E3**
Scale	AS SHOWN			

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig E3 A4.pdf



LEGEND

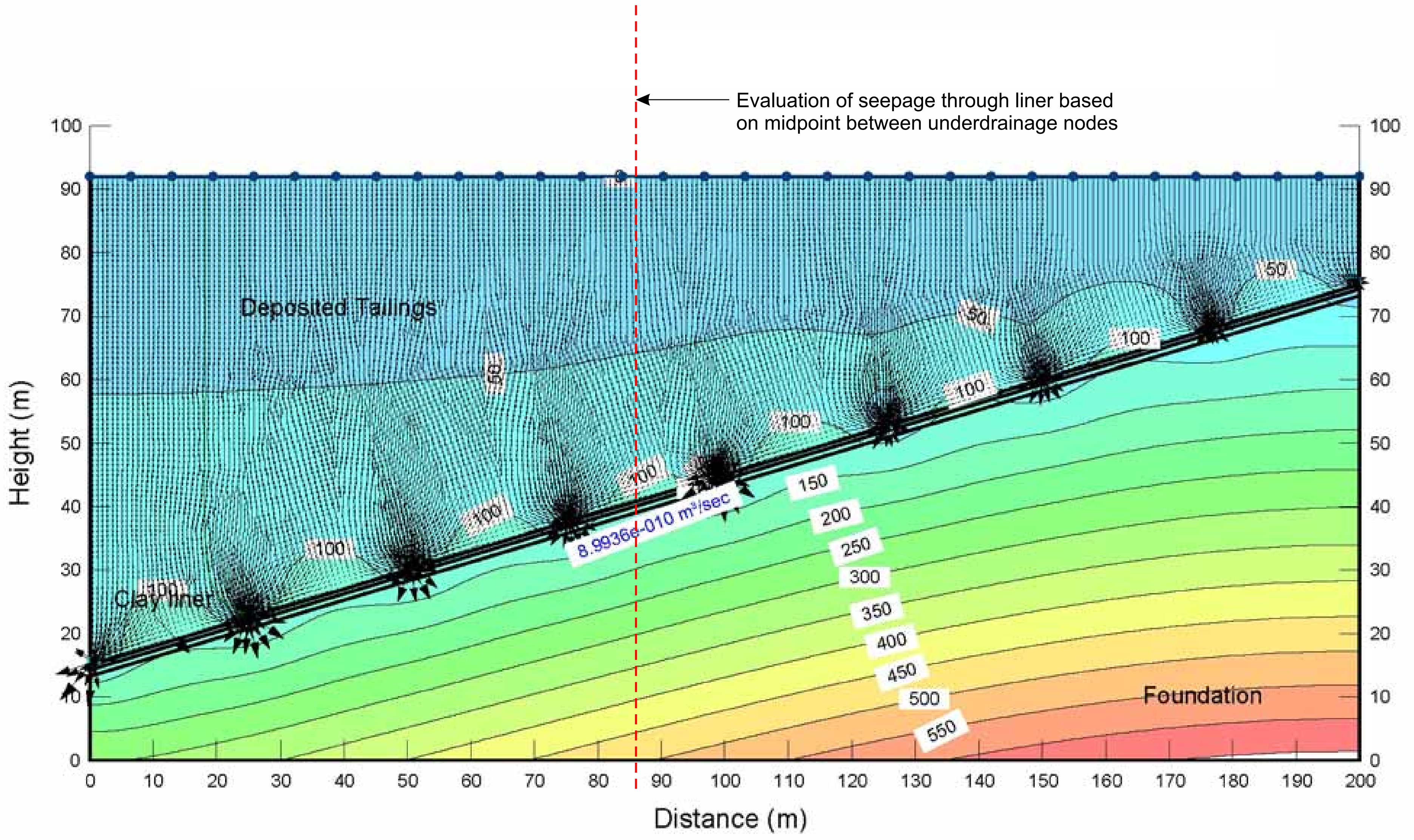
→ Denotes flow path of fluid particle

* Note that all pore pressure contours are in kPa

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	CFF	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A4
Approved	PP		Project no:	MH00335AA
Date	04/10/2007	TAILINGS DRAINAGE FLOW NET PORE WATER PRESSURE CONTOURS (20% SLOPE)		
Scale	AS SHOWN		Figure	E4

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig E4 A4.pdf



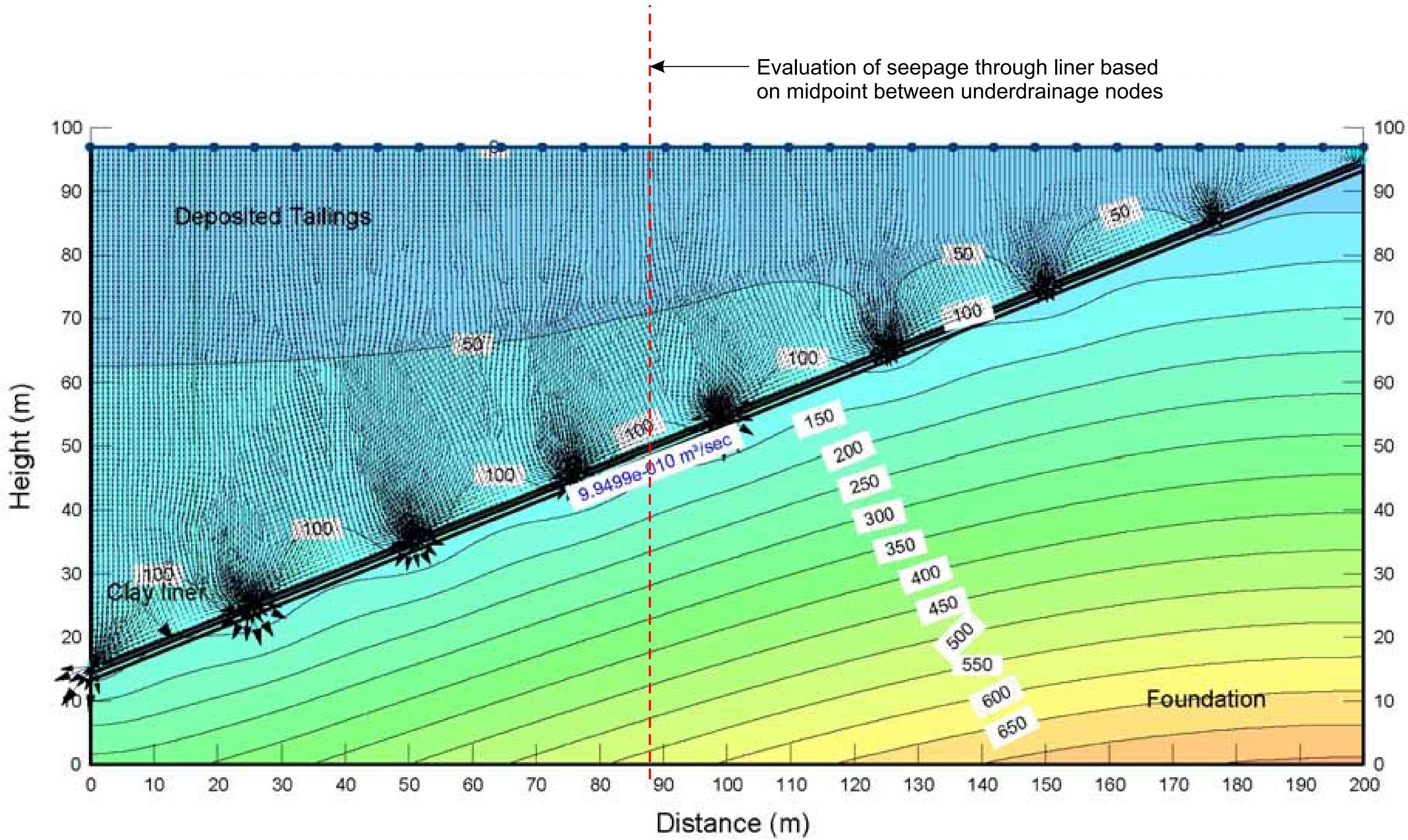
LEGEND

→ Denotes flow path of fluid particle

* Note that all pore pressure contours are in kPa

coffey mining
SPECIALISTS FROM BOARDROOM TO MINE FACE

Drawn	CFF	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY TAILINGS DRAINAGE FLOW NET PORE WATER PRESSURE CONTOURS (30% SLOPE)	Original Size	A4
Approved	PP		Project no:	MH00335AA
Date	04/10/2007		Figure	E5
Scale	AS SHOWN			



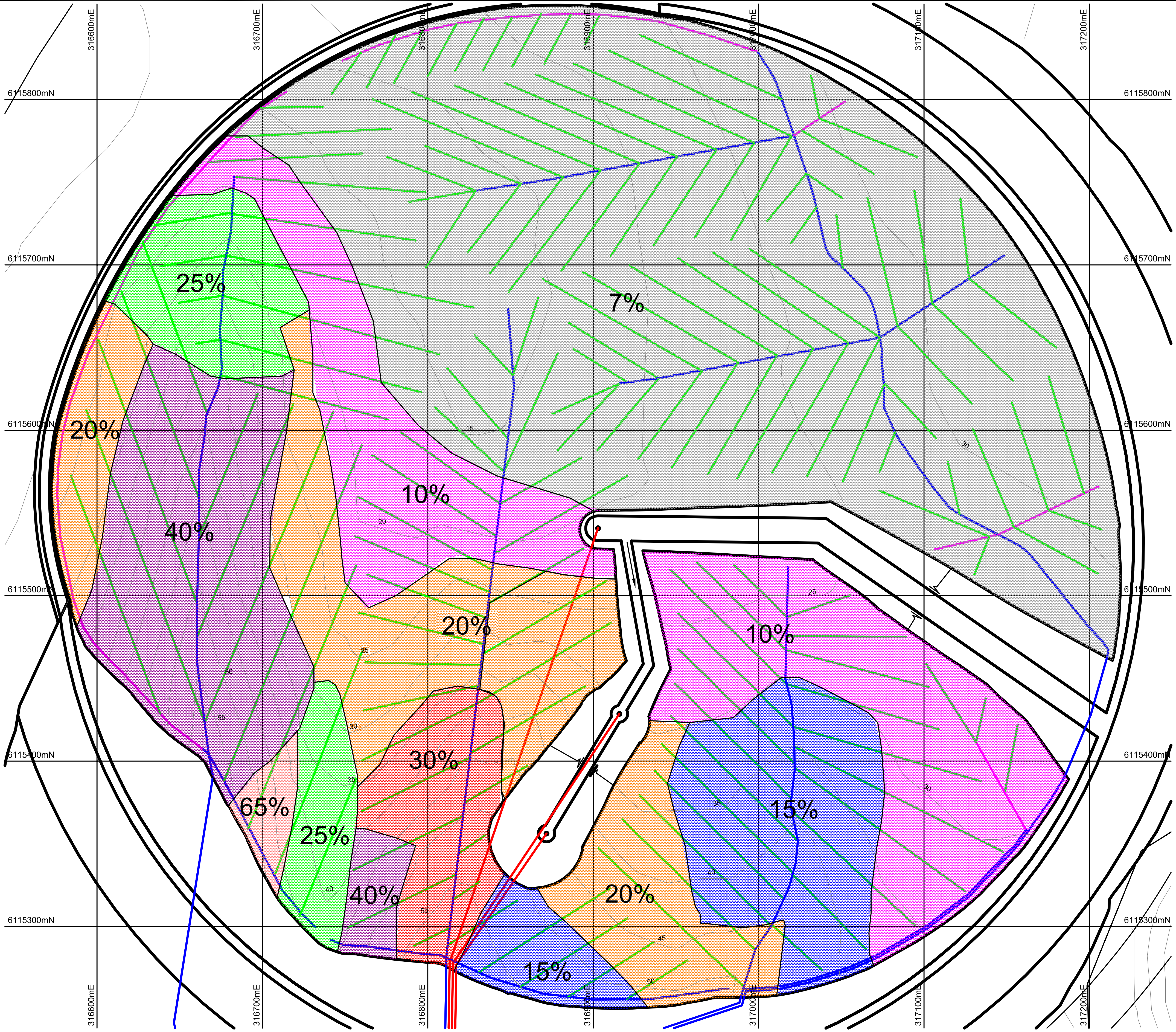
LEGEND

→ Denotes flow path of fluid particle

* Note that all pore pressure contours are in kPa

coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	CFF	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A4
	Approved	PP		Project no:	MH00335AA
	Date	04/10/2007	TAILINGS DRAINAGE FLOW NET PORE WATER PRESSURE CONTOURS (40% SLOPE)	Figure	E6
	Scale	AS SHOWN			

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig E6 A4.pdf



LEGEND

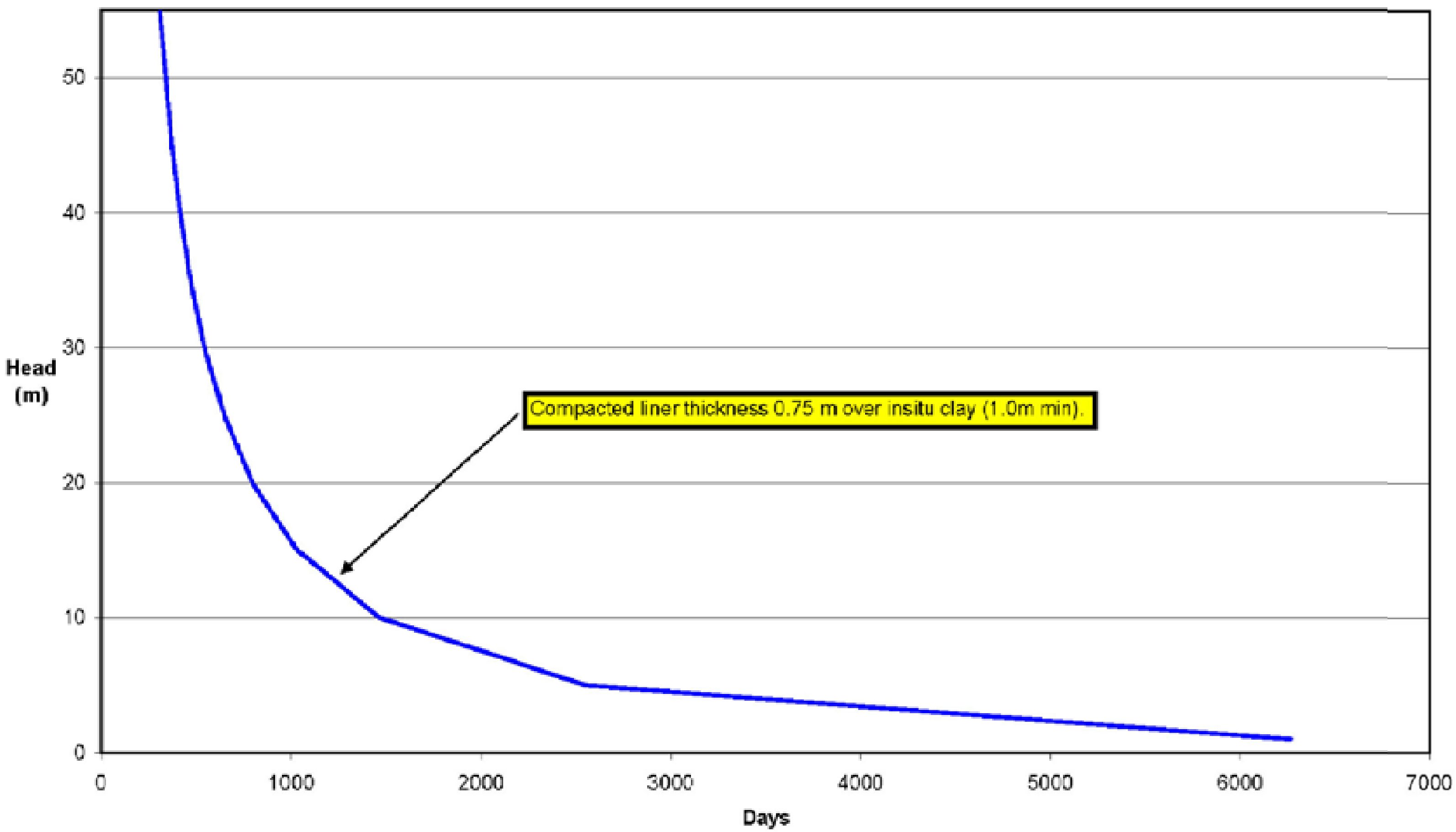
Slope

- 7%
- 10%
- 15%
- 20%
- 25%
- 30%
- 40%
- 65%

- 300 Megaflo
- 450 Megaflo
- Slotted 200OD HDPE Pipe / Solid Outfall Pipe
- Decant Outfall
- Total Head Contour (Maximum thickness of tailings over the clay blanket at final height)

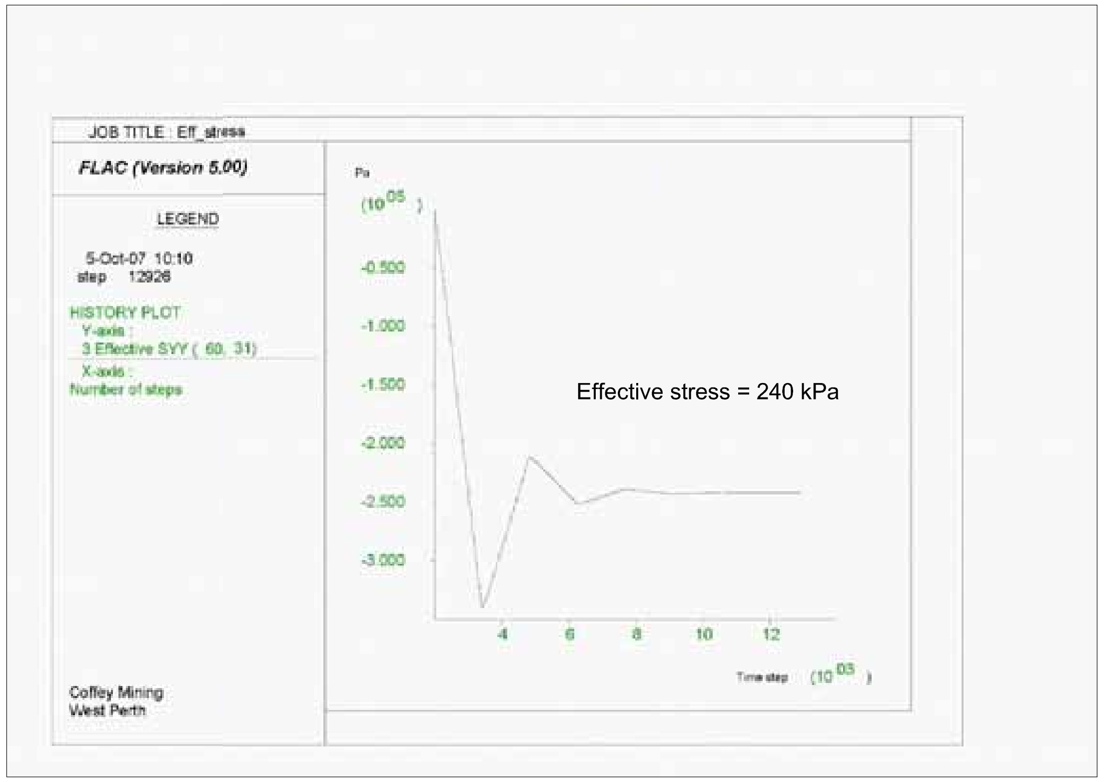
coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	PP	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A3
	Approved	CL		Project no:	MH00335AA
	Date	31/08/07	TOPOGRAPHIC CONTOUR, TOTAL HEAD CONTOUR AND UNDRAINAGE PLAN		
	Scale	1:2500		Figure	E7

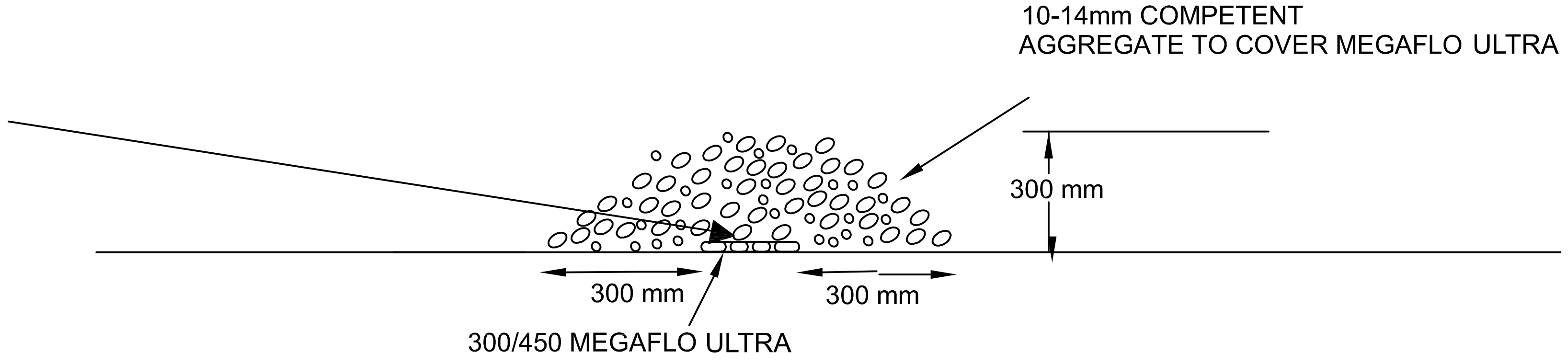
REF:
DWG: F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\Latest Issue\MH00335AA-E1-7.dwg



REF:
DWG: \\Wperfs01\data$\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure\DWG\MH00335AA-E8.dwg

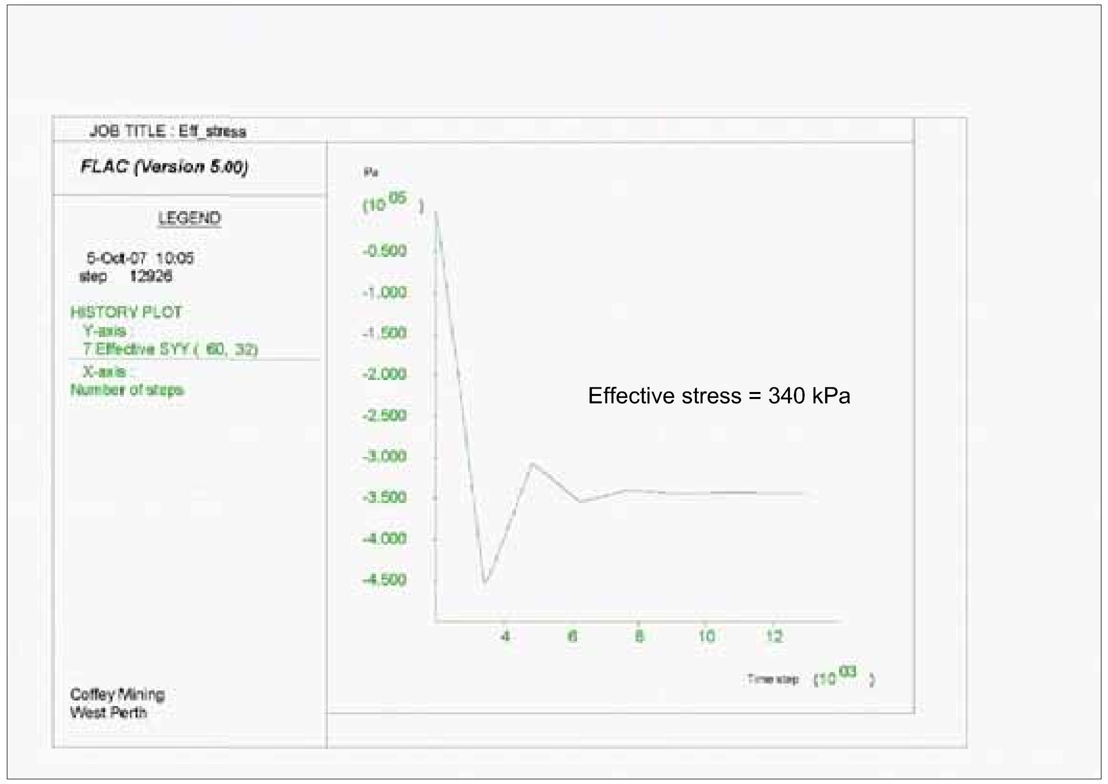
coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	PP	HILLGROVE COPPER PTY LTD KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A4
	Approved	CL		Project no:	MH00335AA
	Date	09/10/07	SEEPAGE TIME vs HYDRAULIC HEAD	Figure	E8
	Scale	NTS			

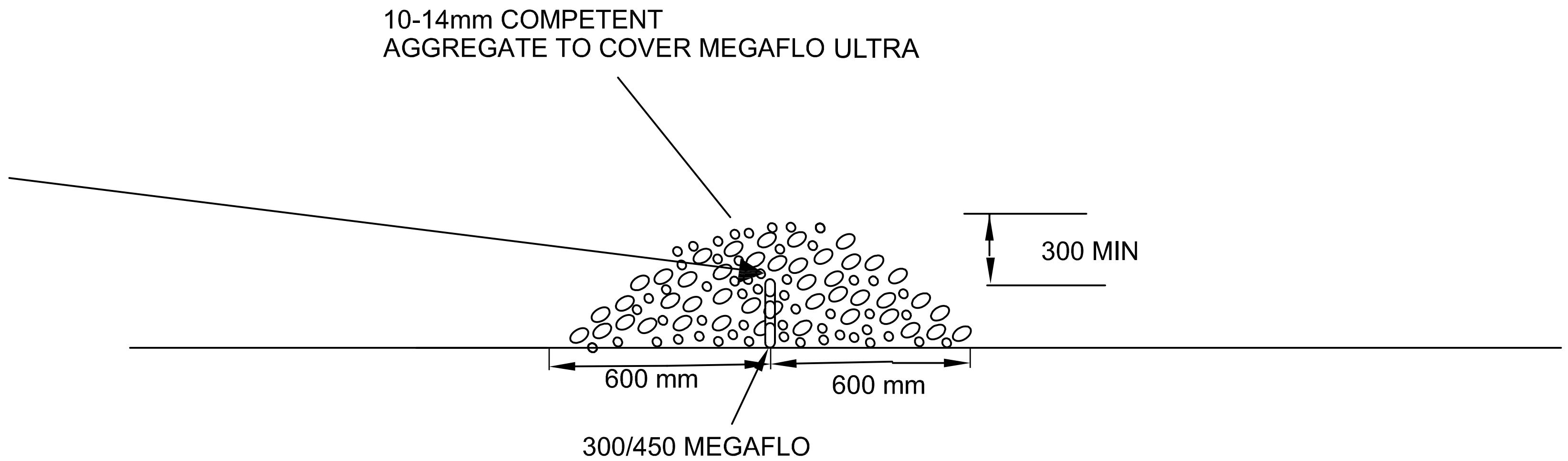




MEGAFLO ULTRA UNDERDRAINAGE - Horizontal Direction

NOT TO SCALE





MEGAFLO ULTRA UNDERDRAINAGE - Vertical Direction

NOT TO SCALE

Parameters

1. 56 m of tailings.
2. Effective stress based on full flow regime within the underdrainage, that is with zero (0) pore pressure at the underdrainage and varying pressures as per the seepage modelling.
3. Minimum aggregate cover 300 mm

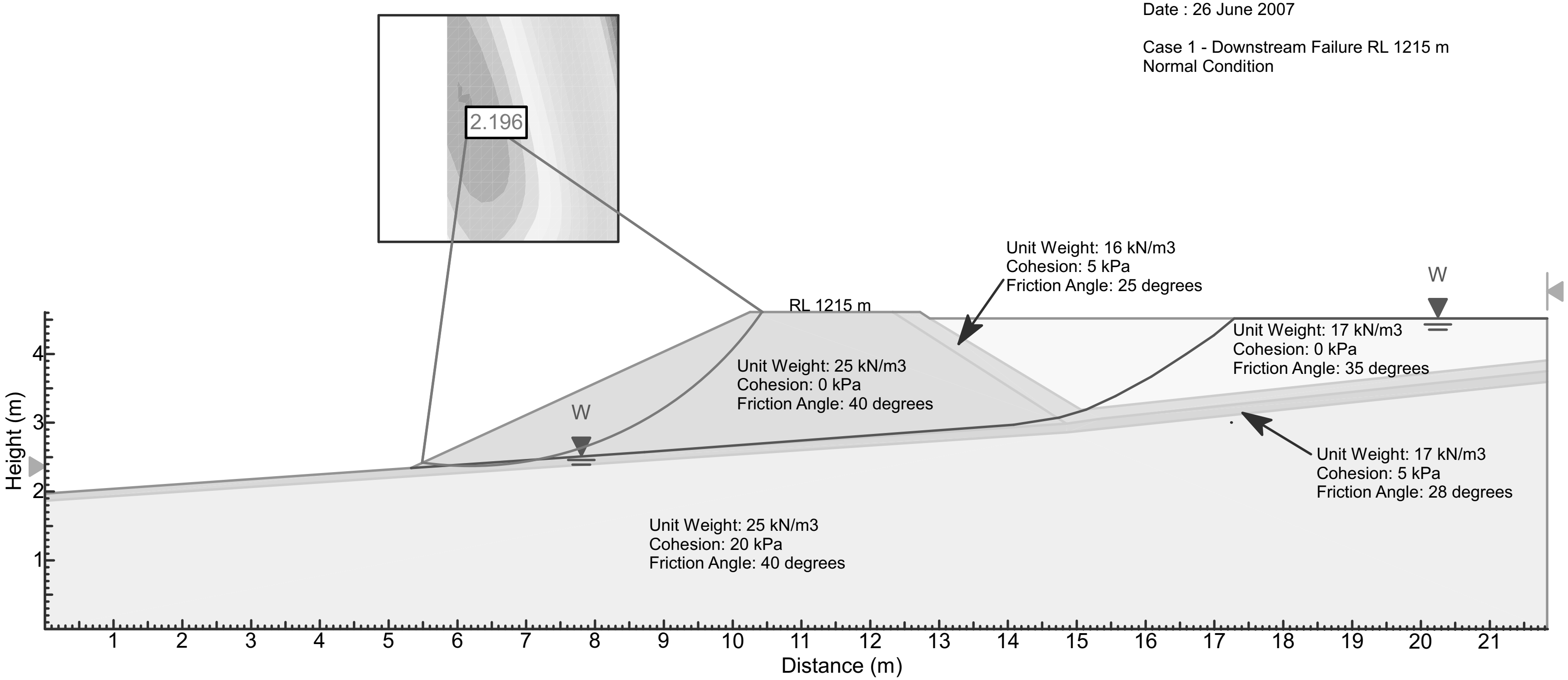
coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	CFF	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A3
	Approved	PP		Project no:	MH00335AA
	Date	05/10/07	EFFECTIVE STRESS PLOTS FOR MEGAFLO ULTRA UNDERDRAINAGE		
	Scale	AS SHOWN		Figure	E9

Appendix F

Stability Analysis

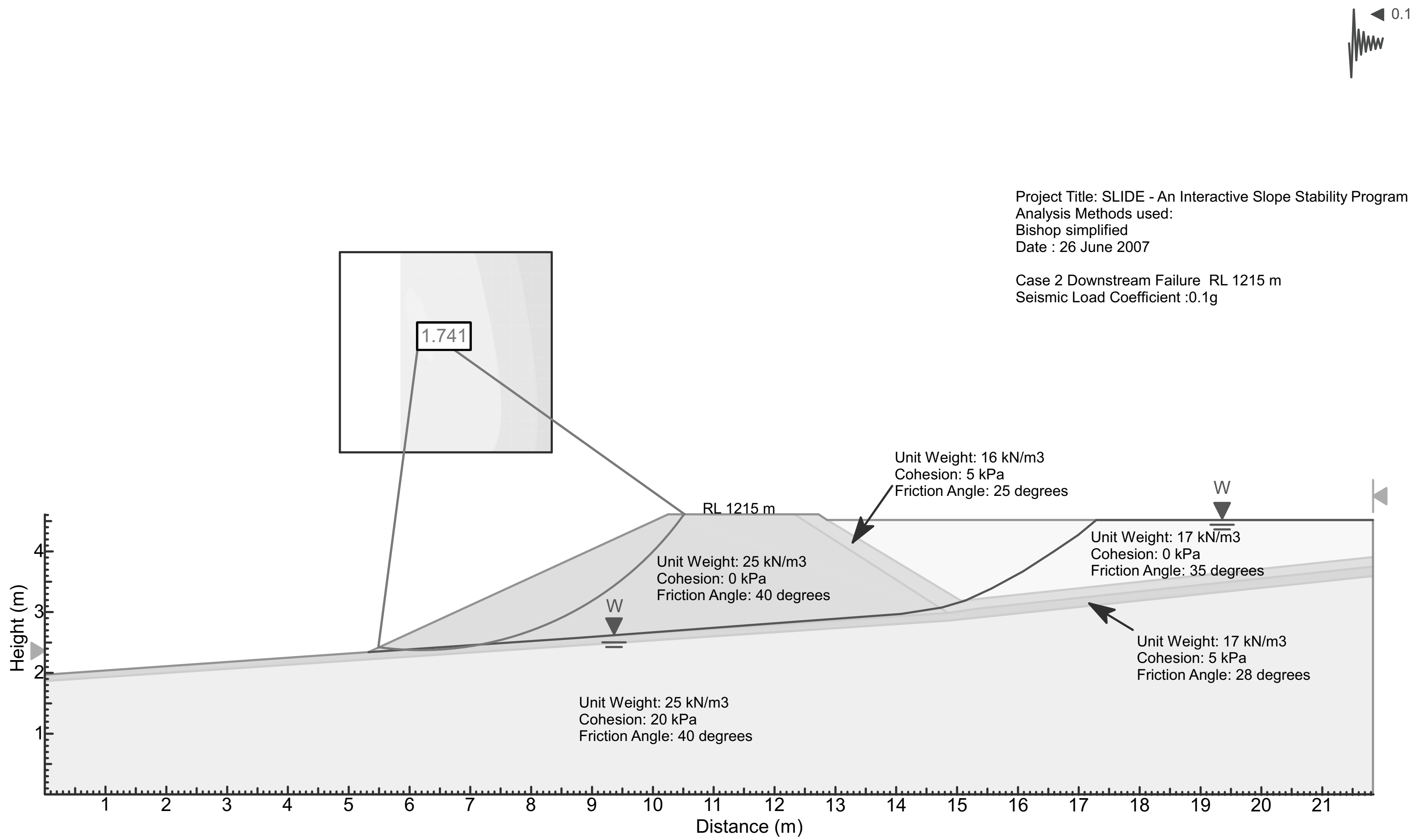
Project Title: SLIDE - An Interactive Slope Stability Program
Analysis Methods used:
Bishop simplified
Date : 26 June 2007

Case 1 - Downstream Failure RL 1215 m
Normal Condition



coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE					
	Drawn	FAC	**HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY CASE 1 DOWNSTREAM FAILURE RL 1215m NORMAL CONDITION**	**Original Size**	A4
	Approved	CL		**Project no:**	MH00335AA
	Date	19/09/2007			
	Scale	AS SHOWN		**Figure**	**F1**

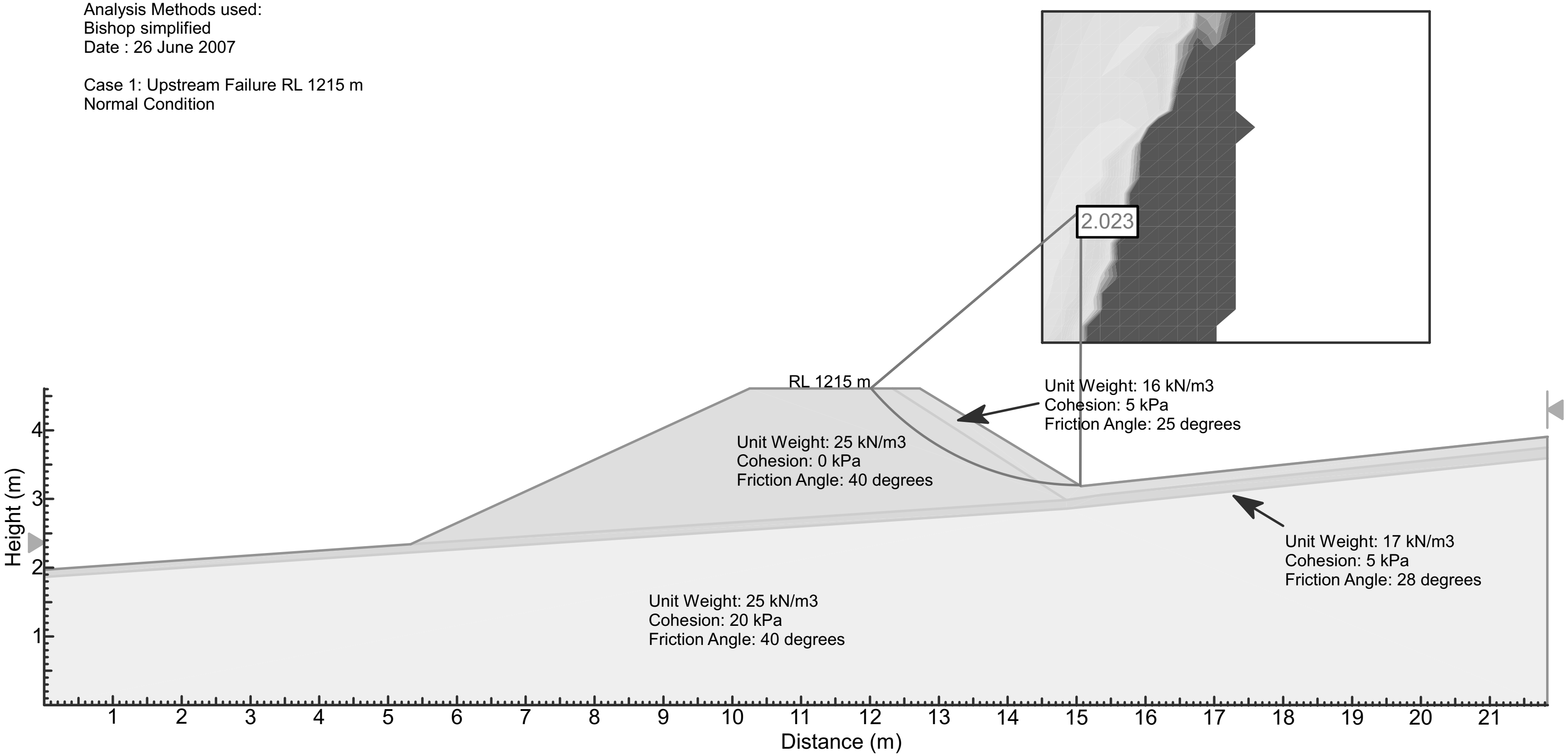
F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig F1 A4.pdf



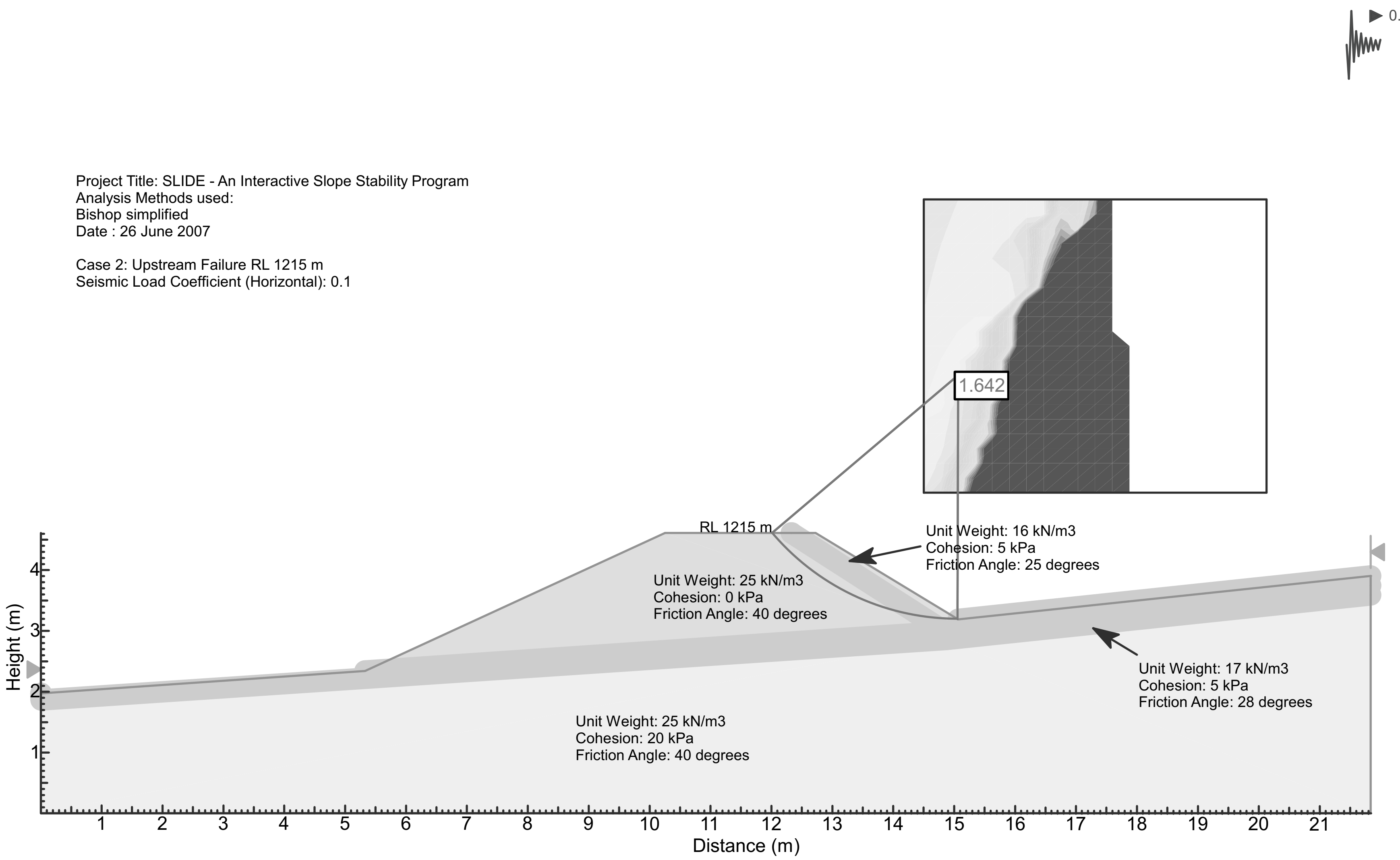
coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	FAC	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY CASE 2 DOWNSTREAM FAILURE RL 1215m SEISMIC LOAD COEFFICIENT 0.1g	Original Size	A4
	Approved	CL		Project no:	MH00335AA
	Date	19/09/2007		Figure	F2
	Scale	AS SHOWN			

Project Title: SLIDE - An Interactive Slope Stability Program
Analysis Methods used:
Bishop simplified
Date : 26 June 2007

Case 1: Upstream Failure RL 1215 m
Normal Condition



coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	FAC	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY CASE 1 UPSTREAM FAILURE RL 1215m NORMAL CONDITION	Original Size	A4
	Approved	CL		Project no:	MH00335AA
	Date	19/09/2007		Figure	F3
	Scale	AS SHOWN			

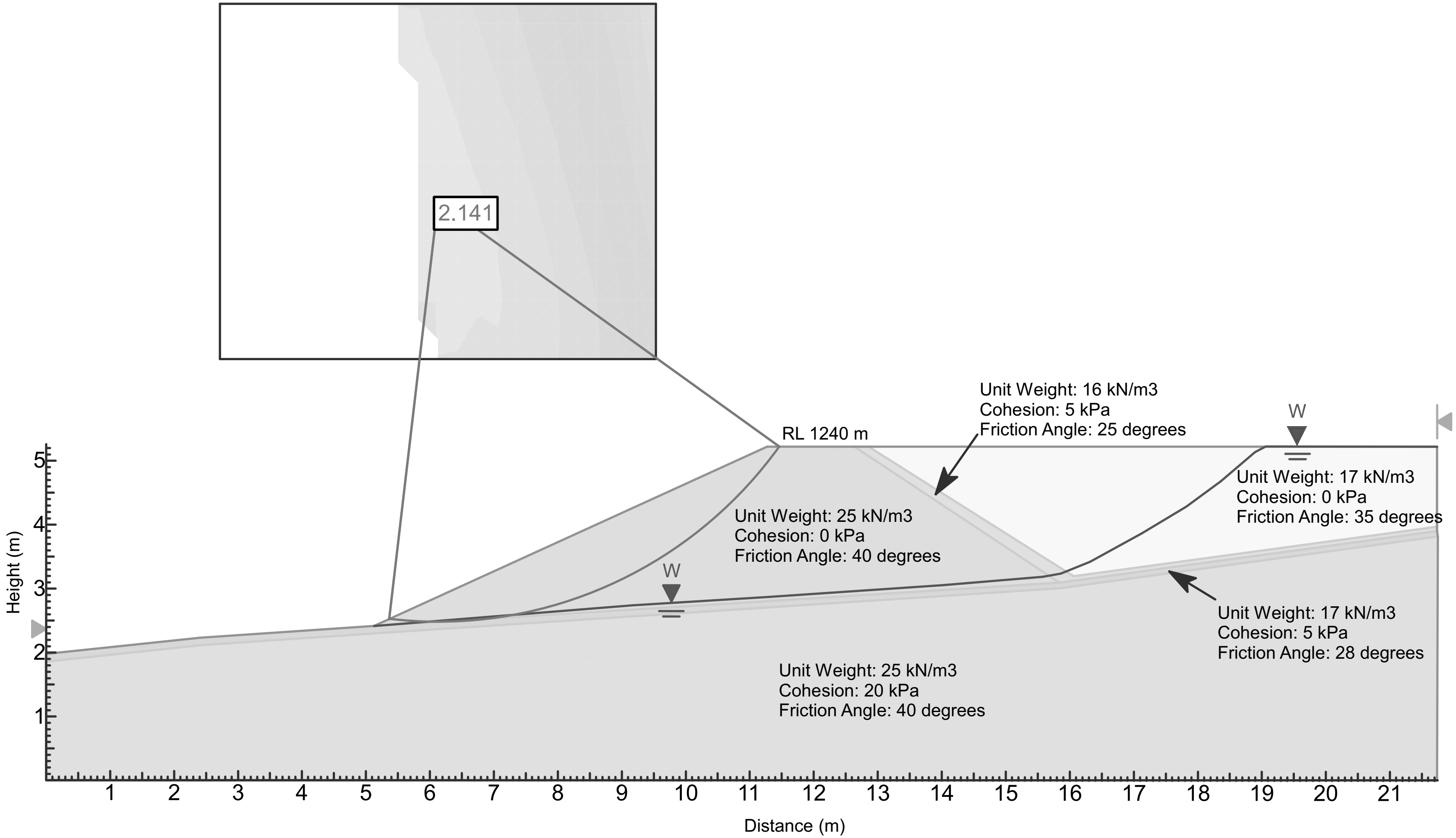


coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	FAC	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY CASE 2 UPSTREAM FAILURE RL 1215m SEISMIC LOAD COEFFICIENT (HORIZONTAL) 0.1	Original Size	A4
	Approved	CL		Project no:	MH00335AA
	Date	19/09/2007		Figure	F4
	Scale	AS SHOWN			

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig F4 A4.pdf

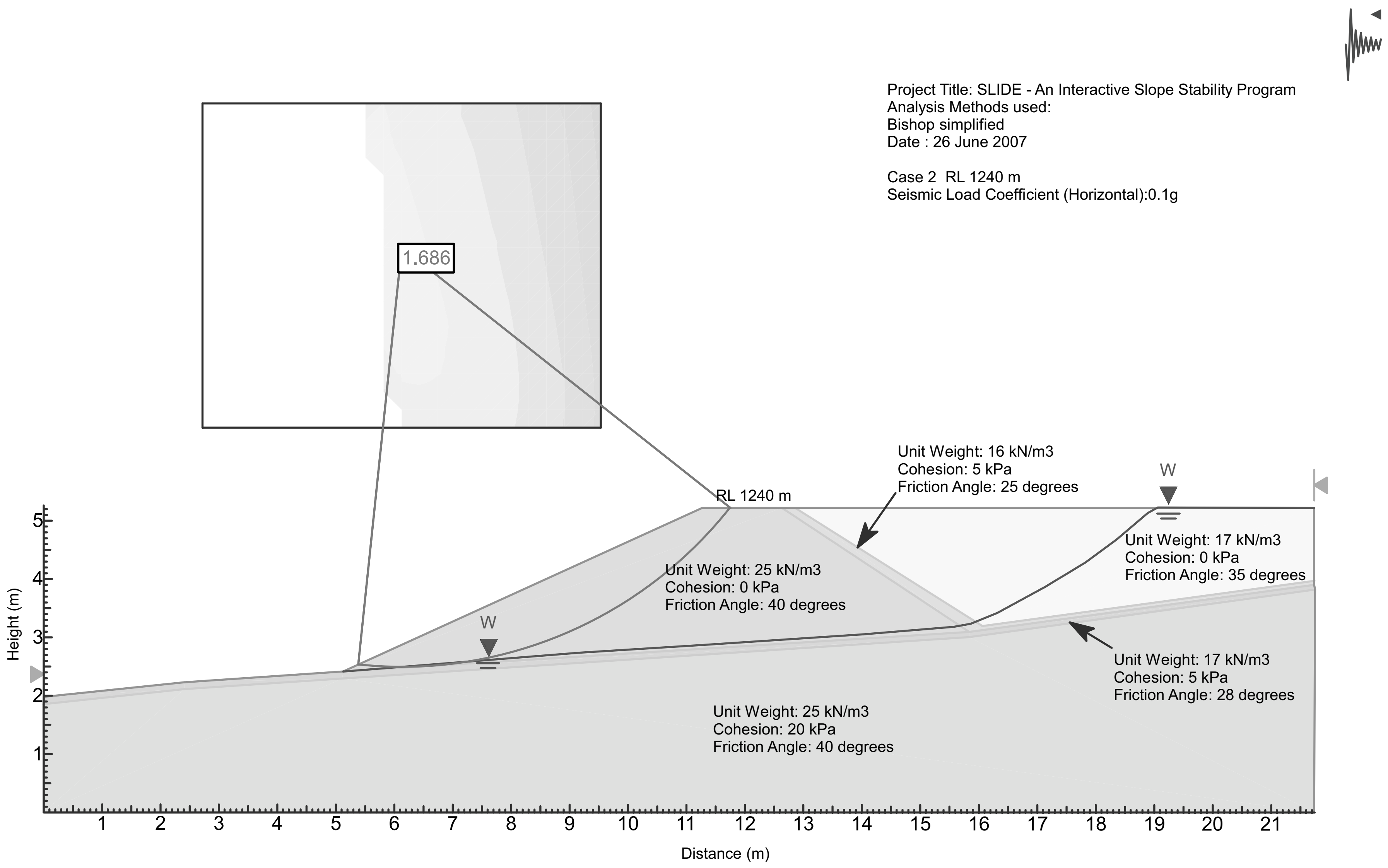
Project Title: SLIDE - An Interactive Slope Stability Program
Analysis Methods used:
Bishop simplified
Date : 26 June 2007

Case 1 RL 1240 m
Normal Condition



coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	FAC	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A4
	Approved	CL	CASE 1	Project no:	MH00335AA
	Date	19/09/2007	RL 1240m		
	Scale	AS SHOWN	NORMAL CONDITION	Figure	F5

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig F5 A4.pdf

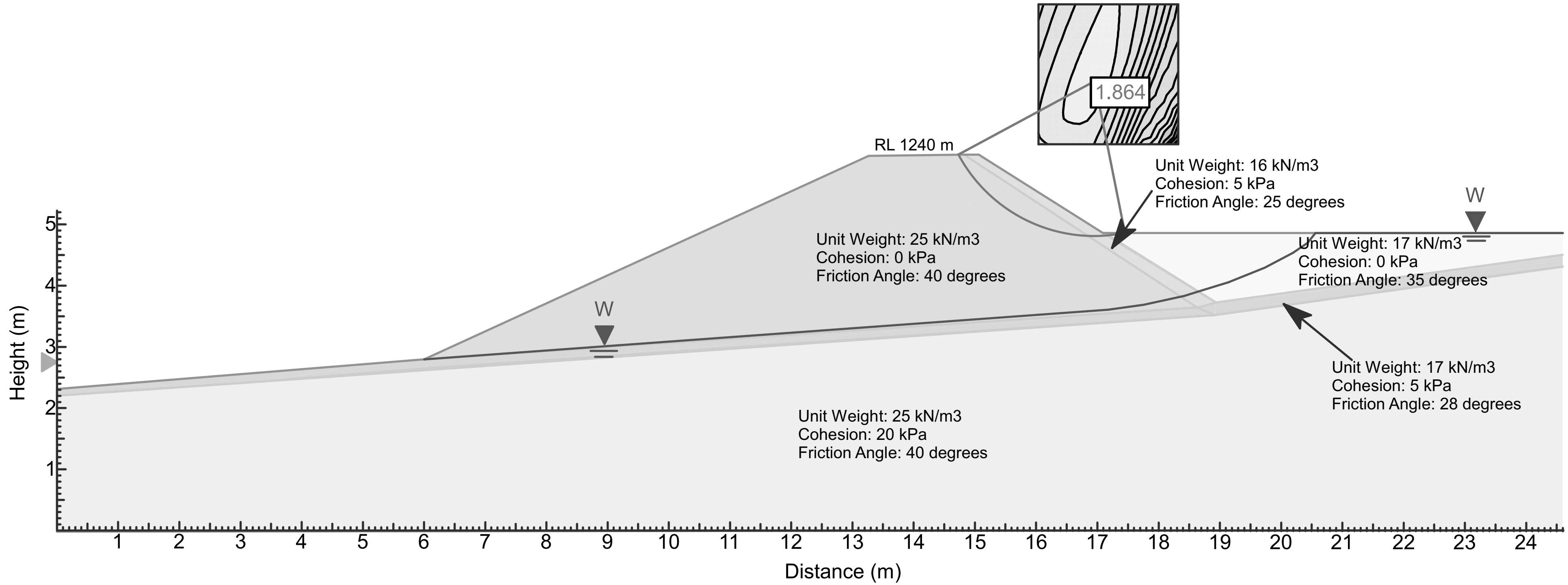


coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	FAC	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY CASE 2 DOWNSTREAM FAILURE RL 1240m SEISMIC LOAD COEFFICIENT (HORIZONTAL) 0.1g	Original Size	A4
	Approved	CL		Project no:	MH00335AA
	Date	19/09/2007		Figure	F6
	Scale	AS SHOWN			

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig F6 A4.pdf

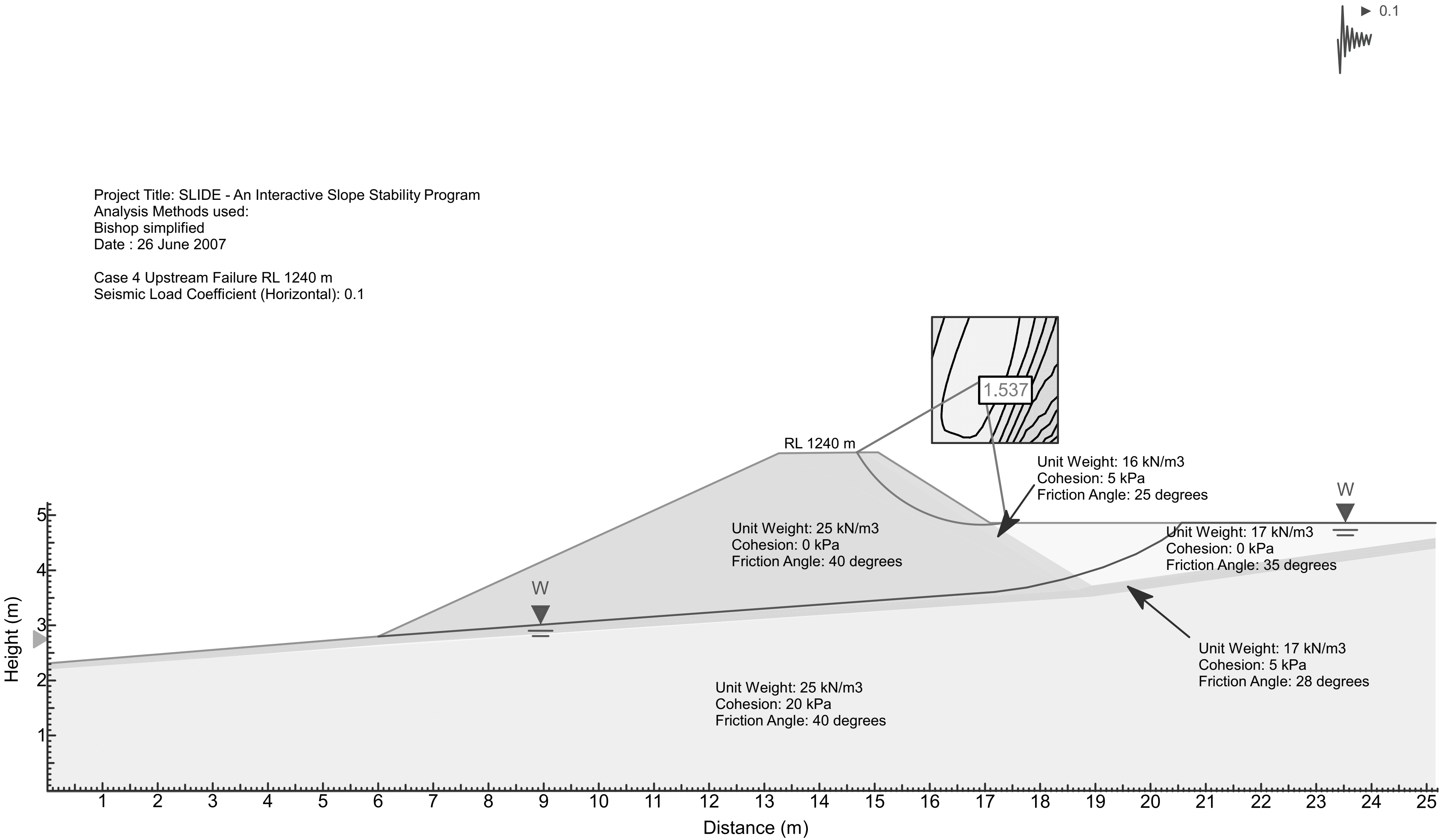
Project Title: SLIDE - An Interactive Slope Stability Program
Analysis Methods used:
Bishop simplified
Date : 26 June 2007

Case 3 RL 1240 m
Normal Condition



coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE	Drawn	FAC	HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY	Original Size	A4
	Approved	CL	CASE 3	Project no:	MH00335AA
	Date	19/09/2007	RL 1240m	Figure	F7
	Scale	AS SHOWN	NORMAL CONDITION		

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig F7 A4.pdf



coffey mining SPECIALISTS FROM BOARDROOM TO MINE FACE					
	Drawn	FAC	**HILLGROVE COPPER PTY LTD COMPANY KANMANTOO TAILINGS STORAGE FACILITY CASE 4 UPSTREAM FAILURE RL 1240m SEISMIC LOAD COEFFICIENT (HORIZONTAL) 0.1**	**Original Size**	A4
	Approved	CL		**Project no:**	MH00335AA
	Date	19/09/2007		**Figure**	**F8**
	Scale	AS SHOWN			

F:\MINE\MH00300-MH00499\MH00335AA Kanmantoo Project Infrastructure \PDF Docs\MH00335AA fig F8 A4.pdf

Appendix G

Risk Assessment

PROJECT: TSF RISK STUDY
CLIENT: HILLGROVE COPPER PTY LTD
LOCATION: KANMANTOO
SUBJECT: RISK ASSESSMENT - SUMMARY

HAZARD	FAILURE MECHANISM RESULTING	POTENTIAL CONSEQUENCES SAFETY	O/B	LIKELIHOOD	RISK	ACTION
Seismic	Embankment deformation, loss of freeboard, flow of water and minor tailings	Major	Catastrophic To $100million	Rare	H	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed
Overtopping	Overtopping of embankment, embankment erosion, flow of water only	Major	Major To $10million	Rare	H	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed
Overtopping	Overtopping of embankment, embankment erosion, flow of water and minor tailings	Major	Catastrophic To $100million	Rare	H	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed
Piping Internal Erosion	High pond level, Embankment erosion, flow of water and minor tailings	Minor	Moderate To $1million	Rare	M	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed
Foundation Sliding	Embankment failure, flow of water and minor tailings	Major	Catastrophic To $100million	Rare	H	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed
Embankment Failure High Water Level	High pond level, Embankment instability, flow of water and minor tailings	Major	Catastrophic To $100million	Rare	H	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed
Tails Line Break Erosion	Tailings line break, embankment erosion, flow of tailings	Moderate	Minor to Moderate $100k - $1M	Likely	H	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed
Seepage	Seepage from TSF or underdrainage collection pond pond	-	Minor to Moderate to $100k/ann*	Likely	H	Seepage reduction measures include: Additional testing of borrow materials to confirm material parameters including permeability Assessment of the rock mass permeability Additional modelling to determine the groundwater monitoring requirements Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the scope of Works and Drawings for construction Ensure management controls are in place to achieve the design objectives as outlined in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Maintaining a minimal supernatant pond in the centre of the Senior management attention needed to ensure compliance with all these requirements
Combination	Embankment failure, flow of water and minor tailings	Major	Catastrophic To $100million	Rare	H	Ensure management controls are in place to achieve the design objectives and compliance with procedures as documented in the Operations Manuals eg: daily inspections by designated plant staff, monthly by plant management, with logs completed after each inspection and annual engineering inspections and reviews. Senior management attention needed

Notes: O/B = Operations/Business
* consequence based on nominal cost of monitoring, pump operation

PROJECT: **TSF RISK STUDY**

CLIENT: **HILLGROVE COPPER PTY LTD**

LOCATION: **KANMANTOO**

SUBJECT: **QUALITATIVE RISK ANALYSIS MATRIX**

Likelihood

Almost Certain p=1	H	H	E	E	E
Likely	M	H	H	E	E
Moderate	L	M	H	E	E
Unlikely	L	L	M	H	E
Rare p<10-4	L	L	M	H	H

Consequence

	Insignificant	Minor	Moderate	Major	Catastrophic
Losses	$10K	$100K	$1M	$10M	$100M
	-	-	-	1 Life	10 Lives

Risk Characterisation Table (after AS/NZS4360:1999)

Legend

E=	Extreme Risk: detailed reseach and management planning required at senior levels
H=	High Risk: senior management attention needed.
M=	Moderate Risk: manage by specific monitoring or response procedures.
L=	Low Risk: manage by routine procedures.

PROJECT:	**TSF RISK STUDY**
CLIENT:	**HILLGROVE COPPER PTY LTD**
LOCATION:	**KANMANTOO**
SUBJECT:	**RISK ASSESSMENT WORKSHEET**

Hazard	Probability	Consequence	Risk	Quantity of materials spilled	Concentrations and Quantity of Contaminants Released	Determine Area of Influence	Determine impacted environment	Quantify environmental effects	Determine the Impact on Stakeholders	Quantify effects on stakeholders	Quantify Corporate Reputation costs	Quantify Remediation costs	Other
Seismic event (maximum credible earthquake)	**Rare**	**Catastophic**	**H**	Requires a 'Dam Break' study. Difficult to undertake given that it requires the prediction of the moisture content of the tailings at the time of failure.	Indeterminant and could be large scale (in excess of 1M m3).	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Loss and pollution of pastoral land, pollution of surface drainage lines impacts on native flora and fauna.	Loss of income and sustainance. Includes company, local pastoralist and effects on flora and fauna.	$100M	$100M	$100M	
Overtopping (water only)	**Rare**	**Major**	**H**	Requires a hydrological study based on rainfall data and review design. Review of study completed by Doug Cooper.	Indeterminant and could be large scale (in excess of 1M m3).	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Loss and pollution of pastoral land, pollution of surface drainage lines impacts on native flora and fauna.	Loss of income and sustainance. Includes company, local pastoralist and effects on flora and fauna.	$10M	$10M	$10M	
Overtopping (water & Tailings)	**Rare**	**Catastophic**	**H**	Requires a 'Dam Break' or hydrologic study. Difficult to undertake given that it requires the prediction of the moisture content of the tailings at the time of failure.	Indeterminant and could be large scale (in excess of 1M m3).	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Loss and pollution of pastoral land, pollution of surface drainage lines impacts on native flora and fauna.	Loss of income and sustainance. Includes company, local pastoralist and effects on flora and fauna.	$100M	$100M	$100M	
Piping Internal Erosion	**Rare**	**Moderate**	**M**	Difficult to quantify.	Slow release in managable quantities.	Area immediately adjecent and downstream of dam toe.	Down stream toe of dam.	Long term pumping and ongoing treatment.	Non-existent.	$1m	Low	$1m	
Foundation Sliding	**Rare**	**Catastophic**	**H**	Requires a 'Dam Break' study. Difficult to undertake given that it requires the prediction of the moisture content of the tailings at the time of failure.	Indeterminant and could be large scale (in excess of 1M m3).	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Loss and pollution of pastoral land, pollution of surface drainage lines impacts on native flora and fauna.	Loss of income and sustainance. Includes company, local pastoralist and effects on flora and fauna.	$100M	$100M	$100M	
Embankment Failure High Water Level	**Rare**	**Major**	**H**	Requires a hydrological study based on rainfall data and review design. Review of study completed by Doug Cooper.	Indeterminant and could be large scale (in excess of 1M m3).	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Loss and pollution of pastoral land, pollution of surface drainage lines impacts on native flora and fauna.	Loss of income and sustainance. Includes company, local pastoralist and effects on flora and fauna.	$10M	$10M	$10M	
Erosion	**Rare**	**Minor**	**L**	Insignificant	Insignificant	Area immediately adjecent and downstream of dam toe.	Area immediately adjecent and downstream of dam toe.	Insignificant	Insignificant	$100k	Low	$100k	
Tailings Line Break	**Moderate**	**Moderate**	**M**	690m3/h until plant shut down.	690m3/h of slurry bearing ......ppm to ......ppm Cu at pH 8 to 9	Raw water dam catchment area or TSF footprint.	Raw water dam catchment area or TSF footprint.	Pollution of raw water contained in raw water dam.	Inconvenience. Minor loss of production and potable water supply.	$1M	$1M	$1M	
Seepage	**Likely**	**Moderate**	**H**	Difficult to quantify.	Slow release in managable quantities.	Area immediately adjecent and downstream of dam toe.	Down stream toe of dam.	Long term pumping and ongoing treatment.	May need to consider alternative water supply to land holders downstream of TSF embankment.	$1M	$100k	$1M	
Combination	**Rare**	**Catastophic**	**H**	Requires a 'Dam Break' study. Difficult to undertake given that it requires the prediction of the moisture content of the tailings at the time of failure.	Indeterminant and could be large scale (in excess of 1M m3).	Area down stream of dam. Mara river and into Lake Victoria.	Area downstream of TSF including process plant and open pit depending on where breach occurs.	Loss and pollution of pastoral land, pollution of surface drainage lines impacts on native flora and fauna.	Loss of income and sustainance. Includes company, local pastoralist and effects on flora and fauna.	$100M	$100M	$100M	
Loss of freeboard due to incompletion of dam construction requirements within mining timeframes.	**Rare**	**Catastophic**	**H**	Requires monitoing of storage volumes and planning of construction works to meet future storage requirements									
Reduction of TSF capacity due to dump failure.	**Likely**	**Major**	**E**	Requires a study of future TSF capacity and construction requirements. Alternative TSF would have to be considered.						$10M	$0	$0	
Inability to achieve minimum design density of tailings stored. (dependant on deposition planning and water balance efficiency).	**Moderate**	**Moderate**	**H**	Requires a study of future TSF capacity and construction requirements. Alternative TSF would have to be considered. Requires routine monitoring.						$10M	$0	$0	

Appendix H

Geochemical Characterisation

HILLGROVE RESOURCES PTY LTD

KANMANTOO COPPER PROJECT

GEOCHEMICAL CHARACTERISATION OF

TAILINGS-PROFILE SAMPLES FROM

EXISTING TAILINGS-STORAGE FACILITY

Implications for Process-Tailings Management

GRAEME CAMPBELL AND ASSOCIATES PTY LTD
(ACN 061 827674)

JULY 2007

Job No. 0721

TABLE OF CONTENTS

Page Nos.

TABLES, FIGURE, PLATE AND APPENDIX

(At Back of Report Text)

TABLES

FIGURE

PLATE

APPENDIX

1.0 INTRODUCTION

Hillgrove Copper Pty Ltd (Hillgrove) are proposing to develop their Kanmantoo Project, which is located in the Mount Lofty Ranges 55 kilometres southeast of Adelaide in South Australia. This is a brownfields development with an existing mine and some infrastructure from previous mining operations, including a tailings-storage facility (TSF) at the site. Overburden removal for mining commenced in August 1970, and treatment of ore commenced in October 1971. Mining ceased in 1975, and the mine placed on care-and-maintenance in 1976.[1]

From the historic operations, a stream of process-tailings (in slurry form) was discharged to an engineered, valley-type TSF (referred to herein as the existing TSF). A new TSF is currently being designed for the proposed project.

Graeme Campbell & Associates Pty Ltd (GCA) was commissioned to carry out geochemical testwork on tailings-profile samples derived from the tailings-bed in the **existing TSF**.

The Static-Testwork Programme focused on the Acid-Formation Potential (AFP), and Multi-Element Composition of the tailings-solids samples.[2] Limited physical testing was also undertaken. In addition, the quality (viz. major/minor-ion chemistry) of tailings-porefluid samples was determined. Finally, the tailings-solids sample tested in the GCA (2007) study for the new TSF was subjected to Kinetic-Testwork (viz. Weathering-Column) to assess sulphide-oxidation rates.

The testwork results are presented and discussed in this report, and implications for process-tailings management highlighted.

[1] Information Source: Email correspondence of 23rd July 2007 from Mr Chris Lane [Coffey Mining Pty Ltd, Perth].
[2] A Static-Testwork Programme comprises "whole-rock" analyses and tests.

Since the orebody is that mined historically, and since the ore-processing routes are broadly similar, the tailings-bed in the existing TSF is an analogue from which lessons may usefully be gained for the design of the new TSF. Due regard needs to be given, however, to the fact that the tailings-bed-surface in the existing TSF was left exposed for several years prior to the construction of a vegetated-cover system during the 1980s.[3]

[3] Topsoil was laid down during 1975 and 1976 on the upper-surface of the tailings-bed. The surfical-tailings were scarified and limed prior to placement of topsoil which was then seeded. (Information Source: Email correspondence of 23rd July 2007 from Mr Chris Lane [Coffey Mining Pty Ltd, Perth]).

2.0 STUDY APPROACH

2.1 Samples

A range of tailings-profile samples was provided to GCA for testing, and are derived from a drilling programme carried out by Coffey Mining Pty Ltd (Adelaide).

The locations of drillholes BH1, BH2, BH3, and BH4, are shown on Figure 1.

Since the drilling was undertaken in May 2007, the moisture status of the tailings-bed should be at the "low-end-of-the-range" (i.e. minimal influences from recent recharge) following the 2006-2007 summer.

Details of sample treatment are given in the laboratory reports presented in Appendix A.

It is understood that the existing TSF operated during the 1970s, and was left exposed for *c.* 5 yrs before being covered with 0.5 m (nominal) of soil/regolith materials with a loam (+/-) texture. The cover supports grasses and shrubs. Although difficult to estimate accurately, under the Mediterranean conditions of the mine-site, the mean-recharge across the cover/tailings-interface may approach several cms per annum, and likely would occur mainly from mid-winter to spring in most years. Prior to covering, the mean-recharge may have locally been within the decimetre+ per year range.

2.2 Testwork Programme

The geochemical testing herein employed methods as described in the GCA (2007) report.

3.0 CHARACTERISATION OF TAILINGS-PROFILE SAMPLES FROM EXISTING TSF

3.1 Physical Characteristics

Values of various physical properties for selected tailings-profile samples from drillholes BH1, BH3 and BH4 are presented in Table 3.1.

The Dry-Bulk-Densities (DBDs) determined on 30-cm sections at different depths were within the range 1.59-2.08 g/cm^3.

Relative-Saturation of Pore-Spaces

The near-saturated state of the samples from BH1 reflect the down-beach position of this drillhole. Under such conditions sulphide-oxidation is negligible (i.e. limited by O_2-diffusion through water-filled pores which is negligibly slow).

The tested samples from BH3 and BH4 had relative-saturations within the range 15.9-21.2 %. These conditions favour sulphide-oxidation, as governed by the reach of the O_2-diffusion front, in turn controlled by sulphide-mineral reactivity.

Intermittent Fines-Enriched Bands

Two depth-intervals (viz. *c.* 8.00-9.00 m, and *c.* 11.60-12.20 m) from drillhole BH3 were used for sectioning to determine the content of fines (i.e. -75µm) determined via dry-sieving. The sections were typically 10 cm in length, except for selected positions where an enrichment in fines was inferred visually (e.g. 12.03-12.05 m as shown on Plate 1). In total, 16 samples were tested.

The range in fines content was 7-24 %. The sample from 12.03-12.05 m had a fines content of 24 %. If this result is excluded, then the range in fines content was 7-15 %, and the mean-fines content was 10 %. The wafer-thin, horizontal laminations shown on

Plate 1 have important implications for maintaining near-saturation conditions locally within the tailings-bed of the new TSF during its active-lifetime.

3.2 Geochemistry

3.2.1 Acid-Base Chemistry of Tailings-Solids

The results from acid-base-chemistry testing on the tailings-profile samples are presented in Table 3.2. The results of related testing on the tailings-solids sample from the GCA (2007) study are also given for comparison.

Key findings include:

- pH-(1:2) values of:
    - *c.* 2-3 within the surface-zone of BH3 (i.e. sulphide-oxidation most intense)
    - *c.* 3-4 typically where unsaturated conditions occur
    - *c.* 4-5 in BH1 associated with near-saturated conditions
- evidence of segregation of sulphide-minerals, and association with tailings-particles of coarser texture (viz. BH3)
- sulphide-decomposition generally at an advanced stage with only minute/trace amounts of "remnant-sulphides", although only modest decomposition in BH3 below the top 4-5 m
- inferred "start-condition" of tailings-solids in existing TSF very similar to the nature of the tailings-solids sample tested in the GCA (2007) study

3.2.2 Multi-Element Composition of Tailings-Solids

The multi-element-analysis results are presented in Tables 3.3-3.5. Reference should be made to the GCA (2007) report for the definition of the Geochemical-Abundance Index (GAI) indicated in these tables.

The tailings-profile samples were variously enriched in Cu, Ag, Bi, and Se. However, none of these enrichments were marked.

The above suite of enriched minor-elements is similar to that observed in the GCA (2007) study.

3.2.3 Quality of Tailings-Porefluids

The analysis results for tailings-porefluid samples from near the bases of BH1 and BH4 are presented in Table 3.6. These samples are derived from turbid fluids drained from the plastic-tubes employed for tailings-profile coring. The tailings-fines were allowed to settle-out, followed by filtration and preservation, for analysis.

The tailings-porefluid samples had pH values of 3.2-4.1, and were variously saline with SO_4 concentrations ranging up to 12,000 mg/L. The salts in solution mainly comprised Fe-sulphates [and most likely dominated by Fe(II)-sulphates].

4.0 REACTIVITY OF TAILINGS-SOLIDS DESTINED FOR NEW TSF

The tailings-solids sample tested in the GCA (2007) study was subjected to kinetic-testing employing a weathering-column similar in design to that described in the AMIRA (2002) document. The column contained *c.* 1.0 kg (dry-solids basis) of tailings-solids, and underwent weekly cycles of desiccation-flushing. At the completion of each drying-cycle, deionised-water was added to elute solutes produced through sulphide-oxidation – this addition was continued until the Electrical-Conductivity (EC) value of the leachate was less than 500 µS/cm.

The analysis results for the column-leachate samples are presented in Table 4.1.

Mass-balance calculations indicate that, during the five (5) weathering-cycles carried out, the Sulphide-Oxidation Rate (SOR) was *c.* 400 mg SO_4/kg/week. Given the Sulphide-S value of 0.78 % (GCA 2007), this SOR estimate means that the sulphide-mineral suite contains reactive varieties, consistent with the occurrence of marcasites (GCA 2007).

The reactive nature of the tailings-solids means that where desaturation occurs within the surface-zone of the dormant tailings-beaches in the new TSF, sulphide-oxidation will be confined close-to-surface. In any case, the high relative-saturation during the active-lifetime of the TSF will suppress sulphide-oxidation via O_2-diffusion control.

5.0 CONCLUSIONS

During the active-lifetime of the new TSF, sulphide-oxidation should be minimal where spigot rotations occur over weeks (c.f. months), so that moist surface conditions occur on the tailings beaches, and near-saturation conditions within the tailings bed. The latter should be favoured by impeding-bands of fines. In addition to curtailed rates of sulphide-oxidation, soluble-alkalinity forms in the “fresh” incoming tailings-slurry will at least partly neutralise any acidity locally generated within the surface-zone of any dormant tailings-beaches.

Although difficult to quantify, soluble-Fe(II) forms should occur in the tailings-pore-fluids, but overall likely not beyond the 10 m/L range when due account is taken of localised sulphide-oxidation within the surface-zone, and mixing/dilution with tailings-pore-fluids derived from the incoming, freshly-deposited-tailings. Since anoxic conditions should prevail at depth, scaling-up of the underdrainage system is considered unlikely, though this is again difficult to quantify *a priori*.

The underdrainage-fluids reporting from the underdrainage-system are anticipated to have a pH of *c.* 5-6 (and possibly slightly higher) with low amounts of latent-acidity in the form of soluble-Fe(II) forms. The Al concentrations should be low (e.g. near-mg/L range), and the Cu concentrations may be within the range 1-10 mg/L. The latent-acidity in the form of soluble-Fe(II) forms means that the underdrainage-fluids could acidify to pH 4 (+/-) upon "daylighting", and ageing in contact with air. However, this acid-producing mechanism should be offset by decant-fluids discharged in larger quantities at a pH likely similar to the tailings-slurry-pH at discharge (i.e. *c.* 8-9). Some form of neutralisation treatment may nonetheless be required as part of the water-conditioning process before the tailings-waters are returned to the process circuit.

It is emphasised that because of the paucity of carbonate-minerals, and the presence of reactive-sulphides, albeit in trace amounts, accurate projection of pH regime and metal-solubility behaviour is difficult for this Project. Monitoring is needed to confirm (or refine) the above anticipated chemistry of the underdrainage-fluids. Routine sampling and analysis is recommended at the discharge-points of both the underdrainage-fluids, and decant-fluids.

6.0 REFERENCES

AMIRA International Ltd, 2002, "ARD Test Handbook", Prepared by Ian Wark Research Institute, and Environmental Geochemistry International Pty Ltd.

Graeme Campbell & Associates Pty Ltd, 2007, "Kanmantoo Copper Project: Geochemical Characterisation of Process-Tailings-Slurry Sample [Static-Testwork] - Implications for Process-Tailings Management", Unpublished report prepared for Hillgrove Resources Pty Ltd.

TABLES

Table 3.1: Physical Characteristics of Tailings-Profile Samples

GCA-SAMPLE-NO.	Depth-Interval (m)	Gravimetric-Water-Content (GWC) [%, w/w]	Dry-Bulk-Density (DBD) [t/m3]	Particle-Density (PD) (t/m3)	Porosity	Volumetric Water-Content (VWC) [%, w/w]	Relative-Saturation (%)
<u>BH4</u>							
GCA7096	1.25-1.55	5.8	1.59	2.93	0.46	9.2	20.0
GCA7094	1.65-1.95	5.4	1.64	2.83	0.42	8.9	21.2
GCA7091	4.65-4.95	5.0	1.58	2.83	0.44	7.9	18.0
<u>BH1</u>							
GCA7102	2.50-2.80	30.4	nm	2.94	nc	nc	nc
GCA7099	5.40-5.70	31.3	1.62	2.95	0.45	50.7	>95
<u>BH3</u>							
GCA7115	4.05-4.35	3.2	1.97	2.98	0.34	6.4	18.8
GCA7112	7.05-7.35	3.3	2.08	3.09	0.33	6.9	20.9
GCA7110	9.80-10.10	2.6	2.07	3.12	0.34	5.4	15.9
GCA7107	13.00-13.30	3.6	1.82	2.93	0.38	6.6	17.4

<u>Notes</u>:
nm = not measured; nc = not calculated.
Relative-saturation is the ratio of VWC and Porosity expressed as a percentage.

Table 3.2: Acid-Base-Analysis and Net-Acid-Generation Results for Tailings-Profile Samples

GCA-SAMPLE NO.	Depth-Interval (m)	MC (%, w/w)	pH-(1:2)	EC-(1:2) [mS/cm]	TOTAL-S (%)	SO_4-S (%)	Sulphide-S (%)	Cr(II)-Red.-S (%)	TOTAL-C (%)	ANC	NAPP	NAG	NAG-pH
										kg H_2SO_4/tonne			
BH3													
GCA7118	0.00-1.50	4.8	2.8	4.1	1.4	1.2	0.20	0.12	0.03	-8	15	12	2.8
GCA7117	1.55-3.00	3.1	2.9	4.9	1.6	0.82	0.80	0.64	<0.01	-6	31	20	2.5
GCA7116	3.00-4.45	3.5	3.3	2.1	0.88	0.35	0.53	0.51	0.01	7	9.3	17	2.6
GCA7114	5.00-5.95	3.1	3.7	2.0	1.2	0.23	1.0	nm	0.02	10	21	24	2.6
GCA7113	6.00-7.45	4.3	3.2	1.3	0.49	0.15	0.34	0.33	0.01	12	-1.5	8.5	3.1
GCA7111	9.00-10.20	3.2	3.3	0.79	0.61	0.13	0.48	nm	0.03	11	3.7	15	2.8
GCA7109	10.20-11.15	2.8	3.6	0.67	1.2	0.13	1.1	0.85	0.08	11	23	24 (21)	2.6 (2.6)
GCA7108	12.20-13.40	3.2	3.6	0.79	0.73	0.17	0.56	nm	0.05	11	6.2	15	2.7
GCA7106	13.40-14.60	7.3	3.9	0.67	0.95	0.12	0.83	nm	0.05	17	8.4	11	3.0
GCA7105	14.60-15.00	18.2	3.9	0.96	2.1	0.16	2.0	1.5	0.03	8	54	29	2.6
BH1													
GCA7104	0.00-1.55	16.2	3.9	1.7	0.34	0.19	0.15	nm	0.02	12	-7.4	6.3	3.4
GCA7103	1.55-2.90	16.2	4.8	1.5	0.35	0.13	0.22	0.22	0.04	15	-8.2	7.7	3.5
GCA7101	2.90-4.50	26.2	4.4	1.5	0.48	0.13	0.35	nm	0.06	15	-4.2	10	3.1
GCA7100	4.50-5.80	36.4	4.4	1.9	0.58	0.16	0.42	nm	0.10	67	-54	13	3.0
GCA7098	7.00-7.90	39.1	4.4	2.0	0.59	0.15	0.44	0.42	0.08	68	-54	11	3.2

Notes:
MC = Moisture-Content; EC = Electrical-Conductivity; ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; NAG = Net-Acid Generation; Cr(II)-Red.-S = Cr(II)-Reducible-S.
pH-(1:2) and EC-(1:2) correspond to pH and EC determined on sample slurries prepared using deionised-water at a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH.
Values in parentheses represent duplicates.

Table 3.2 (Cont'd): Acid-Base-Analysis and Net-Acid-Generation Results for Tailings-Profile Samples

GCA-SAMPLE NO.	Depth-Interval (m)	MC (%, w/w)	pH-(1:2)	EC-(1:2) [mS/cm]	TOTAL-S (%)	SO_4-S (%)	Sulphide-S (%)	Cr(II)-Red.-S (%)	TOTAL-C (%)	ANC	NAPP	NAG	NAG-pH
										kg H_2SO_4/tonne			
BH4													
GCA7097	0.00-1.55	5.6	4.5	0.14	0.30	0.31	<0.01	nm	0.07	5	nc	2.8	3.3
GCA7095	1.55-3.00	4.3	4.2	0.14	0.26	0.28	<0.01	nm	<0.01	12	nc	<0.5	7.8
GCA7093	3.00-4.50	4.5	4.2	0.21	0.19	0.21	<0.01	<0.01	0.03	11	nc	2.5	3.3
GCA7092	4.50-5.95	6.5	4.0	0.36	0.23	0.26	<0.01	nm	<0.01	10	nc	2.7	3.3
GCA7090	6.00-7.45	5.9	3.9	0.49	0.21	0.19	0.02	nm	0.03	5	nc	<0.5	6.7
GCA7089	7.50-8.75	17.8	3.6	2.4	0.34	0.33	0.01	0.07	0.01	6	nc	5.3	3.4
GCA7088	9.00-10.45	30.2	3.5	1.5	0.48	0.23	0.25	nm	0.06	12	-4.3	9.7	3.2
GCA7087	10.50-11.50	31.1	3.7 (3.7)	1.9 (1.8)	0.44 (0.43)	0.21	0.23	0.23	0.07	14 (12)	-4.9	5.3	3.4
BH2													
GCA7121	0.00-1.55	8.0	4.3	0.13	0.21	0.22	<0.01	nm	0.04	9	nc	4.3 (4.8)	3.5 (3.3)
GCA7120	1.55-3.00	10.0	4.0	0.29	0.24	0.24	<0.01	nm	<0.01	4	nc	3.8	3.4
GCA7119	3.00-4.50	21.1	3.9	1.2	0.43	0.17	0.26	0.26	0.03	12	-4.0	6.6	3.2

Notes:
MC = Moisture-Content; EC = Electrical-Conductivity; ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential;
NAG = Net-Acid Generation; Cr(II)-Red.-S = Cr(II)-Reducible-S; nm = not measured; nc = not calculated.
pH-(1:2) and EC-(1:2) correspond to pH and EC determined on sample slurries prepared using deionised-water at a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH. Values in parentheses represent duplicates.

The following is Table 3.1 from the GCA (2007) report for the new TSF (included here for comparison)

GCA-SAMPLE NO.	MC (%, w/w)	TOTAL-S (%)	SO_4-S (%)	Sulphide-S (%)	CO_3-C (%)	ANC	NAPP	NAG	NAG-pH	AFP CATEGORY
						kg H_2SO_4/tonne				
GCA6298	20.5	0.80 (0.76)	0.03 (0.02)	0.78	0.01 (0.01)	9 (8)	16	13 (13)	3.6 (3.7)	**PAF-[Short-Lag]**

Notes:
MC = Moisture-Content; EC = Electrical-Conductivity; ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; AFP = Acid-Formation Potential; PAF = Potentially-Acid Forming;
NAG = Net-Acid Generation; Cr(II)-Red.-S = Cr(II)-Reducible-S; nm = not measured; nc = not calculated.
All results expressed on a dry-weight basis, except for NAG-pH. Values in parentheses represent duplicates.

Table 3.3: Multi-Element-Analysis Results for Tailings-Profile Samples (BH3)

Note: Refer Appendix B in the GCA (2007) report for the definition of the Geochemical-Abundance-Index (GAI) indicated in this table.

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)					AVERAGE-CRUSTAL-ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)				
	1.55-3.00 m [GCA7117]	**5.00-5.95 m [GCA7114]**	**9.00-10.20 m [GCA7111]**	**12.20-13.40 m [GCA7108]**	**14.60-15.00 m [GCA7105]**		**1.55-3.00 m [GCA7117]**	**5.00-5.95 m [GCA7114]**	**9.00-10.20 m [GCA7111]**	**12.20-13.40 m [GCA7108]**	**14.60-15.00 m [GCA7105]**
Al	7.1%	6.5%	6.0%	5.0%	6.8%	8.2%	0	0	0	0	0
Fe	19.5%	14.9%	14.3%	10.3%	16.4%	4.1%	2	1	1	1	1
Na	0.019%	0.037%	0.033%	0.052%	0.043%	2.3%	0	0	0	0	0
K	0.55%	1.0%	0.82%	1.1%	0.91%	2.1%	0	0	0	0	0
Mg	1.3%	1.4%	1.3%	1.4%	1.3%	2.3%	0	0	0	0	0
Ca	0.15%	0.13%	0.12%	0.11%	0.14%	4.1%	0	0	0	0	0
Ag	1.0	0.4	0.6	0.7	2.2	0.07	**3**	2	**3**	**3**	**4**
Cu	1,600	610	460	450	4,200	50	**4**	**3**	**3**	**3**	**6**
Zn	37	46	40	46	48	75	0	0	0	0	0
Cd	<0.1	<0.1	<0.1	<0.1	<0.1	0.11	0	0	0	0	0
Pb	10	15	12	18	20	14	0	0	0	0	0
Cr	62	67	62	57	63	100	0	0	0	0	0
Ni	34	43	28	29	42	80	0	0	0	0	0
Co	140	94	66	61	130	20	2	2	1	1	2
Mn	5,000	3,200	2,900	1,800	4,300	950	2	1	1	0	2
Hg	0.02	<0.01	<0.01	<0.01	<0.01	0.05	0	0	0	0	0
Sn	5.2	5.9	8.2	6.1	6.6	2.2	1	1	1	1	1
Sr	6.0	7.9	9	12	18	370	0	0	0	0	0
Ba	59	110	92	120	94	500	0	0	0	0	0
Th	11	11	9.4	9.3	12	12	0	0	0	0	0
U	2.6	2.7	2.3	2.4	2.6	2.4	0	0	0	0	0
Tl	0.23	0.41	0.32	0.42	0.42	0.6	0	0	0	0	0
V	64	70	66	59	61	160	0	0	0	0	0
As	2	1	<1	<1	<1	1.5	0	0	0	0	0
Bi	92	79	48	81	130	0.048	**6**	**6**	**6**	**6**	**6**
Sb	<0.05	<0.05	<0.05	<0.05	0.07	0.2	0	0	0	0	0
Se	2.3	1.5	1.5	1.2	3.2	0.05	**5**	**4**	**4**	**4**	**5**
Mo	0.8	0.8	0.7	1.0	2.1	1.5	0	0	0	0	0
B	<50	51	<50	<50	<50	10	0	2	0	0	0
P	470	480	450	420	460	1,000	0	0	0	0	0
F	250	460	390	430	400	950	0	0	0	0	0

Note: Average-crustal abundance of elements based on Bowen (1979) [see GCA (2007) report]

Table 3.4: Multi-Element-Analysis Results for Tailings-Profile Samples (BH4)

Note: Refer Appendix B in the GCA (2007) report for the definition of the Geochemical-Abundance-Index (GAI) indicated in this table.

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)			AVERAGE-CRUSTAL-ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)		
	0.00-1.55 m [GCA7097]	3.00-4.50 m [GCA7093]	9.00-10.45 m [GCA7088]		0.00-1.55 m [GCA7097]	3.00-4.50 m [GCA7093]	9.00-10.45 m [GCA7088]
Al	5.3%	5.3%	7.5%	8.2%	0	0	0
Fe	10.5%	8.3%	12.6%	4.1%	1	0	1
Na	0.049%	0.052%	0.11%	2.3%	0	0	0
K	1.3%	1.6%	2.3%	2.1%	0	0	0
Mg	1.5%	1.6%	2.6%	2.3%	0	0	0
Ca	0.079%	0.092%	0.21%	4.1%	0	0	0
Ag	0.3	0.1	0.3	0.07	2	0	2
Cu	390	240	530	50	2	2	**3**
Zn	35	38	73	75	0	0	0
Cd	<0.1	<0.1	<0.1	0.11	0	0	0
Pb	14	15	28	14	0	0	0
Cr	56	53	76	100	0	0	0
Ni	20	25	53	80	0	0	0
Co	35	33	99	20	0	0	2
Mn	1,600	910	950	950	0	0	0
Hg	<0.01	<0.01	<0.01	0.05	0	0	0
Sn	6.7	6.1	14	2.2	1	1	2
Sr	11	9.5	20	370	0	0	0
Ba	140	180	250	500	0	0	0
Th	9.7	9.8	18	12	0	0	0
U	2.3	2.3	4.4	2.4	0	0	0
Tl	0.47	0.62	0.86	0.6	0	0	0
V	70	69	96	160	0	0	0
As	<1	<1	1	1.5	0	0	0
Bi	140	180	250	0.048	**6**	**6**	**6**
Sb	<0.05	<0.05	<0.05	0.2	0	0	0
Se	0.97	0.41	0.64	0.05	**4**	2	**3**
Mo	1.3	1.0	0.7	1.5	0	0	0
B	<50	<50	<50	10	0	0	0
P	410	440	830	1,000	0	0	0
F	530	640	990	950	0	0	0

Note: Average-crustal abundance of elements based on Bowen (1979) [see GCA (2007) report]

Table 3.5: Multi-Element-Analysis Results for Tailings-Profile Samples (BH1 and BH2)

Note: Refer Appendix B in the GCA (2007) report for the definition of the Geochemical-Abundance-Index (GAI) indicated in this table.

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)			AVERAGE-CRUSTAL-ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)		
	BH1 0.00-1.55 m [GCA7104]	BH1 4.50-5.80 m [GCA7100]	BH2 1.55-3.00 m [GCA7120]		BH1 0.00-1.55 m [GCA7104]	BH1 4.50-5.80 m [GCA7100]	BH2 1.55-3.00 m [GCA7120]
Al	7.2%	7.8%	6.0%	8.2%	0	0	0
Fe	11.7%	12.8%	9.1%	4.1%	1	1	1
Na	0.075%	0.10%	0.053%	2.3%	0	0	0
K	2.1%	2.5%	1.8%	2.1%	0	0	0
Mg	2.4%	2.7%	1.7%	2.3%	0	0	0
Ca	0.17%	0.21%	0.12%	4.1%	0	0	0
Ag	0.4	0.4	0.4	0.07	2	2	2
Cu	1,300	440	290	50	**4**	**3**	2
Zn	61	77	46	75	0	0	0
Cd	<0.1	<0.1	<0.1	0.11	0	0	0
Pb	25	26	16	14	0	0	0
Cr	94	110	69	100	0	0	0
Ni	41	45	22	80	0	0	0
Co	79	110	37	20	1	2	0
Mn	1,000	1,100	1,100	950	0	0	0
Hg	<0.01	<0.01	<0.01	0.05	0	0	0
Sn	12	14	7.6	2.2	2	2	1
Sr	19	18	14	370	0	0	0
Ba	220	260	190	500	0	0	0
Th	18	20	13	12	0	0	0
U	4.3	4.8	2.8	2.4	0	0	0
Tl	0.79	0.92	0.69	0.6	0	0	0
V	89	98	75	160	0	0	0
As	1	1	<1	1.5	0	0	0
Bi	64	69	62	0.048	**6**	**6**	**6**
Sb	0.21	0.07	<0.05	0.2	0	0	0
Se	1.1	0.71	0.70	0.05	**4**	**3**	**3**
Mo	1.2	1.1	0.8	1.5	0	0	0
B	<50	<50	<50	10	0	0	0
P	690	800	560	1,000	0	0	0
F	850	1,100	690	950	0	0	0

Note: Average-crustal abundance of elements based on Bowen (1979) [see GCA (2007) report]

Table 3.6: Analysis Results for Tailings-Porefluid Samples

Note: All results in mg/L, except for pH and EC (µS/cm).

ELEMENT/ PARAMETER	BH4 (10.50-11.50 m) [GCA7084]	BH4 (9.00-10.45 m) [GCA7085]	BH1 (7.00-7.90 m) [GCA7086]	ELEMENT/ PARAMETER	BH4 (10.50-11.50 m) [GCA7084]	BH4 (9.00-10.45 m) [GCA7085]	BH1 (7.00-7.90 m) [GCA7086]
Major-Parameters				***Minor-Ions***			
pH	3.2	3.5	4.1	Fe	3,500	2,900	210
EC [µS/cm]	9,800	7,000	5,300	Cu	1.0	<0.1	<0.1
				Ni	5.5	8.2	<0.1
Major-Ions				Zn	2.3	5.5	0.2
				Co	30	31	0.27
Na	120	63	420	Al	3.7	5.5	1.0
K	290	84	310	Cd	0.0019	0.0030	0.0024
Mg	870	330	250	Pb	0.007	<0.005	0.016
Ca	450	470	500	Cr	<0.1	<0.1	<0.1
Cl	170	78	280	Hg	<0.001	<0.001	<0.001
SO_4	12,000	7,700	2,900	As	0.008	0.007	0.002
Si	24	25	16	Sb	<0.0001	<0.0001	<0.0001
				Bi	0.00007	<0.00005	<0.00005
				Se	0.006	<0.005	<0.005
				B	0.5	0.4	0.30
				Mo	0.0017	0.0007	0.0006
				P	<1	<1	<1
				Ag	<0.0001	<0.0001	<0.0001
				Ba	0.0098	0.021	0.042
				Sr	0.14	0.23	1.4
				Tl	<0.0001	<0.0001	<0.0001
				V	<0.1	<0.1	<0.1
				Sn	0.003	0.003	0.002
				U	0.0056	0.0031	0.0028
				Th	0.0011	0.00013	0.00008
				Mn	120	69	17

Note: EC = Electrical Conductivity.

Table 4.1: Analysis Results for Column-Leachates

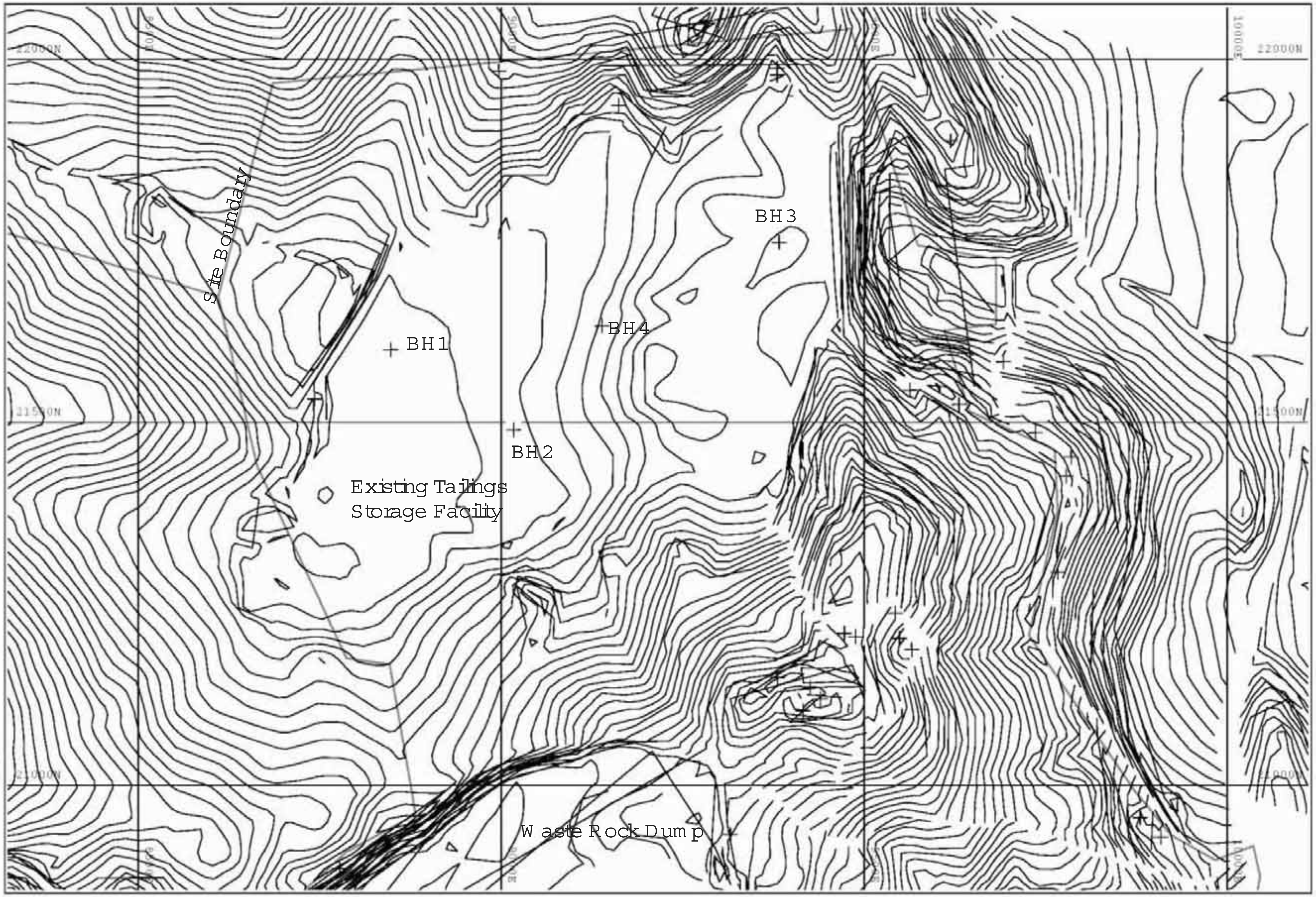
Note: All results in mg/L, except for pH and EC (µS/cm).

PARAMETER	WEEKLY WEATHERING-CYCLES (GCA6298)						
	1-1	**1-2**	**1-3**	**2**	**3**	**4**	**5**
pH	2.8	3.1	3.2	2.9	2.9	3.0	3.0
EC (µS/cm)	1,700	420	260	890	860	890	790
SO_4 (mg/L)	1,200	140	66	350	390	410	300
Fe (mg/L)	160	7.6	2.8	51	47	62	36
Al (mg/L)	71	4.9	1.6	21	25	26	20
Cu (mg/L)	18	2.4	1.2	4.0	4.5	3.7	2.9
Mn (mg/L)	6.7	0.67	0.25	0.82	1.3	0.84	0.61
Leachate Wt (kg)	0.48	0.99	1.00	1.32	1.51	1.54	1.54

Notes:
EC = Electrical Conductivity.
Tailings-solids sample GCA6298 was that tested in the GCA (2007) study.

FIGURE

coffey mining



Coffey Mining Pty Ltd ABN 52 065 481 209			
Drawn	JLB	Hillgrove Resources Ltd Kanmantoo Copper Project Location of Drillholes for Geochemical Study	FIGURE 1
Approved	JLB		
Date	10/07/07		
Scale	As Shown		Job no: MEND04511AA

PLATE

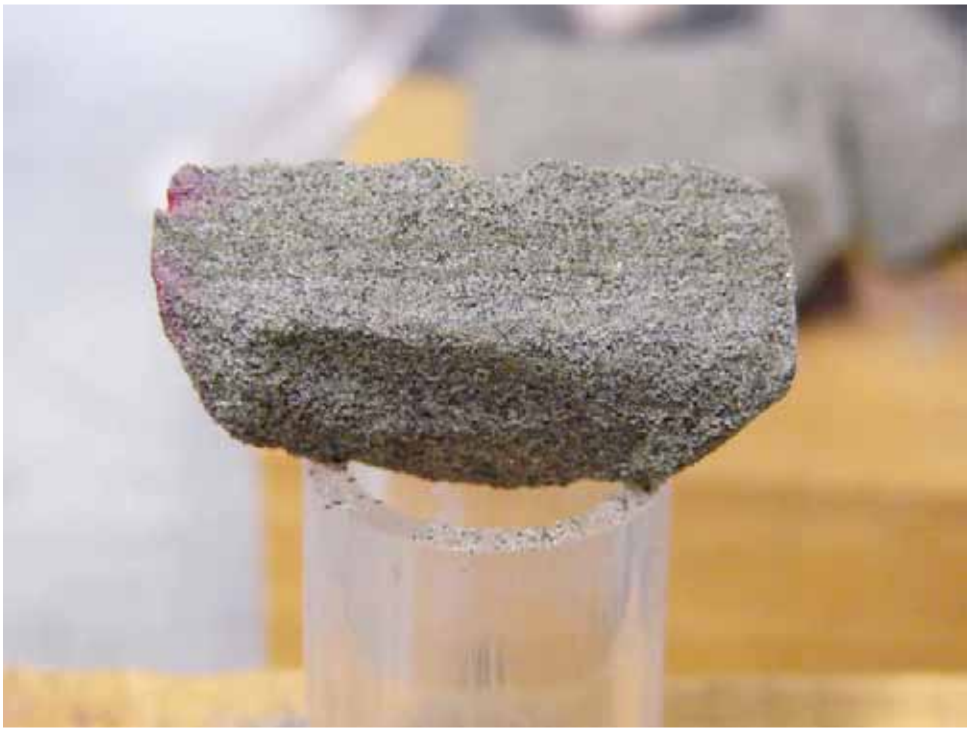


PLATE 1:

Segment of cemented-tailings from BH3, 12.03-12.05 m showing wafer-thin, horizonal laminations.

APPENDIX

LABORATORY REPORTS

Dr G Campbell
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN WA 6255

JOB INFORMATION

JOB CODE	**143.0/0705837**
No. of SAMPLES	63
CLIENT O/N	GCA0721
PROJECT	Base-Metal Operation
STATE	Tailings-Pore-Fluids and Solids
DATE RECEIVED	28th May, 2007
DATE COMPLETED	4th July, 2007

LEGEND

X = Less than Detection Limit
N/R = Sample Not Received
* = Result Checked
( ) = Result still to come
I/S = Insufficient Sample for Analysis
E6 = Result X 1,000,000
UA = Unable to Assay
> = Value beyond Limit of Method

The tailings samples were contained in plastic-walled tubes which were transparent. Tube section were cut with a hack-saw, and contents removed for oven-drying at 80oC in a forced-fan oven which minimises oxidation of sulphide-minerals. After oven-drying, samples were pushed through a 4.75mm sive (brass) and then handmixed prior to testing. Procedures were shown by Dr GD Campbell.

Some grab sub-samples at the time of sampling were taken and deionised-water added to allow measurement of slurry-pH (or “Mud-pH”).

Some samples had tailings-pore-fluids which drained from the tubes, and these pore-fluids were collected, vacuum-filtered (0.45µm membrane), and preserved for analysis, as appropriate.

TAILINGS-PORE-FLUID SAMPLES:

Sample Name	GCA No.	Volume (ml)	Slurry-pH	Slurry-EC (mS/cm)
BH4/1	GCA7084	80	3.2	9.78
BH4/2	GCA7085	220	3.5	6.91
BH1/1	GCA7086	50	4.1	5.29

TAILINGS-SOLIDS SAMPLES:

Sample Name	GCA No.	Slurry-pH	Tray+wet sample (g)	Tray+dry sample (g)	Weight (g) moist-solids	Weight (g) dry-solids	Weight (g) water	Gravimetric Moisture Content
BH4/1a	GCA7087		838.5	644.5	818	624.0	194.0	31.1
BH4/1b	"	4.7	893	686	872.5	665.5	207.0	31.1
BH4/2a	GCA7088		891	694.5	870.5	674.0	196.5	29.2
BH4/2b	"		732.5	562	712	541.5	170.5	31.5
BH4/3a	GCA7089	3.6	578	536.5	557.5	516.0	41.5	8.0
BH4/3b	"		870.5	749.5	850	729.0	121.0	16.6
BH4/3c	"		934.5	746.5	914	726.0	188.0	25.9
BH4/4a	GCA7090		745	712	724.5	691.5	33.0	4.8
BH4/4b	"		746.5	700	726	679.5	46.5	6.8
BH4/4c	"	4.0	737	696	716.5	675.5	41.0	6.1
BH4/5a	GCA7091		645	615	624.5	594.5	30.0	5.0
BH4/5b	GCA7092		824	768	803.5	747.5	56.0	7.5
BH4/5c	"		843	800	822.5	779.5	43.0	5.5
BH4/6a	GCA7093		744.5	713.5	724	693.0	31.0	4.5
BH4/6b	"		819.5	780	799	759.5	39.5	5.2

Sample Name	GCA No.	Slurry-pH	Tray+wet sample (g)	Tray+dry sample (g)	Weight (g) moist-solids	Weight (g) dry-solids	Weight (g) water	Gravimetric Moisture Content
BH4/6c	"		711	686.5	690.5	666.0	24.5	3.7
BH4/7a	GCA7094		673.5	640	653	619.5	33.5	5.4
BH4/7b	GCA7095	4.4	751.5	720.5	731	700.0	31.0	4.4
BH4/7c	"		801	769	780.5	748.5	32.0	4.3
BH4/8a	GCA7096		656	621	635.5	600.5	35.0	5.8
BH4/8b	GCA7097		811	772	790.5	751.5	39.0	5.2
BH4/8c	"	4.8	748	707	727.5	686.5	41.0	6.0
BH3/1a	GCA7105	4.2	1299.5	1102.5	1279	1082.0	197.0	18.2
BH3/2a	GCA7106	4.2	1052	968	1031.5	947.5	84.0	8.9
BH3/2b	"		900.5	855	880	834.5	45.5	5.5
BH3/3a	GCA7107		731	706.5	710.5	686.0	24.5	3.6
BH3/3b	GCA7108	3.9	669.5	649	649	628.5	20.5	3.3
BH3/3c	"		743	720.5	722.5	700.0	22.5	3.2
BH3/5a	GCA7109	3.9	609.5	592.5	589	572.0	17.0	3.0
BH3/5b	"		609	594	588.5	573.5	15.0	2.6
BH3/6a	GCA7110		821	801	800.5	780.5	20.0	2.6
BH3/6b	GCA7111	3.2	983.5	954	963	933.5	29.5	3.2
BH3/8a	GCA7112		829	803.5	808.5	783.0	25.5	3.3
BH3/8b	GCA7113	3.3	939	901	918.5	880.5	38.0	4.3
BH3/9a	GCA7114	4.3	1055	1026.5	1034.5	1006.0	28.5	2.8
BH3/9b	"		992	960.5	971.5	940.0	31.5	3.4
BH3/10a	GCA7115		787.5	763.5	767	743.0	24.0	3.2
BH3/10b	GCA7116	3.6	692.5	669	672	648.5	23.5	3.6
BH3/10c	"		680	658	659.5	637.5	22.0	3.5
BH3/11a	GCA7117	2.8	1098	1061.5	1077.5	1041.0	36.5	3.5
BH3/11b	"		1201.5	1170	1181	1149.5	31.5	2.7
BH3/12a	GCA7118	2.7	1171	1118.5	1150.5	1098.0	52.5	4.8
BH3/12b	Discarded		961.5	906.5	941	886.0	55.0	6.2
BH3/12c	Discarded		816.5	747.5	796	727.0	69	9.5
BH1/1a	Discarded		742.5	556	722	535.5	186.5	34.8
BH1/1b	GCA7098	5.7	582.5	424.5	562	404.0	158.0	39.1
BH1/2a	GCA7099		822	631	801.5	610.5	191	31.3
BH1/2b	GCA7100	5.7	521	387.5	500.5	367.0	133.5	36.4
BH1/3a	GCA7101	5.4	585.5	460.5	565	440	125	28.4
BH1/3b	"		533	434.5	512.5	414	98.5	23.8
BH1/4a	GCA7102		486	377.5	465.5	357	108.5	30.4
BH1/4b	GCA7103	5.4	829	716	808.5	695.5	113.0	16.2
BH1/5a	GCA7104	4.4	555.5	468	535	447.5	87.5	19.6
BH1/5b	"		607.5	538.5	587	518.0	69.0	13.3
BH2/2a	GCA7119	4.2	684.5	563	664	542.5	121.5	22.4
BH2/2b	"		704	564.5	683.5	544.0	139.5	25.6
BH2/2c	"		631	550.5	610.5	530.0	80.5	15.2
BH2/3a	GCA7120	3.9	641	551.5	620.5	531.0	89.5	16.9
BH2/3b	"		719.5	664	699	643.5	55.5	8.6
BH2/3c	"		593.5	566.5	573	546.0	27.0	4.9
BH2/4a	GCA7121	4.3	487	448	466.5	427.5	39.0	9.1
BH2/4b	"		584.5	543.5	564	523.0	41.0	7.8
BH2/4c	"		482.5	451.5	462	431.0	31.0	7.2

NATA Signatory: A Evers
Chief Chemist

Date: 4th July 2007

This document is issued in accordance with NATA's accreditation requirements.

GENALYSIS
LABORATORY SERVICES PTY LTD

Dr G Campbell
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN WA 6255

JOB INFORMATION

JOB CODE	**143.0/0705929**
No. of SAMPLES	26
CLIENT O/N	GCA0721
PROJECT	Base-Metal Operations
STATE	Tailings
DATE RECEIVED	8th June 2007
DATE COMPLETED	18th July 2007

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

The samples were received as tailings solids which required crushing, drying ,mixing, splitting and fine pulverising in a zirconia bowl.

Results of analysis on:

Element		**S_tot**	**C_tot**	**S-SO4**	**EC**	**pH**
Method		**/LECO**	**/LECO**	**Na2CO3/ GRAV**	**W/METER**	**W/METER**
Detection		**0.005**	**0.01**	**0.01**	**0.01**	**0.1**
Units		**%**	**%**	**%**	**mS/cm**	**NONE**
Sample Name						
Control Blank		X	0.01	X	X	4.4
GCA7087		0.433	0.06	0.21	1.76	3.7
GCA7087	Check	0.430	0.07		1.84	3.7
GCA7088		0.480	0.06	0.23	1.46	3.5
GCA7089		0.333	0.01	0.33	2.33	3.6
GCA7090		0.201	0.03	0.19	0.49	3.9
GCA7092		0.222	X	0.26	0.36	4.0
GCA7093		0.182	0.03	0.21	0.21	4.2
GCA7095		0.253	X	0.28	0.14	4.2
GCA7097		0.297	0.07	0.31	0.14	4.5
GCA7098		0.590	0.08	0.15	1.91	4.4
LECO5		1.999	1.08			
GCA7100		0.571	0.10	0.16	1.88	4.4
GCA7101		0.471	0.06	0.13	1.46	4.4
GCA7103		0.343	0.04	0.13	1.42	4.8
GCA7104		0.333	0.02	0.19	1.61	3.9
GCA7105		2.039	0.03	0.16	0.96	3.9
GCA7106		0.948	0.05	0.12	0.67	3.9
GCA7108		0.725	0.05	0.17	0.79	3.6
GCA7109		1.119	0.08	0.13	0.67	3.6
GCA7111		0.605	0.03	0.13	0.79	3.3
GCA7113		0.490	0.01	0.15	1.30	3.2
GCA7114		1.172	0.02	0.23	1.99	3.7
GCA7116		0.880	0.01	0.35	2.10	3.3
GCA7117		1.522	X	0.82	4.86	2.9

Element		S_tot	C_tot	S-SO4	EC	pH
Method		**/LECO**	**/LECO**	**Na2CO3/ GRAV**	**W/METER**	**W/METER**
Detection		**0.005**	**0.01**	**0.01**	**0.01**	**0.1**
Units		**%**	**%**	**%**	**mS/cm**	**NONE**
GCA7118		1.314	0.03	1.24	4.04	2.8
GCA7119		0.427	0.03	0.17	1.13	3.9
GCA7120		0.232	X	0.24	0.29	4.0
GCA7121		0.203	0.04	0.22	0.13	4.3
LECO8		1.060	1.13			
PD-1				4.32		
S_SO4_A				0.63		
S_SO4_B				1.33		

1. The C,S results were determined from the pulverised portion
2. The Carbon and Sulphur was determined according to Genalysis method number SL_W023.
3. S-SO4 was determined by precipitation of BaSO4 according to Genalysis method number ENV_W039
4. pH and EC were analysed on a 1:2 soil to water extract with results reported on the extract basis according to Genalysis method number MPL_W033.

Acid Neutralisation Capacity (ANC)

Sample Name		Fizz Rating	Sample Weight (g)	Molarity HCl	Molarity NaOH	Initial Efferve scence	colour change *	pH drop *	ANC Solution pH	ANC (kg H2SO4/tonne)
GCA7087		0	2	0.4788	0.1051	None	N	3.2	1.9	13
GCA7087	Check	0	2	0.4788	0.1051	None	N	3.3	1.9	12
GCA7088		0	2	0.4788	0.1051	None	N	3.2	2.0	12
GCA7089		0	2	0.4788	0.1051	None	N	NA	1.8	6
GCA7090		0	2	0.4788	0.1051	None	N	NA	2.0	5
GCA7092		0	2	0.4788	0.1051	None	N	3.2	1.7	10
GCA7093		0	2	0.4788	0.1051	None	N	NA	1.7	11
GCA7095		0	2	0.4788	0.1051	None	N	NA	1.7	11
GCA7097		0	2	0.4788	0.1051	None	N	NA	2.0	5
GCA7098		0	2	0.4788	0.4788	None	N	NA	1.4	67
GCA7100		0	2	0.4788	0.4788	None	N	NA	1.4	68
GCA7101		0	2	0.4788	0.1051	None	N	3.2	2.0	14
GCA7103		0	2	0.4788	0.1051	None	N	NA	2.0	14
GCA7104		0	2	0.4788	0.1051	None	N	NA	2.0	11
GCA7105		0	2	0.4788	0.1051	None	N	NA	1.8	7
GCA7106		0	2	0.4788	0.1051	None	N	NA	1.9	16
GCA7108		0	2	0.4788	0.1051	None	N	NA	1.7	11
GCA7109		0	2	0.4788	0.1051	None	N	3.4	1.8	11
GCA7111		0	2	0.4788	0.1051	None	N	NA	1.8	11
GCA7113		0	2	0.4788	0.1051	None	N	3.3	1.8	11
GCA7114		0	2	0.4788	0.1051	None	N	NA	1.8	10
GCA7116		0	2	0.4788	0.1051	None	N	NA	1.8	7
GCA7117		0	2	0.4788	0.1051	None	N	NA	2.0	-5
GCA7118		0	2	0.4788	0.1051	None	N	NA	1.9	-8
GCA7119		0	2	0.4788	0.1051	None	N	NA	2.0	11
GCA7120		0	2	0.4788	0.1051	None	N	NA	2.0	4
GCA7121		0	2	0.4788	0.1051	None	N	NA	1.7	9

Notes:

1. ANC was determined on the -2mm portion. Acid concentrations are as stated
2. Colour change: * Indicates the appearance of a green colouration as the pH=7 endpoint was approached. Two drops of hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron
3. pH drop : * Indicates a pH drop to a value below 4 on addition of peroxide
4. This procedure according to Genalysis methods number ENV_W035
5. A negative ANC indicates that acid was present in the sample in excess of that added for the test by that amount.

NATA ENDORSED DOCUMENT
Company Accreditation Number 3244
The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

NATA Signatory: A Evers
Chief Chemist

Date: 18th July 2007

This document is issued in accordance with NATA's accreditation requirements.

SGS

LABORATORY REPORT COVERSHEET

Date: 17 July 2007

To: Graeme Campbell & Associates
PO Box 247
Bridgetown WA 6255

Attention: Dr Graeme Campbell

Your Reference: GCA 0721 12660
Laboratory Report No: 56337
Samples Received: 13/07/2007
Samples / Quantity: 12 Soil

The above samples were received intact and analysed according to your written instructions. Unless otherwise stated, solid samples are reported on a dry weight basis and liquid samples as received.

Shey Goddard
Administration Manager
CAIRNS

Jon Dicker
Manager
CAIRNS

SGS Australia Pty Ltd ABN 44 000 964 278 | Environmental Services Unit 2, 58 Comport Street, Portsmith 4870 QLD Australia www.au.sgs.com
t +61 (0)7 4035 5111 f +61 (0)7 4035 5122

CLIENT: Graeme Campbell & Associates **Laboratory Report No:** 56337
PROJECT: GCA 0721 12660

LABORATORY REPORT

-------- Our Reference Your Reference	Units	56337-1 GCA 7093	56337-2 GCA 7089	56337-3 GCA 7087
Chromium Reducible Sulfur (S_{CR})	% w/w	<0.005	0.069	0.23

-------- Our Reference Your Reference	Units	56337-4 GCA 7119	56337-5 GCA 7118	56337-6 GCA 7117
Chromium Reducible Sulfur (S_{CR})	% w/w	0.26	0.12	0.64

-------- Our Reference Your Reference	Units	56337-7 GCA 7116	56337-8 GCA 7113	56337-9 GCA 7109
Chromium Reducible Sulfur (S_{CR})	% w/w	0.51	0.33	0.85

-------- Our Reference Your Reference	Units	56337-10 GCA 7105	56337-11 GCA 7103	56337-12 GCA 7098
Chromium Reducible Sulfur (S_{CR})	% w/w	1.5	0.22	0.42

CLIENT: Graeme Campbell & Associates **Laboratory Report No:** 56337
PROJECT: GCA 0721 12660

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD

Chromium Reducible Sulfur (S_{CR})	% w/w	0.005	ASSMAC_22B / CEI-405

CLIENT: Graeme Campbell & Associates **Laboratory Report No:** 56337
PROJECT: GCA 0721 12660

LABORATORY REPORT

QUALITY CONTROL	UNITS	Blank	Replicate Sm#	Replicate Sample||Replicate
Chromium Reducible Sulfur (SCR)	% w/w	[NT]	56337-1	<0.005 || <0.005
QUALTY CONTROL	UNITS	Blank	Replicate Sm#	Replicate Sample||Replicate
Chromium Reducible Sulfur (SCR)	% w/w	[NT]	56337-11	0.22 || 0.22 || RPD: 0

NOTES:
LOR - Limit of Reporting.
* This test is not covered by our current NATA accreditation.

Analysis Date: **Between** 13/07/07 **and** 16/07/07

SGS Terms and Conditions are available from www.au.sgs.com

pH-(1:2) & EC-(1:2) TESTWORK

SAMPLE NO.	SAMPLE WEIGHT (g)	SAMPLE + DEION.-W WEIGHT (g)	pH-(1:2)	EC-(1:2) (mS/cm)
GCA7087	30.0	90.0	3.9	1.5
GCA7088	30.0	90.0	3.8	0.95
GCA7089	30.0	90.1	3.8	1.9
GCA7090	30.0	90.4	4.0	0.47
GCA7092	30.0	90.1	4.1	0.30
GCA7093	30.0	90.5	4.3	0.19
GCA7095	30.0	90.3	4.3	0.13
GCA7097	30.0	90.0	4.6	0.12
GCA7098	30.0	90.2	4.6	1.1
GCA7100	30.0	90.5	4.6	1.1
GCA7101	30.0	90.0	4.6	0.98
GCA7103	30.0	90.3	5.0	1.1
GCA7104-1	30.0	90.2	4.0	1.1
GCA7104-2	30.0	90.1	4.0	1.1
GCA7105	30.0	90.2	4.0	0.77
GCA7106	30.0	90.1	4.0	0.56
GCA7108	30.0	90.3	3.8	0.58
GCA7109	30.0	90.4	3.8	0.55
GCA7111	30.0	90.3	3.4	0.62
GCA7113	30.0	90.6	3.3	0.99
GCA7114	30.0	90.3	3.9	1.6
GCA7116	30.0	90.0	3.5	1.6
GCA7117	30.0	90.1	3.1	4.3
GCA7118	30.0	90.1	2.9	3.6
GCA7119	30.0	90.3	4.3	0.49
GCA7120	30.0	90.4	4.2	0.28
GCA7121	30.0	90.5	4.4	0.13

Note: EC = Electrical-Conductivity.
Testwork performed on crushed (nominal -2 mm) samples.
pH-(1:2) and EC-(1:2) values correspond to pH and EC values of suspensions with a solid:solution ration of *c.* 1:2 (w/w) prepared using deionised-water.
Drift in pH-glass-electrode less than 0.1 pH unit between commencement, and completion, of testwork.
Drift in EC-electrode less than 0.05 mS/cm between commencement, and completion, of testwork.
Testwork performed in a constant-temperature room (viz. 21 +/- 2-3 ^{o}C).

pH-(1:2) & EC-(1:2) TESTWORK (REPEAT)

SAMPLE NO.	SAMPLE WEIGHT (g)	SAMPLE + DEION.-W WEIGHT (g)	pH-(1:2)	EC-(1:2) (mS/cm)
GCA7087	30.0	90.1	3.8	0.94
GCA7088	30.0	90.3	3.6	1.1
GCA7089	30.0	90.1	3.7	1.9
GCA7090	30.0	90.4	3.9	0.39
GCA7092	30.0	90.3	4.0	0.34
GCA7093	30.0	90.3	4.1	0.21
GCA7095	30.0	90.2	4.1	0.16
GCA7105	30.0	90.2	3.9	0.81
GCA7106	30.0	90.0	3.9	0.55
GCA7108	30.0	90.3	3.6	0.67
GCA7109	30.0	90.3	3.7	0.60
GCA7111	30.0	90.0	3.3	0.67
GCA7113	30.0	90.3	3.3	1.1
GCA7114	30.0	90.0	3.9	1.4
GCA7116	30.0	90.5	3.5	1.8
GCA7117	30.0	90.4	3.1	4.4
GCA7118	30.0	90.2	2.9	3.7
GCA7119	30.0	90.0	4.2	1.10
GCA7120	30.0	90.1	4.1	0.36
GCA7121	30.0	90.0	4.3	0.16

Note: EC = Electrical-Conductivity.
Testwork performed on crushed (nominal -2 mm) samples.
pH-(1:2) and EC-(1:2) values correspond to pH and EC values of suspensions with a solid:solution ration of *c.* 1:2 (w/w) prepared using deionised-water.
Drift in pH-glass-electrode less than 0.1 pH unit between commencement, and completion, of testwork.
Drift in EC-electrode less than 0.05 mS/cm between commencement, and completion, of testwork.
Testwork performed in a constant-temperature room (viz. 21 +/- 2-3 ^{o}C).

Dr GD Campbell
28th June 2007

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	Comments	pH of Test Mixture Before Boiling Step	Test Mixture After Boiling Step		Titre [0.5 M-NaOH] (mL)	NAG (kg H_2SO_4/ tonne)
				pH	EC (µS/cm)		
GCA7087	3.0	Reaction peaked within 2 hrs	2.9	3.4	390	3.20	5.3
GCA7088	3.0	Reaction peaked within 2 hrs	2.7	3.2	480	5.90	9.7
GCA7089	3.0	Reaction peaked overnight	3.6	3.4	300	3.20	5.3
GCA7090	3.0	Reaction peaked overnight	7.0	6.7	240	-	<0.5
GCA7092	3.0	Reaction peaked overnight	4.4	3.3	300	1.60	2.7
GCA7093	3.0	Reaction peaked overnight	4.3	3.3	300	1.50	2.5
GCA7095	3.0	Reaction peaked overnight	7.1	7.8	280	-	<0.5
GCA7097	3.0	Reaction peaked overnight	4.6	3.3	340	1.70	2.8
GCA7098	3.0	Reaction peaked within 2 hrs	2.7	3.2	620	6.50	11
GCA7100	3.0	Reaction peaked within 2 hrs	2.6	3.0	630	7.40	13
GCA7101	3.0	Reaction peaked within 2 hrs	2.6	3.1	560	6.10	10
GCA7103	3.0	Reaction peaked within 2 hrs	2.9	3.5	440	4.70	7.7
GCA7104	3.0	Reaction peaked within 2 hrs	2.9	3.4	390	3.80	6.3
GCA7105	3.0	Reaction peaked within 2 hrs	2.2	2.6	1,300	17.30	29
GCA7106	3.0	Reaction peaked within 2 hrs	2.4	3.0	830	6.70	11
GCA7108	3.0	Reaction peaked within 2 hrs	2.4	2.7	950	8.90	15
GCA7109-1	3.0	Reaction peaked within 2 hrs	2.2	2.6	1,300	14.40	24
GCA7109-2	3.0	Reaction peaked within 2 hrs	2.2	2.6	1,300	12.40	21
Blank	3.0		5.9	6.5	76	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997). The pH of the 15 % (v/v) H_2O_2 solution was adjusted to 4.5 using 0.1 M-NaOH prior to commencing the NAG Tests. Test mixtures boiled for *c.* 2 hours to accelerate reaction with H_2O_2. Then, after allowing the test mixtures to cool, 1.0 mL of 0.016 M-$CuSO_4$ solution was added, and the test mixtures again boiled for *c.* 2 hours. The addition of Cu(II) catalyses the decomposition of any residual, unreacted H_2O_2 in the test mixtures (O'Shay *et al.* 1990). K-Feldspar was employed for the Blanks.

Dr GD Campbell
4th July 2007

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g)	Comments	pH of Test Mixture Before Boiling Step	Test Mixture After Boiling Step		Titre [0.5 M-NaOH] (mL)	NAG (kg H_2SO_4/ tonne)
				pH	EC (µS/cm)		
GCA7111	3.0	Reaction peaked within 2 hrs	2.4	2.8	760	9.00	15
GCA7113	3.0	Reaction peaked within 2 hrs	2.6	3.1	510	5.20	8.5
GCA7114	3.0	Reaction peaked within 2 hrs	2.3	2.6	930	14.10	24
GCA7116	3.0	Reaction peaked within 2 hrs	2.5	2.6	870	9.90	17
GCA7117	3.0	Reaction peaked within 2 hrs	2.5	2.5	1,100	12.20	20
GCA7118	3.0	Reaction peaked overnight	3.1	2.8	660	7.10	12
GCA7119	3.0	Reaction peaked within 2 hrs	2.9	3.2	460	4.00	6.6
GCA7120	3.0	Reaction peaked overnight	4.1	3.4	250	2.30	3.8
GCA7121-1	3.0	Reaction peaked overnight	4.9	3.5	200	2.60	4.3
GCA7121-2	3.0	Reaction peaked within 2 hrs	4.3	3.3	270	2.90	4.8
Blank	3.0		5.9	6.7	55	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997). The pH of the 15 % (v/v) H_2O_2 solution was adjusted to 4.5 using 0.1 M-NaOH prior to commencing the NAG Tests. Test mixtures boiled for *c.* 2 hours to accelerate reaction with H_2O_2. Then, after allowing the test mixtures to cool, 1.0 mL of 0.016 M-$CuSO_4$ solution was added, and the test mixtures again boiled for *c.* 2 hours. The addition of Cu(II) catalyses the decomposition of any residual, unreacted H_2O_2 in the test mixtures (O'Shay *et al.* 1990). K-Feldspar was employed for the Blanks.

Dr GD Campbell
4th July 2007

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0705930
No. of SAMPLES	:	11
No. of ELEMENTS	:	32
CLIENT O/N	:	GCA0721 (Job 1 of 1)
SAMPLE SUBMISSION No.	:	
PROJECT	:	Base-Metals Operation (Tailings -Soli
STATE	:	Pulp
DATE RECEIVED	:	08/06/2007
DATE COMPLETED	:	29/06/2007
DATE PRINTED	:	29/06/2007

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY

15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION

12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION

124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION

Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $3.00 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ****

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The 11 samples, as listed in the report, were received as being 'tailings solids' which had been pulverised in a zirconia bowl.

The results have been determined according to Genalysis methods codes :
Digestions : SL_W001 (A/), SL_W007 (BP/), ENV_W012 (DH/SIE), SL_W013 (D/), SL_W012 (CM/).
Analytical Finishes: ICP_W004 (/OES), ICP_W005 (/MS), and AAS_W004 (/CVAP).

The results included the assay of blanks and international reference standards OREAS 45P and SY-2 and Genalysis in-house standards MPL-1,HgSTD-4, and Se_Std.

The results are expressed as parts per million or percent by mass in the dried and prepared material.

NATA Signatory: A Evers
Chief Chemist

Date: 29th June 2007

This document is issued in accordance with NATA's accreditation requirements.

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	0.1	0.02	1	50	0.1	0.01	10	0.1	0.1	2
DIGEST	A/	D/	A/	D/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	MS	OES	MS	OES	MS	MS	OES	MS	MS	OES
SAMPLE NUMBERS										
0001 GCA7088	0.3	7.48	1	X	240.7	67.99	2032	X	99.0	76
0002 GCA7093	0.1	5.29	X	X	176.5	40.73	919	X	32.8	53
0003 GCA7097	0.3	5.26	X	X	136.9	77.37	782	X	34.4	56
0004 GCA7100	0.4	7.80	1	X	254.9	63.14	2045	X	101.8	101
0005 GCA7104	0.4	7.15	1	X	217.7	68.91	1642	X	78.3	94
0006 GCA7105	2.2	6.76	X	X	93.3	122.25	1393	X	121.6	63
0007 GCA7108	0.7	5.00	X	X	115.4	80.68	1004	X	60.5	57
0008 GCA7111	0.6	5.91	X	X	91.3	47.05	1159	X	66.0	62
0009 GCA7114	0.4	6.49	1	51	107.2	78.06	1261	X	93.7	67
0010 GCA7117	1.0	7.10	2	X	59.0	91.34	1462	X	130.9	62
0011 GCA7120	0.4	5.96	X	X	187.7	61.33	1127	X	36.1	69
CHECKS										
0001 GCA7088	0.5	7.45	X	X	246.5	67.94	2029	X	100.1	90
STANDARDS										
0001 HgSTD-4										
0002 MPL-1	16.4		784		150.3	27.94	1.24%	5.1	160.3	1153
0003 OREAS 45P		6.54		X						
0004 Se_Std										
0005 SY-2										
BLANKS										
0001 Control Blank	X	X	X	X	X	0.01	16	X	0.1	X
0002 Control Blank										
0003 Control Blank										
0004 Control Blank		X		X						
0005 Acid Blank	X		X		X	0.03	X	X	0.1	X
0006 Acid Blank										
0007 Acid Blank		X		X						

ANALYSIS

ELEMENTS	Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	1	50	0.01	0.01	20	20	1	0.1	20	1
DIGEST	A/	DH/	D/	CM/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	SIE	OES	CVAP	OES	OES	OES	MS	OES	OES
SAMPLE NUMBERS										
0001 GCA7088	389	990	12.59	X	2.30%	2.52%	948	0.7	1002	53
0002 GCA7093	239	633	8.21	X	1.58%	1.58%	904	1.0	514	25
0003 GCA7097	524	524	10.48	X	1.23%	1.47%	1513	1.3	481	20
0004 GCA7100	434	1008	12.77	X	2.42%	2.62%	1072	1.1	994	45
0005 GCA7104	1236	849	11.65	X	2.03%	2.38%	992	1.2	745	41
0006 GCA7105	4195	392	16.37	X	9015	1.21%	4250	2.1	428	42
0007 GCA7108	449	430	10.25	X	1.04%	1.32%	1760	1.0	511	29
0008 GCA7111	451	387	14.28	X	8165	1.28%	2855	0.7	330	28
0009 GCA7114	608	456	14.87	X	9911	1.36%	3133	0.8	366	43
0010 GCA7117	1511	247	19.48	0.02	5428	1.21%	4944	0.8	185	34
0011 GCA7120	286	682	9.04	X	1.71%	1.66%	1018	0.8	526	22

CHECKS										
0001 GCA7088	391	978	12.44	X	2.32%	2.53%	955	0.6	1000	55

STANDARDS										
0001 HgSTD-4				0.29						
0002 MPL-1	1877				2893	3.65%	1882	55.4	2.83%	1758
0003 OREAS 45P			19.20							
0004 Se_Std										
0005 SY-2		4723								

BLANKS										
0001 Control Blank	X	60	X	X	X	X	X	0.2	X	X
0002 Control Blank										
0003 Control Blank				0.01						
0004 Control Blank			X							
0005 Acid Blank	X				X	X	X	X	X	X
0006 Acid Blank				X						
0007 Acid Blank			X							

ANALYSIS

ELEMENTS	P	Pb	S	Sb	Se	Sn	Sr	Th	Tl	U
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	20	2	10	0.05	0.01	0.1	0.05	0.01	0.02	0.01
DIGEST	A/	A/	A/	A/	BP/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	MS	OES	MS	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS										
0001 GCA7088	828	28	4913	X	0.64	13.3	19.23	17.59	0.86	4.39
0002 GCA7093	435	15	1849	X	0.41	6.1	9.48	9.77	0.62	2.27
0003 GCA7097	408	14	2943	X	0.97	6.7	10.52	9.65	0.47	2.22
0004 GCA7100	795	26	5820	0.07	0.71	14.0	17.21	19.66	0.92	4.71
0005 GCA7104	685	25	3408	0.21	1.09	11.2	18.59	17.07	0.79	4.24
0006 GCA7105	456	20	1.82%	0.07	3.11	6.6	17.21	11.09	0.42	2.55
0007 GCA7108	414	18	6685	X	1.17	6.1	11.07	9.25	0.42	2.33
0008 GCA7111	450	12	6196	X	1.43	8.2	8.71	9.40	0.32	2.25
0009 GCA7114	478	15	1.10%	X	1.48	5.9	7.88	10.61	0.41	2.63
0010 GCA7117	468	10	1.41%	X	2.29	5.2	5.96	10.47	0.23	2.52
0011 GCA7120	553	16	2360	X	0.70	7.6	13.41	12.37	0.69	2.74
CHECKS										
0001 GCA7088	817	28	5031	X	0.61	13.3	19.49	17.37	0.87	4.45
STANDARDS										
0001 HgSTD-4										
0002 MPL-1	582	1526	1.88%	195.28		3.9	402.56	93.87	11.31	8.61
0003 OREAS 45P										
0004 Se_Std					0.64					
0005 SY-2										
BLANKS										
0001 Control Blank	X	X	25	X	X	0.2	X	0.02	X	X
0002 Control Blank					X					
0003 Control Blank										
0004 Control Blank										
0005 Acid Blank	X	X	13	0.07		X	0.06	0.02	X	0.01
0006 Acid Blank										
0007 Acid Blank										

ANALYSIS

ELEMENTS	V	Zn
UNITS	ppm	ppm
DETECTION	2	1
DIGEST	A/	A/
ANALYTICAL FINISH	OES	OES
SAMPLE NUMBERS		
0001 GCA7088	96	73
0002 GCA7093	69	38
0003 GCA7097	70	35
0004 GCA7100	98	77
0005 GCA7104	89	61
0006 GCA7105	61	48
0007 GCA7108	59	46
0008 GCA7111	66	40
0009 GCA7114	70	46
0010 GCA7117	64	37
0011 GCA7120	75	46

CHECKS		
0001 GCA7088	96	73

STANDARDS		
0001 HgSTD-4		
0002 MPL-1	250	1189
0003 OREAS 45P		
0004 Se_Std		
0005 SY-2		

BLANKS		
0001 Control Blank	X	X
0002 Control Blank		
0003 Control Blank		
0004 Control Blank		
0005 Acid Blank	X	X
0006 Acid Blank		
0007 Acid Blank		

METHOD CODE DESCRIPTION

A/MS

Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Mass Spectrometry.

A/OES

Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

BP/MS

Aqua-Regia digest followed by Precipitation and Concentration. Specific for Selenium. Analysed by Inductively Coupled Plasma Mass Spectrometry.

D/OES

Sodium peroxide fusion (Zirconium crucibles) and Hydrochloric acid to dissolve the melt. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

DH/SIE

Alkaline fusion (Nickel crucible) specific for Fluorine. Analysed by Specific Ion Electrode.

CM/CVAP

Low temperature Perchloric acid digest specific for Mercury. Analysed by Cold Vapour Generation Atomic Absorption Spectrometry.

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

TEST CERTIFICATE

Client: Graeme Campbell & Associates P/L
Principal: -
Project: Kanmantoo Project
Location: -

Report No.: HERD07S-03156-9
Job No.: LABTHERD00243AA
Date Tested: 28/06/2007

Soil Particle Density
AS 1289.3.5.1

Laboratory Number	HERD07S-03156	HERD07S-03157	HERD07S-03158	HERD07S-03159
Sample Identification	GCA 7091	GCA 7094	GCA 7096	GCA 7099
Temperature of Test C	20°	20°	20°	20°
Average Soil Particle Density -2.36mm t/m^3	2.83	2.83	2.93	2.95
Average Soil Particle Density +2.36mm t/m^3	-	-	-	-
Average Soil Particle Total Sample t/m^3	-	-	-	-

Remarks: Sampling Method/s - Submitted by client

W. Rozmianiec

Date: 4/07/2007

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

TEST CERTIFICATE

Client: Graeme Campbell & Associates P/L
Principal: -
Project: Kanmantoo Project
Location: -

Report No.: HERD07S-03160-63
Job No.: LABTHERD00243AA
Date Tested: 28/06/2007

Soil Particle Density
AS 1289.3.5.1

Laboratory Number	HERD07S-03160	HERD07S-03161	HERD07S-03162	HERD07S-03163
Sample Identification	GCA 7102	GCA 7107	GCA 7110	GCA 7112
Temperature of Test C	20°	20°	20°	20°
Average Soil Particle Density -2.36mm t/m^3	2.94	2.93	3.12	3.09
Average Soil Particle Density +2.36mm t/m^3	-	-	-	-
Average Soil Particle Total Sample t/m^3	-	-	-	-

Remarks: Sampling Method/s - Submitted by client

W. Rozmianiec

Date: 4/07/2007

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park BC 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

TEST CERTIFICATE

Client: Graeme Campbell & Associates P/L
Principal: -
Project: Kanmantoo Project
Location: -

Report No.: HERD07S-03164
Job No.: LABTHERD00243AA
Date Tested: 28/06/2007

Soil Particle Density
AS 1289.3.5.1

Laboratory Number	HERD07S-03164			
Sample Identification	GCA 7115			
Temperature of Test C	20°			
Average Soil Particle Density -2.36mm t/m^3	2.98			
Average Soil Particle Density +2.36mm t/m^3	-			
Average Soil Particle Total Sample t/m^3	-			

Remarks: Sampling Method/s - Submitted by client

W. Rozmianiec

Date: 4/07/2007

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Coffey Geotechnics Pty Ltd ABN 93 056 929 483
24 Hasler Road Herdsman WA 6017 Australia
PO Box 1530 Osborne Park 6916 Australia
T (+61) (8) 9347 0000 F (+61) (8) 9347 0099
www.coffey.com.au

TEST CERTIFICATE

Client: Graeme Campbell & Associates
Principal: -
Project: Kanmantoo Project
Location: -

Report No.: HERD07S-03246-61
Job No.: LABTHERD00243AA
Date Tested: 3/07/2007

Particle Size Distribution (Part - % Fines)

AS 1289.3.6.1(Part)

Laboratory No.	Sample Identification	Percent Finer Than 0.075mm (%)
HERD07S-03246	BH3 @ 8.00-8.10	11
HERD07S-03247	BH3 @ 8.10-8.20	8
HERD07S-03248	BH3 @ 8.20-8.30	9
HERD07S-03249	BH3 @ 8.30-8.40	11
HERD07S-03250	BH3 @ 8.40-8.50	15
HERD07S-03251	BH3 @ 8.50-8.60	11
HERD07S-03252	BH3 @ 8.60-8.70	9
HERD07S-03253	BH3 @ 8.70-8.80	8
HERD07S-03254	BH3 @ 8.80-8.90	9
HERD07S-03255	BH3 @ 11.63-11.73	7
HERD07S-03256	BH3 @ 11.73-11.83	10
HERD07S-03257	BH3 @ 11.83-11.93	8
HERD07S-03258	BH3 @ 11.93-12.03	10
HERD07S-03259	BH3 @ 12.03-12.05	24
HERD07S-03260	BH3 @ 12.05-12.13	13
HERD07S-03261	BH3 @ 12.13-12.15	11

Remarks: Sampling Method/s - Submitted by client

NATA

This document is issued in accordance with NATA's Accreditation Requirements. Accredited for compliance with ISO/IEC 17025

Authorised Signature:

W.Rozmianiec
Date: 6/07/2007
NATA Acc. Laboratory No 431

SGS

LABORATORY REPORT COVERSHEET

DATE:	25 June 2007
TO:	Graeme Campbell & Associates Pty Ltd PO Box 247 BRIDGETOWN WA 6255
ATTENTION:	Dr Graeme Campbell
YOUR REFERENCE:	GCA Job no. 0721
OUR REFERENCE:	12289
SAMPLES RECEIVED:	13/06/2007
SAMPLES/QUANTITY:	3 Waters

The above samples were received intact and analysed according to your instructions. Unless otherwise stated, solid samples are reported on a dry weight basis and liquid samples as received.

PETER KEYTE
Business Manager

NATA
WORLD RECOGNISED ACCREDITATION

This document is issued in accordance
with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.
NATA accredited laboratory 2562 (1705).
This report must not be reproduced except in full.

SGS Australia Pty Ltd ABN 44 000 964 278 | Environmental Services t +61 (0)8 9458 7278 | 52 Murray Road f +61 (0)8 9451 3505 | Welshpool 6106 | Western Australia | www.au.sgs.com

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 12289
PROJECT: GCA Job no. 0721

LABORATORY REPORT

Your Reference Our Reference Type of Sample	Units	GCA 7084 12289-1 Water	GCA 7085 12289-2 Water	GCA 7086 12289-3 Water
Chloride, Cl	mg/L	170	78	280
Sulphate, SO_4	mg/L	12,000	7,700	2,900

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 12289
PROJECT: GCA Job no. 0721

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Waters and Wastewaters			
Chloride, Cl	mg/L	1	PEI-020
Sulphate, SO_4	mg/L	1	PEI-020

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 12289
PROJECT: GCA Job no. 0721

LABORATORY REPORT

QUALITY CONTROL	UNITS	Blank	Replicate Sm#	Replicate Sample||Replicate	Spike Sm#	Matrix Spike (%)
Chloride, Cl	mg/L	<1	[NT]	[NT]	Control	95%
Sulphate, SO_4	mg/L	<1	[NT]	[NT]	Control	109%

NATA
WORLD RECOGNISED ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.
NATA accredited laboratory 2562 (1705).
This report must not be reproduced except in full.

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 12289
PROJECT: GCA Job no. 0721

LABORATORY REPORT

NOTES:

LOR - Limit of Reporting.

This test is not covered by the scope of our NATA accreditation.
SGS terms and conditions are available from www.au.sgs.com

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0706114
No. of SAMPLES	:	3
No. of ELEMENTS	:	31
CLIENT O/N	:	GCA0721 (Job 1 of 1)
SAMPLE SUBMISSION No.	:	
PROJECT	:	Tailings-Porefluid Samples
STATE	:	Solutions
DATE RECEIVED	:	14/06/2007
DATE COMPLETED	:	10/07/2007
DATE PRINTED	:	10/07/2007

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY
15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION
12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION
124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION
Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $3.00 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ***

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The samples, GCA7084, GCA7085 and GCA7086 were received as being 'tailings porefluids'.

The results have been determined according to Genalysis methods numbers ICP_W004 and ICP_W005.

The analysis included the assay of blanks and Genalysis in-house reference standards. The results are expressed as milligrams per litre or micrograms per litre in the solution.

NATA Signatory: H Pham
ICP Chemist

Date: 10th July 2007

This document is issued in accordance with NATA's accreditation requirements.

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ug/l	mg/l	mg/l	mg/l	ug/l	ug/l	mg/l	ug/l	mg/l	mg/l
DETECTION	0.1	0.1	0.001	0.1	0.5	0.05	0.1	0.2	0.001	0.1
DIGEST										
ANALYTICAL FINISH	/MS	/OES	/MS	/OES	/MS	/MS	/OES	/MS	/MS	/OES
SAMPLE NUMBERS										
0001 GCA7084	X	3.7	0.008	0.5	9.8	0.07	443.6	1.9	29.091	X
0002 GCA7085	X	5.5	0.007	0.4	20.6	X	464.3	3.0	30.199	X
0003 GCA7086	X	1.0	0.002	0.3	41.3	X	498.0	2.4	0.261	X
CHECKS										
0001 GCA7084	X	3.8	0.007	0.4	9.7	0.06	453.2	1.9	30.893	X
STANDARDS										
0001 Alcoa5-OES		2.1		0.9			51.7			0.6
0002 Alcoa8-MS	5.3		0.027		5.0	4.90		5.8	0.519	
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Na	Ni	P
UNITS	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
DETECTION	0.1	1	1	1	0.1	0.1	0.5	1	0.1	1
DIGEST										
ANALYTICAL FINISH	/OES	/OES	/MS	/OES	/OES	/OES	/MS	/OES	/OES	/OES
SAMPLE NUMBERS										
0001 GCA7084	1.0	3427	X	283	867.0	111.2	1.7	112	5.5	X
0002 GCA7085	X	2827	X	84	323.1	68.9	0.7	63	8.2	X
0003 GCA7086	X	210	X	310	241.3	16.6	0.6	415	X	X
CHECKS										
0001 GCA7084	1.0	3347	X	301	888.9	110.4	1.9	117	5.5	X
STANDARDS										
0001 Alcoa5-OES	0.3	2		4	62.3	0.5		248	0.6	X
0002 Alcoa8-MS			5				5.3			
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	Pb	Sb	Se	Si	Sn	Sr	Th	Tl	U	V
UNITS	mg/l	ug/l	mg/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l
DETECTION	0.005	0.1	0.005	0.5	1	0.2	0.05	0.1	0.05	0.1
DIGEST										
ANALYTICAL FINISH	/MS	/MS	/MS	/OES	/MS	/MS	/MS	/MS	/MS	/OES
SAMPLE NUMBERS										
0001 GCA7084	0.007	X	0.006	23.1	3	135.1	1.03	X	5.53	X
0002 GCA7085	X	X	X	24.4	3	225.3	0.13	X	3.05	X
0003 GCA7086	0.016	X	X	15.4	2	1364.8	0.08	X	2.76	X
CHECKS										
0001 GCA7084	0.007	X	0.006	23.1	3	135.7	1.01	X	5.60	X
STANDARDS										
0001 Alcoa5-OES				11.1						0.5
0002 Alcoa8-MS	0.007	5.4	0.024		6	482.7	5.61	4.9	5.33	
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	Zn
UNITS	mg/l
DETECTION	0.1
DIGEST	
ANALYTICAL FINISH	/OES
SAMPLE NUMBERS	
0001 GCA7084	2.3
0002 GCA7085	5.5
0003 GCA7086	0.2
CHECKS	
0001 GCA7084	2.3
STANDARDS	
0001 Alcoa5-OES	0.5
0002 Alcoa8-MS	
BLANKS	
0001 Control Blank	X

METHOD CODE DESCRIPTION

/MS

No digestion or other pre-treatment undertaken. Analysed by Inductively Coupled Plasma Mass Spectrometry.

/OES

No digestion or other pre-treatment undertaken. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0705612
No. of SAMPLES	:	7
No. of ELEMENTS	:	5
CLIENT O/N	:	GCA0721 (Job 1 of 1)
SAMPLE SUBMISSION No.	:	
PROJECT	:	Column - Leachates Samples
STATE	:	Solutions
DATE RECEIVED	:	31/05/2007
DATE COMPLETED	:	11/06/2007
DATE PRINTED	:	11/06/2007

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY

15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION

12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION

124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION

Unit 14a 253 Dormehl Road, Middlepark,

JOHANNESBURG SAMPLE PREPARATION DIVISION

Anderbolt, Gauteng, South Africa 1459.

Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $3.00 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ***

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The 7 samples, as listed in the report, were received as being column leachates.

The results have been determined according to Genalysis methods numbers ICP_W005.

The analysis included the assay of blanks and Genalysis in-house reference standards. The results are expressed as milligrams per litre in the solution.

NATA Signatory: H Pham
ICP CHemist

Date: 8th June 2007

This document is issued in accordance with NATA's accreditation requirements.

ANALYSIS

ELEMENTS	Al	Cu	Fe-Sol	Mn	S
UNITS	mg/l	mg/l	mg/l	mg/l	mg/l
DETECTION	0.01	0.01	0.01	0.01	0.1
DIGEST					
ANALYTICAL FINISH	/OES	/OES	/OES	/OES	/OES
SAMPLE NUMBERS					
0001 GCA6298-1-1	70.80	17.74	155.14	6.64	385.7
0002 GCA6298-1-2	4.82	2.40	7.57	0.67	46.3
0003 GCA6298-1-3	1.54	1.15	2.76	0.25	21.7
0004 GCA6298-2	20.34	3.96	50.75	0.82	114.6
0005 GCA6298-3	24.07	4.50	46.70	1.23	129.2
0006 GCA6298-4	25.48	3.69	61.30	0.84	136.4
0007 GCA6298-5	19.45	2.84	35.57	0.61	99.3
CHECKS					
0001 GCA6298-1-1	66.62	16.71	146.37	6.22	353.4
STANDARDS					
0001 Alcoa5-OES	2.10	0.25	2.13	0.53	21.8
BLANKS					
0001 Control Blank	X	X	X	X	X

METHOD CODE DESCRIPTION

/OES

No digestion or other pre-treatment undertaken. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

HILLGROVE RESOURCES PTY LTD

KANMANTOO COPPER PROJECT

GEOCHEMICAL CHARACTERISATION OF PROCESS-TAILINGS-SLURRY SAMPLE

[STATIC-TESTWORK]

Implications for Process-Tailings Management

GRAEME CAMPBELL AND ASSOCIATES PTY LTD

(ACN 061 827674)

JANUARY 2007

Job No. 0616

TABLE OF CONTENTS Page Nos.

TABLES AND APPENDICES

(At Back of Report Text)

SUMMARY OF TECHNICAL TERMS EMPLOYED IN THIS REPORT

ACRONYM	PARAMETER	DEFINITION/DETERMINATION	UNIT
AFP	Acid-Formation Potential		
ARD	Acid-Rock Drainage		
Total-S	Total Sulphur	Analysis Result	% (w/w)
Sulphide-S	Sulphide Sulphur	Testwork Result [i.e. Sulphide-S = Total-S - Sulphate-S]	% (w/w)
ANC	Acid-Neutralisation Capacity	Testwork Result	kg H_2SO_4/tonne
MPA	Maximum-Potential Acidity	Calculation	kg H_2SO_4/tonne
NAPP	Net-Acid-Producing Potential	Calculation	kg H_2SO_4/tonne
NAG	Net-Acid Generation	Testwork Result	kg H_2SO_4/tonne
NAF	Non-Acid Forming	Calculation: • Sulphide-S < 0.3 % • Sulphide-S ≥ 0.3 %, and negative-NAPP value with ANC/MPA ≥ 2.0	kg H_2SO_4/tonne
PAF	Potentially-Acid Forming	Calculation: • Sulphide-S ≥ 0.3 %, and any positive-NAPP value • Sulphide-S ≥ 0.3 %, and a negative-NAPP value with ANC/MPA < 2.0	kg H_2SO_4/tonne
PAF-[SL]	PAF-[Short-Lag]	Estimation [e.g. inferred from 'kinetic' testing]	
PAF-[LL]	PAF-[Long-Lag]	Estimation [e.g. inferred from 'kinetic' testing]	
SOR	Sulphide-Oxidation Rate	Testwork Result [e.g. obtained from 'kinetic' testing]	mg SO_4/kg/week,

Notes:

The **PAF-[SL]** classification applies to PAF-materials (e.g. mine-wastes, and/or process-tailings) that are initially circum-neutral, but acidify (viz. pH less than 5) within weeks-to-months when exposed, and subjected to an "aggressive-weathering" regime typical of well-watered environments (e.g. where unsaturated-conditions prevail for at least a few days [via drainage/evaporation processes] between successive infiltration/flushing episodes that, in turn, occur regularly [e.g. monthly rainfall patterns comprising 1-2+ major-raindays of 10+ mm "on-average" during most of the annual hydrological-cycle]). The occurrence of thin, dilute films of pore-fluids on sulphide-grain surfaces which are regularly flushed constitutes an aeration/moisture regime that is near-optimal for sulphide-oxidation. In such well-watered settings, surface-zones of exposed mine-wastes/process-tailings seldom experience total-suctions in excess of 1+ bars (i.e. 0.1+ MPa).

The **PAF-[LL]** classification applies to PAF-materials where exposure for years (even decades+) may be needed before acidification develops. Circum-neutral-pH during "lag-phase" weathering is chiefly due to "at-source" buffering by carbonate-minerals.

Climate directly influences "lag-phase" duration, and a sulphide-gangue assemblage classified as PAF-[SL] in well-watered settings where the SOR is controlled by **O_2-supply**, may instead be classified as PAF-[LL] in water-limited settings where the SOR is controlled by **H_2O-supply** in terms of both total-suction, and infrequency of "flushing-episodes" (Campbell 2004, 2006). The formation of "secondary-oxidation-products" (e.g. Fe-oxyhydroxides) as indurated, and tightly adhering/cohering deposits, is typically enhanced during "lag-phase" weathering in water-limited settings, and is a further mechanism by with sulphide-oxidation is stifled under the ensuing "mild" weathering-regime. Surface-zones of exposed mine-wastes/process-tailings in such environments are typically characterised by total-suctions well in excess of 1 bar for most of the year. At high total-suctions, even the physical meaning of pore-fluid "films" becomes tenuous.

1.0 INTRODUCTION

Hillgrove Resources Pty Ltd operates the Kanmantoo Copper Project located to the east of Callington, South Australia.

Ore is treated in the mill, and the resulting stream of process-tailings (in slurry form) discharged to an engineered, tailings-storage facility (TSF).

Graeme Campbell & Associates Pty Ltd (GCA) was commissioned to carry out geochemical testwork on a tailings-slurry sample derived from a bench-scale-metallurgical study.

The Static-Testwork Programme focused on the Acid-Formation Potential (AFP), Multi-Element Composition, and Mineralogy of the tailings-solids sample.[1] In addition, the quality (viz. major/minor-ion chemistry) of the tailings-slurry-water sample was determined.

The testwork results are presented and discussed in this report, and implications for process-tailings management highlighted.

[1] A Static-Testwork Programme comprises "whole-rock" analyses and tests.

2.0 STUDY APPROACH

Details of the sampling and testwork programmes, and the calculations and criteria employed for classifying the tailings-solids sample into an AFP category, are presented and discussed in the following sections.

2.1 Testwork Programme

2.1.1 Sample

The tailings-slurry sample was supplied by Ammtec Ltd (Balcatta). Details of the bench-scale-metallurgical study are presented in Appendix A.

The tailings-slurry sample was provided in a 10-L, opaque plastic-pail that was four-fifths-filled with slurry. The height of the tailings-solids was approximately one-tenth of the total-slurry height. The supernatant (viz. tailings-slurry-water) overlying the tailings-solids was decanted via siphoning, vacuum-filtered (0.45-µm-membrane), and preserved for specific analyses.[2]

The 'sludge' of tailings-solids was passed through a 5-mm-nylon sieve, and then homogenised by hand-mixing. The resulting tailings-solids sample was <u>not</u> washed prior to testing.

2.1.2 Testwork

The testwork methods employed in this study are based on recognised procedures for the geochemical characterisation of mine-waste materials, process-liquors and natural-waters (e.g. AMIRA 2002; Morin and Hutt 1997; Smith 1992; Coastech Research 1991; BC AMD Task Force 1989; APHA 1992).

[2] A sub-sample of the 'raw-filtrate' was employed for the analysis of major-parameters. Sub-samples of the filtrate were dosed with HNO_3 and H_2SO_4 for multi-element analyses, and the determination of NO_3-N and NH_3-N, respectively.

Details of the testwork methods are presented in Appendix B.

Part of the testwork was carried out by Genalysis Laboratory Services (Maddington), and SGS Environmental Services (Welshpool). Specialised testing (viz. auto-titrations and Net-Acid-Generation [NAG] Tests) was undertaken by Dr. Graeme Campbell in the GCA Testing-Laboratory (Bridgetown). The mineralogical work was performed by Dr. Roger Townend of Roger Townend & Associates (Malaga).

Copies of the laboratory and mineralogical reports are presented in Appendix C.

2.2 Calculated Parameters

The Maximum-Potential-Acidity (MPA) value (in kg H_2SO_4/tonne) of the tailings-solids sample was calculated by multiplying the Sulphide-S value (in %) by 30.6. The multiplication-factor of 30.6 reflects both the reaction stoichiometry for the complete-oxidation of marcasite/pyrrhotite, by O_2 to "$Fe(OH)_3$" and H_2SO_4, and the different weight-based units of % and kg H_2SO_4/tonne. The stoichiometry of sulphide-oxidation is discussed further in Appendix B. The Net-Acid-Producing-Potential (NAPP) value (in kg H_2SO_4/tonne) was calculated from the corresponding MPA and Acid-Neutralisation-Capacity (ANC) values (i.e. NAPP = MPA - ANC).

2.3 Classification Criteria

In terms of AFP, mine-wastes may be classified into one of the following categories, viz.

- Non-Acid Forming (NAF).

- Potentially-Acid Forming (PAF).

There are **no** unifying, "standard" criteria for classifying the AFP of mine-wastes (e.g. Price 2005; Campbell 2002a,b; Smith 1992), and reflects the diversity of sulphide- and gangue-mineral assemblages within (un)mineralised-lithotypes of varying weathering- and alteration-status. Rather, criteria for classifying AFP may need to be tailored to deposit-specific geochemistry, and mineralogy, and site-specific climate.

The AFP-classification criteria often employed at mining-operations worldwide are:

- **NAF**: Sulphide-S < 0.3 %. For Sulphide-S ≥ 0.3 %, both a negative NAPP value, and an ANC/MPA ratio ≥ 2.0.

- **PAF**: For Sulphide-S ≥ 0.3 %, any positive-NAPP value; negative-NAPP value with an ANC/MPA ratio < 2.0.

In assessing the AFP of mine-wastes, there is consensus that lithotypes with Sulphide-S contents less than *c.* 0.3 % are unlikely to oxidise at rates fast enough to result in acidification (e.g. pH less than 4-5). This position assumes that the groundmass hosting such "trace-sulphides" is not simply quartz, and/or clays (Price 2005; Price *et al.* 1997), and that for a carbonate-deficient gangue, the sulphide-minerals are not unusually reactive (e.g. sulphide-oxidation rates [SORs] less than *c.* 20-40 mg SO_4/kg/flush) [= *c.* 1-2 kg SO_4/tonne/year for weekly flushing/drying-cycles].[3] A "cut-off" of 0.3 % for Sulphide-S also accords with the findings of kinetic-testing (viz. Weathering-Columns) conducted, since the late-1980s, by Dr. Graeme Campbell for mine-wastes of diverse mineralogy in terms of AFP.

[3] Although 'steady-state' SORs (at circum-neutral-pH) for Sulphide-S contents less than 0.3 % may indeed exceed 1-2 kg SO_4/tonne/year, such rates are generally restricted to either sedimentary forms (e.g. framboidal-pyrites, and marcasites), or hydrothermal-sulphides that are ultrafine-grained, and atypically reactive.

The ANC/MPA criteria for the NAF category reflects the need to compensate for less-than-perfect availability of alkalinity-forms (e.g. carbonate-minerals) for neutralisation of acid produced through sulphide-oxidation. A less-than-perfect availability of alkalinity-forms may arise from:

(a) Restricted accessibility of acid to carbonate-grains;

(b) Rate-limiting dissolution of carbonates-grains near pH=6-7; and,

(c) Depletion of carbonate-minerals through rainfall-fed leaching within waste-dumps.[4]

In terms of (a), restricted accessibility of acid to the surfaces of carbonate-grains may occur at different spatial-scales (viz. at the "whole-rock-scale" where rapid flows of Acid-Rock Drainage [ARD] by-pass the calcareous-matrix of rock-fragments [e.g. limestones] via preferential-flow pathways within a waste-dump, and at the "pore/grain-scale" in which the surfaces of carbonate-grains are "blinded/rimmed" by precipitates of Fe(III)-oxyhydroxides [e.g. ferrihydrite-type phases]). As shown by Li (1997), Fe-rich varieties of ferroan-carbonates are especially prone to "surface-armouring" effects (e.g. kinetic-testing of pyritic tailings-solids containing pyrite, ankerites and siderites resulted in acidic leachates when less than one-third of the carbonate-grains had dissolved). The effectiveness, or otherwise, of circum-neutral buffering is closely tied to inter alia the residence-time of pore-fluids in contact with carbonate-grain surfaces, and therefore a function of mine-site climate. In water-limited settings where flushing from infiltration is infrequent, and where moisture dynamics mainly involve slow unsaturated-flow below "field-capacity" (c.f. regular, rapid flow rates near saturation in well-watered settings), longer residence-times favour diffusion of soluble-alkalinity forms across armoured carbonate-grains, and thereby favour neutralisation reactions.

[4] Depletion of carbonate-minerals through dissolution in meteoric-waters is generally minimal in water-limited settings, especially within the "hydrologically-active-zone" (e.g. top 2-3 m) of a waste-dump, since re-precipitation occurs during evapo-concentration when strongly-desiccating conditions return after major wet-spells.

To compensate for the effects of (a) to (c) above, some practitioners advocate that, for a mine-waste sample to be classified as NAF, it must have an ANC/MPA ratio of at least 3.0 (see review of earlier literature by Smith [1992]). In recent years, fundamental-research (especially estimation of reaction-rates for diverse sulphide/gangue-mineral assemblages), and field-experience at mining operations world-wide, have shown that the potential for ARD production is very low for mine-waste materials with ANC/MPA ratios greater than 2.0 (AMIRA 2002; Price *et al.* 1997, Currey *et al.* 1997, and Murray *et al.* 1995).[5] This ANC/MPA ratio is employed in the present work.[6]

The risk posed by handling PAF-lithotypes during the active-lifetime of a deposit is governed primarily by the duration of the lag-phase (i.e. the period during which sulphide-oxidation occurs, but acidification does not develop, due to circum-neutral buffering by gangue-phases [chiefly carbonate-minerals]).[7] Although the duration of the lag-phase for mine-wastes at field-scale cannot be accurately predicted *a priori*, estimates (albeit approximate) may still be needed to identify threshold exposure-times for the safe handling of PAF-lithotypes, and so reduce ARD risk. Estimates of SORs, and lag-phase duration, may be obtained through programmes of kinetic-testing (viz. Weathering-Columns), and consideration of *inter alia* the moisture/aeration-regimes of exposed (i.e. uncovered) mine-wastes under the climatic conditions of the mine-site (especially rainfall distribution in relation to Potential-Evapotranspiration [PET] rates). In the absence of results from kinetic-testing, experience permits "first-pass" estimates of SORs and lag-phase duration to be made from the results of static-testing, and thereby used to further classify PAF-lithotypes into **PAF-[Short-Lag]** and **PAF-[Long-**

---

5 Such ANC/MPA ratios are consistent with those indicated from SORs, and carbonate-depletion rates, as reported in the International-Kinetic Database for mine-waste materials from around the world (Morin and Hutt 1997).

6 It should be noted that mining-regulators in Nevada (USA) classify a mine-waste sample as NAF, if it is characterised by an ANC/MPA ratio greater than 1.2 (US EPA 1994). This lower ANC/MPA ratio reflects the semi-arid conditions typically encountered at mine-sites in Nevada. Although utilised in the early-1990s, it is understood that an ANC/MPA ratio of 1.2 is still entertained by regulators in Nevada for "screening" PAF and NAF varieties of mine-wastes in semi-arid settings.

7 SO_4 is still produced by sulphide-oxidation during the lag-phase, and appreciable amounts of soluble-forms of certain minor-elements (e.g. Ni and As) may be released at circum-neutral-pH during lag-phase weathering. However, in the latter case, the mine-wastes would need to be at least appreciably enriched in Total-Ni and Total-As to begin with.

Lag] sub-categories. Such "first-pass" estimations are necessarily provisional, and subject to revision, in the light of the outcomes of kinetic-testing, and field observations.

3.0 ACID-BASE CHEMISTRY OF TAILINGS-SOLIDS SAMPLE

The testwork results on the acid-base chemistry of the tailings-solids sample are presented in Table 3.1.

The tailings-solids sample was characterised by (Table 3.1):

- a Sulphide-S content of 0.78 %;
- an ANC value of 8-9 kg H_2SO_4/tonne, and a CO_3-C value of 0.01 %;
- a NAPP value of 16 kg H_2SO_4/tonne; and,
- a NAG-pH value of 3.6-3.7, and a NAG value of 13 kg H_2SO_4/tonne.

The calculated-NAPP and measured-NAG values were well matched.

The testwork results indicate that the tailings-solids sample contained trace amounts of sulphide-minerals (viz. Sulphide-S content of 0.5-1.0 %) in a gangue devoid of carbonate-minerals. The sulphide-mineral suite was dominated by marcasite with sub-ordinate pyrrhotite (Table 4.2).

The tailings-solids sample is classified as PAF, and given both the reactive nature of marcasites, and the "gutless-gangue" in terms of circum-neutral buffering, the sample may be further classified as PAF-[Short-Lag].

4.0 MULTI-ELEMENT COMPOSITION AND MINERALOGY OF TAILINGS-SOLIDS SAMPLE

The multi-element composition and mineralogy of the tailings-solids sample are indicated by the data presented in Tables 4.1 and 4.2, respectively.[8] The corresponding element-enrichments in the samples, as indicated by the values of the Geochemical-Abundance Index (GAI), are also presented in Table 4.1.[9] It should be noted that these element-enrichments are relative enrichments, based on the element contents typically recorded for unmineralised soils, regoliths and bedrocks (Bowen 1979).

The tailings-solids sample was variously enriched in Ag, Bi and Se (Table 4.1).

The tailings-solids sample mainly comprised quartz, chlorites, biotites, and garnets (Table 4.2). The sulphide-mineral suite was dominated by marcasite over pyrrhotite. Although traces of sphalerite and chalcopyrite were identified in the mineralogical study, the Cu and Zn contents of the tailings-solids sample were only 0.037 %, and 0.005 %, respectively (Table 4.1).

The analysis results indicate that, geochemically, the tailings-solids sample was relatively "clean".

[8] The suite of elements listed in Table 4.1 is grouped into (a) the major-elements (viz. Na, K, Mg, Ca, Al and Fe) making-up the lattices of primary-silicates, sulphides, clays, sesquioxides and carbonates, and (b) minor-elements. A distinction is made between minor-elements which, under neutral-to-alkaline conditions, occur (i) as cationic-hydrolysis forms (e.g. Cu), and (ii) as anions/oxyanions (e.g. As). Anionic forms may exhibit moderate solubility under neutral-to-alkaline conditions.
[9] The GAI is defined in Appendix A.

5.0 QUALITY OF TAILINGS-SLURRY-WATER SAMPLE

The analysis results for the tailings-slurry-water sample are presented in Table 5.1.

The tailings-slurry-water sample had a pH value of 6.1, and a salinity (as Total-Dissolved Solids, TDS) of 650 mg/L (Table 5.1).[10]

The concentrations of minor-elements were below, or close to, the respective detection-limits (Table 5.1). The low concentrations of soluble metals attest to the efficiency of metal-sorption reactions under neutral-to-alkaline conditions (Sposito 1984).[11]

The analysis results indicate that the tailings-slurry-water sample was circum-neutral (viz. pH 6-7, and of potable-salinity, with minor-element concentrations either below, or close to, the respective detection-limits.

[10] Perth scheme-water was employed in the bench-scale-metallurgical study.
[11] Sorption reactions include both adsorption and precipitation reactions (Sposito 1984).

6.0 CONCLUSIONS

Based on the testwork results obtained in this study, it is concluded that the process-tailings-slurry sample was characterised by:

- tailings-solids which are classified as PAF-[Short-Lag];
- tailings-solids which are only moderately enriched in Ag, Bi, and Se; and,
- a tailings-slurry-water which is circum-neutral and of potable-salinity, with very-low concentrations of minor-elements.

During the active-lifetime of the TSF, the exposed surface-zone-tailings on the beaches should largely undergo "lag-phase-weathering", assuming that the exposure-times between deposition-cycles is only a matter of weeks (c.f. months).

Sulphide-oxidation within the surface-zone of the tailings-beaches should be constrained by either:

(a) high moisture contents (e.g. relative-saturations greater than *c.* 80 % [v/v]) initially, due to the settling/shrinking-stage of tailings-ageing; or,

(b) residual moisture contents (corresponding to total-suctions above 10+ bars), due to evaporative-drying, and formation of a surface-crust (likely at the "mm/cm-scale"), especially during the summer months.

However, the roles played by (a) and (b) above will depend closely on the reactivity of the sulphide-minerals (chiefly marcasites), and the (seasonal) unsaturated-moisture dynamics within the surface-zone-tailings. A programme of kinetic-testing (viz. Weathering-Columns) would be required to better project the duration of the lag-phase.

At TSF-closure, some form of dry-cover system will likely be required. Given the Mediterranean climate, and the local mallee-type vegetation communities of trees and shrubs, optimising evapotranspiration to minimise percolation beneath the cover system should prove more challenging than that for vegetated store/release-cover systems at mine-sites within the arid Australian interior (Campbell 2004).

7.0 REFERENCES

American Public Health Association, 1992, "Standard Methods for the Examination of Water and Wastewater", 18th Edition, Washington.

AMIRA International Ltd, 2002, "ARD Test Handbook", Prepared by Ian Wark Research Institute, and Environmental Geochemistry International Pty Ltd.

Berigari MS and Al-Any FMS, 1994, "Gypsum Determination in Soils by Conversion to Water-Soluble Sodium Sulfate", *Soil Science Society of America Journal*, 58:1624-1627.

Belzile N, Chen Y-W, Cai M-F and Li Y, 2004, "A Review on Pyrrhotite Oxidation", *Journal of Geochemical Exploration*, 84:65-76.

Bowen HJM, 1979, "Environmental Chemistry of the Elements", Academic Press, New York.

British Columbia Acid Mine Drainage Task Force Report, 1989, "Draft Acid Rock Drainage Technical Guide. Volume 1".

Campbell GD, 2002a, "Geochemistry and Management of Pyritic Mine-Wastes: I. Characterisation", in Proceedings of Workshop on "Soil Technology - Contaminated Land", February 2002, Centre for Land Rehabilitation, University of Western Australia.

Campbell GD, 2002b, "Geochemistry and Management of Pyritic Mine-Wastes: II. Weathering Behaviour and Arsenic Solubility", in Proceedings of Workshop on "Soil Technology - Contaminated Land", February 2002, Centre for Land Rehabilitation, University of Western Australia.

Campbell GD, 2004, "Store/Release Covers in the Australian Outback: A Review", Section 13 in the Proceedings from the Australian Centre for Geomechanics seminar on "Mine Closure – Towards Sustainable Outcomes", 5-6 August, Perth.

Campbell GD, 2006, "Acid-Formation Potential of Mine-Wastes: Sampling, Testwork and Interpretation Approaches for the WA Goldfields", in the Goldfields Environmental Management Groups "2006 Workshop on Environmental Management", 24-26 May 2006, Kalgoorlie-Boulder. In addition, power-point presentation titled: "Geochemistry of Mine-Wastes and Process-Tailings at Gold and Nickel Mines in WA Goldfields: Manner and Rates of Weathering in Water-Limited Environments". A copy of this presentation is available upon request. (gca@wn.com.au).

Coastech Research Inc., 1991, "Acid Rock Drainage Prediction Manual".

Currey NA, Ritchie PJ and Murray GSC, 1997, "Management Strategies for Acid Rock Drainage at Kidston Gold Mine, North Queensland", pp. 93-102 in McLean RW and Bell LC (eds), "Third Australian Workshop on Acid Mine Drainage Proceedings", Australian Centre for Minesite Rehabilitation Research.

Förstner U, Ahlf W and Calmano W, 1993, "Sediment Quality Objectives and Criteria Development in Germany", *Water Science & Technology*, 28:307-316.

Jambor JL, Dutrizac JE and Chen TT, 2000, "Contribution of Specific Minerals to the Neutralization Potential in Static Tests", pp. 551-565 in "Proceedings from the Fifth International Conference on Acid Rock Drainage", Volume I, Denver.

Jambor JL, Dutrizac JE, Groat LA and Raudsepp M, 2002, "Static Tests of Neutralization Potentials of Silicate and Aluminosilicate Minerals", *Environmental Geology*, 43:1-17.

Jambor JL, Dutrizac JE and Raudsepp M, 2005, "Neutralization Potentials of Some Common and Uncommon Rocks, and Some Pitfalls in NP Measurements", in "Challenges in the Prediction of Drainage Chemistry", Proceedings of the 12th Annual British Columbia – MEND ML/ARD Workshop.

Janzen MP, Nicholson RV and Scharer JM, 2000, "Pyrrhotite Reaction Kinetics: Reaction Rates for Oxidation by Oxygen, Ferric Iron, and for Nonoxidative Dissolution", *Geochimica et Cosmochimica Acta*, 64:1511-1522.

Jerz JK and Rimstidt JD, 2004, "Pyrite Oxidation in Moist Air", *Geochimica et Cosmochimica Acta*, 68:701-714.

Lenahan WC and Murray-Smith R de L, 1986, "Assay and Analytical Practice in the South African Mining Industry", The South African Institute of Mining and Metallurgy Monograph Series M6, Johannesburg.

Li MG, 1997, "Neutralization Potential Versus Observed Mineral Dissolution in Humidity Cell Tests for Louvicourt Tailings", pp. 149-164 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Volume I, Vancouver.

Miller S and Brodie K, 2000, "Cover Performance for the Control of Sulfide Oxidation and Acid Drainage from Waste Rock at the Martha Mine, New Zealand", pp. 99-108 in Grundon NJ and Bell LC (eds), "Proceedings of the Fourth Australian Workshop on Acid Mine Drainage", Australian Centre for Mining Environmental Research.

Miller SD, Jeffery JJ and Donohue TA, 1994, "Developments in Predicting and Management of Acid Forming Mine Wastes in Australia and Southeast Asia", pp. 177-184 in "Proceedings of the International Land Reclamation and Mine

Drainage Conference and Third International Conference on the Abatement of Acidic Drainage", Pittsburgh.

Miller S, Robertson A and Donohue T, 1997, "Advances in Acid Drainage Prediction Using the Net Acid Generation (NAG) Test", pp. 535-547 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Vancouver.

Morin KA and Hutt NM, 1997, "Environmental Geochemistry of Minesite Drainage: Practical Theory and Case Studies", MDAG Publishing, Vancouver.

Murray GSC, Robertson JD and Ferguson KD, 1995, "Defining the AMD Problem. I. A Corporate Perspective", pp. 3-15 in Grundon NJ and Bell LC (eds), "Second Australian Acid Mine Drainage Workshop Proceedings", Australian Centre for Minesite Rehabilitation Research.

Nicholson RV and Scharer JM, 1994, "Laboratory Studies of Pyrrhotite Oxidation Kinetics", pp. 14-30 in Alpers CN and Blowes DW (eds), "Environmental Geochemistry of Sulfide Oxidation", ACS Symposium Series 550, American Chemical Society, Washington DC.

O'Shay T, Hossner LR and Dixon JB, 1990, "A Modified Hydrogen Peroxide Method for Determination of Potential Acidity in Pyritic Overburden", *Journal of Environmental Quality*, 19:778-782.

Price W, 2005, "Criteria Used in Material Characterization and the Prediction of Drainage Chemistry: "Screaming Criteria"", Presentation B.1 in "Proceedings of the 12th Annual British Columbia – MEND ML/ARD Workshop on "Challenges in the Prediction of Drainage Chemistry", November 30 to December 1, 2005, Vancouver, British Columbia.

Price WA, Morin K and Hutt N, 1997, "Guidelines for the Prediction of Acid Rock Drainage and Metal Leaching for Mines in British Columbia: Part II. Recommended Procedures for Static and Kinetic Testing", pp. 15-30 in "Proceedings of the Fourth International Conference on Acid Rock Drainage", Volume I, Vancouver.

Rimstidt JD and Newcomb WD, 1993, "Measurement and Analysis of Rate Data: The Rate of Reaction of Ferric Iron With Pyrite", *Geochimica et Cosmochimica Acta*, 57:1919-1934.

Rimstidt JD and Vaughan DJ, 2003, "Pyrite Oxidation: A State-of-the-Art Assessment of Reaction Mechanism", *Geochimica et Cosmochimica Acta*, 67:873-880.

Shaw S, 2005, "Case Studies and Subsequent Guidelines for the Use of the Static NAG Procedure", Presenttaion A.4 in "Proceedings of the 12th Annual British Columbia – MEND ML/ARD Workshop on "Challenges in the Prediction of Drainage Chemistry", November 30 to December 1, 2005, Vancouver, British Columbia.

Smith A, 1992, "Prediction of Acid Generation Potential", in Hutchison IPG and Ellison RD (eds), "Mine Waste Management", Lewis Publishers, Michigan.

Sobek AA, Schuller WA, Freeman JR and Smith RM, 1978, "Field and Laboratory Methods Applicable to Overburdens and Minesoils", EPA-600/2-78-054.

Sposito G, 1984, "The Surface Chemistry of Soils", Oxford University Press, Oxford.

U.S. Environmental Protection Agency, 1994, "Technical Document: Acid Mine Drainage Prediction", EPA530-R-94-036, NTIS PB94-201829.

White AF and Brantley SL (eds.), 1995, "Chemical Weathering Rates of Silicate Minerals", Reviews in Mineralogy, Volume 31, Mineralogical Society of America, Washington, D.C.

TABLES

Table 3.1: Acid-Base-Analysis and Net-Acid-Generation Results for Tailings-Solids Sample

GCA-SAMPLE NO.	MC (%, w/w)	TOTAL-S (%)	SO_4-S (%)	Sulphide-S (%)	CO_3-C (%)	ANC	NAPP	NAG	NAG-pH	AFP CATEGORY
						kg H_2SO_4/tonne				
GCA6298	20.5	0.80 (0.76)	0.03 (0.02)	0.78	0.01 (0.01)	9 (8)	16	13 (13)	3.6 (3.7)	**PAF-[Short-Lag]**

Notes:
MC = Moisture-Content; ANC = Acid-Neutralisation Capacity; NAPP = Net-Acid-Producing Potential; AFP = Acid-Formation Potential; PAF = Potentially-Acid Forming; NAG = Net-Acid Generation.
All results expressed on a dry-weight basis, except for NAG-pH.
Values in parentheses represent duplicates.

Table 4.1: Multi-Element-Analysis Results for Tailings-Solids Sample

Note: Refer Appendix B for the definition of the Geochemical-Abundance-Index (GAI) indicated in this table.

ELEMENT	TOTAL-ELEMENT CONTENT (mg/kg or %)	AV.-CRUSTAL ABUNDANCE (mg/kg or %)	GEOCHEMICAL-ABUNDANCE INDEX (GAI)
	GCA6298		GCA6298
Al	5.4%	8.2%	0
Fe	13.6%	4.1%	1
Na	0.059%	2.3%	0
K	0.91%	2.1%	0
Mg	1.7%	2.3%	0
Ca	0.21%	4.1%	0
Ag	0.8	0.07	**3**
Cu	370	50	2
Zn	50	75	0
Cd	<0.1	0.11	0
Pb	19	14	0
Cr	150	100	0
Ni	54	80	0
Co	68	20	1
Mn	2,300	950	1
Hg	<0.01	0.05	0
Sn	3.3	2.2	0
Sr	11	370	0
Ba	91	500	0
Th	11	12	0
U	3.2	2.4	0
Tl	0.34	0.6	0
V	64	160	0
As	4	1.5	1
Bi	75	0.048	**6**
Sb	0.11	0.2	0
Se	0.99	0.05	**4**
Mo	5.2	1.5	1
B	<50	10	0
P	480	1,000	0
F	540	950	0

Note: Average-crustal abundance of elements based on Bowen (1979).

Table 4.2: Mineralogical Results for Tailings-Solids Sample

GCA6298	
Component	**Abundance**
quartz	dominant
chlorite	major
biotite almandine-garnet	minor
marcasite staurolite magnetite	accessory
pyrrhotite **sphalerite** **chalcopyrite** monazite apatite bismuth	trace

Notes:

dominant = greater than 50 %; major = 20-50%; minor = 10-20 %; accessory = 2-10 %; and, trace = less than 2 %.

Table 5.1: Analysis Results for Tailings-Slurry-Water Sample

Note: All results in mg/L, except for pH and EC (µS/cm).

ELEMENT/ PARAMETER	Tailings-Slurry-Water (GCA6298)	ELEMENT/ PARAMETER	Tailings-Slurry-Water (GCA6298)
Major-Parameters		***Minor-Ions***	
pH	6.1	Fe	0.19
EC [µS/cm]	1,100	Cu	0.01
TDS(gravimetric)	650	Ni	0.24
		Zn	0.11
Major-Ions		Co	0.51
		Al	0.10
Na	96	Cd	0.00033
K	27	Pb	0.0006
Mg	23	Cr	<0.01
Ca	65	Hg	<0.0001
Cl	200	As	0.0004
SO_4	290	Sb	0.00014
HCO_3	10	Bi	<0.000005
CO_3	<1	Se	0.0030
OH	<1	B	0.04
		Mo	0.00009
Nitrogen-Forms		P	0.1
		F	0.2
NH_3-N	2.4	Ag	<0.00001
NO_3-N	1.0	Ba	0.059
		Sr	0.38
		Tl	0.00006
		V	<0.01
		Sn	<0.0001
		U	0.00013
		Th	<0.000005
		Mn	0.72

Note:
EC = Electrical Conductivity; TDS = Total-Dissolved Solids.

APPENDIX A

DETAILS OF BENCH-SCALE-METALLURGICAL-TESTWORK PROGRAMME

Production of a Flotation Tailings Sample for Geo-chemical Testing by G Campbell and Associates.

The flotation tailings sample used for the Geo-chemical test work was derived from three flotation tests conducted on samples from the Kanmantoo copper deposit by AMMTEC laboratories, Balcatta, WA – Job Ref A10080.

Two tests (Ref GS 2420 and GS 2422) were on ore samples from Main zone and the third sample from the smaller O'Neil mineralization zone.

The flotation test conditions adopted for the all tests were as follows;

Ore samples were dry crushed to < 2mm and wet ground in a rod mill to produce a flotation feed sizing of approximately 80% passing 212 microns.

Flotation consisted of a rougher - scavenger stage of 7 minutes using Cytec 3418A (di-thio-phosphinate) as the collector at an addition rate of 50 g\tone of feed together with a small amount approximately 20g\tonne of MIBC (metyl iso-carbinol) as the frother at a pH of 8.5 using lime. The resulting rougher scavenger concentrates, approximately 9% by weight of the feed, were retained for further test investigations. The resulting rougher-scavenger tailings were collected as a pulp in a bucket filled to the brim and dispatched to G Campbell and Associates for geo-chemical test work. The above flotation conditions were used for all three tests however in test GS 2421 on the O'Neil ore zone an addition of 50g\t potassium amyl xanthate was added to the scavenger stage to improve the recovery of a chalcopyrite-pyrite middlings fraction.

An analyses of the key elements in the test work tailings which constituted the submitted sample are outlined below

Test No\Ore Zone	%Wt	%Cu	%Fe	%S
GS2420 (Main)	91.3	0.02	6.2	0.26
GS2422 (Main)	91.9	0.03	6.3	0.88
GS2421 (O'Neil)	91.2	0.07	5.5	1.27

APPENDIX B

TESTWORK METHODS

APPENDIX B

TESTWORK METHODS

B1.0 ACID-BASE-CHEMISTRY TESTWORK ON TAILINGS-SOLIDS SAMPLE

The acid-base chemistry of the tailings-solids sample was assessed by determining:

- Total Sulphur (Total-S) and Sulphate Sulphur (SO_4-S).
- Acid-Neutralisation Capacity (ANC), and Carbonate Carbon (CO_3-C).
- Net-Acid-Producing Potential (NAPP).
- Net-Acid Generation (NAG).

Relevant details of the testwork methods employed are discussed briefly below. Further details are presented in the laboratory reports (see Appendix C).

B1.1 Total-S and SO_4-S Tests

The Total-S value was measured by Leco combustion (@ 1300 ^{o}C) with detection of evolved $SO_{2(g)}$ by infra-red spectroscopy. The SO_4-S value was determined by the Na_2CO_3-Extraction Method (Berigari and Al-Any 1994; Lenahan and Murray-Smith 1986).[1]

The difference between the Total-S and SO_4-S values indicates the Sulphide-S (strictly Non-Sulphate-S) content.

[1] The Na_2CO_3-reagent extracts SO_4-S which occurs as soluble sulphates, and calcium sulphates (e.g. gypsum and anhydrite). It also extracts SO_4 sorbed to the surfaces of sesquioxides, clays and silicates. However, SO_4 present as barytes ($BaSO_4$) is not extracted, and SO_4 associated with jarositic-type and alunitic-type compounds is incompletely extracted.

B1.2 ANC, CO_3-C and pH-Buffering Tests

B1.2.1 ANC Test

The ANC value was determined by a procedure based on that of Sobek *et al.* (1978). This procedure is essentially the "standard" method employed for estimating the ANC values of mine-waste materials (Morin and Hutt 1997; BC AMD Task Force 1989).

The sample was reacted with dilute HCl for *c.* 2 hours at 80-90 ^{o}C, followed by back-titration with NaOH to a pH=7 end-point to determine the amount of acid consumed.[2] The simmering step for *c.* 2 hours differs slightly from the heating treatment of the Sobek *et al.* procedure wherein the test mixtures are heated to near boiling until reaction is deemed to be complete (viz. gas evolution not visually apparent), followed by boiling for one minute. In terms of dissolution of carbonate, primary-silicate and oxyhydroxide minerals, this variation to the Sobek *et al.* method is inconsequential.

The Sobek *et al.* (1978) procedure exposes mine-waste samples to both strongly-acidic conditions (e.g. pH of 1-2), and a near-boiling temperature. Provided excess acid is added, this method ensures that carbonate-minerals (including ferroan- and manganoan-varieties) are dissolved quantitatively, and that at least "traces" of ferro-magnesian-silicates (e.g. amphiboles, pyroxenes, chlorites, micas, etc.), and feldspars, are dissolved. However, under circum-neutral (viz. pH 6-8) conditions required for mine-waste and environmental management, the hydrolysis/dissolution of ferro-magnesian-silicates is kinetically extremely slow (e.g. see review-monograph by White and Brantley [1995]). Near pH=7, the hydrolysis/dissolution rates (under 'steady-state' conditions, and in the absence of inhibiting alteration-rims) of mafic-silicates and feldspars generally correspond to H_2SO_4-consumption rates 'of-the-order' $10^{-11}/10^{-12}$ moles/m^2/s (White and Brantley 1995). As a guide, for minerals of sub-mm grading, such silicate-dissolution rates correspond to Sulphide-Oxidation Rates (SORs) ranging

[2] Two drops of 30 % (w/w) H_2O_2 were added to the test mixtures as the pH=7 end-point was approached, so that any Fe(II) forms released by the acid-attack of ferroan-carbonates and -silicates are oxidised to Fe(III) forms (which then hydrolyse to "$Fe(OH)_3$"). This step ensures that the resulting ANC values are not biased "on-the-high-side", due to the release of Fe(II) during the acidification/digestion step. Such potential bias in ANC values may be marked for mine-waste samples in which "Fe-rich" ferroan-carbonates (e.g. siderite) dominate acid consumption. The addition of the H_2O_2 reagent is <u>not</u> part of the methodology described by Sobek *et al.* (1978).

up to 'of-the-order' 1-10 mg SO_4/kg/week (= *c.* 0.1-1.0 kg H_2SO_4/tonne/year).[3] Maintenance of circum-neutral-pH through hydrolysis/dissolution of primary-silicates is therefore restricted to both "mineral-fines", and slow rates of sulphide-weathering.

Despite the aggressive-digestion conditions employed, the ANC values determined by the Sobek *et al.* (1978) method allow an informed, initial "screening" of mine-waste materials in terms of acid-consuming and pH-buffering properties, especially when due account is taken of gangue mineralogy (Morin and Hutt 1997). Jambor *et al.* (2000, 2002) have presented a compendium of 'Sobek-ANC' values for specific classes of primary-silicates, and assists interpretation of the ANC values recorded for mine-waste materials of varying mineralogy.

B1.2.2 CO_3-C Value

The CO_3-C value is the difference between the Total-C and Total-Organic-C (TOC) values.

The Total-C was measured by Leco combustion (@ 1300 ^{o}C) with detection of evolved $CO_{2(g)}$ by infra-red spectroscopy. The TOC is determined by Leco combustion on a sub-sample which has been treated with strong HCl to decompose carbonate-minerals.

B1.3 NAPP Calculation

The NAPP value of the tailings-solids sample was calculated from the Total-S, SO_4-S and ANC values, assuming that **all** of the Non-Sulphate-S occurs in the form of marcasite/pyrrhotite. The sulphide-mineral suite in the tailings-solids sample was dominated by marcasite with sub-ordinate pyrrhotite (Table 4.2). NAPP calculations serve as a starting point in the assessment of the acid-formation potential of sulphide-bearing materials.

[3] SORs of this magnitude (at circum-neutral-pH) would typically only be recorded for the oxidation of "trace-sulphides" (e.g. Sulphide-S contents less than 0.5 %).

The complete-oxidation of pyrite (= marcasite) may be described by:

$$FeS_2 + 15/4\ O_2 + 7/2\ H_2O = 2H_2SO_4 + \text{"}Fe(OH)_3\text{"}$$

The complete-oxidation of pyrrhotite may be described by:

$$\text{"}FeS_{(s)}\text{"} + 9/2O_{2(g)} + 5/2H_2O_{(l)} = \text{"}Fe(OH)_{3(s)}\text{"} + 2SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)}$$

Pyrrhotite is non-stoichiometric, so that expressing pyrrhotite as "FeS" in the above equation represents an approximation of the oxidation reaction (Belzile *et al.* 2004; Janzen *et al.* 2000). Elemental sulphur (as an intermediate-oxidation product) may also accumulate during pyrrhotite weathering (Nicholson and Scharer 1994), especially at low-pH. However, Elemental-S is ultimately oxidised to H_2SO_4 (albeit via a complex, microbially-mediated pathway involving thiosulphate and an array of polythionates).

It may be shown that, if the Sulphide-S (in %S) occurs as pyrite, and/or pyrrhotite, then the amount of acid (in kg H_2SO_4/tonne) produced through complete-oxidation is given by **30.6 x %S**. The NAPP value of the tailings-solids sample was therefore calculated from the Sulphide-S content (in %S), and 30.6 as the 'conversion-factor' to estimate the amount of acid that may potentially be produced through the aerobic-oxidation of marcasite/pyrrhotite.

It may be shown that, if the Sulphide-S (in %S) occurs as pyrite, then the amount of acid (in kg H_2SO_4/tonne) produced through complete-oxidation is given by **30.6 x %S**.

> Note: The above treatment of oxidation-reaction stoichiometry is restricted to oxidation by 'atmospheric-O_2' which is the dominant oxidant at circum-neutral-pH. A different oxidation-stoichiometry applies under acidic conditions (e.g. pH less than 3-4) where soluble-Fe(III) forms prevail, and then function as the chief oxidant (e.g. Rimstidt and Newcomb 1993).

Mechanistic aspects of pyrite-oxidation and pyrrhotite-oxidation at the molecular-scale were recently reviewed by Rimstidt and Vaughan (2003), and Belzile *et al.* (2004), respectively.

B1.4 NAG Test

The NAG Test is a direct measure of a sample's potential to produce acid through sulphide oxidation, and also provides an indication of the reactivity of the sulphides, and the availability of the alkalinity-forms contributing to the ANC (Miller *et al.* 1997, 1994).

In this test, the sample is reacted with H_2O_2 to rapidly oxidise contained sulphides, and allow the produced acid to react with the acid-neutralising materials (e.g. carbonates). The NAG Test supplements the NAPP-based assessment of the acid-formation potential of mine-waste materials (Morin and Hutt 1997).

The procedure employed in this study is based on that for the 'Static-NAG Test' in its 'single-addition' mode, as described in AMIRA (2002), and by Miller *et al.* (1994, 1997). The Start-pH of the 15 % (w/w) H_2O_2 solution (prepared from A.R.-grade H_2O_2) was adjusted to pH=4.5 using dilute NaOH. In addition, the boiling treatment to decompose residual, unreacted-H_2O_2 following overnight reaction was carried out in two stages (viz. boiling for *c.* 2 hours initially, cooling and addition of 1 mL of 0.02 M-$CuSO_4$ to the test mixtures, followed by boiling again for *c.* 2 hours). The addition of Cu(II) salts catalyses the decomposition of any unreacted-H_2O_2, and thereby prevents "positive-blank" values being obtained (O'Shay *et al.* 1990). Pulped K-feldspar was employed for the blanks run for the NAG-testwork.

Prior to the boiling-steps, the pH values of the test-mixture suspensions are measured, and invariably correspond to an "overnight-period" of reaction. Such pH values reflect buffering under ambient conditions <u>without accelerated dissolution of gangue-phases through boiling</u> to decompose any unreacted-H_2O_2. In the interpretation of NAG-testwork data, it is important to take note of the pH values recorded prior to the boiling-steps, especially for mine-waste samples that have <u>both</u> Sulphide-S contents less than *c.* 1 %, <u>and</u> ANC values less than *c.* 10 kg H_2SO_4/tonne (as typically recorded for a 'carbonate-deficient' gangue). Furthermore, oxidation by H_2O_2 is generally at least 10^4-10^5 faster than the SORs recorded during 'kinetic' testing (e.g. Weathering-Columns) of mine-waste samples. If circum-neutral conditions are to prevail during NAG testwork, then the rate of acid consumption by gangue-phases must be proportionately faster (c.f. rates for 'ambient-weathering'). This aspect must also be borne in mind when interpreting NAG-testwork data, especially for mine-waste materials that are devoid of carbonates, since the dissolution/hydrolysis kinetics of primary-silicates are strongly pH-dependent.

B2.0 MULTI-ELEMENT ANALYSES ON TAILINGS-SOLIDS SAMPLE

The total contents of a wide range of major- and minor-elements in the tailings-solids samples were determined through the use of various digestion and analytical techniques. The detection-limits employed are appropriate for environmental investigations.

Element enrichments were identified using the *Geochemical Abundance Index (GAI)*.[4]

The GAI quantifies an assay result for a particular element in terms of the average-crustal-abundance of that element.[5] The GAI (based on a log-2 scale) is expressed in 7 integer increments (viz. 0 to 6). A GAI of 0 indicates that the content of the element is less than, or similar to, the average-crustal-abundance; a GAI of 3 corresponds to a 12-fold enrichment above the average-crustal-abundance; and so forth, up to a GAI of 6 which corresponds to a 96-fold, or greater, enrichment above average-crustal-abundances.

---

[4] The GAI was developed by Förstner *et al* (1993), and is defined as:

$$GAI = \log_2 [C_n/(1.5 \times B_n)]$$

where:

C_n = measured content of n-th element in the sample.

B_n = "background" content of the n-th element in the sample.

[5] The average-crustal-abundances of the elements for the GAI calculations are based on the values listed in Bowen (1979).

B3.0 ANALYSIS OF TAILINGS-SLURRY-WATER SAMPLE

The tailings-slurry-water sample was analysed for pH, Electrical Conductivity (EC), salinity (as Total-Dissolved Solids, TDS), alkalinity forms, Cl, SO_4, NO_3, NH_3-N, and a wide range of major- and minor-elements employing detection-limits appropriate for environmental investigations

All analyses were performed on appropriately-preserved 'splits' for the determination of specific analytes (see Appendix C).

APPENDIX C

LABORATORY REPORTS

Roger Townend and Associates
Consulting Mineralogists

Unit 4, 40 Irvine drive, Malaga Western Australia 6062
Phone: (08) 9248 1674 Fax: (08) 9248 1502
email: rogertownend@westnet.com.au

GRAEME CAMPBELL AND ASSOC, 10-11-2006

PO BOX 247,

BRIDGETOWN

WA

OUR REF. 21800

YOUR REF 0616

XRD/PLM/SEM ANALYSIS OF ONE TAIL.

(KANMANTOO)

R TOWNEND

RESULTS (XRD/PLM/SEM)

GCA	6298
QUARTZ	DOMINANT
CHLORITE	MAJOR
BIOTITE	MINOR
ALMANDINE GARNET	MINOR
STAUROLITE	ACCESSORY
MARCASITE	ACCESSORY
PYRRHOTITE	TRACE
SPHALERITE	TRACE
CHALCOPYRITE	TRACE
MAGNETITE	ACCESSORY
MONAZITE	TRACE
APATITE	TRACE
BISMUTH	TRACE

Dr G Campbell
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN WA 6255

JOB INFORMATION

JOB CODE	**143.0/0608152**
No. of SAMPLES	1
CLIENT O/N	GCA0616
PROJECT	Kanmantoo Copper project
STATE	Tailings
DATE RECEIVED	01/09/2006
DATE COMPLETED	26/09/2006

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

The sample was received as tailings solids which required drying at 45 degrees Celcius, mixing, splitting and fine pulverising in a zirconia bowl.

Results of analysis on:

Element	**LOD**	**S_tot**	**S-SO4**	**S-SO4**	**C_tot**	**TOC+C**	**C-CO3**
Method	**/GRAV**	**/LECO**	**Na2CO3/ GRAV**	**SO/OES**	**/LECO**	**OrgC/ LECO**	**/CALC**
Detection	**0.01**	**0.005**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Units	**%**	**%**	**%**	**%**	**%**	**%**	**%**
Control Blank	X	X	X	X			
GCA6298	19.49	0.793	0.03	0.07	0.06	0.05	0.01
GCA6298 Dup	20.56	0.759	0.02	0.06	0.05	0.04	0.01
LECO2		2.31			4.38		
PD-1			4.29				
Graphite-1						1.78	
PD-1				4.29			
Control Blank							
S_SO4_A			0.60				
S_SO4_B			1.29				

1. The C,S results were determined from the pulverised portion
2. The Carbon and Sulphur was determined according to Genalysis method number SL_W043.
3. S-SO4 was determined by removal of sulphide sulphur from the samples by boiling in hydrochloric acid followed by leaching with hydrochloric acid to dissolve the remaining sulphate which is then read by OES, method code SL_W045
4. S-SO4 was also determined by precipitation of BaSO4. TOC+C (acid insoluble carbon compounds and elemental carbon) by LECO after removal of carbonates and soluble organic carbon. These methods are not covered by Genalysis terms of accreditation to NATA

Acid Neutralisation Capacity (ANC)

Sample Name	Fizz Rating	Sample Weight (g)	Molarity HCl	Molarity NaOH	Initial Efferves cence	colour change	pH drop	ANC Solution pH	ANC (kg H2SO4/tonne)
GCA6298	0	2.004	0.50	0.103	Nil	No	3.4*	2.3	9
GCA6298 Dup	0	2.006	0.50	0.103	Nil	No	3.4*	2.3	8

Notes:

1. ANC was determined on the -2mm portion. Acid concentrations are as stated
2. Colour change: * Indicates the appearance of a green colouration as the pH=7 endpoint was approached. Two drops of hydrogen peroxide are added to each sample as the endpoint is approached to oxidise any ferrous iron
3. pH drop : * Indicates a pH drop to a value below 4 on addition of peroxide
4. This procedure according to Genalysis methods number ENV_W035

NATA ENDORSED DOCUMENT
Company Accreditation Number 3244
The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

NATA Signatory: R H Essers

Date: 26th September 2006

NATA
WORLD RECOGNISED ACCREDITATION

This document is issued in accordance with NATA's accreditation requirements.

Laboratory Report

NET-ACID-GENERATION (NAG) TESTWORK

Sample Number	Sample Weight (g) [moist]	Sample Weight (g) [dry]	Comments	pH of Test Mixture Before Boiling Step	Test Mixture After Boiling Step		Titre [0.1 M-NaOH] (mL)	NAG (kg H_2SO_4/ tonne)
					pH	EC (µS/cm)		
GCA6298	6.3	5.2	Reaction peaked overnight	2.8	3.6	470	13.30	13
GCA6298 (Repeat)	5.8	4.8	Reaction peaked overnight	2.9	3.7	440	11.90	13
Blank	-	3.4		6.1	7.5	71	-	<0.5

Notes: Test conditions based on those described by Miller *et al.* (1997). The pH of the 15 % (v/v) H_2O_2 solution was adjusted to 4.5 using 0.1 M-NaOH prior to commencing the NAG Tests. Test mixtures boiled for *c.* 2 hours to accelerate reaction with H_2O_2. Then, after allowing the test mixtures to cool, 1.0 mL of 0.016 M-$CuSO_4$ solution was added, and the test mixtures again boiled for *c.* 2 hours. The addition of Cu(II) catalyses the decomposition of any residual, unreacted H_2O_2 in the test mixtures (O'Shay *et al.* 1990). K-Feldspar was employed for the Blanks.

Dr GD Campbell
27th October 2006

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0608153
No. of SAMPLES	:	1
No. of ELEMENTS	:	32
CLIENT O/N	:	GCA0616
SAMPLE SUBMISSION No.	:	
PROJECT	:	Kanmantoo Cooper Project
STATE	:	Ex-Pulp
DATE RECEIVED	:	01/09/2006
DATE COMPLETED	:	11/10/2006
DATE PRINTED	:	11/10/2006

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY

15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION

12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION

124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION

Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $1.95 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ****

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The sample, GCA6298, was received as being a 'tailings solid' which had already been dried and crushed on Genalysis report 143.0/0608152. A 100 gram portion was mixed and split from the bulk prior to being fine pulverised in a zirconia bowl.

The results have been determined according to Genalysis methods codes :
Digestions : SL_W001 (A/), SL_W007 (BP/), ENV_W012 (DH/SIE), SL_W013 (D/), and SL_W012 (CM/)
Analytical Finishes: ICP_W004 (/OES), ICP_W005 (/MS) and AAS_W004 (/CVAP).

The results included the assay of blanks and international reference standards OREAS 45P, and STSD-2 and Genalysis in-house standards TKC5, AE12 and HgSTD-4.

The results are expressed as parts per million or percent by mass in the dried and prepared material.

NATA Signatory: R H Essers

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	0.1	20	1	50	0.1	0.01	10	0.1	0.1	2
DIGEST	A/	A/	A/	D/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	MS	OES	MS	OES	MS	MS	OES	MS	MS	OES
SAMPLE NUMBERS										
0001 GCA6298	0.8	5.18%	4	X	91.0	73.32	2073	X	67.3	142
CHECKS										
0001 GCA6298	0.6	5.31%	4	X	89.4	74.18	1607	X	66.3	129
STANDARDS										
0001 HgSTD-4										
0002 OREAS 45P				X						
0003 STSD-2										
0004 TKC5	15.5	6.03%	629		539.4	30.32	2.46%	5.3	155.4	721
BLANKS										
0001 Control Blank	0.2	X	X	X	0.3	0.02	17	X	X	5
0002 Control Blank	X	X	1		0.1	0.03	12	X	0.2	2
0003 Control Blank										
0004 Control Blank										
0005 Control Blank				X						
0006 Acid Blank	X	X	X		X	0.02	X	X	X	X
0007 Acid Blank										
0008 Acid Blank				X						
0009 Control Blank										

ANALYSIS

ELEMENTS	Cu	F	Fe	Hg	K	Mg	Mn	Mo	Na	Ni
UNITS	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	1	50	0.01	0.01	20	20	1	0.1	20	1
DIGEST	A/	DH/	D/	CM/	A/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	SIE	OES	CVAP	OES	OES	OES	MS	OES	OES
SAMPLE NUMBERS										
0001 GCA6298	354	487	13.48	X	8976	1.65%	2216	5.2	585	54
CHECKS										
0001 GCA6298	362	538	13.57	X	9072	1.67%	2282	4.7	584	53
STANDARDS										
0001 HgSTD-4				0.28						
0002 OREAS 45P			18.79							
0003 STSD-2		992								
0004 TKC5	1806				1.15%	1.67%	1944	61.1	1.71%	2309
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	0.1	X	2
0002 Control Blank	X				X	X	X	0.2	X	2
0003 Control Blank										
0004 Control Blank				X						
0005 Control Blank			X							
0006 Acid Blank	X				X	X	X	X	X	X
0007 Acid Blank				X						
0008 Acid Blank			X							
0009 Control Blank										

ANALYSIS

ELEMENTS	P	Pb	S	Sb	Se	Sn	Sr	Th	Tl	U
UNITS	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
DETECTION	20	2	10	0.05	0.01	0.1	0.05	0.01	0.02	0.01
DIGEST	A/	A/	A/	A/	BP/	A/	A/	A/	A/	A/
ANALYTICAL FINISH	OES	MS	OES	MS	MS	MS	MS	MS	MS	MS
SAMPLE NUMBERS										
0001 GCA6298	476	19	8183	0.11	0.97	3.3	10.47	10.67	0.34	3.15
CHECKS										
0001 GCA6298	479	19	8262	0.09	0.99	3.2	10.14	10.70	0.34	3.05
STANDARDS										
0001 HgSTD-4										
0002 OREAS 45P										
0003 STSD-2										
0004 TKC5	1992	1478	1.32%	185.26		5.7	575.66	143.06	25.48	15.75
BLANKS										
0001 Control Blank	X	X	16	X	0.02	0.2	X	X	X	0.02
0002 Control Blank	X	2	11	X		0.2	X	0.02	X	0.02
0003 Control Blank					0.02					
0004 Control Blank										
0005 Control Blank										
0006 Acid Blank	X	X	X	X		X	X	0.02	0.02	X
0007 Acid Blank										
0008 Acid Blank										
0009 Control Blank					0.01					

ANALYSIS

ELEMENTS	V	Zn
UNITS	ppm	ppm
DETECTION	2	1
DIGEST	A/	A/
ANALYTICAL FINISH	OES	OES
SAMPLE NUMBERS		
0001 GCA6298	63	49
CHECKS		
0001 GCA6298	64	50
STANDARDS		
0001 HgSTD-4		
0002 OREAS 45P		
0003 STSD-2		
0004 TKC5	338	1116
BLANKS		
0001 Control Blank	X	2
0002 Control Blank	X	X
0003 Control Blank		
0004 Control Blank		
0005 Control Blank		
0006 Acid Blank	X	X
0007 Acid Blank		
0008 Acid Blank		
0009 Control Blank		

METHOD CODE DESCRIPTION

A/MS

Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Mass Spectrometry.

A/OES

Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

BP/MS

Aqua-Regia digest followed by Precipitation and Concentration. Specific for Selenium. Analysed by Inductively Coupled Plasma Mass Spectrometry.

D/OES

Sodium peroxide fusion (Zirconium crucibles) and Hydrochloric acid to dissolve the melt. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

DH/SIE

Alkaline fusion (Nickel crucible) specific for Fluorine. Analysed by Specific Ion Electrode.

CM/CVAP

Low temperature Perchloric acid digest specific for Mercury. Analysed by Cold Vapour Generation Atomic Absorption Spectrometry.

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0608154
No. of SAMPLES	:	1
No. of ELEMENTS	:	31
CLIENT O/N	:	GCA0616
SAMPLE SUBMISSION No.	:	
PROJECT	:	Kanmantoo Cooper Project
STATE	:	Solutions
DATE RECEIVED	:	01/09/2006
DATE COMPLETED	:	11/10/2006
DATE PRINTED	:	11/10/2006

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY

15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION

12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION

124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION

Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $1.95 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ***

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The sample, GCA6298, were received as being tailings-slurry-water which had been filtered and acidified.

The results have been determined by ICP-MS according to Genalysis method code ICP_W004 and by ICP-OES according to method code ICP_W005.

The analysis included the assay of blanks and Genalysis in-house reference standards. The results are expressed as milligrams per litre or micrograms per litre in the solution as received

NATA Signatory: R H Essers

ANALYSIS

ELEMENTS	Ag	Al	As	B	Ba	Bi	Ca	Cd	Co	Cr
UNITS	ug/l	mg/l	ug/l	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l	mg/l
DETECTION	0.01	0.01	0.1	0.01	0.05	0.005	0.01	0.02	0.1	0.01
DIGEST										
ANALYTICAL FINISH	/MS	/OES	/MS	/OES	/MS	/MS	/OES	/MS	/MS	/OES
SAMPLE NUMBERS										
0001 GCA6298	X	0.10	0.2	0.04	58.12	X	64.01	0.30	486.4	X
CHECKS										
0001 GCA6298	X	0.10	0.4	0.04	58.99	X	63.14	0.33	502.9	X
STANDARDS										
0001 Alcoa5-OES		1.85		0.93			47.67			0.48
0002 Alcoa7MS	4.52		26.0		5.64	4.907		4.61	497.1	
BLANKS										
0001 Control Blank	X	X	0.1	X	X	X	X	X	0.2	X

ANALYSIS

ELEMENTS	Cu	Fe-Sol	Hg	K	Mg	Mn	Mo	Na	Ni	P
UNITS	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l	ug/l	mg/l	mg/l	mg/l
DETECTION	0.01	0.01	0.1	0.1	0.01	0.01	0.05	0.1	0.01	0.1
DIGEST										
ANALYTICAL FINISH	/OES	/OES	/MS	/OES	/OES	/OES	/MS	/OES	/OES	/OES
SAMPLE NUMBERS										
0001 GCA6298	0.01	0.19	X	26.3	22.51	0.71	0.08	95.1	0.24	0.1
CHECKS										
0001 GCA6298	0.01	0.19	X	26.4	22.80	0.72	0.09	94.9	0.24	0.1
STANDARDS										
0001 Alcoa5-OES	0.24	1.93		3.8	60.32	0.48		230.9	0.52	0.9
0002 Alcoa7MS			5.1				5.10			
BLANKS										
0001 Control Blank	X	X	X	X	X	X	X	X	X	X

ANALYSIS

ELEMENTS	Pb	Sb	Se	Si	Sn	Sr	Th	Tl	U	V
UNITS	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l
DETECTION	0.5	0.01	0.5	0.05	0.1	0.02	0.005	0.01	0.005	0.01
DIGEST										
ANALYTICAL FINISH	/MS	/MS	/MS	/OES	/MS	/MS	/MS	/MS	/MS	/OES
SAMPLE NUMBERS										
0001 GCA6298	0.6	0.13	2.0	8.00	X	360.73	X	0.06	0.122	X
CHECKS										
0001 GCA6298	0.5	0.14	3.0	7.94	X	378.25	X	0.05	0.121	X
STANDARDS										
0001 Alcoa5-OES				9.86						0.48
0002 Alcoa7MS	5.3	5.00	24.6		4.9	485.03	5.253	4.75	4.971	
BLANKS										
0001 Control Blank	X	X	X	X	X	0.05	X	X	X	X

ANALYSIS

ELEMENTS	Zn
UNITS	mg/l
DETECTION	0.01
DIGEST	
ANALYTICAL FINISH	/OES
SAMPLE NUMBERS	
0001 GCA6298	0.11

CHECKS	
0001 GCA6298	0.11

STANDARDS	
0001 Alcoa5-OES	0.48
0002 Alcoa7MS	

BLANKS	
0001 Control Blank	X

METHOD CODE DESCRIPTION

/MS

No digestion or other pre-treatment undertaken. Analysed by Inductively Coupled Plasma Mass Spectrometry.

/OES

No digestion or other pre-treatment undertaken. Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

LABORATORY REPORT COVERSHEET

DATE:	3 November 2006
TO:	Graeme Campbell & Associates Pty Ltd PO Box 247 BRIDGETOWN WA 6255
ATTENTION:	Dr Graeme Campbell
YOUR REFERENCE:	GCA Job No. 0616
OUR REFERENCE:	98284
SAMPLES RECEIVED:	08/09/2006
SAMPLES/QUANTITY:	1 Water

The above samples were received intact and analysed according to your instructions. Unless otherwise stated, solid samples are reported on a dry weight basis and liquid samples as received.

DON SARATHCHANDRA
Senior Chemist

SGS Australia Pty Ltd ABN 44 000 964 278 | Environmental Services t +61 (0)8 9458 7278 | 52 Murray Road f +61 (0)8 9451 3505 | Welshpool 6106 | Western Australia | www.au.sgs.com

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 98284
PROJECT: GCA Job No. 0616

LABORATORY REPORT

Your Reference Our Reference Type of Sample	Units	GCA 6298 98284-1 Water
pH	pH Units	6.1
Conductivity @25^oC	µS/cm	1,100
Total Dissolved Solids @ 180^oC	mg/L	650
Chloride, Cl	mg/L	200
Sulphate, SO_4	mg/L	290
Bicarbonate, HCO_3	mg/L	10
Carbonate, CO_3	mg/L	<1
Hydroxide Alkalinity as $CaCO_3$	mg/L	<5
Fluoride, F	mg/L	0.2
Nitrate, NO_3	mg/L	1.0
Ammonia Nitrogen NH_3-N	mg/L	2.4

CLIENT: Graeme Campbell & Associates Pty Ltd **OUR REFERENCE:** 98284
PROJECT: GCA Job No. 0616

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
--------			
pH	pH Units	0.1	AN-101
Conductivity @25^{o}C	µS/cm	2	AN-106
Total Dissolved Solids @ 180^{o}C	mg/L	10	PEI-002
Chloride, Cl	mg/L	1	PEI-020
Sulphate, SO_4	mg/L	1	PEI-020
Bicarbonate, HCO_3	mg/L	5	PEI-006
Carbonate, CO_3	mg/L	1	PEI-006
Hydroxide Alkalinity as $CaCO_3$	mg/L	5	PEI-006
Fluoride, F	mg/L	0.1	PEI-027
Nitrate, NO_3	mg/L	0.2	PEI-020
Ammonia Nitrogen NH_3-N	mg/L	0.1	PEI-010

LABORATORY REPORT

NOTES:

LOR - Limit of Reporting.
Nitrate and ammonia were determined from the sulphuric acid preserved sample.
This test is not covered by the scope of our NATA accreditation.

GRAEME CAMPBELL & ASSOCIATES PTY LTD
Specialists in Mine-Waste Geochemistry,
& Soil-Moisture-Retention Testing

P.O. Box 247, Bridgetown, Western Australia 6255
Phone: (61 8) 9761 2829 Fax: (61 8) 9761 2830
E-mail: gca@wn.com.au

0721/2

COMPANY:	Hillgrove Resources Pty Ltd
ATTENTION:	Marty Adams
FROM:	Graeme Campbell
SUBJECT:	Kanmantoo Copper Project: Testwork Results for Drilling Samples from Various Site Areas

NO. PAGES (including this page): 10 DATE: 23rd July 2007

Marty,

The results for the drilling samples from areas in the vicinity of the existing tailings-storage facility (TSF) and seepage-pond are presented in Table 1. Related results for samples from the area of the proposed TSF and waste-rock dumps are presented in Table 2.

The locations of the drillholes are given in the Coffey Mining Pty Ltd report to which this factual memorandum-report is included as an appendix.

The testing undertaken herein provides background geochemical information for the soil/geologic-profiles drilled in the respective areas.

Regards,

Dr GD Campbell
Director

Encl. Tables (2 pages)
Laboratory reports (7 pages)

Table 1: Results for Drilling Samples from Areas in Vicinity of Existing Tailings-Storage Facility and Seepage-Pond

GCA-SAMPLE-NO.	Depth-Interval (m)	pH-(1:2)	EC-(1:2) [mS/cm]	Total-S (%)	Total-Cu (%)	Total-C (%)
KMB011						
GCA7122	1-2	7.8	0.55	0.03 (0.02)	120 (110)	0.28 (0.28)
GCA7123	4-5	7.6	1.2	0.08	84	0.34
GCA7124	7-8	6.5	1.1	0.08	72	0.11
GCA7125	10-11	6.4	1.1	0.10	78	0.13
KMB012						
GCA7126	4-5	8.8	0.35	0.02	64	0.09
GCA7127	9-10	8.6	0.60	0.02	81	0.16
GCA7128	14-15	9.1	0.28	0.02	67	0.03
GCA7129	19-20	9.1	0.23	0.01	28	0.13
KMB013						
GCA7130	4-5	9.0	0.31	0.02	330	0.08
GCA7131	14-15	7.4	0.37	0.05	140	0.19
GCA7132	24-25	7.8	0.27	0.10	23	0.17
GCA7133	29-30	4.3	1.4	5.9	2,800	0.10

Notes:
EC = Electrical-Conductivity.
pH-(1:2) and EC-(1:2) correspond to pH and EC determined on sample slurries prepared using deionised-water at a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH.
Values in parentheses represent duplicates.

Table 2: Results for Drilling Samples from Area of Proposed Tailings-Storage Facility and Waste-Rock Dumps

GCA-SAMPLE-NO.	Depth-Interval (m)	pH-(1:2)	EC-(1:2) [mS/cm]	Total-S (%)	Total-Cu (mg/kg)	Total-C (%)
KMB016						
GCA7134	5-6	8.2	0.19	0.03	99	0.20
GCA7135	15-16	7.8	0.22	0.05	150	0.12
GCA7136	25-26	8.4	0.12	0.01	10	0.04
GCA7137	35-36	8.7	0.13	0.04	17	0.07
GCA7138	45-46	8.5	0.13	0.10	30	0.24
GCA7139	55-56	6.8	0.48	0.49	49	0.06
KMB017						
GCA7146	5-6	9.1	0.22	<0.01	63	0.06
GCA7147	15-16	9.0	0.18	<0.01	44	0.05
GCA7148	25-26	8.2	0.38	0.18 (0.19)	91 (81)	0.05 (0.04)
GCA7149	35-36	8.5	0.32	0.10	48	0.04
GCA7150	45-46	8.5	0.33	0.15	29	0.02
GCA7151	55-56	8.5	0.42	0.11	22	0.03
KMB018						
GCA7140	5-6	8.9	0.25	<0.01	44	0.14
GCA7141	15-16	9.2	0.14	<0.01	51	0.06
GCA7142	25-26	8.9 (8.9)	0.17 (0.12)	<0.01	16	0.05
GCA7143	35-36	8.8	0.14	<0.01	21	0.08
GCA7144	45-46	8.7	0.14	<0.01	17	0.03
GCA7145	55-56	8.2	0.13	0.03	33	0.05
KMB019						
GCA7152	5-6	8.6	0.15	<0.01	21	0.06
GCA7153	15-16	8.6	0.18	0.02	42	0.12
GCA7154	25-26	8.7	0.23	0.01	33	0.05
GCA7155	35-36	8.5	0.29	0.14	31	0.06
GCA7156	45-46	8.6 (8.4)	0.25 (0.28)	0.07	51	0.04

Notes:
EC = Electrical-Conductivity.
pH-(1:2) and EC-(1:2) correspond to pH and EC determined on sample slurries prepared using deionised-water at a solid:solution ratio of *c.* 1:2 (w/w).
All results expressed on a dry-weight basis, except for pH-(1:2), EC-(1:2), and NAG-pH.
Values in parentheses represent duplicates.

Graeme Campbell & Associates Pty Ltd

Laboratory Report

pH-(1:2) & EC-(1:2) TESTWORK

SAMPLE NO.	SAMPLE WEIGHT (g)	SAMPLE + DEION.-W WEIGHT (g)	pH-(1:2)	EC-(1:2) (mS/cm)
GCA7122	30.0	90.3	7.8	0.55
GCA7123	30.0	90.4	7.6	1.2
GCA7124	30.0	90.0	6.5	1.1
GCA7125	30.0	90.0	6.4	1.1
GCA7126	30.0	90.3	8.8	0.35
GCA7127	30.0	90.1	8.6	0.60
GCA7128	30.0	90.2	9.1	0.28
GCA7129	30.0	90.5	9.1	0.23
GCA7130	30.0	90.4	9.0	0.31
GCA7131	30.0	90.0	7.4	0.37
GCA7132	30.0	90.2	7.8	0.27
GCA7133	30.0	90.5	4.3	1.4
GCA7134	30.0	90.0	8.2	0.19
GCA7135	30.0	90.3	7.8	0.22
GCA7136	30.0	90.3	8.4	0.12
GCA7137	30.0	90.1	8.7	0.13
GCA7138	30.0	90.2	8.5	0.13
GCA7139	30.0	90.1	6.8	0.48
GCA7140	30.0	90.4	8.9	0.25
GCA7141	30.0	90.3	9.2	0.14
GCA7142-1	30.0	90.1	8.9	0.17
GCA7142-2	30.0	90.1	8.9	0.12
GCA7143	30.0	90.0	8.8	0.14
GCA7144	30.0	90.1	8.7	0.14
GCA7145	30.0	90.0	8.2	0.13
GCA7146	30.0	90.1	9.1	0.22
GCA7147	30.0	90.3	9.0	0.18
GCA7148	30.0	90.0	8.2	0.38
GCA7149	30.0	90.2	8.5	0.32
GCA7150	30.0	90.0	8.5	0.33
GCA7151	30.0	90.1	8.5	0.42
GCA7152	30.0	90.0	8.6	0.15
GCA7153	30.0	90.2	8.6	0.18
GCA7154	30.0	90.2	8.7	0.23
GCA7155	30.0	90.2	8.5	0.29
GCA7156-1	30.0	90.1	8.6	0.25
GCA7156-2	30.0	90.0	8.4	0.28

Note: EC = Electrical-Conductivity.
Testwork performed on crushed (nominal -2 mm) samples.
pH-(1:2) and EC-(1:2) values correspond to pH and EC values of suspensions with a solid:solution ration of *c.* 1:2 (w/w) prepared using deionised-water.
Drift in pH-glass-electrode less than 0.1 pH unit between commencement, and completion, of testwork.
Drift in EC-electrode less than 0.05 mS/cm between commencement, and completion, of testwork.
Testwork performed in a constant-temperature room (viz. 21 +/- 2-3 ^{o}C).

Dr GD Campbell
18th July 2007

ANALYTICAL REPORT

Dr G. CAMPBELL
CAMPBELL, GRAEME and ASSOCIATES
PO Box 247
BRIDGETOWN, W.A. 6255
AUSTRALIA

JOB INFORMATION

JOB CODE	:	143.0/0706097
No. of SAMPLES	:	35
No. of ELEMENTS	:	3
CLIENT O/N	:	GCA0721/2 (Job 1 of 1)
SAMPLE SUBMISSION No.	:	
PROJECT	:	
STATE	:	Ex-Pulp
DATE RECEIVED	:	13/06/2007
DATE COMPLETED	:	19/07/2007
DATE PRINTED	:	19/07/2007

LEGEND

X	= Less than Detection Limit
N/R	= Sample Not Received
*	= Result Checked
( )	= Result still to come
I/S	= Insufficient Sample for Analysis
E6	= Result X 1,000,000
UA	= Unable to Assay
>	= Value beyond Limit of Method

MAIN OFFICE AND LABORATORY

15 Davison Street, Maddington 6109, Western Australia
PO Box 144, Gosnells 6990, Western Australia
Tel: +61 8 9251 8100 Fax: +61 8 9251 8110
Email: genalysis@genalysis.com.au
Web Page: www.genalysis.com.au

KALGOORLIE SAMPLE PREPARATION DIVISION

12 Keogh Way, Kalgoorlie 6430, Western Australia
Tel: +61 8 9021 6057 Fax: +61 8 9021 3476

ADELAIDE SAMPLE PREPARATION DIVISION

124 Mooringe Avenue, North Plympton 5037, South Australia
Tel: +61 8 8376 7122 Fax: +61 8 8376 7144

JOHANNESBURG SAMPLE PREPARATION DIVISION

Unit 14a 253 Dormehl Road, Middlepark,
Anderbolt, Gauteng, South Africa 1459.
Tel: +27 11 918 0869 Fax: +27 11 918 0879

SAMPLE DETAILS

DISCLAIMER

Genalysis Laboratory Services Pty Ltd wishes to make the following disclaimer pertaining to the accompanying analytical results.

Genalysis Laboratory Services Pty Ltd disclaims any liability, legal or otherwise, for any inferences implied from this report relating to either the origin of, or the sampling technique employed in the collection of, the submitted samples.

SIGNIFICANT FIGURES

It is common practice to report data derived from analytical instrumentation to a maximum of two or three significant figures. Some data reported herein may show more figures than this. The reporting of more than two or three figures in no way implies that the third, fourth and subsequent figures may be real or significant.

Genalysis Laboratory Services Pty Ltd accepts no responsibility whatsoever for any interpretation by any party of any data where more than two or three significant figures have been reported.

SAMPLE STORAGE DETAILS

GENERAL CONDITIONS

SAMPLE STORAGE OF SOLIDS

Bulk Residues and Pulps will be stored for 60 DAYS without charge. After this time all Bulk Residues and Pulps will be stored at a rate of $3.00 per cubic metre per day until your written advice regarding collection or disposal is received. Expenses related to the return or disposal of samples will be charged to you at cost. Current disposal cost is charged at $50.00 per cubic metre.

SAMPLE STORAGE OF SOLUTIONS

Samples received as liquids, waters or solutions will be held for 60 DAYS free of charge then disposed of, unless written advice for return or collection is received.

NOTES

*** NATA ENDORSED DOCUMENT ****

Company Accreditation Number 3244

The contents of this report have been prepared in accordance with the terms of NATA accreditation and as such should only be reproduced in full.

The analysis results reported herein have been obtained using the following methods and conditions:

The 35 samples, as listed in the report, was received as being 'rock chips' which required crushing prior to splitting and a 100g portion being fine pulverised in a zirconia bowl.

The results for Cu are based Genalysis method code SL_W001 (A/) with the analytical finishes according to ICP_W004 (/OES). The LECO results have been determined according to Genalysis methods number SL_W023 on the pulverised portion of the samples.

The results included the assay of blanks and Genalysis in-house standard MPL-1 and certified reference material MA-1b.

The results are expressed as parts per million or percent by mass in the dried and prepared material.

NATA Signatory: A P Evers
Chief Chemist

Date: 19th July 2007

This document is issued in accordance with NATA's accreditation requirements.

ANALYSIS

ELEMENTS	C	Cu	S
UNITS	%	ppm	%
DETECTION	0.01	1	0.005
DIGEST		A/	
ANALYTICAL FINISH	/LECO	OES	/LECO
SAMPLE NUMBERS			
0001 GCA7122	0.28	116	0.024
0002 GCA7123	0.34	79	0.071
0003 GCA7124	0.11	74	0.073
0004 GCA7125	0.13	78	0.092
0005 GCA7126	0.09	59	0.015
0006 GCA7127	0.16	85	0.016
0007 GCA7128	0.03	71	0.012
0008 GCA7129	0.13	29	0.006
0009 GCA7130	0.08	343	0.013
0010 GCA7131	0.19	122	0.041
0011 GCA7132	0.17	23	0.097
0012 GCA7133	0.10	2813	5.835
0013 GCA7134	0.20	108	0.024
0014 GCA7135	0.12	149	0.043
0015 GCA7136	0.04	11	0.008
0016 GCA7137	0.07	17	0.034
0017 GCA7138	0.24	31	0.094
0018 GCA7139	0.06	54	0.487
0019 GCA7140	0.14	41	0.005
0020 GCA7141	0.06	49	0.006
0021 GCA7142	0.05	17	0.006
0022 GCA7143	0.08	20	0.008
0023 GCA7144	0.03	17	0.005
0024 GCA7145	0.05	30	0.028
0025 GCA7146	0.06	61	X
0026 GCA7147	0.05	43	X
0027 GCA7148	0.05	86	0.179
0028 GCA7149	0.04	49	0.095
0029 GCA7150	0.02	30	0.143
0030 GCA7151	0.03	23	0.108
0031 GCA7152	0.06	22	X
0032 GCA7153	0.12	41	0.014
0033 GCA7154	0.05	33	0.009
0034 GCA7155	0.06	32	0.138
0035 GCA7156	0.04	50	0.064

CHECKS			
0001 GCA7122	0.28	117	0.016
0002 GCA7148	0.04	83	0.184

ANALYSIS

ELEMENTS	C	Cu	S
UNITS	%	ppm	%
DETECTION	0.01	1	0.005
DIGEST		A/	
ANALYTICAL FINISH	/LECO	OES	/LECO
STANDARDS			
0001 MA-1b	2.48		1.235
0002 MPL-1		1883	
0003 MA-1b	2.49		1.260
0004 MPL-1		1782	

BLANKS			
0001 Control Blank	X	X	X
0002 Control Blank		X	
0003 Acid Blank		X	

METHOD CODE DESCRIPTION

/LECO

No digestion or other pre-treatment undertaken. Analysed by LECO furnace.

A/OES

Multi-acid digest including Hydrofluoric, Nitric, Perchloric and Hydrochloric acids in Teflon Beakers.
Analysed by Inductively Coupled Plasma Optical (Atomic) Emission Spectrometry.

Background Groundwater Quality Investigation of Regional Bores

Kanmantoo Copper Project

South Australia

Prepared for
Mr Marty Adams
Site Manager – Kanmantoo Mine Project
Hillgrove Resources Limited
42 Back Callington Road
CALLINGTON, SA 5254
29 June 2007

Document Title

Background Groundwater Quality Investigation of Regional Bores, Kanmantoo Copper Project, South Australia

Document Author(s)

Damian Newham – Resource and Environmental Management

Distribution List

Copies	Distribution	Contact Name
2	Hillgrove Resources	Mr Marty Adams
2	REM (Archive/ Library)	Mr Don McCarthy

Document Status

Doc. No.	Approved for Issue			
Rev No.		Name	Signature	Date
	Project Manager	E.Picken		29/6/07
	Project Director	D McCarthy		29/6/07

Resource & Environmental Management Pty Ltd
ABN 47 098 108 877
Suite 9, 15 Fullarton Road, KENT TOWN SA 5067
Telephone: (08) 8363 1777 Facsimile: (08) 8363 1477

Executive Summary

Resource & Environmental Management Pty Ltd was commissioned by Hillgrove Resources to undertake background groundwater quality monitoring of regional bores located around the old Kanmantoo Mine site to establish baseline water quality data prior to proposed mine redevelopment.

The groundwater investigation targeted eight regional groundwater bores due to their radial location from the Kanmantoo mine site.

The salinity of groundwater sampled from the regional bores indicates that the likely beneficial uses of groundwater include industry and livestock water supply. Aquatic fresh water ecosystems is an additional potential beneficial use of groundwater when discharging to down hydraulic gradient creek lines.

Groundwater analytical results identified concentrations of cadmium, copper, manganese, mercury and zinc marginally above either the SA EPA (2003) Freshwater Ecosystem or Potable use criteria for groundwater sampled from one or more targeted bores. Groundwater sampled from three monitoring bores reported iron concentrations above the SA EPA (2003) irrigation criteria. In addition elevated concentrations of fluoride were reported above the SA EPA (2003) Livestock and Potable use criteria in groundwater sampled from six of the eight targeted regional bores and most likely are reflective of natural background levels.

Groundwater analytical results for May 2007 where generally consistent with previous data with marginally elevated metals reflective of natural background metals due to the parent rock formation in this area.

Based on the findings of the groundwater background groundwater quality investigation of regional bores, the following recommendations are provided:

- Ongoing groundwater requirements should be incorporated into a groundwater monitoring and management plan (GMMP) prepared for the site. The GMMP should cover pre, operational and post mine development requirements.

- Undertake six monthly groundwater monitoring of targeted regional bores pre mining development to provide a longer term comprehensive background groundwater quality dataset.

Table of Contents

List of Tables, Figures and Appendices

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Resource and Environmental Management Pty Ltd (REM) was commissioned by Hillgrove Resources Limited to undertake background groundwater quality monitoring of regional bores located around the old Kanmantoo Mine site to establish baseline water quality data prior to proposed mine redevelopment. A site location plan is presented in Figure 1.

This report details the outcomes of the regional bores groundwater quality investigation, including historical data undertaken by Parsons Brinckerhoff (PB) in April 2006.

1.1 Background

The old Kanmantoo Mine is located approximately 55 km southeast of Adelaide in the Mount Lofty Ranges in South Australia. The township of Kanmantoo and Callington are located approximately 1 and 3.5 km (respectively) from the former mine site.

The Kanmantoo copper-gold deposit occurs in the base metal rich Kanmantoo trough of the Adelaide Fold Belt. The Kanmantoo Trough is an axial zone which hosts numerous former base metal and copper-gold mines with mining activity historically occurring of both vein and replacement style deposits since the 1800's.

The old Kanmantoo Mine site was operated by Broken Hill South from 1971 to 1976 and closed as a result of low copper prices, high international exchange rate and increasing costs but remained copper rich. The mine produced a total of 4.05 million tonnes of ore grading 1.1% copper and unknown gold.

Hillgrove Resources Limited holds a mining lease over the old Kanmantoo Mine and exploration licenses over surrounding areas and has been undertaking a pre-feasibility study since 2004 to assess the extent of mineralisation of the site and whether future mining of this resource is viable.

Groundwater sampling and analyses from nearby wells was undertaken during the Pre-Feasibility Study (PFS) in recognition of the need to establish baseline groundwater quality conditions prior to any new mining activities. Parsons Brinckerhoff (PB) was commissioned by Hillgrove in early 2006 to undertake sampling of ten wells within a five kilometre radius of the existing open-pit. Most of the wells were in active use and equipped with a windmill or electric-submersible pump at the time of sampling.

Groundwater samples were collected in April 2006 and submitted to Amdel in Victoria for analyses of major ions, trace metals and cyanide. The analyses of the ten groundwater samples from surrounding wells revealed water qualities consistent with the understanding of the regional aquifer system, i.e. pH in surrounding wells was typically between 6.8 to 8.4, salinity (as EC) is quite variable, ranging from about 700 to 9,500 µS/cm and trace metals were typically low and are generally below drinking water guidelines.

This report details the outcomes of an additional groundwater quality investigation targeting these regional bores.

1.2 Objectives

The key objective of the groundwater assessment program is to provide baseline groundwater quality from regional bores surrounding the Kanmantoo Mine site prior to the recommencement of proposed mining by Hillgrove Resources.

1.3 Scope of Works

The scope of works as detailed in REM's proposal dated 3 May 2007 included:

- Sampling and analysis of groundwater from the eight regional bores previously identified by PB (PB, July 2006) in addition to two additional bores identified by REM for the following:
  - Heavy metals (including As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Vn and Zn), total cyanide and major cations and anions.
- Provide a report including sampling methodology and results, in addition to comparison of previous data presented by PB in July 2006, conclusions and recommendations including an assessment of the ongoing preferred sampling frequency for these bores.

2 METHODOLOGY

2.1 Approach

Eight groundwater bores comprising GW01, GW02, GW03, GW05, GW06, GW07, GW08 and GW10 which were sampled by PB (PB, July 2006) were sampled to assess background groundwater quality from neighbouring landholders bores located radially around the old Kanmantoo Mine site. In addition two additional groundwater bores one located north west of the site (bore 6627-5847) and one located south to south east (6727-00683) were sampled to provide additional baseline water quality data. Figure 2 details the regional bore location plan.

Bore 6627-10025 was to be included in this sampling event but could not be located at the time of sampling. This bore has subsequently been identified and will be included in future regional groundwater monitoring events.

2.2 Groundwater Sampling

Groundwater sampling of the regional bores was undertaken on 14 and 15 May 2007.

Field parameters including electrical conductivity, pH, redox and temperature were collected at least three times from each bore, with the exception of bore 6727-00683 where 500 litres of water was pumped out prior to sampling and then the pump would not restart. Sampling generally only proceeding once measured field parameters stabilised to within 3% for electrical conductivity, 0.05 pH unit, 10 mV for redox potential and 0.5°C for temperature. Stabilised field parameters indicate that a representative groundwater sample has been obtained from the aquifer.

Groundwater sampling from bores GW1 and GW5 was undertaken using a disposable Teflon bailer dedicated to each bore; 6727-00683, GW2, GW7 and GW8 were sampled using the existing bore pumps and GW3 and GW10 were sampled from the tank trough and base of the header tank respectively. Bores 6627-5847 and GW6 were not sampled as 6627-5847 was an old windmill where no access to the bore was possible and GW6 was either blocked or dry.

Groundwater samples were placed in laboratory supplied and cleaned bottles with appropriate preservation. Groundwater samples analysed for heavy metals were filtered in the field using 0.45 micron filters prior to placement in a pre-acidified container. Samples were stored on ice in an insulated cooler prior to transport to the laboratory under standard chain of custody protocols.

Groundwater samples were delivered for analysis to Labmark laboratories (Primary Laboratory) and ALS Environmental (Duplicate Laboratory), both National Association of Testing Authorities (NATA) registered laboratories.

During the regional bore sampling program the REM field scientist, Volker Stroeher, was accompanied by Hillgrove Resources representative John Popow (Senior Project Geologist).

2.3 Analytical Laboratory Program and Criteria

Each groundwater monitoring bore was analysed for the following:

- Major Ions including Ca, Na, Mg, K, SO4, Cl and HCO3/ CO3 and minor ions including NO3, NO2 and F; and

- Trace Elements (As, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Se, Vn, Zn and total cyanide).

Quality assurance/quality control samples included 1 in 10 inter- and intra-laboratory duplicate sample analysis.

Based on the potential beneficial uses of groundwater analytical data for groundwater samples have been compared against the following published criteria:

- SA EPA Environment Protection Policy (2003) – Water Quality Potable Use.
- SA EPA Environment Protection Policy (2003) – Water Quality Irrigation Use.
- SA EPA Environment Protection Policy (2003) – Water Quality Livestock Use.
- SA EPA Environment Protection Policy (2003) – Water Quality Aquatic Ecosystems (Fresh Waters).

3 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Site Hydrogeology

Groundwater levels (Table 1) were gauged at each bore location, where possible, on the 14 May 2007 using an electronic dip metre. Measured water levels for May 2007 included 14.5m below the top of the casing (TOC) (GW2), 24.0m TOC (GW7), 28.7m TOC (GW8) and 14.2m TOC (GW10). Access to measure water level and bore depth was not possible for the remaining bores.

3.1.2 Groundwater Analytical Results

Field Parameters

Field parameters (Table 2) measured during the groundwater sampling program indicate the following hydro-geochemical conditions exist in groundwater sampled from the bores in the region:

- pH values in regional groundwater bores in the Kanmantoo/ Callington region reported generally alkaline groundwater ranging from 7.33 (GW7) to 8.63 (GW10). Groundwater sampled from GW8 reported slightly acidic groundwater of 6.91.

- Electrical conductivity of sampled groundwater ranged from moderately saline 1.89 mS/cm (estimated Total Dissolved Solids (TDS): 1,230 mg/L) at GW10 to a brackish 10.49 mS/cm (TDS: 6,819 mg/L) at GW1. All groundwater sampled from the regional bores during May 2007 reported moderate increases in EC/TDS from the previous PB (PB, July 2006) investigation.

- Generally oxidising conditions exist in the groundwater sampled from the regional bores with redox potential ranging from 14 mV (GW7) to 90 mV (GW3). Reducing conditions were reported in groundwater sampled from bores 6727-00683 (-52 mV) and GW5 (-18 mV).

- Temperature of sampled groundwater ranged from was 14.9^{o}C at GW10 to 18.2^{o}C at 6727-00683 and GW8.

Based on groundwater salinity measurements the likely beneficial uses of groundwater includes industrial and livestock water supply. Groundwater salinity trends will be confirmed in subsequent sampling events. Aquatic ecosystem is an additional potential beneficial uses of groundwater when discharging to down hydraulic gradient creek lines.

Field parameter sheets are presented in Appendix A.

Heavy Metals

Groundwater analytical results for heavy metals from the groundwater sampling event conducted by REM in May 2007 are presented in Table 3.

- Cadmium concentration was reported above the SA EPA (2003) Environmental

Protection Water Quality Policy for Potable and Aquatic Ecosystem Fresh Use criteria of 0.002 mg/L in groundwater sampled from GW5 (0.0053 mg/L).

- Copper concentration was reported above the SA EPA (2003) Environmental Protection Water Quality Policy for Aquatic Ecosystem Fresh Use criteria of 0.01 mg/L in groundwater sampled GW3 (0.078 mg/L).

- Iron concentration was reported above the SA EPA (2003) Environmental Protection Water Quality Policy for Irrigation and Aquatic Ecosystem Fresh Use criteria of 1 mg/L in groundwater sampled from 6727-00683 (4.4 mg/L), GW5 (2.2 mg/L) and GW8 (3.6 mg/L).

- Manganese concentration was reported above the SA EPA (2003) Environmental Protection Water Quality Policy for Potable Use Criteria of 0.5 mg/L in groundwater sampled from GW7 (0.65 mg/L) and GW8 (0.55 mg/L).

- Mercury concentrations exceeding the SA EPA (2003) Environmental Protection Water Quality Policy for both Potable and Aquatic Ecosystem Fresh Use criteria of 0.0001 mg/L was reported in groundwater sampled from regional bores GW1, GW2, GW3 and GW5 which all reported 0.0002 mg/L.

- Zinc concentrations were reported to exceed the SA EPA (2003) Environmental Protection Water Quality Policy for Aquatic Ecosystem Fresh Use criteria of 0.05 mg/L in groundwater sampled from regional bores 6727-00683 (0.25 mg/L), GW1 (0.39 mg/L), GW3 (0.63 mg/L) and GW10 (0.11 mg/L).

All remaining metals concentrations tested were reported either below laboratory limit of reporting (LOR) or below relevant criteria values. Figure 3 illustrates concentrations of heavy metals identified in regional groundwater bores.

Summary

Groundwater analytical data reported for May 2007 was generally consistent with that reported by PB for April 2006 with the exception of the following:

- Copper concentrations have declined in groundwater sampled from GW1, GW3 and GW8; and

- Iron and manganese concentrations have increased above criteria in groundwater sampled from GW08.

Previous analytical data (PB, July 2006) also identified selenium concentrations consistently elevated in each regional bore (ranging from 0.015 to 0.043 mg/L). The May 2007 monitoring event reported selenium below LOR in all bores.

Total Cyanide

Total cyanide concentrations were reported either below LOR or below the adopted assessment criteria for all groundwater samples.

Major and Minor Ions

Groundwater analytical results for major ions are presented in Table 4.

Concentrations of fluoride were reported to exceed adopted assessment criteria in groundwater sampled from 6727-00683, GW1, GW2, GW3, GW7 and GW8, however these concentrations are most likely reflective of natural background levels.

Sulphate concentration was reported to exceed the SA EPA (2003) Environmental Protection Water Quality Policy Potable Use criteria of 500 mg/L in groundwater sampled from GW8 (660 mg/L).

Piper diagram plots showing the composition of the major cations and anions plotted for each monitoring wells is illustrated in Figure 4. This plot represents the ratio of different major cations and anions in milliequivalents per litre and can be used to characterise groundwater and mixing patterns between different groundwater bodies.

The geochemical signature of regional bores indicates that the ionic composition of groundwater is chloride and sodium dominant.

3.1.3 Analytical Data Quality

The quality of analytical data produced for this project has been assessed with reference to the following issues:

- sampling technique;
- preservation and storage of samples upon collection and during transport to the laboratory;
- sample holding times;
- analytical procedures;
- laboratory limits of reporting;
- field duplicate agreement;
- laboratory quality assurance/quality control (QA/QC) procedures; and
- the occurrence of apparently unusual or anomalous results.

Laboratory QA/QC procedures and results are detailed in the certified laboratory results contained in Appendix B. A summary of the data quality assessment and a summary of the field duplicate sample relative percentage differences are included as Appendix C.

All samples were collected, stored and transported to the laboratory in accordance with standard REM Chain of Custody protocols which are consistent with the requirements of Schedule B(2) of the NEPM (NEPC,1999). Laboratory analysis was undertaken within specified holding times and in accordance with National Association of Testing Authorities (NATA) accepted analytical procedures and the requirements of Schedule B(3) of the NEPM (NEPC,1999).

The LOR for arsenic due to matrix interference was increased from 0.001 mg/L to 0.01 mg/L which exceeds the SA EPA Environmental Protection Water Quality Policy for Potable Use (0.007 mg/L). This is not considered significant in terms of the overall interpretation of results as no groundwater samples were reported to be suitable for potable use.

The ionic balance for major cations and anions were reported out of acceptable limits for groundwater sampled from the primary laboratory for GW01, GW05, GW07 and GW10. Ongoing groundwater monitoring will confirm the reported major cation and anion results for the May 2007 monitoring program.

Laboratory quality control information from the primary laboratory indicates an acceptable degree of QA/QC information was collected and reported with the data providing confidence in the accuracy and precision of reported results.

4 CONCLUSIONS

The groundwater investigation of regional bores conducted in May 2007 in the vicinity of the old Kanmantoo Mine was undertaken to establish background groundwater quality prior to the proposed recommencement of mining by Hillgrove Resources at the Old Kanmantoo mine site. The groundwater investigation targeted eight nearby regional groundwater bores.

The salinity of groundwater sampled from the regional bores indicates that the likely beneficial uses of groundwater include industrial and livestock water supply. Aquatic ecosystems is an additional potential beneficial use of groundwater when discharging to down hydraulic gradient creek lines. Groundwater salinity trends will be confirmed in subsequent monitoring events.

Groundwater analytical results identified concentrations of cadmium, copper, manganese, mercury and zinc marginally above either the SA EPA (2003) Freshwater Ecosystem or Potable use criteria for groundwater sampled from one or more targeted bores. Groundwater sampled from three monitoring wells reported iron concentrations above the SA EPA (2003) irrigation criteria. In addition elevated concentrations of fluoride were reported above the SA EPA (2003) Livestock and Potable use criteria in groundwater sampled from six of the eight targeted regional bores and most likely are reflective of natural background levels.

Groundwater analytical results for May 2007 where generally consistent with that reported previously with marginally elevated metals reflective of natural background metals due to the parent rock formation in this area. Ongoing groundwater monitoring is recommended to provide a longer term comprehensive background groundwater quality dataset.

5 RECOMMENDATIONS

Based on the findings of the groundwater background groundwater quality investigation of regional bores, the following recommendations are provided:

- Ongoing groundwater requirements should be incorporated into a groundwater monitoring and management plan (GMMP) prepared for the site. The GMMP should cover pre, operational and post mine development requirements.

- Undertake six monthly groundwater monitoring of targeted regional bores pre mining development to provide a longer term comprehensive background groundwater quality dataset.

6 REFERENCES

South Australian Environmental Protection Authority. 2003. *Environment Protection (Water Quality) Policy and Explanatory Report*. 2003.

Parsons Brinckerhoff. 2006. *Kanmantoo Mine – Background Groundwater Quality Investigation. Prepared for Hillgrove Resources*. July 2006

7 LIMITATIONS

This report has been prepared in accordance with the program outlined in the proposal prepared for Hillgrove Resources, dated 3 May 2007. The services performed by REM have been conducted in a manner consistent with the level of quality and skills generally exercised by members of its profession and consulting practice. No warranty or guarantee of site conditions is intended. This report shall only be presented in full and may not be used to support any other objectives than those set out in the report, except where written approval with comments are provided by REM.

The information in this report is considered to be accurate with respect conditions encountered at the site at the time of investigation and considering the inherent limitations associated with extrapolating information from a sample set. Subsurface conditions (including contaminant concentrations) can vary across a particular site and no practical degree of sampling can ever eliminate the possibility that conditions may be present at a site that have not been represented through sampling.

Since subsurface conditions (including contamination concentrations) can change within a limited period of time and space, this inherent limitation to the representation of site conditions provided by this report should always be taken into consideration particularly if the report is used after a delay in time.

Tables

Table 1. Regional Bore Details and Water Level Elevation Data
Hillgrove Resources - Kanmantoo Copper Project

Well	Eastings*	Northings*	Depth of Well (m PVC)	Water Levels (m PVC) 14 May 2007	Comments
6627-5847	316662	6116711	-	-	Windmill-no access
6727-00683	319138	6112192	-	-	Bore pump-diesel motor
GW1	317026	6115934	-	-	Sampled with disposable bailer
GW2	319126	6113697	43	14.5	Filmers Bore-pumped
GW3	318125	6113233	-	-	Auberys Bore-tank trough
GW5	316334	6119141	-	-	Bore not equiped-sampled with dispos
GW6	317660	6118105	-	-	Nakervills Bore-well obstructed or dry
GW7	319759	6114622	-	24	Pumped
GW8	318240	6116795	~120	28.74	Pumped
GW10	319274	6116735	-	14.23	Meltara Nursery Bore-sampled from

Note
* GPS co-ordinates
~ approximate (informed approx 400 feet)

Table 2. Summary of Groundwater Field Parameters (May 2007)
Hillgrove Resources - Kanmantoo Copper Project

Well	pH		Electrical Conductivity (mS/cm)		Total Dissolved Solids (mg/L)		Redox (mV)		Temperature (°C)
	Apr-06	May-07	Apr-06	May-07	Apr-06	May-07	Apr-06	May-07	May-07
6727-00683	-	8.04	-	4.12	-	2,678	-	-52	18.2
GW1	7.33*	7.54	6.24*	10.49	4,056	6,819	182*	54	16.8
GW2	7.6*	8.09	5.99*	8.28	3,894	5,382	175*	15	18.0
GW3	7.58*	7.34	6.15*	8.33	3,998	5,415	161*	90	16.5
GW5	6.78*	7.42	4.41*	8.01	2,867	5,207	- 158*	-18	16.8
GW7	7.41	7.33	4.1	4.58	2,665	2,977	-8	14	16.6
GW8	7.88	6.91	0.254	6.25	165	4,063	35	18	18.2
GW10	8.25	8.63	1.595	1.89	1,037	1,229	160	43	14.9

Note
TDS calculated by multiplying EC by a factor of 650
* Data was recorded July-06

Table 3: Summary of Groundwater Analytical Results - Metals
Hillgrove Resources Regional Bores EZ-04
May-07

Sample	Sample Date	Analyte	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Vanadium	Zinc
		ALS LOR	0.001	0.001	0.001	0.0001	0.001	0.001	0.001		0.001	0.001	0.0001	0.001		0.01	0.005
		Labmark EQL	0.001			0.0001	0.001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.005	0.001	0.005
		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	mg/l	mg/l	mg/l
		SA EPA EPP (Water Quality) 2003 Potable Use	0.007	0.7		0.002			2		0.01	0.5	0.001	0.02	0.01		
		SA EPA EPP (Water Quality) 2003 Irrigation	0.1		0.1	0.01	1	0.05	0.2	1	0.2	2	0.002	0.2	0.02	0.1	
		SA EPA EPP (Water Quality) 2003 Livestock	0.5		0.1	0.01	1	1	0.5		0.1		0.002	0.1	0.02	0.1	
		SA EPA EPP (Water Quality) 2003 Aquatic Ecosystems - Fresh	0.05		0.004	0.002			0.01	1	0.005		0.0001	0.15	0.005		0.05
Sample	**Sample Date**	**Lab Report**															
6727-00683(Labelled 10025)	**15-May-07**	**E031995**	***<0.01**	**-**	**-**	**0.0008**	***<0.005**	**0.01**	***<0.005**	**4.4**	**<0.001**	**0.41**	**0.0001**	**0.007**	**<0.005**	**<0.001**	**0.25**
GW01	11-Apr-06	-	<0.005	-	-	<0.005	0.034	0.009	0.042	<0.1	<0.005	0.18	<0.001	0.027	0.18	-	0.22
	14-May-07	**E031995**	***<0.01**	**-**	**-**	**0.0007**	***<0.005**	**<0.001**	**0.008**	**<0.05**	**<0.001**	**0.003**	**0.0002**	**0.012**	**0.005**	**<0.001**	**0.39**
GW02	11-Apr-06	-	<0.005	-	-	<0.005	0.006	<0.005	0.01	0.3	<0.005	0.093	<0.001	<0.005	0.037	-	0.3
	15-May-07	**E031995**	***<0.01**	**-**	**-**	**<0.0001**	***<0.005**	**<0.001**	**0.007**	**0.08**	**<0.001**	**0.019**	**0.0002**	**0.003**	**<0.005**	**<0.001**	**0.017**
GW03	11-Apr-06	-	<0.005	-	-	<0.005	<0.005	<0.005	0.24	<0.1	<0.005	0.049	<0.001	0.019	0.043	-	0.78
	15-May-07	**E031995**	***<0.01**	**-**	**-**	**0.0053**	***<0.005**	**<0.001**	**0.078**	**<0.05**	**<0.001**	**0.067**	**0.0002**	**0.016**	**<0.005**	**<0.001**	**0.63**
GW04	11-Apr-06	-	<0.005	-	-	<0.005	0.005	<0.005	0.028	<0.1	<0.005	<0.005	<0.001	<0.005	0.034	-	0.032
GW05	24-Apr-06	-	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	2.9	<0.005	0.12	<0.001	0.008	0.014	-	<0.005
	15-May-07	**E031995**	***<0.01**	**-**	**-**	**<0.0001**	***<0.005**	**0.002**	***<0.005**	**2.2**	**<0.001**	**0.14**	**0.0002**	**0.003**	**<0.005**	**<0.001**	**0.015**
GW06	24-Apr-06	-	0.008	-	-	<0.005	<0.005	<0.005	<0.005	0.1	<0.005	0.2	<0.001	<0.005	0.026	-	0.012
GW07	24-Apr-06	-	<0.005	-	-	<0.005	<0.005	<0.005	0.007	0.4	<0.005	0.7	<0.001	0.006	0.011	-	0.031
	15-May-07	**E031995**	***<0.01**	**-**	**-**	**<0.0001**	***<0.005**	**0.002**	***<0.005**	**0.52**	**<0.001**	**0.65**	**0.0001**	**0.006**	**<0.005**	**<0.001**	**0.014**
GW08	24-Apr-06	-	<0.005	-	-	<0.005	<0.005	<0.005	0.031	<0.1	<0.005	0.012	<0.001	<0.005	<0.005	-	0.008
Primary	**14-May-07**	**E031995**	***<0.01**	**-**	**-**	**<0.0001**	***<0.005**	**0.011**	**0.003**	**3.6**	**<0.001**	**0.55**	**0.0001**	**0.011**	**<0.005**	**<0.001**	**0.016**
Intra-Dup1	**14-May-07**	**E031995**	***<0.01**	**-**	**-**	**<0.0001**	***<0.005**	**0.011**	**0.003**	**3.6**	**<0.001**	**0.53**	**0.0001**	**0.011**	**<0.005**	**<0.001**	**0.015**
Inter-GW08	**14-May-07**	**EM0703586**	**0.004**	**0.021**	**0.002**	**0.0002**	**<0.001**	**0.012**	**0.002**	**-**	**<0.001**	**0.596**	**<0.0001**	**0.011**	**-**	**<0.01**	**0.016**
GW09	24-Apr-06	-	<0.005	-	-	<0.005	<0.005	<0.005	0.011	<0.1	<0.005	<0.005	<0.001	<0.005	0.016	-	0.014
GW10	24-Apr-06	-	<0.005	-	-	<0.005	<0.005	<0.005	0.006	<0.1	<0.005	0.046	<0.001	<0.005	0.005	-	0.033
	14-May-07	**E031995**	**<0.001**	**-**	**-**	**<0.0001**	***<0.005**	**<0.001**	**0.005**	**<0.05**	**0.001**	**<0.001**	**<0.0001**	**0.002**	**<0.005**	**<0.001**	**0.11**

Notes

Analyte Concentration in Excess of Adopted Assessment Criteria

LOR Limit of reporting
* EQL increased due to matrix interface
**6727-00683 labelled as 10025 - Certified Laboratory Report (Appendix B)

Table 4: Summary of Groundwater Analytical Results - Total Cyanide, Major Anions and Cations and Alkalinity

Hillgrove Resources Regional Bores EZ-04

May-07

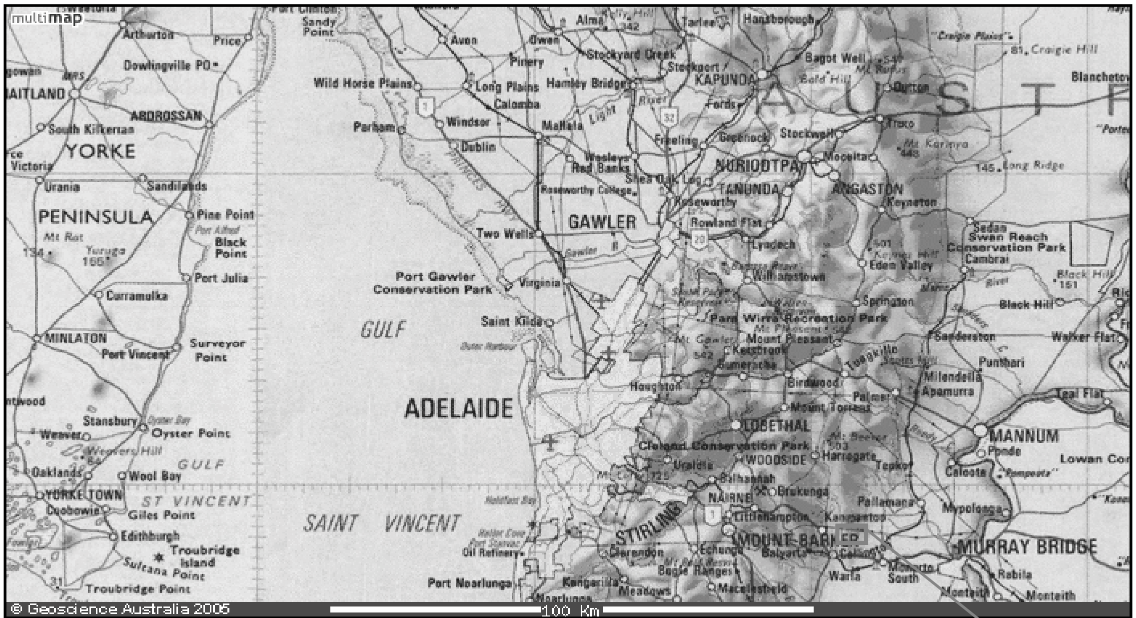
Sample	Sample Date	Analyte	Total Cyanide	Total Alkalinity	Chloride	Flouride	Sulphate	Nitrite as N	Nitrate as N	Calcium	Magnesium	Potassium	Sodium
		LOR	0.005	5	1	0.1	2	0.01	0.01	0.1	0.1	0.1	0.1
		Units	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
		SA EPA EPP (Water Quality) 2003 Potable Use	0.08			1.5	500	1	10				
		SA EPA EPP (Water Quality) 2003 Irrigation				1							
		SA EPA EPP (Water Quality) 2003 Livestock				2	1000	10	30				
		SA EPA EPP (Water Quality) 2003 Aquatic Ecosystems - Fresh											
Sample	**Sample Date**	**Lab Report**											
6727-00683(Labelled 10025)	**15-May-07**	**E031995**	**<0.005**	**290**	**760**	**2.4**	**400**	**<0.01**	**0.01**	**31**	**58**	**41**	**629**
GW01	11-Apr-06	-	<0.005	920	2700	-	400	-	1.4	130	280	100	1900
	14-May-07	**E031995**	**<0.005**	**1060**	**3330**	**2.5**	**440**	**<0.01**	**3.3**	**94**	**183**	**66**	**1850**
GW02	11-Apr-06	-	<0.005	540	1500	-	310	-	<0.5	64	110	60	1000
	15-May-07	**E031995**	**<0.005**	**420**	**1610**	**3.2**	**500**	**<0.01**	**0.32**	**59**	**88**	**45**	**1220**
GW03	11-Apr-06	-	<0.005	316	1300	-	400	-	7.4	36	71	69	1000
	15-May-07	**E031995**	**<0.005**	**270**	**2140**	**2.5**	**490**	**<0.01**	**0.76**	**36**	**70**	**62**	**1340**
GW04	11-Apr-06	-	<0.005	470	910	-	220	-	1.4	120	130	50	720
GW05	24-Apr-06	-	<0.005	530	1700	-	440	-	<0.5	56	98	61	1400
	15-May-07	**E031995**	**<0.005**	**480**	**1170**	**0.7**	**340**	**<0.01**	**0.02**	**61**	**109**	**58**	**1350**
GW06	24-Apr-06	-	<0.005	1100	3200	-	360	-	<0.5	260	290	100	1900
GW07	24-Apr-06	-	<0.005	440	920	-	150	-	<0.5	86	100	55	570
	15-May-07	**E031995**	**<0.005**	**390**	**1340**	**2.1**	**200**	**<0.01**	**0.01**	**92**	**108**	**55**	**618**
GW08	24-Apr-06	-	<0.005	110	76	-	15	-	<0.5	12	8.9	3.2	52
Primary	**14-May-07**	**E031995**	**0.007**	**370**	**1490**	**1.9**	**660**	**<0.01**	**<0.01**	**95**	**140**	**65**	**938**
Intra-Dup1	**14-May-07**	**E031995**	**<0.005**	**400**	**1600**	**1.9**	**660**	**<0.01**	**<0.01**	**94**	**139**	**66**	**952**
Inter-GW08	**14-May-07**	**EM0703586**	**0.005**	**353**	**1440**	**-**	**724**	**-**	**-**	**93**	**146**	**74**	**927**
GW09	24-Apr-06	-	<0.005	396	640	-	120	-	2.6	47	60	29	430
GW10	24-Apr-06	-	<0.005	250	200	-	81	-	22	46	30	11	230
	14-May-07	**E031995**	**<0.005**	**220**	**280**	**0.7**	**99**	**<0.01**	**2.5**	**49**	**30**	**11**	**240**

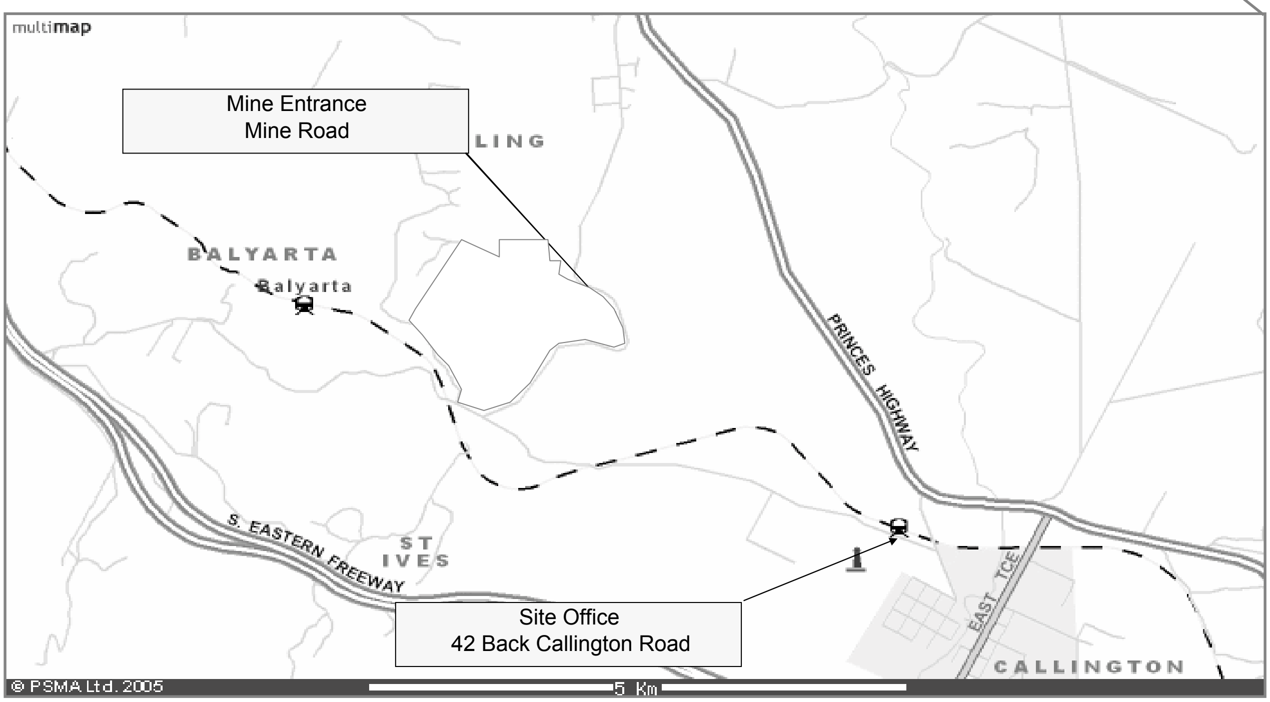
Notes

Analyte Concentration in Excess of Adopted Assessment Criteria

LOR Limit of reporting
* EQL increased due to matrix interface

Figures





Maps Source: www.multimap.com and www.whereis.com

Approximate Site Boundary

N

P:/Hillgrove Resources (EZ)/04-Regional Bores/Sampling May07/Figures/Site Location

rem

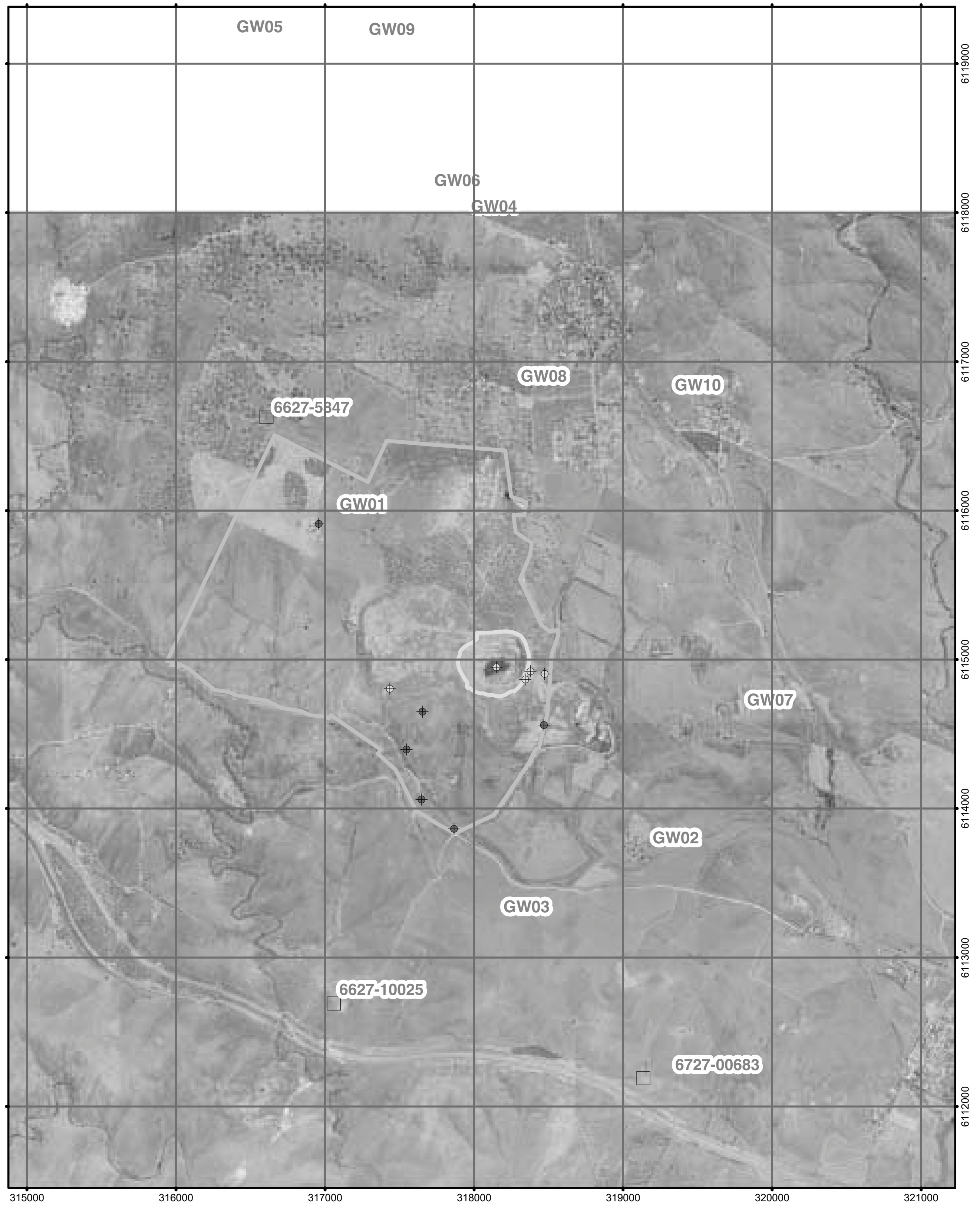
SITE LOCALITY PLAN
HILLGROVE RESOURCES

FIGURE

1

Project: EZ-04

May-07



Legend

- Water Supply Wells
- Regional Bores
- Monitoring Wells
- DWLBC Wells

0 0.25 0.5 1 1.5 2 Kilometres

N

R:/GIS/Hillgrove Resources/04 Regional Wells/Well Location

rem

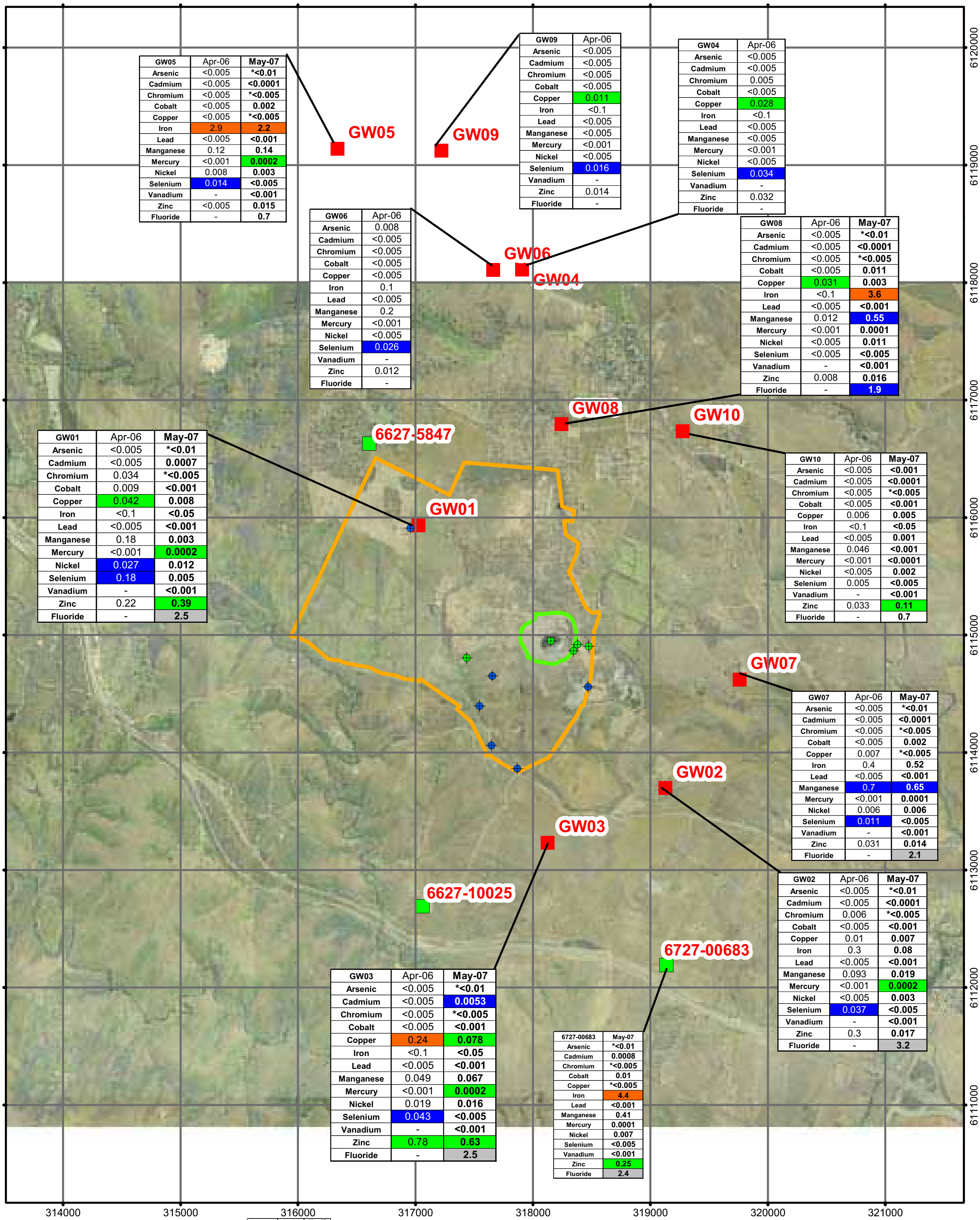
REGIONAL GROUNDWATER BORE LOCATION PLAN

Project: EZ-04

Figure

2

May 2007



GW05	Apr-06	May-07
Arsenic	<0.005	*<0.01
Cadmium	<0.005	<0.0001
Chromium	<0.005	*<0.005
Cobalt	<0.005	0.002
Copper	<0.005	*<0.005
Iron	2.9	2.2
Lead	<0.005	<0.001
Manganese	0.12	0.14
Mercury	<0.001	0.0002
Nickel	0.008	0.003
Selenium	0.014	<0.005
Vanadium	-	<0.001
Zinc	<0.005	0.015
Fluoride	-	0.7

GW09	Apr-06
Arsenic	<0.005
Cadmium	<0.005
Chromium	<0.005
Cobalt	<0.005
Copper	0.011
Iron	<0.1
Lead	<0.005
Manganese	<0.005
Mercury	<0.001
Nickel	<0.005
Selenium	0.016
Vanadium	-
Zinc	0.014
Fluoride	-

GW04	Apr-06
Arsenic	<0.005
Cadmium	<0.005
Chromium	0.005
Cobalt	<0.005
Copper	0.028
Iron	<0.1
Lead	<0.005
Manganese	<0.005
Mercury	<0.001
Nickel	<0.005
Selenium	0.034
Vanadium	-
Zinc	0.032
Fluoride	-

GW06	Apr-06
Arsenic	0.008
Cadmium	<0.005
Chromium	<0.005
Cobalt	<0.005
Copper	<0.005
Iron	0.1
Lead	<0.005
Manganese	0.2
Mercury	<0.001
Nickel	<0.005
Selenium	0.026
Vanadium	-
Zinc	0.012
Fluoride	-

GW08	Apr-06	May-07
Arsenic	<0.005	*<0.01
Cadmium	<0.005	<0.0001
Chromium	<0.005	*<0.005
Cobalt	<0.005	0.011
Copper	0.031	0.003
Iron	<0.1	3.6
Lead	<0.005	<0.001
Manganese	0.012	0.55
Mercury	<0.001	0.0001
Nickel	<0.005	0.011
Selenium	<0.005	<0.005
Vanadium	-	<0.001
Zinc	0.008	0.016
Fluoride	-	1.9

GW01	Apr-06	May-07
Arsenic	<0.005	*<0.01
Cadmium	<0.005	0.0007
Chromium	0.034	*<0.005
Cobalt	0.009	<0.001
Copper	0.042	0.008
Iron	<0.1	<0.05
Lead	<0.005	<0.001
Manganese	0.18	0.003
Mercury	<0.001	0.0002
Nickel	0.027	0.012
Selenium	0.18	0.005
Vanadium	-	<0.001
Zinc	0.22	0.39
Fluoride	-	2.5

GW10	Apr-06	May-07
Arsenic	<0.005	<0.001
Cadmium	<0.005	<0.0001
Chromium	<0.005	*<0.005
Cobalt	<0.005	<0.001
Copper	0.006	0.005
Iron	<0.1	<0.05
Lead	<0.005	0.001
Manganese	0.046	<0.001
Mercury	<0.001	<0.0001
Nickel	<0.005	0.002
Selenium	0.005	<0.005
Vanadium	-	<0.001
Zinc	0.033	0.11
Fluoride	-	0.7

GW07	Apr-06	May-07
Arsenic	<0.005	*<0.01
Cadmium	<0.005	<0.0001
Chromium	<0.005	*<0.005
Cobalt	<0.005	0.002
Copper	0.007	*<0.005
Iron	0.4	0.52
Lead	<0.005	<0.001
Manganese	0.7	0.65
Mercury	<0.001	0.0001
Nickel	0.006	0.006
Selenium	0.011	<0.005
Vanadium	-	<0.001
Zinc	0.031	0.014
Fluoride	-	2.1

GW02	Apr-06	May-07
Arsenic	<0.005	*<0.01
Cadmium	<0.005	<0.0001
Chromium	0.006	*<0.005
Cobalt	<0.005	<0.001
Copper	0.01	0.007
Iron	0.3	0.08
Lead	<0.005	<0.001
Manganese	0.093	0.019
Mercury	<0.001	0.0002
Nickel	<0.005	0.003
Selenium	0.037	<0.005
Vanadium	-	<0.001
Zinc	0.3	0.017
Fluoride	-	3.2

GW03	Apr-06	May-07
Arsenic	<0.005	*<0.01
Cadmium	<0.005	0.0053
Chromium	<0.005	*<0.005
Cobalt	<0.005	<0.001
Copper	0.24	0.078
Iron	<0.1	<0.05
Lead	<0.005	<0.001
Manganese	0.049	0.067
Mercury	<0.001	0.0002
Nickel	0.019	0.016
Selenium	0.043	<0.005
Vanadium	-	<0.001
Zinc	0.78	0.63
Fluoride	-	2.5

6727-00683	May-07
Arsenic	*<0.01
Cadmium	0.0008
Chromium	*<0.005
Cobalt	0.01
Copper	*<0.005
Iron	4.4
Lead	<0.001
Manganese	0.41
Mercury	0.0001
Nickel	0.007
Selenium	<0.005
Vanadium	<0.001
Zinc	0.25
Fluoride	2.4

N

0 0.375 0.75 1.5 2.25 3 Kilometres

R:/GIS/Hillgrove Resources/04 Regional Bores/Metals Conc May07

Legend

- Regional Bores
- DWLBC Wells
- Water Supply Wells
- Monitoring Wells

GW03	Apr-06	May-07
Arsenic	<0.005	*<0.01
Cadmium	<0.005	0.0053
Chromium	<0.005	*<0.005
Cobalt	<0.005	<0.001
Copper	0.24	0.078
Iron	<0.1	<0.05
Lead	<0.005	<0.001
Manganese	0.049	0.067
Mercury	<0.001	0.0002
Nickel	0.019	0.016
Selenium	0.043	<0.005
Vanadium	-	<0.001
Zinc	0.78	0.63

Exceeding Selected SA EPA (2003) Guideline

- SA EPA (2003) Potable
- SA EPA (2003) Aquatic Ecosystems Fresh
- SA EPA (2003) Irrigation
- SA EPA (2003) Livestock

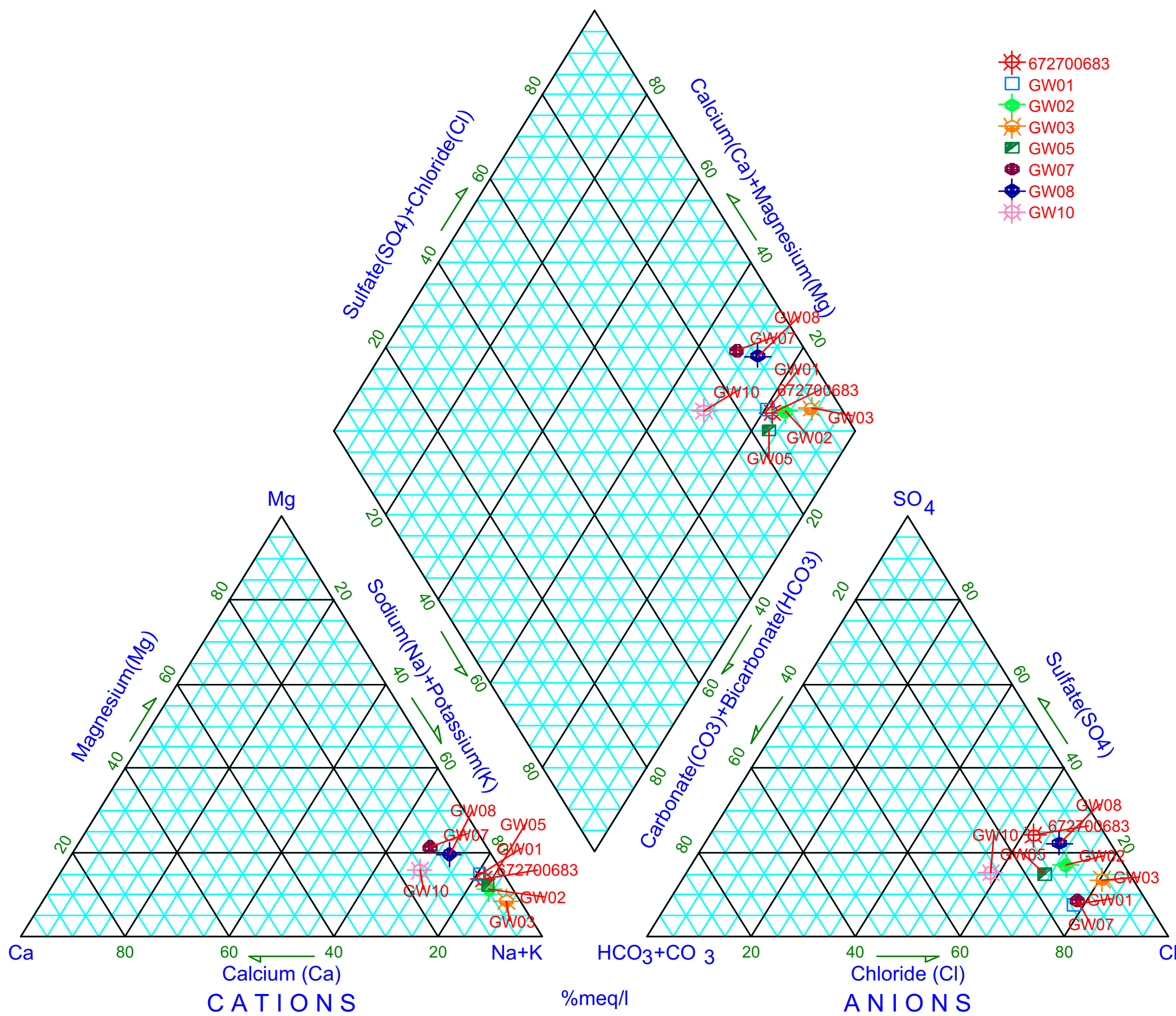
rem

REGIONAL GROUNDWATER BORES - METALS AND FLUORIDE CONCENTRATIONS (mg/L)

Project: EZ-04

Figure 3

May 2007



P:/Hillgrove Resources (EZ)/04 (Regional Bores)/Sampling May07/Tables/PiperPlot

rem

Regional Groundwater Bores - Piper Plot

FIGURE 4

PROJECT EZ-04

May-07

Appendix A

Groundwater Purge Sheets

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	EZ-02	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	727-00683
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):		Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 0319138	
61 12192	

Field Comments

Other Comments and Observations: r = H =

- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Bore pumped on diesel motor

Purging Information

Date: 15/5/07	Name: Volker Stroeher	
Method: Pumped	Tubing Material	Pump Depth
Start Time: 3:10	Finish Time	Pump Speed
Purge Volume (L)	No times purged	Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
3:38	500	8.04	4.12	-52	18.2	Clear, faint H_2S odour, no sheen

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date:		Name:
Method:	Tubing Material	Pump Depth
Start Time	Finish Time	Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name: V. Stroeher	Signature	Date 15/5/07
Sampler's Name: V. Stroeher	Signature	Date 15/5/07
Checked by: CP	Signature CP	Date 25/5/07

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	EZ-002	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	GW01
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):		Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 03170 26	
61 1159 34	

Field Comments

Other Comments and Observations: r = H =
- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Purging Information

Date: 5/5/07	Name: Volker Stroeher		
Method: Disposable bailer	Tubing Material Teflon	Pump Depth	
Start Time: 3:10	Finish Time 3:46	Pump Speed	
Purge Volume (L)	No times purged	Total Purge Volumes (litres)	

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
3:30	1	7.62	10.47	86	17.2	Clear, no odours/sheen
3:32	2	7.52	10.52	57	16.8	Clear, no odours/sheen
3:36	3	7.54	10.49	54	16.8	Clear, no odours/sheen

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date: Name:

Method: Tubing Material Pump Depth

Start Time Finish Time Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name:	V. Stroeher	Signature		Date	15/5/07
Sampler's Name:	V. Stroeher	Signature		Date	15/5/07
Checked by:	EP	Signature	EP	Date	25/5/07

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	EZ-02	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	GW02
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC): 14.50		Well depth (m-PVC)	43
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions: 54 0319126	
611 3694	

Field Comments

Other Comments and Observations: r = H =

- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Purging Information

Date: 15/5/07	Name: Volker Stroeher	
Method: Pumped Bore	Tubing Material	Pump Depth
Start Time: 2:40	Finish Time	Pump Speed
Purge Volume (L)	No times purged	Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
2:47	0.0	8.21	6.78	43	18.6	Clear, no odours/sheen
2:47	200	8.04	8.32	33	18.1	Clear, no odours/sheen
2:49	400	7.98	8.28	15	18.1	Clear, no odours/sheen
2:51	600	8.09	8.28	15	18.0	Clear, no odours/sheen

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date:		Name:
Method:	Tubing Material	Pump Depth
Start Time	Finish Time	Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name:	V. Stroeher	Signature		Date	15/5/07
Sampler's Name:	V. Stroeher	Signature		Date	15/5/07
Checked by:	EP	Signature		Date	25/5/07

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	E7-902	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	GW03
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):		Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 0318125	
6113233	

Field Comments

Other Comments and Observations: r = H =

- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Tank Trough (Auberys Bore)

Purging Information

Date: 14/5/07	Name: Volker Stroeher	
Method: Tank trough	Tubing Material	Pump Depth
Start Time: 4:10	Finish Time	Pump Speed
Purge Volume (L)	No times purged	Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
4:20	250 mL	7.32	8.47	89	17.1	Clear, no odours/sheen
4:22	+500 mL	7.34	8.33	90	16.5	Clear, no odours/sheen
4:24	+500 mL	7.34	8.33	90	16.5	Clear, no odours/sheen

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date:		Name:
Method:	Tubing Material	Pump Depth
Start Time	Finish Time	Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name:	V. Stroeher	Signature		Date	14/5/07
Sampler's Name:	V. Stroeher	Signature		Date	14/5/07
Checked by:	EP	Signature	EP	Date	25/5/07

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	62-02	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	GW05
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):		Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 0316334	
6 11 9141	

Field Comments

Other Comments and Observations: r = H =

- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Purging Information

Date: 15/5/07	Name: Volker Stroeher		
Method: Disposable bailer	Tubing Material		Pump Depth
Start Time: 2:00	Finish Time 2:30		Pump Speed
Purge Volume (L)	No times purged		Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
2:00	1	7.31	8.14	55	19.0	Clear, H_2S odour/sheen-(none)
2:02	2	7.40	8.15	9	17.3	Clear, H_2S odour/sheen-(none)
2:04	3	7.47	8.04	-19	16.9	Clear, H_2S odour/sheen-(none)
2:06	4	7.42	8.01	-18	16.8	Clear, H_2S odour/sheen-(none)

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date:		Name:
Method:	Tubing Material	Pump Depth
Start Time	Finish Time	Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name:	V. Stroeher	Signature		Date	15/5/07
Sampler's Name:	V. Stroeher	Signature		Date	15/5/07
Checked by:	EP	Signature	EP	Date	25/5/07

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	EZ -0/2	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	GW 06
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):		Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 0317660	
6 11 8105	

Field Comments

Other Comments and Observations: r = H =

- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Purging Information

Date: 15/5/07	Name: Volker Stroeher	
Method: Nakervills Bore	Tubing Material	Pump Depth
Start Time:	Finish Time	Pump Speed
Purge Volume (L)	No times purged	Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
		Well	is	dry		

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date: Name:

Method: Tubing Material Pump Depth

Start Time Finish Time Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name:	V. Stroeher	Signature		Date	15/5/07
Sampler's Name:	V. Stroeher	Signature		Date	15/5/07
Checked by:	EP	Signature	EP	Date	25/5/07

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	E2-002	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	GW 07
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):		Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 0319769	
61 114622	

Field Comments

Other Comments and Observations: r = H =

- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Purging Information

Date: 15/5/07	Name: Volker Stroeher	
Method: Pumped	Tubing Material	Pump Depth
Start Time:	Finish Time	Pump Speed
Purge Volume (L)	No times purged	Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
1:00	50	7.41	5.34	-43	18.2	Clear, H_2S odour/no sheen
1:10	150	7.30	4.71	-23	17.5	Clear, H_2S odour/no sheen
1:15	200	7.27	3.99	-2	17.0	Clear, H_2S odour/no sheen
1:20	250	8.01	4.69	-4	16.7	Clear, H_2S odour/no sheen
1:25	300	7.30	4.63	7	16.8	Clear, no odour/no sheen
1:30	350	7.33	4.58	14	16.7	Clear, no odour/no sheen
1:35	400	7.33	4.58	14	16.6	Clear, no odour/no sheen

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date: Name:

Method: Tubing Material Pump Depth

Start Time Finish Time Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name:	V. Stroeher	Signature		Date	15/5/07
Sampler's Name:	V. Stroeher	Signature		Date	15/5/07
Checked by:	EP	Signature	EP	Date	25/5/07

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	E2-002	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	GW08
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC): 28.74		Well depth (m-PVC) 121.92	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 031 8240	
61 16795	

Field Comments

Other Comments and Observations: r = R = H = h =

- Bore Conditions
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Purging Information

Date: 14/5/07	Name: Volker Stroeher		
Method: Pumped	Tubing Material		Pump Depth
Start Time: 2:00	Finish Time		Pump Speed
Purge Volume (L)	No times purged		Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Ceis)	Appearance (Colour / Odour / Turbidity)
2:09	10	7.03	7.04	46	17.1	Clear, H2S odour, no sheen
2:10	20	7.18	6.30	17	17.8	Clear, H2S odour, no sheen
2:19	30	6.96	6.27	18	18.2	Clear, no odour, no sheen
2:20	40	6.91	6.25	18	18.2	Clear, no odour, no sheen

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date: Name:

Method: Tubing Material Pump Depth

Start Time Finish Time Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name: V. Stroeher	Signature	Date	14 / 5 / 07
Sampler's Name: V. Stroeher	Signature	Date	14 / 5 / 07
Checked by:	Signature	Date	/ /

rem

DUP & INTERLAB SAMPLE

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	F2-02	Bore Locked (Y/N)	
Project:	Private Bore GMF	Well ID No.	GW 10
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):	14.23	Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 0319274	
61 16735	

Field Comments

Other Comments and Observations: r = H =
- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Purging Information

Date: 14/5/07	Name: Volker Stroeher		
Method: Grab Sample	Tubing Material		Pump Depth
Start Time:	Finish Time		Pump Speed
Purge Volume (L)	No times purged		Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
	10	7.76	1.903	48	15.0	Clear, no odour/sheen
	20	8.63	1.893	43	14.9	Clear, no odour/sheen
	30	8.63	1.892	43	14.9	Clear, no odour/sheen

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date:		Name:
Method:	Tubing Material	Pump Depth
Start Time	Finish Time	Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name: V. Stroeher	Signature	Date 14 / 5 / 07
Sampler's Name: V. Stroeher	Signature	Date 14 / 5 / 07
Checked by:	Signature	Date / /

rem

Bore Purging and Groundwater Sampling Data Sheet

General Information

Client:	Hillsgrove		
Job Number:	E7-002	Bore Locked (Y/N)	
Project:	Private Bore GME	Well ID No.	5847
Location:		Chem Kit No.	
Depth to Groundwater (m-TOSC):		Well depth (m-PVC)	
Depth to Groundwater (mPVC):		Free product thickness:	
Depth to Groundwater (m-BGL):		RL from TOC:	

Weather Conditions

Rain:	Wind Direction:
Temperature:	Wind Speed:
Cloud Cover:	Upwind Activities:
Location Conditions:	
54 0316662	
6116711	

Field Comments

Other Comments and Observations: r = H =

- Bore Conditions R = h =
- Fate of Tubing, etc. (left in hole/disposal)
- Purge Volume Calculations in Liters(screened & unscreened sections) PV =

$$PV = [(H \times \pi \times r^2) + 0.2(h \times \pi \times (R^2 - r^2))] \times 1000$$

where H = height of water column (m) R = Bore Radius (m) PV =

h = thickness of saturated filterpack (m) r = PVC Radius (m)

PV =

Windmill No Acess

Purging Information

Date: 15/5/07	Name: Volker Stroeher		
Method:	Tubing Material		Pump Depth
Start Time:	Finish Time		Pump Speed
Purge Volume (L)	No times purged		Total Purge Volumes (litres)

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
		NO SAMPLE				

Purging should continue until measurements for pH are within 0.1 pH unit, EC is within 3%, Redox is within 10mV and Temperature is within 0.5 degC of the previous set of parameters.

Sampling Information

Date: Name:

Method: Tubing Material Pump Depth

Start Time Finish Time Pump Speed

Time	Volume Removed (L)	pH	E.C. (mS/cm)	Redox (mV)	Temp (Cels)	Appearance (Colour / Odour / Turbidity)
			As Above			

Purger's Name:	V. Stroeher	Signature		Date	15/5/07
Sampler's Name:	V. Stroeher	Signature		Date	15/5/07
Checked by:	E Picken	Signature	EP	Date	25/5/07

rem

Appendix B

Certified Laboratory Analytical Reports – Groundwater

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

AQIS

AUSTRALIAN QUARANTINE AND INSPECTION SERVICE

SYDNEY License No. N0356.

Accredited for compliance with ISO/IEC 17025. The results of tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the APLAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

Quarantine Approved Premises criteria 5.1 for quarantine containment level 1 (QCI) facilities. Class five criteria cover premises utilised for research, analysis and testing of biological material, soil, animal, plant and human products.

FINAL CERTIFICATE OF ANALYSIS - ENVIRONMENTAL DIVISION

Laboratory Report No:	E031995	Cover Page 1 of 4 plus Sample Results
Client Name:	Resource and Environmental Management	
Client Reference:	EZ-02-02	
Contact Name:	Emily Picken	
Chain of Custody No:	ns	Date Received: 16/05/2007
Sample Matrix:	WATER	Date Reported: 29/05/2007

This Final Certificate of Analysis consists of sample results, DQI's, method descriptions, laboratory definitions, and internationally recognised NATA accreditation and endorsement. The DQO compliance relates specifically to QA/QC results as performed as part of the sample analysis, and may provide an indication of sample result quality. Transfer of report ownership from Labmark to the client shall only occur once full & final payment has been settled and verified. All report copies may be retracted where full payment has not occured within the agreed settlement period.

QUALITY ASSURANCE CRITERIA

Accuracy:	matrix spike:	1 in first 5-20, then 1 every 20 samples
	lcs, crm, method:	1 per analytical batch
	surrogate spike:	addition per target organic method
Precision:	laboratory duplicate:	1 in first 5-10, then 1 every 10 samples
	laboratory triplicate:	re-extracted & reported when duplicate RPD values exceed acceptance criteria
Holding Times:	soils, waters:	Refer to LabMark Preservation & THT table VOC's 14 days water / soil VAC's 7 days water or 14 days acidified VAC's 14 days soil SVOC's 7 days water, 14 days soil Pesticides 7 days water, 14 days soil Metals 6 months general elements Mercury 28 days
Confirmation:	target organic analysis:	GC/MS, or confirmatory column
Sensitivity:	EQL:	Typically 2-5 x Method Detection Limit (MDL)

QUALITY CONTROL GLOBAL ACCEPTANCE CRITERIA (GAC)

Accuracy:	spike, lcs, crm surrogate:	general analytes 70% - 130% recovery phenol analytes 50% - 130% recovery organophosphorous pesticide analytes 60% - 130% recovery phenoxy acid herbicides 50% - 130% recovery
	anion/cation bal:	+/- 10% (0-3 meq/l), +/- 5% (>3 meq/l)
Precision:	method blank:	not detected >95% of the reported EQL
	duplicate lab RPD (metals):	0-30% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)
	duplicate lab RPD:	0-50% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)

QUALITY CONTROL ANALYTE SPECIFIC ACCEPTANCE CRITERIA (ASAC)

Accuracy:	spike, lcs, crm surrogate:	analyte specific recovery data <3xsd of historical mean
Uncertainty:	spike, lcs:	measurement calculated from historical analyte specific control charts

RESULT ANNOTATION

Data Quality Objective	s:	matrix spike recovery	p:	pending	bcs:	batch specific lcs
Data Quality Indicator	d:	laboratory duplicate	lcs:	laboratory control sample	bmb:	batch specific mb
Estimated Quantitation Limit	t:	laboratory triplicate	crm:	certified reference material		
not applicable	r:	RPD relative % difference	mb:	method blank		

David Burns
Quality Control (Report signatory)
david.burns@labmark.com.au

Geoff Weir
Authorising Chemist (NATA signatory)
geoff.weir@labmark.com.au

Simon Mills
Authorising Chemist (NATA signatory)
simon.mills@labmark.com.au

This document is issued in accordance with NATA's accreditation requirements.

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

Environmental Laboratory Industry Group

Foundation Member

Laboratory Report: E031995

NEPC GUIDELINE COMPLIANCE - DQO

1. GENERAL

A. Results relate specifically to samples as received. Sample results are not corrected for matrix spike, lcs, or surrogate recovery data.

B. EQL's are matrix dependant and may be increased due to sample dilution or matrix interference.

C. Laboratory QA/QC samples are specific to this project.

D. Inter-laboratory proficiency results are available upon request. NATA accreditation details available at www.nata.asn.au.

E. VOC spikes & surrogates added to samples during extraction, SVOC spikes & surrogates added prior to extraction.

F. Recovery data outside GAC limits shall be investigated and compared to ASAC (historical mean +/- 3sd). If recovery data <20%, then the relevant results for that compound are considered not reliable.

G. Recovery data (ms, surrogate, crm, lcs) outside ASAC limits shall initiate an investigative action. Anomolous QC data is examined in conjunction with other QC samples and a final decision whether to accept or reject results is provided by the professional judgement of the senior analyst. The USEPA-CLP National Functional Guidelines are referred to for specific recommendations.

H. Extraction (preparation) date refers to the date that sample preparation was initiated. Note that certain methods not requiring sample preparation (eg. VOCs in water, etc) may report a common extraction and analysis date.

I. LabMark shall maintain an official copy of this Certificate of Analysis for all tracable reference purposes.

2. CHAIN OF CUSTODY (COC) & SAMPLE RECEIPT NOTICE (SRN) REQUIREMENTS

A. SRN issued to client upon sample receipt & login verification.

B. Preservation & sampling date details specified on COC and SRN, unless noted.

C. Sample Integrity & Validated Time of Sample Receipt (VTSR) Holding Times verified (preservation may extend holding time, refer to preservation chart).

3. NATA ACCREDITED METHODS

A. NATA accreditation held for each in-house method and sample matrix type reported, unless noted below (Refer to subcontracted test reports for NATA accreditation status).

B. NATA accredited in-house laboratory methods are referenced from NEPC, ASTM, modified USEPA / APHA documents. Corporate Accreditation No. 13542.

C. Subcontracted analyses: Refer to Sample Receipt Notice and additional DQO comments.

LabMark PTY LTD ABN 27 079 798 397
* SYDNEY: Unit 1, 8 Leighton Place Asquith NSW 2077
* Telephone: (02) 9476 6533 * Fax: (02) 9476 8219
* MELBOURNE: 116 Moray Street, South Melbourne VIC 3205
* Telephone: (03) 9686 8344 * Fax: (03) 9686 7344

4. QA/QC FREQUENCY COMPLIANCE TABLE SPECIFIC TO THIS REPORT

Matrix: **WATER**

Page:	Method:	Totals:	#d	%d-ratio	#t	#s	%s-ratio
1	Filtered mercury	9	1	11%	0	1	11%
2	Filtered metals	9	1	11%	0	1	11%
4	Total alkalinity	9	1	11%	0	0	0%
5	Chloride	9	1	11%	0	1	11%
6	Fluoride	9	1	11%	0	1	11%
7	Sulphate	9	1	11%	0	1	11%
8	Nitrite as N	9	1	11%	0	1	11%
8	Nitrate as N	9	1	11%	0	1	11%
10	Total Cyanide	9	1	11%	0	1	11%
11	Filtered metals	9	1	11%	0	1	11%
12	Major cations	9	1	11%	0	1	11%

GLOSSARY:

#d	number of discrete duplicate extractions/analyses performed.
%d-ratio	NEPC guideline for laboratory duplicates is 1 in 10 samples (min 10%).
#t	number of triplicate extractions/analyses performed.
#s	number of spiked samples analysed.
%s-ratio	USEPA guideline for laboratory matrix spikes is 1 in 20 samples (min 5%).

5. ADDITIONAL COMMENTS SPECIFIC TO THIS REPORT

A. All tests were conducted by LabMark Environmental Sydney, NATA accreditation No. 13542, Corporate Site No. 13535., unless indicated below.
B.Total Cyanide(water)Lab 88936 reported matrix spike <20%,corresponding LCS 123%.

LabMark PTY LTD ABN 27 079 798 397
* SYDNEY: Unit 1, 8 Leighton Place Asquith NSW 2077 * MELBOURNE: 116 Moray Street, South Melbourne VIC 3205
* Telephone: (02) 9476 6533 * Fax: (02) 9476 8219 * Telephone: (03) 9686 8344 * Fax: (03) 9686 7344

Laboratory Report: E031995

Laboratory QA/QC data shall relate specifically to this report, and may provide an indication of site specific sample result quality. LabMark DOES NOT report NON-RELEVANT BATCH QA/QC data. Acceptance of this self assessment certificate does not preclude any requirement for a QA/QC review by a accredited contaminated site EPA auditor, when and wherever necessary. Laboratory QA/QC self assessment references available upon request.

LabMark PTY LTD ABN 27 079 798 397

* SYDNEY: Unit 1, 8 Leighton Place Asquith NSW 2077
* Telephone: (02) 9476 6533 * Fax: (02) 9476 8219

* MELBOURNE: 116 Moray Street, South Melbourne VIC 3205
* Telephone: (03) 9686 8344 * Fax: (03) 9686 7344

Laboratory Identification		88936	88938	88939	88940	88941	88942	88943	88944	88945	88936d
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07
Laboratory Analysis Date		23/5/07	23/5/07	23/5/07	23/5/07	23/5/07	23/5/07	23/5/07	23/5/07	23/5/07	23/5/07
Method : E026.1											
Filtered mercury	**EQL**										
Mercury	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	<0.1	0.1	0.1

Results expressed in ug/l unless otherwise specified

Comments:

E026.1: Analysis by CV-ICP-MS or FIMS following BrCl pre-treatment.

Laboratory Identification		88936r	88938s	lcs	mb						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	22/5/07	22/5/07	22/5/07						
Laboratory Analysis Date		--	23/5/07	23/5/07	23/5/07						
Method : E026.1											
Filtered mercury	**EQL**										
Mercury	0.1	0%	100%	92%	<0.1						

Results expressed in ug/l unless otherwise specified

Comments:

E026.1: Analysis by CV-ICP-MS or FIMS following BrCl pre-treatment.

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07
Laboratory Analysis Date		22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07
Method : E022.1											
Filtered metals	**EQL**										
Arsenic	1	*<10	*<10	*<10	*<10	*<10	*<10	*<10	<1	*<10	*<10
Cadmium	0.1	0.8	0.7	<0.1	5.3	<0.1	<0.1	<0.1	<0.1	<0.1	0.8
Chromium	1	*<5	*<5	*<5	*<5	*<5	*<5	*<5	*<5	*<5	*<5
Cobalt	1	10	<1	<1	<1	2	2	11	<1	11	10
Copper	1	*<5	8	7	78	*<5	*<5	3	5	3	*<5
Lead	1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Manganese	1	410	3	19	67	140	650	550	<1	530	430
Nickel	1	7	12	3	16	3	6	11	2	11	7
Selenium	5	<5	5	<5	<5	<5	<5	<5	<5	<5	<5
Vanadium	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	5	250	390	17	630	15	14	16	110	15	250

Results expressed in ug/l unless otherwise specified

Comments: *EQL increased due to matrix interference. # Percent recovery not available due to significant background levels of analyte in sample.

E022.1: Filtered sample directly analysed by ICP-MS.

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	22/5/07	22/5/07	22/5/07						
Laboratory Analysis Date		--	22/5/07	22/5/07	22/5/07						
Method : E022.1											
Filtered metals	**EQL**										
Arsenic	1	--	87%	93%	<1						
Cadmium	0.1	0%	109%	91%	<0.1						
Chromium	1	--	82%	108%	<1						
Cobalt	1	0%	85%	103%	<1						
Copper	1	--	82%	98%	<1						
Lead	1	--	85%	100%	<1						
Manganese	1	5%	98%	115%	<1						
Nickel	1	0%	75%	94%	<1						
Selenium	5	--	109%	94%	<5						
Vanadium	1	--	82%	97%	<1						
Zinc	5	0%	#	90%	<5						

Results expressed in ug/l unless otherwise specified

Comments: *EQL increased due to matrix interference. # Percent recovery not available due to significant background levels of analyte in sample.

E022.1: Filtered sample directly analysed by ICP-MS.

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88944d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Laboratory Analysis Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Method : E035.1											
Total alkalinity	**EQL**										
Alkalinity	5	290	1060	420	270	480	390	370	220	400	220

Results expressed in mg/l unless otherwise specified

Comments:

E035.1: Determination by colour and/or by titration. Results expressed as CaCO3.

Laboratory Identification		**88944r**	**lcs**	**mb**							
Sample Identification		QC	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		--	--	--							
Laboratory Extraction (Preparation) Date		--	16/5/07	16/5/07							
Laboratory Analysis Date		--	16/5/07	16/5/07							
Method : E035.1											
Total alkalinity	**EQL**										
Alkalinity	5	0%	107%	<5							

Results expressed in mg/l unless otherwise specified

Comments:

E035.1: Determination by colour and/or by titration. Results expressed as CaCO3.

Final
Certificate
of Analysis

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Laboratory Analysis Date		18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07
Method : E033.1/E045.1/E047.1											
Chloride	**EQL**										
Chloride	1	760	3330	1610	2140	1170	1340	1490	280	1600	770

Results expressed in mg/l unless otherwise specified

Comments: # Percent recovery not available due to significant background levels of analyte in sample.

E033.1/E045.1/E047.1: Determination by colour and/or by Ion Chromatography. Sample filtered through a 0.45um filter prior to analysis.

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	16/5/07	16/5/07	16/5/07						
Laboratory Analysis Date		--	18/5/07	18/5/07	18/5/07						
Method : E033.1/E045.1/E047.1											
Chloride	**EQL**										
Chloride	1	1%	#	119%	<1						

Results expressed in mg/l unless otherwise specified

Comments: # Percent recovery not available due to significant background levels of analyte in sample.

E033.1/E045.1/E047.1: Determination by colour and/or by Ion Chromatography. Sample filtered through a 0.45um filter prior to analysis.

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Laboratory Analysis Date		18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07
Method : E034.1/E045.1 **Fluoride**	**EQL**										
Fluoride	0.1	2.4	2.5	3.2	2.5	0.7	2.1	1.9	0.7	1.9	2.4

Results expressed in mg/l unless otherwise specified

Comments:

E034.1/E045.1: Determined by FIA-Ion Selective Electrode and/or by Ion Chromatography. Samples filtered through a 0.45um filter prior to analysis.

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	16/5/07	16/5/07	16/5/07						
Laboratory Analysis Date		--	18/5/07	18/5/07	18/5/07						
Method : E034.1/E045.1 **Fluoride**	**EQL**										
Fluoride	0.1	0%	88%	94%	<0.1						

Results expressed in mg/l unless otherwise specified

Comments:

E034.1/E045.1: Determined by FIA-Ion Selective Electrode and/or by Ion Chromatography. Samples filtered through a 0.45um filter prior to analysis.

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Laboratory Analysis Date		18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07
Method : E042.1/E045.1/E056.1											
Sulphate	**EQL**										
Sulphate	2	400	440	500	490	340	200	660	99	660	400

Results expressed in mg/l unless otherwise specified

Comments:

E042.1/E045.1/E056.1: Determination by colour and/or by Ion Chromatography. Sample filtered through 0.45um prior to analysis.

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	16/5/07	16/5/07	16/5/07						
Laboratory Analysis Date		--	18/5/07	18/5/07	18/5/07						
Method : E042.1/E045.1/E056.1											
Sulphate	**EQL**										
Sulphate	2	0%	88%	105%	<2						

Results expressed in mg/l unless otherwise specified

Comments:

E042.1/E045.1/E056.1: Determination by colour and/or by Ion Chromatography. Sample filtered through 0.45um prior to analysis.

Client Name: Resource and Environmental Management

Contact Name: Emily Picken

Date: 29/05/07

Client Reference EZ-02-02

This report supercedes reports issued on: 23/05/07

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Laboratory Analysis Date		18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07
Method : E037.1/E051.1											
Nitrite as N	**EQL**										
NO2-N	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Method : E037.1/E051.1											
Nitrate as N	**EQL**										
NO3-N	0.01	0.01	3.3	0.32	0.76	0.02	0.01	<0.01	2.5	<0.01	0.01

Results expressed in mg/l unless otherwise specified

Comments: # Percent recovery not available due to significant background levels of analyte in sample.

E037.1/E051.1: Nitrate determined by colour. Sample filtered through 0.45um prior to analysis.
E037.1/E051.1: Nitrite determined by colour. Sample filtered through 0.45um prior to analysis.

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	16/5/07	16/5/07	16/5/07						
Laboratory Analysis Date		--	18/5/07	17/5/07	17/5/07						
Method : E037.1/E051.1 **Nitrite as N**	**EQL**										
NO2-N	0.01	--	98%	98%	<0.01						
Method : E037.1/E051.1 **Nitrate as N**	**EQL**										
NO3-N	0.01	0%	#	75%	<0.01						

Results expressed in mg/l unless otherwise specified

Comments: # Percent recovery not available due to significant background levels of analyte in sample.

E037.1/E051.1: Nitrate determined by colour. Sample filtered through 0.45um prior to analysis.
E037.1/E051.1: Nitrite determined by colour. Sample filtered through 0.45um prior to analysis.

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Laboratory Analysis Date		22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07
Method : E040.1/E054.1											
Total Cyanide	**EQL**										
Total Cyanide	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	<0.005	<0.005

Results expressed in mg/l unless otherwise specified

Comments: * Refer to comment in DQO certificate. -

E040.1/E054.1: Strong acid distillate collected in sodium hydroxide. Analysis by colour.

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	16/5/07	16/5/07	16/5/07						
Laboratory Analysis Date		--	22/5/07	16/5/07	16/5/07						
Method : E040.1/E054.1											
Total Cyanide	**EQL**										
Total Cyanide	0.005	--	*	123%	<0.005						

Results expressed in mg/l unless otherwise specified

Comments: * Refer to comment in DQO certificate. -

E040.1/E054.1: Strong acid distillate collected in sodium hydroxide. Analysis by colour.

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07	18/5/07
Laboratory Analysis Date		22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07
Method : E020.1/E030.1											
Filtered metals	**EQL**										
Iron	0.05	4.4	<0.05	0.08	<0.05	2.2	0.52	3.6	<0.05	3.6	4.4

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: Filtered sample directly analysed by AAS and/or by ICP-OES.

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	18/5/07	18/5/07	18/5/07						
Laboratory Analysis Date		--	22/5/07	22/5/07	22/5/07						
Method : E020.1/E030.1											
Filtered metals	**EQL**										
Iron	0.05	0%	98%	101%	<0.05						

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: Filtered sample directly analysed by AAS and/or by ICP-OES.

Final
Certificate
of Analysis

Client Name: Resource and Environmental Management
Contact Name: Emily Picken
Client Reference EZ-02-02
Date: 29/05/07
This report supercedes reports issued on: 23/05/07

Laboratory Identification		**88936**	**88938**	**88939**	**88940**	**88941**	**88942**	**88943**	**88944**	**88945**	**88936d**
Sample Identification		10025	GW01	GW02	GW03	GW05	GW07	GW08	GW10	DUP 1	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		15/5/07	14/5/07	15/5/07	15/5/07	15/5/07	15/5/07	14/5/07	14/5/07	15/5/07	--
Laboratory Extraction (Preparation) Date		16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07	16/5/07
Laboratory Analysis Date		22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07	22/5/07
Method : E020.1/E030.1											
Major cations	**EQL**										
Calcium	0.1	31	94	59	36	61	92	95	49	94	31
Magnesium	0.1	58	183	88	70	109	108	140	30	139	58
Sodium	0.1	629	1850	1220	1340	1350	618	938	240	952	632
Potassium	0.1	41	66	45	62	58	55	65	11	66	42

Results expressed in mg/l unless otherwise specified

Comments: # Percent recovery not available due to significant background levels of analyte in sample.

E020.1/E030.1: Sample directly analysed by Flame AAS and/or ICP-OES.

Client Name: Resource and Environmental Management

Contact Name: Emily Picken

Date: 29/05/07

Client Reference EZ-02-02

This report supercedes reports issued on: 23/05/07

Laboratory Identification		**88936r**	**88938s**	**lcs**	**mb**						
Sample Identification		QC	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		--	--	--	--						
Laboratory Extraction (Preparation) Date		--	16/5/07	16/5/07	16/5/07						
Laboratory Analysis Date		--	22/5/07	18/5/07	18/5/07						
Method : E020.1/E030.1											
Major cations	**EQL**										
Calcium	0.1	0%	#	104%	<0.1						
Magnesium	0.1	0%	#	100%	<0.1						
Sodium	0.1	0%	#	103%	<0.1						
Potassium	0.1	2%	#	106%	<0.1						

Results expressed in mg/l unless otherwise specified

Comments: # Percent recovery not available due to significant background levels of analyte in sample.

E020.1/E030.1: Sample directly analysed by Flame AAS and/or ICP-OES.

Report Date : 18/05/2007
Report Time : 11:06:59AM

Quality, Service, Support

Sample Receipt Notice (SRN) for E031995

Client Details		Laboratory Reference Information	
Client Name:	Resource and Environmental Management	**Please have this information ready when contacting Labmark.**	
Client Phone:	08 8363 1777	**Laboratory Report:**	**E031995**
Client Fax:	08 8363 1477	**Quotation Number:**	- Not provided, standard prices apply
Contact Name:	Emily Picken	**Laboratory Address:**	Unit 1, 8 Leighton Pl. Asquith NSW 2077
Contact Email:	emilypicken@rem.com.au	**Phone:**	61 2 9476 6533
Client Address:	Unit 9, 15 Fullarton Road Kent Town SA 5067	**Fax:**	61 2 9476 8219
Project Name:	EZ-02-02	**Sample Receipt Contact:**	Jakleen El Galada
Project Number:	- Not provided -	**Email:**	jakleen.galada@labmark.com.au
CoC Number:	- Not provided -	**Reporting Contact:**	Jyothi Lal
Purchase Order:	- Not provided -	**Email:**	jyothi.lal@labmark.com.au
Surcharge:	No surcharge applied (results by 6:30pm on due date)		
Sample Matrix:	WATER		
Date Sampled (earliest date):	14/05/2007	**NATA Accreditation:**	13542
Date Samples Received:	16/05/2007	**TGA GMP License:**	185-336 (Sydney)
Date Sample Receipt Notice issued:	18/05/2007	**APVMA License:**	6105 (Sydney)
Date Preliminary Report Due:	23/05/2007	**AQIS Approval:**	NO356 (Sydney)
		AQIS Entry Permit:	200521534 (Sydney)

Reporting Requirements: Electronic Data Download required: No

Sample Condition:
COC received with samples. Report number and lab ID's defined on COC.
Samples received in good order .
Samples received with cooling media: Crushed ice .
Samples received chilled.
Security seals not used .
Sample container & chemical preservation suitable .

Comments: Samples frozen in Melbourne lab to extend THT for nitrate analysis.

Holding Times:
Date received allows for sufficient time to meet Technical Holding Times.
Note: There are Samples within this batch that have been received by the laboratory 0 day(s) after Technical Holding Times expire. LabMark cannot guarantee THT compliance, refer to the extraction dates detailed in the sample grid for confirmation.

Preservation: Chemical preservation of samples satisfactory for requested analytes.

Important Notes:
LabMark shall responsibly dispose of spent customer soil and water samples which includes the disintegration of the sample label. A sample disposal fee of $1.00 is applicable on all samples received by the laboratory regardless of whether they have undergone analytical testing. Sample disposal of environmental samples shall be 31 days (water) and 3 months (soil, HN03 preserved samples) after laboratory receipt, unless otherwise requested in writing by the client. Samples requested to be held in non-refrigerated storage shall incur $5.00/ sample/ 3 months. Additional refrigerated storage shall incur $30/ sample/ 3 months. Combination prices apply only if requested. Transfer of report ownership from LabMark to the client shall occur once full and final payment has been settled and verified. All report copies may be retracted where full payment does not occur within the agreed settlement period.

Analysis comments:

Subcontracted Analyses:

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

Quality, Service, Support

Report Date : 18/05/2007
Report Time : 11:06:59AM

Sample **Receipt** Notice (SRN) for **E031995**

The table below represents LabMark's understanding and interpretation of the customer supplied sample COC request. Please confirm that your COC request has been entered correctly. Due to THT and TAT requirements, testing shall commence immediately as per this table, unless the customer intervenes with a correction prior to testing.

GRID REVIEW TABLE

No.	Date	Depth	Client Sample ID	Requested Analysis: Major cations	Chloride	Fluoride	Filtered mercury	Filtered metals	Filtered metals	Nitrite as N	Nitrate as N	NOx (as N)	PREP Not Reported	Sulphate	Total alkalinity	Total Cyanide							
88936	15/05		10025	●	●	●	●	●	●	●	●	●	●	●	●	●							
88938	14/05		GW01	●	●	●	●	●	●	●	●	●	●	●	●	●							
88939	15/05		GW02	●	●	●	●	●	●	●	●	●	●	●	●	●							
88940	15/05		GW03	●	●	●	●	●	●	●	●	●	●	●	●	●							
88941	15/05		GW05	●	●	●	●	●	●	●	●	●	●	●	●	●							
88942	15/05		GW07	●	●	●	●	●	●	●	●	●	●	●	●	●							
88943	14/05		GW08	●	●	●	●	●	●	●	●	●	●	●	●	●							
88944	14/05		GW10	●	●	●	●	●	●	●	●	●	●	●	●	●							
88945	15/05		DUP 1	●	●	●	●	●	●	●	●	●	●	●	●	●							
			Totals:	9	9	9	9	9	9	9	9	9	9	9	9	9							

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

LabMark

Quality, Service, Support

Report Date : 18/05/2007
Report Time : 11:06:59AM

Sample **Receipt** Notice (SRN) for E031995

No.	Date	Depth	Client Sample ID	Requested Analysis: M9 - MET-F_W	MET-F_W Manganese	MET-F_W Selenium	MET-F_W Vanadium	METF-AAS_W Iron
88936	15/05		10025	●	●	●	●	●
88938	14/05		GW01	●	●	●	●	●
88939	15/05		GW02	●	●	●	●	●
88940	15/05		GW03	●	●	●	●	●
88941	15/05		GW05	●	●	●	●	●
88942	15/05		GW07	●	●	●	●	●
88943	14/05		GW08	●	●	●	●	●
88944	14/05		GW10	●	●	●	●	●
88945	15/05		DUP 1	●	●	●	●	●
			Totals:	9	9	9	9	9

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

CHAIN OF CUSTODY FORM

rem
resource and environmental management

From : Resource and Environmental Management Pty Ltd
ACN: 098 08 877
Suite 9, 15 Fullarton Road, Kent Town
ph: (08) 8363 1777 fax: (08) 8363 1477

LAB USE ONLY
ALS QUOTE NUMBER ME/224/02
Job Code: E031995
Due Date:
Custody seal intact? Not used
Sample cold? Yes. 6°C
Received for Laboratory by: IAN
LABMARK
Date: 16/5/07
Time: 8:30 AM
Recd. Syd 17/5/07

Project No: EZ-02-02
Project Manager: Emily Picken
Sampler(s): Volker
Checked:
Date:

Container Identification

Size			
Type			
Preserv			
Analytes	MAJOR CATIONS & ANIONS	CN	Dissolved Metals: As, Cd, Se, Co, Cr, Un, Cu, Fe, Zn, Hg, Mn, Ni, Pb

Lab identification	Date	Time	Matrix	Sample Identification	Comments		Major cations & anions		CN		Dissolved metals
88936				10029 15/5			✓		✓		✓
88938				GW01 14/5			✓		✓		✓
88939				GW02 15/5			✓		✓		✓
88940				GW03 15/5			✓		✓		✓
88941				GW09 15/5			✓		✓		✓
88942				GW07 15/5			✓		✓		✓
88943				GW08 14/5			✓		✓		✓
88944				GW10 14/5			✓		✓		✓
88945				Dup1			✓		✓		✓

TOTAL

Comments CC: Volker into everything

Sheet of

COC-RevA Anions = Alk, Cl, F, SO_4, NO_2, NO_3

ALS Environmental

CERTIFICATE OF ANALYSIS

Client	: RESOURCE & ENVIRON MANGMNT P/L	*Laboratory*	: Environmental Division Melbourne	*Page*	: 1 of 4		
Contact	: MS EMILY PICKEN	*Contact*	: Paul Loewy	*Work Order*	: **EM0703586**		
Address	: UNIT 9, 15 FULLARTON RD KENT TOWN SA AUSTRALIA 5067	*Address*	: 4 Westall Rd Springvale VIC Australia 3171				
E-mail	: emilypicken@rem.net.au	*E-mail*	: paul.loewy@alsenviro.com				
Telephone	: 8363 1777	*Telephone*	: 61-3-8549 9600				
Facsimile	: 8363 1477	*Facsimile*	: 61-3-8549 9601				
Project	: E2-02-02	*Quote number*	: ME/122/06	*Date received*	: 16 May 2007		
Order number	: - Not provided -			*Date issued*	: 23 May 2007		
C-O-C number	: - Not provided -			*No. of samples*	-	*Received*	: 1
Site	: - Not provided -					*Analysed*	: 1

ALSE - Excellence in Analytical Testing

NATA

WORLD RECOGNISED ACCREDITATION

NATA Accredited Laboratory 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IEC 17025.

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	*Position*	*Department*
Dilani Fernando	Senior Inorganic Instrument Chemist	Inorganics - NATA 825 (13778 - Melbourne)
Terrance Hettipathirana	Senior ICP/MS Chemist	Inorganics - NATA 825 (13778 - Melbourne)

Comments

This report for the ALSE reference EM0703586 supersedes any previous reports with this reference. Results apply to the sample as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

Analytical Results for Samples Submitted
Surrogate Recovery Data

The analytical procedures used by ALS Environmental have been developed from established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

When moisture determination has been performed, results are reported on a dry weight basis. When a reported 'less than' result is higher than the LOR, this may be due to primary sample extracts/digestion dilution and/or insuffient sample amount for analysis. Surrogate Recovery Limits are static and based on USEPA SW846 or ALS-QWI/EN38 (in the absence of specified USEPA limits). Where LOR of reported result differ from standard LOR, this may be due to high moisture, reduced sample amount or matrix interference. When date(s) and/or time(s) are shown bracketed, these have been assumed by the laboratory for process purposes. Abbreviations: CAS number = Chemical Abstract Services number, LOR = Limit of Reporting. * Indicates failed Surrogate Recoveries.

Client : RESOURCE & ENVIRON MANGMNT P/L
Work Order : EM0703586

ALS Environmental

Analytical Results

Analyte	CAS number	LOR	Units	GW08_14/5				
Client Sample ID :				GW08_14/5				
Sample Matrix Type / Description :				WATER				
Sample Date / Time :				15 May 2007 15:00				
Laboratory Sample ID :				EM0703586-001				
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1				
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1				
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	353				
Total Alkalinity as CaCO3		1	mg/L	353				
ED040F: Dissolved Major Anions								
Sulphate as SO4 2-	14808-79-8	1	mg/L	724				
ED045P: Chloride by PC Titrator								
Chloride	16887-00-6	1	mg/L	1440				
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	93				
Magnesium	7439-95-4	1	mg/L	146				
Sodium	7440-23-5	1	mg/L	927				
Potassium	7440-09-7	1	mg/L	74				
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	0.004				
Beryllium	7440-41-7	0.001	mg/L	0.002				
Barium	7440-39-3	0.001	mg/L	0.021				
Cadmium	7440-43-9	0.0001	mg/L	0.0002				
Chromium	7440-47-3	0.001	mg/L	<0.001				
Cobalt	7440-48-4	0.001	mg/L	0.012				
Copper	7440-50-8	0.001	mg/L	0.002				
Lead	7439-92-1	0.001	mg/L	<0.001				
Manganese	7439-96-5	0.001	mg/L	0.596				
Nickel	7440-02-0	0.001	mg/L	0.011				
Vanadium	7440-62-2	0.01	mg/L	<0.01				
Zinc	7440-66-6	0.005	mg/L	0.016				
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001				
EK026: Total Cyanide								
Total Cyanide	57-12-5	0.005	mg/L	0.005				
EN055: Ionic Balance								
Total Anions		0.01	meq/L	62.8				
Total Cations		0.01	meq/L	58.9				
Ionic Balance		0.01	%	3.16				

Surrogate Control Limits

No surrogates present on this report.

ALS Environmental

QUALITY CONTROL REPORT

Client	: **RESOURCE & ENVIRON MANGMNT P/L**	**Laboratory**	: Environmental Division Melbourne	**Page**	: **1 of 8**
Contact	: MS EMILY PICKEN	**Contact**	: Paul Loewy		
Address	: UNIT 9, 15 FULLARTON RD KENT TOWN SA AUSTRALIA 5067	**Address**	: 4 Westall Rd Springvale VIC Australia 3171	**Work order**	: **EM0703586**
				Amendment No.	:
Project	: E2-02-02	**Quote number**	: ME/122/06	**Date received**	: **16 May 2007**
Order number	: - Not provided -			**Date issued**	: **23 May 2007**
C-O-C number	: - Not provided -				
Site	: - Not provided -				
E-mail	: emilypicken@rem.net.au	**E-mail**	: paul.loewy@alsenviro.com	**No. of samples**	
Telephone	: 8363 1777	**Telephone**	: 61-3-8549 9600	**Received**	: 1
Facsimile	: 8363 1477	**Facsimile**	: 61-3-8549 9601	**Analysed**	: 1

This final report for the ALSE work order reference EM0703586 supersedes any previous reports with this reference.

Results apply to the sample as submitted. All pages of this report have been checked and approved for release.

This report contains the following information:

- Laboratory Duplicates (DUP); Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Samples (LCS); Recovery and Acceptance Limits
- Matrix Spikes (MS); Recovery and Acceptance Limits

ALSE - Excellence in Analytical Testing

NATA Accredited Laboratory - 825

This document is issued in accordance with NATA's accreditation requirements.

Accredited for compliance with ISO/IED 17025

WORLD RECOGNISED ACCREDITATION

This document has been electronically signed by those names that appear on this report and are the authorised signatories. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatory	Department
Dilani Fernando	Inorganics - NATA 825 (13778 - Melbourne)
Terrance Hettipathirana	Inorganics - NATA 825 (13778 - Melbourne)

Quality Control Report - Laboratory Duplicates (DUP)

The quality control term **Laboratory Duplicate** refers to an intralaboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity.
- Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations:* ***LOR*** *= Limit of Reporting,* ***RPD*** *= Relative Percent Difference.*
* Indicates failed QC. The permitted ranges for the RPD of Laboratory Duplicates (relative percent deviation) are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting:- Result < 10 times LOR, no limit - Result between 10 and 20 times LOR, 0% - 50% - Result > 20 times LOR, 0% - 20%

Matrix Type: WATER ***Laboratory Duplicates (DUP) Report***

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
ED037P: Alkalinity by PC Titrator						
ED037P: Alkalinity by PC Titrator - (QC Lot: 411871)				**mg/L**	**mg/L**	**%**
EM0703600-003	Anonymous	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	215	222	3.1
		Total Alkalinity as CaCO3	1 mg/L	215	222	3.1
EM0703605-001	Anonymous	Hydroxide Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Carbonate Alkalinity as CaCO3	1 mg/L	<1	<1	0.0
		Bicarbonate Alkalinity as CaCO3	1 mg/L	209	190	9.3
		Total Alkalinity as CaCO3	1 mg/L	209	190	9.3
ED040F: Dissolved Major Anions						
ED040F: Dissolved Major Anions - (QC Lot: 411733)				**mg/L**	**mg/L**	**%**
EM0703542-001	Anonymous	Sulphate as SO4 2-	1 mg/L	132	132	0.0
EM0703588-005	Anonymous	Sulphate as SO4 2-	1 mg/L	129	128	0.9
ED045P: Chloride by PC Titrator						
ED045P: Chloride by PC Titrator - (QC Lot: 411873)				**mg/L**	**mg/L**	**%**
EM0703605-001	Anonymous	Chloride	1 mg/L	7290	7140	2.1
ED093F: Dissolved Major Cations						
ED093F: Dissolved Major Cations - (QC Lot: 411734)				**mg/L**	**mg/L**	**%**
EM0703542-001	Anonymous	Calcium	1 mg/L	11	11	0.0
		Magnesium	1 mg/L	22	22	0.0
		Sodium	1 mg/L	87	87	0.0
		Potassium	1 mg/L	23	23	0.0
EM0703590-001	Anonymous	Calcium	1 mg/L	6	6	0.0
		Magnesium	1 mg/L	1	1	0.0
		Sodium	1 mg/L	8	8	0.0
		Potassium	1 mg/L	3	3	0.0

Matrix Type: WATER *Laboratory Duplicates (DUP) Report*

Laboratory Sample ID	Client Sample ID	Analyte name	LOR	Original Result	Duplicate Result	RPD
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 411552)				mg/L	mg/L	%
EM0703533-001	Anonymous	Arsenic	0.001 mg/L	0.002	0.002	0.0
		Beryllium	0.001 mg/L	<0.001	<0.001	0.0
		Barium	0.001 mg/L	0.199	0.192	3.7
		Cadmium	0.0001 mg/L	<0.0001	<0.0001	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Cobalt	0.001 mg/L	<0.001	<0.001	0.0
		Copper	0.001 mg/L	<0.001	<0.001	0.0
		Lead	0.001 mg/L	<0.001	<0.001	0.0
		Manganese	0.001 mg/L	0.069	0.068	1.6
		Nickel	0.001 mg/L	<0.001	<0.001	0.0
		Vanadium	0.01 mg/L	<0.01	<0.01	0.0
		Zinc	0.005 mg/L	<0.005	<0.005	0.0
EM0703588-001	Anonymous	Arsenic	0.001 mg/L	<0.001	<0.001	0.0
		Beryllium	0.001 mg/L	<0.001	<0.001	0.0
		Barium	0.001 mg/L	0.016	0.016	0.0
		Cadmium	0.0001 mg/L	0.0006	0.0005	0.0
		Chromium	0.001 mg/L	<0.001	<0.001	0.0
		Cobalt	0.001 mg/L	0.035	0.031	10.5
		Copper	0.001 mg/L	0.002	0.002	0.0
		Lead	0.001 mg/L	0.002	0.002	0.0
		Manganese	0.001 mg/L	1.08	1.03	4.6
		Nickel	0.001 mg/L	0.013	0.012	0.0
		Vanadium	0.01 mg/L	<0.01	<0.01	0.0
		Zinc	0.005 mg/L	0.865	0.791	9.0
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 411701)				mg/L	mg/L	%
EM0703533-001	Anonymous	Mercury	0.0001 mg/L	<0.0001	<0.0001	0.0
EM0703588-001	Anonymous	Mercury	0.0001 mg/L	<0.0001	<0.0001	0.0
EK026: Total Cyanide						

Matrix Type: WATER

Laboratory Duplicates (DUP) Report

Laboratory Sample ID	*Client Sample ID*	*Analyte name*	*LOR*	*Original Result*	*Duplicate Result*	*RPD*
EK026: Total Cyanide - continued						
EK026: Total Cyanide - (QC Lot: 412232)				**mg/L**	**mg/L**	**%**
EM0703586-001	GW08_14/5	Total Cyanide	0.005 mg/L	0.005	0.006	0.0

Quality Control Report - Method Blank (MB) and Laboratory Control Samples (LCS)

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of actual laboratory data. Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. Abbreviations: LOR = Limit of reporting.

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	*LOR*			*LCS*	*Low*	*High*
ED037P: Alkalinity by PC Titrator						
ED037P: Alkalinity by PC Titrator - (QC Lot: 411871)		mg/L	mg/L	%	%	%
Total Alkalinity as CaCO3	1 mg/L	----	200	105	80	120
ED040F: Dissolved Major Anions						
ED040F: Dissolved Major Anions - (QC Lot: 411733)		mg/L	mg/L	%	%	%
Sulphate as SO4 2-	1 mg/L	----	300	100	90.3	116
	1 mg/L	<1	1	----	----	----
ED045P: Chloride by PC Titrator						
ED045P: Chloride by PC Titrator - (QC Lot: 411873)		mg/L	mg/L	%	%	%
Chloride	1 mg/L	----	50	110	89	117
	1 mg/L	<1	----	----	----	----
ED093F: Dissolved Major Cations						
ED093F: Dissolved Major Cations - (QC Lot: 411734)		mg/L	mg/L	%	%	%
Calcium	1 mg/L	<1	----	----	----	----
	1 mg/L	----	5	105	85	115
Magnesium	1 mg/L	----	5	102	84.8	115
	1 mg/L	<1	----	----	----	----
Potassium	1 mg/L	----	50	101	83.5	116
	1 mg/L	<1	----	----	----	----
Sodium	1 mg/L	----	50	95.2	88.5	113
	1 mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 411552)		mg/L	mg/L	%	%	%
Arsenic	0.001 mg/L	<0.001	----	----	----	----
	0.001 mg/L	----	0.1	97.0	84	111

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

Analyte name	*LOR*	*Method blank result*	*Actual Results* — *Spike concentration*	*Actual Results* — *Spike Recovery* — *LCS*	*Recovery Limits* — *Dynamic Recovery Limits* — *Low*	*Recovery Limits* — *Dynamic Recovery Limits* — *High*
EG020F: Dissolved Metals by ICP-MS - continued						
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 411552) - continued		mg/L	mg/L	%	%	%
Barium	0.001 mg/L	<0.001	----	----	----	----
	0.001 mg/L	----	0.1	93.7	80	113
Beryllium	0.001 mg/L	<0.001	----	----	----	----
	0.001 mg/L	----	0.1	97.7	80	119
Cadmium	0.0001 mg/L	----	0.1	95.2	85.8	120
	0.0001 mg/L	<0.0001	----	----	----	----
Chromium	0.001 mg/L	----	0.1	93.0	84.3	118
	0.001 mg/L	<0.001	----	----	----	----
Cobalt	0.001 mg/L	----	0.1	95.1	81.2	115
	0.001 mg/L	<0.001	----	----	----	----
Copper	0.001 mg/L	----	0.1	94.1	81.8	118
	0.001 mg/L	<0.001	----	----	----	----
Lead	0.001 mg/L	<0.001	----	----	----	----
	0.001 mg/L	----	0.1	99.1	84.4	116
Manganese	0.001 mg/L	----	0.1	96.7	82.5	117
	0.001 mg/L	<0.001	----	----	----	----
Nickel	0.001 mg/L	----	0.1	94.2	81.8	118
	0.001 mg/L	<0.001	----	----	----	----
Vanadium	0.01 mg/L	----	0.1	95.2	86.1	118
	0.01 mg/L	<0.01	----	----	----	----
Zinc	0.005 mg/L	----	0.1	98.5	87.4	119
	0.005 mg/L	<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS						
EG035F: Dissolved Mercury by FIMS - (QC Lot: 411701)		mg/L	mg/L	%	%	%
Mercury	0.0001 mg/L	----	0.0100	95.0	80.2	120
	0.0001 mg/L	<0.0001	----	----	----	----
EK026: Total Cyanide						
EK026: Total Cyanide - (QC Lot: 412232)		mg/L	mg/L	%	%	%

Matrix Type: WATER

Method Blank (MB) and Laboratory Control Samples (LCS) Report

		Method blank result	Actual Results		Recovery Limits	
			Spike concentration	Spike Recovery	Dynamic Recovery Limits	
Analyte name	*LOR*			*LCS*	*Low*	*High*
EK026: Total Cyanide - continued						
EK026: Total Cyanide - (QC Lot: 412232) - continued		mg/L	mg/L	%	%	%
Total Cyanide	0.005 mg/L	----	0.500	103	80.1	117
	0.005 mg/L	<0.005	----	----	----	----

Quality Control Report - Matrix Spikes (MS)

The quality control term **Matrix Spike (MS)** refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQO's). 'Ideal' recovery ranges stated may be waived in the event of sample matrix interferences. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot. *Abbreviations: **LOR** = Limit of Reporting, **RPD** = Relative Percent Difference.*

* Indicates failed QC

Matrix Type: WATER ***Matrix Spike (MS) Report***

Analyte name	*Laboratory Sample ID*	*Client Sample ID*	*LOR*	*Spike Concentration*	*Actual Results*		*Recovery Limits*	
					Sample Result	*Spike Recovery MS*	*Static Limits Low*	*Static Limits High*
EG020F: Dissolved Metals by ICP-MS								
EG020F: Dissolved Metals by ICP-MS - (QC Lot: 411552)				mg/L	mg/L	%	%	%
Arsenic	EM0703533-001	Anonymous	0.001 mg/L	0.2	0.002	119	70	130
Beryllium			0.001 mg/L	0.2	<0.001	115	70	130
Barium			0.001 mg/L	0.2	0.199	108	70	130
Cadmium			0.0001 mg/L	0.05	<0.0001	116	70	130
Chromium			0.001 mg/L	0.2	<0.001	108	70	130
Cobalt			0.001 mg/L	0.2	<0.001	119	70	130
Copper			0.001 mg/L	0.2	<0.001	114	70	130
Lead			0.001 mg/L	0.2	<0.001	105	70	130
Manganese			0.001 mg/L	0.2	0.069	108	70	130
Nickel			0.001 mg/L	0.2	<0.001	121	70	130
Vanadium			0.01 mg/L	0.2	<0.01	113	70	130
Zinc			0.005 mg/L	0.2	<0.005	122	70	130
EG035F: Dissolved Mercury by FIMS								
EG035F: Dissolved Mercury by FIMS - (QC Lot: 411701)				mg/L	mg/L	%	%	%
Mercury	EM0703559-001	Anonymous	0.0001 mg/L	0.0100	<0.0001	82.3	70	130
EK026: Total Cyanide								
EK026: Total Cyanide - (QC Lot: 412232)				mg/L	mg/L	%	%	%
Total Cyanide	EM0703593-012	Anonymous	0.005 mg/L	0.500	<0.005	99.4	70	130

ALS Environmental

INTERPRETIVE QUALITY CONTROL REPORT

Client	: **RESOURCE & ENVIRON MANGMNT P/L**	**Laboratory**	: Environmental Division Melbourne	**Page**	: **1 of 5**
Contact	: MS EMILY PICKEN	**Contact**	: Paul Loewy		
Address	: UNIT 9, 15 FULLARTON RD KENT TOWN SA AUSTRALIA 5067	**Address**	: 4 Westall Rd Springvale VIC Australia 3171	**Work order**	: **EM0703586**
				Amendment No.	:
Project	: E2-02-02	**Quote number**	: ME/122/06	**Date received**	: 16 May 2007
Order number	: - Not provided -			**Date issued**	: 23 May 2007
C-O-C number	: - Not provided -				
Site	: - Not provided -				
E-mail	: emilypicken@rem.net.au	**E-mail**	: paul.loewy@alsenviro.com	**No. of samples**	
Telephone	: 8363 1777	**Telephone**	: 61-3-8549 9600	**Received**	: 1
Facsimile	: 8363 1477	**Facsimile**	: 61-3-8549 9601	**Analysed**	: 1

This Interpretive Quality Control Report was issued on 23 May 2007 for the ALS work order reference EM0703586 and supersedes any previous reports with this reference.
This report contains the following information:

- Analysis Holding Time Compliance
- Quality Control Type Frequency Compliance
- Summary of all Quality Control Outliers
- Brief Method Summaries

Interpretive Quality Control Report - Analysis Holding Time

The following report summarises extraction / preparation and analysis times and compares with recommended holding times. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. Information is also provided re the sample container (preservative) from which the sample aliquot was taken. Elapsed time to analysis represents time from sampling where no extraction / digestion is involved or time from extraction / digestion where this is present. For composite samples, sampling date/time is taken as that of the oldest sample contributing to that composite. Sample date/time for laboratory produced leaches are taken from the completion date/time of the leaching process. Outliers for holding time are based on USEPA SW846, APHA, AS and NEPM (1999). Failed outliers, refer to the 'Summary of Outliers'.

Matrix Type: WATER — ***Analysis Holding Time and Preservation***

Method	**Date Sampled**	**Extraction / Preparation**			**Analysis**		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Pass?	Date analysed	Due for analysis	Pass?
ED037-P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural							
GW08_14/5	**15 May 2007**	**----**	----	----	**17 May 2007**	29 May 2007	Pass
ED040F: Major Anions - Filtered							
Clear Plastic Bottle - Natural							
GW08_14/5	**15 May 2007**	**----**	----	----	**18 May 2007**	12 Jun 2007	Pass
ED045-P: Chloride by PC Titrator							
Clear Plastic Bottle - Natural							
GW08_14/5	**15 May 2007**	**----**	----	----	**17 May 2007**	12 Jun 2007	Pass
ED093F: Major Cations - Filtered							
Clear Plastic Bottle - Natural							
GW08_14/5	**15 May 2007**	**----**	----	----	**18 May 2007**	12 Jun 2007	Pass
EG020A-F: Dissolved Metals by ICP-MS - Suite A							
Clear Plastic Bottle - Nitric Acid; Filtered							
GW08_14/5	**15 May 2007**	**----**	----	----	**17 May 2007**	11 Nov 2007	Pass
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered							
GW08_14/5	**15 May 2007**	----	----	----	**22 May 2007**	12 Jun 2007	Pass
EK026: Total Cyanide							
White Plastic Bottle - NaOH/Cadmium Nitrate							
GW08_14/5	**15 May 2007**	**18 May 2007**	29 May 2007	Pass	**21 May 2007**	29 May 2007	Pass

Interpretive Quality Control Report - Frequency of Quality Control Samples

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which this work order was processed. Actual rate should be greater than or equal to the expected rate.

Matrix Type: WATER — ***Frequency of Quality Control Samples***

Quality Control Sample Type / Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
ED037-P: Alkalinity by PC Titrator	2	20	**10.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED040F: Major Anions - Filtered	2	20	**10.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED045-P: Chloride by PC Titrator	2	20	**10.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED093F: Major Cations - Filtered	2	20	**10.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-F: Dissolved Metals by ICP-MS - Suite A	2	20	**10.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	2	20	**10.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EK026: Total Cyanide	1	4	**25.0**	**10.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Laboratory Control Samples (LCS)					
ED037-P: Alkalinity by PC Titrator	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED040F: Major Anions - Filtered	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED045-P: Chloride by PC Titrator	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED093F: Major Cations - Filtered	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EK026: Total Cyanide	1	4	**25.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Method Blanks (MB)					
ED040F: Major Anions - Filtered	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED045-P: Chloride by PC Titrator	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
ED093F: Major Cations - Filtered	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EK026: Total Cyanide	1	4	**25.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
Matrix Spikes (MS)					
ED045-P: Chloride by PC Titrator	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG020A-F: Dissolved Metals by ICP-MS - Suite A	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EG035F: Dissolved Mercury by FIMS	1	20	**5.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement
EK026: Total Cyanide	1	4	**25.0**	**5.0**	NEPM 1999 Schedule B(3) and ALSE QCS3 requirement

Interpretive Quality Control Report - Summary of Outliers

Outliers : Quality Control Samples

The following report highlights outliers flagged on the 'Quality Control Report'. Surrogate recovery limits are static and based on USEPA SW846 or ALS-QWI/EN/38 (in the absence of specific USEPA limits). Flagged outliers on control limits for inorganics tests may be within the NEPM specified data quality objective of recoveries in the range of 70 to 130%. Where this occurs, no corrective action is taken. - Anonymous - Client Sample IDs refer to samples which are not specifically part of this work order but formed part of the QC process lot.

Non-surrogates

For all matrices, no RPD recovery outliers occur for the duplicate analysis.

For all matrices, no method blank result outliers occur.

For all matrices, no laboratory spike recoveries breaches occur.

For all matrices, no matrix spike recoveries breaches occur.

Surrogates

For all matrices, no surrogate recovery outliers occur.

Outliers : Analysis Holding Time

The following report highlights outliers within this 'Interpretive Quality Control Report - Analysis Holding Time'.

No holding time outliers occur.

Outliers : Frequency of Quality Control Samples

The following report highlights outliers within this 'Interpretive Quality Control Report - Frequency of Quality Control Samples'.

No frequency outliers occur.

Method Reference Summary

The analytical procedures used by ALS Environmental are based on established internationally-recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house procedure are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported herein. Reference methods from which ALSE methods are based are provided in parenthesis.

Matrix Type: WATER ***Method Reference Summary***

Preparation Methods

EK026-PR : Total Cyanide - APHA 21st ed., 4500 CN- C&N. The sample is distilled with H_2SO_4 releasing all bound cyanides as HCN. The CN is trapped in a caustic solution, and quanitified by colourimetry on FIA. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

Analytical Methods

ED037-P : Alkalinity by PC Titrator - APHA 21st ed., 2320 B This procedure determines alkalinity by both manual measurement and automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

ED040F : Major Anions - Filtered - APHA 21st ed., 3120 Sulphur and Silcon content is determined by ICP/AES and reported as Sulphate after conversion by gravimetric factor.

ED045-P : Chloride by PC Titrator - APHA 21st ed., 4500 Cl - B. Automated Silver Nitrate titration.

ED093F : Major Cations - Filtered - APHA 21st ed., 3120; USEPA SW 846 - 6010 The ICPAES technique ionises filtered sample atoms emitting a characteristic spectrum. This spectrum is then compared against matrix matched standards for quantification. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EG020A-F : Dissolved Metals by ICP-MS - Suite A - (APHA 21st ed., 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020): The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

EG035F : Dissolved Mercury by FIMS - AS 3550, APHA 21st ed. 3112 Hg - B (Flow-injection ($SnCl_2$)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by $SnCl_2$ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EK026 : Total Cyanide - APHA 21st ed., 4500-CN-C & N Total Cyanide is determined from aqueous solutions after distillation with sulphuric acid. The resultant distillate is then captured in a caustic absorber solution followed by FIA. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

EN055 : Ionic Balance - APHA 21st Ed. 1030F. This method is compliant with NEPM (1999) Schedule B(3) (Appdx. 2)

AUSTRALIAN LABORATORY SERVICES PTY LTD ABN 84 009 936 029
4 Westall Rd Springvale VIC 3171 Australia
Telephone: 61-3-8549 9600 Facsimile: 61-3-8549 9601 http://www.alsenviro.com/

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Comprehensive report

Client Details

Client	:	**RESOURCE & ENVIRON MANGMNT P/L**
Contact	:	**MS EMILY PICKEN**
Address	:	UNIT 9, 15 FULLARTON RD KENT TOWN SA AUSTRALIA 5067
Project	:	**E2-02-02**
Order number	:	**- Not provided -**
C-O-C Number	:	**- Not provided -**
Site	:	**- Not provided -**
Sampler	:	**VS**
E-mail	:	emilypicken@rem.net.au
Telephone	:	8363 1777
Facsimile	:	8363 1477

Laboratory Details

Laboratory	:	**Environmental Division Melbourne**
Manager	:	**Paul Loewy**
Address	:	4 Westall Rd Springvale VIC Australia 3171
Quote number	:	EM20060051
Work order	:	**EM0703586**
E-mail	:	paul.loewy@alsenviro.com
Telephone	:	61-3-8549 9600
Facsimile	:	61-3-8549 9601

Dates

Date Samples Received	:	16 May 2007	SRA Issue Date	:	17 May 2007
Scheduled Reporting Date	:	**23 May 2007**	Client Requested Date	:	23 May 2007

Delivery Details

Mode of Delivery	:	Carrier.	Temperature		: 1.2 - Ice bricks present
No. of coolers/boxes	:	1	No. of samples	- Received	1
Security Seal	:	Intact.		- Analysed	1

Comments

Samples received in appropriately pretreated and preserved containers.

Please direct any queries related to sample condition / numbering / breakages to Peter Ravlic.

Analytical work for this work order will be conducted at ALSE Melbourne.

Sample(s) have been received within recommended holding times

Sample Disposal - Aqueous (14 days), Solid (90 days) from date of completion of work order.

When the sampling time is not supplied on the COC documentation, ALSE defaults the sampling time to that of the COC 'relinquishment' time (if supplied). If this also is not supplied, ALSE defaults the sampling time to the 'time of receipt at Laboratory'.

Client	: RESOURCE & ENVIRON MANGMNT P/L	**Work Order**	: EM0703586
Project	: E2-02-02	**ALS Quote Reference**	: EM20060051

Summary of Sample(s) / Container(s) and Requested Analysis

Some items described below may be part of a laboratory process neccessary for the execution of client requested tasks. Packages may contain additional analyses, such as moisture and preparation tasks, that form an implicit part of that package.

ALS Sample ID.	Client Sample ID - Sample Date	**EK026-EM - WATER** Total Cyanide (Melbourne)	**EN055 - WATER** Ionic Balance	**Major Anions - WATER** Cl, SO4, Alkalinity PCT	**Major Cations - WATER** Ca, Mg, Na, K	**W-03 - WATER** 13 Metals (NEPM Suite)					
EM0703586-001	**GW08_14/5 - 15 May 2007**	1	1	1	1	1					
	Total(s) :	**1**	**1**	**1**	**1**	**1**					

Client	: RESOURCE & ENVIRON MANGMNT P/L	**Work Order**	: EM0703586
Project	: E2-02-02	**ALS Quote Reference**	: EM20060051

Requested Reports

ACCOUNTS PAYABLE

- A4 - AU Tax Invoice	Email	anyaoregan@rem.net.au

MS EMILY PICKEN

- A4 - AU Quality Control Report - NEPM format	Email	emilypicken@rem.net.au
- A4 - AU Certificate of Analysis - NEPM format	Email	emilypicken@rem.net.au
- A4 - AU Interpretive Quality Control Report - NEPM format	Email	emilypicken@rem.net.au
- EDI Format - ENMRG	Email	emilypicken@rem.net.au
- A4 - AU Sample Receipt Notification - Comprehensive format	Email	emilypicken@rem.net.au
- Default - Chain of Custody	Email	emilypicken@rem.net.au

Sample Container(s) / Preservation Non-Compliance Log

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

No sample container / preservation non-compliance exist.

CHAIN OF CUSTODY FORM

rem
resource and environmental management

From : Resource and Environmental Management Pty Ltd
ACN: 098 08 877
Suite 9, 15 Fullarton Road, Kent Town
ph: (08) 8363 1777 fax: (08) 8363 1477

A.L.S.

LAB USE ONLY			Container Identification				
ALS QUOTE NUMBER ME/224/02	Project No: E2-02-02	Size					
Job Code:	Project Manager: Emily Pickard	Type					
Due Date:		Preserv					
Custody seal intact?	Sampler(s): V. Stroughton	Analytes	MAJOR Anions & Cations	CN	Dissolved Metals As, Cd Co Cr Cu	Fe Hg Mn Ni Pb Se V Zn	
Sample cold?							
Received for Laboratory by:	Checked:						
Date:	Date: 15/5/07						
Time:							

Lab Identification	Date	Time	Matrix	Sample Identification	Comments		Tick required analytes				
1				GW08_14/5			✓	✓	✓		
						TOTAL					

Comments

Sheet 1 of 1

Environmental Division
Melbourne
Work Order
EM0703586
Telephone : 61-3-8549 9600

CM

COC-RevA

Appendix C

Groundwater Data Quality Assessment

DATA QUALITY SUMMARY REPORT - GROUNDWATER

Project No:	EZ-04
Site:	Regional Bores - Kanmantoo Copper Project
Matrix:	GROUNDWATER
Primary Laboratory:	LabMark (Batch No: E031995)
Secondary Laboratory:	ALS (EM0703586)
No. of Tests Requested/ Reported:	8 primary samples
Frequency of QA/QC undertaken:	1 in 8 samples was undertaken
Frequency of QA/QC Required:	1 in 10 samples is required to be duplicated

Data Quality Issue Assessed	Issue Reviewed	Results Acceptable	Comments
Sampling Technique	✓	✓	
Sample Holding Times	✓	✓	
Analytical Procedures	✓	✓	
Laboratory Limits of Reporting (below relevant guideline value)	✓	✓	See Note 1
Field Duplicate Agreement (RPD%)	✓	✓	See Note 2
Blank Sample Analysis			
Method Blank	✓	✓	
Rinsate Blank	✓	✓	
Laboratory Duplicate Agreement (RPD%)	✓	✓	
Matrix Spikes/Matrix Spike Duplicates			See Note3
Recovery Percentages	✓	✓	
Duplicate Agreement (RPD%)	✓	✓	
Surrogate Recoveries	NA	NA	
Other Issues (i.e Trip Blanks)	NA	NA	

Other Observations:

Note 1: The laboratory limit of reporting (LOR) was raised for arsenic, chromium and copper by Labmark due to matrix interference associated with the salinities of the water samples.

The raised LOR for arsenic exceeds the SA EPA (2003) Environmental Protection Water Quality Policy for Potable Use of 0.007mg/L however due to the salinity of the samples the groundwater can not be considered for use as potable.

The raised LORs for chromium and copper do not exceed any adopted assessment criteria.

Note 2: One inter and intra-laboratory duplicate was undertaken during the May 2007 sampling program at bore GW8
An elevated RPD% was identified between the primary sample and the inter-laboratory duplicate for cadmium

- The elevated RPD% for cadmium is not considered significant to the overall interpretation of the results as the RPD only marginally exceeds the acceptable difference and the reported concentrations are close to LOR where prescision and accuracy are compromised.
- The ionic balance for major cations and anions were reported out of acceptable limits (generally 5%) for groundwater sampled from the primary laboratory for GW01 (8%), GW05 (20%), GW7 (7%) and GW10 (7%). These results will need to be confirmed in subsequent sampling events.

Note 3: Matrix spike recovery for chloride, nitrate and major cations was not available due to significant background levels of analytes in sample.
Total cyanide reported a matrix spike <20%, however the corresponding lab control spike reported 123% which is within acceptable limits.

Summary Comments:

Groundwater analytical data can be used as a basis of interpretation, subject to the limitations outlined above.

Recommended Corrective Action:

none

Data Quality Summary of Relative Percentage Duplicates (RPD%)
Hillgrove Resources Regional Bores EZ-04
May-07

		Analyte	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Vanadium	Zinc
		LOR	0.001	0.001	0.001	0.0001	0.001	0.001	0.001	0.05	0.001	0.001	0.0001	0.001	0.005	0.001	0.005
		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	mg/l	mg/l	mg/l
Sample	**Sample Date**	**Lab Report**															
GW08	14/05/2007	E031995	*<0.01	-	-	0.0001	*<0.005	0.011	0.003	3.6	<0.001	0.55	0.0001	0.011	<0.005	<0.001	0.016
Dup1	14/05/2007	E031995	*<0.01	-	-	<0.0001	*<0.005	0.011	0.003	3.6	<0.001	0.53	0.0001	0.011	<0.005	<0.001	0.015
RPD%			**0.0**	-	-	0.0	0.0	**0.0**	**0.0**	**0.0**	**0.0**	**3.7**	**0.0**	**0.0**	**0.0**	**0.0**	**6.5**
GW08	14/05/2007	EM0703586	0.004	0.021	0.002	0.0002	<0.001	0.012	0.002	-	<0.001	0.596	<0.0001	0.011	-	<0.01	0.016
RPD%			**-**	**-**	**-**	**66.7**	**-**	**8.7**	**40.0**	**-**	**0.0**	**8.0**	**0.0**	**0.0**	**-**	**-**	**0.0**

Notes:
Relative percentage difference >50% for field duplicate
na - not applicable
Reporting

		Analyte	Total Cyanide	Bicarbonate Alkalinity	Carbonate Alkalinity	Total Alkalinity	Chloride	Flouride	Sulphate	Nitrite as N	Nitrate as N	Calcium	Magnesium	Potassium	Sodium	Total Anions	Total Cations	Ionic Balance
		LOR	0.005	1	1	5	1	0.1	2	0.01	0.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1
		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	mg/l	meq/l	meq/l	%
Sample	**Sample Date**	**Lab Report**																
GW08	14/05/2007	E031995	0.007	-	-	370	1490	1.9	660	<0.01	<0.01	95	140	65	938	-	-	-
Dup1	14/05/2007	E031995	<0.005	-	-	400	1600	1.9	660	<0.01	<0.01	94	139	66	952	-	-	-
RPD%			**33.3**	**-**	**-**	**7.8**	**7.1**	**0.0**	**33.3**	**0.0**	**0.0**	**1.1**	**0.7**	**1.5**	**1.5**	**-**	**-**	**-**
GW08	14/05/2007	EM0703586	0.005	353	<1	353	1440	-	724	-	-	93	146	74	927	62.8	58.9	3.16
RPD%			**33.3**	**-**	**-**	**4.7**	**3.4**	**-**	**9.2**	**-**	**-**	**2.1**	**4.2**	**12.9**	**1.2**	**-**	**-**	**-**

Notes:
Relative percentage difference >50% for field duplicate
na - not applicable
LOR - Limits of
Reporting