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J.2 Final Land Use and Rehabilitation Plan

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FINAL LAND USE AND REHABILITATION PLAN

New Acland Coal Mine Stage 3 Project

JANUARY 2014

Contents

1. Introduction

1.1. Project Description

New Acland Coal Pty Ltd (NAC) currently operates the New Acland Coal Mine (Mine), as a 4.8 million tonnes (product coal) per annum (Mtpa) open cut coal mine on Mining Lease (ML) 50170 and ML 50216, adjacent to Mineral Development Licence (MDL) 244, under the approval of Environmental Authority (EA) No. EPML00335713. The Mine is forecasted to deplete its reserves by 2017. The revised Project involves the extension and operation of the Mine, increasing production from 4.8 Mtpa up to 7.5 Mtpa of thermal product coal.

The revised Project involves the extension of the Mine's operating life to approximately 2029 with the inclusion and progressive development of two new resource areas within the area covered by MDL 244, now also covered by Mining Lease Application (MLA) 50232. These resources areas are termed the Manning Vale and Willeroo resource areas. The revised Project will include mining in three new mine pits, namely, the Manning Vale West, Manning Vale East and Willeroo mine pits.

The revised Project will comprises the following key components:

- continuation of existing mining activities to progressively extend to parts of the Manning Vale and Willeroo resource areas within MLA 50232, located to the south and west of current MLs 50170 and 50216;
- production of up to 7.5 Mtpa of product coal equating to approximately 14 Mtpa Run-of-Mine (RoM) coal;
- production of up to 80.4 Mt of product coal over the life of the revised Project;
- maintenance of the existing thin seam coal mining equipment, continuation of the current open cut mining techniques and expansion of the truck and loader mining fleet;
- progressive disposal of coarse rejects to cells within the overburden dumps, along with fine tailings being disposed of in In-Pit Tailings Storage Facilities (ITSFs);
- emplacement of two out-of-pit spoil dumps associated with the Manning Vale and Willeroo mine pits; and
- generation of three depressed landforms at the end of mining by backfilling and re-profiling final mine pits.

The key infrastructure requirements for the revised Project involve:

- upgrade of the existing Coal Handling and Preparation Plant (CHPP) complex, RoM and product coal stockpile areas and supporting infrastructure on ML 50170;
- continued use of tailings disposal within ITSFs located in-pit on ML areas;
- continued use of recycled water from the Wetalla Wastewater Reclamation Facility supplied from Toowoomba via an approved 45 km pipeline that is currently fully operational;
- continued use of a mine surface water management system involving various water management structures staged to accommodate the progressive development of the Mine and based on the principles of diverting clean water and capturing and reusing water from disturbed areas;

- upgrades to the existing administration and heavy vehicle maintenance area on ML 50170;
- relocation and potential upgrade of the current power supply for the mine operation and the local 11kV distribution system;
- diversion of the Jondaryan-Muldu Road around the Manning Vale resource area;
- decommissiong of the Jondaryan Rail Loadout Facility (JRLF);
- construction of a new 8 km rail spur line and balloon loop from Jondaryan onto MLA 50232;
- construction of the Train Loadout Facility (TLF) within MLA 50232; and
- relocation and potential upgrade of the existing local telecommunication network.

In addition, the key features of the revised Project will include the:

- development of a suitable 'off set' strategy to satisfy State and Federal requirements for clearance of significant vegetation within new operational areas (i.e. extent of surface rights areas) on MLA 50232;
- preservation of historical items within Acland;
- comprehensive progressive rehabilitation program involving continuous monitoring and reporting in line with the agreed post mining land use; and
- amendment of NAC's existing EA commensurate to the revised Project's size and scope.

The main physical elements of the revised Project are shown in Figure 1-1.

1.2. Statutory Background

NAC's mining activities within MLs 50170 and 50216 are currently authorised under EA No. EPML00335713. Currently, conditions attached to EA No. EPML00335713 require that a Final Land Use and Rehabilitation Plan (FLURP) be developed and implemented under the Mine's Plan of Operations. The FLURP includes

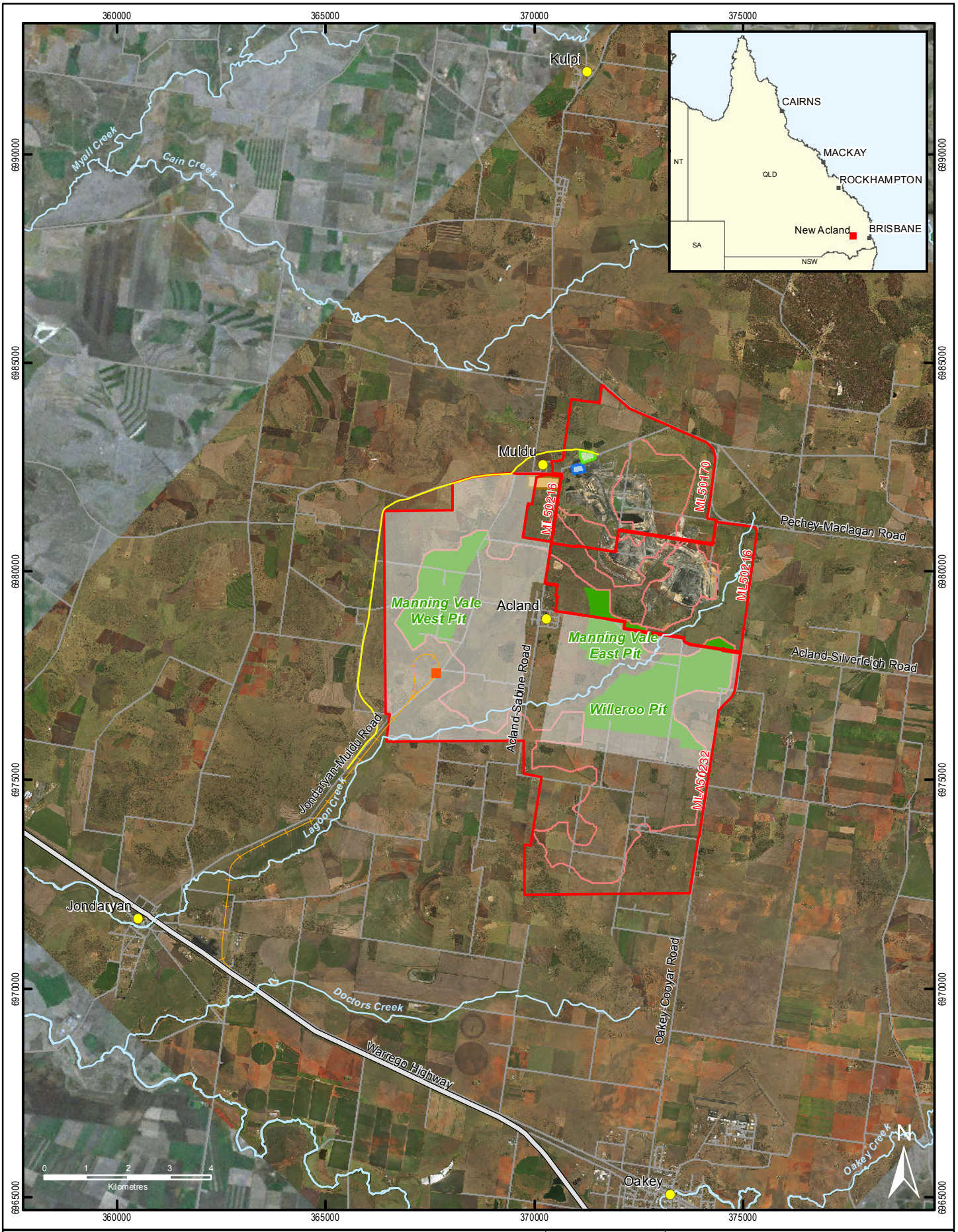
- a description of disturbance type and area;
- pre and post mining land descriptions for all disturbance areas;
- an assessment of pre and post mining capability;
- methodology for the selection of analogue sites, including actual location and descriptions of the analogue sites chosen;
- a description of rehabilitation management techniques incorporating works programs and timetables, monitoring methods and timeframes;
- a framework for the preparation of rehabilitation progress reports; and
- a description of indicators for success.

As part of the revised Project, NAC is amending its current EA No. EPML00335713 for MLs 50170 and 50216 to allow the incorporation of new mining activities within the surface rights areas of MLA 50232. As a result, NAC has updated the FLURP to integrate the revised Project.

1.3. Scope

This document represents the new FLURP for the current Mine (MLs 50170 and 50216) and the revised Project (MLA 50232) and is designed to provide NAC's long term rehabilitation management strategy for its mining activities. NAC has produced a number of accompanying documents that support or complement the FLURP that include topsoil management, final landform design and nature conservation.

The FLURP will be administered as an accompanying document to the Plan of Operations and may be updated from time to time based on advances in rehabilitation techniques, changes to the proposed mining activities; new legal requirements that may arise from statutory or other changes, and/or the correction of accidental omissions/errors.



LEGEND

- Towns and Localities
- Train Loadout Facility
- Rail Spur
- Roads
- Creeks
- Jondaryan-Muldu Road Diversion
- Proposed Extent of Surface Rights Area
- Coal Resource Area
- Mining Tenements
- Stage 3 Pit Areas
- CHPP Precinct
- Material Handling Facility
- Mine Industrial Area

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NEW ACLAND COAL MINE STAGE 3 PROJECT

Figure 1-1 - Revised Project Overview

Scale 1:120,000 on A4
Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 18/09/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\FLURP\130918_NewHope_FLURP_Figure1-1_ProjectOverview.mxd

1.4. Area and Type of Disturbance

1.4.1. Mining Sequence – Mine

The Mine is a truck and shovel operation with excavators mining the overburden and partings, and loaders mining the thin partings and the coal. The coal is transported to the Run-of-Mine (ROM) Pad for processing, with the waste rock material dumped out-of-pit for the box-cut then eventually back in-pit to progressively fill the void behind the operating pit.

A strip mining process based on a block extraction system is employed at the Mine to allow the blending of different quality coals to meet product specification. To provide adequate coal access and to provide opportunities for coal blending, an average of six consecutive blocks operate at any one time. Block size will be typically 150 by 150 metres, which facilitates the blending of different quality coals to meet product specification.

During 2012, mining operations progressed from the North Pit to the adjacent Centre Pit and continued in the South Pit. Mining will progress in both the Centre Pit and the South Pit at the 4.8 Mtpa combined product coal production rate until all reserves have been mined during 2018. The Central Pit's waste rock material is currently being used to backfill the final void of the North Pit, which ceased coal extraction during 2012.

The Centre and South Pits' voids will be backfilled during the progression of the revised Project. The Centre Pit will be used for tailings disposal. While the South Pit will be backfilled with spoil from the revised Project's Manning Vale East Pit and will also be used for coarse reject disposal.

1.4.2. Mining Sequence – Revised Project

Following the successful grant of MLA 50232 during 2015, NAC estimates that approximately 2.5 years will be required to complete design, construction and other related activities that facilitate the continuation of mining. The proposed length of the construction period is governed by external rail developments which influence the rate of product coal transportation off-site. Table 1-1 outlines an indicative schedule for mining related activities within MLA 50232. The construction phase for the revised Project involves the increase in the mining fleet and workforce, construction of supporting infrastructure and development of the new resource areas.

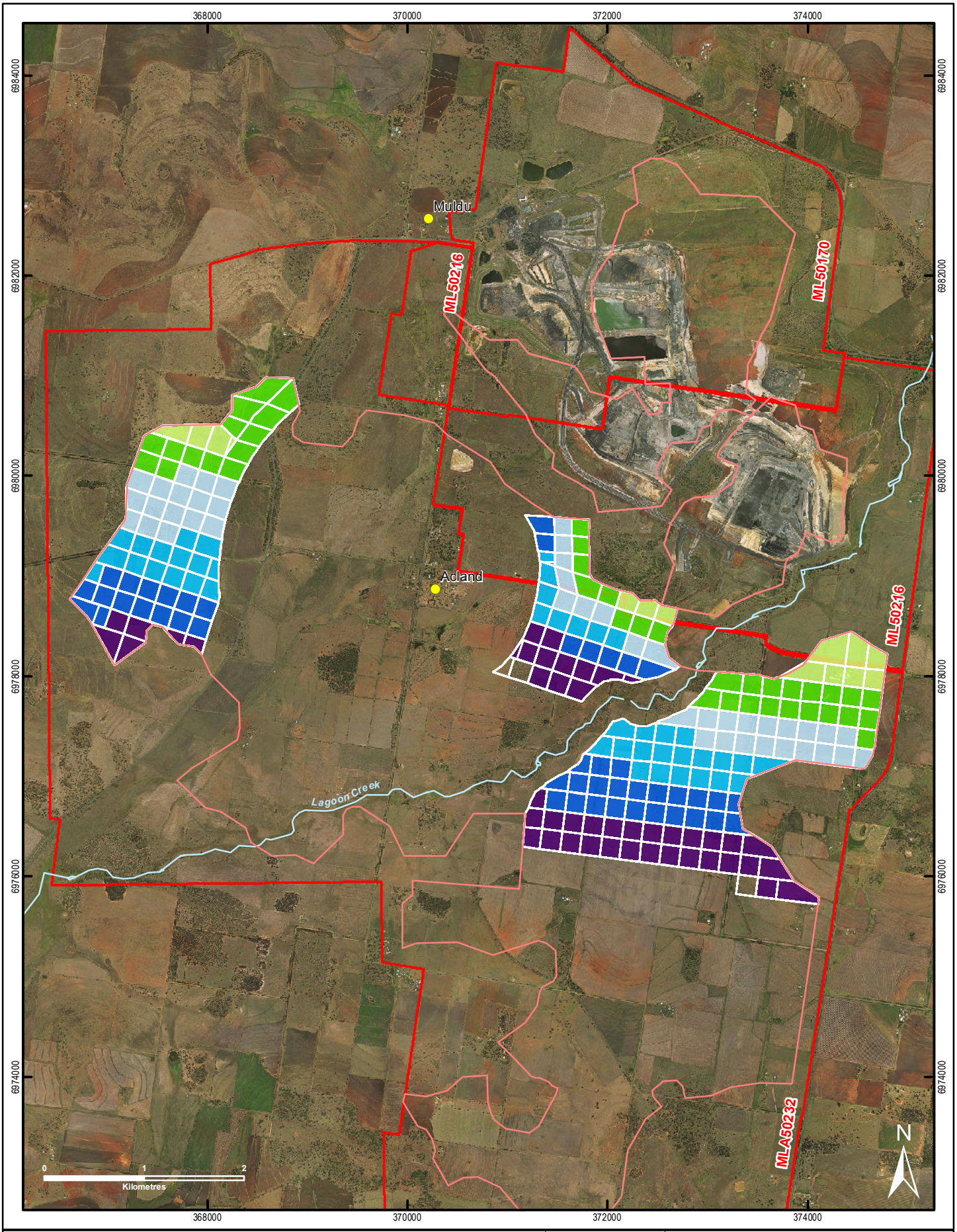
NAC will be responsible for all mining activities within the revised Project site. In line with current practices, NAC may employ contractors for specialist mining activities, such as blasting. All mining and construction activities will be conducted in compliance with the *Coal Mining Safety and Health Act 1999*.

Table 1-1 Indicative Schedule for Mining related activities on MLA 50232

Year	Activity
2015	Environmental and mining approvals (Commonwealth & State)
2015-2017	Cultural Heritage clearance Road closure applications Construction of the rail spur from Jondaryan and a balloon loop within the mining lease Construction of site access and roads (including re-alignments) Construction of water management structures Construction of the additional supporting infrastructure Gradual employment of additional workers
2015	Mining commences within the Manning Vale East reserve area (box-cut

Year	Activity
	construction) within ML 50216
2016	Mining commences within the Manning Vale West reserve area (box-cut and out-of-pit dump construction) within ML 50232
2016	Mining commences within the Willeroo reserve area (box-cut and out-of-pit dump construction) within MLs 50216 and 50232

The life of mine schedule is outlined in Figure 1-2. The life of mine schedule has been modified to allow an exclusion zone around Acland, increase the buffer distance from Oakey and to avoid disturbance of Lagoon Creek, Figure 1-3 provides the proposed conceptual final landform including the locations of the elevated landforms (former out-of-pit spoil dumps) and the depressed landforms (former residual voids). NAC's mine plan for the revised Project has been developed to minimise equipment capital expenditure and operational mining costs, particularly at start-up, and to maximise the net project value over the life of the revised Project.



LEGEND

- Towns and Localities
- Mining Tenements
- Coal Resource Area
- Creeks

Year

- FY2017-18
- FY2019-20
- FY2021-22
- FY2023-24
- FY2025-26
- FY2027-29

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Figure 1-2 - Life of Mine Schedule

Scale 1:50,000 on A4
Projection: Australian Geodetic Datum - Zone 56 (AGD84)

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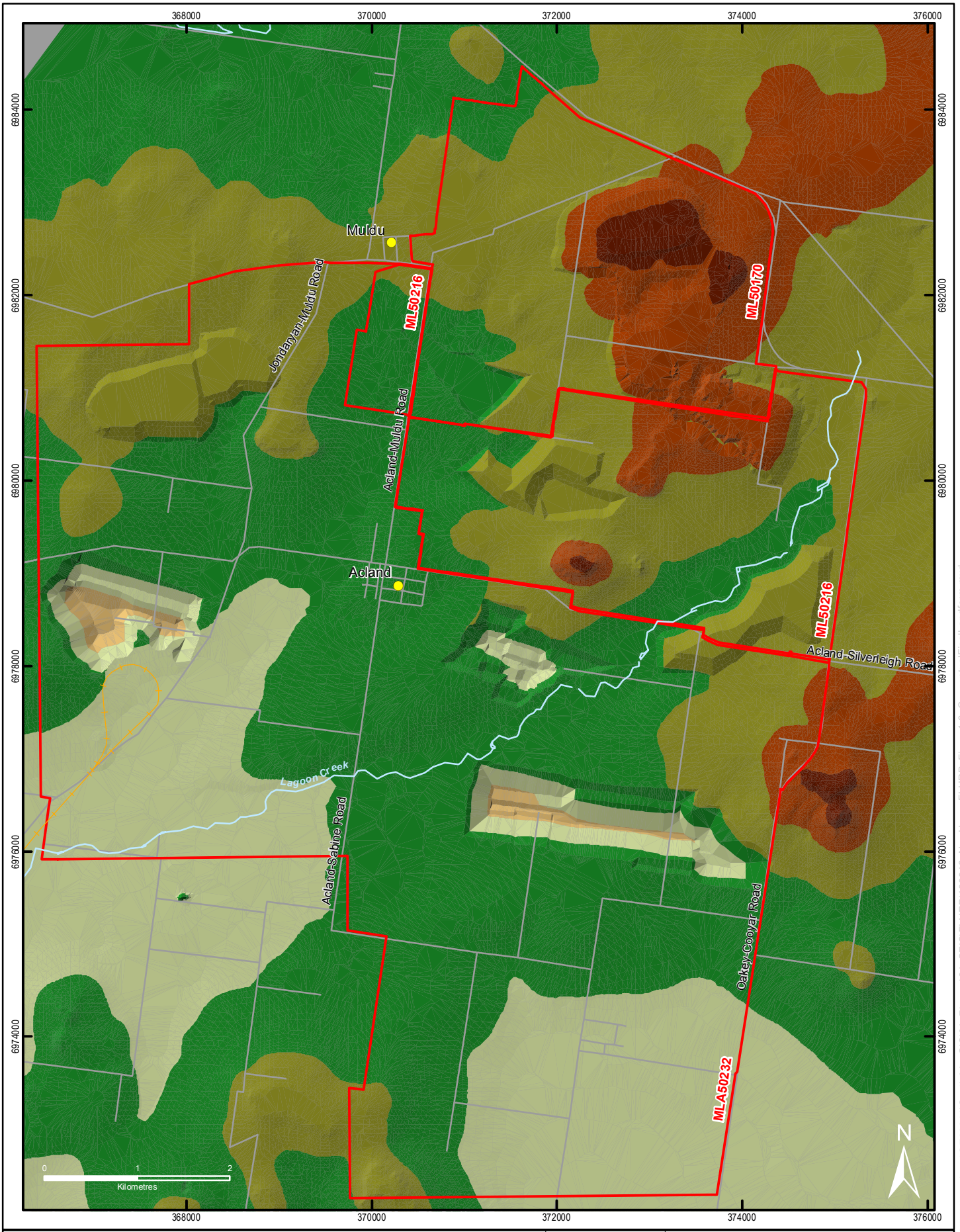

LEGEND

- Towns and Localities
- Rail Spur
- Roads
- Creeks
- Mining Tenements

Elevation

- 604 - 636
- 573 - 604
- 542 - 573
- 511 - 542
- 480 - 511
- 449 - 480
- 417 - 449
- 386 - 417
- 355

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Figure 1-3 - Conceptual Final Landform

Scale 1:54,000 on A4

Projection: Australian Geodetic Datum – Zone 56 (AGD84)

Produced: 18/09/2013 Path: I:\QENV2\Projects\QE06644\Spatial\ArcGIS\01_Figures\01_SEIS\FLURP130918_NewHope_FLURP_Figure1-3_ConceptualFinalLandform.mxd

2. Soils

2.1. Background

Significant soil investigations have been completed for the Mine and revised Project and are reported in detail in the New Acland Coal Mine Stage 2 Expansion – Environmental Impact Statement (SKM 2006) and New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013), respectively. Earlier soil surveys were also completed in 1996 and 1999 for impact assessment work commissioned by Shell Coal Australia Ltd.

The various survey efforts were designed to provide sufficient information on land resources to allow the determination of land suitability, available topsoil, soil erosion, rehabilitation potential and storm water runoff quality and to be consistent with the methods set out by Gunn et al (1988), Queensland DPI (1990), Shields and Williams (1991), DME (1995) and Isabell (1996). Advice on local production systems, land suitability and flood levels has also been obtained from local Department of Natural Resources and Mines (NRM) staff.

2.2. Soil Characteristics

Primary topsoil is the uppermost layer of soil used in site rehabilitation. It is salvaged from the surface horizons of areas to be disturbed, is relatively stable, contains seeds and micro-organisms and is relatively fertile. Secondary topsoil (if used) is placed directly in contact with waste rock and may be obtained from subsurface soil horizons, including weathered rock.

Topsoil was examined to determine its physical and chemical properties. The main chemical properties analysed included pH, electrical conductivity ($EC_{1:5}$), phosphorus and exchangeable sodium percentage (ESP). Physical properties such as permeability and drainage characteristics were inferred from soil profile morphological characteristics such as concretions, depth to rock, observed root depth, colour and mottling. Typical depths of primary and secondary topsoil were determined using DME (1995) guidelines, site data and experience with similar soil types used in the existing rehabilitation strategy for the Mine. A detailed soils assessment is presented in Chapter 4 of the EIS.

3. Land Suitability Assessment

3.1. Introduction

The methodology used to assess the Mine and revised Project site for land suitability for agriculture follows the guidelines established by the former Queensland Department of Primary Industries (DPI) Land Resources Branch (1990), which forms the basis of the *Land Suitability Assessment Techniques of the Department of Mines and Energy* (DME 1995). The revised Project site was assessed for suitability for dryland cropping and grazing land uses and assigned land suitability (LS) classes as outlined by Shields and Williams (1991) and DME (1995). The Mine and revised Project site was also assessed for GQAL in accordance with the *Planning Guidelines - the identification of Good Quality Agricultural Land* (DPI/DLGP, 1993). Agricultural land is defined as land used for crop or animal production, but excluding intensive animal uses. GQAL is land which is capable of sustainable use for agriculture, with a reasonable level of inputs, and without causing degradation of land or other natural resources.

The DPI/DLGP (1993) guidelines were introduced to provide local authorities and development proponents with a system to identify areas of good quality agricultural land for planning and project approval purposes. A summary of the relationship between Land Suitability and GQAL is included in Table 3-1.

Table 3-1 Scheme for Classifying Good Quality Agricultural Land and Correlations with Land Suitability Classes

GQAL Land Class	Land Suitability (Cropping)	Land Suitability (Grazing)	Description
A	1-3	1-3	Crop land - Land that is suitable for current and potential crops with limitations to production that range from none to moderate.
B	4	1-3	Limited crop land - Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
C1	5	1-2	Pasture land - Land that is suitable only for improved or native pastures due to limitations which preclude continuous cultivation for crop production; but some areas may tolerate a short period of ground disturbance for pasture establishment.
C2	5	3	Land suitable for native pastures.
C3	5	4	Land suitable for limited grazing of native pastures.
D	5	5	Non-agricultural land - Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

Source: DPI/ DLGP, 1993

The land suitability class for a land area is determined by the highest ranking limiting factor or a combination of a number of factors defined by DME (1995). Typically only the most severe two or three limiting factors would determine the land suitability and the remainder become irrelevant. The five-class system is based on physical and chemical limiting factors applied directly to specific uses and is described below:

- Class 1 - Suitable land with negligible limitations and is highly productive requiring only simple management practices;
- Class 2 - Suitable land with minor limitations which either reduce production or require more than simple management practices to sustain the use;
- Class 3 - Suitable land with moderate limitations which is moderately suited to a proposed use but which requires significant inputs to ensure sustainable use;
- Class 4 - Marginal land with severe limitations which make it doubtful whether the inputs required to achieve and maintain production outweigh the benefits in the long term; and
- Class 5 - Unsuitable land with extreme limitations that precludes its use.

The land suitability classification identifies limitations of the different soil types present and identifies suitable uses. Land suitability class is determined by the highest ranking limiting factor or a combination of a number of factors. Normally, only the most severe two or three limiting factors would determine suitability and therefore, the remainder become irrelevant. For this reason, only the major limiting factors determining suitability are presented. In this survey, the main limiting factors which determined dryland cropping and grazing suitability class include:

- plant available water capacity (m);
- water erosion (e);
- nutrient deficiency (n);
- salinity (s); and
- soil physical factors (p).

Further explanation of the main limiting factors for agricultural and pastoral production (i.e. dryland cropping and grazing) is provided in Appendix A. Detailed information on the land suitability assessments conducted for the Mine and revised Project are reported in detail in the *New Acland Coal Mine Stage 2 Expansion – Environmental Impact Statement (SKM 2006)* and *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*, respectively. A brief summary of the land suitability changes for the Mine and revised Project are provide in Sections 3.2 to 3.5.

3.2. Pre-mining Land Suitability – Mine

Table 3-2 provides a summary of the pre-mine land suitability assessments for dryland cropping over the Mine area.

Table 3-2 Land Suitability Classes for Dryland Cropping – Pre-Mining

Soil Group	Limitations	Suitability
Soils in upslope and midslope associated with basalt		
Shallow basaltic soils (clay loam and non cracking clay, outcrop soils)	m5, n2, r2-5, e2-5	5
Shallow and mid depth cracking clays on basalt	m3-4, n2, p2, k2, r1-2, e3	3-4
Red and black clays (basaltic influenced soils on colluvium or in situ sediments)	n2, p2, k2, r1-2, e3-4	3-4
Soils in upslope and midslope formed on sediments		
Reddish non cracking and lesser cracking clays on sediments	m2, n2-3, p2-3, k2, e3-4	3-4
Dark cracking clays on sediments (upper slopes)	m1-2, n2, p2, k2, sa1-2, e3-4	3-4
Soils in mid and lower slope		
Dark cracking clays on in situ sediments or colluvium (lower slopes)	m1-2, n2, p2, k2, w2, e3	3
Tight shallow surfaced duplex soils on deep colluvial material	m3, n3, p3-4, k3, w3, e3, f1-5	3, some 5
Alluvial clays in drainage ways	m2, n2, p2, k2, sa1-2, w2, e2, f4-5	5, some 4

2

Table 3-3 provides a summary of the pre-mine land suitability assessments for grazing over the Mine area.

Table 3-3 Land Suitability Classes for Grazing – Pre-Mining

Soil Group	Limitations	Suitability
Soils in upslope and midslope associated with basalt		
Shallow basaltic soils (clay loam and non cracking clay, outcrop soils)	m4-5, r1-5, e2-3	4-5
Shallow and mid depth cracking clays on basalt	m2-3, n2, p2, e1-2	2-3
Red and black clays (basaltic influenced soils on colluvium or in situ sediments)	n2, p2, e1-3	2-3
Soils in upslope and midslope formed on sediments		
Reddish non cracking and lesser cracking clays on sediments	n2, p2, e1-3	2-3
Dark cracking clays on sediments (upper slopes)	n2, p2, e1-3	2-3
Soils in mid and lower slope positions		
Dark cracking clays on in situ sediments or colluvium (lower slopes)	n2, p2	2
Tight shallow surfaced duplex soils on deep colluvial material	m2, n3, p2-3, w2, e2-4, f1-2	3-4
Alluvial clays in drainage ways	n2, p2, w2, e1-4, f1-2	2, some 4

3.3. Pre-mining Land Suitability – Revised Project

Table 3-4 shows the suitability classification for dryland cropping and grazing for each soil type within the revised Project site. The soils present within the revised Project site are generally suitable for cropping to varying degrees on the less steep areas and away from drainage lines. All soils are considered to be suitable for grazing on improved pastures with the exception of some on the upper slopes where steeper soil types exist.

Table 3-4 Major Limitations and Land Suitability Class – Pre Mining

Soil Type	DRYLAND CROPPING		GRAZING	
	Major Limitations and severity	Suitability class	Major Limitations and severity	Suitability class
A1	Plant water availability(2-3) Susceptibility to erosion(2) Soil physical factors(2) Salinity(2) Nutrient deficiency(2) Rockiness(1) Wetness(3) Flooding(1) Workability(2)	2	Plant water availability(2) Susceptibility to erosion(1) Soil physical factors(2) Salinity(2) Nutrient deficiency(1)	2
A2	Plant water availability(3-4) Susceptibility to erosion(2) Soil physical factors(3) Salinity(2) Nutrient deficiency(2) Rockiness(1) Wetness(2) Flooding(2) Workability(3)	3	Plant water availability(3) Susceptibility to erosion(2) Soil physical factors(2) Salinity(2) Nutrient deficiency(2)	3
A3	Plant water availability(5) Susceptibility to erosion(3) Soil physical factors(4) Salinity(2) Nutrient deficiency(3) Rockiness(1) Wetness(3) Flooding(2) Workability(3)	4	Plant water availability(4) Susceptibility to erosion(2) Soil physical factors(3) Salinity(2) Nutrient deficiency(2)	4
A4	Plant water availability(5) Susceptibility to erosion(3) Soil physical factors(3)	5	Plant water availability(4) Susceptibility to erosion(2) Soil physical factors(2)	4

Soil Type	DRYLAND CROPPING		GRAZING	
	Major Limitations and severity	**Suitability class**	**Major Limitations and severity**	**Suitability class**
	Salinity(2) Nutrient deficiency(3) Rockiness(2) Wetness(2) Flooding(2) Workability(2)		Salinity(2) Nutrient deficiency(2)	
A5	Plant water availability(2) Topography(5) Susceptibility to erosion(2) Soil physical factors(1) Salinity(1) Nutrient deficiency(1) Wetness(4) Flooding(4) Workability(2)	5	Plant water availability(1) Susceptibility to erosion(2) Soil physical factors(1) Salinity(1) Nutrient deficiency(1)	2
B1 B1v (steeper & shallow variants)	Plant water availability(2) Susceptibility to erosion(2-3) Soil physical factors(1) Salinity(1) Nutrient deficiency(1) Rockiness(1) Wetness(1) Flooding(1) Workability(1)	B1 – 2 B1v - 3	Plant water availability(1) Susceptibility to erosion(2) Soil physical factors(1) Salinity(1) Nutrient deficiency(1)	2
B2	Plant water availability(2) Susceptibility to erosion(2) Soil physical factors(1) Salinity(1) Nutrient deficiency(1) Rockiness(1) Wetness(1) Flooding(1) Workability(1)	2	Plant water availability(1) Susceptibility to erosion(1) Soil physical factors(1) Salinity(1) Nutrient deficiency(1)	1
B3	Plant water availability(4) Susceptibility to erosion(3) Soil physical factors(2) Salinity(3) Nutrient deficiency(2) Rockiness(1) Wetness(1)	4	Plant water availability(2) Susceptibility to erosion(2) Soil physical factors(1) Salinity(1) Nutrient deficiency(1)	2

Soil Type	DRYLAND CROPPING		GRAZING	
	Major Limitations and severity	Suitability class	Major Limitations and severity	Suitability class
	Flooding(1) Workability(1)			
B4	Plant water availability(4) Susceptibility to erosion(4) Soil physical factors(3) Salinity(2) Nutrient deficiency(2) Rockiness(1) Wetness(1) Flooding(1) Workability(1)	4	Plant water availability(3) Susceptibility to erosion(3) Soil physical factors(2) Salinity(1) Nutrient deficiency(1)	3
BA1	Plant water availability(1) Susceptibility to erosion(3) Soil physical factors(2) Salinity(2) Nutrient deficiency(1) Rockiness(1) Wetness(1) Flooding(1) Workability(1)	3	Plant water availability(1) Susceptibility to erosion(2) Soil physical factors(1) Salinity(1) Nutrient deficiency(1)	2
BA2	Plant water availability(2) Susceptibility to erosion(2) Soil physical factors(2) Salinity(1) Nutrient efficiency(1) Rockiness(2) Wetness(1) Flooding(1) Workability(1)	2	Plant water availability(1) Susceptibility to erosion(1) Soil physical factors(1) Salinity(1) Nutrient deficiency(1)	1
BA3	Plant water availability(5) Susceptibility to erosion(4) Soil physical factors(4) Salinity(1) Nutrient deficiency(2) Rockiness(3) Wetness(2) Flooding(1) Workability(5)	5	Plant water availability(3) Susceptibility to erosion(4) Soil physical factors(2) Salinity(1) Nutrient deficiency(1)	4

3.4. Post Mine Land Use Suitability – Mine

Factors influencing changes in land suitability include changed physical, chemical and biological properties of soil, changes in slope and slope length and changes in soil depth. The mining activities to occur on the Mine are expected to change the nature and hence suitability of the land for certain land use activities. This section will examine the implication of the changes on the suitability of areas for dryland cropping and cattle grazing.

The suitability of the waste rock dumps for dryland cropping and grazing is constrained by slope angle, the nature of soil cover, and altered moisture profile. These constraints would increase the risk of erosion significantly if dryland cropping were undertaken.

The plateau of the final waste dump landforms is not considered suitable for dryland cropping as it would require the replacement of a black cracking clay profile of approximately 900 mm depth and the installation of suitable soil conservation works, and that is considered not practical.

The erosion stability of the waste rock dump may present a severe to extreme limitation to sustainable grazing. Moisture availability for a 30 cm deep topsoil may also be a severe to extreme limitation.

3.4.1. Dryland Cropping

The pre and post mine areas of land suitability for dryland cropping is shown in Table 3-5.

Approximately 74% of the pre-mined area is suitability Class 3, and is suitable for dryland cropping (Table 3-5). This is consistent with existing land use although some potential dryland cropping land currently supports native pastures.

The post mining landscape has 50% of the area suitable for dryland cropping, a decrease of approximately 300 ha. In ML 50216 alone, the post mine area's land suitability will change to 100% within class 5 deeming it unsuitable for this land use practice. Overall, the post mine land suitability classes for dryland cropping of the area are unlikely to be suitable without extreme limitations.

Table 3-5 Pre and Post Mine Land Suitability – Dryland Cropping for the Mine

Land Suitability Class	Area within ML50216 (ha)		% of Total ML50216 Area		Area within Disturbance Footprint within ML50216 (ha)		% of Total ML50216 Disturbance Area	
	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining
1	0	0	0%	0%	0	0	0%	0%
2	0	0	0%	0%	0	0	0%	0%
3	856	549	74%	48%	307	0	72%	0%
4	100	33	9%	2%	68	0	16%	0%
5	199	573	17%	50%	50	425	12%	100%
Total	**1155**	**1155**	**1%**	**1%**	**425**	**425**	**1%**	**1%**

3.4.2. Grazing

The pre and post areas of land suitability for cattle grazing is shown in Table 3-6.

Table 3-6 Pre and Post Mine Land Suitability – Cattle Grazing for the Mine

Land Suitability Class	Area within ML50216 (ha)		% of Total ML50216 Area		Area within Disturbance Footprint within ML50216 (ha)		% of Total ML50216 Disturbance Area	
	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining
1	0	0	0%	0%	0	0	0%	0%
2	816	527	71%	46%	289	0	68%	0%
3	140	54	12%	5%	86	0	20%	0%
4	178	134	15%	12%	44	285	10%	67%
5	21	440	2%	37%	6	140	2%	33%
Total	**1155**	**1155**	**1%**	**1%**	**425**	**425**	**1%**	**1%**

Overall however, post mine land suitability for grazing is substantially greater than that for dryland cropping with over 50% of land deemed Class 3 or higher.

3.5. Post Mine Land Use Suitability – Revised Project

3.5.1. Dryland Cropping

Large areas considered suitable for sustainable dryland cropping were identified within the revised Project site. The pre and post mining areas of land suitability for dryland cropping are shown in Table 3-7. Approximately 31% of the pre-mined area is suitability Class 2 and approximately 23% of the pre-mined area is suitability Class 3, which are suitable for dryland cropping (Table 3-7).

The post mining landscape has 33% of the area suitable for dryland cropping, a decrease of approximately 1,062 ha. Overall, the post mine land suitability classes for dryland cropping of the area are unlikely to be suitable without extreme limitations.

Table 3-7 Pre and Post Mine Land Suitability – Dryland Cropping

Land Suitability Class	Area within revised Project site (ha)		% of revised Project site		Area within Disturbance Footprint (ha)*		% of Disturbance Area	
	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining
1	0	0	0%	0%	0	0	0%	0%
2	1558	757	31%	15%	801	0	55%	0%
3	1182	921	23%	18%	262	0	18%	0%
4	1729	2248	34%	44%	329	848	22%	58%
5	600	1143	12%	23%	73	616	5%	42%
Total	**5069**	**5069**	**100%**	**100%**	**1464**	**1464**	**100%**	**100%**

Note: * The disturbance footprint comprises the mining and infrastructure areas within the revised Project site.

3.5.2. Grazing

A return to grazing is entirely feasible for a majority of the revised Project site post-mining and would include most of the spoil areas and also the infrastructure areas. As indicated above some limitations are expected on elevated features such as out-of-pit dumps and tailings dams. The pre and post mining areas of land suitability for grazing is shown in Table 3-8.

Table 3-8 Pre and Post Mine Land Suitability – Grazing

Land Suitability Class	Area within Project site (ha)		% of Project site		Area within Disturbance Footprint (ha)*		% of Total Disturbance Area	
	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining
1	414	179	8%	4%	236	0	16%	0%
2	3042	1908	60%	38%	1134	0	77%	0%
3	1164	1964	23%	39%	48	848	3%	58%
4	449	1019	9%	20%	47	616	3%	42%
5	0	0	0%	0%	0	0	0%	0%

Land Suitability Class	Area within Project site (ha)		% of Project site		Area within Disturbance Footprint (ha)*		% of Total Disturbance Area	
	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining	Pre-mining	Post-Mining
Total	5069	5069	100%	100%	1464	1464	100%	100%

Note: * The disturbance footprint comprises the mining and infrastructure area within the revised Project site.

3.6. Good Quality Agricultural Land

The Toowoomba Regional Council (TRC) Planning Scheme shows that the Mine and revised Project sites are GQAL. GQAL has been identified on the land within the Mine and revised Project site and it is therefore subject to SPP 1/92. *The Planning Guidelines: The Identification of GQAL* (DLGP and DPI, 1993) has established four classes of agricultural land for Queensland as described in Table 3-10.

Table 3-9 Agricultural Land Classification

Class	Description
Class A Crop land	Land suitable for current and potential crops with limitations to production which range from non to moderate levels.
Class B Limited Crop Land	Land that is marginal for current and potential crops due to severe limitations; and suitable for pastures. Engineering and/or agronomic improvements may be required before the land is considered suitable for cropping.
Class C Pasture Land	Land suitable only for improved or native pastures due to limitations, which preclude continuous cultivation for crop production; but some areas, may tolerate a short period of ground disturbance for pasture establishment. Sub categories are as follows: • C1 Land suitable for improved pastures. In some circumstances may be considered as good quality agricultural land. • C2 Land suitable for native pastures. • C3 Land suitable for limited grazing of native pastures.
Class D Non-agricultural Land	Land not suitable for agricultural uses due to extreme limitations. This may be undisturbed land with significant habitat, conservation and/or catchment values or land that may be unsuitable because of very steep slopes, shallow soils, rock outcrop or poor drainage.

Source: DLGP and DPI, 1993

SPP 1/92 provides a framework for development to be assessed that considers the value of GQAL. The policy acknowledges that there will be developments that can legitimately alienate GQAL because they represent an overriding benefit to the community.

The Mine and revised Project are considered to provide the following overriding community benefits:

- it allows the utilisation of the coal resources of the State;
- it provides substantial employment within TRC area and elsewhere in Queensland;

- it allows the continuation and expansion of a locally significant industry that provides substantial export income to the State;
- it allows the continued utilisation of infrastructure associated with the existing New Acland Coal Mine; and
- there is no alternative location on land of lesser agricultural quality. The Project's location is dictated by the position of the coal reserves.

The Mine will disturb 425 ha of Class A GQAL land. MLA 50232 contains 2,740 ha of Class A GQAL land, 1,729 ha of Class B GQAL land and 600 ha of Class C GQAL land. Further information on GQAL is provided in in the *New Acland Coal Mine Stage 2 Expansion – Environmental Impact Statement (SKM 2006)* and *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

3.7. Erosion Hazard and Control

3.7.1. Erosion Hazard

Open cut mining activities involve land disturbance that can pre-dispose an area to erosion risks. Typical mining activities that require use of erosion mitigation strategies include:

- topsoil stripping ahead of mining development and for infrastructure development such as haul roads, hard stands and access tracks;
- drainage line crossings for pipes and roads;
- spoil dump placement, as spoil is a fractured mix of earthen fines that has a considerable erosion potential; and
- topsoil stockpiles.

3.7.2. Erosion Control

Progressive rehabilitation will be undertaken to stabilise disturbed areas as quickly as practical and to limit erosion. Erosion and sediment control measures will be employed, which are consistent with the practices described in the then Department of Minerals and Energy's, *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland,* (DME 1995).

The design parameters for the construction of erosion control work such as rock armoured or grass lined waterways will be in accordance with established principles for engineering and soil conservation earthworks. A number of variables are included such as time of concentration, rainfall intensity, erosivity, gradient, scour velocities and flow estimations.

The erosion control measures to be employed throughout the life of the Mine and revised Project are summarised in Table 3-11.

Table 3-10 Erosion Causes and Control

Area	Control Measure
Cleared Land	• restrict clearing to areas essential for the works • windrow vegetation debris along the contour • minimise length of time soil is exposed • divert run-off from undisturbed areas away from the works

Area	Control Measure
	• direct run-off from cleared areas to sediment dam
Exposed Subsoils	• minimise length of time subsoil is exposed • direct run-off from exposed areas to sediment dam(s)
Active Pit	• divert run-off from undisturbed areas away from pit • pump rainfall run-off from pit only to the environmental dams for future water recycling purposes or use directly from a sump for dust suppression purposes
Active Waste Rock Dump	• direct all run-off from dumps to sediment dams • avoid placement of sodic waste material on final external batters • control surface drainage to minimise the formation of active gullies
Rehabilitation	• recontour waste rock dumps progressively to landform criteria • install drainage control works • replace topsoil, rip on the contour and seed • direct run-off from rehabilitated areas to sediment dams
Infrastructure	• provide protection in drains (e.g. rip rap, grass) where water velocity may cause scouring • confine traffic to maintained tracks and roads • install sediment traps, silt fences and or hay bales where necessary to control sediment • rehabilitate disturbed areas around construction sites promptly

3.8. Strategic Cropping Land

The *Strategic Cropping Land Act 2012* (SCL Act) commenced on 30 January 2012, and therefore, only applies to the revised Project. The objectives of the SCL Act are to:

- protect land that is highly suitable for cropping;
- manage the impacts of development on that land; and
- preserve the productive capacity of that land for future generations.

The revised Project site is located within the Eastern Darling Downs Zone and within the Southern Protection Area, and therefore, mining operations may result in a permanent impact on Strategic Cropping Land (SCL). Importantly, the revised Project as a result of its statutory approval status is subject to the Transitional Provisions of the SCL Act, which nullify the requirement to demonstrate exceptional circumstances to justify the disturbance of SCL (i.e. under Section 94 of the SCL Act). However, projects subject to the Transitional Provisions are required to demonstrate avoidance and minimisation principles and/or mitigation of permanent impacts (where disturbance is unavoidable). As a result of the nature of mining activities, NAC will be required to mitigate its SCL impacts within the Study area.

In the future, NAC may undertake further soil surveys within the Study area to confirm the extent of 'Potential SCL/SCL' and the mitigation requirements. An assessment of areas to be disturbed by the revised Project against the provisions of the SCL Act will be made following the completion of the further soil surveys and a 'protection decision' will be sought from the NRM. Following completion of the statutory process for SCL, NAC will deliver its mitigation strategies for SCL as a separate program, and as a result, SCL matters are not addressed by this FLURP.

4. Post Mining Land Use & Rehabilitation

4.1. Introduction

Rehabilitation studies at New Acland Coal Mine have examined soils, landforms, the nature of waste materials, drainage and vegetation. These studies have demonstrated the successful use of conventional rehabilitation techniques on a range of materials mined at New Acland Coal Mine. The knowledge gained so far from the existing mining activities will be adapted and used in rehabilitation programs for continuation of the Mine and implementation of the revised Project.

Rehabilitation strategies for the Mine and revised Project will include all areas of disturbance and will be reviewed on a regular basis in order to take into account any changes to mine operations, changes in legislative requirements, results of on-going studies and monitoring and/or through the introduction of future innovations in rehabilitation techniques.

The rehabilitation strategies have been developed after consideration of the Technical Guidelines for the *Environmental Management of Exploration and Mining in Queensland (DME 1995)*. In particular, the following guidelines have been considered:

- *Land Suitability Assessment Techniques* – which addresses the applicability and use of land suitability assessment techniques in determining pre-mining land capability and post-mining land use potential;
- *Determination of Post-Mining Land Use* - which describes the identification and selection of suitable post-mining land use options;
- *Progressive Rehabilitation* - which describes the advantages of and opportunities and strategies for progressive rehabilitation;
- *Assessment and Management of Acid Drainage* – which addresses the identification, evaluation and management of solid waste materials with potential to generate acid drainage and/or heavy metal toxicity;
- *Open Pit Rehabilitation* - discusses the criteria to be applied in the design and rehabilitation of open pits having regard to geophysical aspects, sealing of strata, water accumulation and safety issues;
- *Erosion Control* – which addresses the prediction, control and measurement of soil erosion on mining lease areas;
- *Growth Media Management* – which outlines the selection, handling, storage, treatment and replacement of soils and other media to be used for establishing and growing vegetation on land following mining;
- *Minesite Decommissioning* – which addresses the closure and decommissioning of areas, works and facilities used for mining, including the TSF;
- *Site Water Management* – which discusses the management of water on mine sites so as to reduce the amount of contaminated water that may need to be handled; and
- *Water Discharge Management* – which addresses the management of water discharged from mine sites to ensure compliance with statutory requirements and protection of downstream uses.

4.2. Rehabilitation Principles and Hierarchy

The overriding principle for the rehabilitation program at the Mine and revised Project is that the land should be returned to a post-mine land use that will be stable, self-sustaining and will only require maintenance commensurate with the proposed final land use. The post-mine land use for areas disturbed by mining at the Mine and revised Project will be a self-sustaining vegetation community using appropriate pasture (exotic) and native grasses and scattered plantings of native tree and shrub species. The attainment of this land use will stabilise the landform, protect the downstream water quality and ensure an economic level of pastoral production is achieved by the Acland Pastoral Company (APC) post mining.

4.3. Post-mining Rehabilitation Goal

The main rehabilitation goal is to achieve the proposed final land use of grazing within the Mine and revised Project site by:

- creating stable rehabilitated landforms that are safe to humans and wildlife and are non-polluting;
- ensuring rehabilitated landforms can support sustainable grazing activities;
- implementing and monitoring measurable standards to assess the success of rehabilitated landforms to the agreed grazing post-mining land use;
- ensuring progressive rehabilitation of disturbed land over the life of mine to minimise the amount of land disturbed at any one time and to reduce the rehabilitation burden prior to mine closure; and
- achieving regulatory approval for surrender of the mining tenements to allow complete mine closure.

4.4. Strategies to achieve the Main Rehabilitation Goal

The rehabilitation strategies for each of the four main disturbance domains of solid waste disposal areas (spoil, waste dumps, reject dumps), tailings dams, mine infrastructure areas and linear infrastructure for the Mine and revised Project sites are summarised in Table 4-1. The rehabilitation acceptance criteria proposed later in the report relates to all four domains as they are classified as “disturbed by mining” and will receive the same rehabilitation treatment. For example, tailings emplacements will be capped with mine spoil then, topsoiled and seeded. Once the tailings areas are capped with mine spoil they will receive a similar treatment to other areas of mine spoil/waste dumps etc.. Mine and linear infrastructure areas will generally not require spoil placement or capping but receive topsoil and seeding treatments similar to the solid waste disposal and capped tailings dams.

Table 4-1: Strategies to achieve the Rehabilitation Goals

Domain	Rehabilitation Goals			
	Safe	Non-Polluting	Stable landform	Sustains Agreed Land Use
Solid Waste Disposal	Structurally safe (geotechnically stable). No hazardous materials (geochemically	Minimise erosion through adequate vegetation cover. Runoff and seepage controlled by water	Place wastes above and below original ground level to the agreed slopes. Establish adequate	Return to previous use (grazing)

Domain	Rehabilitation Goals			
	Safe	Non-Polluting	Stable landform	Sustains Agreed Land Use
	benign).	management (e.g. dams).	vegetation cover.	
Tailings Dams	Structurally safe (geotechnically stable). Adequate capping.	Adequately capped. Minimise erosion through adequate vegetation cover. Runoff and seepage controlled by water management.	Stored both in pits below natural surface level and in dams above natural surface. Establish adequate vegetation cover.	Return to previous use (grazing)
Mine Infrastructure areas	Hazardous materials removed.	Remediate contamination so that runoff and seepage are of good quality.	Remove infrastructure or allow continued use of useful infrastructure. Establish adequate vegetation cover.	Return to previous use (grazing)
Linear Infrastructure areas	Structurally safe (geotechnically stable).	Runoff and seepage controlled by water management (e.g. dams). .	Remove infrastructure rip reshape and revegetate or allow continued use of useful infrastructure	Return to previous use (grazing)

4.5. Post Mining Land Use

The proposed post-mine land use for disturbed areas for the Mine and revised Project will be grazing, using native and pasture (exotic) grass species combined with smaller areas of local native tree and shrub species. This nominated land use will ensure that the land remains agriculturally productive, is consistent with the surrounding land uses, and can be re-incorporated into AGC's business.

4.6. Post Mining Land Form

The Mine and revised Project will change the land use and land suitability within those areas disturbed by mining activities. The primary design objective is the creation of stable final landforms that are compatible with the proposed final land use. NAC will use experience gained at New Acland Coal Mine and other New Hope Group (NHG) mines, specialist consultants and relevant research findings to meet this design objective.

Stable landforms will continue to be progressively established as part of the mining process using integrated mine planning and proven earthmoving techniques. The final slopes will be engineered to ensure geotechnical stability and designed to incorporate the required water management structures to manage storm runoff. Established topsoil and revegetation techniques will be applied to create a self-sustaining vegetation community cable of supporting grazing. A regular monitoring regime and grazing trial program will be

implemented to demonstrate rehabilitation success, guide maintenance activities and to develop a long term management regime.

The main disturbance areas requiring rehabilitation for the Mine and revised Project are:

- the out-of-pit waste rock dumps (elevated landforms) associated with the North, South, Manning Vale West and Willaroo Pits;
- the in-pit waste rock dumps at the North, Centre, South, Manning Vale East, Manning Vale West and Willeroo Pits;
- the out-of-pit tailings storage facility (TSF), west of the North Pit;
- the in-pit TSFs within the North and Centre Pits;
- dams not required by the background landowner; and
- infrastructure areas not required by the background landowner.

The Mine's proposed final voids will be backfilled by the existing mining operations or progression of the revised Project. The Central Pit's waste rock material will backfill the North Pit's final void. The Centre Pit's final void will be backfilled by tailings from the CHPP. While the South Pit's final void will be backfilled with waste rock material from the revised Project's Manning Vale East Pit and coarse rejects from the CHPP.

The revised Project's final voids will be reshaped to depressed landforms to ensure they can support the proposed final land use of grazing. NAC has produced a *Final Landform Technical Report (SKM 2013)* that outlines the methodology behind the development of the depressed landforms. The *Final Landform Management Report (SKM 2013)* is provided as an Appendix for the *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

The revised Project's out-of-pit dumps (elevated landforms) will be rehabilitated using 10 m lifts on external dump faces, with a maximum working dump lift height of 30 m. Each new out-of-pit dump will be recontoured from angle of repose slopes to a range of 8.5 degrees to 17 degrees (15% to 30%) depending on operational circumstances. The *Final Landform Technical Report (SKM 2013)* provides further details on the rehabilitation of out-of-pit dumps (elevated landforms).

NAC manages the operation and rehabilitation of its in-pit and out-of-pit TSFs via specific management plans and is required to report annually on the performance of these structures to the Regulatory Authority until they are rehabilitated. In general, these structures are capped with a benign material, topsoiled and seeded with native pasture (exotic) grass species. As a contaminated land requirement, these structures are registered on the Environmental Management Register (EMR) under the *Environmental Protection Act 1994* and will require a long term site-based management plan at the time of mine closure.

Contour banks are constructed after final profiling of the final landforms to control rainfall run-off. The contour banks are designed and constructed to reduce slope length. Run-off is conveyed along the contour banks to a rock-lined waterway or onto natural ground, and then to a sediment dam. Surface run-off from all disturbed areas will pass through sediment dams to reduce the levels of suspended solids. The sediment dams normally discharge to an environmental dam before eventual discharge off site. Water in the environmental dams is recycled to minimise the potential for off-site discharge.

4.7. Rehabilitation Strategy

NAC's rehabilitation strategy relies on the progressive rehabilitation of areas disturbed by mining using a range of proven techniques that include:

- appropriate pre-disturbance preparation, such as a topsoil management plan and integrated mine planning to efficiently coordinate mining activities;
- implementation of practical landform designs to prevent erosion and establish long term geotechnical stability;
- identification of an appropriate post-mine land use consistent with local environmental constraints;
- avoiding the placement of sodic/dispersive materials near the surface of the dumps or within the plant root zone;
- appropriate management of the final TSF waste, including capping with benign waste rock, revegetation to form a stable cover to resist erosion and establishment of a long term site based management plan;
- revegetation trials for selection of appropriate revegetation species and methodologies and development of a long term management regime;
- progressive rehabilitation of disturbed areas using appropriate rehabilitation procedures;
- a rehabilitation monitoring program to assess rehabilitation success against accepted performance indicators; and
- a corrective action program to address areas of substandard rehabilitation.

4.7.1. Progressive Rehabilitation

A progressive rehabilitation program will continue to be implemented for the Mine and revised Project and will be administered by each Plan of Operations. Progressive rehabilitation will commence as soon as possible when areas become available within the operational land.

The main features of the progressive rehabilitation process are:

- construction of waste dumps in 10 m lifts on external dump faces, with a maximum working dump lift height of 30 m;
- development of a stable slope design that incorporates appropriate water management structures (e.g. contour banks, etc.);
- use of suitable topsoil, which will either be stockpiled until recontoured areas are available or respread immediately across available recontoured areas;
- contour ripping to water promote infiltration and minimise run off;
- seeding with an appropriate seed mix (grass, shrub and tree species) prior to the commencement of the wet season to maximise the benefits of subsequent rainfall;
- application of appropriate fertiliser or other soil ameliorants for plant establishment if required; and

- the battering down of final void slopes to create depressed landforms that can safely support the proposed final land use.

The Mine area will possess an approximate total disturbance footprint of 425 ha (i.e. as originally planned). The revised Project site will possess an approximate total disturbance footprint of 2,030 ha. Table 4-2 provides the proposed disturbance types and areas for the revised Project. An indicative rehabilitation schedule for the Mine and revised Project is shown in Table 4-3.

NAC's planned progression of mining activities and the development of its conceptual final landforms may be influenced a range of external factors (e.g. changes to the annual mining rate).

Table 4-2 Disturbance Types – Revised Project

Type of Disturbance	Disturbance Area (Ha)
Mining Areas	921
Elevated Landforms	314
Depressed Landforms	621
Mine Infrastructure	174
Total	2,030

4.7.2. Topsoil Management

NAC has developed a *Topsoil Management Plan (SKM 2013)* for the Mine's and revised Project's topsoil management to ensure leading practice in this critical aspect of rehabilitation. The *Topsoil Management Plan (SKM 2013)* is administered and implemented as a key component of the FLURP, and is provided as an Appendix to the *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

In general, suitable topsoil will be stripped from each of the Mine's and revised Project's new disturbance areas for subsequent use in the rehabilitation program. The topsoil will be stripped as defined by the soil surveys and will either be stockpiled until suitable re-contoured areas are available for rehabilitation purposes or directly returned immediately across the areas to be rehabilitated. The topsoil resources present are more than adequate for the rehabilitation of the waste rock dumps and other disturbed areas.

4.7.3. Revegetation

NAC's revegetation methods for all types of mine disturbed land normally consist of the following practices:

- respreading stockpiled or freshly stripped topsoil;
- contour ripping;
- application of appropriate fertiliser for plant establishment, after soil chemical analysis, if required;
- seeding with an appropriate seed mix.

Competent materials such as basalt may be placed on steeper slopes to aid stability. Contour ripping is used to improve infiltration and reduce mechanical impedance for tree root establishment. This action is normally undertaken immediately after surface preparation

and before revegetation. A seed mix containing native and pasture (exotic) grass and local native shrub and tree species is used to establish a sustainable vegetation cover in a one-pass operation.

The revegetation of mined areas is normally occur prior to the commencement of the wet season (October-December) to maximise the benefits of subsequent rainfall or following the heat of Summer (February-March) – this practice occurs at the existing operations.

4.7.4. Rehabilitation Maintenance

Rehabilitated areas will be monitored in order to identify any areas in need of maintenance. Rehabilitated areas that have not achieved the designated acceptance criteria will be repaired.

Supplementary plantings or seeding may be used to increase species diversity and/or groundcover. Maintenance work will be performed to repair any areas exhibiting excessive soil erosion. If problem areas occur, they will be investigated to determine the reason for substandard rehabilitation and to identify appropriate methods for repair.

4.7.5. Acland Pastoral Company – Rehabilitation Support

The land associated with the Mine and revised Project is predominately owned by the APC, including the majority of the land within Acland. APC was formed during 2006 to productively manage the agricultural land acquired to support the Mine and the implementation of the revised Project. The main focus of APC's activities is to manage agricultural activities on company land both ahead and behind the revised Project's mine path.

This joint land management approach by NAC and APC allows continued agricultural production pre and post mining, which contributes to a more sustainable outcome and ensures that there is an economic imperative as well as environmental and social imperatives driving the revised Project's rehabilitation success. APC also assists NAC with specific rehabilitation management activities, such as general revegetation advice, grazing trials, offset establishment trials, offset management, and weed and pest management.

4.7.6. Grazing Trials

NAC is currently undertaking a formal long term grazing trial within a rehabilitate area of the North Pit's Elevated Landform on ML 50170 at the Mine. This grazing trial includes slope areas and will involve a comparison process with an analogue site in the vicinity of the Mine. The grazing trial program is being managed by the APC and will involve a formal study and report by a professional third party agricultural consultancy and local university. This grazing trial program will be a continuous process with new areas progressively added to the original trial area each year. The grazing trial program will be expanded to include the revised Project's rehabilitation areas designated for grazing. NAC believes the grazing trial program will be a critical assessment tool for demonstrating long term success of its grazing based rehabilitation for the revised Project's future mine closure and mining lease surrender requirements.

From an operational perspective, NAC will use the grazing trial:

- to assess the success of the current rehabilitated area in relation to the performance of cattle growth (beef production);
- to evaluate current rehabilitation practices from a final land use perspective; and

- as required, to develop new rehabilitation strategies to improve rehabilitation and long term grazing performance.

Longer term, the APC will also use this information to develop appropriate land management plans for NAC's former mined land within both the current Mine and the revised Project site. NAC is confident from the current grazing trial process and the grazing activities conducted at the NHG's West Moreton mining operation that it can demonstrate with full scientific rigor that the revised Project's constructed landforms will be able to support grazing (beef production) as the proposed final land use in a long term sustainable manner.

4.7.7. Decommissioning

A Life of Mine (LoM) Plan has been developed for New Acland Coal Mine (including the revised Project). This LoM Plan helps to inform the mine closure planning process and establishes a basis for final landform design and management. The LoM Plan will be continuously revised based on economic, geological and engineering factors. In addition, this LoM Plan will be used to guide the day-to-day operational activities (i.e. to guide medium and short term mine planning). As a result of this continuous planning process a competent Mine Closure Plan will be prepared towards the end of the revised Project's life. This approach is consistent with industry leading practice.

A Mine Closure Plan will be submitted to the Regulatory Authority at least five years prior to the proposed surrender of New Acland Coal Mine's environmental authority and associated mining tenure. The implementation of the Mine Closure Plan will be through the Plan of Operations.

On the completion of mining activities, infrastructure will be treated as follows:

- mine roads will be left behind for use as farm roads or if not required, rehabilitated;
- water dams will remain if required by the relevant landowner and approved by regulators, otherwise, they will be rehabilitated;
- buildings, plant and equipment will be removed and the surface rehabilitated, including the CHPP, workshop, offices, storage tanks and material handling facility and train loadout facility;
- concrete pads will be covered with benign waste rock, topsoiled and revegetated or removed and disposed to the nearest landfill;
- contaminated land management will be completed as required under the Environmental Protection Act 1994;
- all TSFs will possess a competent final cover system; and
- the final voids remaining at the end of the mine life will be battered down to form depressed landforms to support the proposed final land use.

A Final Rehabilitation Report and Environmental Audit Statement will be produced as a statutory requirement of the surrender process for environmental authorities and their associated mining tenures.

4.8. Rehabilitation Timetable

Cumulative indicative rehabilitation targets are given in Table 4-3. Scheduling and reporting of rehabilitation is outlined in each Plan of Operations. Changes and updates to the mine plan and rehabilitation schedule will be made through the Plan of Operations process.

Table 4-3 Cumulative Indicative Rehabilitation Targets – Mine and revised Project

Production Year	Rehabilitated Area (ha)	Cumulative Area Rehabilitated (ha)
To Date	NA	507
2014-15	100	607
2016-17	112	719
2018-19	234	952
2020-21	241	1,193
2022-23	233	1,426
2024-25	146	1,572
2026-27	156	1,728
2028-29	142	1,870
>2030	886	2,756
Total	**2,249**	**2,756**

5. Selection and Description of Analogue Sites

5.1. Methodology for Selecting Analogue Sites

Analogue sites were selected to represent Grazing Land Suitability Classes 2, 3, 4 and 5. Analogue sites are used as a means of providing a baseline to which future land use rehabilitation can be measured against to prove success. The sites are intended to represent a typical example of that Land Suitability Class and provide an opportunity for meaningful monitoring to continue into the future. No replication of previous survey work was required because of the substantial body of information available in relation to soil properties, landscapes, land classes and productivity.

5.2. Description of Analogue Sites

5.2.1. Land Suitability Class 2 - Grazing

The analogue site chosen for Land Suitability Class 2 was located in an area of dark cracking clays on in situ sediments or colluvium (lower slopes). This soil mapping unit is representative of Class 2 Grazing Lands. Table 5-1 describes the current vegetation cover across the Class 2 analogue site and Photograph 5-1 illustrates the typical vegetation found across the transect.

Table 5-1: Class 2 Analogue Site Description - Grazing

Class 2						
Location: 0375262, 6981253						
Sub plot	1	2	3	4	5	Average
% Grass Cover	5	10	10	40	20	17
%Herb/forb Cover	25	40	10	10	30	23
Total Cover	30	50	20	50	50	40

Photograph 5-1 Typical Transect Vegetation Class 2 – Grazing

5.2.2. Land Suitability Class 3 - Grazing

The analogue site chosen for Land Suitability Class 3 was located in an area of tight shallow surfaced duplex soils on deep colluvial material on a lower-mid slope. Table 5-2 describes the current vegetation cover across the Class 3 analogue site and Photograph 5-2 illustrates the typical vegetation found across the transect.

Table 5-2: Class 3 Analogue Site Description - Grazing

Class 3						
Location: 0375384, 6981253						
Sub plot	1	2	3	4	5	Average
% Grass Cover	0	5	5	5	30	9
%Herb/forb Cover	40	25	45	20	40	34
Total Cover	40	30	50	25	70	43

Photograph 5-2 Typical Transect Vegetation Class 3 - Grazing

5.2.3. Land Suitability Class 4 - Grazing

The analogue site chosen for Land Suitability Class 4 was located in an area of Shallow basaltic soils (clay loam and non-cracking clay, outcrop soils). Table 5-3 describes the current vegetation cover across the Class 4 analogue site and Photograph 5-3 illustrates the typical vegetation found across the transect.

Table 5-3: Class 4 Analogue Site Description - Grazing

Class 4						
Location: 0372169, 6979878						
Sub plot	1	2	3	4	5	Average
% Grass Cover	50	65	15	80	70	56
%Herb/forb Cover	0	0	0	0	0	0
Total Cover	50	65	15	80	70	56

Photograph 5-3 Typical Transect Vegetation Class 4 - Grazing

5.2.4. Land Suitability Class 5 - Grazing

The analogue site chosen for Land Suitability Class 5 was located in an area of Shallow basaltic soils (clay loam and non-cracking clay, outcrop soils) Table 5-4 describes the

current vegetation cover across the Class 4 analogue site and Photograph 5-4 illustrates the typical vegetation found across the transect.

Table 5-4: Class 5 Analogue Site Description - Grazing

Class 5						
Location: 0372272, 6979261						
Sub plot	1	2	3	4	5	Average
% Grass Cover	1	15	30	15	5	13.2
%Herb/forb Cover	59	35	5	15	45	31.8
Total Cover	60	50	35	30	50	45

Photograph 5-4 Typical Transect Vegetation Class 5 - Grazing

5.2.5. General Summary – Analogue Sites

Table 5-5 provides a general summary of the each sites location and biophysical details.

Table 5-5 Location and Biophysical Attributes of Analogue Sites

Location		**Biophysical Attributes**	
Land Suitability Class	Geographic Coordinates	Vegetation Cover	Grass Species Diversity
2	27 o 18’ 10S, 151 o 42’ 31E	40%	4
3	27 o 18’ 18S, 151 o 42’ 27E	43%	3
4	27 o 17’ 10S, 151 o 44’ 25E	56%	2
5	27 o 18’ 07S, 151 o 42’ 14E	45%	2

6. Proposed Rehabilitation Acceptance Criteria

6.1. Review of Major Research Projects

6.1.1. Sustainability Indicators for Coal Mine Rehabilitation

This research project was completed under the Australian Coal Association Research Program. The research project's objectives were to:

- monitor the long-term impact of open cut mine rehabilitation on erosion and water quality under natural rainfall conditions;
- evaluate physical and biophysical indicators for sustainable rehabilitation;
- use the monitoring sites as an educational resource; and
- promote outcomes from the study to the industry and the wider community.

In particular, this research assessed runoff, erosion and water quality from rehabilitated land at Curragh, Goonyella Riverside and Oaky Creek mines at two scales - plot (0.01ha) and catchment (0.4ha to 0.9ha) - and three slope gradients - 10 percent, 20 percent and 30 percent. Pasture and tree vegetation treatments were imposed on topsoil and spoil materials and a number of topsoil and spoil plots at each site were left bare to compare with the vegetative treatments.

The research project found that pasture cover is the preferred indicator of rehabilitation sustainability and stability, and topsoil is the more suitable material for vegetation establishment on rehabilitated land. The use of topsoil and pasture cover produced the least runoff, sediment and soluble salt transport. A minimum 50 percent ground cover should be attained for erosion control.

Pasture establishment on spoil was poor at all mine sites, especially where the spoil was hard setting and dispersive. Annual erosion rates from spoil remained unacceptably high throughout the study.

The key findings of this research are as follows.

- Rainfall is the major limiting factor associated with successful rehabilitation. It is critical that pasture cover is established rapidly in order to maximise rainfall infiltration.
- A rehabilitated landscape is at greatest risk of erosion before grass cover is established. The greatest risk of erosion occurs before vegetative growth reaches 50 percent ground cover.
- Pasture establishment to 50 percent cover should be a minimum target indicator for coal mine rehabilitation. Further increases in pasture cover (greater than 80 percent) and biomass are required to reduce erosion rates on 30 percent slopes to negligible levels.
- Topsoil erosion rates declined between slopes once a dense sward of grass cover established (greater than 80 percent cover).
- Vegetative cover reduces the risk of salt movement on-site and off-site through runoff.
- The development of a hard dispersive crust on the spoil material reduced infiltration, produced very poor pasture and tree establishment and resulted in unacceptably high runoff and erosion.

- Surface ripping of slopes greater than 20 percent should be used to improve infiltration and reduce runoff and erosion losses.
- Supplementary irrigation should be used to assist rapid pasture establishment during periods of low rainfall.

6.2. Proposed Rehabilitation Acceptance Criteria - New Acland Coal Mine

6.2.1. Grazing Land

Proposed rehabilitation acceptance criteria have been developed to monitoring the progress of rehabilitation efforts for the Project. Drawing on the findings of Grigg, Emmerton and McCallum (2007) it is considered appropriate to focus on several key criteria to determine rehabilitation success, namely:

- Vegetation cover, measured as a percentage;
- Species diversity, determined from analogue sites;
- Slope;
- Erosion status;
- Absence of declared plants (weeds);
- Exchangeable Sodium Percentage (ESP) (as a measure of soil dispersion);
- Cation Exchange Capacity (CEC) (as a measure of nutrient availability); and
- Root Zone Salinity (RZS).

Vegetation cover, species diversity, slope angle, erosion status and the absence of declared weeds have been incorporated into the acceptance criteria in Table 6-1. Exchangeable Sodium Percentage (ESP), Cation Exchange Capacity (CEC) and Root Zone Salinity (RZS) have been incorporated into the monitoring and reporting framework outlined in Section 7.

Table 6-1 and Table 6-2 illustrate the proposed rehabilitation acceptance criteria for all areas disturbed by mining. The acceptance criteria does not apply to conservation zone areas within the Mine and revised Project as these are covered separately in the *Conservation Zone Management Plan (SKM 2013)*, which is provided as an Appendix of the *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

Table 6-1: Proposed Rehabilitation Acceptance Criteria – Grazing Lands

Land Suitability Class	Acceptance Criteria – Grazing Land						
	Non-polluting	Stability and Sustainable Land Use					
	Active Rill/Gully Erosion	Vegetation Cover [1]	Native and Exotic Grass Species Diversity (sp./ha) [2]	Slopes [3]	Geotechnical Stability	Active Rill/Gully Erosion	Declared Weeds
2	absence	= or > 50%	= or > 4	8.5°-17°	stable	absence	absence
3	absence	= or > 50%	= or > 4	8.5°-17°	stable	absence	absence
4	absence	= or > 50%	= or > 4	8.5°-17°	stable	absence	absence
5	absence	= or > 50%	= or > 4	8.5°-17°	stable	absence	absence

- Vegetation covers at analogue sites with a Land Suitability Class of 4 & 5 were the highest at 45% and 56% respectively (page 42). As most post-mining land will be class 4 & 5, an average of the higher vegetation covers in classes 4 & 5 (50%) were included across all land suitability classes
- This criteria is the highest diversity value found at only 1 of the 4 analogue sites (page 42), however it has been added to all land suitability classes in the acceptance criteria
- This criterion has been developed separately from experience at the Mine (i.e. demonstrated geotechnical stability). Slope will be designed from 8.5° to 17° (15% to 30%) but consideration will be given to the lower slope angles. Further information can be located in the *Final Landform Management Report (SKM 2013)* that accompanies *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

Table 6-2: Proposed Rehabilitation Acceptance Criteria – Treed Areas (generally <5%)

Land Suitability Class	Acceptance Criteria – Grazing Land Treed Areas						
	Non-polluting	Stability and Sustainable Land Use					
	Active Rill/Gully Erosion	Vegetation Cover (incl. tree/shrub canopy) [1]	Native Tree/shrub & Native/Exotic Grass Species Diversity (sp./ha) [2]	Slopes [3]	Geotechnical Stability	Active Rill/Gully Erosion	Declared Weeds
2-5	absence	= or > 50%	Eucalyptus sp. = or >2 Acacia sp. = or >2 Other tree/shrub sp. = or >2 Grass = or > 3	8.5°-17°	stable	absence	absence

1) This criteria is an average from analogue sites.

2) The majority of the rehabilitated land will be returned to grazing with exotic pastures established. Where pockets of trees/shrubs have been established the diversity criteria will apply taking into account the limited diversity of some remnant communities near the mine.

3) This criteria has been developed separately from experience at the Mine (i.e. demonstrated geotechnical stability). Slope will be designed from 8.5° to 17° (15% to 30%) but consideration will be given to the lower slope angles. Further information can be located in the *Final Landform Management Report (SKM 2013)* that accompanies *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

6.3. Seed Mix

Example seed mixes for the Grazing Lands and Treed Areas are included in Table 6-3 and Table 6-4. The seed mixes will be modified over time as species suitability/success and seeding rates are monitored and assessed.

Table 6-3 Example Seed Mix – Grazing Lands

Botanical Name	Common Name	Seeding rate (kg/ha)
Cynodon dactylon	Green Couch	2.0
Chloris gayana	Katambora Rhodes Grass	5.0
Echinochloa utilus*	Japanese Millet	3.0
Panicum coloratum	Bambatsii Panic	3.0
Panium maximum	Gatton Panic	4.0

Table 6-4: Example Seed Mix – Treed Areas

Botanical Name [1]	Common Name	Seeding rate (kg/ha)
Angophora costata spp costata	Smoothbark Apple	0.3
Allocasuarina littoralis	Black She-Oak	0.3
Casuarina cristata	Belah	0.3
Eucalyptus crebra	Narrow Leaf Ironbark	0.3
Eucalyptus melanophloia	Silver-leaf Ironbark	0.3
Eucalyptus orgadophylla	Mountain Coolabah	0.3
Alphitonia excelsa	Red Ash	0.2
Geijera parviflora	Wilga	0.3
Acacia leiocalyx	Black Wattle	0.2
Acacia salicina	Sally Wattle	0.2

Botanical Name [1]	Common Name	Seeding rate (kg/ha)
Acacia stenophylla	River Cooba	0.2
Acacia harpophylla	Brigalow	0.2
Senna artemisiodes	Silver Cassia	0.2
Dodonaea viscosa	Sticky-hop Bush	0.2
Cynodon dactylon	Green Couch	1.0
Bothriochloa decepiens	Pitted Blue Grass	2.0
Bothriochloa bladhii	Forest Blue Grass	2.0
Dicanthium sericeum	Qld Blue Grass	2.0
Echinochloa utilus*	Jap Millet	2.0

1) Species have been derived from the flora survey undertaken for the New Acland Coal Stage 2 EIS.

7. Reporting Framework

7.1. Monitoring of Rehabilitation Works

At the commencement of rehabilitation works in a new area, permanent photograph points will be established and delineated with a star picket or similar. The geographic location and bearing of the photograph should be recorded using GPS. This point will form the start of a permanent monitoring site. This will be an on-going process over the life of the Mine and revised Project.

7.2. Annual Rehabilitation Reports

An Annual Rehabilitation Report will be submitted to the Regulatory Authority with each Annual Return. This report will be qualitative and comprise a pictorial display of new rehabilitation areas and any significant rehabilitation events over the 12 months in older rehabilitation areas. The Annual Rehabilitation Report will include the following:

1) a summary description of visual monitoring for active rill/gully erosion within the first 12 months after seeding and after heavy rainfall events;

2) photographs of the new rehabilitation areas from permanent photographic points;

3) a summary record of treatments used, including seeding rates, soil treatment, topsoil source; and

4) a summary description of any failure of rehabilitation works and maintenance conducted or proposed to be conducted for these areas.

7.3. Revegetation Monitoring Program

Formal revegetation monitoring will be conducted by a competent person and will occur every two years. New rehabilitation areas will be added as necessary (i.e. dependant on establishment success which may be affected by rainfall, seedling establishment and other seasonal factors). This formal monitoring regime will apply to Mine areas and the revised Project from adoption of this FLURP (i.e. following replacement of the Mine's previous FLURP), and will continue until all rehabilitation works are deemed successful at New Acland Coal Mine for surrender of the associate mining tenure.

It is proposed that rehabilitation will be monitored every two years until success has been achieved. During this monitoring the revegetation will be compared against the success criteria proposed in Table 6-1 (general grazing areas) and Table 6-2 (treed areas within grazing areas). The following information will be collected for rehabilitation areas during the biennial monitoring visits:

1) photographs of existing and new rehabilitation areas from permanent photographic points;

2) record to treatments used for each new rehabilitation, including seeding rates, soil treatment, topsoil source;

3) botanical description of the rehabilitation area, including percentage cover and species diversity;

4) selective measurement of ESP, CEC and RZS;

5) presence and abundance of weed species;

6) landform monitoring, including slope angle, contour bank spacing, waterways, presence/absence of active rill/gully erosion; and

7) any failure of rehabilitation works and maintenance conducted or proposed to be conducted for these area.

7.4. Identification of Remedial Works

Remedial works may be required at a number of stages during the rehabilitation process, including the following actions.

Soil remediation may be required prior to the seeding/planting of rehabilitation areas. This requirement will be based on the soil type, stripping depths applied, and if applicable, the residence time in storage.

Failure to achieve the desired levels of vegetation cover and species diversity will require supplementary seeding and/or planting.

Weed infestation will require treatment to an appropriate standard or as defined by legislation.

Erosion damage may require repair depending on the level of severity. The potential for erosion will be controlled by the establishment of a good ground cover (i.e. >50%) and through the correct design of water management structures.

8. Protected Ecological Areas

8.1. Overview

To enhance the ecological outcomes of the Mine and revised Project and to address Commonwealth and State statutory requirements, NAC has committed to the implementation and management of a number protected ecological areas that will form part of the final land use for the former mined and surrounding lands. These matters are managed separate of the FLURP and are briefly summarised in Sections 8.2 to 8.5.

8.2. Conservation Zone

For the Mine and revised Project, NAC has committed to a conservation zone over Bottle Tree Hill and 50 metres either side of Lagoon Creek to protect and enhance ecologically significant areas of remnant vegetation not to be mined and to promote restoration of the Lagoon Creek riparian zone. To manage these ecologically significant areas NAC has produced a *Conservation Zone Management Plan (SKM 2013)*, which is provided as an Appendix to the *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*. In general, the *Conservation Zone Management Plan (SKM 2013)* delineates the ecological significant areas to be protected and provides a structured approach to enhance the revegetation of these ecological significant areas using a mix of techniques, involving natural regeneration, direct seeding and planting of seedlings.

8.3. Blugrass Offset Management Area

The revised Project has been deemed a 'controlled action' under the *Environmental Protection and Biodiversity Conservation Act 1999* for the Matters of National Environmental Significant: 'threatened species and communities'. In relation to threatened ecological communities, the revised Project will impact *Dichanthium sericeum* (Queensland Bluegrass) based grasslands, and as a result, NAC is planning to establish an offset area on APC owned land adjacent to the revised Project.

NAC has prepared a *Bluegrass Offset Management Plan (SKM 2013)* (Appendix J.8) which outlines the methodology for establishing and managing a *Dichanthium sericeum* based grassland community. Key aspects of the BOMP include the revegetation and management goals/objectives, offset area details, planned revegetation techniques, rehabilitation acceptance criteria, a monitoring and reporting regime, a maintenance regime for weeds and poor establishment and a comprehensive long term management regime. The *Bluegrass Offset Management Plan (SKM 2013)* is provided as an Appendix to the *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

8.4. Threatened Species Translocation Area

The revised Project has been deemed a 'controlled action' under the *Environmental Protection and Biodiversity Conservation Act 1999* for the Matters of National Environmental Significant: 'threatened species and communities'. In relation to threatened ecological communities, the revised Project will disturb a number of scattered patches of the threatened/protected species, *Homopholis belsonii* (Belson's Grass), which are mainly located within road reserves. NAC intends to transplant all threatened/protected species endangered by the revised Project's activities.

As a result, NAC has produced a *Threatened Species Translocation Plan (SKM 2013)* that includes transplantation and management goals/objectives, site details, a propagule collection and propagation strategy, planned transplantation techniques, transplantation success criteria, a monitoring and reporting regime, a maintenance regime for weeds and

poor establishment and a comprehensive long term management regime. The *Threatened Species Translocation Plan (SKM 2013)* is provided as an Appendix to the *New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013)*.

8.5. Biodiversity Offset Strategy

NAC has produced a Biodiversity Offset Strategy for the revised Project to address the Commonwealth and State statutory ecological requirements. The Biodiversity Offset Strategy references the management of the *Dichanthium sericeum* based grassland community and the threatened/protected species, and outlines the third party offset strategy for the remaining Commonwealth and State base ecological matters (i.e. Endangered Regional Ecosystems dominated by *Acacia harpophylla* (Brigalow) and dominated by *Eucalyptus populnea* (Poplar Box)).

NAC's Biodiversity Offset Strategy is provided in Appendix I of the New Acland Coal Mine Stage 3 Project – Environmental Impact Statement (SKM 2013).

9. References

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Sinclair Knight Merz (2013) Topsoil Management Plan

Sinclair Knight Merz (2013) Final Landform Technical Report

Sinclair Knight Merz (2013) Conservation Zone Management Plan

Sinclair Knight Merz (2013) Threatened Species Translocation Plan

Sinclair Knight Merz (2013) Bluegrass Offset Management Plan

Appendix A: Major Limiting Factors to Agricultural and Pastoral Production

Plant Available Water Capacity (m)

Plant available water capacity (PAWC) is the quantity of moisture stored in the soil profile that is available to a plant for uptake. The PAWC is a significant soil parameter as much of the cash cropping within the revised Project site is based on fallow storage of moisture within the soil profile. Table shows the criteria proposed for the assessment of the moisture availability limitation for crops.

Table A-1: PAWC Criteria for Assessing Cropping Limitations (Shields and Williams (1991))

Limitation Level	Dryland Cropping PAWC (mm)	Grazing PAWC (mm)
1	>150	>125
2	130-150	100-125
3	90-130	75-100
4	70-90	50-75
5	<70	<50

Source: QDPI, 1991

In the survey, PAWC for soil groups was assessed from site specific chemistry using effective rooting depth estimations developed in accordance with Harris et al (1999). Effective rooting depth and PAWC estimations were further refined from observed field morphology. Field morphology observations and chemical data used included the presence of hardpans, bleaching, soil texture, barriers to root growth such as high sodium, gravel, poor soil structure, high electrical conductivity and chloride.

PAWC suitability estimates and limitation levels for soils within the revised Project site are shown in Table A-2. These results indicate that most soil types have a reasonable to very good soil water storage potential.

Table A-2: Estimated PAWC and Limitation Levels

Soil Type	Est. effective rooting depth (cm)	PAWC (mm)	Available plant moisture limitation (m)	
			Dryland cropping	Beef cattle grazing
A1	60 - 90	93 - 134	3	2
A2	50 - 60	85 - 95	4	3
A3	30- 60	70 - 90	4-5	3
A4	80 - 90	80 - 90	4	3
A5	60 - 80	110 -130	2	1
B1 B1 shallow variant	90+ 60 - 70	120-140 95 - 120	2 3	1 1/2
B2	90+	120 - 140	2	1
B3	30 - 50	65 - 82	4	3
B4	90+	130 - 142	2	1

Soil Type	Est. effective rooting depth (cm)	PAWC (mm)	Available plant moisture limitation (m)	
			Dryland cropping	Beef cattle grazing
Ba1	80 - 90	150 +	1	1
Ba2	50 - 60	120 - 140	2	1
Ba3	30-40	30 - 60	5	4/5

On a moisture availability basis, most soil types offer potential for dryland cropping apart from the sandy duplex A4 and the shallow basalt hills Ba3. High potential cropping soils include Ba1, Ba2, B1, B2 and A1. Other alluvial soils A2, A3, A4 and A5 in addition to B3 are more marginal for cropping.

Pasture production to achieve maximum output for grazing activities occurs in a shallower root zone than for cropping activities (QDPI, 1991). Limitation levels for grazing are also shown in Table A-2.

Susceptibility to Water erosion (e)

The risk of soil loss from water erosion magnifies with increased water velocity when the land is devoid of vegetation for cropping. The risk of soil loss has been assessed as low to moderate in the undulating softwood scrub and basaltic upland soils when limitation levels of 2 and 3 are applied. During the survey, some evidence of erosion was observed under a cropping regime, however it was not considered severe. Erosive effects could intensify under poorly managed cropping regimes based on the particular soil type.

Table A-3 summarises the general ratings for grazing activities (QDPI, 1991). Cropping limitation ratings were developed using the DME (1995).

Table A-3: Land Suitability for Grazing – Effects of Slopes

Limitation rating	1	2	3	4	5
Cracking clays	<3% slope	Slopes 3-6%	Slopes 6-9%	Slopes 9-15%	>15%
Sodic rigid soils	<1% slope	Slopes 1-3%	Slopes 3-6%	Slopes 6-12%	>12%

Source: DME 1995

Nutrient deficiency (n)

Nutrient limitations for grazing and rainfed cropping uses within the revised Project site were rated using the surface horizons analysis data collected from the survey (DME 1995). Shields and Williams (1991) state that a major limiting factor to pasture production in northern Australia is reduced pasture quality as a result of deficiencies in nitrogen and phosphorus. Other elements which also play key roles are potassium and calcium. Most clay soils within the revised Project site are not significantly limited by nutrient deficiency for cropping or grazing. Accordingly, no soil has attracted a major fertility limitation level, with three being the highest estimate assessed.

Salinity (s)

Salinity is described as the reduction in dry matter yield as a result of soluble salt in the soil profile. Salinity also contributes to reduced water availability limitation. Increasing salinity in the soil profile (below 50 cm) was evidenced across the old alluvial clay plains A1 to A4 and

the upland brigalow soils of B3. Most other soil types have no limitation from elevated salinity within the root zone.

Soil Physical Factors (p)

Physical factors refer to restrictions in the establishment and vigour of pastures as a result of soil surface condition and are typically related to size of surface aggregates which affects tendencies to seal and hardset. Only the hardsetting A4 soil has any significant limitation with respect to this limiting factor.

Agricultural Suitability Classes

Cropping lands in suitability classes 1 to 3 are considered well suited to that particular use as the benefits should outweigh the inputs required to initiate and maintain production. Suitability class 4 is marginal for crops based on the extent of inputs required to initiate production. Suitability class 5 has severe limitations based on the inputs required and therefore would not justify a cropping use.

Suitability classes 1 to 3 for grazing are considered suitable for significant pasture improvement. While suitability class 4 offers marginal potential for pasture improvement, suitability class 5 is not suitable for improvement and is therefore restricted to grazing of native pastures with low productivity.