

Appendix A. Study Method

This appendix provides a summary of the Study method.

A.1 Study Technical Definitions, Terms and Concepts

A.1.1 Work Plan

Mining activities in Victoria are regulated under the *Mineral Resources (Sustainable Development) Act 1990* (MRSDA) by Earth Resources Regulation (ERR) of the Department of Economic Development, Jobs, Transport and Resources (DEDJTR).

MRSDA stipulates that “*mineral and stone resources are developed in ways that minimise adverse impacts on the environment and the community; and... the health and safety of the public is protected in relation to work being done under a licence*” (MRSDA 1990).

A Work Plan is a legal requirement to undertake work on a Mining Licence area under the MRSDA. In addition to being appropriate to the nature and scale of the proposed mining activities and specifying how the mine operator will eliminate or minimise key risks, the Work Plan must include a rehabilitation plan for land to be disturbed by mining activities.

A.1.2 Land Use, Landform, Mine Closure and Rehabilitation

Land use is the collective term that encompasses the ownership, the activity and the biophysical surface cover of the land. Land use describes all aspects of activity continuously across a landscape, such as; agricultural uses, environmental uses and residential/industrial uses (Department of Economic Development, Jobs, Transport and Resources, 2015).

Multiple land use involves using land for different purposes simultaneously, and sustainably, within a defined area. Sequential land use involves using land first for one purpose, and then later for another purpose, once the original purpose is no longer required. Sequential land use may be a reinstatement of the former land use or development of an alternative land use.

Landform is the shape (morphology) and character of the land surface that result from the interaction of physical processes (United States National Soil Survey Centre, 2005).

Mine closure is a whole of mine life process which typically culminates in tenement relinquishment. It includes decommissioning and rehabilitation. The period of time when the operational stage of a mine is ending or has ended, and the final decommissioning and mine rehabilitation is being undertaken. Closure may be only temporary in some cases, or may lead into a program of care and maintenance (Commonwealth Department of Industry, 2006).

Mine rehabilitation involves the establishment of a final landform that meets key risk mitigation criteria (e.g. stability, groundwater, surface water, fire, public safety, biodiversity, public and private infrastructure) agreed under the relevant regulatory statute and which facilitates the agreed sequential land use. It is the responsibility of the mine operator to establish the agreed final landform however the broader community and regulators should provide guidance on the agreed land use and associated capability criteria.

A.1.3 Short, Medium and Long Term Options

An option is a final landform and whether it is possible to achieve some, all or none of the final landform in the short, medium or long term.

For the remainder of the report a future mine rehabilitation option is referred to as either:

- Preliminary option – an option that exists but potential viability is untested at each mine site. The study tests preliminary options and establish their potential viability. A preliminary option is graded as either a potential viable or currently unviable option; and
- Potential viable option – an option that is potentially viable for a mine site. The study assesses the risks, costs, schedule etc. of potential viable options and provides findings regarding issues that warrant more detailed investigation.

In consultation with the Inquiry the study has interpreted the short, medium and long term as follows:

- Short Term - From now until end of mining operations. During this period the mine operators are required to progressively rehabilitate the mine to meet the landform agreed with ERR within the approved Work Plan. Each mine operator advised the Inquiry of their current scheduled mine closure date:
 - Yallourn Mine – scheduled closure 2032;
 - Hazelwood Mine – scheduled closure 2033;
 - Loy Yang – scheduled closure 2048.
- Medium Term – from end of mining operations to 15 years after end of mining operations. During this time mine operators will be actively rehabilitating mined areas to achieve their final landform;
- Long Term – the period 15 years after end of mining operations. Achievement of the final agreed landform may take an undefined number of years depending on the landform and impacting factors. The final landform would be expected to be available for sequential land use during this period however it is possible that ongoing maintenance and management requirements would exist to mitigate residual risks associated with mining activity and the rehabilitated final landform.

A.1.4 Key Technical Terms and Definitions

Table 10-1 defines the key technical terms used in the report.

Table 10-1 : Key Technical Terms and Definitions

| Technical Term | Definition |
|----------------|--|
| Batter | The sloped parts of a mine face within an open pit. The term “batter angle” is used to refer to the slope of the face. |
| Bench | The horizontal step in the face of an open cut mine. A “benched” pit is one with a number of alternating benches and batters. |
| Biodiversity | The variety of plant and animal life in a particular habitat, a high level of which is usually considered to be important and desirable. |
| Buffer | An area of the Mining Licence area which is unavailable for mining and is set aside to ensure sufficient separation between mining and sensitive land uses. Buffers also ensure that mining does not encroach too close to boundaries. They may provide a natural visual screen for the Mining Licence area. |
| Dewatering | Removing groundwater to enable mining works to continue at depth. |
| Coal Fire | Combustion of in situ coal either at surface or underground from an external or internal ignition source. |
| Groundwater | The water contained in rocks or subsoil. Groundwater impacts can include impacts on Groundwater Dependent Ecosystems (e.g. an ecosystem in which species composition and natural ecological process is determined by groundwater) and third party users. |
| Instability | Any excess movement or potential movement of a mass of rock, debris, or earth within any open cut pit slope, cliff, cutting, or fill embankment that had the potential to impact on mine workers, mine infrastructure, general public, public and private infrastructure and environmental values (e.g. rivers) adjacent to the mine site. This movement could occur as a result of local geological and groundwater conditions, but can be exacerbated by inappropriate rehabilitation activities, exceptional weather, |

| Technical Term | Definition |
|----------------|---|
| | earthquakes and other factors. The hazards could include movement and landslides which have their source in both the area under consideration and also those that may have their source outside the area but might travel onto or regress into the area. Small and constrained movement within defined tolerance is not considered instability. |
| Pit Lake | A body of water that fills the mine void to, or approximately to, the pit crest and which covers the majority of the pit surface area. |
| Pit Water Body | A body of water that partially fill the mine void to a level below the pit crest and which covers a portion of the pit surface area. For the purpose of this report the term pit water body has been used to distinguish between a pit lake that completely fills the pit void and pit lake that only partially fills a pit void. |
| Risk | <p>Risk is the chance of something happening that will have an impact (positive or negative) on an entity. It is specified in terms of the likelihood of an event or circumstance and the consequences that may flow from it.</p> <p>Inherent risk and residual risk refer to the level of risk identified prior to and following the effective implementation of risk control(s).</p> |
| Risk control | Policies, standards and procedures used to eliminate, avoid or minimise adverse risks. Often applied as a hierarchy in order of application (e.g. elimination, substitution, engineering controls, administrative (procedural) controls, and personal protective equipment). |
| Risk criteria | Criteria associated with identified risk issues which facilitate the determination of residual risk to a level as low as reasonably practicable (ALARP). |
| Surface water | The generic term used to describe any water that can be found on the earth's surface. It includes water from rivers, creeks and catchment run-off water that is collected and stored in dams. |
| Water Table | For the purposes of this study and the landform options being assessed, Jacobs have used the description of the water table to be the shallowest expression of groundwater level in the unconfined upper aquifers. In some cases deeper aquifers will have pressure surface levels that may be above the water table. The water table is always below ground level (by definition). In the Latrobe Valley, the water table is often within a metre or two of the ground surface, especially near rivers. |
| Weight Balance | <p>In the context of the Latrobe Valley coal mines "weight balance" is the desired equilibrium (with built in factor of safety) between the uplift pressure from deep groundwater aquifers and the mass of the pit with coal and overburden removed, but with replaced material and water. A weight balance is necessary in order to minimise the risk of mine floor heave and thus to assist in overall mine stability. Weight balance can be achieved by:</p> <ul style="list-style-type: none"> • Pumping groundwater out of the aquifers to reduce aquifer pressure; • Back filling of overburden or other material into the mine voids; • Filling with water above the mine floor and back filled material; or • A combination of the above. |

A.1.5 Study Scope

The scope of the study was defined by:

- Inquiry's timeframe and Terms of Reference;
- Focus on landforms and potential land uses;
- 'High-level study assessment - Order of magnitude/concept' level cost estimates and early pre-feasibility level of risk assessment);
- Geographical extent of the mine site rehabilitation evaluated;
- Options in the context of planned closure;
- Available technical data and information;

- Community consultation; and
- Engagement with a Technical Review Group (referred to as a Deliberative Forum).

Inquiry's Timeframe and Terms of Reference

Jacobs was formally appointed to commence on 24th July 2015 and a draft report was required by the Inquiry on 12th October 2015. Over this 11 week period Jacobs' analysed 18 different preliminary options (six options per mine) and six potential viable options (two per mine). Each preliminary and potential viable option was assessed against a 9 point criteria spanning fire risk, landform stability (both during mining and post-operations), environmental degradation (groundwater, surface water, biodiversity), beneficial land use, compatibility and extent of difference to current mine operator Work Plans. Potential viable options were assessed also on the basis of estimated cost, timing and capacity to ensure progressive rehabilitation.

The criteria used to assess the options were set by the Inquiry's Terms of Reference.

Focus on landforms

The end of mining and rehabilitation of the mined areas opens up significant opportunities for development of the land and subsequent land use. The purpose of this study is not to establish the viability (or otherwise) of the potential post-mining land use(s) but to consider the impact of the choice of landform on land use(s). The study was not required to assess the economic merit or impact on community liveability of different potential post mining land uses.

Level of study

The study has been completed at an order of magnitude/concept level of study for the cost estimation and features of an early pre-feasibility level of study for assessment of the preliminary and potential viable options (e.g. Risk assessment has used a Failure Mode Analysis technique and a relatively comprehensive assessment criteria has used). A study at this level of analysis is typically based on available information and use the technical experience and knowledge of targeted professionals to make strategic, informed and reasoned judgments. Jacobs have used techniques such as the Failure Mode Analysis risk assessment technique to gain greater appreciation of the technical viability of each potential mine rehabilitation option.

This study has sought to check if any potential viable has been overlooked as greater attention is being applied to future mine rehabilitation.

This study provides insight into the substantive mine rehabilitation issues. The study should inform the direction and scope of further studies and enquiries. To provide context regarding the level of assessment completed in this study, there could be another four levels of study completed before reaching a final decision on the final design for the final landform for each mine:

- Class 4 – Full Pre-Feasibility study for each of the potential viable options;
- Class 3 – Feasibility study,
- Class 2 - Detailed/Control study; and
- Class 1 – Definitive Estimate study

At the completion of each class, the development should incrementally increase in maturity and certainty. An order of magnitude/concept cost estimate and early pre-feasibility level of study is appropriate for this study as it examining a wide range of preliminary options across three different sites (six options per site, 18 options in total).

A study with this level of assessments commences with the broadest array of preliminary options and a strategic appreciation of major issues and challenges. A group of professionals seek to eliminate unviable options and arrive at a shortlist of potential viable options noting the important issues and risks that warrant closer examination in subsequent studies.

Geographic Extent of Mine Rehabilitation

Mining operators are responsible for the rehabilitation of all disturbed land within the Mining Lease. Disturbance associated with open pits and overburden dumps represent the significant portion of risk and cost associated with mine rehabilitation and achievement of final landform. Therefore for the purpose of this study the assessment of options has focused on the open pit. The following are excluded from the study:

- Removal and rehabilitation of all infrastructure, buildings or services;
- Removal and rehabilitation and removal of power generation and distribution infrastructure; and
- Rehabilitation of ex-pit disturbance.

Planned Closure

The study has considered options in the context of a planned closure of the coal mines. In a planned closure of a mine there is an orderly wind down of mining operations and a co-ordinated transition to active mine site rehabilitation.

Unplanned closure involves the proponent suddenly leaving the mine site. In some instances minimal progressive rehabilitation may have been completed. Rehabilitation of the mine site may fall to either the next land owner/user or government.

Available Technical Data and Information

Only data provided by the Inquiry and available within the public domain was used in the development of this report. Jacobs has relied on the accuracy of all data provided. Data and information has been used from the provided information to inform “an order of magnitude/concept” level of study.

Due to the study’s short timeframe and information made available Jacobs did not examine in detail the current status of mine rehabilitation at each of the three mines. Nor have Jacobs undertaken any modelling or site level investigations of the three mines.

Jacobs participated in two meetings organised by the Inquiry with interested stakeholders. The meetings were facilitated and lead by the Inquiry. The meetings were with:

- GHD;
- RMIT

The Inquiry provided Jacobs with a summary of international leading practice in the rehabilitation of coal mines and a brief description of potential post-mining landforms identified from a range of sources. Jacobs’ used this and other information to inform the identification of potential post-mining land uses and thereby the preliminary landform(s) (options) required to support the post-mining land uses.

The bibliography (refer section 10) contains a list of all the documents made available to Jacobs by the Inquiry. Jacobs has reviewed and relied on information from the documents in manner consistent with an order of magnitude/concept study which is to identify the significant strategic issues and themes (e.g. rehabilitation options, major risk areas etc.).

Jacobs was not required to produce a literature review that summarised and distilled all the analysis, findings and conclusions contained in the 85 documents listed in the bibliography. Given the amount of information produced regarding subjects and themes related to mine rehabilitation and closure in the Latrobe Valley, Jacobs suggest that a thorough literature review would be a useful activity to form a very clear baseline understanding of all the issues. This will help make future research and studies more effective, efficient and economical.

Community Consultation

A member of the Jacobs team attended and participated in community consultation workshops and Jacobs' team members have reviewed public submissions to the Inquiry to inform the study. However, it was not Jacobs' responsibility to lead, facilitate or summarise community consultation undertaken by the Inquiry.

Engagement Technical Review Group (Deliberative Forum)

On the 27th and 28th October 2015 Jacobs participated in a Deliberative Forum organised and facilitated by an independent facilitator appointed by the Inquiry. The organisations represented at the Deliberative Forum were:

- Victorian Department of Economic Development, Jobs, Transport and Resources;
- GDF Suez and their technical advisers;
- AGL and their technical advisers;
- Energy Australia and their technical advisers; and
- The Victorian Government Technical Review Board (selected members attended)

Dr Friedrich von Bismarck, a renowned specialist in coal mine rehabilitation from Germany attended the Deliberative Forum at the request of the Inquiry.

Over one and half days Jacobs outlined the draft findings of their study and the members of the Deliberative Forum provided comment on technical validity and merit.

A.1.6 Study Team

The Jacobs' study team incorporated skills and experience in mine rehabilitation and closure, coal mine operations, fire, hydrogeology and geotechnical engineering, integrated water management, natural resource management and land use planning. The Study team and management comprised:

- Darren Murphy – Study Lead/Project Manager;
- Phillip Burn – Assistant Project Manager, Environmental Management;
- Andrew Tingay – Study Director;
- Dr Wendy Smith – Report Writing;
- Carolyn Cameron – Vision and Report Review;
- Greg Hoxley – Hydrogeology;
- Kevin Dugan – Geotechnical;
- Charlie Speirs – Mine Management;
- Lewis Esuider and Rohan Miller – Cost estimations;
- Alan Wright – Pit Lake Design Adviser;
- Nicola Logan – Surface Water Adviser and
- Don Blenkinsop – Fire Risk Adviser.

A.2 Study Method

The Study method is focused on reviewing each of the possible final landform/mine rehabilitation options and evaluating which are viable. The method begins with data gathering (Section A.2.1). Using the information collected, the study team formed an appreciation of coal mining in the Latrobe Valley and consensus regarding the important issues and challenges confronting mine rehabilitation.

A suggested regional long term mine rehabilitation vision and outcomes (Section A.2.2) was formulated which is intended to guide decision making for future more detailed studies. Land uses identified via data gathering and vision/outcome setting were matched to a required landform. This process was used to identify preliminary potential mine rehabilitation options (Section A.2.3). A multi-criteria analysis (MCA) was undertaken to inform an

assessment of these preliminary potential final landforms/mine rehabilitation options (Section A.2.4). A more detailed assessment of each of the potentially viable final landform/mine rehabilitation options (Section A.2.5) followed. For each potential viable option the following was completed:

- A risk assessment using a Failure Mode Effects Risk analysis technique;
- A comparison of risk controls and implementation actions required for the potentially viable mine rehabilitation option and the mine operator's current Work Plans;
- A cost estimate to implement the risk controls;
- An assessment of the capacity for progressive rehabilitation and;
- An implementation schedule.

Figure below illustrates how each part of the study method informs the identification of a set of potentially viable final landform/mine rehabilitation options for each mine.

Figure 10-1 : Study Method



A.2.1 Data Gathering

Community Consultation

The Inquiry organised three community consultation events (Moe, Morwell and Traralgon) to hear community issues regarding the rehabilitation of the three mines. These were carried out on the 4th and 5th August 2015.

Participants at the community consultation were asked to consider two key questions:

- What are the infrastructure needs of the Latrobe Valley and how can the mines sites can play a role?
- What can be achieved in the short term while the mines are in operation?

Mine Operators

Jacobs were provided with a range of confidential data and information from each mine operator via the Inquiry (e.g. current mining Work Plan).

Victorian Government

Jacobs were provided confidential and publicly available information from the Victorian Government regarding aspects of mine rehabilitation. For example, Department of State Development and Business Innovation (2013) Ground Water Impacts and Management for Lignite Mining In the Latrobe Valley (DRAFT). The report covered current mining impacts, land subsidence, groundwater discharge, future ground water use, mining sequence, depressurisation requirements, predictive ground water model, model of ground water pumping requirements, subsidence impacts and mine void filling associated with different rates/scenarios of future mining at the three mines.

Publicly Available Information about Latrobe Valley and Mines

Jacobs sourced and referred to other publicly available information about the Latrobe Valley and the coal mines (e.g. Latrobe Valley Regional Growth Plan).

Public Submissions

The Inquiry invited written public submissions on mine rehabilitation with the period for comment closing on the 17th August 2015. More than 25 submissions were received from a wide range of individuals and groups including:

- AGL;
- ALP;
- CFMEU;
- Daniel Caffrey;
- David Langmore;
- Elise Wedrowicz;
- Energy Australia;
- Environment Victoria;
- Federation University Australia;
- GDF SAE;
- GHD;
- Gilio Barbara;
- GLaWAC;
- Haztech Environmental;
- Indigenous Design;
- Jane Caffrey;
- Kyle Bush;
- Latrobe City Council;
- Latrobe Valley Prefabricated Energy Efficient Buildings;
- Lorraine Bull;
- Margaret Gaulton;
- Minerals Council of Australia Victoria Division;

- Ron Sait;
- Victorian Government and;
- West Gippsland Catchment Management Authority.

Leading Practice Desktop Review

The Inquiry provided Jacobs with a summary of findings of a literature review regarding leading practice in the rehabilitation of open cut coal mines. This included case study information regarding:

- Potential land uses for rehabilitated mined areas (type of land use, if applicable to a specific mine, if it is a short, medium or long term option, landform needed to support the land use, risk factors associated with the land use, if the land use has been successfully implemented elsewhere in comparable conditions);
- Potential landforms for rehabilitated mined areas (type of landform, if applicable to a specific mine, if it is a short, medium or long term option, land use that could be supported, risk factors associated with the landform, if the landform had been successfully implemented elsewhere in comparable conditions).

A.2.2 Regional Mine Rehabilitation Vision and Outcome

The purpose of the Regional Mine Rehabilitation Vision and Outcome was to articulate the aspirations of the community and other entities regarding the future land uses and final landforms of the mined areas. The vision was constructed using a conceptual model (illustrated in Figure 10-2) that considers a range of issues over different spatial and temporal scales including:

- Social needs – what amenity values were important to the stakeholders;
- Economic needs – what economic outcomes were important to stakeholders (e.g. job creation, infrastructure that improves productivity, efficiency and competitiveness of the region) and;
- Environmental drivers – what environmental outcomes were important to stakeholders (e.g. protection of environmental values, enhanced condition of environmental values etc.).

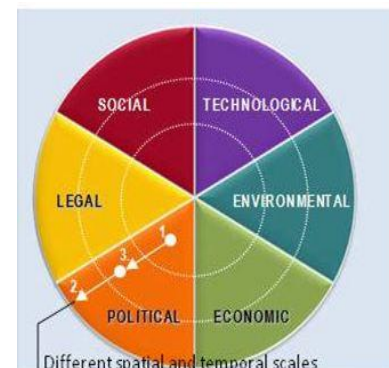


Figure 10-2 : Visioning Model

A.2.3 Identify Potential Preliminary Options

Jacobs produced a tool used to match desired land uses with requisite landforms to identify a potential set of preliminary final landforms/mine rehabilitation options. This tool enabled Jacobs to analyse land use and landform data and information provided by the Inquiry (as sourced from mine operators, community consultation, public submissions and desktop literature review).

Table 10-2 illustrates the type of information gathered and analysed about landforms and land uses.

Table 10-2 : Land Use and Landform Matching Tool Used To Identify Preliminary Options

| Landform Header (Lake, backfill) | Landform detail (describe the landform features identified in public submissions, background material) | Location of Landform (Hazelwood, Yallourn, Loy Yang or all) | Timing (short medium long term) | Land uses which could support the land for (e.g. Hydro Power, Boating Recreation) | Risk factors (fire stability environment) | Proven and Demonstrated Application (based on a case study, state how the landform was achieved, state key differences / similarities between the case study and Latrobe Valley mines) | Idea source (HMFI submission number, background report title and page reference) |
|----------------------------------|--|---|---------------------------------|---|---|--|--|
| Mine Pit Lake | Lake with XYZ | All | Long term | Use agreed land use term | Water use | | Submission 490 - Morwell Yacht Club |

A.2.4 Criteria to Assess Preliminary and Potential Options

The preliminary final landform/mine rehabilitation options identified were assessed using a Multi-Criteria Analysis (MCA) to identify potentially viable final landforms/mine rehabilitation options.

MCA is a qualitative technique used for screening preliminary options to assess their initial viability. MCA uses agreed assessment criteria with appropriate weightings to guide an assessment process undertaken by the multi-disciplinary study team.

The selection of criteria is an important component of the MCA and considerable care was taken when choosing them. The selected criteria are based on the Terms of Reference, however note that not all Terms of Reference (e.g. estimated cost, progressive rehabilitation) were embraced within the MCA as it was more appropriate to consider some elements within the more detailed analyses that occur later.

For each criteria, a Compliance Statement was developed that explicitly states the outcomes being sought through mine rehabilitation. The Technical Working Group assessed each preliminary landform/mine rehabilitation option against the extent to which they met the Compliance Statement using the ratings of “Non-compliant”, “Partly Complies”, “Complies”, “Exceeds Compliance” and “Best Practice”.

The final stage of the MCA assessment was to determine whether the final landform/mine rehabilitation option presented any insurmountable challenges and would therefore be excluded from further consideration.

In conclusion, six viable options across the three mines (two per site) were identified and agreed as the basis for further detailed review as potential viable mine rehabilitation options.

Table 10-3 : Multiple Criteria Analysis

| Criteria | Description | Compliance Statement |
|--------------------------|--|---|
| Fire risk | Fire risk refers to fires that start either inside or outside the rehabilitated areas. Consideration is given to the impact of the landform on the risk of fires igniting and propagating. | <ul style="list-style-type: none"> Progressive implementation of the landform will maintain or reduce the fire risk in the medium and long term. |
| Mine Stability | Refers to the prevention of unwanted movement of the pit slopes while the mine continues to function. Movement could occur as a result of geological conditions but could also be exacerbated by inappropriate rehabilitation activities, weather, earthquakes and other factors. Stability considers the potential impact on people, infrastructure and the environment | <ul style="list-style-type: none"> Establishment of the landform will sustain safety and stability requirements during operations |
| Final Landform stability | Refers to the long term stability of the landform after the cessation of mining operations. Due to the permanence of the landform, higher safety | <ul style="list-style-type: none"> Establishment of the landform will achieve safety and stability |

| Criteria | Description | Compliance Statement |
|--|--|--|
| | controls are required for Landform Stability compared with Operational Stability. | requirements following the cessation of operations |
| Groundwater | Groundwater relates to the water contained in rocks or subsoil. The mines currently keep groundwater out by dewatering processes. As the mines transition, protecting groundwater quality and quantity for consumption and ecosystem support will be crucial to environmental protection and sustainability of the transition and closure process. | <ul style="list-style-type: none"> The landform will not alter groundwater quality (from background). The landform will not impact upon groundwater dependent ecosystems (GDE's). The landform will not impact on groundwater availability for other users |
| Surface water | Surface water relates to water from, creeks and catchment run-off during rainfall. As the mines transition, managing the inflow of surface water and protecting its quality and quantity will be crucial to environmental protection and sustainability of the transition and closure process. | <ul style="list-style-type: none"> The landform will not alter surface water drainage or water quality (from background). The landform will not impact upon ecological water requirements. The landform will not impact on surface water availability for other users. |
| Biodiversity | Biodiversity relates to the variety of plant and animal life able to be supported by the mines during transition and closure. Biodiversity also relates to the presence of threatened species which have protection under state or commonwealth legislation | <ul style="list-style-type: none"> Ecological function of the landform will be aligned with the regional catchment strategy. |
| Future beneficial land use | Refers to the community amenity provided by the final landform and the ability to support the long term vision for mine transition and closure. | <ul style="list-style-type: none"> The landform supports multiple land uses and the ability to adapt to changing community expectations, economic conditions and environmental values. |
| Compatibility | Refers to the ability of a landform at one mine to coexist with landforms at other mines. For example, if one mine is still operational and dewatering, it's not technically possible to construct a lake at an adjacent mine | <ul style="list-style-type: none"> The landform supports multiple landform options at other sites. |
| Statutory and Work Plan Considerations | Refers to the current Work Plans that mining operators have in place for each mine. | <ul style="list-style-type: none"> The landform is compliant with the <i>Mineral Resources (Sustainable Development) Act 1990</i>. The landform does not require significant deviation from the current mine plans. The landform minimises the special conditions pursuant to relevant legislation at the time. |

A.2.5 Assessment of Potential Viable Options

Failure Mode Analysis Risk Assessment

To determine the residual risk associated with each of the potential viable final landforms/mine rehabilitation options a FMA was conducted as a facilitated workshop with the relevant technical specialists. The FMA specifically assessed the risks associated with each final landform/mine rehabilitation option and identify potential failure modes and required controls.

For each key risk area (e.g. landform stability, groundwater, surface water, biodiversity, fire) each option for each mine was analysed:

- Impact Scenario – a statement of the potential adverse impact associated with the option;
- Causes – statement(s) regarding what might trigger the adverse impact;
- Primary Risk control – the risk treatment control to avoid, minimise or mitigate the causes;
- Failure Modes – what conditions could lead to the primary risk control failing to avoid, minimise or mitigate the cause(s);
- Secondary Risk control – the risk treatment control used prevent the failure of the primary risk control;
- Residual Risk Analysis – the type of risk impact (environmental, health and safety, financial etc.), the risk consequence rating, the risk likelihood rating, the overall risk rating and a description of the overall risk rating;
- Assumptions – any assumptions made underpinning the analysis of the impact scenario, causes and effectiveness of primary and secondary controls and;
- Recommendations – any actions that should be taken to address the uncertainty associated with the risk.

Figure 10-3 outlines the risk consequence, risk likelihood and risk rating criteria used.

Report on Future Options For Rehabilitating the Hazelwood, Yallourn and Loy Yang Mines in the Latrobe Valley



Figure 10-3 : Failure Mode Analysis Likelihood, Consequence and Risk Rating Tables

| | | Consequence | | | | |
|------------|---|-------------|----------|----------|----------|----------|
| | | 1 | 2 | 3 | 4 | 5 |
| Likelihood | A | Moderate | High | Critical | Critical | Critical |
| | B | Moderate | High | High | Critical | Critical |
| | C | Low | Moderate | High | Critical | Critical |
| | D | Low | Low | Moderate | High | Critical |
| | E | Low | Low | Moderate | High | High |

Likelihood

| L | Likelihood Category | Likelihood Description | Frequency |
|---|---------------------|---|-----------------------------------|
| A | Almost certain | Event will occur during the closure phase | Typically occurs 1-2 years |
| B | Likely | Event may occur frequently during the closure phase and post relinquishment | Typically occurs 1-10 years |
| C | Possible | Event may occur during the closure phase and could occur postrelinquishment | Typically occurs in 1 - 50 years |
| D | Unlikely | Event is unlikely to occur during the closure phase but could occur post relinquishment | Typically occurs in 1 - 200 years |
| E | Rare | Event is very unlikely to occur during the closure phase and unlikely to occur post relinquishment. | Greater than 200 year event. |

Consequences

| C | Consequence Category | Health & Safety (H&S) | Environment (ENV) | Community and Regulatory Acceptant (CRA) | Technical Feasibility (TF) | Compliance (COM) | Cost | | |
|---|----------------------|---|---|---|--|---|----------------|------------|----------------------|
| | | | | | | | Closure Cost % | Schedule % | Post Closure Costs % |
| 5 | Catastrophic | Multiple fatalities or serious disabling illness to multiple people. | Impact that is widespread unconfined and requiring long-term recovery, leaving major residual damage (typically >10 years). Significant, uncontrollable fire risk. | Active opposition, outrage or wide spread loss of trust across the community and key stakeholders. Likely constraint or restriction to established or pending consents. | Impact so large work plans redundant and current LpM designs not conducive to development of proposed closure landform. Significant operational changes required in order to implement proposed option. Requiring significant additional studies to be completed prior to submission of work plans / final closure designs. | Potential litigious action or serious threat to ability to relinquish tenure and transfer liability. | >30% | >45% | >15% |
| 4 | Major | Single fatality, severe irreversible damage to one or more persons | Impact that is unconfined and requiring long-term recovery, leaving residual damage (typically <10 but >5 years). Major, uncontrollable fire risk. | Refusal to engage or tangible expressions of mistrust amongst community members and key stakeholders. | Major changes to current work plans, operational practice or closure design required to support development of proposed landform. Requiring significant additional studies to be completed prior to submission of work plans / final closure designs. | Potential breach of statutory conditions or commitments or potential delay to relinquishment of tenure (by >10 years) | 10%-30% | 15%-45% | 7.5%-15% |
| 3 | Serious | Injury or reversible health effects to one or more persons | Near-source confined and medium-term recovery impact (typically <5 but >2 years) Serious, manageable fire risk. | Threat to oppose, disengage or express mistrust amongst some community members and key stakeholders. Moderate level non-compliance with moderate influence on public opinion and decision-makers. | Significant changes to current work plans, operational practice or closure design required to support proposed landform. No additional studies required to be undertaken. | Non-compliance with moderate potential for impact. | 5%-10% | 7.5%-15% | 2.5%-7.5% |
| 2 | Medium | Reversible injury or health effects of concern that would typically result in medical treatment to one or more persons. | Near-source confined and short-term reversible impact (typically <2 year). Minor manageable fire risk. | Tangible expressions of trust/ mistrust amongst a few community members with some influence on public opinion and decision-makers. | Some changes to current work plans or closure design required to support development of proposed landform. | Non-compliance with external standard, contract or operating procedure with low potential for impact. | 1%-5% | 2.5%-7.5% | 1%-2.5% |
| 1 | Minor | Minor injury or reversible health effects of little concern and requiring first aid treatment at most. | Near-source confined and promptly reversible impact (typically <1 year). Potential fire risk. | Tangible expressions of trust/ mistrust amongst a handful of community members with no influence on public opinion and decision-makers. | No changes to current work plans, operational practice or closure design required to facilitate development of proposed landform. | Non-conformance with internal operational procedure with low potential for impact. | 2.5% | <2.5% | <1% |

Comparison of potential viable option with current mine operator's Work Plan

Following identification of primary and secondary controls through the FMA each control for each landform option was qualitatively assessed during facilitated workshop with relevant technical specialists for the following key aspects:

- Consistency with Current Work Plan – whether the identified control was established within the current Work Plan for the specific mine
- Timing of Implementation - whether the identified control was able to be implemented in the short, medium or long terms
- Interdependence: - whether the identified option was dependent upon, or likely to be impacted upon, by the implementation of a landform option, and associated controls, at an adjacent mine

Further to the above aspects specific assumptions and potential knowledge gaps relevant to the identified controls were noted.

Implementation Schedule

The development of the Implementation Schedule for each option for each mine involved:

- Identifying the risk controls to be implemented based the outputs of the risk assessment;
- Determining the appropriate sequence and inter-dependency between each of the identified risk controls;
- Defining the core activities that need to be performed to plan, design, construct, install, operate and monitor the risk controls; and
- Placing the core activities against the appropriately sequenced risk controls to create an indicative implementation schedule for each viable option for each mine.

Cost Estimation

The following basis of estimate is provided to facilitate interpretation and understanding of the cost estimates presented within the main report (refer to sections 8.4.1.3, 8.4.2.3, 8.5.1.3, 8.6.1.3, 8.6.1.3 and 8.6.2.3)³⁴ and detailed within the following appendices (Appendices E1, E2, E3, E4, E5, E6, E7, E8 and E9).

Limitation Statement

Jacobs has used its best endeavours within the context of a generally accepted definition of a study of this nature to determine current pricing and equipment lead times for items within this Estimate.

However, Jacobs cannot warrant the accuracy of this Estimate to points in time significantly beyond the date at which this report has been prepared.

Jacobs advises that before applying this Estimate provided herein, the user determines current market rates/prices at that point in time (including any foreign exchange variations), in order to capture any price/rate movements that have occurred since the production of this report. This process ensures that the currency and accuracy of this Estimate is maintained.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in connection with the provisions of the agreement between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party. In no part of this report does Jacobs, either explicitly or implicitly, make any recommendation or endorsement of the viability or otherwise of the study.

³⁴ Jacobs 2015, *Review of Future Rehabilitation Options for the Loy Yang, Hazelwood and Yallourn Coal Mines in the Latrobe Valley (Rev 1)*, Report prepared for the Hazelwood Mine Fire Inquiry

Background

Cost estimates (represented by costs schedules – see Appendices E1, E2, E3, E4, E5, E6, E7, E8 and E9) have been prepared to facilitate the assessment of potential viable options at:

- Yallourn coal mine;
- Hazelwood coal mine; and
- Loy Yang coal mine.

The cost estimates have been independently prepared against the following risk issues identified within the Inquiry's Terms of Reference:

- Fire Risk;
- Mine Landform Stability (Collapse);
- Groundwater;
- Surface Water; and
- Biodiversity.

Initially, six preliminary options were considered, however following elimination of several options on the basis of viability (based on both bulk earthworks quantities or ongoing management requirements) through the MCA process, cost estimates have been prepared in consideration of the stated risk issues for the following potential viable options for each mine site (Yallourn, Hazelwood and Loy Yang):

- Pit Lake;
- Partial Backfill to below Water Table.

Scope of Estimates

Costs have been prepared for comparative purposes only and are not intended to represent actual implementation costs (e.g. under an EPCM contract). Estimates have been prepared to a Jacobs Class 5 (Order of Magnitude) level with a target accuracy range of $\pm 50\%$ ³⁵.

Inputs

The cost estimates are based on:

- Rates adapted from Jacobs existing closure rates suite;
- Quantities developed based on high-level sketches and assumptions; and
- Costing schedule based upon the Failure Modes Assessment (refer Appendices D1, D2, D3, D4, D5 and D6) for each site covering the risk issues, design controls and activities.

Qualifications

The following qualifications are made in regard to the cost estimates

- Cost are inclusive of direct costs based on the determination of relevant quantities and rates (including mobilisation and demobilisation³⁶);
- Quantities have been based on data identified within information provided by Inquiry or available in the public domain only;
- Cost estimates established for identified risk issues are independent of one another and are not cumulative;

³⁵ Unassessed

³⁶ Included as a 5% factor of all non-maintenance costs

- It is assumed that bulk civil works associated with overburden placement and slope battering activities can be accommodated within current Work Plans and have been excluded from the Cost Estimates on the basis that they will be completed using existing site equipment as an Operational expense; and
- Quantities and associated costs are considered conservative in line with the target accuracy of the estimate

Exclusions

The following items specifically excluded from the cost estimates:

- Operational bulk civil works within current Work Plans;
- Field Indirects;
- EPCM costs;
- Owners Costs;
- Contingency and escalation;
- Removal and disposal of Infrastructure;
- Remediation of site contamination;
- Community consultation;
- Socio-economic capacity development;
- Heritage preservation and management of sites;
- Contaminated site (e.g. soil and groundwater) remediation;
- Hazardous material collection, treatment and disposal;
- Human resource management (e.g. retention, redeployment and redundancy);
- Financing costs;
- Growth;
- Contingency and escalation;
- Recovery of salvaged materials;
- Costs associated with planning or specialist consultant fees; and
- Risk modelling and/or sensitivity analysis.

Estimate Preparation

The cost estimates have been prepared in accordance with the Jacobs Asset Closure Cost Estimate Guideline³⁷ (ANZ-WI-1325 Rev 0) (Jacobs 2014).

Estimate Criteria

The cost estimates has been prepared to the following criteria:

- Base date Q3 2015 (no allowance for escalation);
- Target accuracy range of $\pm 50\%$ ³⁸;
- Labour rate information based upon in-house data;
- Expressed in Australian Dollars (\$AUD); and
- Exclusive of Goods and Services Tax (GST).

³⁷ Jacobs 2014, *Jacobs Asset Closure Cost Estimate Guideline [Rev 0]*, Document Number ANZ-WI-1325

³⁸ Unassessed

Report on Future Options For Rehabilitating the Hazelwood, Yallourn and Loy Yang Mines in the Latrobe Valley



Estimate Compilation

The cost estimate is based on the rehabilitation works being delivered by a single contractor in three separate contracting periods (short, medium and long term) with associated mobilisation and demobilisation costs included. All indirect costs and contingency allocation have been excluded.

Risk Controls and Activities

Risk controls and activities to address each risk issue – as presented within the Final Report (refer to section 8.2.2.1) – have been included within the cost estimates.

Rehabilitation Measures

Rehabilitation measures have been adapted from Jacobs rehabilitation cost database and assigned to relevant risk controls and activities within the cost schedules for each option at each mine.

Duplication of cost items across risk controls and risk issues have been removed. These have been identified within the cost estimates for each potential viable option at each mine.

Quantities

Quantities have been established against rehabilitation measures for units of measure presented in Appendix E. Quantities have been sourced from information provided by Inquiry, available within the public domain or developed by suitable qualified Jacobs' personnel.

Quantities are presented within the cost estimate and are based on current assumed conditions and do not account for projected life of mine landforms, although the potential for current Work Plans to encompass specific proposed activities with respect to bulk civil works has been assumed.

Labour

Labour rates have been developed and allocated to the cost estimate with distributable factors assigned to the base rate. Labour rates applied include base salary, overtime, labour on cost, location allowances, travelling and all other relevant labour costs, related to the completion of the works. Rates used in the cost estimate are based on internal similar projects undertaken within the East Coast of Australia and are current as of Quarter 3 2015. The breakdown of the rate is provided in **Table 10-4**.

Table 10-4 Breakdown of Labour Rate

| Component | Operator Rate (\$/hr) |
|--|-----------------------|
| Base Rate – Labourer/Operator | \$89.00 |
| Distributable Costs – Labourer/Operator | \$112.14 |
| Total Labour Rate – Labourer/Operator | \$201.14 |

The labour rate is subject to distributable costs to cover the following:

- Supervision: project managers, occupational health, safety and environment (OHS&E) personnel, project engineers and supervisors;
- All travel and accommodation costs based on FIFO roster according to AGAA site regulations;
- Working calendar is a 21/7 day fortnight, 55 working hours/week;
- All insurances;
- All OHS&E requirements;
- Small tools costs; and
- Contractor's profit margins and overhead.

Report on Future Options For Rehabilitating the Hazelwood, Yallourn and Loy Yang Mines in the Latrobe Valley



Equipment Costs

Equipment costs used to develop the rates have been based upon Jacobs' internal database.

Unit Rates

Costs for rehabilitation are based on closure 'crews' comprising labour and equipment costs developed from Jacobs existing in-house database. Each crew corresponds to a particular rehabilitation measure.

Within each estimate, the crew costs have been summarised against each of the rehabilitation measures for reference. The costs identified within each of the estimates are reflective of the quantities and haulage distances required to complete those tasks.

Site Specific Assumptions

Selected assumptions and exclusions regarding site specific implementation of identified risk controls, activities and measures are presented within the Final Report appendices (refer Appendices E1, E2, E3, E4, E5, E6, E7, E8 and E9). Additional assumptions forming the basis for cost development are included in the following tables.

Table 10-5 Yallourn Assumptions

| Element | Value |
|--|-------------------|
| Total pit depth | 95m |
| Partial Backfill below the Water Table pit depth | 66m |
| Angle of repose | 37 ⁰ |
| Batter angle | 18.4 ⁰ |
| Partial Backfill below the Water Table pit perimeter | 6,994m |
| Semi-permeable cover layer depth | 2m |
| Pit floor area | 202ha |

Table 10-6 Hazelwood Assumptions

| Element | Value |
|--|-------------------|
| Total pit depth | 120m |
| Partial Backfill below the Water Table pit depth | 64.5m |
| Angle of repose | 37 ⁰ |
| Batter angle | 18.4 ⁰ |
| Partial Backfill below the Water Table pit perimeter | 8,815m |
| Semi-permeable cover layer depth | 2m |
| Pit floor area | 836ha |

Table 10-7 Loy Yang Assumptions

| Element | Value |
|--|-------------------|
| Total pit depth | 200m |
| Partial Backfill below the Water Table pit depth | 104.5m |
| Angle of repose | 37 ⁰ |
| Batter angle | 18.4 ⁰ |
| Partial Backfill below the Water Table pit perimeter | 7,158m |
| Semi-permeable cover layer depth | 2m |
| Pit floor area | 248ha |