R5 — BMA Guideline for the Design of Sustainable Mine Landforms

BMA GUIDELINE FOR THE DESIGN OF SUSTAINABLE MINE LANDFORMS



SAFE
STABLE
SUSTAINABLE

DRAFT

Last Review Date 21/1/2008

This Draft to be provided to BMA operations for review and comment.

LANDFORM SUSTAINABILITY GUIDELINES
CONTENTS

1 PREAMBLE

Historically, the rehabilitation effort of opencut coal mines in Central Queensland has been relatively ad hoc and conducted as an activity based on regrading accessible mine spoil disturbed by open cut mine operations. The focus of mine planning has essentially been on scheduling excavation and short hauling overburden while the solutions to producing a sustainable long term landform were being developed. This has resulted in an inter-departmental disconnect between mine planning, operations and rehabilitation. Focus for rehabilitation has been on the one to five year time frame, viewed as more of an imposition and not seen as part of the mining operation aimed at reducing closure liability.

It is estimated that BMA mine leases currently account for approximately 9% of BHP Billiton managed lands, yet represents some 45% of the total land disturbance requiring rehabilitation. There is also a considerable and increasing backlog of rehabilitation which is being driven by mining production scheduling demands, coupled with deeper prestrip excavation requirements.

Until recently, many mines considered that there would be little requirement for rehabilitation of the entire disturbed area. The perception being that the rehabilitation effort should focus on external facing spoil and crest areas, with little attention being paid to major disturbance elements such as ramps and voids, despite the substantial erosion and land stability risks that these areas bring to the overall spoil landform.

In recent years, however, a greater awareness of stewardship, community and sustainability issues associated with opencut mining have arisen. BHP Billiton closure planning and Enterprise Wide Risk Management (EWRM) processes have provided increased recognition that 'rehabilitation' applies to all of the mined out and disturbed lands on the BMA minesites. It is now recognized that major disturbance categories such as ramps and final voids will also generally require substantial rehabilitation to provide stable and beneficial use outcomes compatible with the BHP Billiton Sustainable Development Policy. Sequenced excavation to enable cost effective backfill of ramps and voids will be necessary in some instances to allow progressive rehabilitation and reduce liabilities well before eventual mine closure.

EWRM and associated final landform investigations have also shown that:

- Design and construction of a cost effective stable final landform is not economically feasible in the latter stages of typical pit development. Costs would be prohibitive to undertake very major spoil regrade or backfill activities after shorter haul and incremental cost opportunities are lost.
- Spoil room availability is highly sensitive to final highwall location.
- A set of operational principles is required to ensure a suitable landform by mine closure.
- These principles must allow for variation in location of the final highwall.

Work undertaken at several BMA mine sites indicates that our mines will continue to generate increasing amounts of prestrip spoil for the balance of mine life. Some mines, for example Saraji Mine, have huge predicted spoil room deficits which may require an alteration of conventional mining practices. The solution to the spoil room deficit may rest upon cost effective utilization of voids using a scheduled sequential void infill strategy. The implementation of changed mining strategies to apparent dip mining may also facilitate improved spoil backfill and lowered overall mine closure liability.

There is also recognition that there are significant rehabilitation challenges and liabilities associated with ‘conventional’ out of pit rejects and tailings placement. Utilization of voids will also need to take into account tailings and coal reject disposal.

The rehabilitation of disturbed land is considered to be an integral part of sustainable BMA open cut mining. BHP Billiton mining operations are now required to mandate closure planning processes aimed at elimination of most of the rehabilitation liability by end of mine life, with only residual completion of work during the decommissioning phase. This can only be achieved by closely coordinated mine and rehabilitation planning. Above all, careful consideration by mine planning personnel is required in designing excavation and spoil placement programs, and importantly scheduling mining activity to provide a favorable closure outcome. It is recognized that this requires some cultural change and redeployment of responsibilities to some extent.

Spoil placement planning to reduce long term disturbance is seen as an essential element in closure liability reduction as well as enabling progressive rehabilitation to occur. If careful planning is not undertaken, unacceptably high liabilities to the company and the community will occur. It is now recognized that mine planning requires a basic set of fundamental performance criteria to guide the landform planning process. Without such guidelines, the long term sustainability outcomes being sought by BHP Billiton, its regulator and the community cannot be assured.

In summary, so that closure liabilities can be adequately managed, mine operations must be undertaken in accordance with agreed operational principles or strategies which should be implemented early in the mine development, not at the end of mine life when opportunities for cost effective spoil placement will have passed. Proactive, Life of Asset (LoA) spoil fit is required as an essential planning tool so decision making does not regress to be reactive. **The practice of scheduling mining programs for maximizing returns based on contemporary coal prices will need to be changed to ensure that profitability is balanced with reduced longer term closure liability**.

These guidelines provide recommendations on landform design as well as providing background information on legal aspects, corporate requirements and closure planning and risk assessment all of which have direct bearing on the establishment of the landform sustainability guidelines.

1.1 NON CONFORMING STANDARDS

These guidelines do not override any existing commitment in any statutory operational approval including Environmental Authorities, Environmental Management Plans, or Plans of Operations where there may be commitment to higher standards of environmental performance. However, when sites may wish to apply different design strategies than outlined in this guideline, the site shall demonstrate that such design criteria are likely to meet closure liability minimisation and rehabilitation sustainability requirements.

1.2 SCOPE LIMITATION

It should be noted that the following guidelines have been developed on a conservative basis given the generally poor outcomes for Tertiary spoil rehabilitation in the Bowen Basin to date. Effective rehabilitation of mine spoil in the Bowen Basin has proved to be extremely challenging. A harsh climatic environment typified by periods of extreme rainfall and drought, together with landforms built from fragile spoil demands that conservative treatments are applied wherever possible. Sites are encouraged to investigate various combinations and permutations of spoil type/depth/treatments that may be used to overcome erosional instability in the pathway to successful vegetation establishment.

It is not the intent of this guideline to provide detailed design for any particular aspect of landform construction; such detail will be site specific. These guidelines are aimed at establishing overall management, planning and performance criteria that are applicable to mining, bulk earthworks and spoil placement programs which are the important elements controlling the **overall shape** of the final landform and the ultimate liability of the company at mine closure.

1.3 UPDATE & REVIEW

This guideline is part of the closure plan for all BMA minesites. It is a living document and will necessarily develop into the future. This document will require regular update and review reflecting possible changes in corporate requirements, legislation, community expectation and mining practices. Other triggers for change to the guidelines include continuous improvement initiatives and improved industry understanding in rehabilitation practices and sustainability outcomes and learnings. Annual review and update in line with BHP Closure Standard July 04 is required.

2 SUSTAINABLE DEVELOPMENT

The Minerals Council of Australia (MCA) has redeveloped its sustainable development code. The code is now known as Enduring Value – the Australian Minerals Industry Framework for Sustainable Development."

The key role of "Enduring Value " is to translate the Principles of Sustainable Development into practices that ensure that industry operates in a manner which is attuned to the expectations of the community, and which seeks to maximize the long-term benefits to society that can be achieved through the effective management of Australia's natural resources.

The code defines Sustainable Development in operational terms as being to:

1. Implement and maintain ethical business practices and sound systems of corporate governance.
2. Integrate sustainable development considerations within the corporate decision making process.
3. Uphold fundamental human rights and respect cultures, customs and values in dealings with employees and others who are affected by our activities.
4. Implement risk management strategies based on valid data and sound science.
5. Seek continual improvement of our health and safety performance.
6. Seek continual improvement of our environmental performance. Further explanation is provided by the code for environmental aspects as:
    1. Assess the positive and negative, the direct and indirect, and the cumulative environmental impacts of new projects – from exploration through to closure.
    2. Implement an environmental management system focused on continual improvement to review, prevent, mitigate or ameliorate adverse environmental impacts.
    3. Rehabilitate land disturbed or occupied by operations in accordance with appropriate post-mining land uses.
    4. Provide for safe storage and disposal of residual wastes and process residues.
    5. Design and plan all operations so that adequate resources are available to meet the closure requirements of all operations.

BHP Billiton is a signatory to the MCA Enduring Value and has implemented programs to improve rehabilitation outcomes in line with the code and other sustainability objectives.

3 LEGAL PROVISIONS

3.1 QUEENSLAND ENVIRONMENTAL LEGISLATION

The environmental management and regulation of the mining industry in Queensland for leases established under the Mineral Resources Act is administered by the Environmental Protection Agency through provisions of the Environmental Protection Act 1994 (EP Act). This Act provides for the assessment, decision-making and the issuing of environmental authorities for mining activities and enforcement of the conditions of the authority. Some leases established under the CQCA Agreement Act may not be directly regulated by the EP Act; however BMA has entered into a written agreement with the Queensland Government to operate its mines in accordance with the EP Act.

The Queensland regulator requires that land disturbed by mining is rehabilitated to stable and beneficial agreed uses. Overall the three mandatory rehabilitation requirements for stability, beneficial use and protection of water quality remain. These elements are further defined as:

- **Stable landform** – thus the requirement to place spoil to final landform design standard. Stability covers both erosional and geotechnical stability. Attainment of erosional stability requires substantially more effort in planning and construction than is required for geotechnical stability.
- **Beneficial use** – e.g. stable native bush land, grazing or cropping with no ongoing liability to BHP Billiton or the community.
- **Preservation of downstream water quality** – existing and future use of the down stream water not compromised. Silts, salts and acids are not released from spoil or voids to groundwater or surface water.

Progressive rehabilitation is Queensland government policy and it is up to the mining company to demonstrate that its rehabilitation programs are effective in permanently stabilizing land and returning a beneficial agreed landuse.

The recently released **EPA Guideline 18: Rehabilitation Requirements for Mining Projects** provides further clarification on what the Government expects as outcomes for minesite rehabilitation. Overall, the general performance goals in Guideline 18 appear to be more stringent than earlier guidelines.

Guideline 18 specifies that there are four general rehabilitation goals required for rehabilitation of areas disturbed by mining including:

- Safe to humans and wildlife.
- Non-polluting.
- Stable.
- Able to sustain an agreed post-mining land use.

The regulator has also provided some clarification on its preferred position for acceptance of final voids (including voids, shafts, adits and subsidence areas) in the guideline. The guideline refers to three basic levels of acceptance:

- Generally acceptable - requires extensive void treatment including the possibility of backfill or considerable regrading,
- May be acceptable - a minimalist treatment is imposed such as sealing coal seams and hazardous material, allowing the void to fill with water, building a safety bund, battering unstable slopes etc. to ensuring minor risk to fauna or stock. Overall the regulator may consider a land use situation of “unused void with low risk”.
- Rarely acceptable **-** leaving a void that has or accumulates hazardous material, poor quality water and is in a structurally unsound condition.

In view of the regulatory requirements for **acceptable** rehabilitation, it is unlikely that mine leases rehabilitated to an inadequate standard will be able to be relinquished. Inadequate rehabilitation may include a landform with erosional processes causing vegetation failure. This may involve active, sheet wash, rill and gully development on the batters of the final landform as may be evident on any topographic feature such as on boxcut spoil faces, dump batters, tailings dams embankments and open voids and ramps.

Compliance with all legislation including the EP Act has important business implications for BMA and BHP Billiton.

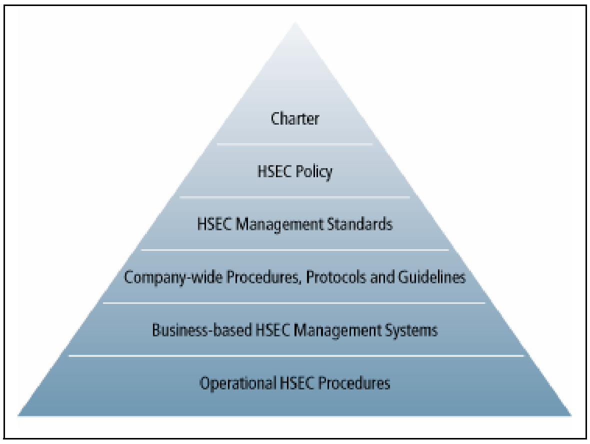
3.2 CORPORATIONS DUTY TO DECLARE LIABILITIES

There is a requirement under Australian corporation’s law for companies to accurately estimate and state their liabilities. Furthermore as a US listed corporation, BHP Billiton operations fall within accountability under the Sarbanes Oxley Act 2002. Sarbanes Oxley was enacted to address perceived abuses, questionable reporting and inadequate management practices after a series of high profile scandals and market crashes of large US corporations such as WorldCom and Enron. It is intended to "deter and punish corporate and accounting fraud and corruption, ensure justice for wrongdoers, and protect the interests of workers and shareholders".

The Act primarily applies to and is concerned with the practices of companies listed on a US stock exchange. Thus, the Act’s requirements apply to any Australian company currently listed on a US stock exchange and filing an annual Form 20-F with the United States Securities and Exchange Commission (SEC). This includes companies maintaining dual listings with other exchanges and companies utilizing American Depository Receipts (ADRs). The Act requires that both the CEO and CFO certify that internal financial control of the Group is effective. Criminal penalties apply to certifications issued in bad faith

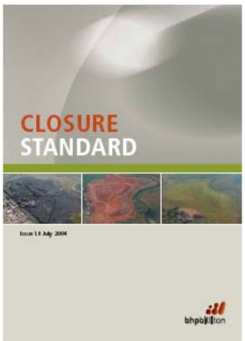
4 OPERATIONAL MANAGEMENT & CLOSURE PLANNING

BHP Billiton's position is that it has an overriding commitment to health, safety, environmental responsibility and sustainable development. All operations have been informed via dissemination of charters, policies and standards that rehabilitation of disturbed land to meet or exceed community and regulatory expectations is essential to maintain and enhance its reputation including at a local, national and international level. The mechanisms that deliver this requirement for high standard of environmental performance include:



- Charters, Policies, Standards, management systems, guidelines and operational procedures which demonstrate a very strong commitment to best practice environmental management. The BHP Billiton Charter mandates an overriding commitment to health, safety, environmental responsibility and sustainable development.
- The Sustainable Development Policy includes a commitment to enhance biodiversity protection by assessing and considering ecological values and land-use aspects in investment, operational and closure activities.
- The Health Safety Environment and Community Standard No 12 on Stewardship mandates that the lifecycle HSEC impacts associated with resources, materials processes and products are minimized and managed and initiatives are identified and implemented to reduce the environmental impact of operations. This includes that Programs are implemented to protect, manage and, where appropriate, enhance biodiversity values.

BHP Billiton operations now have specific corporate closure planning and tasking requirements established within the BHP Billiton Closure Standard. The standard mandates compliance with relevant legislative and regulatory requirements and links to BHP Billiton's Charter and Sustainable Development Policy. The closure standard objectives include:



1. Ensuring shareholder value is preserved.
2. Establishing BHP Billiton management accountability and ownership of closure activity.
3. Complying with relevant or applicable legislative requirements.
4. Limiting or mitigating adverse environmental effects, including taking into account biodiversity.
5. Providing a reasonable basis on which the financial consequences of closure can be estimated, recognized and managed including consideration of any tax consequences.
6. Avoiding or minimizing costs and long term liabilities to BHP Billiton and to the government and public.

7. Achieving sustainable land-use conditions as agreed with the applicable government regulator and affected communities.
8. Ensuring investment decisions include appropriate consideration of closure, including both quantitative and qualitative impacts of closure.

All BMA mines are now aware of the Closure Standard and its requirements. KPI’s have been set in Management Teams Scorecards and all sites are progressing closure planning. Essential to the closure planning and implementation process is the development of a final landform plan based on sustainability principles and demonstration that such a plan is being implemented in day to day operations - including short, medium, and long term plans and reflected directly in mining scheduling and spoil placement programs.

4.1 THE EWRM PROCESS

Risk assessment and cost ranging for rehabilitation outcomes is routine practice for all BMA operations. Supporting the risk basis of the BHP Billiton Management Standards is the Enterprise-Wide Risk Management (EWRM) Policy, which is progressively embedding risk management processes into all critical business systems to enable the company to adopt a precautionary approach to business management. When critical decisions are being made, managers are required to look beyond the obvious risks and recognize all sources of uncertainty, including issues related to health, safety, environment and community.

EWRM processes including the Australian and New Zealand Risk Assessment Standard, (AS/NZS 4360:2004), is now integrated into the way BMA carries out its business. All sites have prepared a risk register identifying the major risks for closure and beyond. The risk assessment was undertaken by various site personnel including long term planners, environmental personnel, representatives from CHPP and mine operations.

Risk ranging and cost assessments were concluded and across all mine sites a number of common major risks were quickly identified by the various working groups. Nearly all of these risks were related to landform stability and the adequacy of the site’s rehabilitation programs. These risks included:

- Rehabilitation Criteria – company may not meet performance criteria or government raises goal posts.
- Landform Stability - principally poor design parameters with inherent high erosion risks.
- Final Voids – long term stability cannot be met without substantial treatment.
- Community Pressure – possible community outrage when landforms fail.
- Tailings Dam Failure – wall fails due to erosion, seismic event etc.
- Water Management Criteria - ineffective rehabilitation results in sediments and salts migrating to creeks and rivers.
- Creek Diversion – poor design and or construction leads to erosion of batters and siltation further downstream.
- Out of Pit Reject Dumps. Insufficient capping allows fire to establish; erosion of batters exposes rejects etc.
- Groundwater – saline waters impact on regional aquifer.
- Contaminated Sites – groundwater is impacted by mobilization of contaminants.

- Infrastructure CPP, ROM – decommissioning costs probably higher than expected.
- Haul Roads – decommissioning costs probably higher than expected and cannot leave for future landholder use.

See following Table No 1 which provides an **example** of the EWRM matrix.

Table 1 EWRM Impact Types & Severity Levels

HSEC Severity Level	Severity Level	Impact Types							Severity Factor
		Change in ESVA	Change in project return (NPV)	Health and Safety	Natural environment	Social / Cultural heritage	Community / Govt / Reputation / Media	Legal	
7	a	>US$1B	>US$5B	> 500 fatalities or very serious irreversible injury to 5000 persons	Very significant impact on highly value species, habitat or eco system	Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Prolonged international condemnation	Potential jail terms for executives and or very high fines for company. Prolonged, multiple litigation	1000
6	b	US$100M – US$1B	US$500M – US$5B	>50 fatalities, or very serious irreversible injury to >500 persons.	Significant impact on highly valued species, habitat, or ecosystem.	Irreparable damage to highly valued items of cultural significance or breakdown of social order.	International multi-NGO and media condemnation.	Very significant fines and prosecutions. Multiple litigation.	300
5	c	US$10M – US$100M	US$50M – US$500M	Multiple fatalities, or significant irreversible effects to >50 persons	Very serious, long-term environmental impairment of ecosystem function. .	Very serious widespread social impacts. . Irreparable damage to highly valued items.	Serious public or media outcry (international coverage).	Significant prosecution and fines. Very serious litigation, including class actions.	100
4	d	US$1M – 10M	US$5M – 50M	Single fatality and/or severe irreversible disability (>30%) to one or more persons.	Serious medium term environmental effects.	On-going serious social issues. Significant damage to structures/ items of cultural significance.	Significant adverse national media/ public/ NGO attention.	Major breach of regulation. Major litigation.	30
3	e	US$100,000 – 1M	US$500,000 – 5M	Moderate irreversible disability or impairment (<30%) to one or more persons.	Moderate, short-term effects but not affecting ecosystem function.	Ongoing social issues. Permanent damage to items of cultural significance.	Attention from media and/or heightened concern by local community. Criticism by NGOs.	Serious breach of regulation with investigation or report to authority with prosecution and/or moderate fine possible.	10
2	f	US$10,000 – 100,000	US$50,000 – 500,000	Objective but reversible disability requiring hospitalisation	Minor effects on biological or physical environment.	Minor medium-term social impacts on local population. Mostly repairable.	Minor, adverse local public or media attention and complaints.	Minor legal issues, non-compliances and breaches of regulation	3
1	g	<US$10,000	<US$50,000	No medical treatment required.	Limited damage to minimal area of low significance.	Low-level repairable damage to commonplace structures.	Public concern restricted to local complaints.	Low-level legal issue.	1

EWRM risk assessments show that the most substantive risks which have great potential impact to the business relate to the erosional and geotechnical stability of the final landform. Landscape disturbance is the major impact of opencut mine operations and represents by far the greatest element of the rehabilitation liability.

Overall at the end of 2006, BMA mines have a significant rehabilitation liability based on current unit costs for rehabilitation and treatments outlined in EM Plans and Environmental Authorities. However, the EWRM process found that some of the existing 'approved' treatments do not meet BHP Billiton sustainability requirements, hence substantially greater potential costs to mitigate landform disturbance have been estimated. Higher costs are indicated particularly for pits and ramps than can not be cost effectively backfilled as part of operational spoil placement operations.

The EWRM process highlighted that the final landform should not be considered as merely a consequence of an excavation program, but rather the outcome of a planned mining and spoil placement program by which a stable landform has been reinstated.

4.2 Tertiary Spoil

One of the greatest challenges to the achievement of erosionally stable landforms in Central Queensland is the effective rehabilitation of Tertiary spoil. Much of the Tertiary spoil being excavated as prestrip is inhospitable to revegetation with an extreme erosion risk. The poor performance of this spoil is a consequence of adverse physical and chemical factors including:

- High exchangeable sodium percentage (ESP) - generally > 15%, thus the spoil material is dispersive and erodible
- Low cation exchange capacity (CEC) – generally < 10 -15 meq/100 grams, thus the spoil material is very infertile.
- Highly variable pH, mostly alkaline to pH 9 plus, leading to nutrient availability limitations.
- Often quite saline up to 4,000uS/cm and exceeding vegetation tolerance limits.
- Unfavourable particle size with fine sand and silt >50% and clays up to 30%. This predisposes the material to strong surface crust development and high erodibility.

Management of inhospitable **Tertiary** spoil is required to ensure that erosion impacts are tolerable. This requires a conservative approach to rehabilitation and involves moderate slopes generally less than 10% together with application of a cover of hospitable non dispersive Permian Spoil. On steeper slopes, such as short angle of repose dump surfaces encapsulation of Tertiary material with a thick cover of durable rock is recommended. The rock should contain sufficient benign, preferably fertile fines to provide a growth media for native vegetation. If the rock contains insufficient fines, topsoil or like material may have to be dozed across the rock surface/face.

Some poor quality hostile Permian spoil can also require special treatments such as capping with more hospitable benign spoil.

Selective handling practices using the mine earthworks schedule effectively provides a great opportunity to isolate hostile and or dispersive spoils. Overburden characterisation must be carried out including establishment of an inventory of competent rock resources. The mapping and management of all spoil materials and the associated selective handling via the earthworks/mining schedule throughout the life of mine will help provide for a cost effective long term sustainable rehabilitation outcome.

4.3 LANDFORM ELEVATION

Landform stability involving elevated spoil dumps depends on two primary aspects, firstly spoil characteristics as discussed above and secondly on the height differential. Height differential between dump crest and natural ground or base of final void together with design grade dictates the final slope length. Long slopes are conducive to erosional instability, whereas steep slopes are susceptible to mass failure – i.e. geotechnical instability.

It is important to note that to date BMA and industry experience on the rehabilitation of significantly elevated dumps is limited to about 50 to 60m. Thus there are risks involved with the rehabilitation of more elevated spoil which are yet to be fully understood.

Long steep slopes (250m) appear to have been satisfactorily stabilized at Goonyella Riverside mine on a 50 - 60m high out of pit Tertiary spoil dump. Parts of the outer face have been regraded to 25 – 30%

and mulched with a sandstone rock mix. After several years, no significant erosional damage is apparent and native vegetation establishment is extensive.

A portion of the outer face of the same dump was regarded in 2007 to approximately 14% forming an exceptionally long overall slope (450m). Cross slope drainage structures have been installed to reduce effective slope length and the slope has been topsoiled, ripped and seeded. Despite the intensive design and construction effort undertaken by that site to rehabilitate this slope, significant gullying occurred during a rainfall event when piping of dispersive spoils caused localized failure of the graded bank system. Also, an associated rock lined waterway failed largely due to dispersion and sediment mobilization below the rock protection. Failures of even much shorter lengths of Tertiary spoil rehabilitation are not uncommon on Tertiary spoil in the Bowen Basin.

Rehabilitation of very long slopes formed from dispersive Tertiary spoil, even slopes established at relatively modest grades is prone to failure. Capping with a less dispersive media is necessary. In general, the development of landforms which are entirely dependent on the performance of cross slope drainage structures and down slope armored waterways will carry a risk of failure into the future as well as require ongoing expenditure for maintenance. Thus there is scope for changing conventional practices and the development of landforms which are more attuned with geomorphological processes. Landforms with a high drainage density and limited slope length are more likely to tolerate periods of intense rainfall.

At this stage it appears that rock mulching will offer greater prospects of achieving stability on the batters of elevated Tertiary spoil landforms - compared to conventional regrade treatments. However, whatever the actual prescription is applied, the design ought to be conservatively based and attempt to build in reasonable tolerance for uncertainty such as settlement, exposure to high intensity rainfall, bush fire and drought events.

5 MINE PLANNING & OPERATIONS ROLES & RESPONSIBILITIES

5.1 INTRODUCTION

These guidelines provide a hierarchical set of strategies aimed to reduce corporate liability and meet sustainability outcomes and legal requirements. The guidelines are sufficiently flexible to accommodate the projected land capability, site geology, depth of final workings, elevation of spoil emplacement areas, and availability of capping material and spoil quality.

These guidelines follow-on from the EWRM and closure planning process and have been developed to assist mines in implementing changed operational strategies and design criteria necessary for the rehabilitation of mining affected land. Core requirements include an understanding of:

- Roles and accountabilities which may need to be adjusted to ensure that a satisfactory closure program can be implemented.
- Realistic mine life estimation through the comprehensive Resource Development Plan.
- Estimating excavation and spoil placement requirements.
- Scheduling mining operations to ensure cost effective closure scenarios
- Constructing mine landforms which meet stability criteria.

The key principles which support sustainability objectives and which underpin the development of the Landform Planning Guidelines include:

- Minimizing the disturbance footprint
- Protecting and where practicable enhancing biodiversity
- Progressive Rehabilitation
- Selective handling of spoil materials
- Stable landform outcomes – erosional and geotechnical
- Beneficial final landuse
- No off site impacts – protection of downstream waters
- Minimizing company liability
- Meeting or exceeding community expectation and regulatory requirements

These guidelines also address roles and responsibilities necessary to implement changed practices and outline design strategies which support the sustainable mine landform outcomes being sought by BHP Billiton.

5.2 CORPORATE MANAGERS

Successful implementation of the closure planning process and consequent reductions in corporate closure liabilities as well as improved stakeholder relationships (including. State, National and International) is ultimately dependent on BMA as a corporation taking all necessary action to ensure that all of its operations meet BHP Billiton closure requirements.

Corporate Mine Managers shall establish KPI's for Mine Managers, including senior site executives (GM's) for:

- Implementing practices to ensure that closure planning and liability reduction strategies are developed and embedded into the mine operation.

5.3 MINE MANAGEMENT

Successful implementation of the closure planning process on individual mine sites and development of effective programs aimed at liability minimization is dependent on the mine manager embracing the closure concepts and taking all necessary action to ensure that operations conducted at the site align with agreed closure plan strategies.

Mine Managers shall establish KPI's for mine planning and production managers for:

- Implementing changed practices.
- Achievement of long term liability reductions.
- Development of the Closure Plan for the site.
- Embedding closure requirements fully into the organizational structure.
- Ensuring that the Final landform plan is fully consistent with Long Term Mine Plan and that the Final Landform Plan is fully imbedded into short, medium and long term mine plans.
- Ensuring that the closure concepts are fully understood by all management and senior employees.
- Carrying out progressive rehabilitation
- Reviewing compliance of the operation against agreed strategies.

5.4 MINE PLANNING

Mine planners are responsible for developing mine plans which align with agreed closure strategies and the development of the minescape in accordance with final landform and progressive rehabilitation requirements.

Mine planning for operations should include at least the following:

- Identify the probable limits of mining based on realistic assumptions and projections on demand, pricing, production cost and resource availability.
- Prepare a Resource Development Plan and Life of Asset Plan.
- Resource optimization planning must demonstrate due regard to BHP Billiton's environmental protection and sustainability commitments.
- Determine the approximate volumes of overburden that requires stripping and disposal, process and location for the expected life of mine.
- Develop geological models of the mining areas to identify suitable durable rock resources for capping programs in the rehabilitation.
- Suitable material type on final surface to be established via effective scheduling for shovel-conveyor / truck-shovel operations and selective placement of spoil according to the stratigraphic characterization model.

- Develop long term plans and schedules showing how spoil topography including inpit, out of pit spoil, ramps and voids will be constructed and managed so as to conform to the closure landform design strategies and progressive rehabilitation requirements. This may include scheduled sequential pit closure and backfilling ramps and voids with prestrip spoil or CPP wastes, investigating and planning for changed mining methods e.g. changing conventional down dip to across dip mining methodology.
- Design mining programs which protect major rivers and creeks, recognizing that biodiversity values are usually very high on and along side watercourses in Central Queensland.
- Cost in realistic unit rates for quality rehabilitation programs and diversion construction when investment decisions are being made. Under-estimation of rehabilitation costs can result in adverse business decisions being made and ultimately increase long term liability as well as having significant implications under Sarbanes Oxley legislation.
- Identify the appropriate equipment to manage the final landform haul and shaping requirements, review resultant costs and effects on the business model.
- All plans produced for short term operational focus should reference the long term strategy or goal for stable landform development (agreed long term mine landform).
- Stripping plans and schedules shall ensure that adverse Tertiary spoil placement be restricted to flat/level areas with more competent Permian material allocated to slopes. Competent rock material shall be used for steep slope armoring.
- Spoil excavation and haulage shall be scheduled and operated to ensure that dispersive spoil (normally Tertiary spoil) shall be buried with at least 2 m of non dispersive spoil. (Normally Permian spoil).

5.5 MINE OPERATIONS

Operations will conduct day to day mining including short and medium term operations which support the long term planning requirements.

In doing so:

- Placement of waste material shall conform to the development of final landform design strategies, be consistent with the development of a stable long term landform outcome and progressive rehabilitation requirements.
- Short haul options for waste disposal (rejects and spoil) which do not support long term agreed landform outcomes should be avoided.
- Spoil shall be placed only in accordance with the short term spoil dumping plans and schedules for any particular area. Short term plans must be consistently linked to long term plans which in turn are fully compliant with the Closure Plan and Final Landform Plan.

5.6 MINE ENVIRONMENT

Environmental officers coordinate the development of closure plans and supporting investigations and provide an advisory service to Technical Services, Mine Planning and Operations.

Environmental impact mitigation management should include:

- Preparing soils and spoils inventories.
- Review mine plans to check conformance with BHP Billiton closure requirements, progressive rehabilitation goals and the closure plan.
- Provide an advisory service to mine planning on erosional stability and landform treatments that utilize the results of site rehabilitation monitoring, industry experience, various ACARP rehabilitation research projects (e.g. MINEROSION) and landform modelling outcomes.
- Prepare detailed rehabilitation treatments for landforms designed by mine planning and technical services. Plan those tasks necessary to rehabilitate the spoil landform that has been constructed in accordance with agreed final spoil landform criteria.
- Signoff on mine planning strategies for short term dump options consistent with achieving the final determined landform.
- Review and inspection of as-built spoil dumps, spoil infill areas and ascertain conformance with short term plans and longer term strategies.
- Provide timely advice as is required to mine planning.
- Update closure rehabilitation costs and feed back to Corporate Environment Team.
- Complete, maintain and update the mine Closure Plan in alignment with BHP Billiton requirements.

6 LANDFORM DESIGN GUIDELINES

6.1 SPOIL PLACEMENT

Steep slopes are prone to aggressive erosion. Tertiary materials at most mines are dispersive whereas Permian materials tend to be far less dispersive.

Inpit spoil placement over dragline spoil and, in ramps and voids is preferred method of spoil disposal. Out of Pit dumps increase the disturbance footprint and overall liability and should be avoided if practicable.

Spoil should be placed according to mine plans and designs which meet key closure requirements for cost effective stable landform and rehabilitation outcomes. Strategies used to meet closure requirements include:

- Progressively backfilling of redundant/final voids including ramps and mine void that have been identified as no longer needed for other strategic uses e.g. not required for CPP waste or water supply purposes.
- Backfilling of final voids and regrading of ramps sequentially with prestrip spoil material, to reduce the number of open pits at closure.
- Developing final spoil landform grades which average 10% slope or less (Subject to encapsulation with more hospitable Permian spoil)
- Taking into account material types and selective handling requirements as per mandated material management implemented through the earthworks /spoil handling schedule.

On sloping situations, except where **favorable spoil characterization exists,** Tertiary spoil should be clad with benign rocky Permian spoil. Management strategies include:

i) Slopes established at 10% or less, Tertiary spoil material is covered with at least 0.5 m Permian spoil, then 300mm clay topsoil (if available), then ripped and seeded.

ii) Slopes comprising Tertiary spoil 10% to 15% should be lined with no less than 1m of selected benign Permian spoil, then topsoiled and ripped and seeded.

iii) Slope length on Tertiary spoil should be limited as far as practicable. Reliance on cross slope drainage structures artificially reduces slope length and may not be sustainable. Major erosional induced failures can occur on slopes with a total batter length greater than 200m.

iv) On steep batters (15% - 20%) either a minimum of 1m of durable rock mulching over 1m minimum depth of Permian spoil cap or 2m of durable rock mulching.

Slopes greater than 25% require use of 2 m of durable rock mulch. Slopes greater than 35% should be avoided.

Spoil placement in other configurations is possible providing for example:

- Use of geomorphological design based landform concepts is encouraged. This is an emerging concept based on design of landforms which fit more comfortably with natural drainage and erosional processes. These landforms do not rely on cross slope drainage structures, or benched arrangements and are developed with sufficient drainage intensity to limit slope length and consequent erosional processes to tolerable levels.

Rock armored steeper slopes may be tolerable with this concept given that slope lengths are much less than for conventional spoil placement scenarios. However, more design assessment and investigation is required to demonstrate cost and feasibility.

- Benched landforms are unproven but may be may acceptable provided:

i) Lifts between benches are less than or equal to 10 m (higher lifts may be acceptable if dump trucks require greater elevation to tip over).

ii) Final batters between lifts (after regrade) are established at no steeper than 25% and covered with 2 m of **durable** sandstone or basalt rock mulch (or other suitable durable rock material) and,

iii) A 10m width of residual level cross fall bench remains for access and drainage purposes.

iv) There shall be at least one lateral collector drain per 100m of slope length. Durable rock armored waterways will be used as required to receive water collected from lateral collector drains. Any drain constructed on spoil with a gradient >1.5% shall be lined with durable rock mulch. . Lateral fall may be required along the length of one or more benches and established at 0.5 to 1% grade to provide for controlled drainage opportunities.

v) Bench tops formed by Tertiary spoil are to be lined with Permian spoil to at least 1 m depth.

Note: To date BMA experience with long rock armoured slopes is limited to approximately 60m vertical elevation. Thus unless conducted on a trial basis, dump vertical elevation should be limited to less than 60m. Dumps in excess of 60m will require geotechnical investigation as well as special considerations for erosion control.

Suitable capping spoil will have pH(1:5) in range 6 - 8.5 and EC(1:5)< 600uS/cm and ESP < 10%. Use of the lower ESP spoils is always preferred. If acid conditions are suspected, NAG pH > 4.5. The presence of significant presence of durable sandstone rock in the spoil matrix is required whenever this material is available.

- In some instances poor quality dispersive or saline Permian spoil may need to be capped with better quality / more durable Permian Spoil.
- Unless backfill is planned, rehabilitation of spoil adjacent to ramps and lowwalls should allow sufficient buffer width for future spoil regrade so that rehabilitation is not destroyed when these features are regraded.
- Out of Pit dumps are considered to be the **least preferred** strategy. Where practicable, out of pit dumps should be placed against spoil. E.g. boxcut spoil and used to advantage to reduce regrade costs and minimize the disturbance footprint.

Utilization of voids can be a more cost effective means of pre-strip placement, rather than hauling material up to significant elevation or long distances up dip. In addition, void infill will also result in substantial reduction of rehabilitation liability. Progressive rehabilitation requirements are such that campaign mining and void infill may be a preferred strategy.

6.2 RAMPS

Ramps make up a considerable percentage of the mine disturbance footprint. Steep sides and long slopes produce ongoing landform instability and the integrity of rehabilitation above ramp crests is jeopardized unless ramp batters are stabilized:

Ramps treatments include:

- Backfilling sequentially with mine spoil or CPP waste.
- Regraded to <10% and capped with Permian spoil as required.
- Steeper slope options should not normally exceed 25% slope and be and capped with at least two meters of durable rock and soil matrix.
- Drainage off adjacent prestrip dumps should be integrated into the ramp backfill design.

Wherever practicable, Highwall and Lowwall Ramps are preferred to conventional ramp inclines through the spoil mass. This substantially increases inpit spoil disposal capacity as well as reduced landform reshaping costs and providing opportunities for progressive rehabilitation. BMA landform studies clearly show that improved spoil fit and reduced haul elevation opportunities are available through strategic ramp infill.

6.3 LOWWALL

Lowwalls are typically characterized by substantial spoil height above the pit. Very long steep angle of repose batters are conducive to permanent landform instability and the integrity of rehabilitated spoil on the crest above is jeopardized unless lowwalls are stabilized.

Lowwalls may be:

- Backfilled sequentially with mine spoil or CPP waste.
- Regraded to <10% and capped with Permian spoil as required.
- Steeper slope options should not exceed 25% slope and be and capped with at least two meters of durable rock and soil matrix as described for the highwall.
- Drainage off adjacent prestrip dumps should be integrated into the lowwall treatment design.

When voids are used for spoil disposal or can be strategically used for tailings disposal, lowwall reshaping costs can be substantially reduced.

6.4 HIGHWALL

Tertiary materials on highwalls are generally dispersive and incompetent. Permian mudstones and shales are also unstable; bedding and faulting planes create further opportunities for instability.

Highwalls are a major long term safety risk to humans and fauna. Erosion and back-cutting of Tertiary strata may cause considerable degradation to surrounding land.

Highwall management and treatment strategies include:

- Sequential backfilling of final voids including ramps with prestrip spoil and or CPP waste is preferred.
- Regrading to <10% slope, covering with at approx. 1m benign rocky Permian spoil before topsoil application. (The 0.5m application depth referred to in S6.1 is associated with shorter slope treatments than is envisaged for the very long slopes that might be produced from regrade of the high and low wall). Alternatively, a steeper slope up to 25% can be formed and clad with durable rock mulch to at least 2 m deep. If rocky hospitable Permian spoil is placed at least 1m depth first, the thickness of the durable rock mulch cover may be reduced to 1 m. Note that the lowwall should be regraded first to minimize the amount of natural ground that will be disturbed by regarding the highwall.
- Mine planners will develop mine schedules showing how the mining operation can optimize the backfill of final voids, minimizing lengths of residual highwalls, during operations and satisfy progressive rehabilitation requirements.
- Where spoil haulage is too costly and/or cost effective scheduling can not be prepared, the mine plan is to be re-developed to show alternative strategies to reduce void volumes and prestrip dump heights and disturbed areas including:
    - i) Rescheduling mining sequences of pits, to demonstrate progressive backfilling of open void up to an economic limit.
    - ii) Changed mining practices – eg revert from mining across the strike to apparent or down dip mining methodology.
    - iii) Not mining deeper seams for last one or more strips, e.g. three seams, then two seams, then one seam.
    - iv) Narrowing final strip to reduce future void regrade cost
    - v) Highwall spoil dumping to reduce future regrade length and cost.
    - vi) Highwall treatments to render wall safe and stable using a range of potential options – including blasting to form rocky scree at less than 45% slope, benched structures with durable rock cladding (if wall is erodible), large protection bund beyond crest of highwall – at least 3 m high and 10 m wide, covered with durable rock mulch.
    - vii) Any other strategy which has clear benefits for reducing the cost of rehabilitating the void/highwall and meeting sustainability, stability and safety objectives.

6.5 TAILINGS DISPOSAL

Above ground tailings disposal facilities are costly to rehabilitate, increase the disturbance footprint, have significant long term potential for instability and leachate generation.

Tailings disposal methods include:

- In pit disposal is preferred option. Above ground out of pit facilities should not be constructed unless there is a clear business case demonstrating that the benefits outweigh the costs. This includes consideration of the potential cost impact for excavation of the tailings deposit at mine closure and haulage to a suitable void for permanent isolation and rehabilitation.

- Co-disposal methodology is preferred to conventional slurry deposition as water recovery is maximized; potential impacts on groundwater are reduced and geotechnical strength, hence access for timely rehabilitation is improved.
- If void space is available, in pit disposal using beaching and water recovery is acceptable.
- Disposal of tailings slurry without beaching and water recovery is poor practice, reduces progressive rehabilitation opportunities and increases likelihood of groundwater impacts.
- Rehabilitation of above ground tailings dams will include:
    - i) Rock cladding of batters and/or batters re-established at no steeper than 15% and topsoiled ripped and seeded. Rock cladding using durable competent rock shall exceed 1 m depth on batters.
    - ii) Spillway designed to ensure integrity of batters for 1:1000 year storm. Walls capable of sustaining seismic loads.
    - iii) Capping tailings surface with at least 2 meters competent benign spoil.
    - iv) Prevention of surface ponding.
    - v) Drainage from the surface in a sustainable and controlled fashion.
    - vi) Building a drainage surface that sheds water from the capping in a sustainable fashion.
    - vii) Applying 250 - 300 mm topsoil; application of native seed, and fertilizer as required to establish a diverse vegetative cover.

Rehabilitation of inpit tailings disposal sites includes:

- Capping with a minimum benign spoil cover of 2m, plus topsoil and conventional ripping and seeding techniques.
- Prevention of surface ponding.
- Drainage from the surface in a sustainable and controlled fashion.
- Disposal of coarse rejects on tailings dam surfaces may assist with the development of the final landform design.

Above ground out of pit tailings dams increase the disturbance footprint, often impact on biodiversity, reduce visual amenity and are difficult to redevelop into landforms compatible with the surrounding natural terrain. Unless substantial embankment stabilization is undertaken, these structures will require ongoing maintenance after mine closure.

6.6 REJECT DISPOSAL

Above ground out of pit reject disposal facilities are costly to rehabilitate, increase the disturbance footprint and have significant potential for leachate generation potential.

Rejects disposal options may include:

- In pit disposal is the preferred means of disposal.

- Out of pit facilities should not be constructed unless there is a clear business case demonstrating that the benefits outweigh the costs. This includes consideration of the potential cost impact for excavation of the rejects deposit at mine closure and haulage to a suitable void for permanent isolation and rehabilitation

Rehabilitation of out of pit reject dumps will include:

i) Regrading to 10% overall grade.

ii) Capping with at least 2 meters competent benign spoil.

iii) Rock lining of earthen batters with durable rock soil mix to 2 m depth.

iv) Coverage of 250 - 300 mm topsoil, application of native seed, and fertilizer as required to establish a diverse vegetative cover.

v) Where dumps are elevated, significant rock lined drainage structures are likely to be required to limit erosion down batter slopes.

Rehabilitation of inpit rejects disposal sites will include

- Regrading to 10% overall grade.
- Capping with at least 2 meters competent benign spoil.
- Coverage of 250 - 300 mm topsoil, application of native seed, and fertilizer as required to establish a diverse vegetative cover.

Above ground out of pit reject dumps increase the disturbance footprint, often impact on biodiversity, are unsightly and difficult to redevelop into landforms that are compatible with the surrounding natural terrain. Unless substantial embankment stabilization is undertaken, these structures will require ongoing maintenance after mine closure.

6.7 DIVERSIONS

6.7.1 Major Creeks and Waterways

Major Creeks in Central Queensland are prime biodiversity corridors and are very important in terms of regional biodiversity maintenance. Mining through major waterways may contradict BHP Billiton's commitment to protect and enhance biodiversity values in its Sustainable Development Policy.

Diversions of major creeks and waterways should be avoided to minimize impacts on riparian ecology. If diversion of a major creek or waterway is necessary, the following matters should be considered.

- The investment decision includes a full realistic cost estimate for the construction of a diversion which meets at least the Department Natural Resources and Water (DNRW) 2005, Watercourse Diversions - Central Queensland Mining Industry Guideline Version No 1. This guideline is based on Earth Tech, (2002). Bowen Basin River Diversions, Design and Rehabilitation Criteria, Australian Coal Association Research Program (ACARP).
- If dispersive earth forms the embankments, batter slopes of less than 15%, are required unless the batters are lined with competent coarse durable sandstone, volcanic rock or some other equivalent permanently durable rock material.

- Maintain buffer around existing creeks, rivers and diversions sufficient to demonstrate that there is a 50 m wide clearance between crest of the creek, river or diversion embankment and the projected toe of the spoil emplacement after it has been regraded to <10% for Tertiary spoil and <12% for Permian spoil.
- Where practicable, the existing stream length should be re-established in the diversion planning. The Regulator does not often approve diversions which do not meet stream length / stream power criteria.
- Where existing diversions require realignment, sustainable channel and embankment designs incorporating DNRW guidelines and modest batters no steeper than 15% through incompetent earth or strata will be established. Early construction of the new channel forward of an upstream plug is preferred to enable enhanced establishment and stability of riparian vegetation, before the plug is excavated and the new channel is exposed to river flows.

Several BMA sites are outlaying considerable expenditures on rebuilding poorly performing diversions. These are structures in which the original design engineers gave little or no consideration to fundamental fluvial processes and landform stability aspects including stream length restoration, batter stability and biodiversity values. Poor design outcomes impact the business reputation, make for non compliant outcomes and can have significant adverse impact on the business value.

6.7.2 Minor Creeks

Diversions of minor creeks and waterways is recognized as necessary for effective mining operations, for reasons including access to resource, cost effective mining operations and prevention of pit flooding.

Diversions of minor waterways may proceed when:

- The diversion of any minor waterway, particularly its final drainage alignment, should be consistent with the agreed long term landform.
- A satisfactory long term permanent corridor for the waterway is identified and subject to cost assessment and that cost must be included in the investment decision,
- Regulatory approval to divert the minor waterway has been granted.

Whenever practicable, minor diversions should be constructed on a permanently sustainable basis. Many licensed "temporary" diversions are approved only for the operational life of the mine and reconstruction is required upon closure.

All diversions should preferably be constructed well in advance of mining operations to allow backup and sediment drape and vegetation establishment for one or more seasons prior to being exposed to full creek flow.

6.8 DURABLE ROCK IDENTIFICATION & SALVAGE

Steep slope rehabilitation will largely depend on the provision of a durable rock resource. Durable rock does not swell and breakdown – typical mudstone, shale and poorly cemented sandstones common in much of the Bowen Basin highwall strata is not considered durable rock.

Use of durable rock has application when steep slopes are to be created or repaired.

- Good quality competent durable rock is a valuable resource to protect against erosive forces on steep slopes, creek diversions and erosion control structures.
- Durable rock includes indurated, well cemented sandstones, basalts as well as other siliceous based and ironstone cap rocks that can used as a permanent cover to protect diversion batters and stream banks, drainage channels and steep spoil areas.
- Most mine sites have limited occurrences of durable rock strata that will be excavated as part of routine mining program. Thus all sites should undertake sufficient geological investigation to define this resource, and then develop plans and schedules to selectively place the material into stockpiles in close proximity to future use zones.

Durable rock is a very valuable resource for rehabilitation of mine site disturbance as its use brings substantial potential to reduce rehabilitation costs and increase the likelihood of stability. Use of durable rock includes but is not limited to: Lining spoil faces and batters, lining walls of above ground tailings dams, lining diversion channels, lining drainage structures in rehabilitation and other areas and lining highwall and lowwalls after steeper treatments are applied.

6.9 RESOURCE INVENTORY

Sustainable landform development will rely on the capability and quantity of topsoil, spoil and rock resources that may exist at the site. Resource characterization and inventory is fundamental to sound planning practice. All mine sites shall prepare the following:

1. Inventory of soil type and volumes stockpiled and balance of soil resources in the planned disturbance footprint.
2. Spoils characterization mapping covering all existing spoil areas as well as future disturbance areas. This will provide information on existing spoil areas that may require capping with benign spoil, the location and volume of available benign spoil and as well define areas in the future which may also require capping or selective handling to avoid a cap requirement.
3. Inventory of available durable rock material, quantities required to complete the final landform and an action plan signed off by mine management to recover and store that rock for the rehabilitation requirement. This will require interrogation of exploration data and also possibly commissioning drill hole based exploration program aimed specifically at identifying and quantifying the existence of durable rock strata that may lie in the planned mining path
4. Durable rock resources should be mapped and made available on GIS and mine planning tools used for scheduling.

ATTACHMENT 1 PHOTOGRAPHS

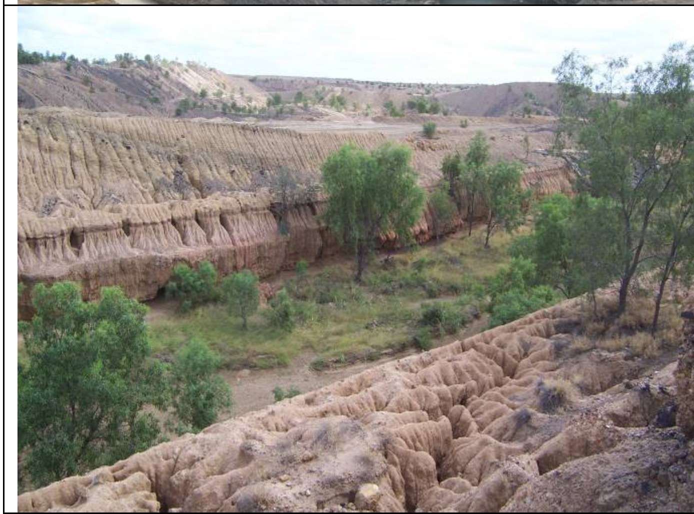
EXAMPLES OF ACCEPTABLE AND UNACCEPTABLE REHABILITATION OUTCOMES

	Steep (17%) rehabilitation on Tertiary spoil – approximately 15 years after completion of rehabilitation work. Site is badly eroded with significant gully development.
	Completely failed rehabilitation. Sodic Tertiary spoil on 12% slope – topsoil layer has eroded completely. Rills and gullies are levelling the landform.

	Permian spoil – at low 5% gradient, dense well established pastures with no evidence of erosion. Background, ungraded spoil.
	As above, another area of well established rehabilitation sited on Permian spoil at approximately 12% grade.
	Tertiary Spoil out of pit dump, steeper 25% batters have been clad with sandstone. Native trees and shrubs establishing. A viable strategy for rehabilitation of Tertiary spoil dumps.

	As above, but also showing the marked difference between exposed Tertiary Spoil and rock mulched area.
	14% Regraded Tertiary spoil slope below breach in a graded bank. Extreme erosion can occur when graded banks fail. The overall slope length on this outer batter approaches 450m in length. Failure of a graded bank, particularly one in the upper slope area can cause localised catastrophic gullying. Graded banks in Dispersive Tertiary spoil are high risk
	Rock lined waterway established in Tertiary Spoil has been deeply scoured following storm event. Geofabric has been used but has not prevented failure of this structure. Use of big rock without benefit of a considerable percentage finer media such as non dispersible clays and gravels, has allowed water to flow through the open rock matrix at the interface of the geotextile and dispersible Tertiary spoil. The Tertiary spoil at the base of the waterway has simply dispersed and mobilised with low flows and the structure has eventually collapsed into the incised scour.

	10% regraded Tertiary slope with 0.5m of Permian spoil rubble spread across the area before topsoiling, ripping and seeding. This practice promises to provide good erosion control during the high risk pasture and shrub development stage.
	Deep steep ramps, major liability if left insitu. Regrading or backfilling is required to enable these areas to form part of the rehabilitated landscape. The preference is to use these voids for spoil disposal. Unless rock mulched, these slopes require regrading to less than 12% for Permian spoil and less than 10% for Tertiary spoil.
	Deep steep ramp with angle of repose batters below existing poor quality rehabilitation of Tertiary spoil. Unless ramps are regraded or backfilled, erosional processes will cause gullies and rills to extend into the rehabilitation above crest. Future regrading of ramp batters below existing rehabilitation will consume much of the rehabilitation, unless these ramps are backfilled with prestrip spoil.

	Major operational pit. Mines need to ensure that plans are in place to stabilise final voids using progressive backfill, major regrade efforts, benching with durable rock cladding and other techniques that ensures the area is safe and stable when the lease is relinquished.
	Creek Diversion through Tertiary spoil. A costly example of earlier poor diversion design outcomes with significant potential for downstream sediment impact.
	Severe back cutting of Quaternary alluvium in small creek diversion. Extreme erosion can occur when stream length and or substantial outlet protection is not catered for. Expensive repair undertaken as shown below in following image.

	Rebuilt above diversion. Work effort required new channel excavation, backfilling of original diversion channel and construction of a substantial rock lined waterway into the creek.
	Rilled and piped out external wall of tailings dam. Wall constructed from extremely dispersive Tertiary spoil.
	Gross instability of Tertiary spoil in water filled void.

	Durable rock being used to line re constructed diversion channel. Original diversion channel failed due to inadequate design.

ATTACHMENT 2 SLOPE TREATMENT GUIDELINE SUMMARY

Complete following feed back from BMA sites