Phone: (03) 6350 6466

Your Ref:

Our File: BD3105

Forestry Tasmania

15 June 2012

Phil Masters
CBM Sustainablity Group
8 Broadland Drive
PO Box 1971
Launceston Tas, 7250

Dear Phil

Hardrock Coal Mining Pty Ltd Fingal Tier Coal Project DPEMP comments

Please find summary of agreed outcomes from our discussions relating to Forestry Tasmania's DPEMP comments on the above project.

- HRCM and FT have agreed that a Forest Lease is the appropriate mechanism to effectively expand the existing informal reserve in and around the site, as shown in dwg C2-05. This allows the area managed for conservation within the lease, when coupled to the existing informal reserve, to form part of the threatened fauna impact mitigation strategy for the Fingal Tier Coal Project.
- FT also confirms that ongoing fire mitigation works within the State Forest in and around the Project Site will be undertaken by FT. The Forest Lease will confirm the details in respect to fire management within the forest lease including the undertaking that management through burning can only be undertaken by FT. This Forest Lease will not cover the mine works or mine infrastructure. This will be covered by Mineral Resources Tasmania's Mining Lease.
- FT has been advised that the proposed water infrastructure at the Project Site will not require ACDC approval, due to the dams being less than 1 megalitre. It confirms that the approval for the proposed settling ponds will be granted through the current EPA and Break O'Day Council Land Use Permit application process, and Council Building Approval process. However FT requires these dams/ settling ponds to meet design and construction standards appropriate for the site.
- FT has been consulted in the design and development of the Interburden Management Plan. FT is agreeable for Abrahams Quarry to be used to place interburden from the proposed mine providing;
  - the material meets EPA guidelines for storage,
  - that the material is suitable for use in rehabilitation purposes,
  - it will not cause future environmental issues on State forest or to other adjoining neighbours.
  - EPA to provide conformation to FT that any AMD assessment of the interburden material meets the required environmental standards for proposed use on State forest.
- HRCM has confirmed its commitment to seal Valley Rd to a pavement width of 6.2m between the Esk Hwy and the Project Site entrance. FT believes this surfacing and road widening to 6.2m, excluding table drains, will provide safe access to other

PEFC
PEFC/21-23-01

AUSTRALIAN FORESTRY STANDARD
AFS/01-21-01

public road users. HRCM to provide adequate road warning signage, along the Valley Road sections, to Australian Standards.

- HRCM has also confirmed that mine entrances will be capped during mine decommissioning and rehabilitation.

Yours Sincerely

Peter Williams
ASSISTANT FOREST MANAGER (BASS DISTRICT)

CLIENTS | PEOPLE | PERFORMANCE

Hardrock Coal Mining

Fingal Coal Project

Review of Geotechnical Assessment

May 2012

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

This "Hard Rock Mining Fingal Coal Project Geotechnical Assessment Review":

1. *has been prepared by GHD Pty Ltd for Hard Rock Mining;*
2. *may only be used and relied on by Hard Rock Mining;*
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To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report:

- *were limited to those specifically detailed in section 2 of this Report;*
- *did not include a site visit.*

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking services and preparing the Report ("Assumptions"), including (but not limited to):

- *The supplied document did not contain a site plan or other images sufficient to independently assess the influence of topography or geology at the site. For this reason, Strata's judgements on topographic and geological features have not been verified and have been accepted at face value as being complete and accurate.*

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the time of preparation and may be relied on until 28 May 2013, after which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

Contents

1. Introduction

GHD was commissioned by CBM Sustainability Group on 11 May 2012 to undertake a review of a geotechnical assessment of the proposed surface infrastructure development at the Fingal Coal Project, Fingal Tasmania, undertaken by Strata Geoscience and Environmental.

The proposed surface infrastructure development involves multiple sites to be located on moderate to steep slopes. These sites are possibly underlain by active slope deposits which may present land stability risks to construction as well as ongoing mine operations.

This brief report outlines the results of the review, and contains comments on the limitations of the reviewed assessment and further geotechnical investigations requirements through the following stages of the project.

2. Scope of Review

The scope of this review was to assess the report by Strata Geoscience and Environmental (Strata) and to advise on ongoing geotechnical assessments.

It should be noted that this review has been undertaken based on the limited plans and images contained within the report and without a site visit and has not sought to independently assess the influence of topography or geology at the site. For this reason the judgements on topographic and geological features have not been verified and have been accepted at face value as being complete and accurate.

3. Supplied Information

Document supplied for this review.

- Strata Geoscience and Environmental, March 2012. *Geotechnical Investigation Fingal Coal Project*. Ref. No. 0427FINAL.

4. Strata Geotechnical Investigation

The title of the reviewed Strata report is initially misleading, as the report is essentially a qualitative landslide risk assessment (LRA), with only very preliminary geotechnical investigation to support the LRA. This is recognised by the authors of the report as they refer to the geotechnical investigation as ‘geotechnical reconnaissance’.

The geotechnical assessment reported by Strata is a preliminary or feasibility stage investigation rather than defining the detailed engineering parameters, and will need to be supplemented by further geotechnical investigations. In a project of this scale, the geotechnical investigations are often completed in a two stage approach, the initial investigation to inform site selection for the proposed infrastructure components and sometimes their concept design (suitable for development applications), and a further more targeted investigation to inform detailed design and construction.

5. Geotechnical Review and Site Investigations

The geotechnical investigation as completed has comprised a site inspection, review of available aerial photography, published geological and hydrogeological information, and a series of excavator test pits. It is noted that the test pits have been geologically logged, but no insitu testing or sampling for laboratory testing was reported.

It is noted that this area is not included in the existing coverage of the MRT Landslide Map Series (Mazengarb, 2004/10).

It is emphasised that this level of geotechnical site investigation can be regarded as reconnaissance level investigation, but does inform on conceptual geological and hydrogeological conditions for the purpose of concept stage infrastructure design.

Of significance in the discussion of the initial site inspection undertaken is the recognition that "*the entire site showed evidence of recent active landscape movement, primarily as rock falls from higher areas associated with the talus, but also as incision and runout in drainage lines. The area around the office is possibly a former debris slide, with some morphological features of a landslide evident*".

6. Geotechnical Slope Stability Risk Assessment

This section of the report initially attempts to provide a slope angle based classification in order to identify landslide hazard zones.

The report then goes on to develop a qualitative risk assessment for each individual infrastructure site and to develop risk mitigation options and residual risk assessment.

The mitigation options outlined in the summary risk assessment tables are conceptual only, and their effectiveness in mitigating the residual risk will be highly dependent on detailed geotechnical investigation and design.

7. Comments

In general, GHD considers that the Strata team have done a good job and is appropriate within the scope of the project. The report was of a high standard and is a document that was found to be very easy to read and to follow.

Strata has developed an 'initial' geotechnical model for the location of the mine site surface infrastructure. We deliberately use the term "initial" as we believe that there is much more to be done to get the model to a stage where the project team would have the confidence required to make important decisions on the location and detailed design of the surface works.

However the report is suitable to provide conceptual design geotechnical requirements necessary for this level of surface infrastructure design.

The following comments are provided:

- The detailed geology model of the site remains substantially incomplete and at a concept level only. The next stage of geotechnical site investigation must attempt to provide a detailed level of knowledge of the distribution and engineering properties of geological materials at this site.
- The initiating factors in landslide activity are generally rainfall intensity, source area geology, and topography and slope. It may be advisable in this highly landslide susceptible environment to develop a series of landslide susceptibility zoning maps for each identified landslide hazard. This zoning map will assist subsequent infrastructure site selection/detailed design.
- The incidence of landsliding to rainfall intensity may be non-linear, however, there is often a "threshold" rainfall intensity below which landsliding will generally not occur, and above which there is a greater frequency of landsliding with increased rainfall.
- Detailed geotechnical work should be done to analyse rainfall records and the coincidence with recorded land instability. In similar investigation projects, much information of value has been obtained by searches of local newspaper records, local historical societies, and community stakeholder consultation.
- In developing landslide trigger conditions, the incidence of slope movement events (landslides) is not entirely dependent on 24 hour rainfall totals. In the case of debris slides, their occurrence is generally related to the incidence of high intensity, short duration rainfall events. With deep-seated landslides, the role of antecedent rainfall (rainfall in period prior to high intensity rainfall event) may also be an important factor.
- The effect of rainfall intensity is best interpreted by use of the IFD (intensity-frequency-duration) charts that are generally available from the Bureau of Meteorology for the local area. This chart relates rainfall intensity and duration by means of statistically determined average recurrence intervals. It may become apparent from this relationship that the recorded landslide events may conform to a measurable ARI (annual recurrence interval) event. This analysis may enable separation of those rainfall events which will result in recorded flooding without landslides, from those rainfall events which have a high probability of initiating significant slope mass movement.
- The summary risk assessment tables provided for each main infrastructure element contain consequence descriptors that are not agreed in some instances. An example is the adoption of Medium consequence for impact by a debris flow on the office building (Table 4). Debris flows are

high velocity and high energy movements of a saturated soil and rock slurry. These flows commonly follow pre-existing drainage paths, and are often of high density, perhaps 60% to 70% solids by weight, so that boulders as big as cars may be rolled along. The impact of such slurry on a building will almost certainly result in extensive damage. GHD believe that the consequence descriptor most appropriate for this type of landslide and facility is Major.

- The mitigation measures (options) included in the assessment summary tables are not agreed without further qualification. For example, in Table 2 the options offered to mitigate a debris flow include "*engineered and drained retaining structures"* and *'upslope drainage diversion…".* Debris flows are very high energy and particularly destructive landslide events, and as such we have considerable concern in reliance on retaining structures or drainage diversions as effective mitigating measures.
- As the estimates of likelihood, consequence and subsequently risk are based on highly uncertain factors, the judicious use of descriptors is advised.
- In the summary risk assessment tables, we offer some clarification between what constitutes a hazard, and what an initiating factor is. The inclusion of heavy prolonged rainfall as a hazard is not agreed. This is an initiating factor in both surface erosion and several of the landslide types. Perhaps the hazard in this case is surface erosion.

The major observation from this review is that the geotechnical assessment reported by Strata is a preliminary or feasibility stage investigation suitable for the current project stage. This will need to be supplemented by further geotechnical investigations to inform detail design of surface infrastructure.

8. Recommendations

An outline of further investigation is advised as:

- Collation and analysis of available information to identify and refine the relationship between the incidence of landsliding and the major causal factors.
- Design and implementation of detailed geotechnical investigations sufficient to enable confident siting and design of the surface infrastructure elements. I envisage that these investigations will comprise geological and geomorphic mapping, digital terrain analysis, geophysical investigation, test pitting, geotechnical borehole drilling, insitu and laboratory physical and chemical testing of test pit and borehole exposures and samples, installation and monitoring of both groundwater and surface displacement measurement devices.
- Inclusion of a review process in the geotechnical investigations.

The above requirements will form the basis of the scope of works going forward to allow for the development of detailed geotechnical models suitable for informing the detailed design of surface infrastructure.

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Document Status

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		Name	Signature	Name	Signature	Date
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0	G. Granger	S. Johnson	On File	R. Koenig	On file	08/06/12

Sustainable Consulting Solutions

Fingal Tier Coal Mine Water Management Plan

For

CBM Sustainable Design / Hard Rock Coal Mining

14 June 2012
Revision 2

Project No: 3867.008

SCIENTISTS | ENGINEERS | MANAGERS | FACILITATORS

Integrated Management System
QUALITY AS/NZS ISO 9001 | ENVIRONMENT AS/NZS ISO 14001 | OH&S AS/NZS 4801

DOCUMENT ISSUE AUTHORISATION

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Anthony Williams
BSc (Hons)

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CONTENTS

1. INTRODUCTION

1.1 Project Overview

HardRock Coal Mining Pty Ltd (HRCM) is seeking approval for an underground coal mine and associated works located off Valley Road to the east of Fingal, Tasmania. HRCM intend to develop the Fingal Tier Coal Mine within exploration permit EL16/2010. Mine operations are proposed over two sites; the underground mine and operations area around valley adits, and the proposed interburden waste rock dump adjacent to the nearby Abrahams Quarry.

HRCM plans to develop a coal deposit adjacent to the existing Duncan colliery, which is owned and operated by Cornwall Coal Company. The major coal seams modelled in EL16/2010 result in a total inferred resource of 447 Mt. The initial mine plan has identified approximately 13.4 Mt of accessible mineable coal in the initial mine plan. It is anticipated that once the mine is established, the initial extraction rate will be up to 1 Mt of coal per year, which will be used entirely for export markets.

The project is being developed over a pre-existing coal mine known as Barbers or Valley 2 mine which was abandoned in the 1960s. Accordingly, the development footprint will be minimised and contained to the extent of the previously disturbed area of the abandoned mine workings and access tracks.

The Development Proposal and Environmental Management Plan (DPEMP) was submitted to the Tasmanian Environmental Protection Agency (EPA) in January 2012. This Water Management Plan (WMP) has been prepared in response to the EPA's request for supplementary information dated 28 February 2012.

Figure 1: Locality of the Mine and Waste Rock Dump

1.2 Scope of Development

The proposal involves the following key construction activities:

- Road works, including hardstand areas;
- Culverts and creek diversion;
- Water improvement system incorporating settling ponds;
- 1ML sediment basin/catchment dam;
- Conversion and use of an disused quarry as a waste rock dump;
- Water supply and distribution;
- Packaged wastewater treatment plant;
- HV Electricity supply, including substation and transformer;
- Electrical services and reticulation; and
- Construction of:
    - mine portal,
    - loading hoppers,
    - fixed conveyors,
    - ventilation system,
    - workshop and staff amenities building, and the
    - administration building.

The objective of mine closure is to attain an operationally and economically feasible closure while taking into account community priorities, environmental requirements and sustainability of not only the rehabilitation, but of the final land use.

1.3 Objectives of the WMP

The objectives of the WMP are to ensure that water on the mine site is managed so as to avoid environmental nuisance and harm. It focuses on strategies to manage soil and water quality within the site area to provide assurance those operations will not result in unacceptable impacts on surface and groundwater systems, groundwater dependent ecosystems and downstream water users.

The WMP will determine water management measures to be implemented by mine personnel to ensure that any water leaving the mine site is disposed via the designated discharge point and complies with permit discharge limits; and that water is managed according to relevant statutory requirements. It also outlines a monitoring and reporting schedule and includes procedures for review and reporting of results.

1.4 Responsibilities and Accountabilities

The Senior Site Executive is responsible for the overall environmental performance of the Fingal Tier Coal Mine. Senior Operational managers will have direct environmental responsibility for their areas of control while the Environmental Manager will provide direction and advice to ensure site environmental conformance is maintained. All employees and contractors will have a responsibility to manage operations in an environmentally responsible manner. All environmental incidents will be reported to the Environmental Manager. All employees and contractors will be provided with environmental awareness training through a site induction process.

The key responsibilities of the HRCM employees and contractors are outlined below:

1.4.1 Mine Manager

The Mine Manager will be directly responsible for ensuring:

- That the WMP is implemented across the operation;
- That immediate mitigation action is taken in the event of any incident causing or threatening environmental nuisance or environmental harm;
- That community complaints are recorded and addressed;
- That reporting to the Director of Environmental Management is carried out within 24 hours of any incident;
- That monitoring, assessment and statutory reporting pertaining to water is carried out according to designated procedures; and
- That the WMP is reviewed as necessary, for instance: after any changes to the operation or changes in reagents, etc.; or every three years coinciding with the EMP Review Report.

1.4.2 Environmental Manager

The Environmental Manager will be responsible for:

- Reporting to the Mine Manager on the implementation of the WMP;
- Implementing this WMP;
- Keeping this WMP up to date;
- Informing all staff and contractors of their roles and responsibilities pertaining to water management;
- Informing and training all staff and contractors in all water management measures, with particular emphasis on those relevant to their tasks;
- Holding training refreshers regularly or when water management changes are to be implemented; and
- Ensuring that all complaints are recorded, investigated and, where appropriate, mitigation measures are put in place to rectify issues.

1.4.3 Staff and Contractors

All staff and contractors will be responsible to:

- Apply all water management methods and practices available to them to help:
  - minimise the use of water,
  - minimise erosion and sediment entrainment,
  - minimise the contamination to natural and man made water ways and water bodies;
- Stop all work that generates or has the potential to cause environmental harm or nuisance, and instigate procedures to minimise environmental harm or nuisance;
- Immediately report any incidents to the Environmental Manager; and
- Be proactive, by reporting any potential incidents and suggesting management methods or improvements.

1.5 Relationship with Other Plans

The WMP supports the objectives and commitments outlined in the DPEMP for the site and will form part of the Environmental Management Plan (EMP).

The Waste Rock Management Plan (WRMP) will provide detailed information in dealing with possible acid metaliferous or saline drainage arising from mined and stored carbonaceous material and primarily interburden waste rock that will be disposed at Abrahams Quarry.

1.6 Consultation with Government Agencies

The EPA has provided guidelines for water quality monitoring, as well as feedback on the concept water infrastructure design through the DPEMP review process.

1.7 Statutory Requirements

As yet no permit conditions have been prescribed by any regulatory authority; however the WMP and DPEMP have been developed to address the requirements of the following legislation:

- *Environmental Management and Pollution Control Act 1994*
- *Mineral Resources Development Act 1995*
- *Tasmanian Environment Protection Policy (Air Quality) 2004*
- *Draft Environment Protection Policy (Noise) 2002*
- *Resource Management and Planning Appeal Tribunal Act 1993 and associated amendments*
- *State Policy on Water Quality Management 1997*
- *Threatened Species Protection Act 1995*
- *Water Management Act 1999 and associated regulations*
- *Workplace Health and Safety Act 1995*
- *Aboriginal Relics Act 1975*
- *Environment Protection and Biodiversity Conservation Act 1999*
- *National Environmental Protections Council (Tasmania) Act 1995*
- *Forest Practices Act 1985*
- *Native Forestry Agreement Act 1980*
- *Historical Cultural Heritage Act 1995*
- *Weed Management Act 1999*
- *Land Use Planning Act 1993*
- *Native Title (Tasmania) Act 1994*
- *Crowns Land Act 1976*
- *Fire Services Act 1979*

1.8 Community Expectations

Environmental nuisance and harm could **potentially** arise from:

- Excessive use of local water supply,
- Impacts on groundwater levels and supply,
- Excessive erosion of unsealed surfaces,
- Excessive input of sediments into receiving waterways,
- Accidental spills of untreated waters, process chemicals, hazardous fluids, etc,
- Contamination of waterways with sediment and toxic, noxious or aesthetically unpleasant compounds or wastes (eg. sewage),

- Contamination of groundwater;
- Impact on fauna and flora in and near waterways due to high sediment, contaminants or waste load.

It is also understood that the community of Fingal and the Break O'Day Municipality expects that:

- The mine's water usage, underground dewatering, and stormwater runoff will not impact on adjacent property owners or the water resources used by the town,
- The mine's wastewater will be treated on site,
- There will not be any contaminated or turbid runoff from the mine site into local drainage lines or into Cardiff Creek; and
- Water quality in Cardiff Creek will not be impacted by the discharge of mine water at the licensed discharge point.

1.9 DPEMP Commitments

The following commitments were detailed in the Development Proposal and Environmental Management Plan (DPEMP, January 2012) and are relevant to the WMP:

- Commitment 2 - Diesel usage will be minimised where possible by the selection of best practice plant and equipment for use during mining operations, and ensuring this equipment is kept in optimal running order.

- Commitment 3 - Coal dust will be minimised during extraction, storage and transport through the raising of coal moisture levels.

- Commitment 4 - Dust due to vehicle traffic on Valley Rd will be mitigated by the regular usage of a site based water cart as required.

- Commitment 5 - Excess water discharge volume and quality will be managed via a Water Management Plan developed in consultation with EPA, and aligned to baseline flow and water quality.

- Commitment 6 - Further hydrogeological assessments will be undertaken, including:

  - The conversion of exploration drill holes to groundwater monitoring wells (relatively shallow holes) with deeper holes fitted with grouted-in piezometers to provide water level data from multiple horizons. Groundwater levels (with data loggers) will be sampled (monthly for first year, then quarterly for indicators and annually for full suite) in the monitoring wells.
  - Packer testing in uncased boreholes during drilling.
  - The measurement of groundwater discharges in creek and former mine workings using V-notch weirs where possible or estimated from stream profiles and flow velocities.
  - Permeability (slug) testing in each of the completed monitoring wells.
  - Drawing up of groundwater contour and flow maps based on monitoring well sampling and gauging.

- Commitment 7 - The net discharge groundwater quality will be continually monitored, to inform the water improvement process.

- Commitment 9 – If confirmed as benign, initial development interburden rock is to be stored as fill in nearby quarry or borrow pits and rehabilitated as per the Quarry Code of Practice 1999. Additional waste rock which will be mined during ongoing mine operations will be stored underground.

- Commitment 16 - A site Safety and Environmental Management Plan will be developed for use during mine construction and ongoing operation.

- Commitment 17 – Tasmania Fire Service will be consulted during development of the Fire Management Plan.

- Commitment 21 - Undertake monthly sampling to assess water quality during the project approvals process, and liaise with EPA during this process to refine the sampling regime if necessary.

- Commitment 22 – Undertake further hydrogeological analyses to further the understanding of groundwater interaction with proposed mining activities.

- Commitment 23 - A Mine Closure Plan will be developed as the project progresses over the mine life.

2. SITE SPECIFIC INFORMATION

2.1 Location

The site is located in State Forest, adjacent to areas used for forestry activities, and is located approximately 6.7km due east of Fingal within the Cardiff Creek catchment. The site is located near the coordinates 41°37'57"S and 148°03'24"E (587739E, 5390332N) off Valley Road which circles 300m to the west and south of the site. It is in an area previously disturbed by mining activities, which has been allowed to naturally revegetate. It contains old mining equipment, general refuse and coal finger dumps.

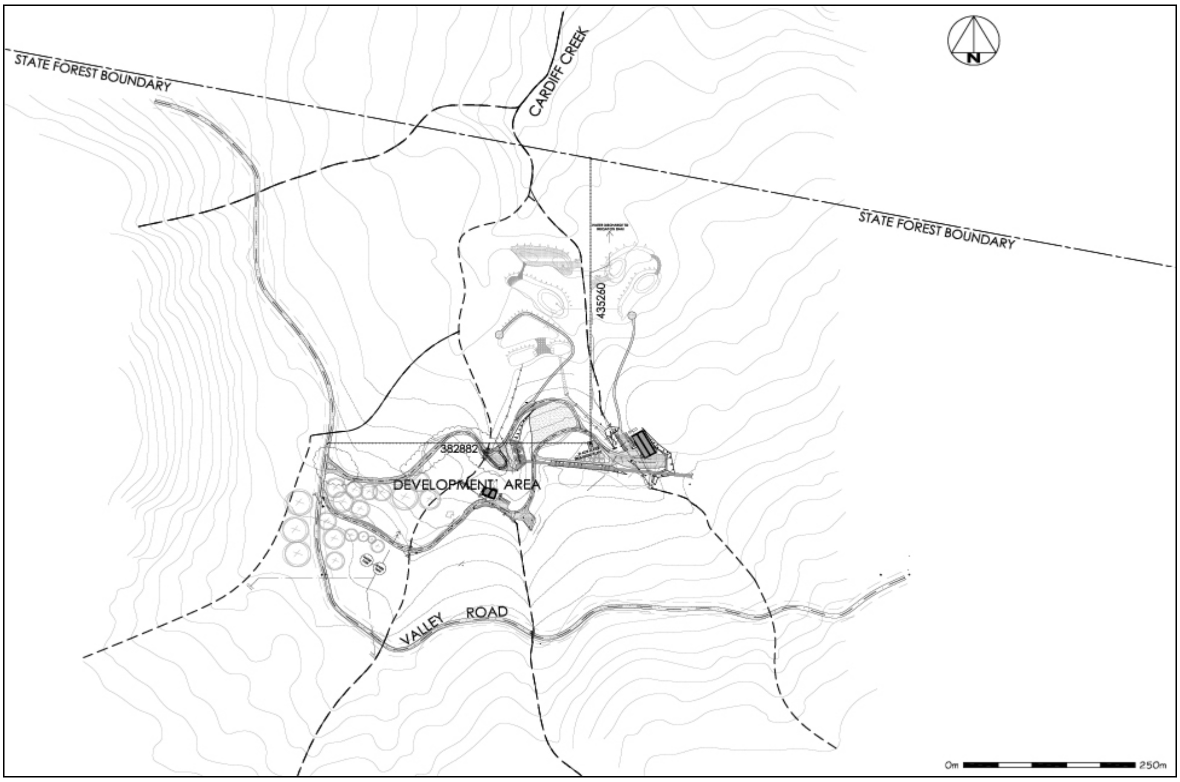


Figure 2: Proposed Development Area

2.2 Temperature

Temperature records show that mean maximum temperature ranges from a low of 12.1°C in July to a high of 23.4°C in January. Mean maximum temperatures range from a low of 0.5°C in July to a high of 10.3°C in January.

2.3 Evaporation

Evaporation data inferred from Bureau of Meteorology SILO patched point data gives a mean evaporation of 2.79mm. Evaporation peaks in January with a mean daily evaporation of 5.2mm and June has the least evaporation with the mean being only 0.9mm per day.

2.4 Soils

The Geotechnical Assessment was conducted by Strata Geoscience and Environmental (March 2012). This assessment included 12 pits around the mine area including Unified Soil Classification System (USCS) of the soil and subsoil.

The first 500mm topsoil and subsoil material generally consisted of high and low plasticity clays (CH and CL), clayey sands (SC), silty clays (CH), silty sands (SM) and poorly graded sands (SP). Given the soils contain a large fraction of clays it has been assumed they are highly dispersible.

2.5 Rainfall

An extensive climate data record exists at the nearest Bureau of Meteorology (BOM) weather stations in the Fingal Township. Measurements have been made across several stations (some now closed) amounting to a total of 124 years of measurements. There are currently two active BOM stations in the Township (station No.092012 Fingal Legge Street and station no.092091 Fingal South Esk River).

On average, there are around 112 rain days per year and mean annual rainfall total of 611mm at the Legge Street station. The highest monthly rainfall occurs in June with mean monthly rainfall of around 65 millimetres and least in January with mean monthly rainfall of around 44 millimetres. Historical daily rainfall data was obtained from the BOM for the Fingal Weather Station 92012 at Legge Street from which data dating back to 1888 is available. **Figures 3 and 4** below graphically demonstrate the very infrequent larger events and the significant number of much smaller background events.

Analysis of rainfall data from a single station is considered unreliable and therefore such data should not generally be used for design purposes (http://www.bom.gov.au/hydro/has/cdirswebx/cdirsdoc.shtml#Ifd). However, in order to provide temporally and spatially consistent rainfall intensity-frequency-duration data (IFD) the BOM, as part of the revision of *Australian Rainfall and Runoff (Institute of Engineers Australia, 1987),* derived accurate IFDs by incorporating data stations Australia-wide.

The variables used to calculate IFDs in **Table 1** are based on a 0.025° latitude by 0.025° longitude grid.

2.6 Water Requirements

The main water requirements for the site include:

- Construction water,
- Process water,
- Domestic water; (ablutions, kitchens, etc.)
- Conveyor & other dust-mitigation water-spraying devices,
- Fire truck water, and
- Vehicle wash-down.

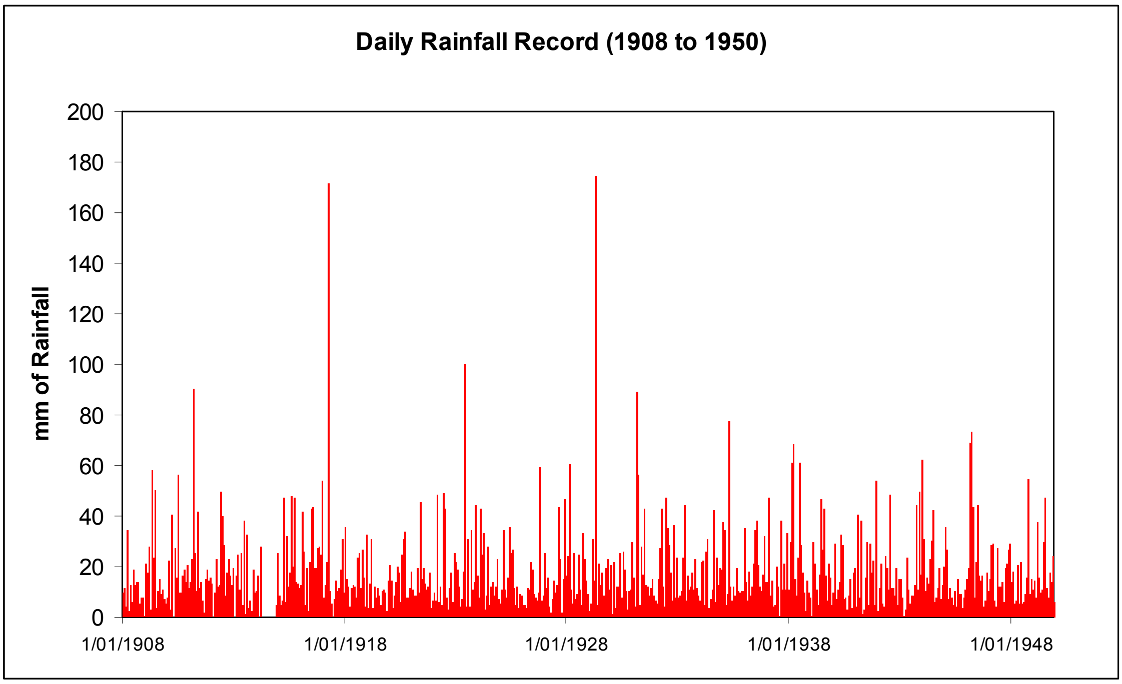


Figure 3: Daily Rainfall Record

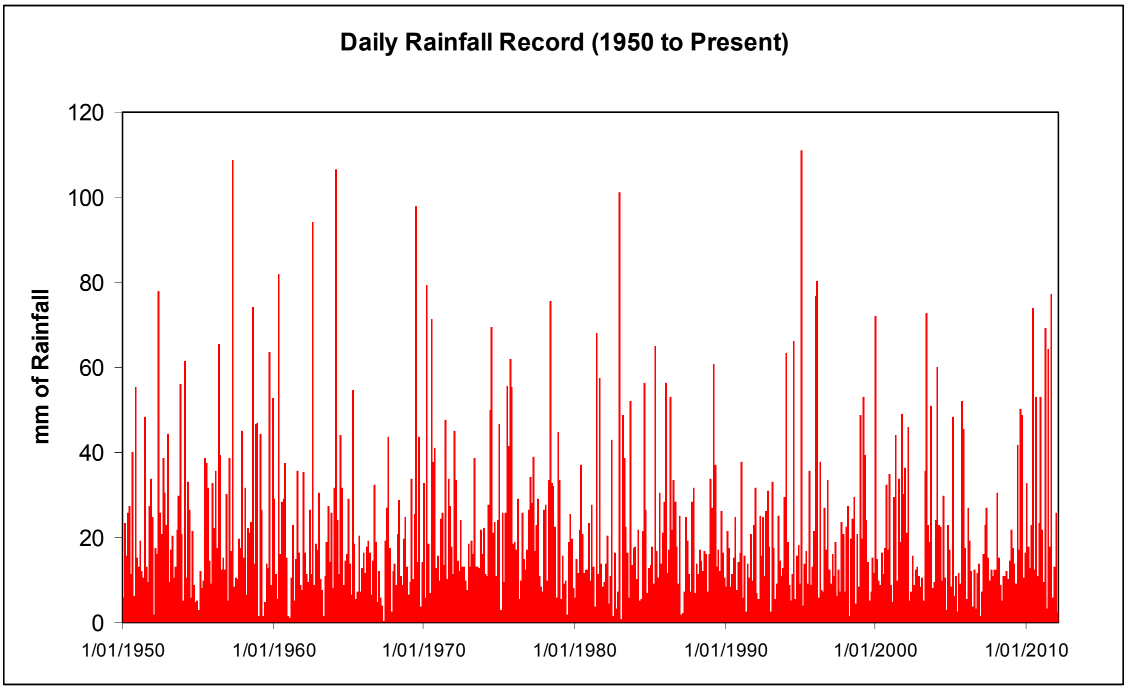


Figure 4: Daily Rainfall Record

Table 1: IFD Figures for 41.625S, 148.050E (Near Hard Rock Coal Operations)

	ARI						
DURATION	1 Year	2 years	5 years	10 years	20 years	50 years	100 years
5Mins	46.5	62.1	86.4	103	124	155	180
6Mins	43.7	58.3	81.1	96.4	117	145	169
10Mins	36.3	48.2	65.8	77.4	92.7	114	132
20Mins	27	35.4	46.5	53.7	63.3	76.5	87.2
30Mins	22.3	28.9	37.3	42.6	49.8	59.6	67.5
1Hr	15.7	20.2	25.5	28.8	33.2	39.3	44.1
2Hrs	11.1	14.2	17.7	19.8	22.8	26.8	29.9
3Hrs	9.07	11.6	14.4	16.1	18.5	21.7	24.2
6Hrs	6.44	8.24	10.2	11.4	13.1	15.3	17.1
12Hrs	4.45	5.7	7.11	7.96	9.16	10.8	12
24Hrs	2.88	3.7	4.7	5.32	6.17	7.32	8.22
48Hrs	1.73	2.25	2.94	3.39	3.97	4.79	5.45
72Hrs	1.26	1.66	2.22	2.58	3.05	3.71	4.26

Rainfall intensity, I, is in mm/hr. Appendix A presents this data as a series of curves.

2.7 Catchments and Drainage

The site lies on a steep northerly facing slope within the catchment area known locally as Smudgy Gully. This catchment extends approximately 800m to the top of the tier to the south and south west and consists of many drainage and creek lines that are steep and often heavily scoured. The high mobility of the stone and scree along the drainage lines is typical throughout the steep flanks of the Tier, often with no surface flow, but water flowing freely below the rubble. Below Valley Rd, Cardiff Creek is well defined, and in places the creek bed has exposed solid sandstone substrate and clear of rubble.

The previous mining activities included tracks and spoil dumps and therefore not all drainage lines follow along their natural alignment. As Valley Rd effectively encircles the catchment of the site, the road drainage creates a cut-off drain and concentrates overland flows to Cardiff Creek. Cardiff Creek flows north-easterly through the site and intercepts the western, central and eastern drainage lines within the immediate area.

2.7.1 Cardiff Creek

Cardiff Creek is a class 3 stream and is the main stream through the site. It has a catchment of harvested forest and informal reserved forest in Smudgy Gully. Larger storm events increase turbidity through the entrainment of sediment from the steep talus laden gullies and erosion of the water courses. Other factors contributing to increase turbidity may include forestry roads and landings, and exposed soils in harvested areas.

It has been observed that generally the flow in the creek is steady and clear and reasonable flow rates occur in all but extended dry spells. Above the site the catchment has the potential to deliver a good and ample source of clean water. At the downstream end of the site, the magnitude of flow increases approximately threefold compared to that at the top of the site due to the confluence of the western, central and eastern drainage lines.

Beyond the site Cardiff Creek flows to the boundary of State Forest, then through the bush grazing land at the top of the Kooringa property (6092 Esk Main Road), in the lower slopes of the Tier, and finally some 3 km through the cleared and farmed land of the alluvial plain into the Break O'Day River at the Killymoon Bridge. There is a Baseline water quality monitoring site at Killymoon Bridge operated by DPIPWE.

2.7.2 Western Drainage Line

The Western drainage line is a class 4 stream. It is mapped as joining Cardiff Creek above the site, but in fact joins near the northern extents of the site below the proposed infrastructure area. Flow is passed under Valley Rd by a culvert at the point of the site access and is supported by a well forested catchment between two well defined bluffs of the Tier. It has been observed as having good flows in winter maintaining some flow of clean, clear water through spring but dry in summer.

2.7.3 Central Drainage Line

The central drainage line is heavily scoured and scree filled and has little observable surface flow except during larger rain events. A study of the mapped contours of the various catchments demonstrates a potential catchment area of two thirds the size of the Cardiff Creek catchment. However actual flows appear to be considerably less than those from Cardiff Creek. Old mine workings have resulted in the central drain being somewhat realigned, particularly by the spoil finger dump at Valley No. 1 mine just before it reaches Cardiff Creek. To improve the existing alignment flowing against the edge of the finger dump and discharging into Cardiff at the base, it is proposed to direct this drainage line to Cardiff Creek before the finger dump, to mitigate effects of erosion. This will separate through flow of the natural drainage from any surface water collected from the working.

2.7.4 Eastern Drainage Line

The eastern drainage line experiences the least flow of the site waterways, and now drains over the top of the collapsed mine adit entrance to Valley No. 2. It is largely a marshy soakage over the floor of the historic Valley No. 2 working floor. Some recent storm events, the largest since the 1960s, have eroded deep channels off the end of the floor in the vicinity of the previous wash plant, though after normal rain events the drainage into the top of the site is often no more than a trickle. Similar drains parallel the eastern drainage line and it is possible that they are linked by constructed elements further uphill either deliberately for the purpose of wash water in previous operations or by concentrated drainage from Valley Rd. Appropriate bypass of this natural drainage through the site includes redistribution of the catchment drainage to the parallel drainage lines to the east and piping through the work area.

2.8 Acid and Metalliferous Drainage Assessment

An assessment of the potential for the coal mine and associated waste rock dump to produce acidic, metalliferous or saline drainage (AMD) was conducted by GHD Pty Ltd (GHD) in May 2012. Key findings from the assessment were as follows:

- Testing indicates that the coal and probable waste rock at the proposed adit portal and area of early development has a relatively low sulphur content,
- A significant proportion of total sulphur in the carbonaceous material is organic sulphur which will not generate acid when naturally oxidised,

- The net acid generation (NAG) pH and net acid producing potential (NAPP) results, using inorganic sulphur content and acid base accounting, indicate the material represents a low risk of acid generation,
- The remaining waste rock is either non-acid-forming or even has significant potential to neutralise acid generated by other material,
- The tested material does not represent a risk of soil dispersion or saline drainage although some may be moderately alkaline
- Based on water draining from the adit of the Valley No.2 mine, the drainage has only slightly elevated iron and manganese with all other analysed parameters being within acceptable limits for drinking, irrigation or freshwater aquatic ecosystems.

GHD recommends that:

> *As exploration and development works progress, additional AMD testing, including sequential NAG or column leach tests, should be done on materials proposed to be either drained or mined, to confirm the materials are consistent with those tested to date. Given the low risk of AMD development only general sediment and erosion control is necessary, with some additional water quality monitoring and blending of NAF and PAF material if identified.*

The report did not identify any potentially acid forming material. Only non-acid forming (NAF) and acid consuming non-acid forming (AC-NAF) waste rock will be stored onsite during the initial mine development. This will be stored at the nearby Abraham's Pit, while all coal extracted during the initial mine development will be taken offsite as a saleable product.

For detailed mine planning, scheduled excavation and volumes refer to the:

- GHD AMD report (2012); and
- SEMF Waste Rock Management Plan (2012).

3. SITE WATER BALANCE

3.1 Water Sources

Site water can be categorised by location (underground or above ground) or by type (wastewater or potable water).

Inflow water sources into the **underground** mine workings can be described as:

- Minimal natural strata inflow of groundwater,
- Water piped from above ground storage used for mining and ancillary underground operations (such as dust control). A large proportion of this water is returned to the surface in extracted coal, and
- Water from high rainfall periods that enter old shallow mine workings via surface cracks and faults etc.

Sources of water flowing on or to the **above ground** environment can be described as:

- Stormwater runoff from the following catchments:
    - Valley No.2 adit area,
    - Loading area,
    - Laydown area, and
    - The haul road.
- Water taken from the Cardiff Creek and western drainage line,
- Excess water piped from underground to above ground storage and treatment, and
- Rainfall from building roofs.

The main **wastewater** streams from the site include:

- Domestic water (eg. ablution blocks, coffee rooms/kitchens),
- Construction water,
- Process water,
- Mine dewatering,
- Vehicle wash down water; and
- Runoff during the development of the site, and from the hardstand runoff during operations.

The main **potable** streams from the site include:

- Water taken-off for domestic supply from the Cardiff Creek and western drainage line, and
- Rainwater from building roofs (stored in tanks).

3.2 Development Phase Mine Water Management

3.2.1 Peak Flow Calculations

Table 2 shows the peak flows (L/s), based on the *Australian Rainfall and Runoff* (1998) rational method, for the 1 year through to the 100 year ARI event. An impervious fraction of 70% was assumed for the undeveloped catchment. Given the predominance of clays in the soil profile a high-end runoff calculation was completed.

Table 2: Peak Flows for Development Catchments

$^{10}I_1$ (mm/hr) =	28.8	**ARI**	**1 Year**	**2 years**	**5 years**	**10 years**	**20 years**	**50 years**	**100 years**
f (fraction impervious) =	0.7	**Intensity (mm/hr)**	46.5	62.1	86.4	103	124	155	180
C'_{10} =	0.15	**Fy**	0.67	0.75	0.9	1	1.1	1.2	1.3
C_{10} =	0.68	**Cy**	0.45	0.51	0.61	0.68	0.74	0.81	0.88
Catchment	**Area (m2)**	**Area (km2)**	**Q_1**	**Q_2**	**Q_5**	**Q_{10}**	**Q_{20}**	**Q_{50}**	**Q_{100}**
Adit Area	2466	0.002466	14.4	21.6	36.0	47.7	63.1	86.1	108.3
Loading Area	2843	0.002843	16.6	24.9	41.5	55.0	72.8	99.3	124.9
Laydown Area	4263	0.004263	24.9	37.3	62.2	82.4	109.1	148.8	187.2
Haul Road	1457	0.001457	8.5	12.7	21.3	28.2	37.3	50.9	64.0

Given their relative small size the time take for rainfall landing on the top end of each of the four catchments to reach the sediment basin was around 5 minutes. Therefore it is reasonable suggest that the total instantaneous flow from all catchments is simply the sum of the flows from the individual catchments. In the 1 year ARI example this equates to 64.5 L/s.

3.2.2 Sediment Retention Basin Volume Requirement

Given the predominance of clays in the topsoil and subsoil, combined with the steep catchments there is a high risk of erosion when stripping and levelling the site. The footprint of the development will be minimal, only around 1.1 hectares, and will occur over a previously disturbed area. In order to maintain stormwater quality, during this initial establishment and development phase of the mine, stormwater and runoff will be managed by one or more sediment basins.

The 'Blue Book' *Soils and Construction Volume 1* (4^{th} Edition 2004) outlines a method for determining the required basin size for a given development taking into the catchment size and slope, rainfall intensity and its susceptibility for soil loss. Each of the four subcatchments that will be developed, the adit area, the loading area, the laydown area and the haul road were analysed to determine soil loss and basin requirements. The outputs from these calculations are presented in Appendix B.

The assessment was based on the following assumptions:

- That exposed soils are dispersible,
- That the receiving environment is 'sensitive', and
- That the duration of disturbance of the site is between 6 and 12 months.

Required retention is less if soils are not dispersive, the duration of disturbance is less than 6 months, and if there is a 'standard' receiving environment. At the time this report was written the development phase of the mine was less than 6 months, however the more severe case has been assumed to provide a worst case sediment volume estimate.

Based on this calculation the total required capacity for a single basin, or a group of basins, is 486m^3 (approximately 0.5 ML). Of this a total of 308m^3 is required for sediment storage and 178m^3 for settling, based on a 6-monthy management period. That is at least once every 6 months sediment is removed from the basin. If the total capacity of basins was increased to 1ML, greater detention time and removal efficiency would be gained, as well as a larger water resource for reuse.

3.2.3 *Sediment Retention Basin Dimensions*

Best practice recommends that sediment basins be constructed with a minimum length to width ratio of 3:1, minimum sediment settling zone depth of 600mm, and a minimum 750mm freeboard between the crest of spillway and top of the dam wall.

The logical location of any basins is down slope from the laydown area between the eastern drainage line and Cardiff Creek. There is approximately 180m between these drainage lines. The nature of the terrain down slope from the adit and laydown areas, though on a slope, lends itself to the construction of a long but thin detention basin. This will allows plenty of length along the contours to give a high length to width ratio.

There is no compulsory number or limitation to the total number of basins. What is important is the adherence to best practice design and construction principles, and maximising the efficiency of sediment removal. Detailed design of the basins will take into account site constraints and topography, and will be engineered as far as possible to allow effective manual sediment removal, maintenance, and water resource management.

If a series of basins is used a significant proportion of total sediment removal will occur within the first basin. Regular desilting of this basin would be necessary, while others in the sequence would require less attention. If it is determined that flocculation is required the use of a smaller end-of-series pond can often minimise the quantity of chemical flocculants used.

3.2.4 *Verifying Treatment Efficiency*

Full analysis will be conducted at the detailed design stage, however to verify effective removal of sediment can be achieved at this site, two concept calculations were conducted.

Layout Example 1: One Basin

Assumptions:

- Designed for the 1 year ARI peak flow = 65 L/s
- Permanent pool depth = 2m
- Length = 70m
- Width = 11.75m
- Size slopes = 2W:1H
- Volume = 1 ML
- Turbulence/short circuiting parameter = 0.76

Layout Example 2: Three Basins in Sequence

Assumptions:

- Designed for the 1 year ARI peak flow = 65 L/s
- Basin 1 Volume = 0.25ML (45m long x 7.5m wide x 1.25m deep)
- Basin 2 Volume = 0.5ML (60m long x 10m wide x 1.25m deep)
- Basin 3 Volume = 0.25ML (45m long x 7.5m wide x 1.25m deep)
- Size slopes = 2W:1H
- Turbulence/short circuiting parameter = 0.76

It can be seen in Tables 3 to 6 that sediment basins are not effective at removing clay-sized particles (less than 0.004 mm diameter) unless supplemented by chemical dosing. Dosing may be required before planned discharge to the receiving environment.

Table 3: Particle Removal Efficiencies for Layout 1

Particle	Particle Diameter (μm)	Removal (%)
Very Course Sand	2000	100.0
Coarse Sand	1000	100.0
Medium Sand	500	100.0
Fine Sand	250	100.0
Very Fine Sand	125	100.0
Coarse Silt	62	100.0
Medium Silt	31	100.0
Fine Silt	16	99.9
Very Fine Silt	8	95.0
Clay	4	65.3

Table 4: Cumulative Particle Removal Efficiencies after Basin 1 (Layout 2)

Particle	Particle Diameter (μm)	Removal (%)
Very Course Sand	2000	100.0
Coarse Sand	1000	100.0
Medium Sand	500	100.0
Fine Sand	250	100.0
Very Fine Sand	125	100.0
Coarse Silt	62	100.0
Medium Silt	31	99.9
Fine Silt	16	96.4
Very Fine Silt	8	63.2
Clay	4	25.9

3.2.5 Sediment Basin Water Balance

A monthly water balance was conducted for a sediment basin as per layout example 1 in Section 3.2.4. This took into account:

- Historical monthly rainfall accumulations since January 1900;
- Evaporation from the of the basin;
- Infiltration loss (assumed from the floor of the basin only);
- Hydraulic conductivity of silty clay = 1mm/hr; and
- 1 ML is available for storage.

The following volumetric runoff coefficient profile was used as follows to represent catchment saturation in the wetter and dryer months:

Table 5: Cumulative Particle Removal Efficiencies after Basin 2 (Layout 2)

Particle	Particle Diameter (μm)	Removal (%)
Very Course Sand	2000	100.0
Coarse Sand	1000	100.0
Medium Sand	500	100.0
Fine Sand	250	100.0
Very Fine Sand	125	100.0
Coarse Silt	62	100.0
Medium Silt	31	100.0
Fine Silt	16	99.9
Very Fine Silt	8	89.3
Clay	4	49.2

Table 6: Cumulative Particle Removal Efficiencies after Basin 3 (Layout 2)

Particle	Particle Diameter (μm)	Removal (%)
Very Course Sand	2000	100.0
Coarse Sand	1000	100.0
Medium Sand	500	100.0
Fine Sand	250	100.0
Very Fine Sand	125	100.0
Coarse Silt	62	100.0
Medium Silt	31	100.0
Fine Silt	16	100.0
Very Fine Silt	8	96.1
Clay	4	62.4

Table 7: Volumetric Runoff Coefficient

Volumetric Runoff Coefficient	
Month	**Cv**
January	0.5
February	0.5
March	0.5
April	0.6
May	0.7
June	0.7
July	0.7
August	0.7
September	0.7
October	0.7
November	0.6
December	0.6

The water surface area and basin volume relationship was modelled according to Figure 5.

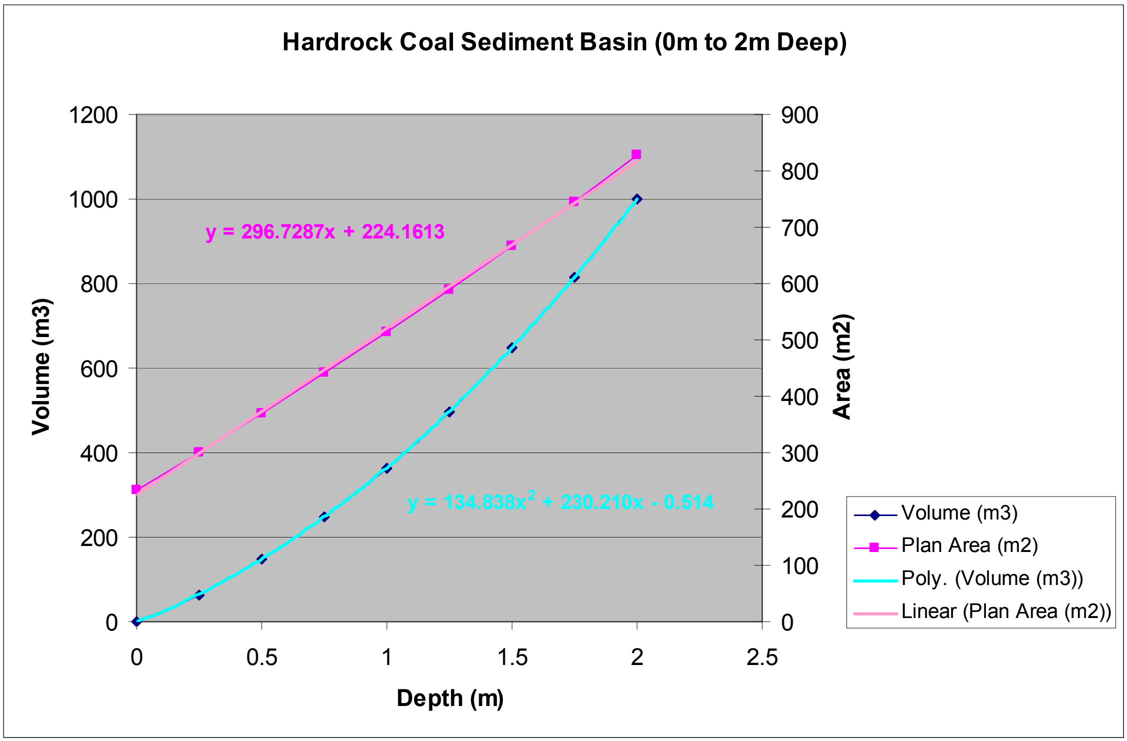


Figure 5: Sediment Basin Surface Area and Volume Relationship with Depth

A monthly water balance determined that, based on the historical data, spills would occur in approximately 44% of months. A summary of the spills are as follows:

- Maximum monthly spill volume – 1.70 ML
- Average monthly spill volume – 0.33 ML

It will be necessary to design and install spillways between and basins in series and to the required discharge point. Although spills will regularly occur in wet weather events, the basin arrangement will remain effective in removing all but highly dispersible particles. Given the ongoing erosion the adjacent drains, noted in Section 2.7, as well as the disturbed nature and size of the surrounding catchments to it is expected that the quality of water released by the basin will be of comparable or of higher quality than the receiving water.

The water balance for this scenario is displayed graphically in Figure 6 and does not take into account the possibility of reduction in volume due to water use.

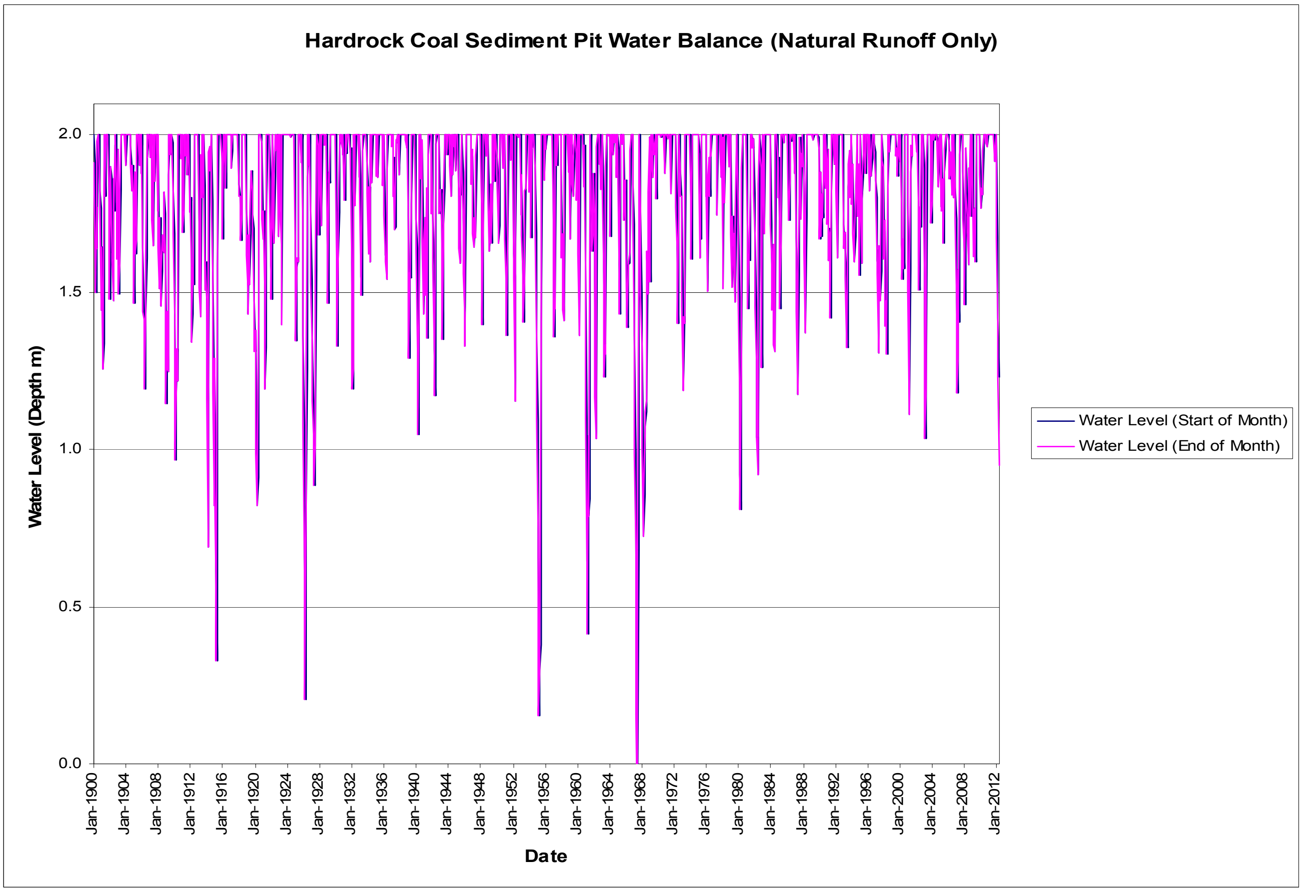


Figure 6: Disturbed Catchment Water Balance

3.3 Operational Phase Mine Water Management

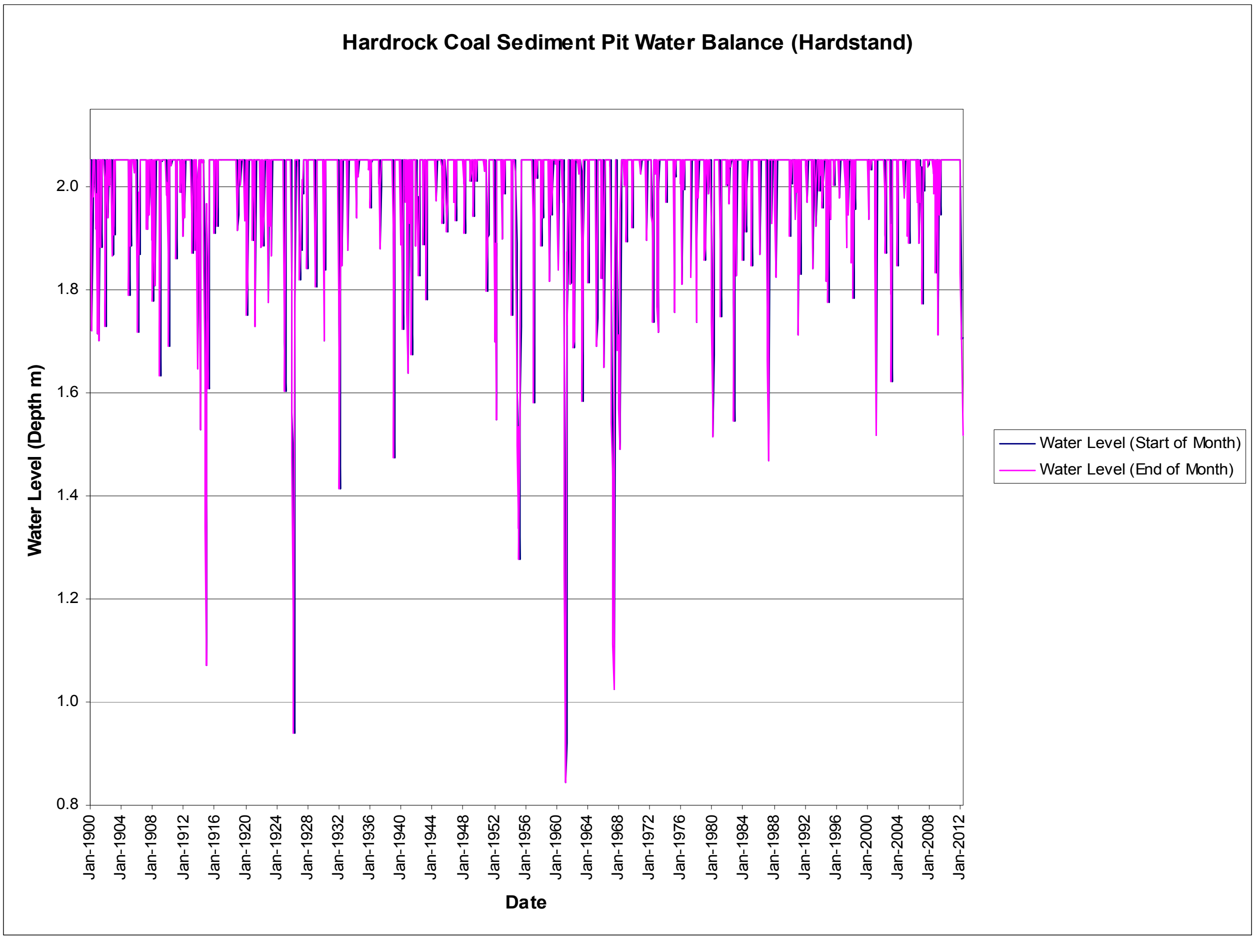
3.3.1 Hardstand Water Balance

Water supply for construction, operations and the mining process will be supplied primarily by the 1 ML retention basin(s). Pre and post commissioning of the site, the water in the basin(s) will be available for reuse. Following commissioning the disturbed areas will be converted to hardstand and the EPA has requested that all water drained from the coal loading area is diverted to water improvement. These areas will be drained via swales and culverts into the receiving basin(s). As such the basin will continue to pick any mine associated debris such as coal particulates, dust and soil that is deposited then entrained in the runoff from the area.

Using similar principles to the water balance conducted in Section 3.2.5 a historical monthly water balance was conducted on the catchments being 100% impervious. The water balance for this scenario is displayed graphically in Figure 7

A water balance determined that, based on the historical data, spills would occur in approximately 74% of months. A summary of the spills are as follows:

- Maximum monthly spill volume – 3.02 ML
- Average monthly spill volume – 0.49 ML



. **Figure 7: Hardstand Catchment Water Balance**

There is more inflow from the hardstand catchment and less opportunity for the basin level to reduce in volume through evaporation and exfiltration. As such the water level does not fall below 0.8m.

The water balance does not take into account the possibility of reduction in volume due to water use. Advice received from mine engineers currently designing the mine plan is that 30ML per year will be required for underground operations. The extracted coal has an in-situ moisture level of approximately 5% which will be raised to 8% to minimise dust related safety issues. At the target extraction rate of 1Mt per annum, this equates to a water requirement of 30ML per annum. It is therefore likely that drawdown of the basin will be required and volumes of spills will decrease

This scenario is analysed in Section 3.4.

3.3.2 Settlement of Coal Fines

Coal dust and debris is likely to be deposited in the sediment detention basin from:

- Runoff from the hardstand and handling areas; and
- Excess groundwater pumped out from underground operations.

The finest particles of coal will be mine dust. The Best Practice Environmental Management in Mining (1998) publication states that the size of the dust particles ranges from 1 μm to 100 μm, with a typical distribution of sizes is as follows:

- Less than 1 µm - 0.2 percent;
- Between 1µm and 2.5 µm - 2 to 5 percent;
- Between 2.5 µm and 10 µm - 15 to 40 percent; and
- Greater than 10µm - 50 to 70 percent.

It is difficult to estimate the amount of coal material that will make its way to the sediment basin. However, given that the basin requires only $180m^3$ to hold a generous amount of eroded soil ($1m^3$ per day for 6 months); the $1000m^3$ detention basin has sufficient capacity. To put this further into context the *entire* catchment would have to have an average depth of 16.4mm of coal material deposited on it for it to be washed off and fill $180m^3$ of the basin.

Given that double the required basin volume of 0.5ML is available for sediment and sludge the storage volume is more that adequate. Physical removal and maintenance of the basin is planned to be carried out at least every 6 months after which capacity will be renewed.

As per the particle removal efficiencies in Table 3, the particulates down to around the 8 µm size will be removed efficiently; to remove smaller particles effectively flocculation will be required.

3.4 Underground Mine Water Management

3.4.1 Groundwater Supply, Demand and Quality

In their groundwater modelling incorporating the first three years of mining, GHD found that inflow using stochastic distribution model gave steady-state 90th percentile of 1.5 L/s (GHD 2012). This calculation was consistent with flows derived from a simple calibrated model. This natural groundwater is expected to be of high quality and it will usually be retained generally for use as utility water at source.

Given that it is expected that 30ML per year (approximately 0.95 L/s) will be required for underground operations, it is anticipated that the need to pump excess groundwater to the surface will be minimal. It is possible that infiltration may fluctuate significantly due to rainfall events, or lack of rainfall, on the surface. The most likely scenario, however, is that water from the surface will be pumped into the mine.

Sections 5.1 and 5.2 of the GHD Hydrogeological Review determine the groundwater encountered will be of high quality, with the potential for it to achieve the drinking water environmental value. The review indicated that groundwater would generally have the following properties:

- Electrical conductivity <1,000 µS/cm;
- pH ranges from 7.2 to 7.5;
- All metals analysed, except for iron (0.305 mg/L) and manganese (0.495 mg/L), were below ANZECC & ARMCANZ (2000) trigger values for long-term irrigation (LTV), livestock water supply and freshwater aquatic ecosystems (FAE95%) and NHMRC 2004 Australian Drinking Water guidelines (ADWG); and
- Low sulphate levels.

It was also noted that water samples taken from the Valley No.2 adit were similar to the Cardiff Creek samples.

In the unlikely case that low quality groundwater is encountered it will be retained for reuse or isolated, collected and pumped to the retention basin for treatment there. It is generally expected however that additional water improvement, other than that provided in the basin, will be unnecessary.

3.4.2 *Net Groundwater Shortfall Scenario*

The following water balance was conducted for the scenario that the supply of groundwater for operational purposes is insufficient, and therefore water needs to be pumped in from the detention basin. If this occurs the requirement is more than likely to be small. On average it is predicted there will be a surplus of 0.65 L/s after operational uses have been met.

A shortfall example 0.5 L/s has been modelled using the same methods in Section 3.2. A requirement to pump 0.5 L/s equates to around 1.3ML per month. The basin is only 1 ML in size so the requirement would, more often than not, be in excess that that what the basin can deliver. Figure 8 shows that historically the basin would rarely able to completely supply this level of operational water deficit.

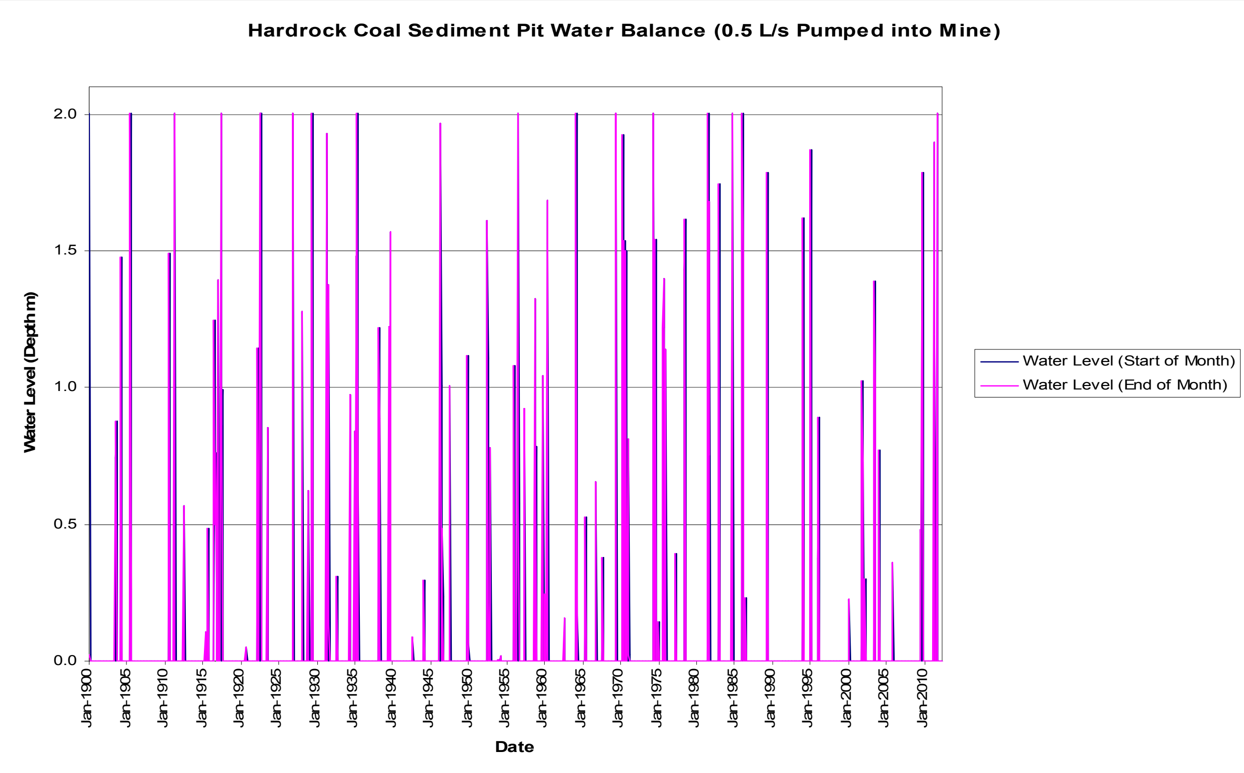


Figure 8: Operational Pump-Out Water Balance

The average monthly deficit amounts to 0.87 ML. This means that on average the basin would be able to supply approximately 0.44 ML per month, or 0.17 L/s.

Given the broad scale of this model, alterations can be made to enhance the volume of water available from the basin. For instance the hydraulic conductivity of the basin wall was based on 1mm/hr, an indicative value for silty clay. If material the basin is formed from is less permeable, the average amount of water available would increase to 0.23 L/s.

Therefore, if as the mine is developed it is found that there is a shortfall in the groundwater available underground, the limitations of basin to provide water should be considered. Additional water may be required from the drainage lines, storage tanks, or transported in from external supplies.

3.4.3 Net Groundwater Excess Scenario

On average it has been predicted there will be a surplus groundwater inflow of 0.65 L/s. Although the most likely scenario is for this water to be completely utilised in underground operations or allowed to dissipate naturally underground, it is possible that on occasion some will be pumped some to the surface. In this case groundwater would be pumped directly to the retention basin.

The average net monthly inflow of water to the basin from runoff (Runoff less exfiltration less evaporation) is 0.36 ML. By adding a further 1.3 ML per month (0.5 L/s) from the pumping of groundwater the average excess that will spill from the basin each month is therefore 1.66 ML (0.63 L/s).

The indicative basin design flow in Section 3.2 was the 1 year ARI peak flow of 65 L/s which is about ten times greater than pump-out example. Therefore it can be said with great confidence that if the basin requirements are met, a much larger flow can be pumped from underground and sediment removal efficiencies will be maintained.

3.5 Potable Water Requirements

A predicted water need of 2.5 to 5 ML per year of potable water will be sourced primarily from Cardiff Creek and the western drainage line which will be treated and stored. The timing and volume of take-off is to be managed against flow and quality in the natural system. If necessary the supply will be supplemented by water collected from the roofs of buildings, stored in large rainwater tanks, and by water transported by vehicle to the site if required. If there remains a shortfall from these sources additional water may be available from water treated in the sediment basin. It is, however, expected that Cardiff Creek and the western drainage line are adequate to supply a sustainable yield of water suitable for potable and domestic use.

A small packaged water treatment unit consisting of a storage tank, dual cartridge filtration, UV disinfection and pressure supply pump is proposed, to ensure the water is suitable for potable use. It will be installed according to requirements set out by Break O' Day Council's Environmental Health Officer.

4. DOMESTIC WASTE WATER MANAGEMENT

It is proposed that all black and grey water influent generated from the proposed facilities be diverted into a packaged treatment plant capable of treating a peak loading of 120 equivalent persons (EP) per day to cater for anticipated staff numbers between 50-100 (Minarco, 2011). This will provide for a 20% buffer above expected maximum staff numbers.

Loading is based upon all water being sourced from reticulated water with standard water savings fixtures fitted in all buildings. WSA 02 2002-2.3 Sewerage Code of Australia states the average loading for sewerage is 180 L per EP, giving total anticipated total daily sewerage loading rate of:

180 L/EP/d X 100 EP = 18 KL/d
Influent will be reticulated via gravity fed sewer lines (with pumping stations as required) to a centralised packaged treatment plant capable of treating flows from 120 EP /day. This plant will likely be a containerised and portable activated sludge style system, with a expected footprint of approximately 20 m2 and the following basic configuration:

Inlet screen → Balance Tank → Primary Tanks (Anaerobic and Anoxic tanks) → Aeration Tank → Clarifying Tank → Dosing and Holding Tank

This plant will treat effluent to secondary grade conforming to the specifications defined under *AS1546 -2008 On-site domestic wastewater treatment units - Septic tanks* and *AS1547-2000 On-site domestic waste water management.*

A number of commercially available containerised systems are suitable for treatment of anticipated flows to the secondary treatment level. Examples include but are not limited to the RWS 120EP, Aqueo AS Range or the CRS STP 120. The plant will be monitored and serviced at the required intervals as stipulated by the manufacturer/supplier.

The proposed disposal strategy for treated effluent is to dose the sediment/retention basins, which will ultimately be discharged to the receiving environment. It is proposed to treat the effluent to a Class B standard as prescribed in *Environmental Guidelines for Use of Recycled Water in Tasmania (2002).*

The water treatment parameters required under this guideline for Class B are:

- 100cfu/ml Thermotolerant Coliforms
- pH 5.5-8.0
- BOD <50mg/L
- Nutrient, toxicant and salinity controls

5. PROPOSED SURFACE WATER MONITORING PLAN

5.1 Background

In accordance with DPEMP Commitment 21 (CBM Sustainability, 2012), HRCM have implemented a 'pre-approval phase' monthly surface water sampling program. Details of that program are presented in Section 5.2 along with a summary of results to date

Whilst the 'pre-approval stage' surface water quality monitoring program provides a valuable characterisation of existing surface water quality, HRCM also acknowledge the need to develop, then implement an expanded surface water sampling program for implementation during the mine development and operative phases. Section 5.3 of this report provides details of the proposed expanded surface water monitoring program, for consideration by the EPA.

The rationale guiding development of the 'pre-approval phase' and the 'expanded construction / operative phase' surface water monitoring programs is provided in the:

> '*National Water Quality Management Strategy – Paper Number 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality*' (ANZECC, 2000) (Hereafter referred to as the NWQMS).

The NWQMS details a framework for the selection and application of relevant water quality guidelines, at a local scale. Broadly speaking that approach involves the following:

- Define primary management aims;
- Define water quality objectives;
- Determine appropriate water quality guidelines;
- Establish monitoring and assessment program; and
- Implement management responses (as appropriate).

These components are discussed in the following report sub-sections.

5.1.1 Primary Management Aims

HRCM aim to develop and operate a best practice coal mining operation that does not adversely impact nearby / downstream surface waters, the aquatic ecosystems they sustain, or down stream water uses (farming, recreation use etc.).

5.1.2 Water Quality Objectives

The surface water monitoring programs detailed in Sections 5.2 (pre-approval phase surface water quality monitoring program) and 5.3 (proposed post-approval surface monitoring program) have been developed with due consideration of the protected environmental values (PEVs) of the downstream receiving environment (The South Esk River).

The PEVs are defined in the following document:

> '*Environmental Management Goals for Tasmanian Surface Waters, Macquarie River & South Esk River*' (DPIW, 2005).

PEVs assigned to the South Esk River include:

A: Protection of Aquatic Ecosystems
(ii) Protection of modified (not pristine) ecosystems from which edible fish are harvested taking into consideration Forestry Tasmania's Management Classification System.

B: Recreational Water Quality and Aesthetics
(i) Primary contact water quality
(ii) Secondary contact water quality
(iii) Aesthetic water quality

E: Industrial Water Supply (Hydro-Electric Power Generation)

In summary, the PEV's recognise the:

- Modified (not pristine) nature of the South Esk Catchment;
- General healthy nature of this system;
- Requirements for protection of recreational (primary and secondary contact), aesthetic, fishing and industrial water values.

5.1.3 *Selection of appropriate water quality guidelines*

Summary of stressor types

The NWQMS (ANZECC, 2000) delineates between physical and chemical stressors that cause; 1) direct, or 2) indirect effects. Additionally, direct effect physical and chemical stressors are divided into; 1) those that are directly toxic and 2) those that are not toxic, but can still directly impact ecosystems and biota. This information is summarised in Figure 9.

Both direct and indirect physical / chemical stressors (See Figure 9) are included in the pre-approval phase surface water monitoring sample suite, which was developed in consultation with the EPA. These parameters are integrated into the expanded construction / operative phase surface water monitoring program (See Section 5.3 for details), but with the intent of reviewing the parameter suite upon submission of the first 'Annual Environmental Review' to the EPA.

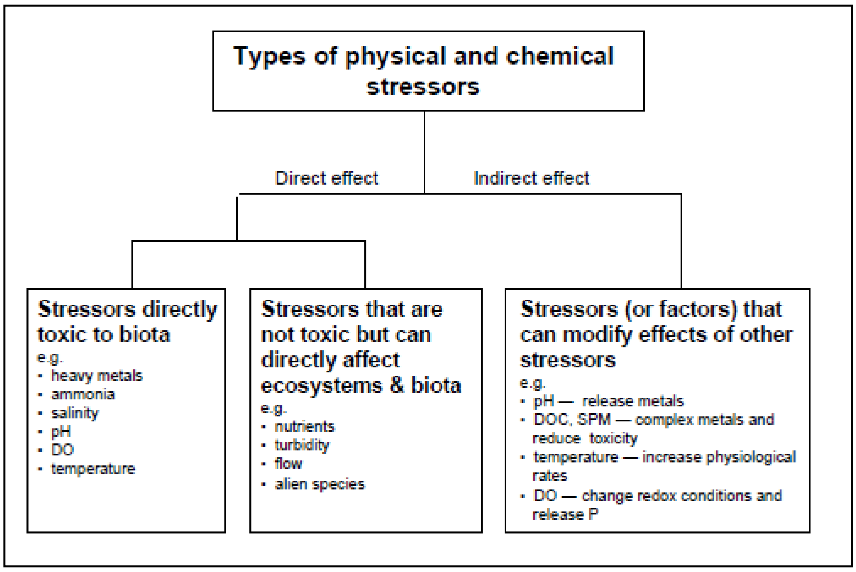


Figure 9: Types of physical and chemical stressors

<u>Adopted guideline trigger values</u>

Consideration of the PEVs detailed in Section 5.1.2 led to the adoption of the following guideline trigger values, for surface water assessment purposes;

- Default trigger values for south east Australian - slightly disturbed highland ecosystems (See Table 3.3.2 and 3.3.3 of NWQMS);
- Toxicant trigger values for protection of 95% of freshwater species (See Table 3.4.1 of NWQMS);
- Guidelines for recreational water quality and aesthetics (See Section 5 of the NWQMS); and
- EPA discharge limits previous applied to Tasmanian mines.

The 95% protection of aquatic ecosystems toxicant trigger levels were selected based on the requirement to protect species inhabiting a slight to moderately disturbed aquatic ecosystem (these are default values assigned in the NWQMS).

5.1.4 Proposed Monitoring and Assessment program

Section 5.2 of this report details the existing surface water quality monitoring program and provides a summary of results to date.

Section 5.3 details the proposed expansion of the surface water quality monitoring program, during the construction and operative phases of the project. The proposal is not absolute; rather it is submitted for EPA's consideration.

5.1.5 Implement Appropriate Management Responses.

Once approved and implemented, results from the expanded surface water monitoring program will be reviewed and compared with adopted guidelines on an ongoing basis. Results will also be collated and reported to the Director (EPA), via the Annual Environmental Review process.

Where exceedances of adopted guidelines are noted, these will be investigated and appropriate control measures implemented to ensure potentially adverse impacts are minimised. All surface water quality issues resolved in a timely manner. EPA will be advised of any issues with potential to cause environmental harm.

5.2 Pre-Approval Stage Surface Water Quality Monitoring Program

The pre-approval stage - surface water quality monitoring program was developed in consultation with EPA. The program is comprised of monthly surface water quality monitoring, at four locations across the site (See Figure 10).

Surface water monitoring commenced in October 2011 and is on-going. A broad range of parameters have been analysed, with results compared to the adopted guideline trigger values detailed in Section 5.1.3.

Initially, EPA required analysis of both dissolved and total metal fractions in surface waters, but this requirement has been reduced to analysis of total metal fractions.

Analysis of total metal concentrations (only) is common practice, with the requirement for analysis of dissolved (also referred to as the labile or potentially bio-available metal fractions) only applying where total metal concentrations exceed adopted guidelines.

All surface water quality results are compared with adopted guidelines in Table 8 and discussed below.

5.2.1 Results

Surface water quality results relating to; 1) general physical properties, 2) cations and anion and 3) metals are detailed separately below.

<u>Physical properties</u>

Flow rates at the four surface water monitoring points varied markedly. For instance:

- Sampling sites on Cardiff Creek ('Cardiff – A' and 'Cardiff – B') recorded flow rates in excess of 5L / second in five of the seven sampling events;
- The 'Valley – M' sampling site, located on the eastern drainage line recorded flow rates below 2L / second in each sampling event; and
- The 'Valley A' sampling site located on the central drainage line, recorded flow rates less than 5L / second during the October and November 2011 sampling events and no flow in all subsequent events.

Site pH levels ranged from 6.69 to 8.37 throughout the sampling period. These results were:

- Within the ANZECC (2000) recreational and aesthetic guideline range of 5 to 9; but
- Slightly higher than the upper pH ANZECC (2000) guideline specified for south east Australian - slightly disturbed highland ecosystems (specified range of 6.5-7.5), indicating that site surface waters are slightly alkaline.

The pH values at the 'Valley – M' sampling site were typically lower than other sites during a given sampling event, with values for this site ranging from 6.5 to 7.6. The relatively lower pH values (though still in the normal range) were likely attributable to the presence of; 1) the old mine adit and 2) coal fragments in small waste piles at this location.

Conductivity levels met adopted guideline trigger values at all sampling sites, the exception being the ‘Valley – M’ site, which recorded levels that were in excess of two times the upper guideline value (350µS/cm^3) during each sampling event.

Total dissolved solids (TDS) levels met adopted guideline trigger values at all sites, but with levels at the ‘Valley – M’ site, typically being 3 to 5 times higher than other sample sites.

Total Suspended Solid (TSS) levels met adopted trigger values, but values at the ‘Valley – M’ were high, relative to other locations.

Turbidity levels in surface waters ranged from 2.7 to 12 NTU, being at the lower end of the ‘normal range’ specified as default trigger values for south east Australia - slightly disturbed highland ecosystems (2-25 NTU). Only one reading of 0.9 recorded at the ‘Valley – M’ site was noted to be slightly below the normal range.

Cations and anions

Cation and anion concentrations met adopted guideline trigger values across the site throughout the sampling period.

Metals that exceeded adopted guideline trigger levels

Total aluminium concentrations commonly exceeded ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems. They occasionally also exceeded ANZECC (2000) Recreation and Aesthetic guideline trigger values, suggesting potential adverse impacts on downstream aquatic ecosystems, recreational activities and stream aesthetics.

Further analysis of the dissolved aluminium concentrations showed dissolved aluminium levels (these represent the labile, or bio-available fraction) were well below ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems, suggesting minimal potential for aquatic ecosystems impacts.

Total and dissolved iron concentrations at site ‘Valley – M’ commonly exceeded adopted ANZECC (2000) Recreation and Aesthetic guideline trigger values indicating potential to adversely impact the aesthetic and recreational values of down stream receiving environments. One sample collected from Cardiff Creek at sample site ‘Cardiff – A’ in December 2011 also exceeded this guideline.

No ANZECC (2000) 95% species protection trigger value for freshwater ecosystems was available for iron, so potential aquatic ecosystem impacts could not be assessed.

Total and dissolved manganese (Mn) concentrations at site ‘Valley – M’ commonly exceeded adopted ANZECC (2000) Recreation and Aesthetic guideline trigger values, but were below ANZECC (2000) 95% species protection trigger values for freshwater ecosystems. This suggests that Mn concentrations at these locations, have the potential to adversely impact the aesthetic and recreational values of down stream receiving environments. However concentrations would not likely cause adverse impacts on aquatic ecosystems.

Three total copper (Cu) concentrations at sites ‘Valley – M’ and one total Cu concentration at ‘Cardiff A’ exceeded ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems. Where this occurs, the NWQMS (2000) requires that the trigger value for Cu be adjusted to take into consideration water hardness (expressed as the concentration of $CaCO_3$ in mg/L) at the site.

Comparison of analysis results with calculated Hardness Corrected Trigger Values (HCTV – See Table 9) showed all Cu concentrations to be below HCTVs with little potential to pose an aquatic ecosystems threat.

Metals below adopted guideline trigger level

Most metals analysed during the investigation did not exceed adopted guideline trigger values. However, unfortunately in some instances laboratory detection limits were below adopted trigger values. Now that adopted guideline values are known, HRCM will ensure that laboratory detection limits in future sampling events are less than adopted guideline trigger values.

Table 10 provides a summary of results for metals that didn't exceed the adopted guideline trigger values.

5.2.2 *Summary*

Surface waters at the site are slightly alkaline, with Cardiff Creek havin ghte highest flow rates. Water quality within Cardiff Creek and both the western and central drainage line appeared to be of good quality, meeting adopted water quality guideline levels.

In contrast surface waters at the 'Valley – M' located on the eastern drainage line, near the old mine adit site was characterised by:

- Slightly more acidic water (though still in the normal range);
- Elevated conductivity levels (typically 2 to 3 times adopted guideline levels);
- Elevated TDS and TSS concentrations, relative to other sampling locations (though still within adopted guideline levels);
- Iron and manganese levels in excess of ANZECC (2000) Recreation and Aesthetic guideline trigger values, though with minimal potential to adversely impact aquatic ecosystems.

An elevated iron result in excess of ANZECC (2000) Recreation and Aesthetic guideline trigger values was also recorded at Cardiff Creek (Cardiff – A sampling site), indicating potential to adversely impact the aesthetic and recreational values of down stream receiving environments.

Elevated Al concentrations recorded during the monitoring event are likely associated with the presence of suspended aluminosilicate minerals (primarily clays). As such, elevated Al concentrations are unlikely to adversely impact aquatic ecosystems, as is evidenced by the absence of dissolved Al in surface water samples. Dissolved Al concentrations should continue to be ascertained and assessed during subsequent monitoring events (See Table 11 for details).

Laboratory detection limits for Cd, Cr(VI) and Pb were typically higher than adopted guideline trigger levels, precluding an accurate determination of elemental concentrations in surface waters. However, given that concentrations were below laboratory detection limits, it is anticipated that the potential for adverse surface water quality impacts are low. HRCM will ensure that laboratory detection limits in future sampling events are below the recently adopted guideline levels..

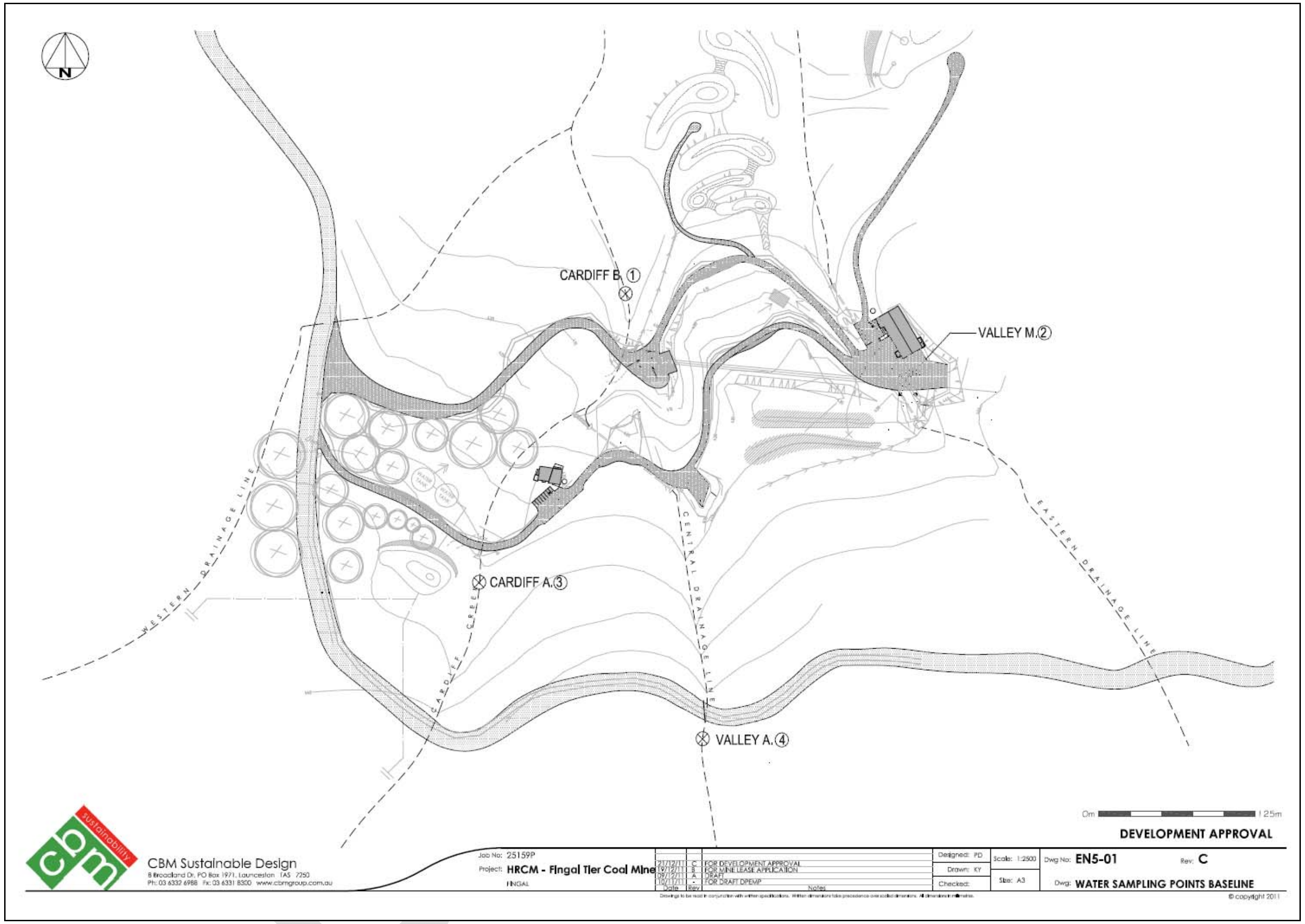


Figure 10 – Existing Surface Water Monitoring Locations

Table 8- Summary of Pre-Approval Surface Water Monitoring Results

Lab tested data	ANZECC 2000 Default trigger values for south east Australia - slightly disturbed highland ecosystems (a)	ANZECC 2000 95% species protection trigger values for freshwater aquatic ecosystems (b)	ANZECC 2000 Recreation and Aesthetic guideline trigger values (c)	EPA discharge limits commonly applied to Tasmanian mines (d)	2011-10 Cardiff A	2011-10 Cardiff B	2011-10 Valley M	2011-10 Valley A	2011-11 Cardiff A	2011-11 Cardiff B	2011-11 Valley M	2011-11 Valley A
Physical properties												
Alkalinity Total mg CaCO3/L			500,000	-	72	72	292	-	79	82	267	-
Conductivity (uS/cm3)	30-350 with typical Tas value of 90	-	-	-	188	192	702 (a)	172	203	205	698 (a)	248
Dissolved Oxygen (mg/L)	90 - 110 (% saturation)!	-	>6.5 or >80% saturation	-	10.4	10.4	6.4 ©	10.3	9.86	10.27	8.98	9.86
Flow (L/s)	NA	-	NA	-	6	6	<2	<5	10	10	<2	<5
pH	6.5-7.5	-	5-9	-	8.1 (a)	8 (a)	7.2 (a)	7.9 (a)	8 (a)	8.2 (a)	7.6 (a)	7.9 (a)
Total Dissolved Solids (mg/L)	-	-	1,000	-	117	103	406	119	142	130	395	163
Total Suspended Solids (mg/L)	2-25	-	-	30-60***	<5	<5	<5	< 5	< 5	< 5	18	8
Turbidity NTU	2-25	-	-	-	2.9	2.7	0.9 (a)	-	3.3	3	11	-
Cations and Anions												
Bromide mg/L	-	-	-	-	<0.1	<0.1	0.2	-	<0.1	<0.1	0.2	-
Ca Dissolved mg/L	-	-	-	-	12.2	12.2	59.8	-	13.8	14.3	59.2	-
Ca Total mg/L	-	-	-	-	12.4	12.5	60.2	-	13.8	14.1	56.6	-
Chloride mg/L			400	250	15.4	16.2	62.3	-	14.5	14.5	67.4	-
K Dissolved mg/L	-	-	-	-	0.6	0.68	1.26	-	77	0.82	1.58	-
K Total mg/L	-	-	-	-	0.62	0.66	1.33	-	0.81	0.82	1.62	-
Mg Dissolved mg/L	-	-	-	-	5.29	5.6	29.9	-	6.6	6.86	33.3	-
Mg Total mg/L	-	-	-	-	5.29	5.66	30.1	-	6.57	6.74	32	-
Na Dissolved mg/L	-	-	300	-	16.4	16.8	41.2	-	19.5	20	45.6	-
Na Total mg/L	-	-	300	-	16.8	17	41.4	-	19.5	19.6	43.3	-
Sulphate mg/L	-	-	400	250	2.4	2.4	4.3	-	2.4	2.3	5.3	-
metals												
Al Dissolved µg/L	-	55 where pH is gretater than 6.5	200	-	<5	<5	<5	-	<20	<20	<20	-
Al Total µg/L	-	55 where pH is gretater than 6.5	200	-	55 (b)	54	23	-	167 (b)	210 (b,c)	568 (b,c)	-
As Dissolved µg/L	-	As V = 13, but As III = 24	50	-	<1	<1	<1	-	<10	<10	<10	-
As Total µg/L	-	As V = 13, but As III = 24	50	-	<1	<1	<1	-	<10	<10	<10	-
Cd Dissolved µg/L	-	0.2 ^^	5	-	<0.1	<0.1	<0.1	-	<1	<1	<1	-
Cd Total µg/L	-	0.2 ^^	5		<0.1	<0.1	<0.1	-	<1	<1	<1	-
Co Dissolved µg/L	-	-	-	-	<0.5	<0.5	0.9	-	<1	<1	<1	-
Co Total µg/L	-	-	-	-	<0.5	<0.5	1.1	-	<1	<1	<1	-
Cr III Dissolved µg/L	-	-	50	-	<1	<1	<1	-	<1	<1	<1	-
Cr III Total µg/L	-	-	50	-	<1	<1	<1	-	2	<1	<1	-
Cr VI µg/L	-	1	-	-	<5	<5	<5	-	<5	<5	<5	-
Cu Dissolved µg/L	-	1.4^^	1000	-	<1	<1	<1	-	<1	<1	<1	-
Cu Total µg/L	-	1.4^^	1000	-	<1	<1	<1	-	<1	<1	2	-
Fe Dissolved µg/L	-	-	300	-	<20	<20	305©	-	<20	<20	100	-
Fe Total µg/L	-	-	300	-	87	102	511©	-	184	189	1430©	-
Hg Dissolved µg/L	-	0.06**(inorganic)	1	-	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	-
Hg Total µg/L	-	0.06**(inorganic)	1	-	<0.05	<0.05	<0.05	-	<0.05	<0.05	<0.05	-
Mn Dissolved µg/L	-	1900	100	-	2.7	0.7	495 ©	-	<5	<5	69	-
Mn Total µg/L	-	1900	100	-	4.9	3	525 ©	-	**<5**	<5	350 ©	-
Ni Dissolved µg/L	-	11^^	100	-	<0.5	<0.5	1.6	-	<10	<10	<10	-
Ni Total µg/L	-	11^^	100	-	<0.5	<0.5	2.2	-	<10	<10	<10	-
Pb Dissolved µg/L	-	3.4^^	50	-	<0.5	<0.5	<0.5	-	<7	<7	<7	-
Pb Total µg/L	-	3.4^^	50		<0.5	<0.5	<0.5	-	<7	<7	<7	-
Zn Dissolved µg/L	-	8.0^^	5000	-	<1	<1	<1	-	<1	<1	1	-
Zn Total µg/L	-	8.0^^	5000	-	<1	<1	2	-	2	1	7	-

Lab tested data	2011-12 Cardiff A	2011-12 Cardiff B	2011-12 Valley M	2011-12 Valley A	2012-01 Cardiff A	2012-01 Cardiff B	2012-01 Valley M	2012-01 Valley A	2012-02 Cardiff A	2012-02 Cardiff B	2012-02 Valley M	2012-02 Valley A
Physical properties												
Alkalinity Total mg CaCO3/L	71	71	297	NO FLOW				NO FLOW			364	NO FLOW
Conductivity (uS/cm3)	190	197	798 (a)	NO FLOW	206	217	862 (a)	NO FLOW	207	218	925 (a)	NO FLOW
Dissolved Oxygen (mg/L)	9.57	8.97	6.54	NO FLOW	12.28	12.38	12.91	NO FLOW	12.13	10.78	11.03	NO FLOW
Flow (L/s)	<5	<5	<1	NO FLOW	<5	<5	<1	NO FLOW	6.7	6.7	<1	NO FLOW
pH	7.8 (a)	7.8 (a)	7.5	NO FLOW	8.1 (a)	7.9 (a)	6.5	NO FLOW	7.93 (a)	8.37 (a)	6.83	NO FLOW
Total Dissolved Solids (mg/L)	144	169	529	NO FLOW	134	141	552	NO FLOW	141	142	592	NO FLOW
Total Suspended Solids (mg/L)	< 5	7	14	NO FLOW				NO FLOW			14	NO FLOW
Turbidity NTU				NO FLOW	8.2	7.3	1.7	NO FLOW	8.7	8	12.3	NO FLOW
Cations and Anions												
Bromide mg/L	<0.1	<0.1	<0.1	NO FLOW				NO FLOW			0.2	NO FLOW
Ca Dissolved mg/L	12.1	12.9	61.4	NO FLOW				NO FLOW				NO FLOW
Ca Total mg/L	12.2	12.6	64.4	NO FLOW				NO FLOW			76.2	NO FLOW
Chloride mg/L	12.6	14.6	64.8	NO FLOW				NO FLOW			65.9	NO FLOW
K Dissolved mg/L	0.69	0.69	1.3	NO FLOW				NO FLOW				NO FLOW
K Total mg/L	0.72	0.75	1.38	NO FLOW				NO FLOW				NO FLOW
Mg Dissolved mg/L	5.65	6.36	34.2	NO FLOW				NO FLOW				NO FLOW
Mg Total mg/L	5.65	6.29	35.5	NO FLOW				NO FLOW			40.7	NO FLOW
Na Dissolved mg/L	17	16.4	47.1	NO FLOW				NO FLOW				NO FLOW
Na Total mg/L	16.8	16	48.8	NO FLOW				NO FLOW				NO FLOW
Sulphate mg/L	1.9	2.1	10.8	NO FLOW				NO FLOW				NO FLOW
metals												
Al Dissolved µg/L	<20	<20	<20	NO FLOW				NO FLOW				NO FLOW
Al Total µg/L	261 (b,c)	232 (b,c)	628 (b,c)	NO FLOW				NO FLOW			440 (b,c)	NO FLOW
As Dissolved µg/L	<10	<10	<10	NO FLOW				NO FLOW				NO FLOW
As Total µg/L	<10	<10	<10	NO FLOW				NO FLOW			3	NO FLOW
Cd Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Cd Total µg/L	<1	<1	<1	NO FLOW				NO FLOW			<0.1	NO FLOW
Co Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Co Total µg/L	<1	<1	2	NO FLOW				NO FLOW			1.8	NO FLOW
Cr III Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Cr III Total µg/L	<1	<1	<1	NO FLOW				NO FLOW			1	NO FLOW
Cr VI µg/L	<5	<5	<5	NO FLOW				NO FLOW			<5	NO FLOW
Cu Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Cu Total µg/L	<1	<1	<1	NO FLOW				NO FLOW			2	NO FLOW
Fe Dissolved µg/L	<20	24	<20	NO FLOW				NO FLOW			1790 ©	NO FLOW
Fe Total µg/L	259	567©	1780©	NO FLOW				NO FLOW				NO FLOW
Hg Dissolved µg/L	-	-	-	NO FLOW				NO FLOW				NO FLOW
Hg Total µg/L	-	-	-	NO FLOW				NO FLOW			<0.05	NO FLOW
Mn Dissolved µg/L	<5	<5	348 ©	NO FLOW				NO FLOW			309 ©	NO FLOW
Mn Total µg/L	6	8	375 ©	NO FLOW				NO FLOW				NO FLOW
Ni Dissolved µg/L	<10	<10	<10	NO FLOW				NO FLOW				NO FLOW
Ni Total µg/L	<10	<10	<10	NO FLOW				NO FLOW			2.7	NO FLOW
Pb Dissolved µg/L	<7	<7	<7	NO FLOW				NO FLOW				NO FLOW
Pb Total µg/L	<7	<7	<7	NO FLOW				NO FLOW			0.5	NO FLOW
Zn Dissolved µg/L	<1	<1	1	NO FLOW				NO FLOW				NO FLOW
Zn Total µg/L	2	2	4	NO FLOW				NO FLOW			6	NO FLOW

Lab tested data	2012-03 Cardiff A	2012-03 Cardiff B	2012-03 Valley M	2012-03 Valley A	2012-04 Cardiff A	2012-04 Cardiff B	2012-04 Valley M	2012-04 Valley A	2012-05 Cardiff A	2012-05 Cardiff B	2012-05 Valley M	2012-05 Valley A
Physical properties												
Alkalinity Total mg CaCO3/L	87	87	381	NO FLOW	83	83	382	NO FLOW	81	81	357	NO FLOW
Conductivity (uS/cm3)	211	209	877 (a)	NO FLOW	214	188	901 (a)	NO FLOW	203	204	905 (a)	NO FLOW
Dissolved Oxygen (mg/L)	13.52	10.3	10.5	NO FLOW	14.43	13.25	10.7	NO FLOW	10.15	11.76	10.88	NO FLOW
Flow (L/s)	6	6	<1	NO FLOW	5.3	5.3	<1	NO FLOW	**8.3**	8.3	<1	NO FLOW
pH	7.79 (a)	7.86 (a)	6.69	NO FLOW	8.16 (a)	8.02 (a)	6.89	NO FLOW	8.21 (a)	7.92 (a)	7.13	NO FLOW
Total Dissolved Solids (mg/L)	137	136	561	NO FLOW	139	122	577	NO FLOW	160	130	576	NO FLOW
Total Suspended Solids (mg/L)	< 5	< 5	5	NO FLOW	< 5	< 5	10	NO FLOW	<5	<5	<5	NO FLOW
Turbidity NTU	5.2	3	10.2	NO FLOW	5.5	5.9	7.8	NO FLOW	4.9	3.3	3.9	NO FLOW
Cations and Anions												
Bromide mg/L	<0.1	<0.1	0.2	NO FLOW	<0.1	<0.1	0.2	NO FLOW	0.02	0.03	0.19	NO FLOW
Ca Dissolved mg/L	14.7	14.5	80.8	NO FLOW				NO FLOW				NO FLOW
Ca Total mg/L	14.3	14.1	78.8	NO FLOW	14.4	14.3	78	NO FLOW	7	9	59	NO FLOW
Chloride mg/L	12.7	12.7	66.1	NO FLOW	13.3	13.3	70.3	NO FLOW	13	13	78	NO FLOW
K Dissolved mg/L	0.83	0.74	1.31	NO FLOW				NO FLOW				NO FLOW
K Total mg/L	0.75	0.74	1.3	NO FLOW				NO FLOW	<1	<1	1	NO FLOW
Mg Dissolved mg/L	6.51	6.64	42.4	NO FLOW				NO FLOW				NO FLOW
Mg Total mg/L	6.26	6.46	43.3	NO FLOW	6.32	6.37	45.6	NO FLOW	2	5	36	NO FLOW
Na Dissolved mg/L	19.5	19.5	56.9	NO FLOW				NO FLOW				NO FLOW
Na Total mg/L	19.7	19.7	55.8	NO FLOW				NO FLOW	18	24	68	NO FLOW
Sulphate mg/L	2.6	2.5	11.9	NO FLOW	2.6	2.5	15.2	NO FLOW	3	3	24	NO FLOW
metals												
Al Dissolved µg/L	<20	<20	<20	NO FLOW				NO FLOW				NO FLOW
Al Total µg/L	145 (b)	88 (b)	109 (b)	NO FLOW	110 (b)	153 (b)	24	NO FLOW	100 (b)	60 (b)	190 (b)	NO FLOW
As Dissolved µg/L	<10	<10	<10	NO FLOW				NO FLOW				NO FLOW
As Total µg/L	<10	<10	<10	NO FLOW	<1	<1	2	NO FLOW	2	2	2	NO FLOW
Cd Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Cd Total µg/L	<1	<1	<1	NO FLOW	<0.1	<0.1	<0.1	NO FLOW	<0.1	<0.1	<0.1	NO FLOW
Co Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Co Total µg/L	<1	<1	<1	NO FLOW	<0.5	<0.5	1.2	NO FLOW	<1	<1	1	NO FLOW
Cr III Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Cr III Total µg/L	<1	<1	<1	NO FLOW	<1	<1	<1	NO FLOW	2	2	2	NO FLOW
Cr VI µg/L	<5	<5	<5	NO FLOW	<5	<5	<5	NO FLOW				NO FLOW
Cu Dissolved µg/L	<1	<1	<1	NO FLOW				NO FLOW				NO FLOW
Cu Total µg/L	<1	<1	<1	NO FLOW	1	<1	1	NO FLOW	2	<1	3	NO FLOW
Fe Dissolved µg/L	<20	<20	<20	NO FLOW				NO FLOW				NO FLOW
Fe Total µg/L	130	97	1230 ©	NO FLOW	132	220	630 ©	NO FLOW	180	150	680 (c)	NO FLOW
Hg Dissolved µg/L	<0.05	<0.05	<0.05	NO FLOW				NO FLOW				NO FLOW
Hg Total µg/L	<0.05	<0.05	<0.05	NO FLOW	<0.05	<0.05	<0.05	NO FLOW	<0.1	<0.1	<0.1	NO FLOW
Mn Dissolved µg/L	<5	<5	151 ©	NO FLOW				NO FLOW				NO FLOW
Mn Total µg/L	<5	<5	272 ©	NO FLOW	7.1	12.9	247 ©	NO FLOW	5	4	223 ©	NO FLOW
Ni Dissolved µg/L	<10	<10	<10	NO FLOW				NO FLOW				NO FLOW
Ni Total µg/L	<10	<10	<10	NO FLOW	0.6	<0.5	2.3	NO FLOW	<1	<1	2	NO FLOW
Pb Dissolved µg/L	<7	<7	<7	NO FLOW				NO FLOW				NO FLOW
Pb Total µg/L	<7	<7	<7	NO FLOW	<0.5	0.5	<0.5	NO FLOW	<1	<1	<1	NO FLOW
Zn Dissolved µg/L	<1	<1	1	NO FLOW				NO FLOW				NO FLOW
Zn Total µg/L	2	5	3	NO FLOW	2	1	2	NO FLOW				NO FLOW

Notes

(a) = Exceedance of ANZECC 2000 Default trigger values for south east Australia - slightly disturbed highland ecosystems

(b) = Exceedance of ANZECC 2000 95% species protection trigger values for freshwater ecosystems

(c) = Exceedance of ANZECC 2000 Recreation and Aesthetic guideline trigger values

(d) = Exceedance of EPA discharge limits commonly applied to Tasmanian mines

** = 99% default trigger level adopted, due to the potential for; a) mercury to biaccumulate, and b) secondary poisoning effects to occur.
*** A TSS limit of 30mg/L is commonly applied where the lowest flow rate of the receiving waters is less than 50 times greater than the flow rate of emission; or 60 mg/L is commonly applied where the lowest flow rate of the receiving waters is at least 50 times greater than the flow rate of the emission.

! = Guideline is given as percentage saturation - whereas results have been provided in mg/L. Therefore results cannot presently be compared with this guideline. Hardrock should consider obtaining future DO readings in the field, with results recorded in the form % O2 saturation at a pre-determined water depth.

^^ = Where the trigger values is exceeded, then a hardness modified trigger value (HMTV) should be derived using the appropriate formula in Table 3.4.3 of the NWQMS. The analysis results should then be compared with the HMTV. Note calculation of a HMTV requires that the water hardness results are also obtained (these are expressed as CaCO3).

Table 9 – Comparison of Cu results with hardness corrected trigger values

Sample number	Sample date	HCTV (µg/L)	Sample result (µg/L)	Analysis result below HCTV
Cardiff A	May 2012	3.25	2	Yes
Valley – M	Nov. 2011	8.97	2	Yes
Valley – M	Feb. 2012	11.68	2	Yes
Valley – M	May 2012	11.49	3	Yes

Table 10 – Metals that were below adopted guideline trigger values

<table>
<tr><th>Parameter</th><th>Comments</th><th>Was laboratory detection limit was greater than adopted guideline trigger value?</th></tr>
<tr><td>Arsenic (As)</td><td>All analysis results were below ANZECC (2000):
95% species protection trigger values for freshwater aquatic ecosystems; and
Recreation and Aesthetic guideline trigger values.
It is therefore anticipated that potential for adverse surface water quality impacts are low.</td><td>No</td></tr>
<tr><td>Cadmium (Cd)</td><td>All analysis results were below ANZECC (2000) Recreation and Aesthetic guideline trigger values.

There were however, some issues with the lower detection limit of some analysis results (See final column for details).</td><td>Yes - In most instances laboratory detection limits (typically 1µg/L) were higher than ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems (0.2µg/L).

Whilst no significant guideline exceedances likely occurred, minor exceedances may not have been detected. It is however, anticipated that the potential for potential for adverse surface water quality impacts are low.</td></tr>
<tr><td>Cobolt (Co)</td><td>No guideline was available for cobalt, but levels were typically below the laboratory detection limits (0.5 to 1µg/L), so are unlikely to cause significant environmental impacts.</td><td>NA</td></tr>
<tr><td>Chromium (III)</td><td>All analysis results were below ANZECC (2000) Recreation and Aesthetic guideline trigger value of (50µg/L).

No ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems were available. However, results were typically below (or just above) laboratory detection limits (1µg/L), so levels are unlikely to cause significant environmental impacts.</td><td>No</td></tr>
<tr><td>Chromium (VI)</td><td>All results were below laboratory detection limits, so are unlikely to pose significant environmental impacts.

Additionally, chromium (VI) compounds are not found in nature. Naturally occurring chromium typically exists as the Cr (III) form, it also commonly occurs as the mineral chromite and in many soils.

The National Pollutant Inventory (NPI, 2012), states that potential sources of anthropogenic Chromium VI include:
Chemical manufacturing industry e.g. dyes for paints, rubber and plastic products;
Metal finishing industry (e.g. chrome plating).
Manufacturers of pharmaceuticals, wood, stone, clay and glass products;
Electrical and aircraft manufacturers, steam and air conditioning supply services.
Cement producing plants as cement contains chromium.
Incineration of council refuse and sewage sludge.
Combustion of oil and coal.
Given the absence of these processes at the site, it is unlikely that Cr(VI) would be present.

Also – see comments in final column.</td><td>Yes - laboratory detection limits (5µg/L) was higher than ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems (1µg/L).

Whilst no significant guideline exceedances likely occurred, minor exceedances may not have been detected.

It is anticipated that the potential for chromium VI to be present it low.</td></tr>
</table>

Parameter	Comments	Was laboratory detection limit was greater than adopted guideline trigger value?
Mercury (Hg)	Mercury levels were below ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems (0.06µg/L), so are unlikely to cause significant environmental impacts.	No
Nickel (Ni)	All analysis results were below ANZECC (2000): • 95% species protection trigger values for freshwater aquatic ecosystems (11µg/L); and • Recreation and Aesthetic guideline trigger values (100µg/L). Levels are unlikely to cause significant environmental impacts.	No
Lead (Pb)	All analysis results were below ANZECC (2000) Recreation and Aesthetic guideline trigger value of (50µg/L). No results were above ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems (3.4µg/L). There were however, some issues with the lower detection limit of analysis results (See final column for details). It is anticipated that lead levels are unlikely to cause significant environmental impacts.	Yes - laboratory detection limits during November and December 2011 and March 2012 were higher than ANZECC (2000) 95% species protection trigger values for freshwater aquatic ecosystems (7µg/L versus 3.4µg/L). Whilst no significant guideline exceedances likely occurred, minor exceedances may not have been detected.
Zinc (Zn)	All analysis results were below ANZECC (2000): • 95% species protection trigger values for freshwater aquatic ecosystems; and • Recreation and Aesthetic guideline trigger values. It is therefore anticipated that potential for adverse surface water quality impacts are low	No

5.3 Proposed Construction / Operative Phase Surface Water Monitoring Program

Proposed sampling locations for the expanded surface water monitoring program are shown in Figure 11 and described in Table 11.

During the first twelve month period of mine construction / operation, surface water sampling should occur at the frequencies detailed in Table 11. The specified parameters should be analysed, with results compared to the adopted guideline detailed in Table in Table 8. Results should be communicated to the EPA in the first ‘Annual Environmental Review’.

Where the parameter concentrations are shown to be consistently below adopted guideline levels, or permit conditions during this period, then HRCM will seek EPA approval to reduce:

- The number of parameters analysed in future sampling events; or
- The frequency of sampling for specific parameters (For instance, EPA may determine that general water quality parameters should continue to be analysed quarterly, but metal and ion concentrations need only be analysed annually.

Oil and grease should be added to the parameter suite with a guideline level of 10mg/L applied (this value is commonly specified in EPA permits).

It is suggested that the sediment retention basin spillway site ‘SPILL’ (See Figure 11 for sample site location) be utilised as the licensed discharge point for the site. This seems appropriate as all mine affected site water will be treated at this location prior to discharge to the eastern drainage line. It is recognised that EPA will likely set specific surface water discharge permit conditions for the spillway site.

Finally, surface water quality monitoring will also be required at the proposed interburden waste rock dump site. The proposed location of that facility is distal to the area discussed in this report. Water quality monitoring at that location is detailed in the ‘Waste Rock Dump Management Plan’ (SEMF, 2012).

Table 11 Proposed sampling locations and monitoring frequencies.

Location	Description	Purpose	Three monthly monitoring	Discharge monitoring
Cardiff - A#	This sampling location has been relocated further up Cardiff Creek, to a location above Valley Road. Relocation of this sampling point will prevent Valley Road runoff from impacting background surface water quality characterisation.	Characterise background surface water quality in Cardiff Creek	Yes*	NA
Cardiff - B	This existing sampling location is located on Cardiff Creek between the loading hoppers / haul road area and settling ponds.	Characterise potential loading / haul road impacts on Cardiff Creek, prior to surface water entering the proposed settling ponds.	Yes*	NA
Cardiff - C	This is a new sampling site located below: 1. The confluence of Cardiff Creek and the western drainage line; and 2. Sediment retention basin spillway inputs.	Characterise surface water quality after receiving site water inputs, including spillway overflow from the sediment retention basin.	Yes*	Yes*
WDL - A	This is a new sampling location established just upstream of Valley Road, where the western drainage line passes under the road via a culvert.	Characterise background surface water quality in the western drainage line - which collects surface flow from a well forested catchment, located between two bluffs on the Tier	Yes*	NA
Valley - A	This is a new sampling location established upstream of Valley Road on the central drainage line.	Characterise background surface water quality in the central drainage area, which collects flow from a less densely vegetated catchment area.	Yes*	NA
Valley – M1	This is a new sampling location established just upstream of Valley Road, where the eastern drainage line passes under the road via a culvert.	Characterise background surface water quality in the eastern drainage area, which also collects flow from a less densely vegetated catchment area.	Yes*	NA
Valley – M#	This sampling location has been relocated to a point: - Further down the eastern drainage line, below the point where the pipe installed to bypass the old wash plant rejoins the eastern drainage line; and - Above sediment retention basin spillway inflows to the eastern drainage line.	Characterise eastern drainage line water quality after passing through the old wash plant area, but prior to receiving discharge from the sediment retention basins.	Yes*	NA
Spill	This new sampling location will be located in the sediment retention basin spillway, prior to discharge to the eastern drainage line.	Characterise sediment retention basin water prior to, or during discharge events.	Yes [a]	Yes [a]

Notes:
* = Where no flow is present during the three monthly, or annual sampling event, then samples should be collected during the next flow event of sufficient magnitude to allow the sample to be collected.
# = Sampling location has been moved from its previous location.
[a] = In the event that no discharge is occurring, collect the sample as close as possible to the spillway in the sediment retention basin.

Parameter suite:
The following parameters should be analysed:

- General water quality parameters including; TSS, conductivity, sulphate, chloride and oil / grease;
- Total metals; Al (total and dissolved), As, Ba, Cd, Co, Cr (VI), Cr (III), Cu, Fe, Hg, Mo, Mn, Ni, Pb, Se, Zn; and
- Cations (Ca, Mg, Na and K).

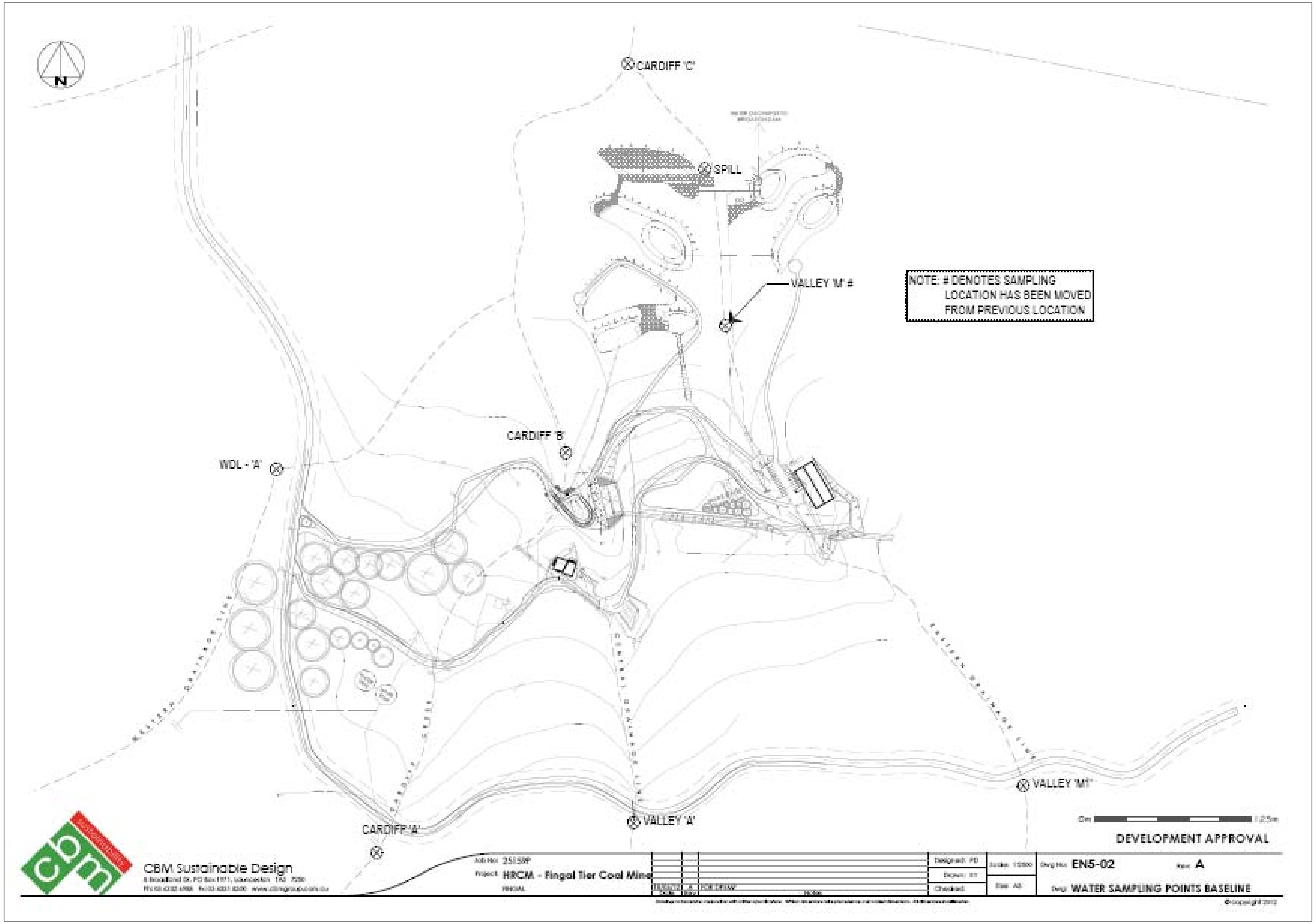


Figure 11 – Proposed Surface Water Monitoring Locations

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6. REFERENCES

ANZECC (2000) *National Water Quality Management Strategy – Paper Number 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

CBM Sustainability Group Pty Ltd (2012), *Fingal Tier Coal Project Development Proposal and Environmental Management Plan (DPEMP)*, Launceston, Tasmania.

DPIW (2005) *Environmental Management Goals for Tasmanian Surface Waters, Macquarie River & South Esk River*, Tasmania.

GHD Pty Ltd (2012) *Report for HardRock Mining Fingal Coal Mine Acid and Metalliferous Drainage (AMD) Assessment*, Hobart, Tasmania.

GHD Pty Ltd (2012) *Report for HardRock Mining Fingal Coal Mine Stage 2 Hydrogeological Review*, Hobart, Tasmania.

Institution of Engineers, Australia (1998) *Australian Rainfall and Runoff: A Guide to Flood Estimation* , Vol. 1, Editor-in-chief D.H. Pilgrim, Barton, ACT.

Minarco Mine Consult (2011) *Initial Technical Review of Fingal Coal Project.*

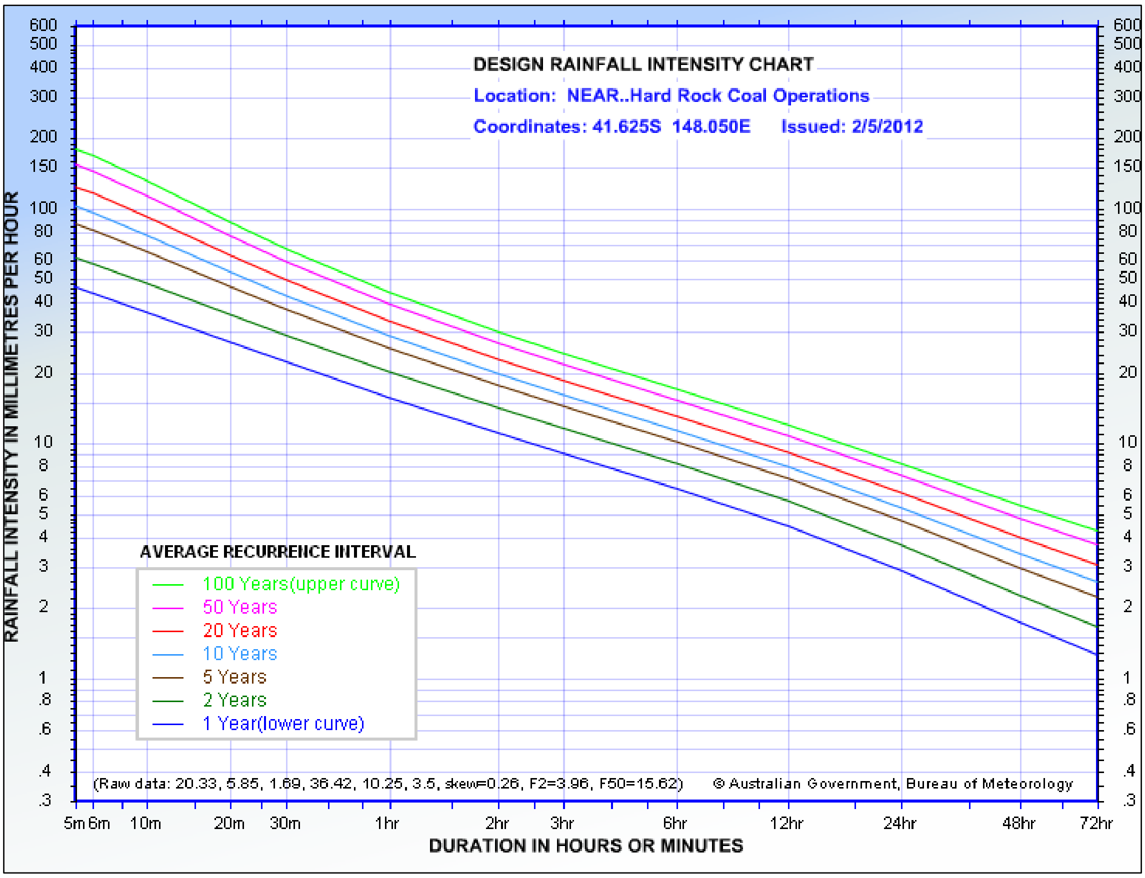
NPI (2012), *National Pollutant Inventory Substances – Fact Sheets,* http://www.npi.gov.au/substances/chromium-vi/source.html, viewed 17th June 2012.

Landcom (2004), *Managing Urban Stormwater: Soils and Construction "The Blue Book" 4th ed. Volumes 1 & 2E*, New South Wales Government.

SEMF (2012), *Fingal Tier Coal Mine Waste Rock Dump Management Plan*, Launceston, Tasmania.

7. APPENDICES

APPENDIX A – DESIGN RAINFALL INTENSITY CHART



APPENDIX B – SEDIMENT BASIN CALCULATIONS

HRCM Coal Adit Area Sediment Basin Sizing Calculations

1. Sediment Zone Volume

Blue Book Vol.1 Appendix J Sheet J-5

Sediment Zone Management is for a 12 Month Period, So Volume Calculated by RUSLE

Site area	Catchments				Remarks
	Adit Area	Loading Area	Laydown Area	Haul Road	
Total catchment area (ha)	0.247	0.285	0.426	0.146	Sediment Dam Catchment
Disturbed catchment area (ha)	0.247	0.285	0.426	0.146	Assume all areas are disturbed
Rainfall data					
Design rainfall depth (days)	5	5	5	5	
Design rainfall depth (percentile)	85	85	85	85	
x-day, y-percentile rainfall event	23	23	23	23	
Rainfall intensity: 2-year, 6-hour storm	8.24	8.24	8.24	8.24	See IFD chart for the site
RUSLE Factors					
Rainfall erosivity (*R*-factor)	1610	1610	1610	1610	Automatic calculation from above data
Soil erodibility (*K*-factor)	0.05	0.05	0.05	0.05	RUSLE data can be obtained from Appendixes A, B and C
Length/gradient (*LS*-factor)	8.4	4.8	7.18	7.9	
Erosion control practice (*P*-factor)	1.3	1.3	1.3	1.3	
Ground cover (*C*-factor)	1	1	1	1	
Calculations					
Soil loss (t/ha/yr)	879	502	751	827	
Soil Loss Class	6	6	6	6	See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	676	386	578	636	

Soil Loss Volume (Sediment Zone Volume) (m^3)	84	55	123	46	Based on an 6-monthly management period

2. Settling Zone Volume (for Type D & F Soils)

Blue Book Vol.1 Appendix J Page J-4

Site area	**Catchments**				**Remarks**
	Adit Area	Loading Area	Laydown Area	Haul Road	
Disturbed catchment area, A (ha)	0.247	0.285	0.426	0.146	Assume all areas are disturbed
Volumetric runnoff coefficient, C_v	0.7	0.7	0.7	0.7	
x-day, xxth-percentile rainfall event	23	23	23	23	
Settling Zone Volume (m3)	40	46	69	24	

3. Total Basin Volume = Settling Zone Volume + Sediment Zone Volume

Sediment Zone Volume (m^3)	84	55	123	46	308
Settling Zone Volume (m^3)	40	46	69	24	178
Total Required Capacity (m^3)	123	101	192	70	486

Sustainable Consulting Solutions

Fingal Tier Coal Mine - Waste Rock Management Plan

For

CBM Sustainable Design / Hardrock Coal Mine

18 June 2012
Revision 2

Project No: 3867.008

SCIENTISTS | ENGINEERS | MANAGERS | FACILITATORS

Integrated Management System
QUALITY AS/NZS ISO 9001 | ENVIRONMENT AS/NZS ISO 14001 | OH&S AS/NZS 4801

DOCUMENT ISSUE AUTHORISATION

PROJECT: Fingal Tier Waste Rock Management Plan **Project No:** 3867.008

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Date	Purpose of Issue/Nature of Revision	Rev	Reviewed by	Issue Authorised by
18/6/12	Draft for client review	1	RA	CO
18/6/12	Final	2	RA	CO

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CONTENTS

1. INTRODUCTION

1.1 Project Overview

Hard Rock Coal Mining Pty Ltd (HRCM) is seeking approval for an underground coal mine and associated works located off Valley Road to the east of Fingal, Tasmania. HRCM intend to develop the coal mine within exploration permit EL16/2010. Mine operations are proposed over two sites; the underground mine and operations area around the Valley No. 2 adit, and the proposed inter-burden waste rock dump adjacent to the nearby Abraham's Pit.

HRCM plans to develop a coal deposit adjacent to the existing Duncan colliery, which is owned and operated by Cornwall Coal Company. The major coal seams modelled in EL16/2010 result in a total inferred resource of 447 Mt. The initial mine plan has identified approximately 13.4 Mt of accessible mineable coal in the initial mine plan. It is anticipated that once the mine is established, the initial extraction rate will be up to 1 Mt of coal per year, which will be used entirely for export markets.

During the initial three months of mine development it is planned that any non-saleable waste rock will be disposed at the waste rock dump site next to Abraham's Pit. Mine engineers project that that a constant stream of about 417 m^3/day of waste rock will be generated over the 3 month adit construction period.

1.2 Location

Abraham's Pit is a gravel quarry currently operated by Forestry Tasmania, located off Valley Road, approximately 10 km east of Fingal and south east of HRCM's adit area. Crushed dolerite is extracted and used as road base material for nearby Forestry Tasmania roads. The proposed dump site is directly adjacent to the eastern side of the active quarry extraction area.

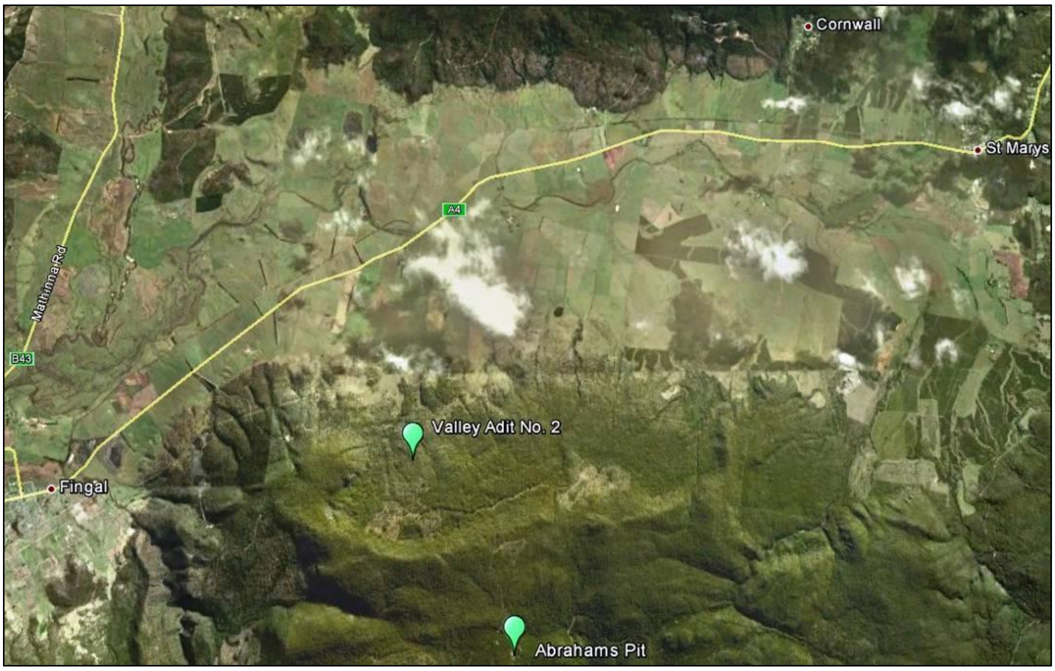


Figure 1: Locality of the Mine and Waste Rock Dump (589911E 5386983N)

The WRD site is an abandoned section of Abraham's Pit that was last quarried between 20 and 30 years ago. As such, a modest amount of re-establishment with natural revegetation has occurred with local species. It is however quite sparse given the lack of topsoil and the rock that covers most of the site (refer to site photos in Appendix A).

1.3 Waste Rock Characterisation

A waste rock characterisation assessment was undertaken by GHD Pty Ltd (GHD) to identify the characteristics of the waste rock and whether it may have potentially detrimental effects on surface runoff or seepage water quality, during the life of the mine and waste dump, and post-closure. Key findings from the assessment (GHD, 2012) were as follows:

- Testing indicated that the coal and probable waste rock at the proposed adit portal and area of early development has a relatively low sulphur content,
- A significant proportion of total sulphur in the carbonaceous material is organic sulphur which will not generate acid when naturally oxidised,
- The net acid generation (NAG) pH and net acid producing potential (NAPP) results, using inorganic sulphur content and acid base accounting, indicate the material represents a low risk of acid generation,
- The remaining waste rock is either non-acid-forming or even has significant potential to neutralise acid generated by other material,
- The tested material does not represent a risk of soil dispersion or saline drainage although some may be moderately alkaline
- Based on water draining from the adit of the Valley No.2 mine, the drainage has only slightly elevated iron and manganese with all other analysed parameters being within acceptable limits for drinking, irrigation or freshwater aquatic ecosystems.

GHD recommended that:

> *As exploration and development works progress, additional AMD testing, including sequential NAG or column leach tests, should be done on materials proposed to be either drained or mined, to confirm the materials are consistent with those tested to date. Given the low risk of AMD development only general sediment and erosion control is necessary, with some additional water quality monitoring and blending of NAF and PAF material if identified.*

The report did not identify any potentially acid forming material. Only non-hazardous, Non-Acid Forming (NAF) and Acid Consuming Non-Acid Forming (AC-NAF) material will be disposed of at the WRD. On-going geochemical testing will be required during extraction to ensure no acid forming or producing waste is disposed at the WRD.

HRCM implemented a 'pre-approval stage' surface water monitoring program across the site between October 2011 and May 2012. Results are detailed in Section 5.2 of the 'Hardrock Coal Mining - Fingal Tier Coal Mine Water Management Plan' (SEMF, 2012) and support GHD's conclusions.

Specifically, surface water quality results at the adit site highlighted:

- Elevated conductivity levels, but with pH levels still within the neutral pH range;
- TDS and TSS concentrations are within adopted guideline levels; and

- Iron and manganese levels are in excess of ANZECC (2000) Recreation and Aesthetic guideline trigger values. However, they meet the ANZECC (2000) aquatic ecosystems guideline trigger values for protection of 95% of aquatic ecosystems, and therefore illustrate minimal potential to adversely impact downstream aquatic environments.

2. WASTE DUMP CONSTRUCTION

After any available topsoil has been stripped and stockpiled, the WRD will be built. Soil stockpiles will be used to cover the WRD as dumping is completed.

Mine engineers estimate waste rock from the initial development will be generated at around 417 m^3 per day for three months, or 38,500 m^3 in total. The WRD will be constructed from the bottom up, initially with a series of batters and benches as shown in Figure 2.

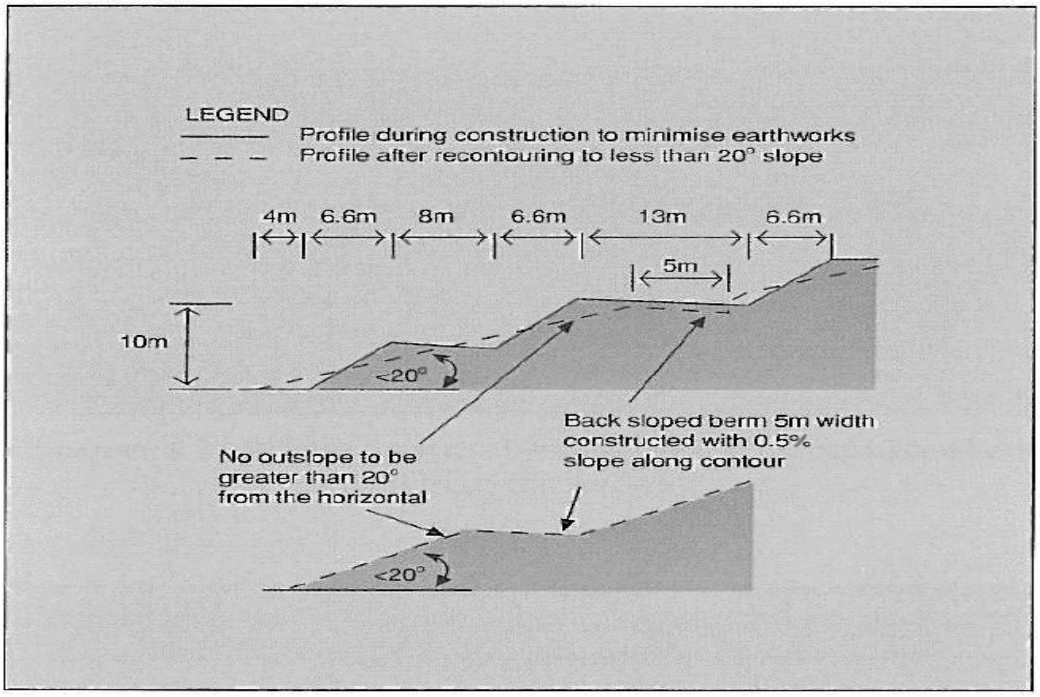


Figure 2: Extract from BPEM specifications for guiding slope formation (Environment Australia, 1998)

Drawings 3867.008-SK01 and 3867.008-SK02 (See Appendix B) show a more detailed indicative first stage placement. As the filling of the WRD progresses, rock will be placed to conform to the surrounding batters as shown in drawing 3867.008-SK05 and 3867.008-SK06 (See Appendix B). Slopes of the batters and the final landform will not exceed more than 20° (refer to BPEM specifications in Figure 2).

The dump footprint shown in drawing SK05 allows space for a sediment detention pond at the south-eastern extent of the site, adjacent to the gravel road. An additional contingency volume of approximately 10,000 m^3 is available which would take the total capacity of the dump to around 48,000 m^3. This could be gained by relocation of the proposed sediment pond next to the 300mm diameter culvert to the southern side of the gravel road, and if the dump is stretched slightly at its north-eastern extent.

It is vital that stability and drainage density of the earthworks are considered in order to aid in run-off and erosion control. Slopes will be designed so that the velocity of runoff is reduced as the catchment of the slope increases. Generally, contour drains and side berms will be installed at the toe of each batter and will direct runoff from north to south, to encourage slow run-off infiltration. Drains steeper than 2% are to be rock lined to a depth of 2.5 times the maximum rock diameter.

Earthworks also need to be compatible with the hydrology of the surrounding area. Water will be collected from the most southern extent of the WRD and directed to a sediment pond located at the south-east of the site. The existing site has very little topsoil and large amounts of surface rock are present. It is anticipated that any potential runoff increase would result from increased grades and not be associated with decreased site permeability.

As the WRD develops, erosion of the faces of the batters is a distinct possibility. Rehabilitation will occur progressively throughout the construction of the WRD so far as is reasonably practicable. If particularly slopes are identified they can be sown with a temporary grass cover (sterile rye grass) and jute geotextile incorporated to minimise any initial erosion. This will minimise surface erosion until the native vegetation takes hold. Rehabilitation is discussed further in Section 4.

If any areas are, out of necessity, constructed at steeper than 20^o, physical instability could pose a potential safety hazard. If this eventuates HRCM will block areas where public access is likely, and the erection of appropriate warning signs will occur to ensure public safety.

3. SEDIMENT CONTROL

3.1 Sediment Generating Area

The area between the existing quarry and the gravel roads nominated for the interburden WRD will provide a short term sediment generating surface until rehabilitation is completed. The surface exposed to runoff during placement of waste rock and prior to vegetation establishment will gradually increase up to a maximum of approximately 10,500m^2.

The staged construction - comprising benching and batters incrementally before contouring – will permit short surface flow paths to be collected in swales for direction to the sediment traps. The final surface – infill of the benches and batters - with deep contour ripping along a uniform slope will slow run off along the longer sloped flow path, with runoff directed to the main waste rock dump perimeter drains channelling to the sediment traps.

Interburden materials are expected to comprise the siltstones associated with the coal seam at depth. This material has been noted as being lightly dispersive, and for the purposes of this report will be classified as Type F (as per the Landcom publication *Blue Book – Managing Urban Stormwater Volumes 1 & 2*). Detailed analysis of the material will be undertaken to ensure the appropriate sediment basin design is achieved.

The dumping, placement, compaction & shaping program is a very short duration, less than six months and the establishment of vegetation and substantial rehabilitation of the waste rock dump can be expected to take another 12-18 months. Therefore a sediment trapping period of around two years is required. This informs the design parameters as per Table 6.1 of the *Blue Book Volume 2E – Mines & Quarries* and shown in Table 2. The receiving environment, for the purposes of the design, has been classified as “sensitive”.

The proposed basin location is on the south-east side of the WRD, near the existing culvert.

3.2 Sediment Retention Basin Volume and Design Requirements

The basin is expected to be located across from the waste rock dump site with existing roadside drainage directing runoff to an existing 300mm diameter culvert. Detailed site survey will be required however the basin parameters will be based on the following rainfall accumulations:

Table 1: Rainfall Accumulations

Percentile	5 day total (mm)
80th	16.5
85th	20.4
90th	27.2
95th	40.7
99th	83.3

Table 2: Sediment Basin Design Parameters (from Landcom, 2004)

	Minimum average recurrence interval (ARI) of design storm event (unless otherwise indicated)							
Duration of disturbance	< 6 months		6–12 months		1–3 years		> 3 years	
Sensitivity of receiving environment ('standard' or 'sensitive')[1]	standard	sensitive	standard	sensitive	standard	sensitive	standard	sensitive
Temporary drainage (erosion) controls[2]								
– designed to have a non-erosive hydraulic capacity to convey	2 yrs	5 yrs	5 yrs	10 yrs	10 yrs	20 yrs	20 yrs	20 yrs
Temporary sediment control measures[3]								
– should be constructed to remain structurally sound in:	2 yrs	5 yrs	5 yrs	10 yrs	10 yrs	20 yrs	20 yrs	20 yrs
Type C sediment retention basin								
– designed to achieve required water quality for flows up to:	0.5 x 1 yr	1 yr	1 yr	2 yrs	1 yr	2 yrs	1 yr	2 yrs
– embankment and spillway designed to be structurally sound in[4]:	10 yrs	20 yrs	20 yrs	50 yrs	50 yrs	100 yrs	50 yrs	100 yrs
Type F or D Sediment retention basin								
– designed to achieve required water quality for storms up to nominated five-day duration percentile event:[5]	75^{th}	80^{th}	80^{th}	85^{th}	80^{th}	85^{th}	90^{th}	95^{th}
– designed to achieve required water quality for storms up to nominated five-day duration percentile event with enhanced erosion controls[6]:	75^{th}	75^{th}	75^{th}	80^{th}	75^{th}	80^{th}	90^{th}	95^{th}
– embankment and spillway designed to be structurally sound in[4]:	10 yrs	20 yrs	20 yrs	50 yrs	50 yrs	100 yrs	50 yrs	100 yrs

[1] A 'sensitive' receiving environment is one that has a high conservation value, or supports human uses of water that are particularly sensitive to degraded water quality.
[2] e.g. diversion banks, perimeter banks, catch drains, level spreaders, check dams, batter drains and chutes.
[3] e.g. sediment fences, stacked rock sediment traps etc. on small catchments where used as a 'last line of defence' (i.e. without a down-slope sediment basin).
[4] This is indicative only – consider the risks of basin failure for each basin to determine appropriate spillway design flow.
[5] For a five-day management period. Adjustment factors to the five-day volumes for alternate management periods are 85% for two-days, 125% for 10 days and 170% for 20 days.
[6] Enhanced erosion controls are described on **vol.1** section 6.3.4(g).

The '*Blue Book'* requirements can therefore be summarised as follows:

5 day 85^{th} percentile rainfall accumulation:	20.4mm
Embankment and spillway design:	1 in 50 year ARI peak flow
Soil group runoff classification:	Group D
Volumetric runoff coefficient:	0.50
Peak flow runoff coefficient:	0.86

Calculations using these inputs determine that the spillway and embankment be designed to accommodate a peak discharge of 740 l/s. The existing 300mm culvert under the road may therefore need to be increased in size to accommodate the potential for higher runoff peaks during placement and rehabilitation of the WRD.

Minimum volumetric and dimensional requirements for a single basin sized to treat the WRD, in the short period before rehabilitation shall comprise the following:

Settling zone volume:	$220m^3$
Sediment storage volume:	$110m^3$
Total basin volume:	$330m^3$

Based on settling requirements for the coarse fraction down to 0.02mm, the basin requires:

Basin surface area:	$350m^2$
Depth of settling zone:	0.6m
Minimum length to width ratio:	5:1

4. REHABILITATION PRINCIPLES AND PROCEDURES

Rehabilitation refers to the activities required to return disturbed ground back to a condition similar to that before disturbance. It includes the activities required to create an environment suitable for the establishment of vegetation such as re-contouring, establishing appropriate drainage control, and correct placement of geotextiles and topsoil. Once completed satisfactorily, then the revegetation phase can commence. Therefore, the long-term goal of rehabilitation is to stabilise disturbed areas and provide an environment that promotes the ecological succession of native species endemic to the area.

Key rehabilitation objectives for the HRCM waste rock dump, following the cessation of disposal activities are to:

- Where practical, reshape all disturbed areas so that they are stable and conform to existing landforms;
- Establish an adequately drained landscape;
- Apply cover and final topsoil layers as necessary;
- Revegetate the disturbed area with appropriate local plant species,
- Control erosion through appropriate drainage control and revegetation; and
- Monitor and manage the rehabilitated areas until the vegetation is self-sustaining or acceptable to regulatory authorities and the local community.

Prior to and during the rehabilitation process, HRCM will consult with Forestry Tasmania, as the land manager whose quarry operations, and nearby forestry operations may be affected by the WRD.

As the dumping operations are likely to be completed within 6 months, the progressive rehabilitation schedules as undertaken on larger, long-term operational mine sites and WRDs is less relevant as a management tool. It is planned that rehabilitation and revegetation will partially commence as sections of the WRD are completed. The majority of rehabilitation and revegetation will be underway immediately after the cessation of operations.

The strategic rehabilitation procedures that will be adopted for rehabilitation operations are outlined below.

3.1 Site Preparation

Site preparation will consist of the following phases of work:

(a) Planning: Consideration will need to be given to the logistics and timing of activities, obtaining appropriate contractors and getting them on site at the right time of year, seed/plant and fertiliser acquisitions, and preparing contour maps to plan and record rehabilitation activities.

(b) Demolition and removal: All redundant machinery and infrastructure that cannot be sold will be demolished and taken off site as scrap or waste.

(c) Earthworks: Earthworks that may be required include profiling and reshaping to conform to surrounding landforms, batter treatment, placement of geotextiles and topsoil, and ripping where appropriate.

(d) Topsoil: It is unlikely that any significant quantities of topsoil are available onsite. However, if stockpiling of topsoil, subsoil and rocks is required it will be undertaken following best practices and kept in separate stockpiles for later re-use. Temporary sediment fencing and berms will be used to control run-off from stockpiles, including shallow settling ponds if required.

3.2 Re-Profiling and Contouring

The first task is to use heavy machinery including bulldozers to profile and reshape any remaining industrial landscapes to conform to surrounding landforms, softening sharp corners and re-grading steep slopes to approximately no more than 20^{o} as per Figure 2, Section 2. This will provide stability to what are in essence fill deposits.

Earthworks also need to be compatible with the hydrology of the surrounding area. It is vital that stability and drainage density of the earthworks are considered in order to aid in run-off and erosion control. Slopes will be designed so that the velocity of runoff is reduced as the catchment of the slope increases. Drains steeper than 2% are to be rock lined to a depth of 2.5 times the maximum rock diameter and will continue to be directed to the sediment pond at the south-east of the site.

3.3 Ripping

The movement of heavy machinery about the site will compress the waste inter-burden material (wheeled machinery can exert pressures of $5kg/cm^2$) and it is common practice to deep rip the newly formed surfaces, usually after topsoil applications to ensure bonding of the layers. Ripping of broad-scale areas prior to revegetation will occur along the contours, and is beneficial in:

- Encouraging infiltration;
- Relieving soil compaction;
- Binding the topsoil to the subsoil;
- Increasing the volume of soil readily accessible to plant roots; and
- Preventing erosion.

Typical ripping depths vary between 30 and 100cm depending on site conditions, the degree of compaction, and the depth of cover over buried waste. Steeper slopes with deep covers may benefit from deeper ripping to help to slow overland flow. For ripping to be effective, the ground should be dry so it shatters (best conditions are likely to occur in summer). Tyne separation distances should equal ripping depth to affect release across the profile. The depth of ripping should be adjusted in the light of actual site conditions, to avoid bringing up buried rocks.

3.4 Topsoil and Soil Ameliorants

Topsoil will be required for application to areas needing rehabilitation and to act as a rooting medium prior to revegetation. Some topsoil stockpiles may be made available as the site is developed however, given the site is part of a disused section of quarry, it is anticipated that new sources of topsoil will be required to adequately cover the waste rock. An adequate depth of topsoil will be spread in order to be conducive to revegetation initiatives. Clay capping is required because the materials are NAG neutral, therefore there should be no reason why a forest ecosystem cannot be encouraged.

Even if what appears to be good quality topsoil is used as a cover, it will be advisable to obtain a number of soil analyses to ensure soil properties are adequate for revegetation. Comparison of the data to control sites in the existing bushland will provide an indication if any further chemical soil amelioration is required. Some form of liming and/or appropriate fertiliser treatment may be required, especially if the soils have been stored for a long time. Where practical soil will be stockpiled as windrows and seeded with grass to stimulate microbiological activity, increase organic content and reduce erosion impacts.

3.5 Erosion Control

Site rehabilitation monitoring will include ongoing assessment of site erosion particularly associated with revegetation areas. Depending on seasonal rainfall, some erosion can be expected until adequate vegetation cover is established, whether as minor gully erosion in the drainage lines or more widespread rilling on sloping ground. Areas of erosion will be stabilised utilising appropriate techniques including but not limited to further revegetation sowings (including temporary cover crops if required), temporary sediment fencing, earthworks (drain stabilisation or cut-off bunds) and/or the laying of geotextile materials.

Temporary vegetation covers can be established using non-fertile cover crops like cereal rye which provide some protection until the native species are established. These vegetation covers also aid in weed suppression, increasing soil carbon levels and stimulating soil microbial activity.

On some batters and steeper banks there may be a requirement to use a stabilising geotextile, like Jute Mesh "Soil Saver", which provides rainfall protection but has a large enough mesh to allow plants to grow up through the mat. The jute will naturally break down within a few years, by which time the native plants should be established. The extent of use and location of these items across the site will become part of the on-going monitoring of the works.

5. REVEGETATION

Revegetation is important in the control of erosion and to create a stable long term protective cover. The goal of initial revegetation efforts is not necessarily to produce a plant community which is identical to the surrounding area. The initial revegetation works should, however, endeavour to establish the basis for a self sustaining system. This, in turn, will allow ecosystem succession and lead to a more stable environment for vegetation.

It is essential to encourage native colonisation and propagation of vegetation wherever possible. However, the relationship between physical, chemical and biological factors may restrict revegetation. For example, a lack of topsoil combined with other factors (e.g. low fertility) may not be able to immediately sustain vegetation growth. Revegetation over materials other than topsoil is possible, although additional work such as the application of fertilisers/gypsum are likely to be needed to improve the ability of the medium to support plant growth over the long term. Post rehabilitation soil testing will confirm what chemical in-balances need to be addressed.

On sites which lack topsoil, seeding rates may need to be increased compared to those on topsoils to ensure a satisfactory cover of plants is achieved. Given the limited amount of topsoil available on the site, rehabilitation by HRCM may involve the placement of clay over some areas, which will have to be treated with various ameliorants for a successful germination of seed (gypsum for example helps break down heavy clays while providing some buffering). Disturbed sites are generally deficient in nutrients and the preparation of certain sites with ripping can improve nutrient accumulation and recycling in the post-mine soil profile.

An on-going application of fertiliser is likely to be required at some sites for some time. The use of fertilisers at the beginning of revegetation programs has been shown to increase species numbers, plant cover and density, and growth rates. The choice of fertiliser used by HRCM and the amount in rehabilitation activities will be guided by soil tests but 250kg/ha is a standard figure, which may need to be repeated in follow up years. Many of Australian native plant species have evolved in nutrient deficient soils (commonly low in phosphorous and potassium) and may not respond favourably to certain fertilisers. As such, fertiliser selection should take into account the specific requirements of plants being propagated at the site.

4.1 Plant and Seed Types

Revegetation will involve the re-establishment of indigenous plant species in line with nearby existing plant communities. Acacias are often useful as site colonisers, due to rapid growth rates and the ability to put nitrogen into the soil. Similarly callistemon species tend to grow rapidly and can colonise rocks substrates, whilst producing fine fibrous root mats that aid in erosion control. Both species produce flowers that attractive native birds, which may introduce native seed from nearby areas. As such, the inclusion of acacia and callistemon species should be considered as potential colonisation species for the site. Further specialist botanical advise should however be sought when determining an appropriate species list for the site.

HRCM will source seed mixes from reputable local seed collectors, taking note of the seed provenance location, date the seed was collected, conditions required for storage and germination rates for each species. HRCM acknowledge the potentially significant lead times required to source local province seed and will aim to engage appropriate seed collection contractors at an early stage (if required).

In areas such as the boundary of the WRD along the gravel road to the south and east, HRCM may use seedlings where rapid vegetation establishment is necessary, or where germination rates from seed have been found to be inadequate. The use of seedlings is likely to be limited due to the expense and the amount of labour required, but can be sourced from local nurseries. Again, locally endemic species will be used that have successfully grown on previously rehabilitated areas.

In addition, other rehabilitation techniques will be implemented such as the placement of seed bearing branches of colonising shrubs (including of tea-tree) to encourage quicker revegetation and assist in erosion prevention. The use of native plants such as *Juncus spp* (or similar) in the form of rooted cuttings for damp areas will also be considered where colonisation of the areas adjacent to the sediment pond is not occurring.

Mechanical devices and spreading machines (hydro-seeders and straw-mulchers) are used for broadcasting seeds in the mining industry provided slopes are not too steep, otherwise hand sowing will be required, especially in small corners of the site difficult to access.

It is important that seed mixes and application rates are worked out precisely for the designated area. This not only ensures that all areas are covered evenly but provides the basis of subsequent assessment of field germination success and seedling survival. Generally a contract should specify a program of seed collection in the spring and summer and seeding should take place in autumn, soon after the completion of earthworks.

4.2 Timing of Revegetation

In line with the local climate at Fingal, reseeding, planting of seedlings and application of fertilisers will ideally occur in late autumn through to early spring to ensure that there is sufficient moisture available for germination and plant establishment, and damage due to frost minimised. All preparatory works required will be ideally completed over the preceding summer/early autumn.

6. OTHER REHABILITATION ISSUES

5.1 Weeds

Controlling the introduction and spread of weeds is important during and after rehabilitation. HRCM will employ weed management strategies during mining and rehabilitation operations. The use of weed identification charts and specific treatment regimes will be developed by HRCM prior to the commencement of active mining operations. It is important that weeds are managed prior to, during and after mining operations, as weeds can rapidly colonise disturbed areas. Weeds elsewhere on the Lease and in areas adjacent to the disturbed areas and surrounding the proposed mining operations will be controlled by HRCM to reduce the potential seed bank.

5.2 Fauna

Faunal re-colonisation of rehabilitated areas is expected to gradually occur with the re-establishment of plant communities. It is possible that some invertebrate species would be present in the topsoil material that will be applied to the disturbed site, and would therefore initiate the invertebrate re-colonisation process. Vertebrate species and mammals are expected to gradually return to the disturbed sites over time.

5.3 Access Roads

Temporary access tracks on the waste dump will be assessed as to which are nominated for closure, and which will remain temporarily open for rehabilitation operations and then closed. Surfaces which are to be rehabilitated will be ripped and have drainage measures installed as necessary. Revegetation of the tracks with appropriate seed mixes will be similar to the treatment of the surrounding areas using mechanical and/or hydro-seeding methods.

5.4 Refuse Disposal

No general refuse will disposed of at the dump, only non acid producing or forming waste rock.

7. REHABILITATION MONITORING AND COMPLETION CRITERIA

After cessation of works HRCM will still continue to manage the site. This is essential to ensure on-going water quality objectives are being met and that landforms remain stable and are not eroding. In addition, the monitoring of revegetation success must be quantitative if it is to provide the necessary feedback on species performance, rehabilitation treatments and seed application rates. Rehabilitated areas need to be monitored and managed as the rehabilitation success can be compromised by the invasion of feral and stock animals, weeds, and human activities. Maintenance, which may be required of HRCM following the initiation of rehabilitation activities, could include:

- Replanting failed or unsatisfactory areas;
- Repairing any erosion or landform failure problems;
- Fire management;
- Pest and weed control;
- Follow up fertiliser applications, and
- Control of native and introduced fauna.

In order to determine that the rehabilitation program has been successful, defining success or completion criteria is a key component. Monitoring can be used to demonstrate that rehabilitation requirements have been met and the site is safe and stable.

Components recommended for inclusion in completion criteria include:

- Physical (e.g. stability, resistance to erosion, re-establishment of drainage);
- Biological (e.g. species richness, plant density, estimate of stems per unit area, canopy cover, seed production, fauna return, weed control, productivity, establishment of nutrient cycles);
- Water quality standards for drainage water, and
- Public safety issues.

Possible completion criteria, which may be adopted for HRCM rehabilitation operations, are given in Table 3.

Table 3: Completion Criteria

Issue	Criteria
Stability	Batters as determined by geotechnical assessment. Stability to be monitored for a suitable time after completion.
Landform	Quarry rehabilitated. To be contoured to conform visually to the surrounding landscape. Tracks ripped and rehabilitated with no or minimal signs of erosion.
Revegetation	Any residual benches capped with topsoil and revegetated. Transects, plant cover, density and diversity. Revegetation with seed mixes appropriate to the area. Transects, plant cover, density and diversity.
Water Quality	On-going monitoring at the sediment basin.
Safety	Appropriate batters and slopes. Sediment dam surface unlikely to pose a safety hazard.
Control	Ensure that the levels of weed infestation remain low and no greater than the surrounding areas
Removal	All items to be removed from site. Areas to be cleaned and rehabilitated for revegetation
Timing	Works will be complete within approximately 6 months of WRD closure

It is important that the post-mining landform, drainage, and vegetation associations are stable and self-sustaining, visually compatible with the surrounding land and meet community expectations. Progressive rehabilitation can be an important tool in achieving these objectives. Where possible, HRCM will concurrently rehabilitate worked out or disused areas, with activities on other sections of land. The rehabilitation endpoints will be agreed on by HRCM, MRT and DPIPWE. DPIPWE will be notified of the cessation of disposal activities in the area.

8. REHABILITATION MONITORING RECOMMENDATIONS

An indicative approach will be used by HRCM for post-decommission monitoring of all rehabilitation works undertaken. Newly rehabilitated areas will be monitored monthly for the first 6 months, then at 12 months (year 1), and then annually from then on for 5 years. A summary of the post decommissioning monitoring program is provided in Table 4.

Sediment pond water quality monitoring will be completed on a monthly basis for the first twelve months. Surface water will be analysed for parameters shown in Table 4. results will then be compared to the adopted guideline trigger values detailed in Table 8 of the 'HardRock Coal Mining - Fingal Tier Coal Mine Water Management Plan' (SEMF, 2012). An oil and grease guideline level of 10mg/L will also be applied (this value is commonly specified in EPA permits).

Results will be compiled on a monthly basis and communicated to the EPA in the first 'Annual Environmental Review'. Where results indicate potential to cause environmental harm, HRCM will immediately notify the EPA and implement appropriate control measures to adequately control adverse environmental impacts.

Where the parameter concentrations are shown to be consistently below adopted guideline levels, or permit conditions during the first twelve month period, then HRCM will seek EPA approval to reduce:

- The number of parameters analysed in future sampling events; or
- The frequency of sampling for specific parameters (For instance, EPA may determine that general water quality parameters should continue to be analysed quarterly, but metal and ion concentrations need only be analysed annually.

Table 4: Rehabilitation Monitoring Program

Parameter	Sampling/Monitoring Approach
Pit wall stability	Visual, photographic, periodic survey.
Sediment pond water quality to be analysed monthly (In the event of overflow, water should be collected from the pond discharge point, otherwise samples are to be collected from the pond itself).	General water quality parameters to include; TSS, TDS, conductivity, sulphate, chloride and oil / grease; Metals (total concentrations) to include; Al (total and dissolved fractions), As, Ba, Cd, Co, Cr (VI), Cr (III), Cu, Fe, Hg, Mo, Mn, Ni, Pb, Se, Zn. Cations (Ca, Mg, Na and K).
Vegetation Establishment	Transects, density, cover, diversity, photographic, regeneration
Erosion	Visual, photographic, sediment loading in runoff

Notes: TDS = Total Dissolved Solids, TSS = Total Suspended Sediment

Reports on the progress of rehabilitation works will be provided to management and a summary of findings included in the Annual Environmental Review Report to EPA. Parameters for assessment of rehabilitation works for sign off after 5 years of monitoring will be agreed on with EPA and MRT and a close out inspection organised with these parties.

8.1 Vegetation Recording

Records will be kept of how the WRD was rehabilitated and revegetated including all seeding specifications. These can be used to refine future direct seeding on areas which may fail to produce an adequate cover.

Assessing establishment
Assessment of the site can be done at different stages:

1. After 3 months to assess germination rates:
Identification of species at this stage will be difficult, but identification of 'plant groups' should be possible.

2. After 12 months to assess establishment and survival rates:
Establishment rates will be measured against the desired outcome of Conservation compared to the cover of plants in adjacent control sites. This will help fine tune seeding mixes for future projects and help identify reasons for success or failure.

3. After 18 months to assess any new germination:
A poor germination in the first year may be followed by late germination in year two, especially of hard seeded species. Areas of failure or low cover of plants will be re-sown. Thereafter, all sites will be monitored annually out to Year 5 following closure.

Rehabilitation sites will be monitored at the above mentioned times to determine germination success, diversity and cover. If there are judged to be insufficient number of desired species emerging to provide a reasonable cover in the next year, additional treatment will be considered after testing to determine likely causes of poor results. Remedial work would be undertaken at the next suitable opportunity and may, depending on any follow up soil tests, and require additional fertiliser.

4. During the construction and rehabilitation phases:
Conduct surface water quality monitoring of sediment pond water in accordance with Table 4.

9. REFERENCES

ANZECC (2000) *National Water Quality Management Strategy – Paper Number 4 – Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

CBM Sustainability Group Pty Ltd (2012), *Fingal Tier Coal Project Development Proposal and Environmental Management Plan (DPEMP)*, Launceston, Tasmania.

DPIW (2005) *Environmental Management Goals for Tasmanian Surface Waters, Macquarie River & South Esk River*, Tasmania.

DPIPWE (1999) *Quarry Code of Practice*, Hobart, Tasmania.

GHD Pty Ltd (2012) *Report for HardRock Mining Fingal Coal Mine Acid and Metalliferous Drainage (AMD) Assessment*, Hobart, Tasmania.

GHD Pty Ltd (2012) *Report for HardRock Mining Fingal Coal Mine Stage 2 Hydrogeological Review*, Hobart, Tasmania.

Environment Australia (1998) *Landform Design for Rehabilitation: Best Practice Environmental Management in Mining*, Commonwealth of Australia.

Institution of Engineers, Australia (1998) *Australian Rainfall and Runoff: A Guide to Flood Estimation* , Vol. 1, Editor-in-chief D.H. Pilgrim, Barton, ACT.

Landcom (2004), *Managing Urban Stormwater: Soils and Construction "The Blue Book" 4th ed. Volumes 1 & 2E*, New South Wales Government.

SEMF (2012), *Fingal Tier Coal Mine Water Management Plan*, Launceston, Tasmania.

APPENDIX A

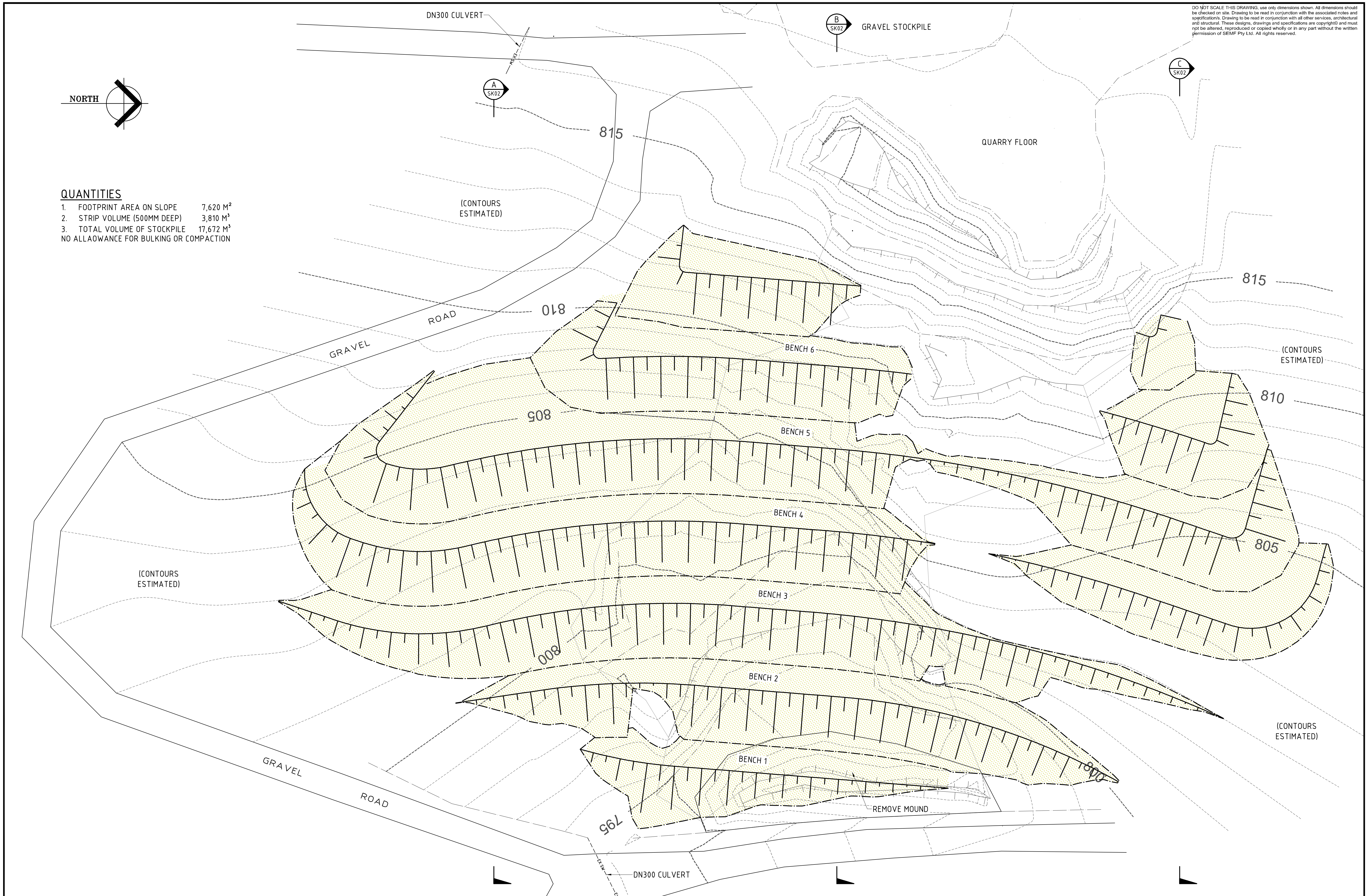
APPENDIX A - Waste Rock Dump Site Photos

	View to the west from the toe of the proposed dump site.
	View to the south-west from the toe of the proposed dump site.

	Toe of the waste rock dump to the west of the gravel road.
	Operations at Abraham's Pit.
	View north-east extent of the operational quarry, which drops away to the waste rock dump site.

APPENDIX B

APPENDIX B – Preliminary WRD Design Drawings



QUANTITIES

1. FOOTPRINT AREA ON SLOPE 7,620 M^2
2. STRIP VOLUME (500MM DEEP) 3,810 M^3
3. TOTAL VOLUME OF STOCKPILE 17,672 M^3

NO ALLAOWANCE FOR BULKING OR COMPACTION

REV.	DESCRIPTION	DRN	CHK	APP.	DATE
B	QUANTITIES ADDED				

DRAWING CHECK	SIGNATURE	DATE	CO-ORDINATION CHECK	SIGNATURE	DATE
DRAWN			STRUCT.		
DESIGNED			MECH.		
CHECKED			ELECT.		
CLIENT			HYDR./CIVIL		
			FIRE/ENV.		

CLIENT: CBM HARD ROCK COAL

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Website: www.semf.com.au
ACN 117 492 814 ABN 24 117 492 814

PROJECT: WASTE ROCK STOCKPILE

TITLE: SITE LAYOUT

A1

STATUS: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

SCALE @ A1 1:250
DIMENSIONS IN MILLIMETRES

DRAWING No. 3867.008- SK01
REV. B

REV.	DESCRIPTION	DRN	CHK	APP.	DATE

DRAWING CHECK	SIGNATURE	DATE	CO-ORDINATION CHECK	SIGNATURE	DATE
DRAWN			STRUCT.		
DESIGNED			MECH.		
CHECKED			ELECT.		
CLIENT			HYDR./CIVIL		
			FIRE/ENV.		

CLIENT: CBM HARD ROCK COAL

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Website: www.semf.com.au
ACN 117 492 814 ABN 24 117 492 814

PROJECT: WASTE ROCK STOCKPILE

TITLE: SITE SECTIONS

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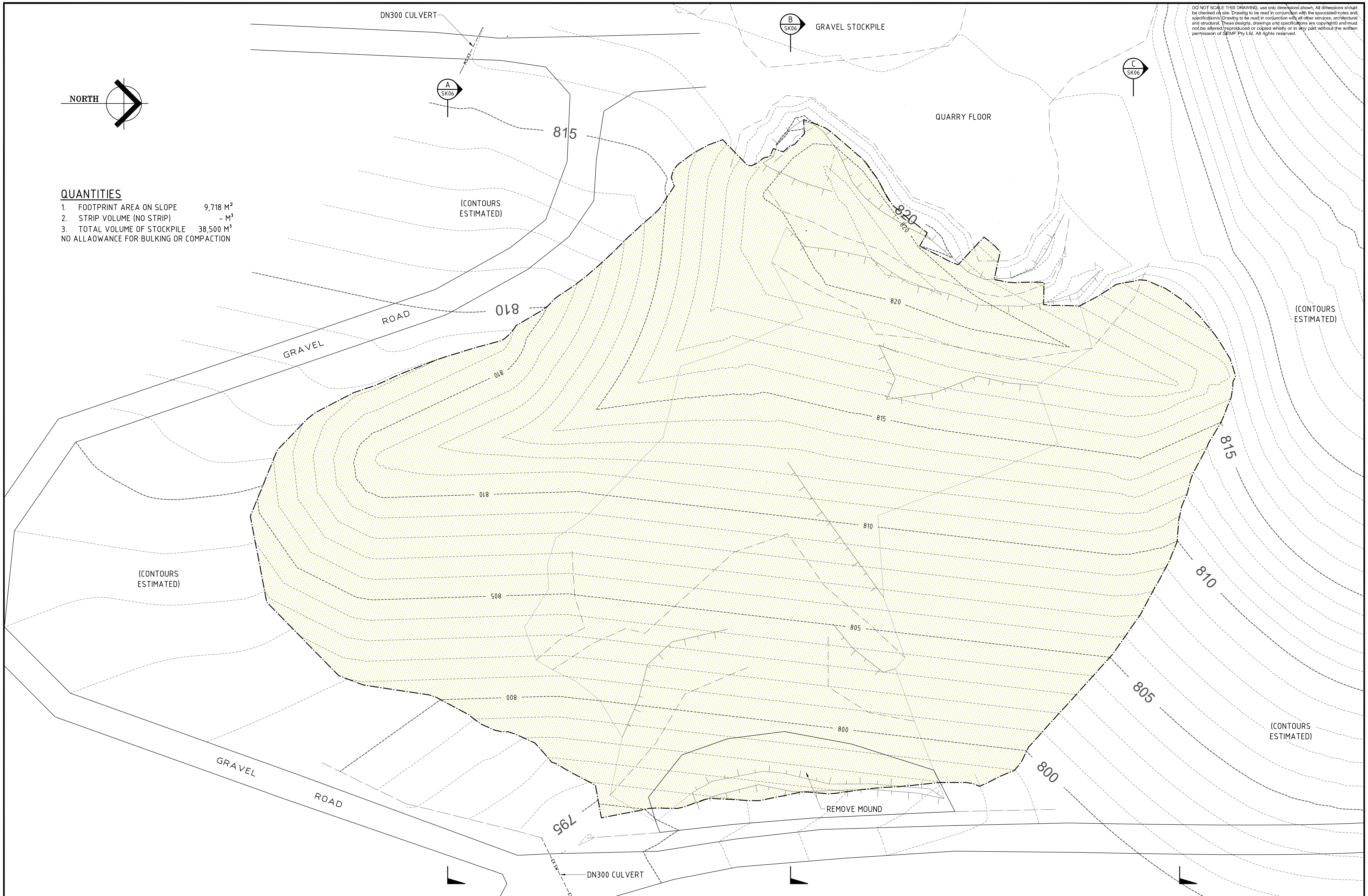
STATUS: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

SCALE @ A1: 1:250 DIMENSIONS IN: MILLIMETRES

DRAWING No. 3867.008- SK02 REV. A



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DRAWING CHECK	SIGNATURE	DATE	CO-ORDINATION CHECK	SIGNATURE	DATE
DRAWN	BRC	15.6.12	STRUCT.		
DESIGNED			MECH.		
CHECKED			ELECT.		
CLIENT			HYDR./CIVIL		
			FIRE/ENV.		

CLIENT: CBM HARD ROCK COAL

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ACN 117 492 814 ABN 24 117 492 814

PROJECT: WASTE ROCK STOCKPILE

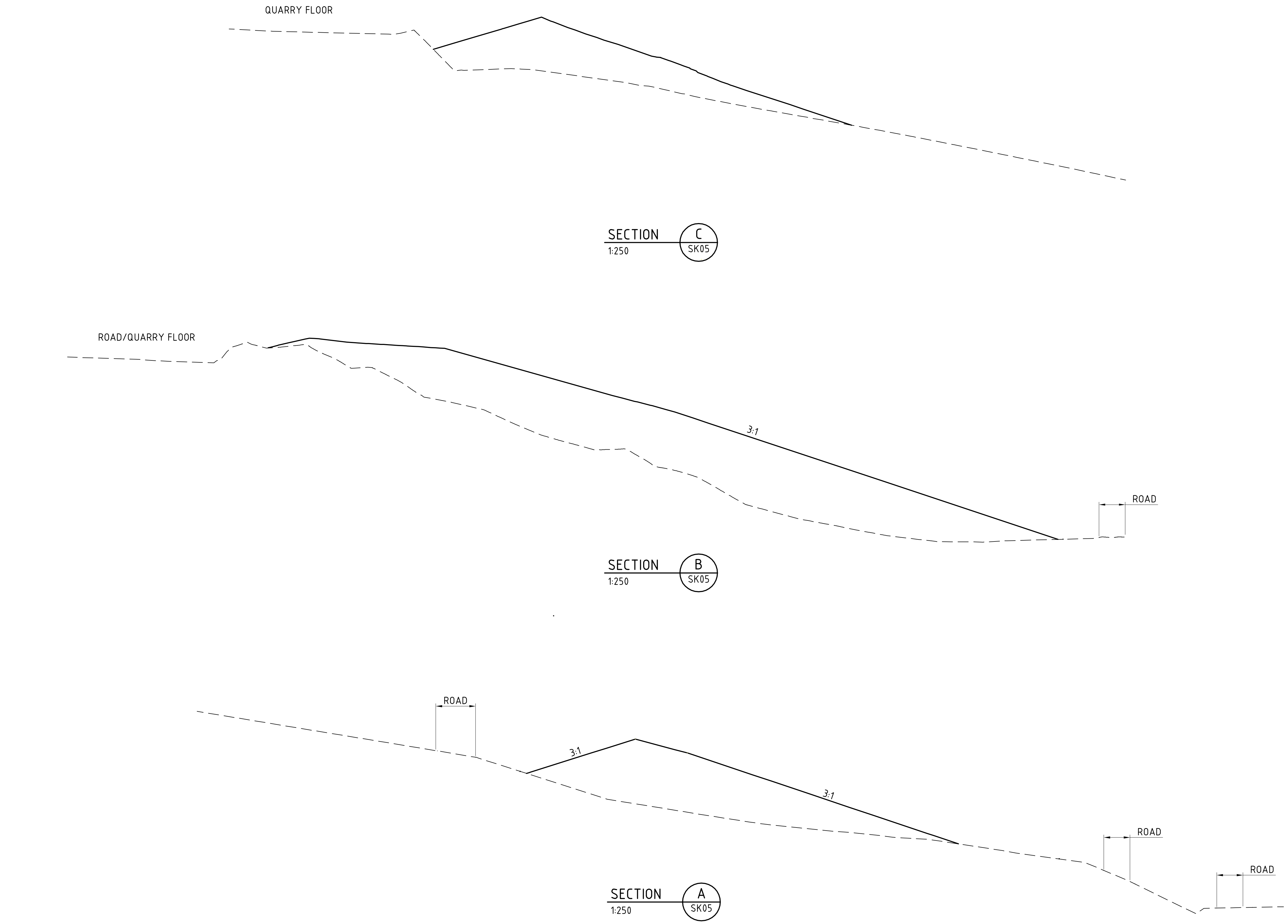
TITLE: SITE LAYOUT 3

5000 0 5000 1000 15000 A1

STATUS: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

SCALE @ A1: 1:250 DIMENSIONS IN: MILLIMETRES

DRAWING No. 3867.008- SK05 REV. B



REV.	DESCRIPTION	DRN	CHK	APP.	DATE
B	STOCKPILE SECTIONS REVISED TO SUIT MODIFIED EXISTING SURFACE	BRC			15.6.12

DRAWING CHECK	SIGNATURE	DATE	CO-ORDINATION CHECK	SIGNATURE	DATE
DRAWN	BRC	15.6.12	STRUCT.		
DESIGNED			MECH.		
CHECKED			ELECT.		
CLIENT			HYDR./CIVIL		
			FIRE/ENV.		

CLIENT: CBM HARD ROCK COAL

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Website: www.semf.com.au
ACN 117 492 814 ABN 24 117 492 814

PROJECT: WASTE ROCK STOCKPILE

TITLE: SITE SECTIONS 3

5000 0 5000 10000 15000 A1

STATUS: PRELIMINARY ONLY
NOT TO BE USED FOR CONSTRUCTION

SCALE @ A1: 1:250 DIMENSIONS IN: MILLIMETRES

DRAWING No. 3867.008- SK06 REV. A

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Sustainable Consulting Solutions

Fingal Tier Coal Mine

AMD Contingency Management Plan

For

CBM Sustainable Design / Hard Rock Coal Mining

20 July 2012
Revision 0

Project No: 3867.008

SCIENTISTS | ENGINEERS | MANAGERS | FACILITATORS

Integrated Management System
QUALITY AS/NZS ISO 9001 | ENVIRONMENT AS/NZS ISO 14001 | OH&S AS/NZS 4801

DOCUMENT ISSUE AUTHORISATION

PROJECT: Fingal Tier Coal Mine Water Management Plan **Project No:** 3867.006

AUTHORS:

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Date	Purpose of Issue/Nature of Revision	Rev	Reviewed by	Issue Authorised by
22/07/12	Draft for client review	0	RA	AW
23/07/2012	Final for client (CBM)	1	CBM / AW	AW

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EXECUTIVE SUMMARY

An AMD report developed for the site by GHD during 2012 highlighted an absence of PAF material at the proposed development site (to date). The presence of PAF-LC material, which was primarily associated with coal seam material, was however also noted and the preliminary nature of the findings acknowledged.

In the absence of detailed information regarding potential AMD issues associated with the site, EPA requested development of an AMD contingency Management Plan. This AMD-CMP fulfils that requirement.

It details a range of <u>precautionary AMD management measures</u> that have been developed for the site, in the unlikely event that significant quantities of non-saleable PAF-LC, or PAF material are encountered, during the mine construction and operative phases.

Targeted locations for implementation of precautionary AMD control measures include:

- The mine adit (Including temporary suspect PAF holding areas (above and below ground);
- Designated PAF / PAF-LC material disposal areas (should the need arise);
- General waste rock dump and associated drainage / sediment retention basin, located at the disused quarry site; and
- Sediment retention basins and associated water improvement system, located to the north of the mine adit and associated above ground infrastructure.

A combination of suspect PAF avoidance, material characterisation, selective handling procedures and passive / active AMD management measures have been developed for the site. These are linked to laboratory testing of waste rock (AMD characterisation) and continuous pH / alkalinity monitoring of surface and mine water. This provides multiple lines of defence against potential oxidation of PAF material (and subsequent potential AMD development), should any such material be encountered.

CONTENTS

List of Acronyms

ACM	AMD Classification - Acid Consuming material (NAPP less than -100 kg H2SO4/tonne and pH greater than 4.5)
AF	AMD Classification - Acid Forming
AC-NAF	AMD Classification: Acid Consuming – Non Acid Forming
AMD	Acid and Metalliferous Drainage
AMD-CMP	Acid and Metalliferous Drainage – Contingency Management Plan
AMD-Report	'*CBM Sustainable Design Report for Hard Rock - Fingal Coal Mine: Acid and Metalliferous Drainage (AMD) Assessment*'. GHD (2012).
ANC	Acid Neutralisation Capacity
BPEM	Best Practice Environmental Management
DPEMP	*Fingal Tier Coal Project Development Proposal and Environmental Management Plan'.* (CBM Sustainability Group Pty. Ltd. 2012).
HRCM	Hard Rock Coal Mine
MPA	Maximum Potential Acidity
NAG	Net acid generation
NAF	AMD Classification - Non Acid Forming (negative NAPP and NAGpH greater than 4.5).
NAPP	Net acid producing potential
PAF	AMD Classification - Potentially Acid Forming material (NAPP greater than 10 kg H2SO4/tonne and NAGpH less than 4.5)
PAF-LC	AMD Classification - Potentially Acid Forming material – Low capacity (NAPP between 0 and 10 kg H2SO4/tonne and NAGpH less than 4.5).
PEV	Protected Environmental Values as detailed in '*Environmental Management Goals for Tasmanian Surface Waters, Macquarie River & South Esk River'* (DPIW, 2005)
WMP	Water Management Plan
WRMP	Waste Rock Management Plan
UC	AMD classification – Uncertain (contradictory NAG and NAPP results such as negative NAPP with NAG less than 4.5 or positive NAPP with NAGpH greater than 4.5).

1. STRUCTURE OF THE AMD CONTINGENCY MANAGEMENT PLAN

The purpose of the AMD-CMP is to provide best practice environmental management control measures for the proposed HRCM Fingal Tier Coal Project in the unlikely event that non-saleable material classified as PAF or PAF-LC is encountered during initial mine development.

All evidence gathered during the 12 month long environmental impact assessment process, including surface water sampling, NAG and NAPP testing of drill core, and sulphur testing of coal has indicated a low risk of AMD, yet a level of uncertainty as to the risk of AMD remains, which will only be resolved at significant cost and time pressures through further drilling and AMD testing of drill core in areas where further geological information is not required.

This document will seek to reduce any residual risk of AMD by detailing precautionary control measures for both interburden and leachate in the event that PAF or PAF-LC material is intercepted.

An overview of the proposed development, previous AMD results, the regulatory requirement for production of an AMD-CMP, the documents scope, requirements for review and designated responsibilities are detailed In Section 2.

Section 3 of the report details the formative processes and controlling factors involved in Acid and Metalliferous Drainage (AMD) development. Associated potential environmental impacts (generally) are also discussed. The concept of primary, secondary and tertiary factors as a framework for assessment and management of AMD is also presented.

Section 4 of the AMD-CMP details primary, secondary and tertiary AMD control factors specific to this site and the potential implications thereof.

Section 5 details; implementation of Best Practice Environmental management (BPEM) control measures at the site including; appropriate AMD characterisation, disturbance minimisation, selective handling procedures, passive and active treatment options and monitoring procedures.

Section 6 of the report provides a brief summary of the AMD-CMP.

2. SITE SPECIFIC INFORMATION

2.1 Project Overview

HardRock Coal Mining Pty Ltd (HRCM) is seeking approval for an underground coal mine and associated works located off Valley Road to the east of Fingal, Tasmania. HRCM intend to develop the Fingal Tier Coal Mine within exploration permit EL16/2010. Mine operations are proposed over two sites; the underground mine and operations area around valley adits, and the proposed interburden waste rock dump adjacent to the nearby Abrahams Quarry (Figure 1).

HRCM plans to develop a coal deposit adjacent to the existing Duncan colliery, which is owned and operated by Cornwall Coal Company. The major coal seams modelled in EL16/2010 result in a total inferred resource of 447 Mt. The initial mine plan has identified approximately 13.4 Mt of accessible mineable coal in the initial mine plan. It is anticipated that once the mine is established, the initial extraction rate will be up to 1 Mt of coal per year, which will be used entirely for export markets.

The project is being developed over a pre-existing coal mine known as Barbers or Valley 2 mine, which was abandoned in the 1960s. Accordingly, the development footprint will be minimised and contained to the extent of the previously disturbed area of the abandoned mine workings and access tracks.

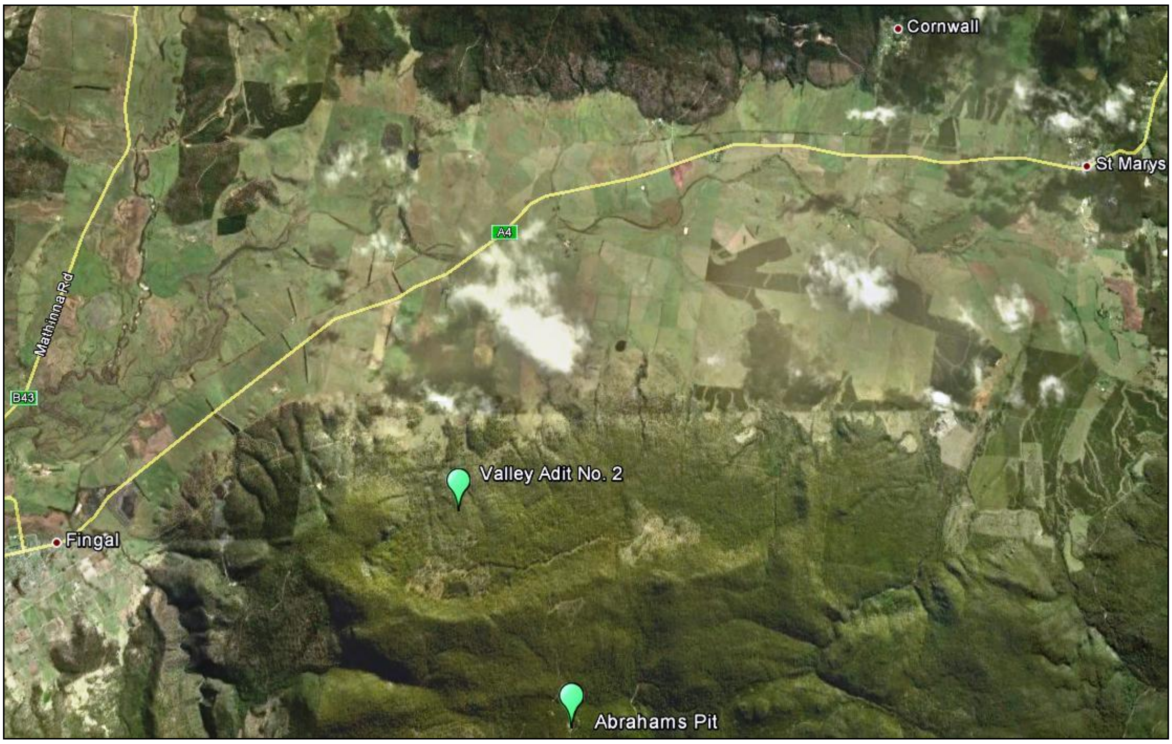

Figure 1 - Locality of the Mine and Waste Rock Dump

The Development Proposal and Environmental Management Plan (DPEMP) was submitted to the Tasmanian Environment Protection Agency (EPA) in January 2012.

This AMD-CMP has been prepared in response to the EPA's request for additional information dated 5th July 2012 regarding AMD management measures for the site.

2.2 Previous AMD results and Scope of the AMD Contingency Management Plan

The GHD (2012) draft report titled: '*CBM Sustainable Design Report for Hard Rock Fingal Coal Mine Acid and Metalliferous Drainage Assessment*' (the AMD-Report) highlights:

- A review of historic coal seam data, combined with detailed assessment (static testing) of material from two recent geological cores, highlighted only a low potential for AMD production;
- Coal and probable waste rock generated at the proposed adit area has a relatively low sulphur content,
- A significant proportion of total sulphur in the carbonaceous material (coal) is organic sulphur, which will not generate acid when naturally oxidised;
- The absence of Potentially Acid Forming (PAF) material at the site, but the presence of minor Potentially Acid Forming – Low Capacity (PAF-LC) associated with the coal seam measures;
- An absence of PAF, or PAF-LC material in coal seam host rocks (mudstones and sandstones) and the likely absence of PAF, or PAF-LC material in carbonaceous mudstone host rocks;
- Considerable potential acid buffering capacity from Acid Consuming - Non Acid Forming (AC-NAF) material at the site (See Section 4.1.2);

The AMD report also noted the presence of significant calcite veins outside of the sampled area in the AMD report. It is likely that this material would also have potential to be used as Acid Consuming Material (ACM) material (should the need arise), though its usefulness for that purpose is yet to be assessed by either static or kinetic AMD testing.

In summary, whilst potential for AMD issues at the site appear to be low, the preliminary nature of these findings and the need for additional AMD characterisation work (static and kinetic testing) is acknowledged by the authors.

This AMD-CMP details precautionary AMD management measures to be implemented by HRCM across the site, in the unlikely event that significant quantities of non-saleable PAF-LC, or PAF material are encountered during the mine construction and operative phases of the project.

Targeted locations for implementation of precautionary AMD control measures include:

- The mine adit (Including the temporary suspect PAF holding area);
- The proposed above ground temporary suspect PAF holding area and the co-located PAF / PAF-LC material disposal areas (to be fully developed should the need arise) ;

- General waste rock dump and associated drainage / sediment retention basin, located at the disused quarry site; and
- Sediment retention basins and associated water improvement system, located to the north of the mine adit and associated above ground infrastructure.

2.3 Objectives

The objectives of this AMD supplement are to ensure that any PAF or PAF-LC material identified during adit construction and mine site operation is managed in accordance with industry best practice and does not:

- Compromise the protected environmental values of the downstream receiving surface water environment (See section 5.1.2 of the surface water management plan), or
- Result in any considerable depreciation is site groundwater quality.

2.4 Review

Further AMD characterisation of rock will also be conducted during adit construction (static and kinetic testing). As a minimum static testing will occur on a fortnightly basis, or where new geological units, with potential to be disturbed by mining processes are encountered. Kinetic testing will occur on an as required basis to model likely AMD scenarios.

Surface water monitoring of pH, alkalinity and sulphate levels will be regularly assessed to provide early warning of any potential sulphide oxidation at the site (See 5.2.5 for details).

Monitoring data will also be used to assess the adequacy of proposed, or existing AMD measures, with adaptations to the AMD-CMP as required. This will ensure appropriate control of any potential AMD issues, should they arise.

In summary, the AMD-CMP will act as a 'live document' that is periodically updated to ensure its currency and best practice environmental management of any potential AMD issues, throughout the mine life (including the decommissioning and rehabilitation phases).

2.5 Responsibilities and Accountabilities

The Senior Site Executive is responsible for the overall environmental performance of the Fingal Tier Coal Mine. Senior Operational managers will have direct environmental responsibility for their areas of control, while the Environmental Manager will provide direction and advice to ensure site environmental conformance is maintained. All employees and contractors will have a responsibility to manage operations in an environmentally responsible manner. All environmental incidents will be reported to the Environmental Manager. All employees and contractors will be provided with environmental awareness training through a site induction process.

The key responsibilities of the HRCM employees and contractors are outlined below:

2.5.1 Mine Manager

In addition to the requirements detailed in the Waste Rock and Surface Water management plans the Mine Manager shall also ensure:

- AMD sampling, monitoring and control measures detailed in this supplement are implemented;
- The AMD supplement is reviewed as necessary, for instance in the event that:
  - Non saleable PAF-LC, or PAF material is encountered in significant quantities;
  - An alteration in mining processes, or the nature of the material mined (additional geological units encountered) could reduce the suitability / appropriateness of proposed AMD management measures; or
  - The AMD control measures are found not to result in an appropriate level of control, or where monitoring suggests that oxidation of sulphide material is likely occurring to an extent that could compromise the suitability of water for offsite discharge to the downstream receiving environment.

2.5.2 Environmental Manager

The Environmental Manager will be responsible for:

- Reporting to the Mine Manager on the implementation of the AMD-CMP;
- Implementing this AMD-CMP;
- Keeping this AMD-CMP up to date;
- Informing all staff and contractors of their roles and responsibilities pertaining to the AMD-CMP;
- Informing and training all staff and contractors in all AMD measures, with particular emphasis on those relevant to their tasks;
- Holding training refreshers regularly, or when AMD management changes are to be implemented; and
- Ensuring that all complaints and system improvement requests are recorded, investigated and where appropriate, mitigation measures are put in place to rectify issues.

2.5.3 Staff and Contractors

All staff and contractors will be responsible to:

- Apply all AMD-CMP methods and practices available to them to help minimise any potential AMD environmental impacts;
- Stop all work that generates, or has the potential to cause environmental harm or nuisance, and instigate procedures to minimise environmental harm or nuisance;
- Immediately report any incidents to the Environmental Manager; and
- Be proactive, by reporting any potential incidents and suggesting management methods or improvements.

2.6 Relationship with other management plans

The AMD-CMP supports the objectives and commitments outlined in the:

'Fingal Tier Coal Project Development Proposal and Environmental Management Plan' (DPEMP), [CBM Sustainability Group Pty Ltd (2012)] and supporting management plans, including the:

- Surface Water Management Plan (SEMF, 2012); and
- Water Rock Management Plan (SEMF, 2012).

The AMD-CMP provides detailed information in dealing with possible AMD arising from:

- Mined carbonaceous material (primarily coal); and/or
- Inter-burden waste rock that will be produced during adit construction.

2.7 Consultation with Government Agencies

The EPA has provided guidelines for water quality monitoring, as well as feedback on the concept water infrastructure design through the DPEMP review process. This AMD-CMP has been provided in response to an EPA request for additional information, related to the management of any potential AMD that may arise during construction, operation, decommissioning and rehabilitation of the Fingal Tier Coal Mine.

2.8 Statutory Requirements

As yet no permit conditions have been prescribed by any regulatory authority, however this AMD-CMP has been developed with due consideration of the

- *Environmental Management and Pollution Control Act 1994*
- *State Policy on Water Quality Management 1997*
- *Water Management Act 1999 and associated regulations;*
- *Best Practice Environmental Management in Mining – Management of sulphidic mine waste and acid drainage* (Environment Australia 1997)*;*
- *Leading Practice Sustainable Development for the Mining Industry – Managing acid and metalliferous drainage'*. (Department of Industry Tourism and Resources, 2007).

2.9 Community Expectations

Historic legacies associated with inappropriate management of PAF material are well documented, with a high degree of community awareness surrounding this. The community of Fingal and the Break O'Day Municipality likely expect that mine site activities should not:

- Result in offsite contamination of various environmental media including; soils, air, surface and groundwater;
- Adversely impact local ecosystems, supported by these environmental media;

- Limit existing, or future offsite water uses, such as (but not limited to); water for human consumption / stock watering, irrigation, fishing, swimming or other recreational activities; or
- Compromise water quality in Cardiff Creek at the licensed discharge point, or the downstream environment, including Protected Environmental Values (PEVs) assigned to the South Esk River [See Section 5.1.2 of the SWMP (SEMF 2012) for details].

3. INTRODUCTION TO ACID METALIFFEROUS DRAINAGE

3.1 Acknowledgement

An extensive overview of Acid and Metalliferous Drainage (AMD) and associated best practice guidelines in provided in the following documents:

'*Best Practice Environmental Management in Mining – Managing sulphidic mine wastes and acid drainage'*. (Environment Australia, 1997);

'*Leading Practice Sustainable Development for the Mining Industry – Managing acid and metalliferous drainage'*. (Department of Industry Tourism and Resources, 2007).

This AMD supplement draws extensively from these documents, with other reference sources, provided on an as required basis.

3.2 AMD Process summary

Oxidation of sulphidic minerals is a natural process, resulting from sulphide mineral exposure to atmospheric conditions. In mining situations this process is accelerated, when large volumes of sulphide rich materials are exposed. AMD resulting from oxidation of these materials may adversely impact both the immediate and wider environment.

Mine site AMD issues are commonly associated with runoff, or seepage from waste rock stockpiles, tailings impoundments, or coal reject material.

3.3 AMD Process chemistry

Whilst AMD chemistry is complex, it can be broadly summarised by illustration of pyrite oxidation (pyrite is one of the principal sulphide minerals commonly involved in the process), which involves:

Equation 1

The oxidation of sulfide to sulfate, which solubilises ferrous iron (iron (II),

$$2FeS_2(s) + 7O_2(g) + 2H_2O(l) = 2Fe^{2+}(aq) + 4SO_4^{2-}(aq) + 4H^+(aq)$$

Equation 2

Soluble ferrous iron is then oxidised to ferric iron (iron (III)):

$$4Fe^{2+}(aq) + O_2(g) + 4H^+(aq) = 4Fe^{3+}(aq) + 2H_2O(l)$$

Equation 3

Either of these reactions can occur spontaneously, or can be catalyzed by microorganisms that derive energy from the oxidation reaction. The ferric irons produced can also oxidize additional pyrite and oxidize into ferrous ions:

$$FeS_2(s) + 14Fe^{3+}(aq) + 8H_2O(l) = 15Fe^{2+}(aq) + 2SO_4^{2-}(aq) + 16H^+(aq)$$

The net effect of these reactions is to release H^+, which lowers the pH (increases acidity) and maintains the solubility of the ferric ion. The increased acidity subsequently allows other metals to be dissolved and taken into solution, thus potentially increasing their bioavailability.

3.4 Summary of potential AMD environmental impacts

Documented, environmental impacts associated with AMD include:

- Development of acid conditions in exposed surface materials (with potential to adversely affect rehabilitation outcomes);
- Impacts on downstream surface water and groundwater quality via potential increase in water acidity (low pH), increased solubility and/or release of metals (irrespective of actual pH) and increased salinity or solute loads (as a result of oxidation and neutralisation products).

3.5 Potential for AMD generation

As previously stated, AMD production is linked to the oxidation of sulphidic minerals in the presence of water (See Sections 3.2 and 3.3). Additionally, mining activities commonly:

- Expose previously buried geologic materials to an oxygen rich surface environment; whilst also
- Significantly increasing the surface areas exposed to oxygen via; blasting, crushing and screening processes.

Despite these potential issues, sulphide minerals will not always be present at high concentrations in mined material, considerably reducing AMD production potential, at some locations. Laboratory methods for assessing potential sulphide oxidation risks are discussed in Section 3.5.1. A number of other primary, secondary and tertiary factors also directly affect the potential for site specific AMD generation. These are also discussed below in Sections 3.5.1 to 3.5.3.

3.5.1 Laboratory assessment

In order to achieve BPEM of AMD, the early identification and understanding of the risk of AMD is required in order to devise a strategy to manage that risk. Representative sampling and laboratory analysis is required to understand the AMD risk associated with an ore body and host rock.

The stages required to achieve this are as follows:

- Make reference to other mining operations in the region, particularly those situated in the same geological sequence. These operations may provide information on the likely characteristics of the ore body and host rock.
- Determine a sampling plan which will provide a good representation of the ore body and host rock. Include sampling of potential low sulphide containing materials and alkaline materials, as these materials will be useful in managing the AMD risk. The sampling plan should be similar to those used to determine ore grades and reserves. Density of sampling will

be dependent on variability of rock types and level of confidence in predictive ability.

- Conduct tests on rock samples. This should include static testing (acid base accounting or NAPP test, NAG, saturate paste pH and conductivity (EC) and total and soluble metal analysis), and kinetic testing - which simulates weathering and oxidation of rock and process water samples over time under exposure to moisture and air. Further detail on test types and their meaning is provided below.
- Interpret the results to characterise the ore body and host rock across the operation, for use during risk mitigation strategy development.

Static Testing

Static testing is the first step in the systematic evaluation of materials to be disturbed and generated by mining operations. Details of the typical static tests follow.

NAPP is a calculated result which is obtained by subtracting the estimated acid neutralising capacity from the maximum potential acidity of the sample. Maximum Potential Acidity (MPA) is calculated by determining the sulphur content (%) multiplied by a conversion factor which gives the kg of acid per tonne, assuming complete oxidation of the sulphur. Acid Neutralisation Capacity (ANC) is a measure of the materials ability to buffer or neutralise acid produced by the oxidation of sulphur in the material.

A sample with NAPP greater than zero is usually classified as PAF and a sample with NAPP close to or below zero is classified as non-acid forming (NAF). NAPP should be used for screening purposes only, as the generation of acid in the field depends on the reactivity of the material. It is noted that organic sulphur found in coal wastes is typically not a major source of acid in the field.

NAG testing estimates the acid potential directly by introducing a strong oxidising agent, such as hydrogen peroxide, and is a quick and easy test which can produce results within 24 hours. A NAG pH result of greater than 4 classifies the result as non-acid forming, and equal to or less than 4 indicates higher risk.

The NAPP and NAG tests are complementary – NAPP gives a theoretical maximum potential for acid generation and neutralisation to derive the theoretical balance, whereas NAG is a direct measure of the acid formed from the balance of these reactions.

The final AMD classification for a given material is determined by plotting the NAGpH against the NAPP for that sample, with results interpreted as follows (GHD 2012):

- Potentially acid-forming - low capacity (PAF-LC) (NAPP between 0 and 10 kg H2SO4/tonne and NAGpH less than 4.5);
- Potentially acid-forming (PAF) (NAPP greater than 10 kg H2SO4/tonne and NAGpH less than 4.5);

- Non-acid –forming (NAF) (negative NAPP and NAGpH greater than 4.5);
- Acid consuming material (ACM) NAPP less than -100 kg H2SO4/tonne and pH greater than 4.5; and
- Uncertain (UC) (contradictory NAG and NAPP results such as negative NAPP with NAG less than 4.5 or positive NAPP with NAGpH greater than 4.5).

The saturated paste pH and conductivity test is the simplest static test, and is easily carried out in the field. A representative sample of crushed rock (<1mm) is mixed in distilled water to form a paste and left for 12 to 24 hours. The pH and electrical conductivity (EC) of the sample is then taken. If the pH is less than 4, the material is naturally acidic regardless of the NAPP result. An EC of more than 2 dS/cm indicates a high level of soluble constituents.

Total and soluble metal analysis is also useful, as increased levels of soluble metals in the material (compared with background) is an indicator of sulphide oxidation.

Kinetic Testing

Geochemical kinetic tests involve established site or laboratory tests to simulate weathering and oxidation of rock and process waste samples over time under exposure to moisture and air. The tests can provide:-

- An indication of the oxidation rate;
- An indication of time periods for onset of acid generation (lag time);
- An indication of the effectiveness of control techniques, which may limit the reaction rates of oxidising material, and
- Data for prediction of metal release and loading in drainage and leachate from waste materials.

The NAPP and NAG tests are useful screening tools to assess the likelihood of acid drainage developing through accelerated oxidation and neutralisation reactions. Despite the level of interpretation required, NAPP and NAG tests are the preferred method for characterising mine rock and process wastes for both the industry and regulators.

3.5.2 AMD Factors

Important factors controlling AMD production and behaviour can be grouped into primary, secondary and tertiary factors. These are discussed in the next three sections of the report.

3.5.3 Primary AMD Factors

Primary AMD factors are directly involved in the generation of sulphide oxidation products and include:

- The presence of sulphide minerals
- Water availability for oxidation and transport;
- Oxygen availability;
- Physical characteristics of the material;

And to a lesser degree:

- Temperature;
- pH;
- Ferric/ferrous iron equilibrium; and
- Microbiological activity.

Importantly, the presence of sulphide minerals is a prerequisite to the development of AMD. Sulphide minerals such as pyrite (FeS_2) and Chalcopyrite ($CuFeS_2$) are not uniformly distributed throughout the earth's crust. Rather, they are most commonly associated with ultra-mafic rock sequences. It follows that AMD issues typically occur within ultra-mafic rock sequences.

The presence of oxygen is also a prerequisite for AMD production, with oxygen exclusion being utilised as an important AMD control method. Importantly, because the concentration of oxygen in air is at least 4 orders of magnitude higher than in water, saturating PAF materials with water can be a very effective AMD control mechanism.

Where oxidation occurs in the absence of bacterial catalysts it is known as abiotic and where bacteria catalyse the reaction it is known as biotic. The oxidation rate of pyrite is accelerated by the bacteria Thiobacillus ferrooxidans (iron oxidising) and Thiobacillus thiooxidans (sulphur oxidising), which are associated with nearly all cases of acid drainage.

pH exerts a significant control on AMD production, with maximum oxidation of pyrite occuring between a pH of 2.4 and 3.6 and rapidly decreasing above this level. Under these very acid conditions ferric iron also becomes a powerful oxidising agent, which in turn may attack other sulphide minerals, further increasing the rate of sulphide oxidation and generation of oxidation products (See See equation 3 in Section 3.3).

3.5.4 Secondary AMD Factors

<u>Secondary factors consume or alter sulphide oxidation products</u>

An important secondary factor influencing the acidity generated, and hence pH, is the presence of other minerals able to neutralise acidity. Carbonates are the only alkaline minerals which naturally occur in sufficient quantities to be considered effective in the control and prevention of acid drainage. Silicate minerals and aluminosilicate, such as mica and clay minerals, have some acid consuming ability but are of minor significance relative to the carbonates.

The amount of alkaline material in the rock may be sufficient to offset the acid producing potential of the material and acid drainage will not eventuate, as long as the reaction rates of the respective materials are similar. However, in some cases the reaction kinetics are such that metals are mobilised even though acid conditions do not occur. In these situations, sulphate and these metals are indicators of the oxidation process and may be indicators of impending acid drainage problems.

The pH of the reaction media may also influence the ferrous/ferric iron equilibrium. At low pH, ferric iron acts as an oxidant, while at pH values greater than 3.5 ferric iron will precipitate as ferric hydroxide $Fe(OH)_3$. Sulphide oxidation rates have also been shown to increase with increasing partial pressures of oxygen, an effect that is more pronounced when catalysing bacteria are active.

3.5.5 *Tertiary AMD Factors*

Tertiary factors are the physical conditions (materials, minesite topography, climate etc) that influence the significance of any sulphide oxidation, the potential for migration into the wider environment and consumption of oxidation products.

Climatic regimes can impact of acid drainage, the most significant climatic factors being rainfall and temperature. Moisture is rarely limiting to the oxidation reaction; however, surface runoff and infiltration resulting from rainfall are the main mechanisms for transporting oxidation products into receiving environments.

The rate of sulphide oxidation is substantially lower in water than in air, owing to at least a four orders of magnitude difference in oxygen diffusion rates in these two media. So saturation of sulphidic wastes with water offers a major oxidation control strategy.

In wetter climates, control of acid drainage may also permit adequate dilution of reaction products to be achieved in receiving waters, thus minimising the potential effects on aquatic ecosystems.

In drier climates, while oxidation of sulphide minerals may be occurring in mine wastes, the hydrological balance is such that there is only minimal transport of oxidation products. Infrequent rain may result in oxidation products accumulating in wastes over long dry periods and their release to the environment being controlled by geochemical processes. However, even in these circumstances the oxidation products may accumulate at the surface, causing revegetation problems on disturbed land.

The physical nature of mine wastes also affects their acid generating potential. The rate of acid generation is a function of the surface area of sulphides exposed for oxidation. For instance, oxidation may be limited to the surface of compacted, fine grained, weathered stockpiles, compared with stockpiles made up of coarse materials where wind action (air pressure gradients) and exothermically driven air circulation allow oxidation throughout the stockpile. It follows that AMD is also a function of material characteristics such as; particle size, hardness, resistance to weathering and permeability. These physical characteristics determine oxygen flux and water flux (percolation rates) through a waste stockpile, which subsequently determines oxidation and AMD leachate generation rates.

Finally, the chemistry of receiving waters may be an important factor in determining the impact of acid drainage transported into rivers and streams. Metal toxicity in water can be affected by water hardness, or the amount of alkalinity in the water. Where waters are alkaline this will tend to neutralise acid drainage and promote the precipitation of metals to less toxic forms. Dissolved organic matter (carbon) may complex metals in solution, affecting toxicity or bio-availability to aquatic organisms.

4. SITE SPECIFIC CONSIDERATIONS

4.1 Primary and secondary AMD factors

4.1.1 Geology

Best practice AMD management requires consideration to other mining operations in the proposed extraction region, particularly any mine extracting material from the same stratigraphic or geological sequence, which may provide information on acid generating characteristics of similar ore bodies and host rocks.

Cornwall Coal has operated in this area, extracting carbonaceous material from the same coal seams without any publicised AMD issues.

4.1.2 Potential AMD characterisation

An assessment of the potential for the coal mine and associated waste rock dump to produce AMD was completed by GHD Pty Ltd (GHD) in July 2012. Samples from two geological bores (VR004B and VR006 in Figure 2) underwent detailed examination and were classified for their potential to cause AMD (total of 27 samples were collected from coal samples and associated confining host rocks – primarily mudstone and sandstone).

Key geologic units identified during that investigation and their associated AMD classification are summarised in Table 1, which clearly shows:

- PAF-LC material seems to be restricted to coal seam measures;
- Sandstone and mudstone are classified as AC, or NAF material; and
- Carbonaceous mudstone is likely NAF (See cement in final column of Table 1).

Table 1 – Classification of AMD classification for geological units that may be disturbed by mining processes

Geological unit	AMD classification	Comments
Coal	NAF, UC to PAF- LC	Vast majority of coal will be removed for sale
Sandstone	AC to NAF	
Mudstone	AC to NAF	
Carbonaceous mudstone	NAF (Samples HVC096 and HVC127 CrbMdst), PAF-LC (Sample HVC098)	Half of sample HVC098 was logged as coal, likely explaining the PAF-LC classification for that sample. The classification of NAF is thus more likely.

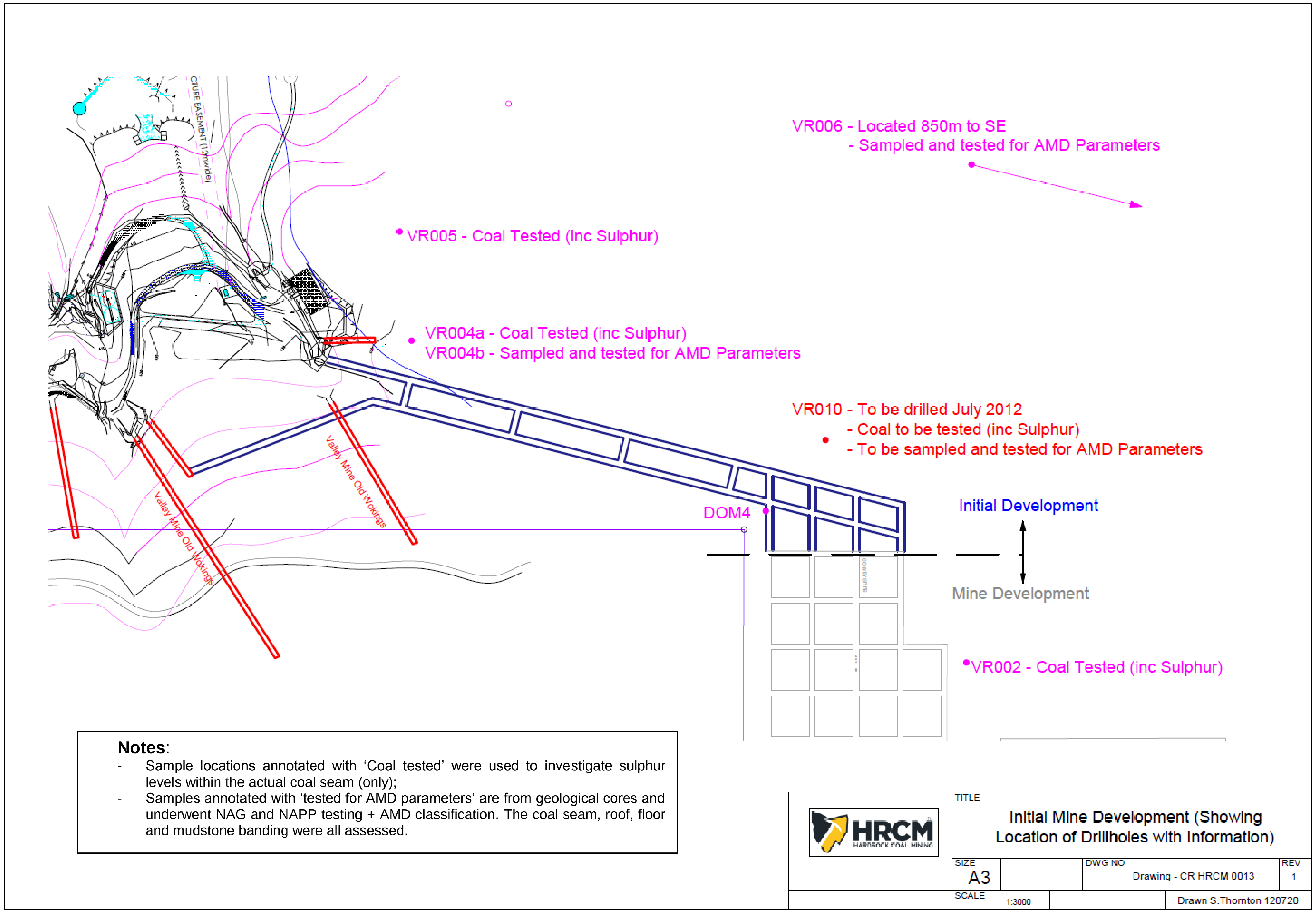

Figure 2- AMD sampling locations

Key AMD findings and recommendations from the GHD (2012) assessment are as follows:

- Historical data and recent testing indicate that the coal and potential waste rock at the proposed adit portal and area of early development have relatively low sulfur content. A significant proportion of total sulfur in the carbonaceous material is organic sulfur that will not generate acid when naturally oxidised.

- NAG testing of coal seams, roofs and floors produced slightly alkaline to slightly acidic solutions except for coal or carbonaceous mudstone samples which were in part acidic, although the acidity was most likely due to partial oxidisation of organic matter. The NAG pH, net acid producing potential (NAPP) results (using inorganic sulfur content) and acid base accounting combined indicate;

    - The material does not represent a significant risk of acid generation.
    - The remaining waste rock is either non-acid-forming or even has significant potential to neutralise acid generated by other material.

  The tested material includes both mudstone present in the roof above F seam in the western area, represented by holes VR004B (tested) and VR005 and lithic sandstone roof material in the east represented by holes VR003 and VR006 (tested).

- The tested material does not represent a risk of soil dispersion or saline drainage although some may be moderately alkaline. Based on a full ICPMS suite of total metal analyses, none of the metals were significantly elevated, when compared using a geochemical abundance index.

- Based on the chemistry of water currently draining from the adit of the Valley No.2 mine, the drainage has only slightly elevated iron and manganese with all other analysed parameters being within acceptable limits for drinking, irrigation or freshwater aquatic ecosystems.

- Although no confirmed PAF material was identified, the visual observation of pyrite in some coal samples indicates that there is a possibility to encounter some PAF-LC at the site (albeit a low risk). Consideration of AMD management when coal material is mined will be required and further classification of materials will be required as part of further advancements of the project, however it is recognised that most of the coal material is likely to be removed off site. There is potential to manage the low risk of AMD from waste rock and coal by blending of NAF and ACM with PAF-LC material, depending on the relative volumes.

- As exploration and development works progress, additional AMD testing, including sequential NAG or column leach tests (Kinetic tests), should be done on materials proposed to be either drained or mined, to confirm the materials are consistent with those tested to date. Future NAG testing of carbonaceous material will include extended boil NAG testing to eliminate organic acids.

- A detailed waste rock management plan should be developed in line with the detailed mine planning, including volumes and scheduled excavation of the various materials. Given the low risk of AMD development, a high level of management is not likely to be required and is likely to comprise general sediment and erosion n control, with some additional water quality monitoring and blending of NAF and PAF material, if identified.

4.2 Tertiary AMD factors

4.2.1 Location

The site is located in State Forest, adjacent to areas used for forestry activities in an area previously disturbed by mining activities, which has been allowed to naturally revegetate. It contains old mining equipment, general refuse and coal finger dumps. As such, the area is not pristine, with aquatic ecosystems having previously been exposed to some level of disturbance by mining and forestry activities.

4.2.2 Soils

A Geotechnical Assessment was conducted by Strata Geoscience and Environmental (March 2012). This assessment included 12 pits around the mine area including Unified Soil Classification System (USCS) of the soil and subsoil.

The first 500mm topsoil and subsoil material generally consisted of high and low plasticity clays (CH and CL), clayey sands (SC), silty clays (CH), silty sands (SM) and poorly graded sands (SP). There is potential that these materials could be utilised for appropriate lining of PAF-LC, or PAF encapsulation structures, however they will need to be assessed to ensure they are not dispersive and have appropriate geotechnical characteristics. In the event that no suitable clay layers were available at the site, the potential for use of HDPE liners or other geo-textile solutions could also be explored.

4.2.3 Temperature

Temperature records show that mean maximum temperature ranges from a low of 12.1°C in July to a high of 23.4°C in January. Mean maximum temperatures range from a low of 0.5°C in July to a high of 10.3°C in January.

4.2.4 Evaporation

Evaporation data inferred from Bureau of Meteorology SILO patched point data gives a mean daily evaporation of 2.79mm. Evaporation peaks in January with a mean daily evaporation of 5.2mm and June has the least evaporation with the mean being only 0.9mm per day.

4.2.5 Rainfall

An extensive climate data record exists at the nearest Bureau of Meteorology (BOM) weather stations in the Fingal Township. Measurements have been made across several stations (some now closed) amounting to a total of 124 years of measurements. There are currently two active BOM stations in the Township (station No.092012 Fingal Legge Street and station no.092091 Fingal South Esk River).

Historical daily rainfall data was obtained from the BOM for the Fingal Weather Station 92012 at Legge Street from which data dating back to 1888 is available. Figure 3 and Figure 4 graphically demonstrate the very infrequent larger events and the significant number of much smaller background events.

On average, there are around 112 rain days per year and mean annual rainfall total of 611mm at the Legge Street station. The highest monthly rainfall occurs in June with mean monthly rainfall of around 65 millimetres and least in January with mean monthly rainfall of around 44 millimetres (Figure 5).

The high annual rainfalls, coupled with the consistency of precipitation and relatively low to modest levels of evaporation throughout the year, would likely supply a consistent water source for use in AMD control measures such as:

1. Saturating (or more commonly maintaining with 10% of saturation) any PAF materials;

2. Ensuring that clay caps over waste rock dumps are kept moist to prevent cracking and oxygen ingress; and

3. Ensuring that settling basins do not run dry, which could expose PAF bottom sediments to atmospheric oxygen, with resultant sulphide oxidation and acid generation.

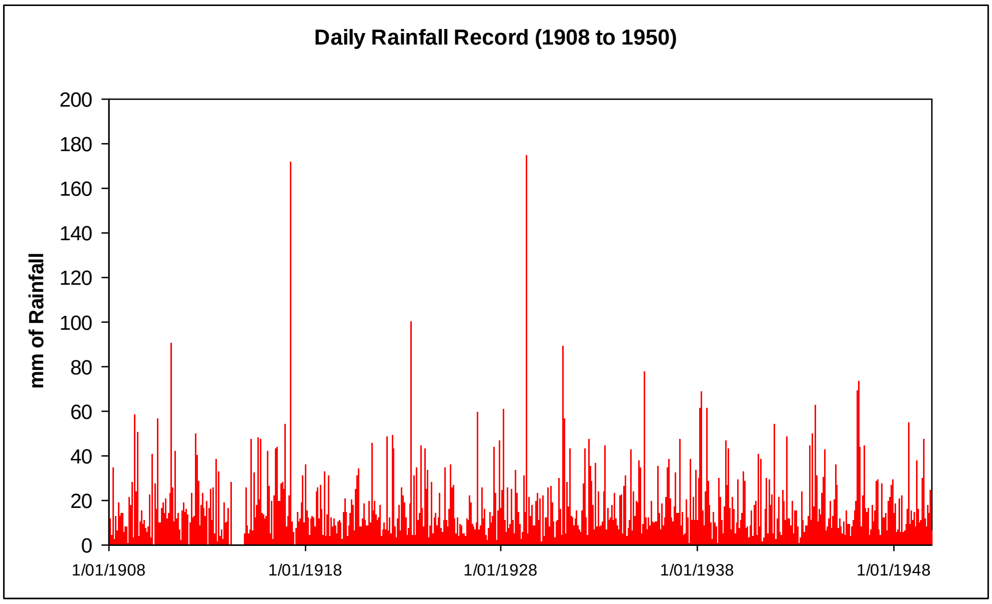

Figure 3: Daily Rainfall Record

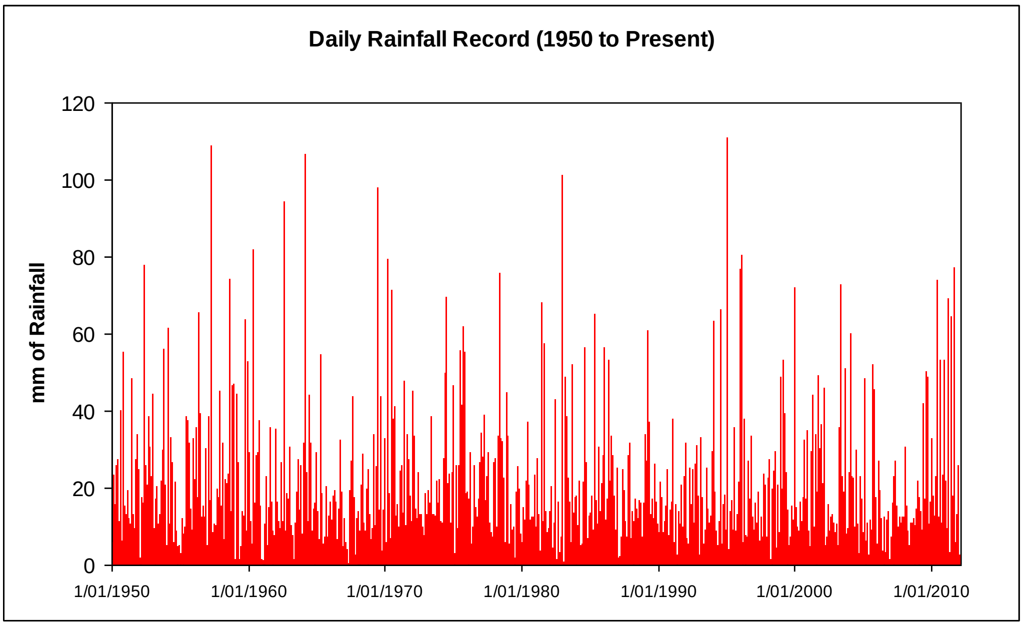

Figure 4: Daily Rainfall Record

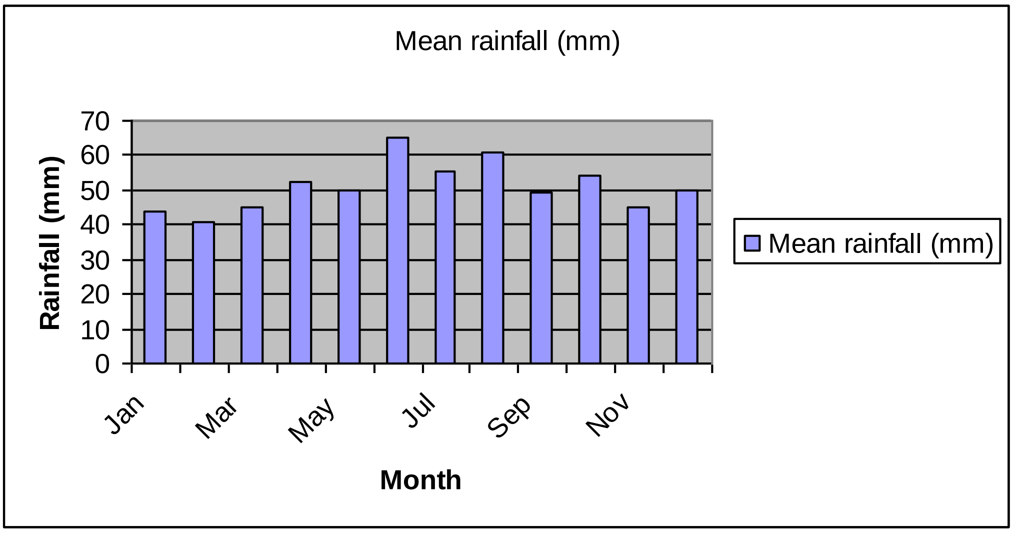

Figure 5: Mean monthly rainfall

It should also be noted that high intensity rainfall events commonly occur in the area (Figure 3 and Figure 4). Such events could be assumed to have considerable erosive powers, as is evidenced by the incised nature and heavily scoured nature of surface water drains and creeks transecting the site (See Section 4.2.6) and may also cause periodic localised flooding.

4.2.6 Catchment, streams and drainage lines

Site surface drainage is illustrated in Figure 6. The site lies on a steep northerly facing slope within the catchment area known locally as Smudgy Gully. This catchment extends approximately 800m to the top of the tier to the south and south west and consists of many drainage and creek lines that are steep and often heavily scoured. The high mobility of the stone and scree along the drainage lines is typical throughout the steep flanks of the Tier, often with no surface flow, but water flowing freely below the rubble. Below Valley Rd, Cardiff Creek is well defined, and in places the creek bed has exposed solid sandstone substrate and clear of rubble.

The previous mining activities included tracks and spoil dumps and therefore not all drainage lines follow along their natural alignment. As Valley Rd effectively encircles the catchment of the site, the road drainage creates a cut-off drain and concentrates overland flows to Cardiff Creek. Cardiff Creek flows north-easterly through the site and intercepts the western, central and eastern drainage lines within the immediate area.

Cardiff Creek

Cardiff Creek is a class 3 stream and is the main stream through the site. It has a catchment of harvested forest and informal reserved forest in Smudgy Gully. Larger storm events increase turbidity through the entrainment of sediment from the steep talus laden gullies and erosion of the water courses. Other factors contributing to increase turbidity may include forestry roads and landings, and exposed soils in harvested areas.

It has been observed that generally the flow in the creek is steady and clear and reasonable flow rates occur in all but extended dry spells. Above the site the catchment has the potential to deliver a good and ample source of clean water. At the downstream end of the site, the magnitude of flow increases approximately threefold compared to that at the top of the site due to the confluence of the western, central and eastern drainage lines.

Beyond the site, Cardiff Creek flows to the boundary of State Forest, then through the bush grazing land at the top of the Kooringa property (6092 Esk Main Road), in the lower slopes of the Tier, and finally some 3 km through the cleared and farmed land of the alluvial plain into the Break O'Day River at the Killymoon Bridge. There is a Baseline water quality monitoring site at Killymoon Bridge operated by DPIPWE.

Western Drainage Line

The Western drainage line is a class 4 stream. It is mapped as joining Cardiff Creek above the site, but in fact joins near the northern extents of the site below the proposed infrastructure area. Flow is passed under Valley Rd by a culvert at the point of the site access and is supported by a well forested catchment between two well defined bluffs of the Tier. It has been observed as having good flows in winter maintaining some flow of clean, clear water through spring but dry in summer.

Central Drainage Line

The central drainage line is heavily scoured and scree filled and has little observable surface flow except during larger rain events. A study of the mapped contours of the various catchments demonstrates a potential catchment area of two thirds the size of the Cardiff Creek catchment. However actual flows appear to be considerably less than those from Cardiff Creek. Old mine workings have resulted in the central drain being somewhat realigned, particularly by the spoil finger dump at Valley No. 1 mine just before it reaches Cardiff Creek. To improve the existing alignment flowing against the edge of the finger dump and discharging into Cardiff at the base, it is proposed to direct this drainage line to Cardiff Creek before the finger dump, to mitigate effects of erosion. This will separate through flow of the natural drainage from any surface water collected from the working.

Eastern Drainage Line

The eastern drainage line experiences the least flow of the site waterways, and now drains over the top of the collapsed mine adit entrance to Valley No. 2. It is largely a marshy soakage over the floor of the historic Valley No. 2 working floor. Some recent storm events, the largest since the 1960s, have eroded deep channels off the end of the floor in the vicinity of the previous wash plant, though after normal rain events the drainage into the top of the site is often no more than a trickle. Similar drains parallel the eastern drainage line and it is possible that they are linked by constructed elements further uphill either deliberately for the purpose of wash water in previous operations or by concentrated drainage from Valley Rd. Appropriate bypass of this natural drainage through the site includes redistribution of the catchment drainage to the parallel drainage lines to the east and piping through the work area.

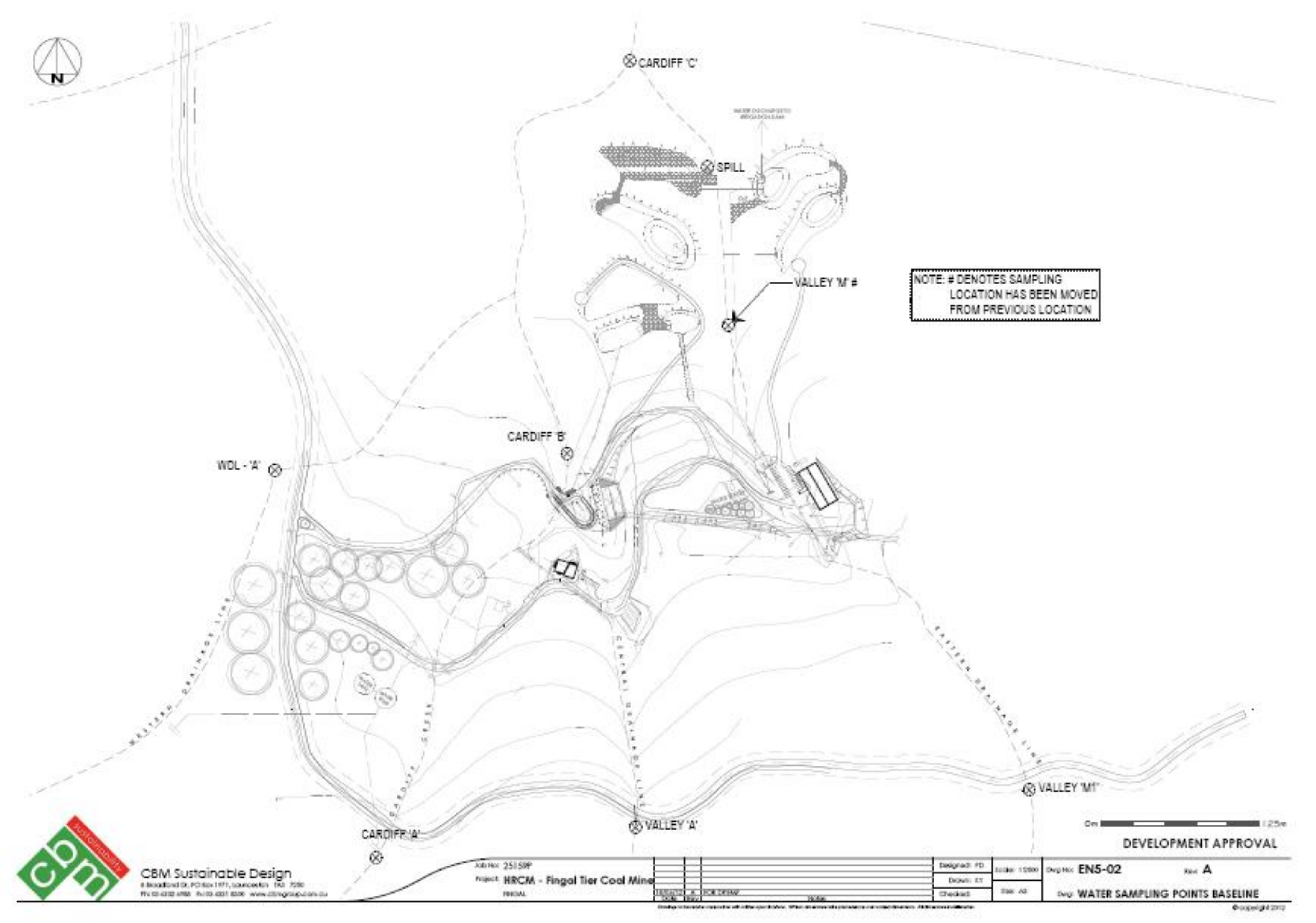

Figure 6: Existing surface water drainage, proposed surface water sampling sites

5. PROPOSED MANAGEMENT MEASURES

5.1 Best Practice AMD management principles

Best practice Environmental Management (BPEM) of potential or actual AMD can be achieved through the early recognition of the potential for acid drainage and the adoption of appropriate risk management strategies.

Essential BPEM-AMD control factors include:

- Understanding the physical and chemical factors in sulphide oxidation (Section 3.2 and 3.3);
- Geochemical characterisation of waste materials for acid generating potential (Section 3.5.1 and 4.1.2);
- Classifying and quantifying the acid generating risk of all materials to be disposed of throughout the mine life (Sections 4.1.2 and 5.2.1);
- Developing appropriate mine planning and selective handling and disposal practices for materials of different risk (Sections 5.2.1 to 5.2.3);
- Management commitment to implementing the preferred management strategies (Section 2.5);
- Work force training to identify and manage these different materials (Section 2.5.2); and
- Monitoring to evaluate the performance of remediation strategies and strategy revision as required (Section 2.4).

5.2 Description of onsite AMD management procedures

A range of BPEM of AMD concepts have been integrated into the site's AMD management framework. Proposed measures to be implemented can be divided into the following categories (in sequential order):

1. Material characterisation;
2. Minimise disturbance of suspect PAF-LC and PAF materials;
3. Selective handling procedures;
4. Passive treatment processes;
5. Active Treatment processes.

A flow diagram illustrating AMD management measures to be implemented at the site is provided in

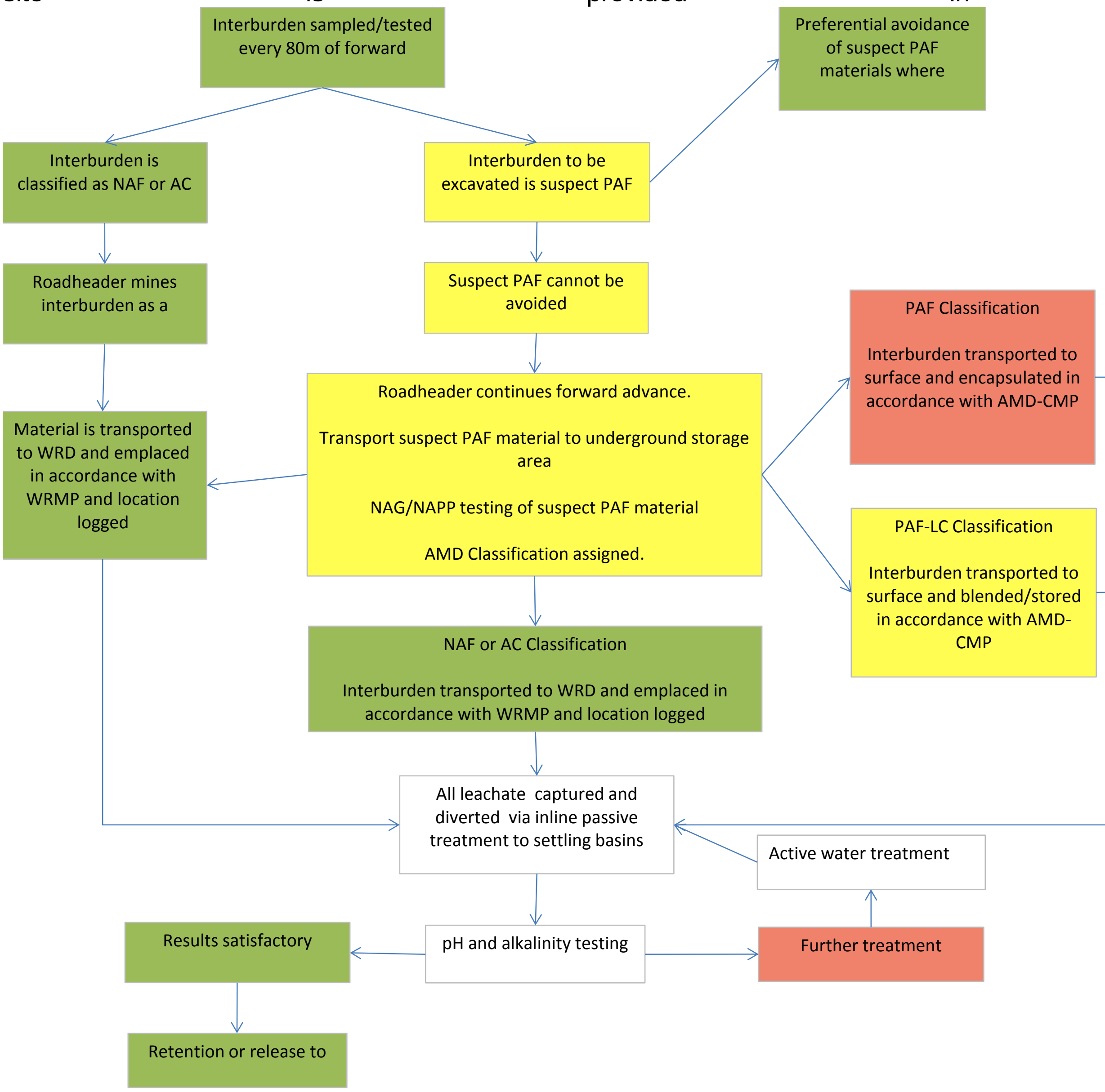

Figure 7. The proposed location for both the underground and above ground ‘suspect PAF holding areas are shown in Figure 8. If required, the PAF encapsulation area and/or PAF-LC blending and disposal area will likely be co-located at the above ground holding area.

Other indicative AMD management control measures for the mine site are shown in
Figure 9. These indicative control measures will also be implemented at the Abraham’s Pit waste rock facility (i.e. use of limestoned surface drains, pH / alkalinity monitoring and installation of an active dosing unit, with the option to recirculate surface water through the dosing system should the need arise). Proposed AMD control measures are detailed in Sections 5.2.1 through 5.2.5.

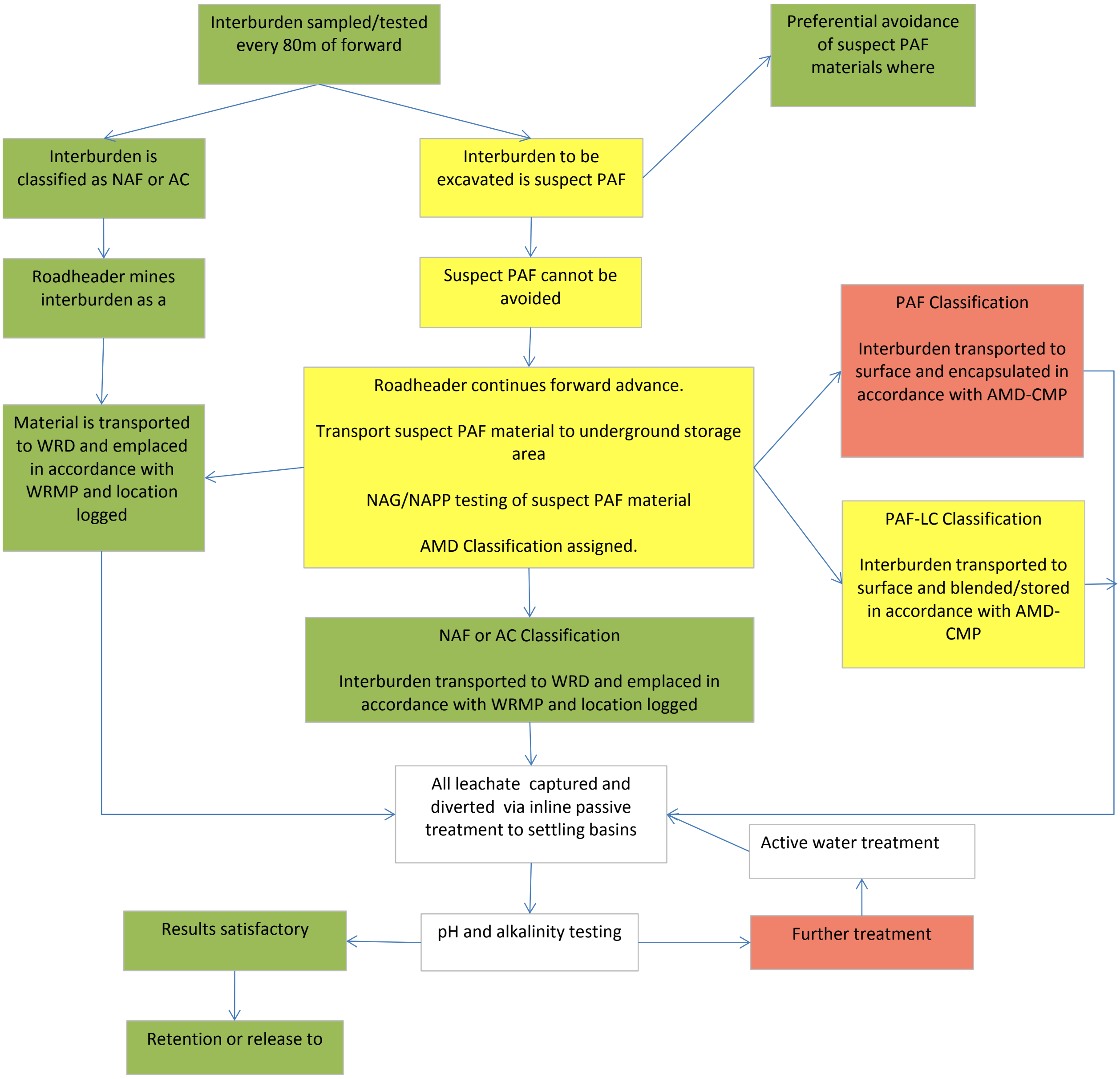

Figure 7: AMD management flow chart

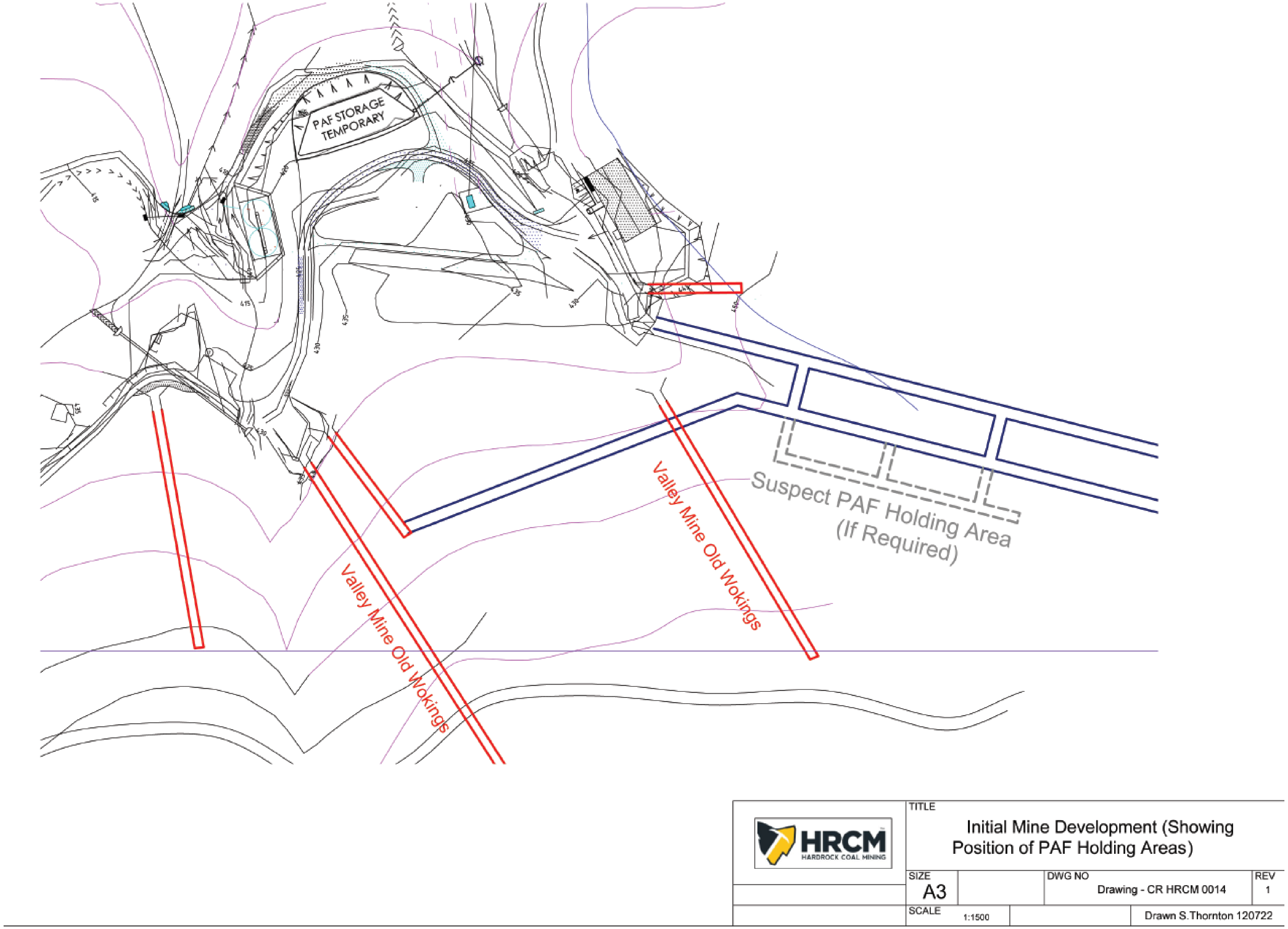

Figure 8: Proposed location of 'suspect PAF holding areas'. If required, co-location of the 'PAF-LC blending/disposal area' and 'PAF encapsulation area' would likely occur at the above ground holding area

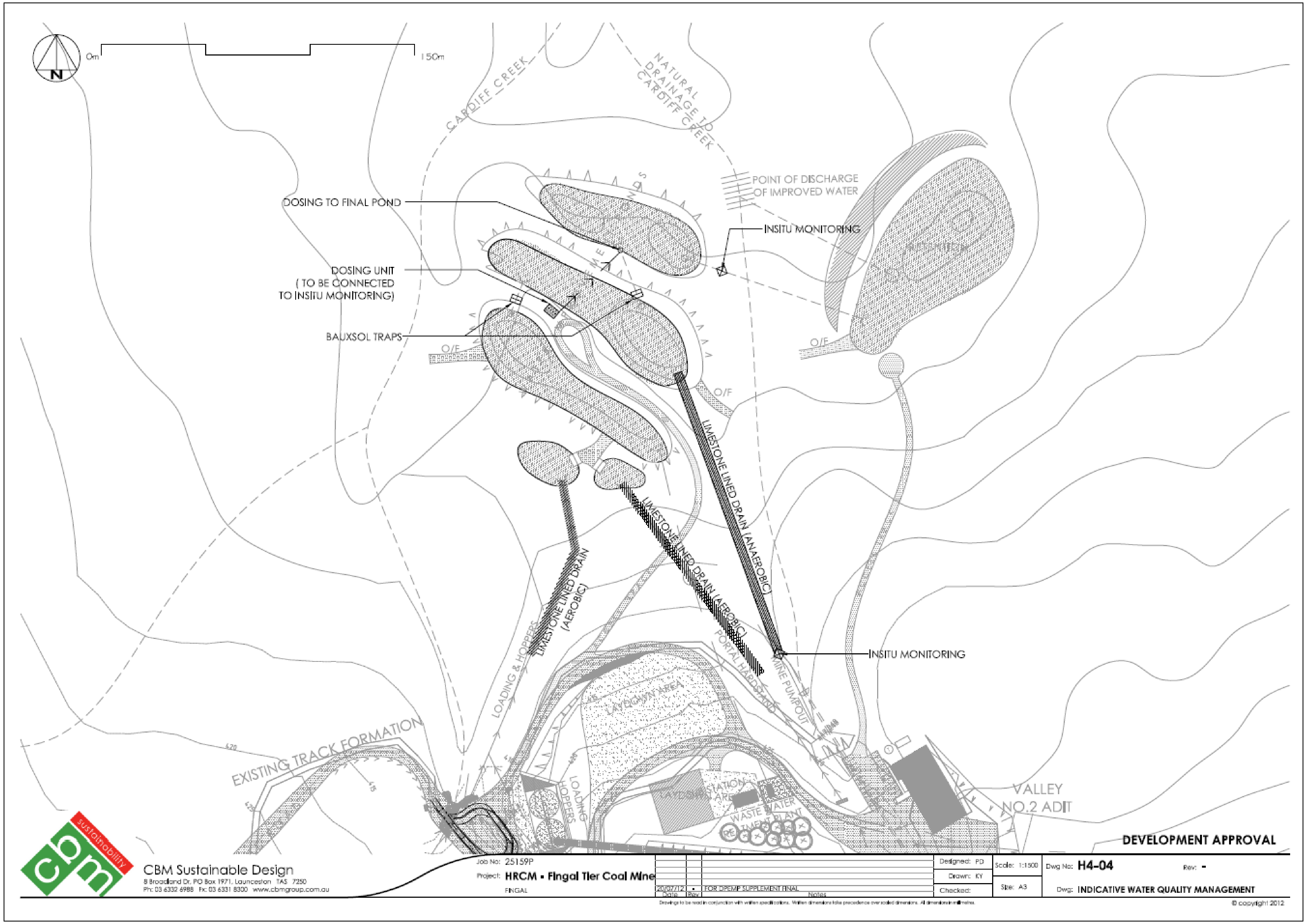

Figure 9: Proposed indicative AMD controls, at the mine site

5.2.1 Material characterisation

Ongoing rock characterisation will be completed, to understand the relationship between; AC, NAF, PAF-LC, PAF and UC materials and specific geologic units. This information will assist in visual identification and avoidance of non-saleable PAF-LC and PAF materials (where possible).

Sampling and AMD characterisation of important rock types will occur:

- Every 80m of road header advancement (approximately every fortnight), throughout the six month adit construction period; or
- When new, or visibly different geological units are encountered (throughout the mines construction and operative phases).

A waste rock log will be used to record the location of all waste rock generated during adit construction and during the mining process. This will assist where:

- AMD classification illustrates that PAF-LC, or PAF material has accidentally been sent to the waste rock dump, or
- Material with specific characteristics needs to be recovered (for instance setting aside, or recovering AC material for mixing with PAF-LC material – See Section 5.2.3 for details).

5.2.2 Minimise disturbance of suspect PAF-LC and PAF materials

HRCM propose to extract and sell all disturbed coal seam material (a buyer for low grade coal produced during adit construction has also been identified). As such, the potential for AMD production within the mine, due to dewatered processes is likely limited. This will however, be further assessed via ongoing material characterisation – See 5.2.1).

There is further potential to minimise any oxidation of dewatered mine areas containing PAF, or PAF-LC material, that will not be extracted. This could be achieved by sealing any suspect surfaces with 'Shotcrete' or a similar product (should the need arise). This process would likely be limited to unusual circumstances, for instance where the adit cuts through an adjacent coal seam face that will not be mined.

Where suspect and non-saleable PAF-LC or PAF material must be disturbed, it will be handled as per the following:

- Transferred to the temporary underground storage area, to be constructed in close proximity to the adit entrance (Figure 8), in an area composed of either NAF, or AC rock types. It will have an approximate holding capacity of 5,000m^3 (With potential for further extension if required);

- A second, larger temporary holding facility (approximate capacity of 30,000m^3), for additional storage of suspect non-saleable PAF-LC or PAF material will also be constructed above ground in close proximity to the adit (See Figure 8).

Both temporary storage locations will have impermeable bases, constructed of well compacted clay (to a suitable type and thickness), or other suitably impervious material. The basal material will direct any temporary stockpile leachate into designated drains, for subsequent transfer to the sites water treatment system, which integrates a number of passive and active AMD treatment components and monitoring systems (See Section 5.2.4 and 5.2.5 for details).

Coal will be extracted for sale, without onsite processing. This will significantly reduce the amount of coal dust produced and process water generated. Direct loading of coal material onto trains will occur where practical, with only minor coal stockpiling occurring.

Any temporary coal stockpiles will be kept moist, or treated with appropriate surfactants to avoid excessive dust generation. Surface flows from stockpile, loading areas and hardstand areas will also be diverted to the sites surface water treatment system, prior to release (See Sections 5.2.4 and 5.2.5).

5.2.3 Selective handling procedures

Material characterisation procedures detailed in Section 5.2.1 facilitates AMD classification of various rock groups (See Table 1 for a summary of preliminary rock type AMD classifications), so they can be managed in a predetermined manner.

Specifically, selective handling and disposal practices for three waste rock streams have been developed. They are:

- Stream 1 - NAF, or AC materials to be sent to the waste rock dump;
- Stream 2 - PAF-LC material to be blended with AC material, formed into suitable / stable landforms, covered with topsoil and revegetated;
- Stream 3 - PAF material to be appropriately encapsulated above ground in appropriately designed facilities, to prevent oxygen ingress and subsequent oxidation of sulphide material.

Each of the three waste streams are discussed separately below.

Stream 1 – NAF or AC waste rock material

In accordance with the sites Waste Rock Management Plan (SEMF, 2012), only NAF, or AC material will be stored at the Abraham's Pit waste rock facility (preliminary AMD testing, suggests this material will principally include sandstones and mudstone – See Table 1 for details).

As detailed in Section 5.2.1, a waste rock log will be used to track the location of all waste produced during adit construction and ore extraction. The log will contain specific information regarding:

- The type of material (mudstone, sandstone, or other) deposited at the waste rock dump and where it is located;
- Sample numbers presumed to be represent that rock type.

This will allow simple and efficient recovery of waste rock materials (if necessary). For instance;

- PAF-LC, or PAF accidentally emplaced at the waste rock dump could be identified / removed (where necessary); and
- Appropriate AC material for mixing with PAF-LC, or PAF material could also be identified.

Stream 2 – PAF-LC waste rock material

Because PAF-LC is presumed to represent a low AMD risk, it will be managed in accordance the 'AMD-Report' recommendations (GHD 2012), namely blending of PAF-LC with NAF / AC material. Once appropriate kinetic modelling has confirmed the suitability of this method, blending will likely occur at the PAF-LC blending and disposal area shown in Figure 8).

The blending of material will be undertaken with machinery such as a bulldozer/compactor. The material can be placed in relatively thin layers (approximately 100mm) and then then mixed via a bulldozer tyne or compactor feet prior to final compaction.

All blended stockpiles will be made into stable landforms, covered with suitable NAF material, topsoil, revegetated and monitored. All leachate from this area will be collected and directed to the sites water treatment system (See Sections 5.2.4 and 5.2.5 below).

Stream 3 - PAF waste rock material

The ultimate destination of any segregated PAF material will be encapsulation within an appropriately designed facility, constructed in accordance with BPEM guidelines.

HRCM will review the most appropriate location for the PAF encapsulation facility, using a risk assessment framework and taking into account the most recent available information. HRCM will liaise with EPA regarding proposed location and design features.

HRCM will also ensure that any PAF encapsulation facility is constructed in accordance with BPEM. Specifically, it will:

- Evaluate all potential cover materials and appropriate geo-textile membranes, based on their capacity to minimise oxygen ingress;
- Where possible integrate water saturated (or more typically within about 10% of saturation) material zones into the structure. This layer substantially reduces the oxygen flux through the cover, as the diffusion coefficient of oxygen through water is at least one order of magnitude smaller than that in air.
- Incorporate the following three zones into the structure:

- Zone A, usually the base zone, with high water retention properties, which provides the greatest barrier to oxygen diffusion ('water retention' zone);
- Zone B, which acts as a water reservoir to ensure that some portion of the water retention zone remains close to saturation; and
- Zone C, or the surface zone that protects the cover from erosion ('barrier' zone).

The use of capillary breaks to minimise solute transport to the surface, as well as surface revegetation requirements to assist in landform stability and moisture control will also be integrated as appropriate.

Appropriate kinetic testing of PAF and AC material will also be completed to determine, the most appropriate bending ratios within any such structure.

5.2.4 Passive water treatment processes

A range of passive water quality management measures have been integrated into the AMD management process. At the mine site these will include (See Figure 9):

- Water from the adit, underground mine workings and the underground 'suspect PAF holding area', will be pumped to the surface and discharged to the surface water retention basins, via an anoxic limestone drain. The use of the anoxic limestone drain will likely:
    - Assist in pH control, whilst preventing surface skims from developing on the crushed limestone material;
    - Promote precipitation of stable sulphide metal complexes, where the sulphate rich anoxic water contacts oxygen rich water in the surface water retention basin. These sulphide complexes should then settle out of solution, reducing metal and sulphate loads in discharge water and limiting metal bioavailability.
- Collection of water from other hardstand areas (including the 'above ground suspect PAF holding area', PAF-LC blending and disposal site and PAF encapsulation areas). Subsequent transfer to sediment retention basins 1 and 2, via aerobic limestone lined surface water drains). These drains will be visually inspected, with limestone material re-crushed (to expose clean reactive surfaces), or replaced on an as required basis.

Surface water at the Abraham's Pit waste rock facility, will be collected in limestone lined surface water drains and directed to the sediment retention basin at that site, prior to discharge. These drains will be visually inspected, with limestone material re-crushed (to expose clean reactive surfaces), or replaced on an as required basis.

5.2.5 Surface water monitoring active Water Treatment

In the event that passive treatment methods fail to adequately control pH levels:

  - Chemical dosing will be completed via top of pond quick lime dosing, at both the waste rock disposal site and a designated pond at the mine site water treament

In the event that the pH of discharge water stills proves unsatisfactory, the use of more target specific dosing agents may be used to augment, or even replace the quick lime dosing process (Potential chemical dosing products include ‘Vironmine’ products, ‘Bauxsol’ etc.).

Surface water quality will be assessed via continuous monitoring of pH at:

- The point where mine water exits the mine adit, en-route to the surface water ponds (provides an early indication of any severely impacted water being transferred to the water treatment system (Figure 9);

Near the discharge point from mine site surface water treatment system (See

- Figure 9);
- At the discharge point of the sediment retention basin, located at the Abraham’s Pit waste rock facility.

In the event that surface water quality is inappropriate for discharge (outside the pH discharge range specified in the sites environmental permit), water could be recirculated through the systems, with additional dosing as required to obtain effective control.

Optionally, where poor quality mine water is shown to be causing the issue, HRCM, could temporarily reduce mine water pumping rates to the surface, or temporarily cease adit construction works, allowing relatively larger inputs of other surface waters into the water treatment system.

Monitoring of alkalinity in surface water locations will also be continuously monitored to provide an early indication of potential sulphide oxidation in the system (provides an indication that the systems buffering capacity is being exploited by oxidation of sulphide material). This can assist with identification of AMD issues, prior to changes in pH being noted.

A portable pH / alkalinity meter will be kept onsite to allow periodic investigation of water quality at locations, other than fixed point monitoring locations, should the need arise.

6. SUMMARY

The AMD-Report (GHD 2012) highlighted an absence of PAF material at the site to date, but the presence of PAF-LC material, which is primarily associated with coal seam materials. The preliminary nature of these findings, was however acknowledged.

Consequently, a range of precautionary AMD management measures have been developed for the site, in the unlikely event that significant quantities of non-saleable PAF-LC, or PAF material are encountered, during the mine construction and operative phases.

Targeted locations for implementation of precautionary AMD control measures include:

- The mine adit (Including temporary suspect PAF holding areas (above and below ground);
- Designated PAF / PAF-LC material disposal areas (should the need arise);
- General waste rock dump and associated drainage / sediment retention basin, located at the disused quarry site (referred to as Abraham's Pit waste rock facility); and
- Sediment retention basins and associated water improvement system, located to the north of the mine adit and associated above ground infrastructure.

A combination of suspect PAF-LC and PAF avoidance, material characterisation, selective handling procedures and passive / active AMD management measures have been developed for the site.

These procedures are linked to laboratory testing of waste rock (AMD characterisation) and continuous pH / alkalinity monitoring of surface and mine water. This provides multiple lines of defence against potential oxidation of PAF material (and subsequent potential AMD development), should any such material be encountered.

The robust nature and flexibility of proposed measures should suitably mitigate any AMD impacts associated with the site.

7. REFERENCES

CBM Sustainability Group Pty Ltd (2012), *Fingal Tier Coal Project Development Proposal and Environmental Management Plan (DPEMP)*, Launceston, Tasmania.

Environment Australia (1997) *Best Practice Environmental Management in Mining – Managing sulphidic mine wastes and acid drainage*. Canberra.

Department of Industry Tourism and Resources (2007) *Leading Practice Sustainable Development for the Mining Industry – Managing acid and metalliferous drainage*. Australian Government, Canberra.

DPIW (2005) *Environmental Management Goals for Tasmanian Surface Waters, Macquarie River & South Esk River*, Tasmania.

GHD Pty Ltd (2012) *Report for HardRock Mining Fingal Coal Mine Acid and Metalliferous Drainage (AMD) Assessment*, Hobart, Tasmania.

SEMF (2012), *Fingal Tier Coal Mine Waste Rock Dump Management Plan*, Launceston, Tasmania.

SEMF (2012), *Fingal Tier Coal Mine Water Management Plan*, Launceston, Tasmania.

Caason Fingal Tiers Mine Project

Aboriginal Heritage Impact Report

Break O'Day Local Government Area

August 2012

Prepared for

CBM Sustainability and Design

on Behalf of

HardRock Coal Mining

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EXECUTIVE SUMMARY

Kayandel Archaeological Services (KAS) in association with Vernon Graham (Aboriginal Heritage Officer) was engaged by HardRock Coal Mining to undertake an archaeological pedestrian survey for an Aboriginal Heritage Impact Report under the current standards and guidelines issued by Aboriginal Heritage Tasmania (AHT) for the proposed development of a thermal coal mining operation in the former Valley Coal Mine in the Fingal Tiers, to be known as the Caason Fingal Tiers Mine.

The field assessment was carried out on the 21st October 2011. Consultation with the wider Aboriginal community was undertaken by the Aboriginal Heritage Officer (AHO).

As part of the pedestrian survey assessment, areas proposed for the surface infrastructure were focused on, with additional survey areas were targeted if/when sensitive landforms or favourable visibility conditions were identified for locations immediately adjacent to those proposed for impact. Isolated find, TASI 11696 was identified *in situ* on the southern alignment of an existing forestry access road. Isolated find, TASI 11697 was identified on a spur line between two unnamed drainage lines. Isolated find, TASI 11698 identified during a pre-survey inspection of the project area by Lance Syme. One Potential Archaeological Deposit was identified based upon landscape formation and level of previous disturbance and the views of the AHO present on the day of the survey.

It is recommended that:

1. a permit under Section 14 of the Aboriginal Relics Act 1975 be obtained to impact TASI 11696 and TASI 11698, before the proposed development begins;

2. an Aboriginal Heritage Management Plan be prepared for the project.

More specifics of each recommendation is available in Section 6.3.

ABBREVIATIONS

AHIR:	Aboriginal Heritage Impact Report
AHT:	Aboriginal Heritage Tasmania (former Tasmanian Aboriginal Heritage Office)
ATSIHP Act:	Aboriginal and Torres Strait Islander Heritage Protection Act, 1984
CFTM:	Caason Fingal Tiers Mine
EPBC Act:	Environment Protection and Biodiversity Conservation Act, 1999
HCM:	Hardrock Coal Mine
KAS:	Kayandel Archaeological Services
TALSC:	Tasmanian Aboriginal Land & Sea Council
TASI:	Tasmanian Aboriginal Site Index

Definitions

The following terms are used throughout this report and within this context are defined as follows:

Aboriginal values: a wide range of attributes or 'values' described by Aboriginal people to exist within a particular area. These are generally used by Aboriginal people to describe their association to that area. These attributes have been defined in this report to include spiritual/cultural values, family values, resource values, educational values and Aboriginal sites and places. However, Aboriginal people may use other terms or identify other aspects of Aboriginal values.

Aboriginal place: a place where Aboriginal values and associations to that location have been identified, which may or may not bear any physical signs of Aboriginal use.

Aboriginal site: an Aboriginal place which has physical signs of Aboriginal occupation or use.

Aboriginal resources: an aspect of Aboriginal values which focus on the Aboriginal use of plants and animals. This encompasses the use of these resources for subsistence and economic reasons but also recognises that plant and animal resources are an important aspect of educational, spiritual and family values.

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1. INTRODUCTION

1.1. The Proponent

The proponent for the Caason Fingal Tiers Mine (CFTM) is Hardrock Coal Mining (HCM), an Australian company that belongs to the Caason Group of companies.

1.2. Purpose and Project Brief

Kayandel Archaeological Services (KAS) was commissioned by HCM to conduct an Aboriginal Heritage Impact Report (AHIR for the Project of the subject area, in accordance with current standards and guidelines issued by Aboriginal Heritage Tasmania (AHT). The documents include, but are not limited to:

- "Aboriginal Heritage Guidelines and Standards Package for Consulting Archaeologists" prepared by Aboriginal Heritage Tasmania;,
- The Aboriginal Relics Act 1975;
- The Burra Charter

1.3. The Subject Area

The subject area is located in the Fingal Tiers in northeast Tasmania approximately 7 kilometres east of township of Fingal (Figure 1 and Figure 2).

The proposed development site lies nestled within a small trough between the 410-450m contours, on the northeastern slopes of Spion Kop, at the northern edge of the Fingal Tier State Forest, straddling Cardiff Creek (Figure 1 and Figure 2). The Valley Road passes the site on the western side, looping around to the south where it continues generally southeast towards Dukes Road. Access to the site is via existing roadways on the west side leading off Valley Road.

1.4. The Development Proposal

HCM is currently reviewing the viability of a proposal to develop a thermal coal mining operation in the former Valley Coal Mine in the Fingal Tiers in northeast Tasmania. The Project would involve redevelopment of an existing inactive underground mine, for which some above-ground infrastructure, such as access roads, already exists (Figure 3). The main impacts associated with the proposed development of the Project would include:

- Installation of a new mine portal close to the east of the old mine entrances
- Upgrading of the existing access road and haul road associated with the old mine, both connecting the Valley Road and the mine portal, to make them fit for use again.
- Construction of a mine office towards the end of the access road, about 100 m before the western entrance to the old mine
- Construction of a workshop and amenities immediately to the north of the new mine portal
- Placement of receiving hoppers at the end of the haul road
- Installation of a belt road from the mine portal to the receiving hoppers and the beginning of the haul road
- Creation of a water improvement area north of the road systems
- Installation of creek culverts and stormwater management areas in regard to the existing watercourses.

1.5. Aim and Objectives of the Assessment

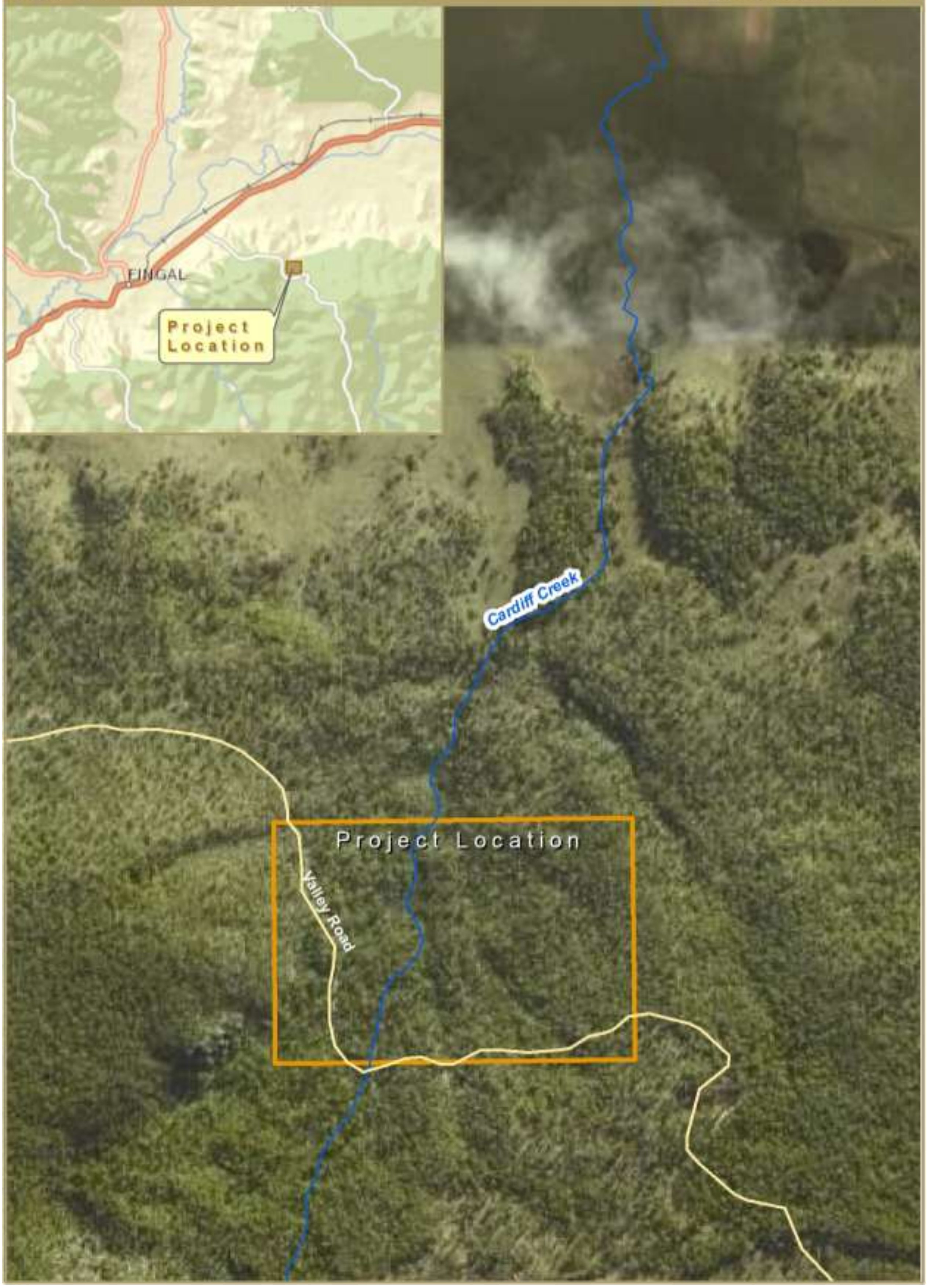
The objective of this study is to provide HCM with an AHIR suitable for inclusion in an Environmental Impact Study (EIS) for the project. This study involves a description of context of the subject area, identification of heritage places and cultural values in the subject area, an assessment of the potential impacts to Aboriginal heritage as a result of the Project and development of recommendations to minimise, manage and mitigate potential impacts.

1.6. Report Authors

This report was drafted jointly by Lance Syme, Patrick Ball and Stuart Elder. Patrick prepared an initial draft, which was formatted and added to by Stuart. Lance Syme edited the final report.

Figure 1 Regional Area — **Fingal Teir Hardrock Coal**

Figure 2 Project Location



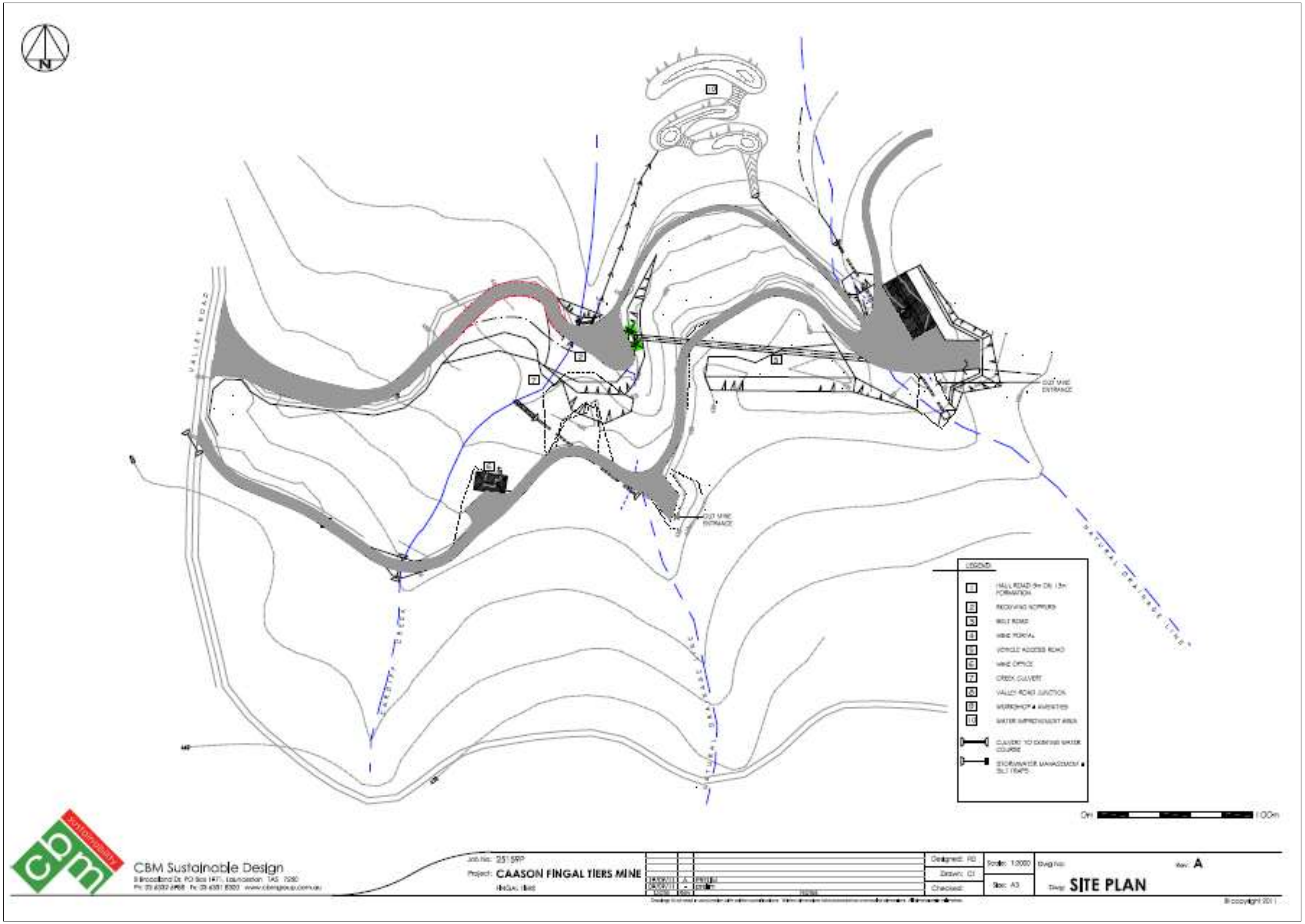


Figure 3: Project development layout

2. ENVIRONMENTAL BACKGROUND

The natural environment of an area influences the availability of local resources such as food and raw materials for artefacts, rock platforms for engravings and axe sharpening, and rock outcrops that may provide shelter. The landscape also provides the sediments which may bury objects and archaeological features, as well as the erosive processes that might expose or disperse them. Detailing the landscape context is an integral procedure that assists with the modelling of potential past Aboriginal landuse practices and/or predicting site distribution patterns within any given landscape (Guilfoyle, 2006).

With respect to Aboriginal archaeology, land formation processes may impact upon the type and frequency of archaeological remains. Past climate may also impact upon the location and types of resources available, which in turn would impact upon settlement and mobility patterns of past Aboriginal groups in the area (Mulvaney and Kamminga, 1999: 297-319).

The location of different site-types (such as middens, open artefact scatters, axe grinding grooves, petroglyphs [engravings], etc.) are strongly influenced by factors such as these along with a range of other associated features, which are specific to different land systems and bedrock geology (Mulvaney and Kamminga, 1999: 297-319).

Conducting a review of landscape context assists in the determination or prediction of the potential of a landscape to have accumulated or preserved objects, the ways Aboriginal people may have used the landscape in the past, with regard to identifiable resources or focal points for activities, and the likely distribution of the material traces of Aboriginal land use based on these factors.

2.1. Land Use History

The location of the proposed development has previously been an operational coal mine, and much of the area intended for redevelopment has already been exploited in a similar manner to what is proposed.

In the pre-contact period, Aborigines used the Fingal Valley, including the South Esk and Break O'Day Rivers, as a travel route from Ben Lomond Tier to the coast. The Oyster Bay tribe preferred to use 'well-defined routes' (Ryan 1996, p. 20). Conversely, John Batman was informed, by Aborigines of other tribes, that the Ben Lomond tribe did not follow defined tracks and reports them travelling cross-country near the Break O'Day Plains a little to the north (Kee 1987; 1991). These tribes seem to have fired the land at times, possibly to facilitate movement. Descriptions of their seasonal movements suggest that this may not have been an intensively exploited tract of territory (see Ryan).

2.2. Climate

The temperature buffer provided by the ocean gives northeast Tasmania a mild maritime climate, without seasonal extremes. However, this buffering effect diminishes with distance from the coast (Kee 1987, p. 3).

Average temperature, rainfall and wind-speed readings for Fingal, taken from the online service of the Australian Government Bureau of Meteorology, are provided below in Table 1. The recording station is in Legge Street, Fingal (237 m altitude; 41.64°S, 147.97°E), and records date back to 1882.

	March 2011	June 2011	September 2011	December 2011
Maximum temperature (°C)	21.5	12.7	15.3	21.4
Minimum temperature (°C)	7.9	1.1	3.2	8.7
Total monthly rainfall (mm)	45.2	64.9	49.3	50.0

Table 1: Fingal local quarterly rainfall summary for 2011

(Source: http://www.bom.gov.au/climate/averages/tables/cw_092012.shtml)

The total rainfall recorded in the twelve months between February 2011 and January 2012 was 872.2 mm.

It should be noted that the Project site is around 200 metres higher altitude than Fingal itself, lying as it does between the 415 and 450 metre contours.

2.3. Hydrology

The subject area is situated in the Fingal Tier region, approximately 7 km east of Fingal township, where the Break O'Day River joins Tasmania's longest river system, the South Esk. The Break O'Day River curves northeast around Fingal Tier, with tributaries flowing into it from the Tier. Cardiff Creek passes through the Project site, draining north from local peak Spion Kop and into the Break O'Day River to the north. Three smaller, nameless creeks flow into Cardiff Creek in the vicinity of the Project site. Other creeks flowing down from the

Tier, to the east of the subject area, flow into the Fingal Rivulet and join the South Esk near Fingal.

2.4. Vegetation

Tasmania's northeast region has a diverse flora and fauna (Kee 1991). Much of the Fingal Valley has been cleared for grazing, so consists of paddocks. Graham notes that the remaining vegetation is essentially native, but does not elaborate as to species.

Present satellite imagery (Google maps - accessed 20/04/2012, 1515AEST) shows the site area to have reverted to natural reforestation since the suspension of mining activities (Plate 1).

2.5. Geology

The region consists of a series of strata, with the early Palaeozoic Mathinna Beds (slate, phyllite and siltstone) at the base, overlain by the Permian/Triassic Parmeener Super Group (conglomerate, sandstone, mudstone, siltstone and limestone); above these are Tertiary deposits present as 'valley fillings' and Quaternary silt and sand on valley floors. The Parmeener Super Group contains extensive Jurassic dolerite sills, including those that form the plateau known as the Fingal Tier, while Devonian Ben Lomond Granite can be found intruded among the Mathinna Beds. Coal seams are present in the Parmeener Super Group sediments, most significantly in its upper 200 metres, as well as the lowest sediments (the Mersey Coal Measures). The major faultline in the region is the Cornwall Fault, which runs north of St Marys but, to the south, curves off westwards (Salway, Hancock and Jago 1979, pp. 3-12).

The Mathinna Beds are exposed in the South Esk and St Pauls but not the Break O'Day river valley, except east of the Cornwall Fault and where it converges with the South Esk. Various substrata of the Parmeener Super Group outcrop in the Break O'Day river valley, including the Mersey Coal Measures and the Cascade Group. On the other hand, the coal measures of the upper Parmeener Super Group are poorly exposed in the river valleys of the region, as they tend to be covered by extensive dolerite scree and alluvium. This scree has been observed up to 116 metres deep.

In his archaeological survey of the Cullenswood 3 extension, Huys (2011) noted that the underlying rock was dolerite. He observed different soil types in the two areas he investigated, both slightly above the valley floor. One consisted of a brown, sandy loam;

the other had a 20 cm layer of sandy loam, with many doleritic nodules, above a light brown regolith clay deposit, containing the same nodules. These were presumably the Quaternary deposits described by Salway et al. (1979), with input from dolerite scree.

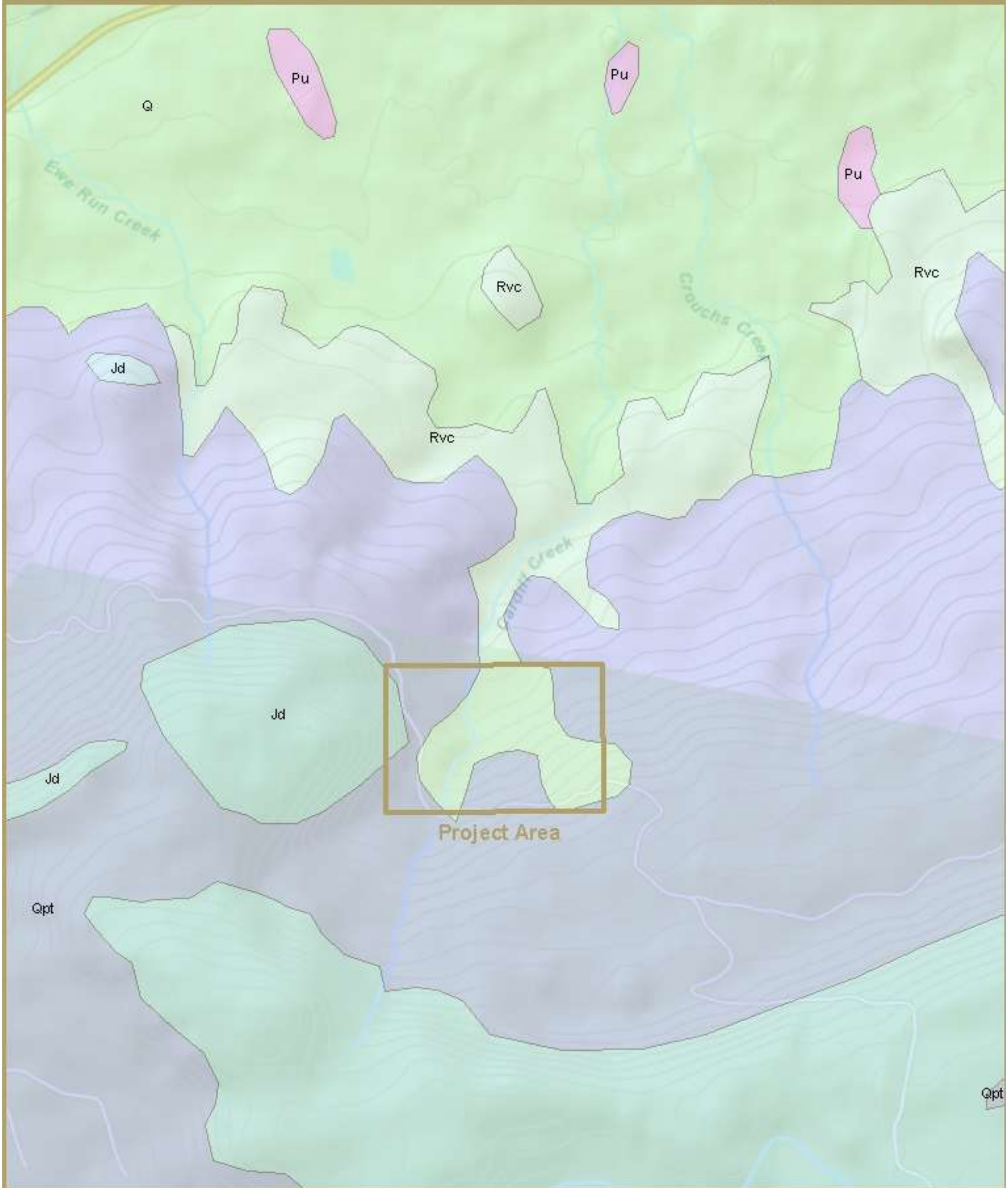
2.6. European Land Use History

European settlement of the Fingal area from the early 1800s, led to extensive sheep farming, with clearing and logging of the land for pastoral purposes.

Following Milligan's discovery of coal reserves in the Fingal Valley in 1849, there have been intermittent mining operations in the region, a good summary of which can be found in Bacon (1983, 1991). The Cornwall Coal Company incorporated in 1886 (Southgate 1983, p. 1-2). It has been '*a major employer* [in the Fingal Valley since then] *with considerable influence on the pattern of settlement and community structure*' (*ibid*., p. 13). The Fingal Coalfields, associated with the Fingal Tier and Fingal Valley, contain rich seams of coal, which have since been exploited by Cornwall Coal, notably at the Cullenswood Mine, near St Marys, and the Duncan Mine, near Fingal itself. In the late 1970s the Hydro-Electric Commission was investigating development of coalmining in the Exempt Area. The Valley Coal Company Pty Ltd operated the Valley Mine (or Barber's Mine) from 1955 to 1964. It is this mine that the Project aims to redevelop.

Figure 4 Local Geology

Fingal Teir Hardrock Coal



Jd -Dolerite (tholeiitic) with locally developed granophyre.
Pu - Upper glaciomarine sequences of pebbly mudstone, pebbly sandstone and limestone.
Q - Undifferentiated Quaternary sediments.
Qpt - Talus, vegetated and active
Rvc - Lithic sandstone, siltstone and mudstone with some coal and basal quartz sandstone.

3. ABORIGINAL ASSOCIATIONS WITH THE LANDSCAPE

The Fingal area appears to be on the boundary of two Aboriginal rangelands. the Project location is approximately 6.7 kilometres east of Fingal township, which lies just east of the junction of the Break O'Day and South Esk Rivers. While the precise territorial limits of Tasmania's various tribes are uncertain, this river system formed a boundary between the lands of the Ben Lomond tribe and the Oyster Bay tribe. Maynard's (2009) survey of the Ormley property, 15 kilometres southwest of Fingal, places it in the 'overlapping country' of the *Plinderairemeener* and *Tonenerweenerlarmenne*, both bands of the Ben Lomond tribe. However, Fingal lies east of the rivers, with Fingal Tier further east still. This should place it on the edge of the Oyster Bay territory (the *Leetermairremenner* band).

Given the relative proximity of the Fingal Tier to the Fingal Valley (associated with the South Esk and Break O'Day Rivers) and the fact that both tribes used the Valley as a route to and from the coast, Aboriginal heritage connected with either tribe might potentially be present at the study area. There is no evidence, however, that either tribe frequented the Fingal Tier. In his survey of the Cullenswood 3 mine extension, Huys (2011) found Aboriginal sites most frequent (and most likely to be present) along the lower slopes of the river valley, left by groups travelling through the area. He considered that this finding was likely to hold good for the Fingal Valley more generally.

3.1. Ethnographic Information

There is limited ethno-historical material about these tribes. Kee's survey of the north east of Tasmania deals with the Ben Lomond tribe but not the Oyster Bay one. She notes that early European descriptions of Tasmanian Aborigines say less about northeastern groups than about more southern ones, as there was less contact with them (Kee 1991, pp. 28, 31) The Ben Lomond tribe appears to be especially poorly known. There is almost no record of its religious or artistic culture and no ethno-historical references to their material culture, although she does cite a reference to huts that seem to have been constructed by this tribe (*ibid*, pp. 28, 31).

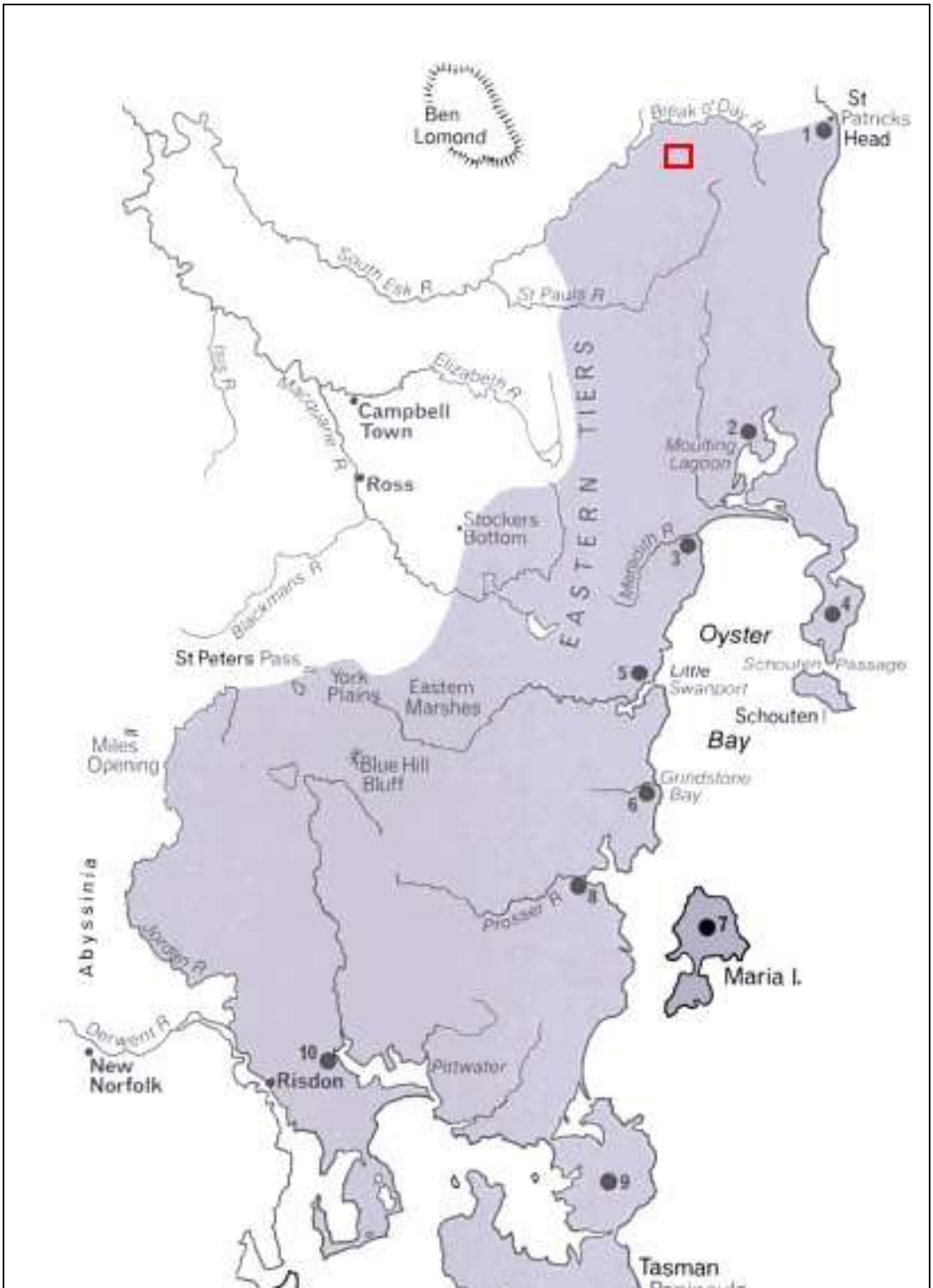


Figure 5: Geographical spread of Oyster Bay tribe (After Ryan)

Brown's (1986) equivalent survey of south-eastern Tasmania, which does take in the Oyster Bay territory, states that southern tribes are relatively poorly documented, as by Robinson's day this area had been thoroughly settled and depopulated of Aboriginal people (p. 24). While he presents ethnographic information about the Oyster Bay tribe, none of his examples come from the northern part of its territory, the area relevant to this survey. The information he provides often does not specify which of the three tribes covered by his survey is being described.

However, his description of the Oyster Bay tribe more generally is likely to hold true for the *Leetermairremenner* band, which occupied the Moulting Lagoon area. Little is known of the religious beliefs of southern tribes and what Brown cites (Brown 1986, p. 47-8) seems not to be about the Oyster Bay tribe. There are no ethno-historical references to Aboriginal art in the south-east, except for body art in the form of cicatrices (*ibid*., p. 45). Brown cites descriptions of material culture (dwellings, weapons, clothing, ropes, containers and tools) but it is not clear whether these relate to the Oyster Bay tribe, or to the South East or Big River tribes (*ibid*., pp. 34-42).

3.1.1. Tribal territories and seasonal movements

For both tribes, the Fingal area seems to have been a place through which they passed rather than an intensively exploited area. Maps of the territories and travel routes of Tasmanian tribes can be found in Ryan, p. 15 and pp. 34-35 (Figure 5and Figure 6).

The Ben Lomond tribe had a territory of around 260 square kilometres, which contained the Ben Lomond mountain region and the South Esk river valley. There seem to have been around 150-200 members altogether, in three or four bands (Kee 1991). The *Tonenerweenerlarmenne* band probably contained 50-80 people pre-contact and was present on the eastern edge of this territory. (In general, Tasmanian tribes consisted of bands of 40-70 individuals, composed of 5-7 family groups with 2-8 members each (Kee 1991, p18). However, information on the structure and precise territories of these bands is limited.

The tribe was landlocked but had seasonal passage to the coast through Oyster Bay land. The *Tonenerweenerlarmenne* moved along the Fingal Valley to get there, which took them past Fingal Tier and the nearby Break O'Day Plains. According to Ryan, the tribe travelled via St Marys Pass (*ibid*., p. 33):

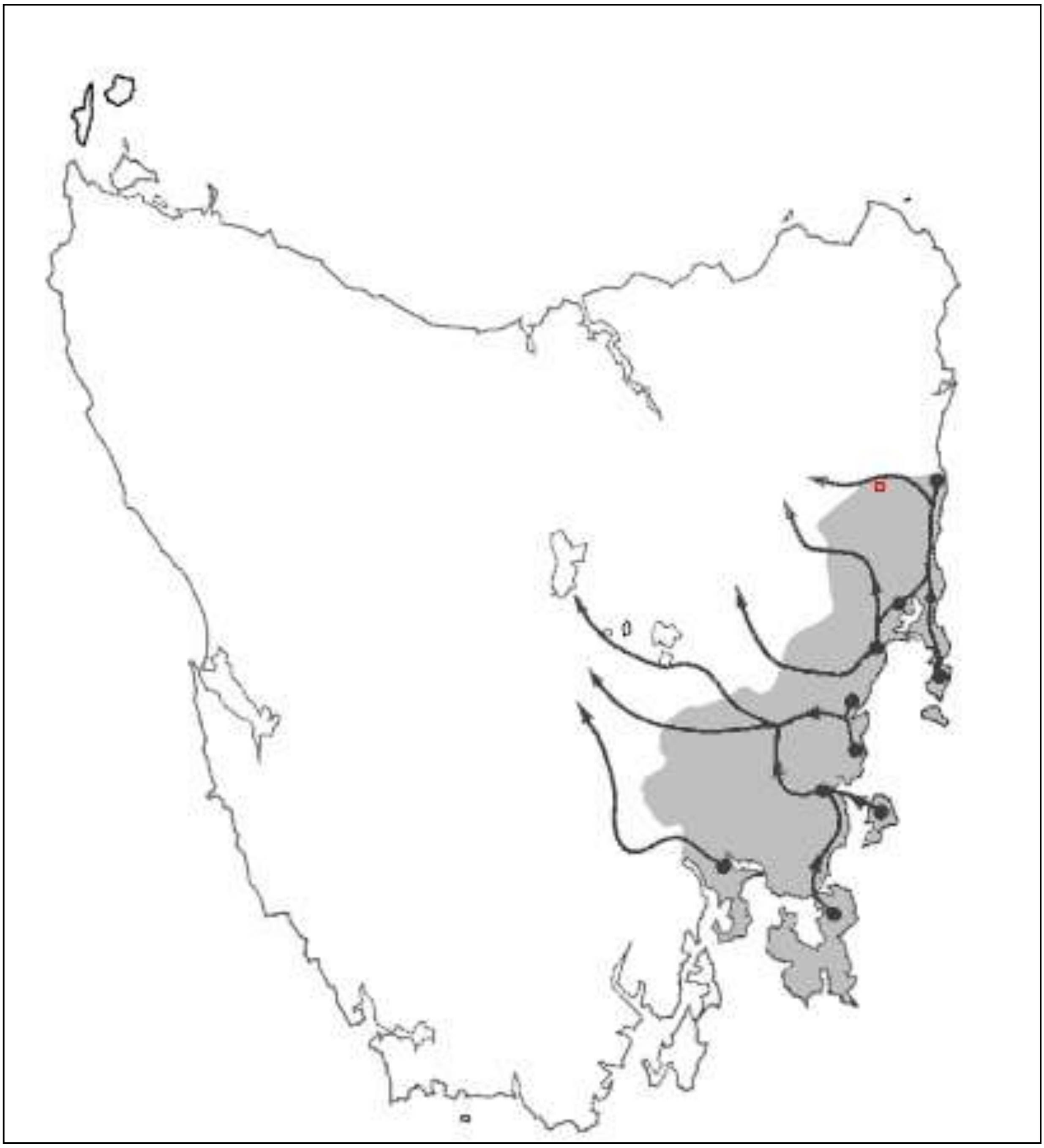


Figure 6: Routes of travel of the Oyster Bay tribe (after Ryan)

> *One band (apparently the Tonenerweenerlarmenne) had foraging rights at North Oyster Bay at Moulting Lagoon between August and October, and then moved to the North Midlands territory at Stockers Bottom in November, retiring to the Ben Lomond Tier for the summer. Sometimes they went with some North Midlands people to visit Big River country for hostile purposes. In January they were known to visit the east coast for seals and muttonbirds, returning to the Midlands Plain in autumn and then back to the coast for the winter* (Ryan 1996, p. 33).[1]

Although they followed the Fingal Valley, the Ben Lomond tribe seems not generally to have followed beaten tracks but instead roamed the countryside (they may have fired the land partly to facilitate movement (*ibid*., p. 25), although there is debate as to the degree to which fire management actually took place (*ibid*., p. 13) John Batman, looking for its surviving members in 1830 with the assistance of women of the tribe, noted that the women had been searching for them in the Fingal Tier area: '*Heard today that the women was coming down from Break O'Day Plains … Had been round towards Georges River and St Patrick's Head*' (Batman, (4/8/1830), cited in Kee 1991, p. 101).

The Oyster Bay tribe was Tasmania's largest, with 700-800 members. Its territory covered 7800 square kilometres from the Derwent River north to St Patricks Head (Plate 1). It consisted of ten bands, of which the *Leetermairremenner* was the most northerly (Ryan 1996, p. 17). Gatherings of around 500 members were recorded around Hobart in 1804 and earlier (Brown, pp. 23-4). These must have involved most of the tribe, which may indicate that bands were fairly mobile within the tribal range, although whether the *Leetermairremenner* would have come so far south is questionable.

The Oyster Bay tribe too passed through the Fingal Valley from the coast to Ben Lomond Tier (Figure 4). The movements of northern bands of the tribe, such as the *Leetermairremenner*, resembled those of the Ben Lomond tribe. They tended to travel in spring or autumn. They spent winter on the coast, eating shellfish and marine plants. From August to October they went to coastal places such as Moulting Lagoon for birds and

[1] (Note, though, that Hiatt (1968) suggests that Aboriginal seasonal movements should be regarded as trends, not invariable mass movements: not all bands would have moved every year (Brown 1986, p. 33)).

their eggs. From late October many travelled to Stockers Bottom, in the North Midlands, or to Ben Lomond Tier, via the St Pauls and Break O'Day Rivers, to spend the summer. At the end of January they revisited the coast, for seals and muttonbirds, then returned inland to hunt marsupials.

Near the coast, the tribe appears to have favoured open forests close to the shore for its campsites. There is no ethnohistorical mention of their choices when camping inland. However, Robinson's descriptions of Aborigines of the Central Highlands suggest that these preferred to camp near lagoons, lakes, rivers or other water bodies. Brown suggests that the Oyster Bay tribe may have done the same (Brown 1986, p. 31).

Although the seasonal movements of this band and the *Tonenerweenerlarmenne* were similar, so they may have spent time in each other's company, there were differences between them in terms of wider tribal interactions. The northern Oyster Bay bands seem to have been on close and friendly terms with the Big River people, for instance, (Ryan 1996, p. 20), whereas the *Tonenerweenerlarmenne* had hostile relations with this group and sometimes allied with the North Midlands tribe against them (*ibid*., p. 33).

By the time of European arrival, the Ben Lomond tribe was settled in the interior and the Oyster Bay tribe on the coast (Plate 1). Since the Fingal Valley seems to have been used as a corridor between coast and interior, until both areas were settled the usage patterns may have been different. Glaciation prevented Aboriginal occupation of the north eastern highlands until around 10,000 years ago, although it seems that formerly glaciated areas may have been settled rapidly once deglaciation took place. Territorial expansion may also have been promoted by the vegetation changes that accompanied a cooler and drier period that began around 3500 years ago. Conversely, before around 6000 years ago the sea level was 150 metres lower than at present, with the result that the coastlines were different (Kee 1991, p. 14). These kinds of factors are likely to have influenced which parts of Tasmania were settled and also the seasonal travel routes taken. This makes it hard to be certain how long the territorial and travel patterns observed by early Europeans had been in existence.

European arrival from 1803 brought swift disruption to the Aboriginal way of life, with the last groups from the Fingal Valley captured and deported around 1832. Fingal, being inland, was not exposed to European contact until the settlement expansion of the 1820s. However, since both Aboriginal tribes who frequented the area spent part of the year on the coast they are likely to have encountered Europeans before British expansion into the Fingal Valley.

The seal trade resulted in trading connections between Aboriginal peoples and the sealers, with Aborigines gathering along the coast by 1810 at suitable points, such as Eddystone Point, to barter sealskins and kangaroo skins for commodities. Aboriginal women began to be hired out to sealers for the season in exchange for dogs. This had several consequences. The depletion of women in Aboriginal bands began to produce a population decline. Trade affected Aboriginal seasonal movements and intertribal interactions, with coastal tribes tending to remain near the coast all year and abducting the women of neighbouring groups to sell to the sealers. As seal populations declined, the larger sealing operations moved elsewhere, leaving smaller bands of sealers, generally rougher and sometimes escaped convicts, whose interactions with the Aborigines became more violent.

Meanwhile, between 1817 and 1823, four thousand free settlers migrated to Tasmania, many to begin farming. This resulted in a dramatic increase in the numbers of land grants and consequent expansion of the 'settled districts', generally along river systems. The sheep population rose significantly, at the expense of the kangaroos that the Aborigines hunted (Ryan 1996, pp. 83-85). As a result, pressure for valuable resources was placed on Aboriginal communities inland.

From the start of the 1820s the Fingal Valley and Break O'Day regions began to be opened up to Europeans. In 1820, Rice reported fertile land in the Fingal Valley region. Settlement around Fingal started in the 1820s, with James Grant, William Talbot, Robert Hepburn, Francis Groom and others allocated land from 1821 onward. In 1825 John Helder Wedge, the Government Surveyor, reported fertile territory around the Break O'Day Plains, a little to the north of the Fingal Tier, with settlement commencing within the next few years.

In late 1830, George Augustus Robinson was informed that there were only two groups of Aborigines left in the northeast, one in the Fingal Valley (Ryan 1996, p. 150). Anthony Cottrell was sent to capture this band in early 1831 (*ibid*, p. 153) and succeeded in January 1832, in north Oyster Bay. By this time it was the last surviving group (*ibid*, p. 157). These locations suggest the group was the *Tonenerweenerlarmenne*, as they correspond to its known distribution and travel patterns. The band seems to have moved along the Fingal Valley to Oyster Bay shortly before being captured.

3.2. Archaeological Context

No archaeological field investigations had been undertaken for the study area, other than those carried out for the purposes of assessing the impact of the present proposed development.

3.2.1. Previous Aboriginal Cultural Heritage Investigations

Graham, 2007-2008; Huys, 2011: The Cullenswood coal-mine (and extensions)

Graham (2007-2008) examined the area around the nearby Cullenswood open cut coalmine for Aboriginal heritage. As individual blocks of land were cleared and bulldozed, in preparation for extension of the mine, Graham carried out site surveys and documented his findings in a series of reports numbered 1-34. Most of the reports for 2007-2008 have been examined (Numbers 21, 22, 26-28, 31-32, 34) but earlier reports have not. These surveys located several artefact scatters and isolated artefacts, although some surveys (26, 28, 31 and 34) found no material. The unseen reports seem also to have documented sites in some cases.

Huys undertook an assessment of Cullenswood 3 and proposed a model of Aboriginal occupation of the Fingal Valley on the basis of his findings. He refers to two earlier surveys of 2010, which identified two PADs (Potential Archaeological Deposits) in the study area, one associated with an isolated artefact (TASI 11265). Because PADs often feature poor surface visibility, meaning artefacts can be hidden in the subsoil, three transects were ploughed and examined to check whether material was in fact present. No Aboriginal material was found in any of the transects and, in view of the intensive nature of the investigation, Huys concluded that Aboriginal artefacts were either absent, or present in very low densities in these locations.

He combined this information with earlier data from a study of the Cullenswood 2 extension area to form hypotheses about Aboriginal settlement patterns more generally in this part of the Fingal Valley. Sites and artefacts appear to be concentrated on the '*elevated and level terraces that fringe the southern edge of the low-lying valley floor*' (Huys 2011, p. 15). On the valley floor itself and the steeper hill slopes that surround it, artefact densities are very low. The chosen campsites (TASI sites 10945 and 10946 in

Cullenswood 2) probably represent 'interim locations' used by groups in transit through the Fingal Valley and chosen because they were raised and level sites on well-drained soil and close to the food resources of the valley floor (*ibid*., p. 15). People are likely to have foraged but not camped on the valley floor, because of the poor drainage, the regular flooding and the cold air that collected there. Site density is likely to be low there and consist of isolated artefacts. From the fact that one of the PADs resembled the favoured campsite areas but had no artefacts, Huys concluded that sandy soils were preferred to loam for campsites, as soil type was the only difference from the favoured sites. Huys argued that these conclusions about site distribution and density should hold for the rest of the Fingal Valley and predicted a low density of material throughout the Cullenswood 3 study area.

Other surveys for Aboriginal heritage in the Fingal area have been carried out by Sim (1997) and Maynard (2009).

Sim (1997) examined the proposed route of a subsurface telephone cable for Aboriginal heritage material. This ran 3.545 km from Fingal township to the foothills of Bare Rock, through heavily disturbed land (pasture and dwellings). No sites were located. Sim remarked that (at that time) few Aboriginal sites had been recorded around Fingal or from the base of the Fingal Valley; he noted that this could reflect lack of investigation or pastoral disturbance of the land. Numerous sites had previously been found by Kee (1991; 1987) 20 km west of Fingal, by Sim 15 km north-west, and Moore reported artefacts from near Avoca.

Maynard (2009) carried out an Aboriginal heritage values survey of a proposed dam extension on the Ormley property, near Fingal. The dam was on a tributary of the South Esk River, a known travel route of Aboriginal people in the past. No heritage sites were located.

3.3. Registered Aboriginal Site Distribution

A search of the Tasmanian Aboriginal Site Index (TASI) completed on the 20th of August 2011 identified 25 knownAboriginal sites within the surrounding area (See Figure 7 and Table 2).

The majority of Aboriginal sites identified from TASI were located in the last fifteen years during surveys arising from the proposed extension to Cornwall Coal's open cut mine at Cullenswood, 3.6 km west of St Marys, some 9km north east of the current project area.

The majority of these sites were found by Graham in 2004-08, on or around the blocks of land being cleared of vegetation and topsoil in preparation for extension of the mine (the Cullenswood mine extension). Some were situated near disturbed or eroded soil, such as around access tracks, perhaps because the investigation did not involve targeted digs but rather inspection of cleared and later bulldozed land. Nine sites consisted of artefact scatters while five involved isolated artefacts. TASI 10641 consisted of two artefacts in the vicinity of a historical site (although the site card does not specify what this site was). A range of items was observed: debitage, flakes, cores, manuports, scrapers and multipurpose tools. The most common material used was quartz. The only one of these sites directly affected by the mining excavation was TASI 10328, which was salvaged and relocated to prevent destruction; the letter (dated 25.06.2007) granting permission for relocation can be found in an appendix at the end of Graham's Report No. 22. (The other sites either fell outside the zone of operations or were protected by the erection of a fenced buffer around them for the duration of the work.)

A further four sites were identified by Huys and O'Sullivan, in the course of surveying in 2010 and 2011. TASI 10945 and 10946 were in the Cullenswood 2 extension zone; these were isolated artefacts on elevated ground a little above the valley floor. TASI 11265 and 11266, in the Cullenswood 3 extension area, were also isolated artefacts. Huys identified a Potential Archaeological Deposit lying around TASI 11265, where the presence of further Aboriginal material was anticipated. However, archaeological investigation failed to find anything, leading him to conclude that sites in this vicinity were likely to be of low density or else absent (see above).

A number of other sites are poorly documented on the TASI site cards. Three sites were recorded by Ferguson in 1986 (TASI 3275, 3294 and 3295), another three by Hamilton in 2001 (TASI 8904, 8905 and 8906) and another, TASI 8866, consisting of two flakes, by Scotney in 2001. All were artefact scatters or isolated artefacts, but the site cards present little other information.

TASI	Site Type	Site description from TASI
3275	Artefact Scatter	-
3294	Isolated Artefact	-
3295	Artefact Scatter	-
8866	Artefact Scatter	2 flakes, silcrete and cherty hornfels
8904	Isolated Artefact	-
8905	Artefact Scatter	-
8906	Isolated Artefact	-
9738	Artefact Scatter	4 items, 1 quartz, 3 cherty hornfels
9920	Isolated Artefact	cherty hornfels broken flake and red ochre
9967	Isolated Artefact	damaged cherty hornfels flake
10328	Isolated Artefact	brown chert
10336	Artefact Scatter	scrapers, debitage, manuports
10337	Isolated Artefact	broken cherty hornfels flake
10419	Isolated Artefact	white quartz broken flake
10468	Artefact Scatter	two quartzite flakes, various quartz bits
10475	Artefact Scatter	cores, scrapers, manuports, m/purpose tools
10576	Artefact Scatter	14 artefacts
10641	Artefact Scatter	2 stone items associated with a historical site
10740	Artefact Scatter	various flakes
10821	Artefact Scatter	-
10926	Artefact Scatter	various flakes
10945	Isolated Artefact	-
10946	Isolated Artefact	-
11265	Isolated Artefact	quartzite flake
11266	Isolated Artefact	chert broken flake

Table 2: Sites recorded on the TASI database in the vicinity of the project study area

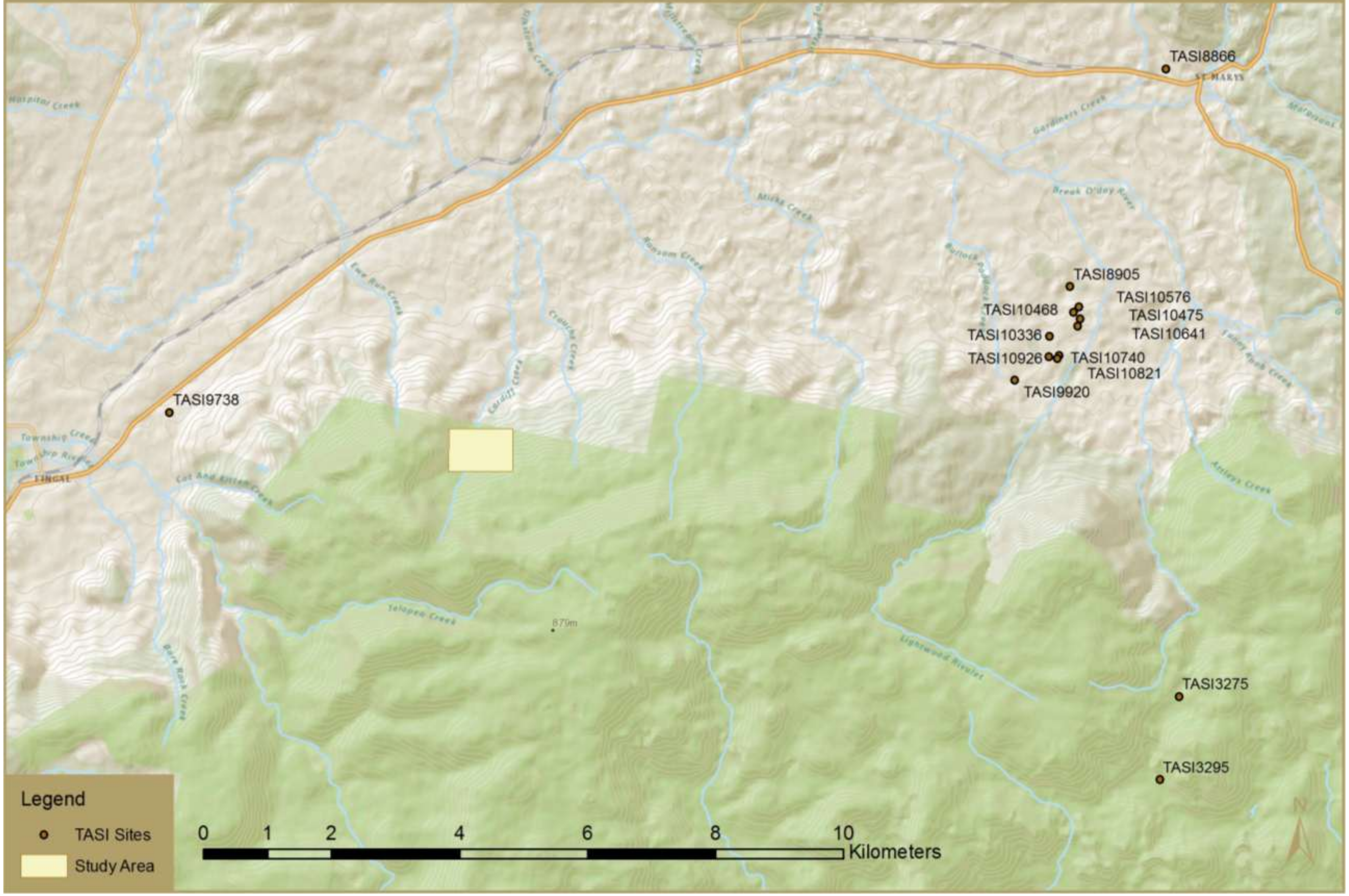
It is interesting to note that the entire 25 sites from TASI are open context artefact sites of varying artefactual densities (see Table 3). Given that TASI is a record only of those sites that have been reported to AHT it is highly likely that there are further Aboriginal heritage sites within the surrounding area and that based upon the available landforms these sites may be of different types to those currently recorded.

Site Type	Frequency	%
Artefact Scatter	13	52%
Isolated Artefact	12	48%

Table 3: Site Type Frequency

Figure 7 TASI Sites

Fingal Teir Hardrock Coal



4. FIELD ASSESSMENT

Consultation with AHT regarding the projects scope, schedule and proposed methodology for the completion of the archaeological survey was undertaken on 21st October 2011. During the discussions the it was explained that initially the proponent was assessing only those areas proposed to be impacted by the necessary surface infrastructure to enable to project to be economically viable and that once it was determined that the project was viable additional survey and assessment would be undertaken to assess the impacts associated with the extraction or the coal resource.

Areas identified for survey were those areas proposed for surface infrastructure (as shown in Figure 3). It was proposed that these areas be subject to a pedestrian archaeological assessment with additional targeted survey being undertaken if/when sensitive landforms or favourable visibility conditions where identified for locations immediately adjacent to those proposed for impact. On the day of the survey no other issues where identified that would require a re-evaluation of this decision and accordingly the survey was carried out employing pedestrian survey techniques.

4.1. Method, Coverage and Limitations

Pedestrian survey was carried out across the study area; the location and survey routes of the survey leader were captured using a handheld Global Positioning Satellite (GPS) system (see Figure 8). All Aboriginal heritage items were individually way pointed (See Figure 9). Due to the proposed development utilising much of the pre-existing mine infrastructure, the survey was in the main confined to the areas of proposed ground disturbance, including:

- the roadways entering the site from the Valley Road;
- the proposed Water Improvement Area;
- the proposed Receiving Hopper and Belt Road areas;

Additionally, the higher ground to the east and southeast of the main workings was walked, as was the northern and north-eastern periphery of the proposed Water Improvement Area.

The survey was conducted by Lance Syme and Vernon Graham, walking approximately 3-5m apart, closely inspecting the ground surfaces for traces of Aboriginal cultural material.

Ground surface visibility was generally low to moderate due to grass and vegetation cover over most of the survey area, though occasional areas of exposure that had improved visibility. Plate 2 shows the typical visibility within the south eastern portions of the study area.

Transect	Landform	Exposure Type	Length (m)	Width (m)	Av. Vis (%)	Effective Coverage (length x width x visibility) (m2)
T1	Mid-slope	Patchy grass, logging track	220m	20m	30	1320
T2	Mid and Lower Slope	Patchy grass, logging track, mullock heaps	385m	20m	30	2310
T3	Mid-slope	Patchy vegetation	210m	20m	40	1680
T4	Mid-slope	Patchy vegetation, logging track, mullock heaps	345m	20m	35	2415
T5	Mid-slope	Dense vegation	15m	20m	25	75
T6	Mid-slope	Dense Vegatation, Mullock Heaps	275m	20m	25	1375
T7	Mid-slope	Patchy Vegatation	220m	20m	25	1100
T8	Lower Slope	Patchy Vegetation	660m	20m	40	5280
T9	Lower Slope	Patchy vegetation, logging track	345m	20m	40	2760
T10	Lower Slope	Open scrubland	255m	20m	40	2040
T11	Mid and Lower Slope	Open scrubland, logging track	110m	20m	40	880
T12	Mid-slope	Patchy grass, logging track	515m	20m	30	3090

Table 4: Survey Coverage

Plate 1: View west along T1. Existing Track to be upgraded.

Plate 2: View South at beginning of T2.

Plate 3: View of erosion high(south) side of access track approx.. 1/3 along T2

Plate 4: Midpoint of T2 view of small flat area north of access track

Plate 5: View of gravel deposits in Cardiff Creek, western end of T12

Plate 6: View of section of Cardiff Creek showing excess coalwash from historic mining activities

Plate 7: View of northern of a Area of Aboriginal Sensitivity, T9

Plate 8: View of Cardiff Creek showing high levels of previous disturbance and coalwoash deposits

4.2. Aboriginal Sites

Two Aboriginal sites, both identified as single artefact sites, 1 and 2 were noted during the field assessment. One isolated artefact was located on the western side of an old bridge crossing Cardiff Creek, and another was located on a spur line c.100m east of Cardiff Creek, on the southern side of a former mine access track (Figure 8).

The isolated artefact sites comprise single pieces of worked Quartz, and attest to the opportunistic utilisation of loose Quartz pebbles found in the locality, most likely the Cardiff Creek or one of the other natural drainage channels that cross the site. This activity suggests transient passage through the study area rather than periodic settlement. That said however, the vegetation and other ground cover noted during the site survey could easily have masked any more significant artefact scatters, such as those found elsewhere in the Fingal valley, which may otherwise point towards temporary settlement and/or hunting activity.

An area of Potential Archaeological Deposits was also identified (Figure 8, Site 3). It lay to the south of the proposed overland conveyor site, between the 440m and 450m contours.

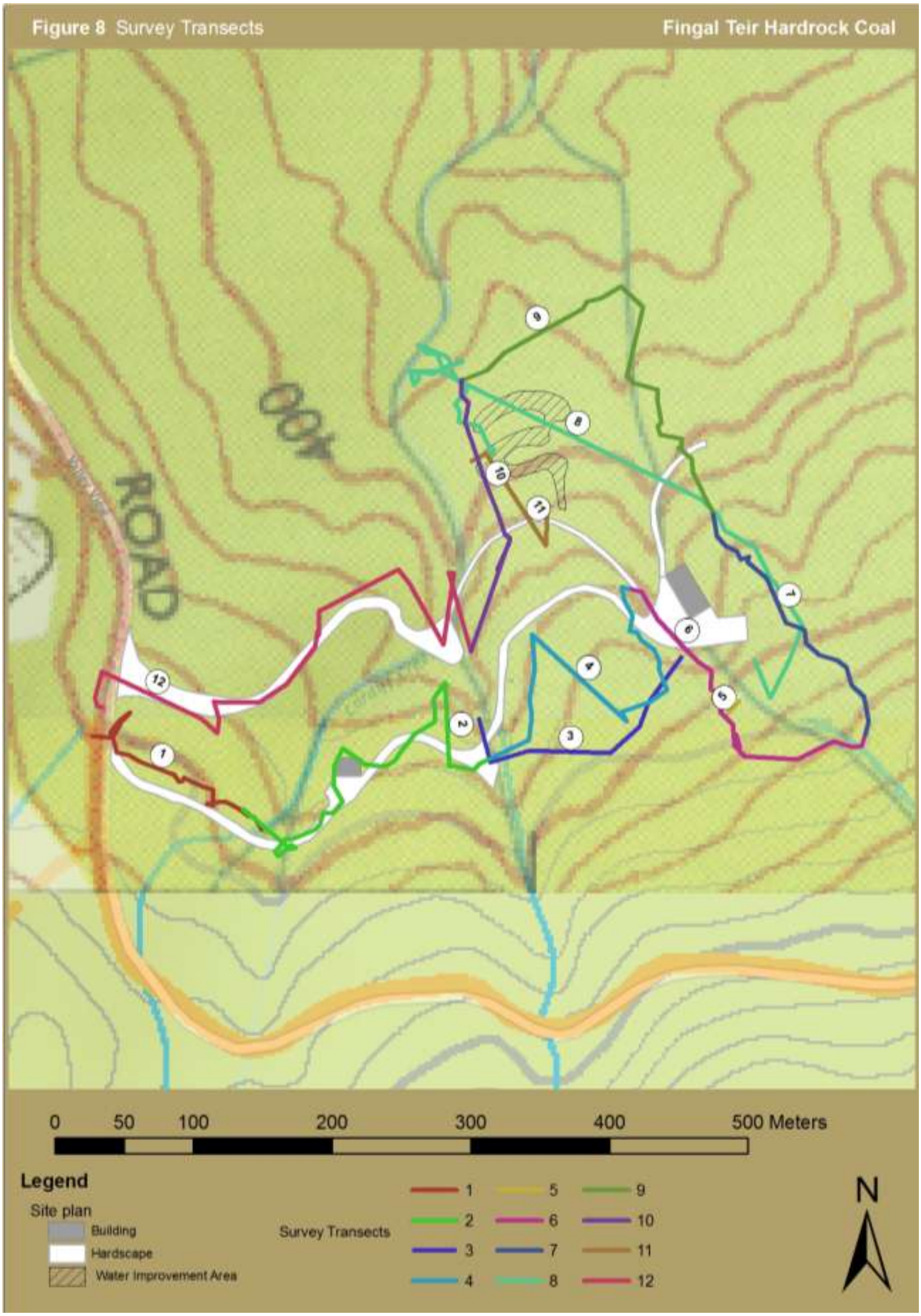


Figure 8 Survey Transects
Fingal Teir Hardrock Coal
ROAD
400
0 50 100 200 300 400 500 Meters
Legend
Site plan
Building
Hardscape
Water Improvement Area
Survey Transects
1 2 3 4 5 6 7 8 9 10 11 12
N

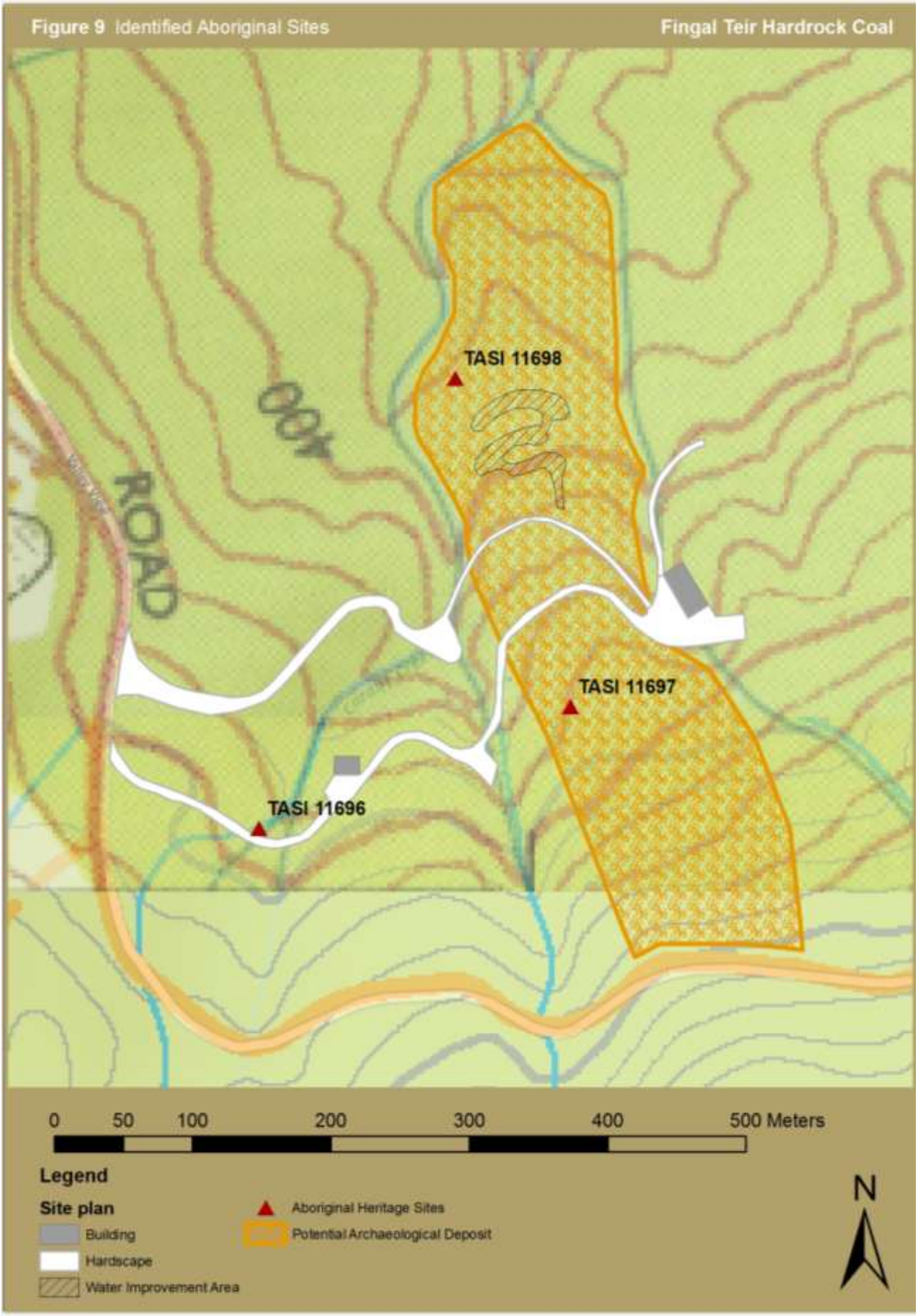


Figure 9 Identified Aboriginal Sites
Fingal Teir Hardrock Coal
ROAD
400
TASI 11698
TASI 11697
TASI 11696
0
50
100
200
300
400
500 Meters
Legend
Site plan
Building
Hardscape
Water Improvement Area
Aboriginal Heritage Sites
Potential Archaeological Deposit
N

4.2.1. Aboriginal Site TASI 11696

This isolated artefact is situation on the southern alignment of an existing forest c.5m from the crossing of Cardiff Creek (see Figure 9).

The artefact is a quartzite core that exhibits 6 flake scars across 3 platforms. Pebble cortex is present across 50% of the exterior surface of the artefact.

Plate 9: Artefact's at TASI 11969

Plate 10: General Location of TASI 11969 view east along existing track

4.2.2. Aboriginal Site TASI 11967

This isolated artefact was found upon a spur line between two unnamed drainage lines that drain into the main channel of Cardiff Creek in the western portions of the study area (See Figure 9).

The artefact is manufactured from white quartzite and exhibits characteristics for bi polar flaking techniques.

Plate 11: Artefact from TASI 11697

Plate 12: General View of TASI 11697 looking south up spur line

4.2.3. Aboriginal Site TASI 11698

This isolated find was identified during a pre-survey inspection of the project area by Lance Syme. The artefact was unable to be related during the survey.

The artefact was a core manufactured from tuff.

It is situated to the east of Cardiff Creek, slightly above the creek channel in a flattish elevated position (See Figure 9).

Plate 13: Artefact from TASI 11698

Plate 14: General Location of TASI 11698

4.3. Aboriginal Site Potential

Formulating Aboriginal site predictive statements for the project study area is an essential part of any cultural heritage assessment. The potential for Aboriginal sites to exist needs to be considered so that all possible impacts of the development can be evaluated. The predictive model below has been developed through assessing the nature and distribution of Aboriginal sites identified during the field assessment, and taking into consideration other sites types in the immediate vicinity of the proposed development.

This is supplemented through an understanding of landform development and environmental factors (vegetation communities, distribution of potable water).

The relatively small footprint of the proposed development and the landforms within the study area, along with the low levels of surface visibility during the field survey are considered to have allowed the formation of a sound Aboriginal site predictive statement (Table 3). This model does not apply to the Aboriginal cultural landscape or to Aboriginal people's relationship to that landscape.

4.4. Broader Aboriginal Values

This section requires the input of Vernon Graham, Aboriginal Heritage Officer.

4.5. Significance of Aboriginal Sites

The significance of Aboriginal values is described within a framework provided by 'The Burra Charter' (Australia ICOMOS 1999), which defines aesthetic, historic, scientific, social and spiritual values. A general statement of the significance for each value is presented below. This is based on discussions with and information provided by Vernon Graham, and the results of the field assessment.

Aesthetic values: This includes aspects of sensory perception, including form, scale, colour, texture and material, smells and sounds associated with a place and its use (Australia ICOMOS 1988, section 2.2). The aesthetic value of the study area has been altered by modern clearing and land use. This has reduced the aesthetic value of the study area in relation to Aboriginal heritage.

Site type	Potential for Aboriginal Sites	Comments
Artefact scatters and/or isolated artefacts	Moderate	Stone artefact scatters are the most common site type, and may occur across a range of landforms. Elevated locations adjacent to an important resource habitat would have been targeted by Aboriginal people.
Burial sites	Low	Whilst burial sites cannot be ruled out completely, they are an uncommon find, and no previous sites of this type have been recorded in the vicinity to date.
Carved or scarred trees	Low	No culturally-modified trees were identified during the fieldwork phase of the assessment, and there are no recorded sites in the vicinity. Much of the site was cleared of all vegetation during the lifetime of the original mine working.
Ceremonial grounds or 'bora'	Very low	Such sites tend to occur on relatively flat ground at lower altitudes. No ceremonial sites were identified during the field inspection.
Engravings	Low	There are no recorded sites within the proposed development area or immediate vicinity. Such sites are usually found in areas of rock shelves or flattened outcrops, but no such areas were identified during the field inspection.
Fish traps	Very low	Cardiff Creek flows roughly centrally through the site, but at the time of the field inspection, it was noted that there were several areas of ingress and course alteration. A low flow rate also suggests that this location would not have been a suitable key habitat for fish.
Grinding bowls/groove sites	Low	There are no recorded sites within the proposed development area or immediate vicinity. Such sites are usually found in areas of rock shelves or flattened outcrops, but no such areas were identified during the field inspection.
Post-contact sites	Low	There are no recorded sites within the proposed development area or immediate vicinity, and no material evidence (i.e. knapped glass artefacts) was noted during the field inspection.
Potential Archaeological Deposits (PADs)	Moderate	Areas which may contain PADs are often on slightly elevated ground close to a reliable water source, and where settlement-related may reasonably be expected to have occurred. One such area was identified during the field inspection, and therefore the presence of hitherto unknown subsurface archaeological deposits cannot be ruled out.
Rock shelters/Rock Art sites	Low	There are no recorded sites within the proposed development area or immediate vicinity. Such sites are usually found in areas of rock shelves or overhangs, but no such areas were identified during the field inspection.
Stone alignments	Very low	There are no recorded sites within the proposed development area or immediate vicinity, and no such sites were located during the field inspection. Due to the nature of the recent mining activity in the study area, it is highly unlikely that any such sites would have survived, if they existed prior to development.
Stone or Ochre quarries	Low	There are no recorded sites within the proposed development area or immediate vicinity, and no such sites were located during the field inspection. The two isolated artefacts identified during the field inspection were of Quartz, suggesting that there is no ready source of workable stone in the vicinity, other than Quartz pebbles recovered from the creek. There were no signs of Ochre-bearing rock within the study area.
Water holes, wells and/or pot holes	Very low	There are no recorded sites within the proposed development area or immediate vicinity. Such sites are usually found in areas of rock shelves or flattened outcrops, but no such areas were identified during the field inspection.

Table 5: Predictive Model of Aboriginal Site Potential

Historic values: A place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity, or as the site of an important event. For any given place the significance will be greater where evidence of the association or event survives *in situ*, or where the settings are substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of subsequent treatment (Australia ICOMOS 1988, section 2.3). The study area has evidence of Aboriginal occupation, and as such has some historic value, as it demonstrates Aboriginal occupation of the area.

Scientific values: The scientific or research value of a place will depend upon the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place may contribute further substantial information (Australia ICOMOS 1988, section 2.4). The study are has some scientific potential given that Aboriginal artefacts are present and other buried artefacts are likely to be present. The higher eastern part of the study area has higher archaeological potential as it appears to be less disturbed than the lower western and central parts of the study area. Archaeological excavation would be needed to assess this potential. The site could contribute new information on Aboriginal occupation of Frogmore Peninsula/Midway Point.

Social values: These embrace the qualities for which a place has become a focus of spiritual, political, national or other cultural sentiment to a majority or minority group (Australia ICOMOS 1988, section 2.5).

Significance Attribute	TASI 1	TASI 2	TASI 3	General Project Area
Aesthetic	Low	Low	Low	The aesthetic value of the project study area has been substantially altered by European land use practices, and as such has reduced aesthetic values to Aboriginal people.
Historic	Low	Low	Low	No historical values to Aboriginal people for the project area have been established.
Scientific	Low	Moderate	Moderate	The study area is assessed as having low to moderate archaeological potential
Social	Low	Low	Low	The study area has no known social values to Aboriginal people
Spiritual	N/A	N/A	N/A	Refer to Section below

Table 6: Assessed Significance Values

Aboriginal Cultural Significance

Insert Statement from Vernon Graham report here

Archaeological Significance

The area has been assessed as having a low archaeological significance, based upon the three isolated artefact sites, and an area of Potential Archaeological Deposit. The archaeological significance may be elevated if further sites are located, and/or if the PAD is tested and proves to yield evidence of Aboriginal occupation.

5. LEGISLATION

5.1. State Legislation Protecting Aboriginal Sites

5.1.1. Aboriginal Relics Act 1975

The primary State legislation that relates to the protection and management of Aboriginal cultural values is the Aboriginal Relics Act 1975, which provides protection for Aboriginal relics made prior to 1876 and relevant details are summarised below.

The Aboriginal Relics Act 1975 defines a relic as:

- any artefact, painting, carving, engraving, arrangement of stones, midden, or other object made or created by any of the original inhabitants of Australia or the descendants of any such inhabitant;
- any object, site, or place that bears signs of the activities of any such original inhabitants or their descendants; or
- the remains of the body of such an original inhabitant or of a descendant of such an inhabitant who died before the year 1876 that are not interred in-
  - any land that is or has been held, set aside, reserved, or used for the purposes of a burial ground or cemetery pursuant to any Act, deed, or other instrument; or
  - a marked grave in any other land.

The Act specifies that: *No object made or created after the year 1876 shall for the purposes of this Act be treated as a relic, and no activity taking place after that year shall for those purposes be regarded as being capable of giving rise to such a relic.*

Section 14 specifies that:

> *Except as otherwise provided in this Act, no person shall, otherwise than in accordance with the terms of a permit granted by the Minister of Environment, Parks, Heritage and the Arts on the recommendation of the Director –*
>
> *Destroy, damage, deface, conceal, or otherwise interfere with a relic;*
>
> *Remove a relic from the place where it is found or abandoned;*

A permit is required under Section 14: Subsection (f), for '*an excavation to be made or any other work to be carried out on Crown land for the purpose of searching for a relic*'.

This permit would apply to works such as archaeological subsurface testing and excavation.

5.2. Commonwealth Legislation Protecting Aboriginal Sites

5.2.1. Aboriginal and Torres Strait Islander Heritage Protection Act (ATSIHP Act), 1984

Whereas the State Act provides legal protection for all physical evidence of past Aboriginal occupation (pre 1876), the Aboriginal and Torres Strait Islander Heritage Protection Act 1984, and subsequent amendments provides for the preservation and protection of Aboriginal cultural property in a wider sense. Such cultural property includes any places, objects and folklore that 'are of particular significance to Aboriginals in accordance with Aboriginal tradition'. There is no cut-off date and the Act may apply to contemporary Aboriginal cultural property as well as Aboriginal sites. The Act is not intended to exclude or limit the operation of State legislation in those situations where the latter makes adequate provision for the protection of sites, objects and skeletal remains.

It is considered unlikely that Aboriginal sites and values identified in the project study area would receive protection under this legislation. This is due to the adequate provisions of the Aboriginal Heritage Act 1975 for the protection of Aboriginal sites. In order for Aboriginal places, objects and folklore to be protected under this legislation, proof of their 'particular significance to Aboriginal in accordance with Aboriginal tradition' would be required.

5.2.2. Environment Protection and Biodiversity Conservation Act (EPBC Act), 1999

The EPBC Act enhances the management and protection of Australia's heritage places, including World Heritage properties. It provides for the listing of natural, historic or Indigenous places that are of outstanding national heritage value to the Australian nation as well as heritage places on Commonwealth lands and waters or under Australian Government control.

World heritage properties and national heritage places are recognised as a matter of national environmental significance under the EPBC Act. Consequently, any action that is likely to have a significant impact on heritage properties and places must be referred to the Minister and undergo an environmental assessment and approval process. No Aboriginal sites or places in the project study area fall within this category.

6. MANAGEMENT ISSUES AND RECOMMENDATIONS

This section outlines the legislative framework protecting Aboriginal sites, the views of Aboriginal stakeholders regarding this assessment and the development, and the impact of the development on Aboriginal values. Management implications and consultation with TALSC have informed the recommendations that conclude this report.

6.1. Aboriginal View Regarding the Development

Views documented by the consultants during meetings with Aboriginal stakeholders are provided below.

Tasmanian Aboriginal Land & Sea Council (TALSC)

TALSC raised the following matters regarding this assessment and the proposed development:

- Insert once available

Aboriginal Heritage Tasmania (AHT)

The following issues were raised in relation to this project by the AHT:

- Insert once available

6.2. Impact of the Development on Archaeological Values

The implications of this assessment are discussed in terms of the potential impact of the proposed Caason Fingal Tiers Mine on Aboriginal sites and values.

Aboriginal Sites and Zones of Aboriginal Site Potential

Three Aboriginal sites have been identified as part of this assessment. Each of the identified artefacts was manufactured from different raw materials i.e. quartzite, quartz and tuff.

TASI 11696 is located immediately adjacent to the existing access roadway and is proposed to be widened and have water management structures installed within the immediate area. TASI 11697 is situated in the vicinity of the proposed route of the overland conveyor and should be able to be avoided. TASI 11698 is situated down slope of the proposed Water Improvement Area and is likely to be subject to impact from ground works associated with the construction of the Water Improvement facilities. One Potential Archaeological Deposit was identified based upon the combination of landform, local topography, level of previous disturbance and the views of the Aboriginal Heritage Officer present on the day of the survey (Figure 9).

6.3. Recommendations

The following recommendations have been formulated in response to the identified management implications.

Recommendation 1: Impact to TASI 11696 and TASI 11698

A Permit under Section 14 of the Aboriginal Relics Act 1975 should be sought for impact to TASI 11696 and TASI 11698.

Recommendation 2: Preparation of an Aboriginal Heritage Management Plan

A Management Plan should be prepared for the project. The management plan should be prepared by an individual with recognised training and qualifications and experience in Aboriginal cultural heritage management. The management plan should as a minimum identify the scale and scope of future investigatory works i.e. archaeological survey, sub-surface testing and/or salvage (as appropriate), strategies for dealing with un-anticipated identification of Aboriginal relics, identify managements zones and applicable controls for ground disturbance works within these zones, identify any permits and approvals that would be required with respect to impacts to Aboriginal heritage, provide consideration for the curation of Aboriginal relics that may be retrieved to the project area and a timeframe for regular update and review.

7. REFERENCES

Australia ICOMOS, *The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance 1999*, Australia National Committee of the International Council on Monuments and Sites.

BACON, C. A., 1983, Analysis of coal from the Duncan Seam. Duncan Colliery, Fingal. Unpubl. Rep. Dep. Mines Tasm. 1983/36.

BACON, C. A. 1991, The coal resources of Tasmania. *Bull. geol. Surv. Tasm. 64.*

Brown, S., 1986 *Aboriginal Archaeological Resources in South East Tasmania: An Overview of the Nature and Management of Aboriginal Sites.* National Parks and Wildlife Service, Tasmania. Occasional Paper No. 12.

Bureau of Meteorology

Graham, V., 2007-08 *Monitoring for Aboriginal Heritage regarding the Extension of existing Open Cut Mining for Cornwall Coal Pty Ltd at Cullenswood being west of St Marys within Break O'Day Municipality, Tasmania*. Final Reports, numbers 21, 22, 26, 27, 28, 31, 32 and 34

Guilfoyle, D.R. 2006 *Aboriginal Cultural Heritage Regional Studies: an illustrative approach*. Cultural Heritage Division, NSW Department of Environment and Conservation.

Huys, S., 2011 *A Cultural Assessment of Cullenswood 3, Fingal Valley, Eastern Tasmania. Stage 2: Ploughing Program.* Final Addendum Report

Kee, S., Australian Heritage Commission & Tasmania Dept. of Lands, Parks and Wildlife, 1987 *North East Tasmanian Archaeological Survey: A Regional Study*, Dept. of Lands, Parks and Wildlife, Hobart

Kee, S., 1991 *Aboriginal Archaeological Sites in North East Tasmania*, Dept. of Parks, Wildlife and Heritage, Hobart. Occasional Paper No. 28

Maynard, L., 2009 *An Aboriginal Heritage Values Survey of New Inundation Area of an existing Farm Dam on the Ormley Property near Fingal*. Unpublished assessment report.

Mulvanny, J. And Kamminga, J. 1999 *Prehistory of Australia*, Allen & Unwin. St. Leonards, NSW.

Rice

Ryan, L., 1996 *The Aboriginal Tasmanians* (2nd edn.) Allen & Unwin. St. Leonards, NSW.

Salway, I.J., Hancock, R.G. and Jago, P., 1979 *Preliminary Proposal for the Exploitation of Coal Reserves in the Fingal Coalfield, Tasmania. Part I – Geology*. Robertson Research (Australia) Pty Ltd. Technical Report number 523. Prepared for the Hydro-Electric Commission (Hobart).

Sim, R., 1997 *Report for the Tasmanian Aboriginal Community on: An Archaeological Assessment for the Community on the Proposed Telstra Cable Route, Fingal*. Unpublished assessment report.

Southgate, D., 1983 *The Cornwall Coal Company 1886-1980*. Environmental Studies Project Report 1980/7. Centre for Environmental Studies, Hobart.