Annual Environmental Management Report

2015

(SMALL MINE VERSION)

Enhance Place Mine

Prepared by: Enhance Place Pty Ltd

February 2016

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1 INTRODUCTION

1.1 BACKGROUND DEVELOPMENT

Enhance Place Pty Ltd (Enhance Place) was established in 1997 to recover remnant coal from areas previously open cut mined in the 1950's. A principle objective of Enhance Place was to provide the means to improve the appearance and general amenity of the land through the rehabilitation of land previously impacted by mining.

Enhance Place operated the Enhance Place Open Cut Coal Mine (Enhance Place Mine) from 1997 until its closure in June 2005 following the extraction of all economically feasible coal reserves.

The Enhance Place Mine is located in the Western Coalfields of NSW at Blackmans Flat, 15km north of Lithgow on the southern side of the Castlereagh Highway. The site is approximately 3km south-west of Mount Piper Power Station.

The Enhance Place Mine extracted coal over the abandoned Eastern Main Underground Mine workings (Eastern Main Mine). The Eastern Main Mine operated as a Board and Pillar mine until 1975. Mining activities were undertaken by six employees, being augmented for short periods by secondment of maintenance, operating or rehabilitation personnel from other areas of the contractor's operations as required.

When open cut operations ceased in June 2005 and since then, surface water control, rehabilitation of land-form with seeding and fertilisation, feral animal and weed control programmes have been implemented with final rehabilitation nearing completion.

During the 2015 reporting period, ongoing management of the site was undertaken in the form of targeted weed management and stock management.

1.2 MINE PRODUCTION, PRODUCT AND MARKET

The mine ceased production at the end of June 2005 when all coal reserves had been extracted. There was no coal production or active mining operations undertaken at Enhance Place during the 2015 reporting period. Details of production history are detailed in Table 1.

Table 1
Production History

Year	Production Total (Tonnes)
1998	73,632
1999	86,007
2000	77,804
2001	77,579
2002	77,109
2003	101,851
2004	89,000
2005	27,228
Total	**609,940**

2 TITLE DETAILS

Name of Mine	Enhance Place Mine		
Mining Titles/Leases	ML 1422	**Expiry Date**	03/12/2018
Mining Titles/Leases	ML 1458	**Expiry Date**	29/11/2020
Mining Titles/Leases	ML 1520	**Expiry Date**	29/08/2023
Name of Leaseholder	Enhance Place Pty Ltd		
Name of Mine Operator	As above		
Postal Address	Enhance Place Pty Ltd		
	PO Box 202		
	Wallerawang, N.S.W, 2845		
Telephone	(02) 6355 7893		
Fax	(02) 6355 7894		
Email	Graham.goodwin@energyaustralia.com.au		

2.1 LAND OWNERSHIP AND LAND USE BOUNDARIES

Land ownership of the Enhance Place Mine consists of private freehold and crown land. The current status of land ownership, tenure and pre-mining land use at the Enhance Place Mine is summarised in **Table 2** and shown on **Figure 1**.

Table 2
Land Ownership

Land Owner/Occupier	Lot/DP	Tenure (freehold leasehold)	Pre-mining land use
Mr & Mrs J. Cherry	301/751636	Freehold	Grazing
Mrs J. Cope	302/751636 303/751636	*Perpetual Lease*	Grazing
D & J Hunt	370/751651	Freehold	Grazing
State of NSW - Glen Davis Recreation Area (R. 59960)	304/751636 305/751636	Crown Land	Grazing
State of NSW	7004/1026541	Crown Land	Bush/grazing
M & L Morris	101/1145705	Freehold	Grazing

Figure 1
Land Ownership Plan

2.2 CONSENTS AND LICENCES

Local Council Area: Lithgow City Council Development Consent 36/99

Development Consent: granted [✓]

required but not granted [ ]

not required [ ]

Do licences granted by other agencies apply to the mine activities? Yes [✓] No [ ]

EPA	[✓] - EPL No.6312 surrendered 28/09/2005 after cessation of mining
NPWS	[N/A]
Dam Safety	[N/A]
Other	[N/A]

2.3 MOP AND AEMR PERIOD

MOP Commencement Date	31 May 2013	**Completion Date**	16 January 2017
AEMR Start Date	1 January 2015	**End Date**	31 December 2015

2.4 SIGNATURES

Mining Engineering Manager

Signature 

Name Graham Goodwin

Date 26.2.16

3 ACTIONS FROM 2014 AEMR

Action items from Trade and Investment Resources and Energy review of the Enhance Place 2014 AEMR and site inspection are as follows:

Item No.	*Issue/ observation*	*Action*	*Due Date*	Addressed in 2015 AEMR
5	*Addition of soil ameliorants across the rehabilitation sites have not been initiated*	*A Soil Amelioration Plan needs to be submitted to DRE detailing the process, timing and management for the soil amelioration that is to be undertaken.*	*31/12/15*	Section 5.1
6	*Enhance Place pasture showing poor results under the impacts of compaction and overgrazing by the landowners stock.*	*Provide DRE with a Stock Management Plan to accompany the soil amelioration management plan for this site.*	31/12/15	Section 5.2

4 MINING OPERATIONS DURING THE REPORTING PERIOD

There were no mining activities undertaken at the Enhance Place Mine during the reporting period as mining ceased on 29 June 2005.

Table 3
Production and Waste Summary

	Production and Waste (cubic metres)		
	Start of Reporting Period	**At end of Reporting Period**	**End of next reporting(estimated)**
Topsoil stripped	nil	nil	Nil
Topsoil used/spread	nil	nil	Nil
Waste Rock	nil	nil	Nil
Ore	nil	nil	Nil
Processing Waste	nil	nil	Nil
Product	nil	nil	Nil

5 REHABILIATION DURING THE REPORTING PERIOD

A summary of the disturbed and rehabilitated areas at the Enhance Place Mine is summarised in **Table 4**.

Table 4
Rehabilitation Summary

		Cumulative Area Affected (hectares)		
		To Date	**Last Report**	**Next Report (estimated)**
A: MINE LEASE AREA				
A1	**Mine Lease(s) area**	30.6	30.6	30.6
B: DISTURBED AREAS				
B1	**Infrastructure Area**	nil	nil	Nil
B2	**Active Mining Area**	nil	nil	Nil
B3	**Waste Emplacements**	nil	nil	Nil
B4	**Tailings Emplacements**	n/a	n/a	n/a
B5	**Shaped Waste Emplacement**	nil	nil	Nil
ALL DISTURBED AREAS		**nil**	**nil**	**Nil**
C: REHABILITATION PROGRESS				
C1	**Total Rehabilitated Area**	24.2	24.2	24.2
D: REHABILITATION ON SLOPES				
D1	**10 to 18 Degrees**	1.2	1.2	1.2
D2	**Greater than 18 Degrees**	0.5	0.5	0.5
E: SURFACE OF REHABILITATED LAND				
E1	**Pasture and Grasses**	21	21	21
E2	**Native Forest / Eucalypt**	1.2	1.2	1.2
E3	**Plantations and Crops**	nil	nil	Nil
E4	**Other**	2	2	2

Since mining ceased in June 2005 approximately 21 ha of the study area has been rehabilitated to pasture. Pasture was sown with *Cox's River Mix*, comprising:

- 40% Fescue;
- 25% Cocksfoot;
- 20% Subterranean clover;
- 6% Perennial rye grass;
- 5% White clover; and,
- 4% Phalaris.

An additional 1.2 ha has been planted with trees and shrubs.

5.1 ONGOING REHABILITATION MAINTENANCE

An agronomist was engaged by Enhance Place to inform development of quantitative rehabilitation completion criteria and provide advice and recommendations for pasture improvement strategies, including the addition of soil ameliorants for each of the rehabilitation domains at Enhance Place (refer **Appendix B**). The agronomist recommendations have been incorporated within the Care and Maintenance MOP, approved by DRE.

These recommendations are summarised below:

Enhance Place (Morris Property):

- Control of African Lovegrass and broadleaf weeds prior to pasture renovation
- Application of Muriate of Potash (MOP) (0.25 tonnes/ha) and Di-ammonium Phosphate (DAP) (0.20 tonnes/ha) and gypsum (3.0 tonnes/ha) to pasture areas.
- Implement stock management through time control or rotational grazing to allow each paddock to have a period of rest and growth.
- The ongoing rehabilitation maintenance works undertaken during the 2015 reporting period, including erosion control, tubestock planting, hydromulch application, seeding and weed control are presented in **Table 5** and **Table 6**.

Enhance Place (Crown Land):

- No remedial action required. Continue to monitor against agreed rehabilitation completion criteria.

Table 5
Maintenance Activities on Rehabilitated Land

Nature of Treatment	Area Treated (ha) 2014 Reporting period	Area Treated (ha) 2015 Reporting period	Comment/control strategies/ treatment detail
Additional erosion control works (drains re-contouring, rock protection)	0	2	Erosion control works on existing erosion channels within treed rehabilitation area. Installation of jute mesh sown with fast growing grass seeds (rye grass). Erosion control works undertaken on cracking occurring on crests of slopes adjacent to the treed rehabilitation area; and slope adjacent to the Castlereagh Highway. Repair of sediment basin wall subject to erosion. Re-shaping of slopes and re-stacking using existing rock structures was undertaken.
Re-covering (detail - further topsoil, subsoil sealing etc)	0	2	Application of hydromulch to bare earth areas within the treed rehabilitation area.
Soil treatment (detail - fertiliser, lime, gypsum etc)	0	2	Application of hydromulch containing fertilizer to bare earth areas within the treed rehabilitation area.
Treatment/Management (detail - grazing, cropping, slashing etc)	30.6	30.6	Horse grazing by current land owner, approximately 15 animals. Draft Stock Management Plan developed. Proposed consultation with landowner to implement grazing management practices to improve pasture growth.
Re-seeding/Replanting (detail - species density, season etc)	0	1.2	Planting of 600 native grass species tube stock within treed rehabilitation area.
Adversely Affected by Weeds (detail - type and treatment)	17	17	Integrated weed management control for African Lovegrass, Blackberry, St. John's Wort and Sweet Briar undertaken as per the schedule presented in **Table 6.** To be continued in next reporting period.
Feral animal control (detail - additional fencing, trapping, baiting etc)	0	0	No additional feral animal control was undertaken.

Plate 1 Jute mesh installation in treed rehabilitation area

Plate 2 Cracking on crest of slope

Plate 3 Cracking on crest of slope repaired

Plate 4 Repair to slope adjacent to Castlereagh Highway

Plate 5 Sediment basin wall repaired

Plate 6 Sediment basin wall repair

Plate 7 Hydromulch application in treed rehabilitation area

Plate 8 Tube stock planting, with jute mesh and hydromulch in background

Table 6
Weed Control Schedule for Rehabilitated Land

Species	Control method	Summer			Autumn			Winter			Spring		
		December	January	February	March	April	May	June	July	August	September	October	November
African Lovegrass *Eragrostis curvula*	Flupropanate 745 g/L (trade name *Taskforce*) 300 mL per 100 L of water (note 14 day stock withholding period) **Non-chemical options:** appropriate grazing management	X	X	X							X	X	X
Blackberry *Rubus fruticosus* aggregate species	Triclpyr 300 g/L + Picloram 100 g/L + Aminopyralid 8 g/L **(trade name *Grazon Extra*)** 350 or 500 mL per 100 L water **Non-chemical options:** slashing of young bushes and use of biological control agents	X	X	X									X
St. John's Wort *Hypericum perforatum*	Triclpyr 300 g/L + Picloram 100 g/L + Aminopyralid 8 g/L **(trade name *Grazon Extra*)** 500 mL per 100 L of water **Non-chemical options:** appropriate grazing management and use of biological agents	X											X
Sweet Briar *Rosa rubiginosa*	Triclpyr 300 g/L + Picloram 100 g/L + Aminopyralid 8 g/L **(trade name *Grazon Extra*)** 500 mL per 100 L of water **Non-chemical options:** mechanical removal or grubbing	X	X	X								X	X

5.2 STOCK MANAGEMENT

A Stock Management Plan has been commissioned for the Enhance Place Mine to aid in the management of the rehabilitated pasture areas which are currently affected by compaction and overgrazing by the landowners stock. A draft version (Feb 2016) of this plan is attached in **Appendix C**. This document encompasses a Trigger Action Response Plan, which nominates the actions required when certain triggers are observed; and a Land Management Schedule, which provides the actions required and timing for achieving land management target goals.

DRE were notified of the progress of the Stock Management Plan in December 2015.

As this plan is still in a draft format, submission to DRE for approval has not yet occurred.

5.3 REHABILITATION MONITORING

During the reporting period, rehabilitation monitoring was undertaken against the rehabilitation completion criteria in the now approved Care and Maintenance MOP (February 2015). The Rehabilitation Monitoring Report is included in **Appendix B**.

During the monitoring survey, no significant or active erosion was identified within the treed rehabilitation area, however, in the pasture area surface cracking was evident at the crests of some slopes. These were repaired, refer **Plate 3**. Overall there has been a significant decrease in the presence of African love grass following targeted spraying during the reporting period. It was noted that outbreaks of African Love grass were present in both the pasture and treed rehabilitation areas, however these had been recently sprayed and were no longer evident.

As recommended within the Rehabilitation Monitoring Report, it is proposed to continue weed management and monitoring. Planting of additional native species tubestock, supplemented with fertiliser and mulch was undertaken within the treed area. Engagement with the landowner of the pasture area will be undertaken for consideration to implement the grazing practices outlined in the draft Stock Management Plan, to optimise pasture growth.

Monitoring the final landform and stability of the site will continue while Enhance Place hold relevant mining authorities over the area.

5.4 FURTHER DEVELOPMENT OF FINAL REHABILATION PLAN

This has not altered since the previous reporting period.

5.5 METEOROLOGICAL DATA

An automatic weather station was installed at the Pine Dale Open Cut Mine project site in 2006 (located in nearby Blackmans Flat). The data is downloaded by RCA Laboratories-Environmental (previously Metford Laboratories) from Newcastle, NSW.

The average rainfall is 785.5mm at Lithgow (Cooerwull) Station, approximately 15km from the Enhance Place Mine (Source: Bureau of Meteorology, based on the rainfall period 1878 – 2015). During the reporting period Pine Dale Mine received 756.2mm of rainfall and experienced 144 rainfall days. Rainfall during this period was observed to be greater than rainfall recorded in 2014 (704.8mm and 145 rainfall days), but is lower than the area's long term annual average. The Annual Rainfall for the period 2006 – 2015 recorded at the Pine Dale Mine meteorological monitoring station can be seen in **Figure 2**, whilst the monthly rainfall for 2015 can be seen in

Figure 3.

Figure 2
Blackmans Flat Annual Rainfall 2006- 2014

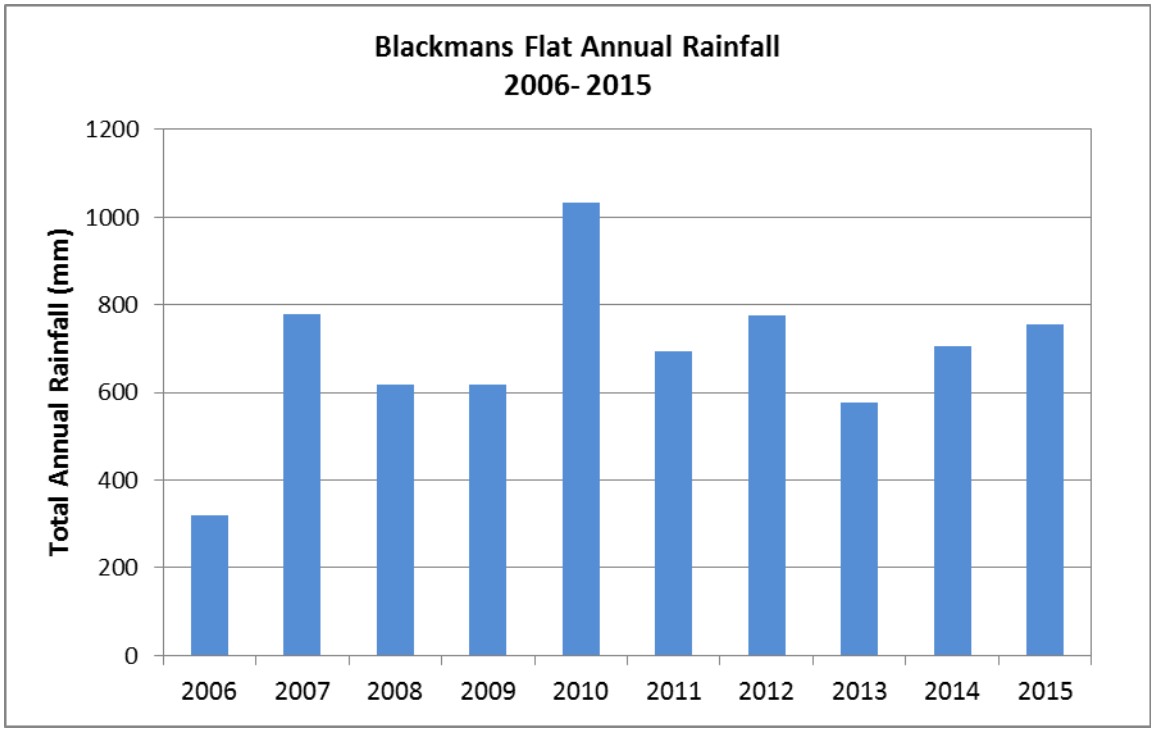
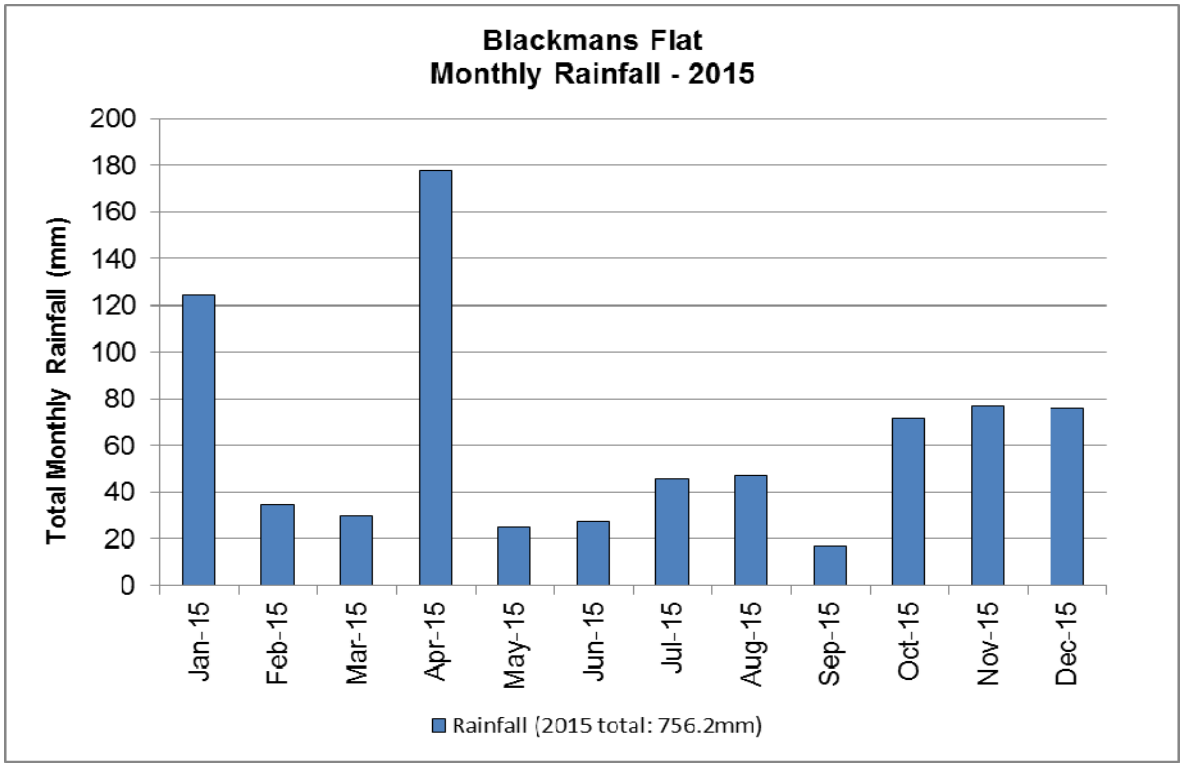


Figure 3
Blackmans Flat Monthly Rainfall 2015



6 ENVIRONMENTAL PERFORMANCE

The final landform and water management structures have been completed at Enhance Place. These areas and structures are inspected on a monthly basis by the Mining Engineering Manager.

It should be noted that the majority of land within the leases of Enhance Place Mine is privately owned and landowner permission is required to access the site. The land is predominately used for grazing horses year round.

There were no environmental incidents reported during the 2015 reporting period.

The proposed final land use and ownership of the Glen Davis Recreation Trust area at the Enhance Place Mine is progressing in consultation with Lithgow City Council and other relevant stakeholders.

Enhance Place will move to relinquish Mining Leases over the site following a satisfactory rehabilitation outcome and the resolution of the Glen Davis Trust land. Enhance Place will consult with relevant regulators and stakeholders to ensure final land use and landform objectives are achieved. Until the relevant leases are relinquished Enhance Place will continue ongoing monitoring and maintenance of the rehabilitated area as required.

7 COMMUNITY AND LIAISON

7.1 ENVIRONMENTAL COMPLAINTS

There were no environmental complaints recorded during the reporting period from the general public or near neighbours.

Discussions with key landholders were ongoing during the reporting period to ensure dialogue was maintained regarding land management matters.

Appendix A

Enhance Place Mine Plan

REHABILITATION AREA -TREES

SECONDARY DOMAINS
REHABILITATION AREA - TREES
REHABILITATION AREA - PASTURE

Portion 69
Road
Portion 298
Portion 299
Portion 300
Por 309
Portion 310
Portion 308
Portion 307
Portion 306
Portion 301
Portion 302
Portion 303
Portion 304
Portion 305
Portion 370
Road
DP1026541
7004
Closed Road (Gaz. 29th July 1927)
From Cullen Bullen
DAM
Transmission Line Easement 25m wide (DP 617824)
CASTLEREAGH HIGHWAY
To Wallerawang
House
Catchment Drain
Catchment
Drain
SEDIMENT RETENTION BASIN
3 CELL CULVERT
ML 1520
ML 1458
ML 1442
101
DP1145705
WETLAND
Tree line
Lot 2
DP 596248
N

MINE MANAGER

5.3.14
DATE

NOTES:

CRAVEN, ELLISTON & HAYES (LITHGOW) PTY.LTD.
CONSULTING LAND, ENGINEERING AND MINING SURVEYORS
ACN 056 544 551
"ASTROLABE" RUTHERFORD LANE, LITHGOW, 2790 PH: (02) 6351 2281, FAX: (02) 6352 1339
EMAIL : survey@ceh.com.au

DATE	18–12–13
AMENDED	
SURVEYOR	T.H./T.E
DRAWN	K.L.F./D.M.
CHECKED	

ENHANCE PLACE MINE
FINAL REHABILITATION AND
POST MINING LAND USE

SCALE - 1 : 1250 (A1 SHEET)

DWG No
ENH-REH
PLAN 3

Appendix B

Soil Assessment and Recommendations for Rehabilitated Areas – Pine Dale Mine and Enhance Place Mine

global environmental solutions

Soil Assessment and Recommendations for Rehabilitated Areas

Pine Dale Mine and Enhance Place Mine

Report Number 630.11011

10 November 2014

for Enhance Place Pty Ltd

Version: Final

Soil Assessment and Recommendations for Rehabilitated Areas

Pine Dale Mine and Enhance Place Mine

PREPARED BY:

SLR Consulting Australia Pty Ltd
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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
630.11011	Draft 1	23 October 2014	Murray Fraser	Andrew Hutton	Andrew Hutton
630.11011	Final	10 November	Murray Fraser	Andrew Hutton	Andrew Hutton

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TABLES

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1 INTRODUCTION

Enhance Place Pty Ltd (Enhance Place) owns and operates the Pine Dale Mine and Enhance Place Mine in accordance with Project Approval (PA) 10_0041 and PA 451_01 respectively, granted by the Minister for the Department of Planning and Environment.

SLR was engaged by Enhance Place to:

- Undertake soil analysis and any other assessment as required, to inform development of quantitative rehabilitation completion criteria for Growth Media Development phase of rehabilitation; and
- Provide advice and recommendations for pasture improvement strategies required to achieve the agreed rehabilitation completion criteria as described in the relevant Mining Operations Plan.

Five sites have been rehabilitated between Pine Dale Mine and Enhance Place Mine and require ongoing monitoring and maintenance to ensure they continue to move towards achieving the agreed rehabilitation completion criteria. These sites are shown in **Figure 1** and **Figure 2** and are identified as the following:

Pine Dale Mine

- Area A;
- Area C (Jenkins property); and
- Area 8.

Enhance Place

- Morris Property; and
- Crown Land block.

2 METHODOLOGY

A detailed walk-through inspection of these five areas was undertaken by Murray Fraser (SLR Senior Agronomist) and Ben Eastwood (Environmental Manager) on 10th September 2014. The initial objective of the inspection was to assess the current condition of these rehabilitated areas and particularly the extent African lovegrass (*Eragrostis curvula*) and formulate an action plan so as rehabilitation objectives can be met.

Where possible soil samples were taken from the topsoil (0-10 cm) and subsoil (between 20-40 cm) at each inspection site and sent to Soiltec Laboratories for nutrient testing and further analysis.

A traffic light risk rating has been used to describe any soil nutrient deficiencies/toxicities which may be limiting plant establishment and production in the rehabilitation areas at each of the sites. **Table 1** below outlines the meaning of each rating as per the traffic light methodology. Detailed soil test results are contained in **Appendix A**.

Table 1 Soil Nutrient Descriptors

Rating	Descriptor
	Soil nutrient is present in levels that are deficient /toxic and are highly likely to be impacting optimum plant growth.
	Soil nutrient is present in levels that are marginally deficient /toxic and may be impacting optimum plant growth.
	Soil nutrient is present in levels which are ideal for optimum plant growth.

The principal intention of the inspection was to develop an overall practical and staged strategy to supplement the initial rehabilitation strategy and subsequently meet mine rehabilitation commitments and completion criteria.

H:\Projects-SLR\630-SydNTL\630-NTL\630.11011 Enhance Place Rehab Completion Criteria\SLR Data\Drafting\Figures\ArcGIS\SLR630.11011_FieldPoints_PD_01.mxd

SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
AUSTRALIA
T: 61 2 4037 3200
F: 61 2 4037 3201
www.slrconsulting.com

Project No.:	630.11011
Date:	11/11/2014
Drawn by:	LH
Scale:	1:10,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N

0 100 200 300 400 m

Enhance Place Pty Ltd

Pine Dale Rehab Completion Criteria

Inspection Points

FIGURE 1

H:\Projects-SLR\600-Grn\TL\630-NTL\630.11011 Enhance Place Rehab Completion Criteria\SLR Data\Drafting\Figures\Arc\GIS\SLR\630011011_FieldPoints_EP_01.mxd

SLR
10 KINGS ROAD
NEW LAMBTON
NEW SOUTH WALES 2305
AUSTRALIA
T: 61 2 4037 3200
F: 61 2 4037 3201
www.slrconsulting.com

Project No.:	630.11011
Date:	23/10/2014
Drawn by:	LH
Scale:	1:4,000
Sheet Size:	A4
Projection:	GDA 1994 MGA Zone 56

N

0 25 50 75 100 m

Enhance Place Pty Ltd

Enhance Place Rehab Completion Criteria

Inspection Points

FIGURE 2

3 INSPECTION RESULTS

The following section summarises the results for each of the sites inspected at both Pine Dale Mine and Enhance Place Mine. It is intended to show the general condition of each site at the time of the inspection as well as document some of the constraints identified, such as lack of topsoil depth and nutrient toxicities or deficiencies which may be limiting desirable plant establishment and growth.

Further information is included in **Section 5** which includes a list of recommendations for each of the sites.

3.1 Pine Dale Mine

3.1.1 Area A

Plate 1 below shows the general landscape setting for site PD5 within Area A at Pine Dale Mine during the site inspection undertaken on the 10th September 2014. The rehabilitation objective for PD5 is to be rehabilitated to a native woodland vegetation community.

Plate 1: Site PD5 Pine Dale Mine Area A – Landscape Setting

During the inspection it was observed that there has been limited success with establishment of eucalypt species, although where tracks were bulldozed through the initial planting, saplings now appear to be growing reasonably well.

Mushroom compost, lime and gypsum spread in 2013 can be seen on the soil surface. This appears to have boosted the growth of young trees and encouraged volunteer clover growth, both through addition of nutrients and soil moisture retention. Testing confirmed the topsoil is highly acidic and may be contributing to the very slow establishment of eucalypts.

Plate 2 below shows the groundcover composition at PD5 during the site inspection.

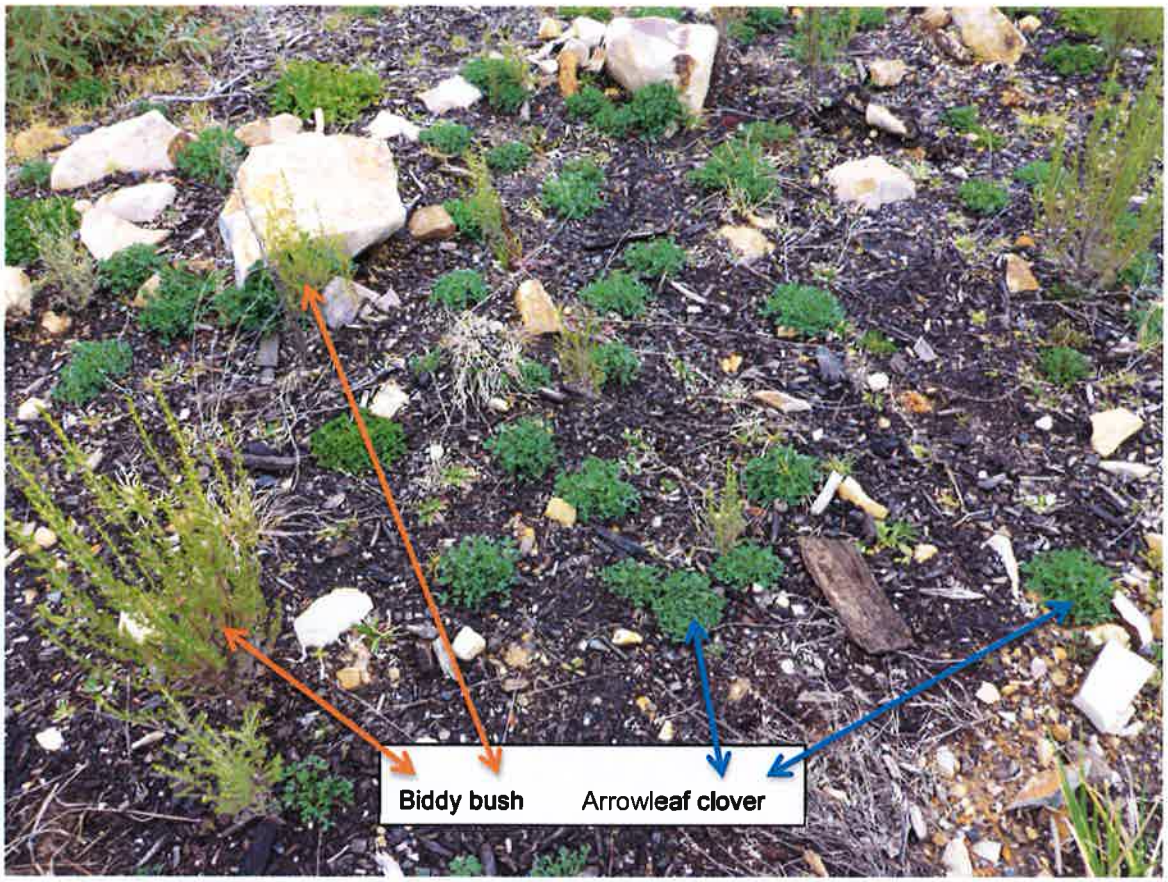

Plate 2: Site PD5 Pine Dale Mine Area A – Groundcover Composition

Recently established clover plants can be seen after application of lime with mushroom compost and gypsum which has reduced acidity at the soil surface and provided improved moisture holding capacity.

The main weed observed at PD5 during the inspection is biddy bush (*Cassinia arcuata*) which SLR understands is currently spot-sprayed for control in this area.

Plate 3 following shows approximately 4 cm of highly acidic, darker topsoil, which was sandy clay loam texture over the lighter coloured sub soil, which was a medium sandy clay texture.

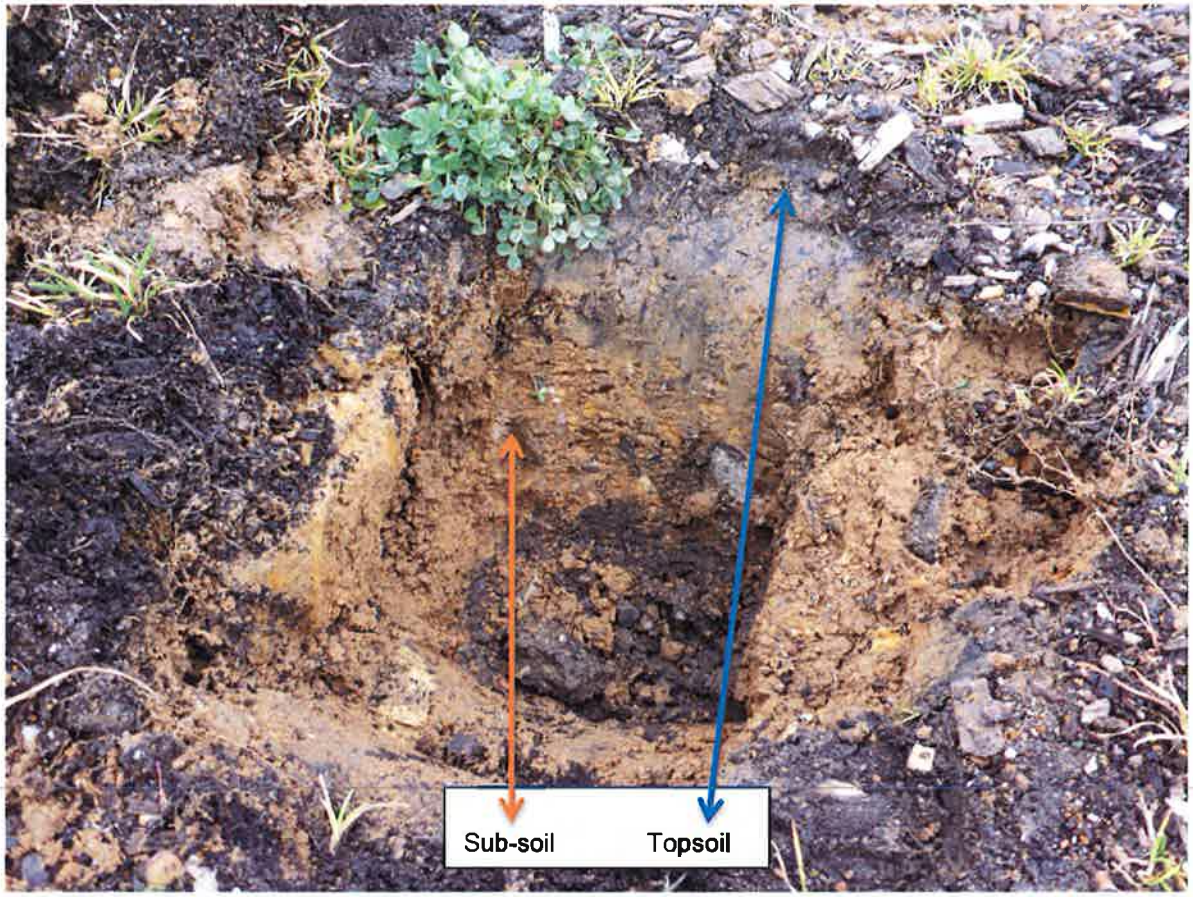

Plate 3: Site PD5 Pine Dale Mine Area A – Depth of Topsoil

Table 2 below describes the soil nutrient descriptors which are limiting plant establishment and production in the rehabilitation Area A as demonstrated by samples collected at site PD5.

Table 2 PD5 Soil Test Summary

Site	Soil Element	Descriptor 0-4 cm	Descriptor 20-30 cm
PD5 Area A Native Vegetation Rehabilitation	pH		
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies/toxicities limiting vegetation and pasture growth at PD5 are very low pH and very high aluminium in the topsoil, along with sodium, sulfur and calcium, whilst potassium and nitrogen are marginal.

3.1.2 Area C (Jenkins Property)

Plate 4 below shows PD3, and represents a reference site located adjacent to the previously mined area. Site PD3 has not been disturbed by mining activity and has not been rehabilitated. Site PD3 is considered to be representative of pre mining land use conditions in regards to soil profile and vegetation cover for this area and is a reference site for the purpose of this assessment.

Plate 4: Site PD3 Pine Dale Mine Area C – Landscape Setting

As PD3 has not been disturbed by mining or rehabilitation activity, this represents an original grazing area prior to mining.

Topsoil consists of a sandy clay loam less than 10 cm in depth over a medium clay subsoil. This area supports a perennial grass and clover pasture, including cocksfoot, tall fescue, phalaris, sub clover, with some annual ryegrass and *Vulpia* sp., some of which can be seen in **Plate 5**.

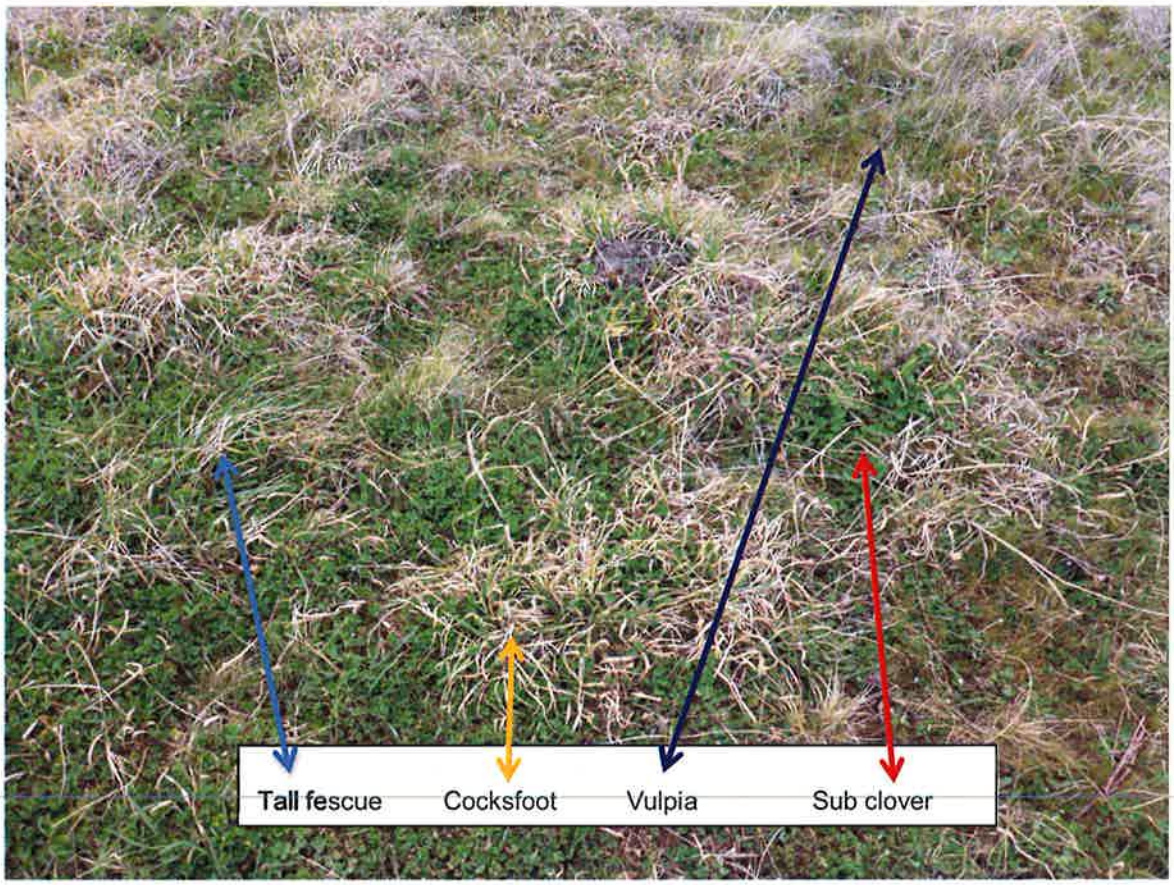

Plate 5: Site PD3 Pine Dale Mine Area C – Pasture Composition

PD3 has 100% groundcover with a mixed perennial grass and clover pasture. Whilst pH in the topsoil is marginal and highly acidic at depth, the varieties present are tolerant of acidity resulting in minimal impact on pasture growth or persistence. There is no African lovegrass present in this area which is likely due to minimal disturbance of this site.

Darker topsoil to a depth of 10 cm over the lighter coloured sub soil can be seen following in **Plate 6**.

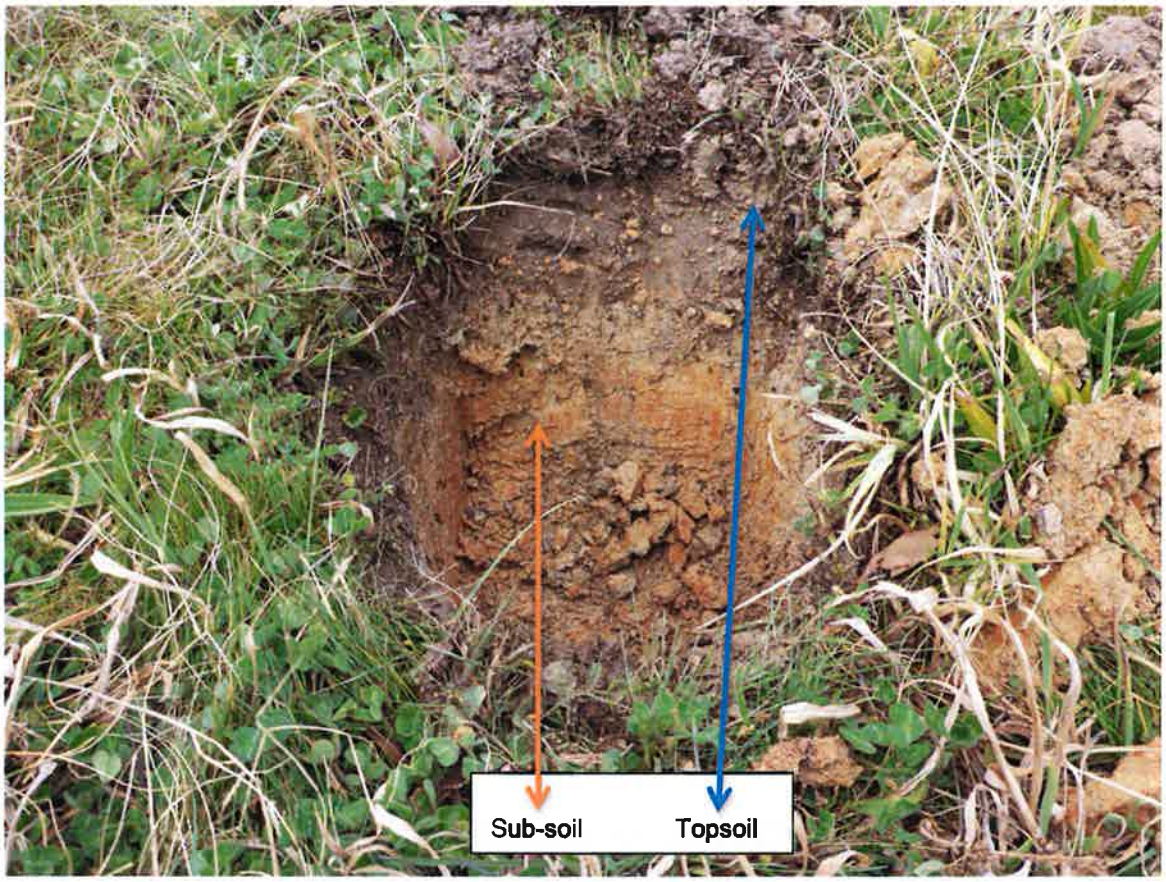

Plate 6: Site PD3 Pine Dale Mine Area C – Depth of Topsoil

Table 3 PD3 Soil Test Summary

Site	Soil Element	Descriptor 0-10 cm	Descriptor 30-40 cm
PD3 Area C Nil Disturbance	pH		
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies limiting pasture growth at PD3 are sulfur, nitrogen, zinc and calcium, whilst sodium levels and pH are marginal.

Plate 7 below shows the landscape setting of the earliest rehabilitation undertaken at Pine Dale Mine Area C (PD1).

Plate 7: Site PD1 Pine Dale Area C – Landscape Setting

PD1 was one of the initial areas to be rehabilitated when the original Pine Dale Mine was operating, with the resulting cocksfoot based pasture having 100% groundcover. The main factor behind the successful pasture establishment is the depth of topsoil (over 30 cm) laid down over the subsoil. This depth of topsoil provides an excellent growing medium for the cocksfoot based pasture, although while a number of nutrients are deficient. The high water holding capacity of the topsoil also aids in excellent pasture growth.

Plate 8 following shows the composition of the cocksfoot and clover pasture at PD1.

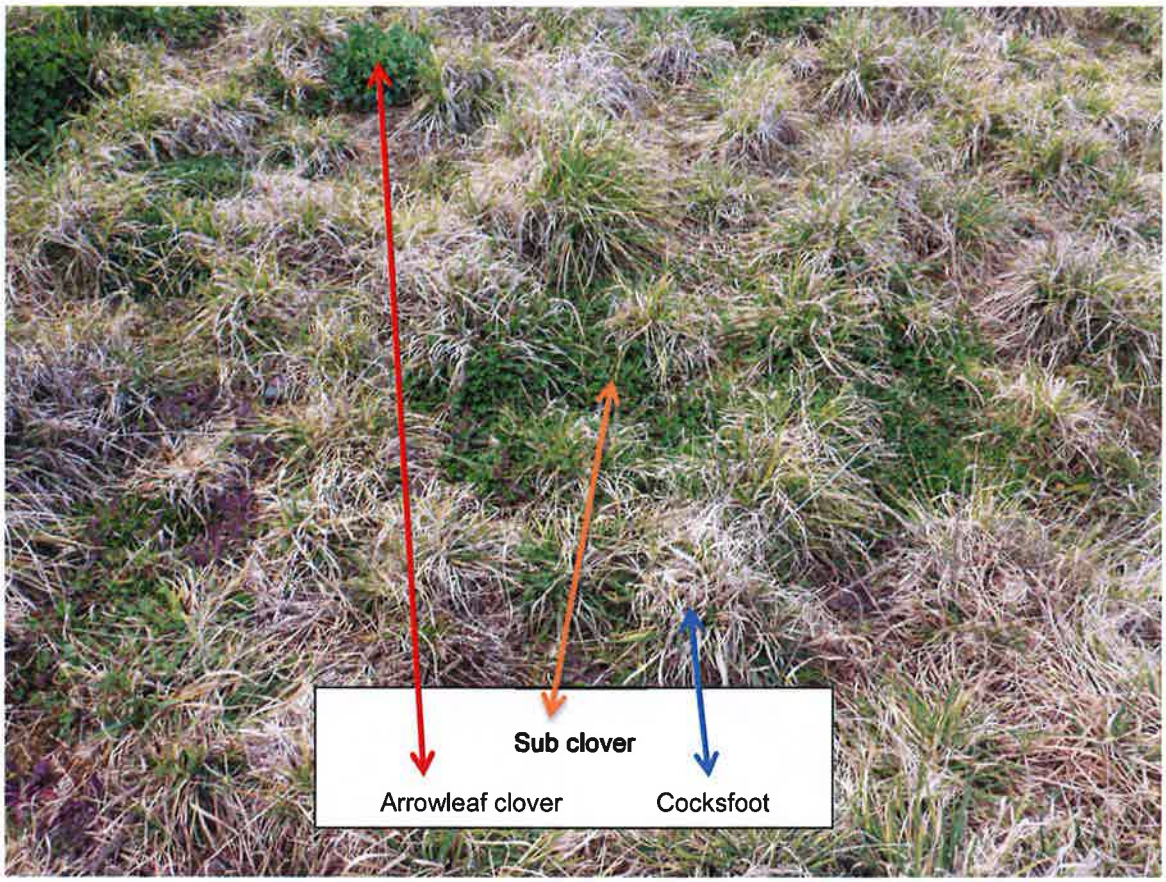

Plate 8: Site PD1 Pine Dale Mine Area C – Pasture Composition

Other desirable pasture species present at PD1 include perennial phalaris, arrowleaf clover, sub clover and vetch. Due to the excellent groundcover of this perennial pasture there are few weeds of any significance present.

PD1 has an excellent capacity for sustainable cattle grazing, both through the established pastures vigour and species composition, with an ideal perennial grass/clover ratio (80% grass to 20% clover).

Plate 9 following shows the 30 cm of darker topsoil over the lighter coloured sub soil at PD1.

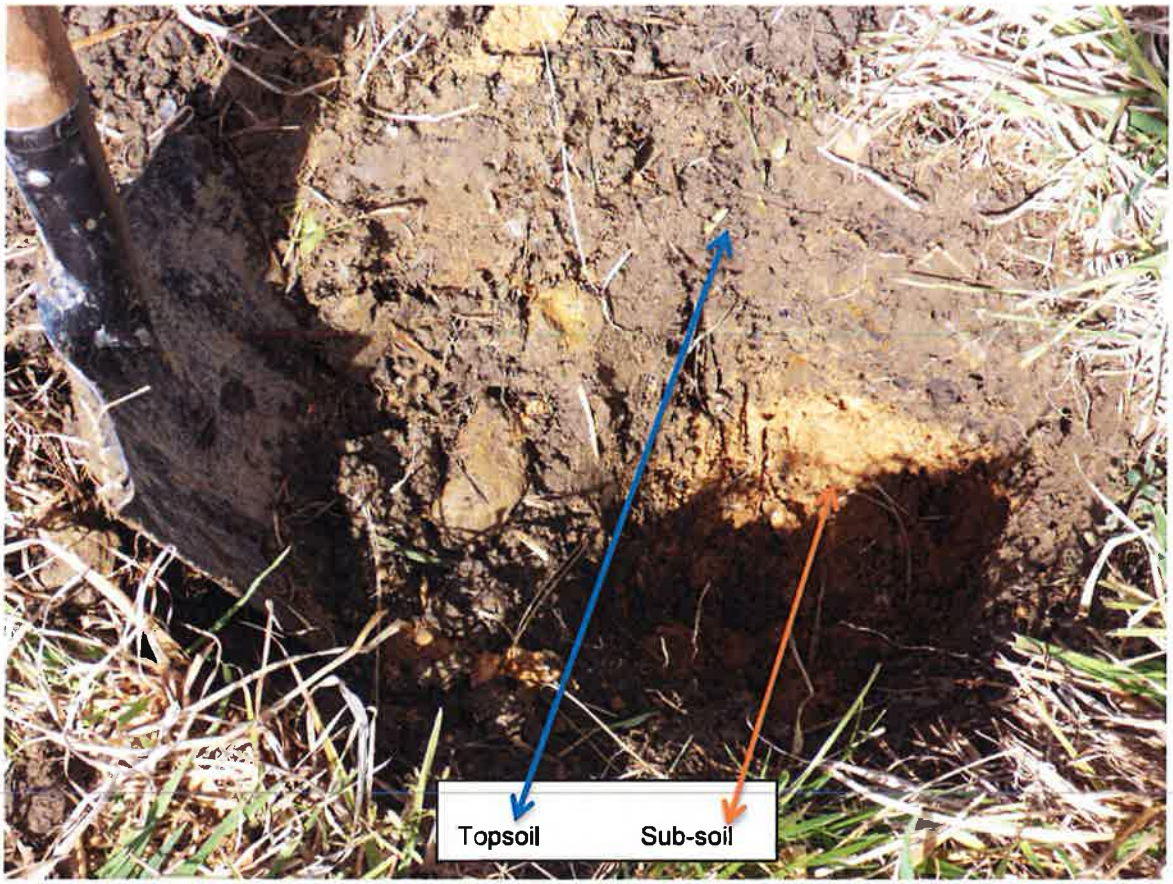

Plate 9: Site PD1 Pine Dale Mine Area C – Depth of Topsoil (30 cm)

Table 4 below describes the soil nutrient descriptors which are limiting plant establishment and production in the rehabilitation areas for site PD1.

Table 4 PD1 Soil Test Summary

Site	Soil Element	Descriptor 0-10 cm	Descriptor 30-40 cm
PD1 Area C Excellent Pasture Rehabilitation	pH		
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies limiting pasture growth at PD1 are potassium, sulfur, nitrogen, zinc and calcium, whilst sodium levels are marginal. Correction of these deficiencies will result in greater rainfall use efficiency and an extended growing season for this area of pasture, which results in a greater capacity to support more livestock for a longer period of time.

Plate 10 below shows pasture at PD2 dominated by annual clover, with some African lovegrass present.

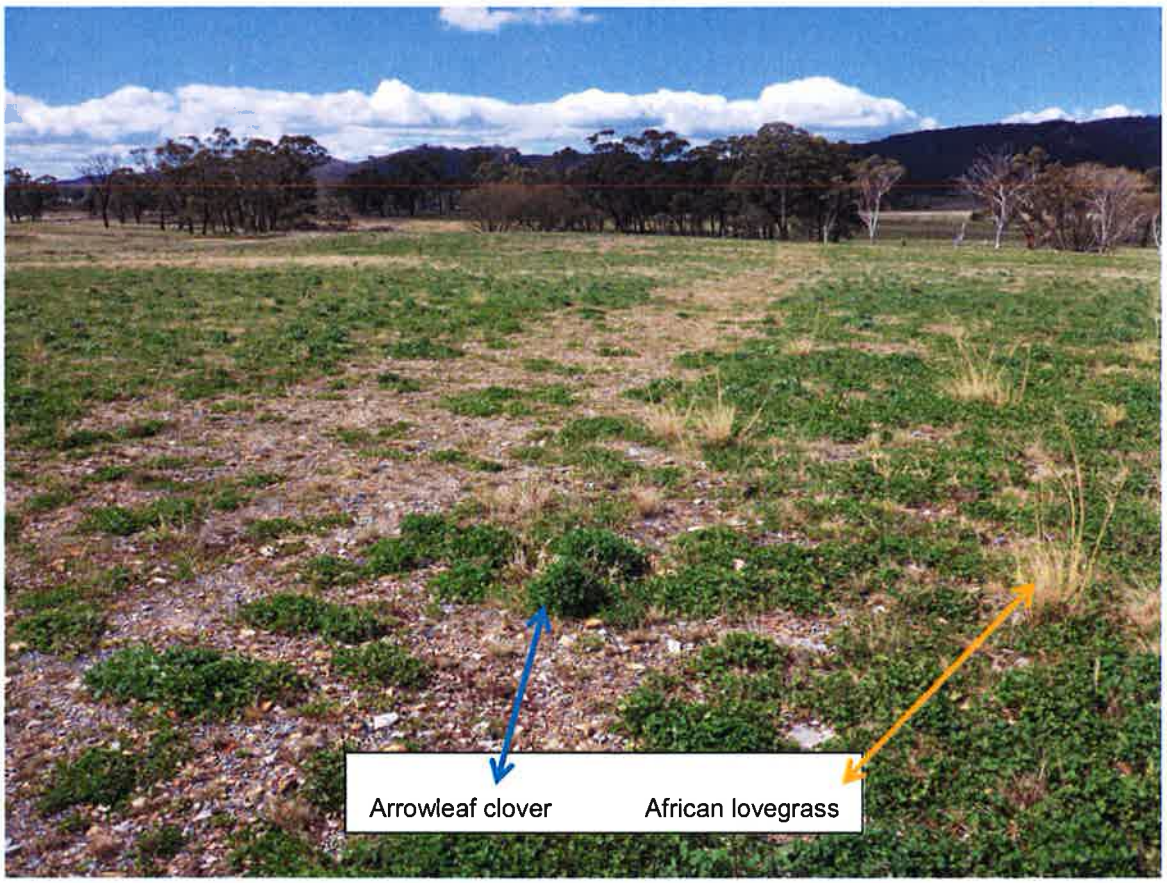

Plate 10: Site PD2 Pine Dale Mine Area C – Landscape Setting

PD2 was rehabilitated at a later stage to PD1 and has had very little topsoil applied, with the majority of the area appearing to be just overburden and subsoil. The pasture is dominated by annual clover with few perennial pasture grasses. Once the clover hays off in late spring it is expected that there will be very little in the way of pasture for grazing livestock during summer and early autumn.

There are significant areas of African lovegrass which will need control with *Taskforce* herbicide (745 g/L Flupropanate) during autumn or spring before any pasture improvement is undertaken. This will provide residual control on further germinations of African lovegrass for 2-3 years whilst not impacting pasture seed germination.

Spreading the mushroom/lime/gypsum compost mixture previously used on Area A would be extremely beneficial here to start the process of "making" topsoil and increasing soil microbial activity. The contour banks which have been cut into the hillsides post pasture establishment should also undergo this treatment, as in their current condition they will not support any significant pasture growth.

Plate 11 below shows arrowleaf clover at PD2 with overburden clearly seen between clover plants.

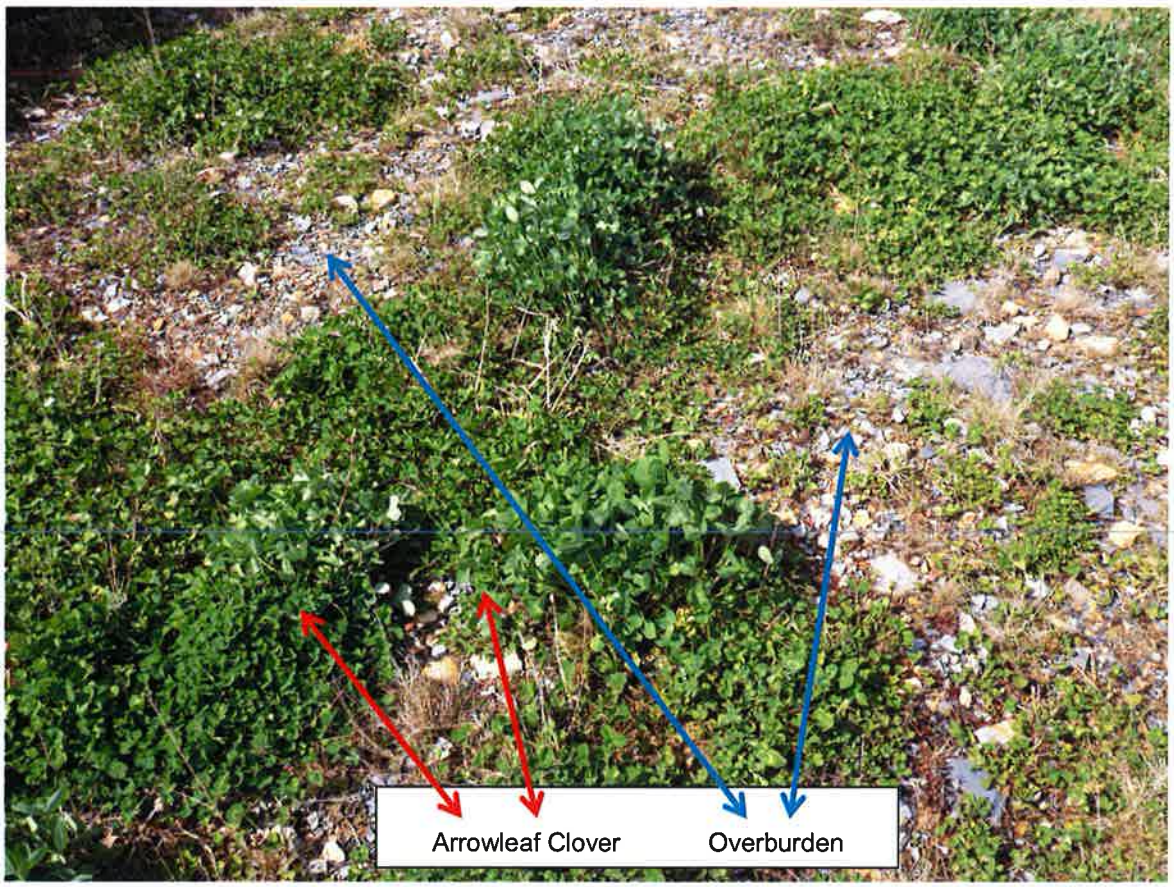

Plate 11: Site PD2 Pine Dale Area C – Pasture Composition

Table 5 following describes the soil nutrient descriptors which are limiting plant establishment and production in the rehabilitation areas for site PD2.

Table 5 PD2 Soil Test Summary

Site	Soil Element	Descriptor 0-10 cm	Descriptor 20-30 cm
PD2 Area C Poor Pasture Rehabilitation	pH		
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies limiting pasture growth at PD2 are highly acidic pH, low potassium, sulfur, nitrogen, zinc and calcium, whilst sodium and aluminium levels are marginal. The main constraint limiting pasture growth at PD2 is lack of moisture holding capacity due to minimal topsoil.

3.1.3 Area 8

Plate 12 below shows the landscape setting for site PD4 at Area 8, with only very limited pasture establishment.

Plate 12: Site PD4 Pine Dale Mine Area 8 – Landscape Setting

PD4 was also rehabilitated at a later stage to PD1 and has had very little topsoil applied, with the majority of the area appearing to be overburden and subsoil. Due to the amount of overburden/rock present from a depth of 10 cm, only 0-10 cm was sampled for laboratory testing at PD4.

There are significant areas of African lovegrass which will need control with *Taskforce* during autumn or spring before any pasture improvement is undertaken. This will provide residual control of further germinations of African lovegrass whilst not impacting pasture seed germination.

Spreading the mushroom/lime/gypsum compost mixture previously used on Area A would be extremely beneficial here to start the process of "making" topsoil and increasing soil microbial activity.

Plate 13 following shows some arrowleaf clover with a significant number of African lovegrass tussocks.

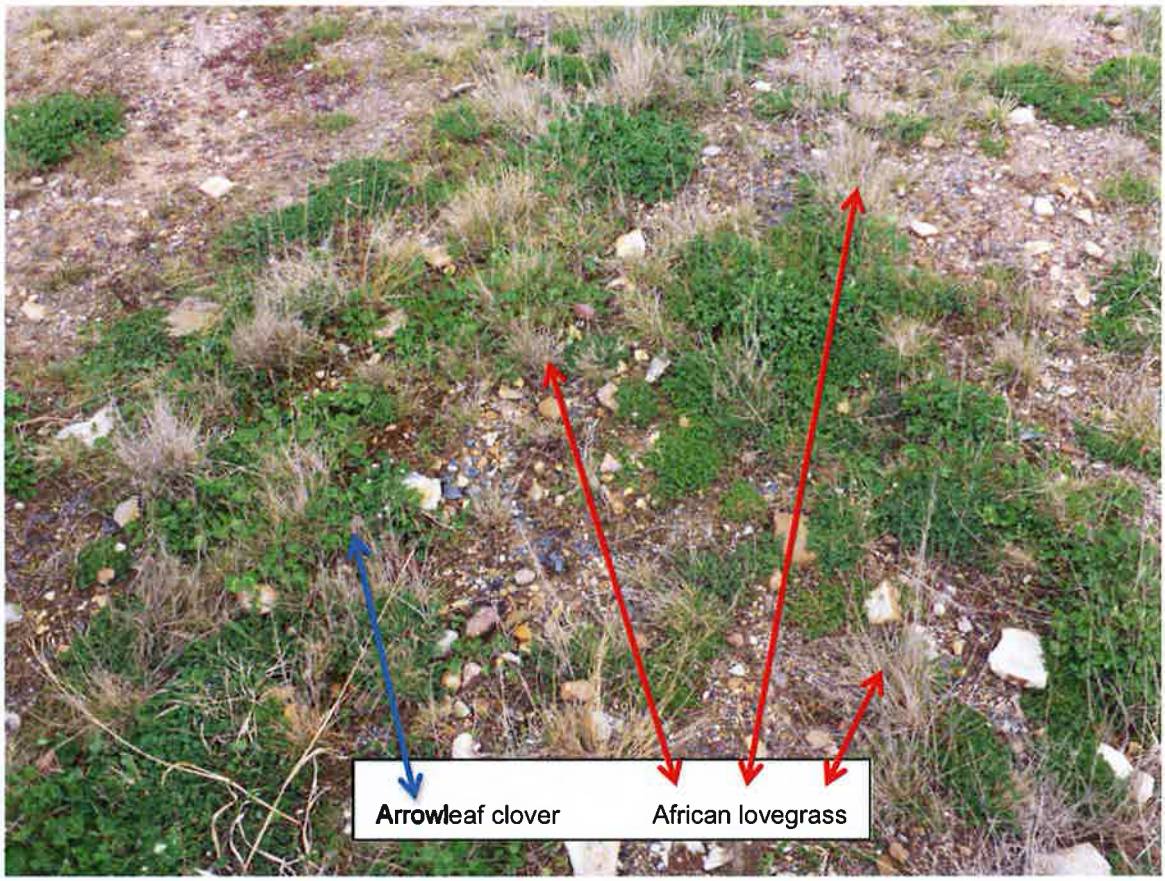

Plate 13: Site PD4 Pine Dale Mine Area 8 – Pasture Composition

African lovegrass can be seen spread between the clover plants. This pasture will provide very little grazing value once the clover hays of in late spring.

Table 6 below describes the soil nutrient descriptors which are limiting plant establishment and production in the rehabilitation areas for site PD4.

Table 6 PD4 Soil Test Summary

Site	Soil Element	Descriptor 0-10 cm	Descriptor 20-30 cm
PD4 Area 8	pH		Not Tested (Rock)
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies limiting pasture growth at PD4 are nitrogen and zinc, whilst sodium, sulfur and calcium are marginal. The main constraint for pasture growth at Area 8 is lack of topsoil.

3.2 Enhance Place Mine

3.2.1 Morris Property

Plate 14 below shows the landscape setting at EP1 on the Morris property, showing very little growth of the established pasture.

Plate 14: Site EP1 Enhance Place Mine (Morris Property) North – Landscape Setting

The Morris property is heavily overgrazed, whilst there are three fenced and watered paddocks the block is being grazed by horses as one large set stocked paddock. This has resulted in palatable pasture species being grazed right down to ground level and a decline in pasture quality and quantity.

The pasture has reasonable populations of perennial grass and clover, although with the continued heavy grazing pressure by horses the perennial grasses will thin out and be replaced by less palatable annual weeds.

Plate 15 following shows weeds present at EP1 including wild sage, scotch thistle, spear thistle and flatweed, which can all be controlled by a broadleaf weed herbicide application.

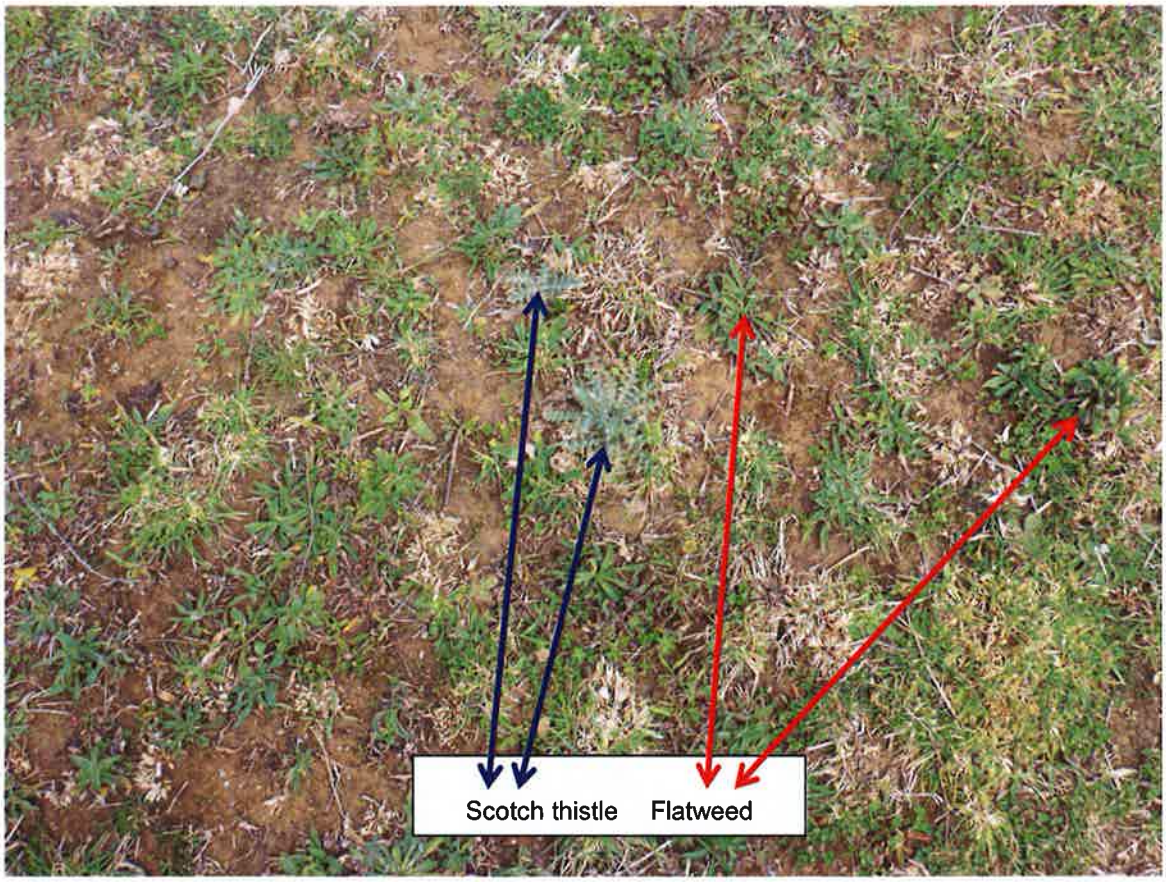

Plate 15: Site EP1 Enhance Place Mine (Morris Property) North – Pasture Composition

Table 7 below describes the soil nutrient descriptors which are limiting plant establishment and production in the rehabilitation areas for site EP1.

Table 7 EP1 Soil Test Summary

Site	Soil Element	Descriptor 0-10 cm	Descriptor 30-40 cm
EP1 Morris North	pH		
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies limiting pasture growth are nitrogen and calcium, whilst sulfur, potassium and zinc are marginal.

Plate 16 below shows the landscape setting at EP3 on the Morris property, where the pasture is dominated by annual clovers and medic.

Plate 16: Site EP3 Enhance Place Mine (Morris Property) South – Landscape Setting

Again there are very few perennial grasses due to constant overgrazing and trampling by horses. Some annual medic is present which proved reasonable winter and spring grazing, however these paddocks will be bare during summer and autumn with few palatable pasture plants.

There are significant areas of African lovegrass which will need to be controlled before any pasture improvement is undertaken. It is recommended that this is controlled using *Taskforce* during autumn or spring.. This will provide residual control on further germinations of African lovegrass whilst not impacting on pasture seed germination.

The Morris property will have no improvement in pasture composition or density without adopting time control or rotational grazing methods where by each paddock can have a period of rest and growth before grazing again.

Plate 17 following shows the dominance of the annual clover and medics in the pasture at EP3.

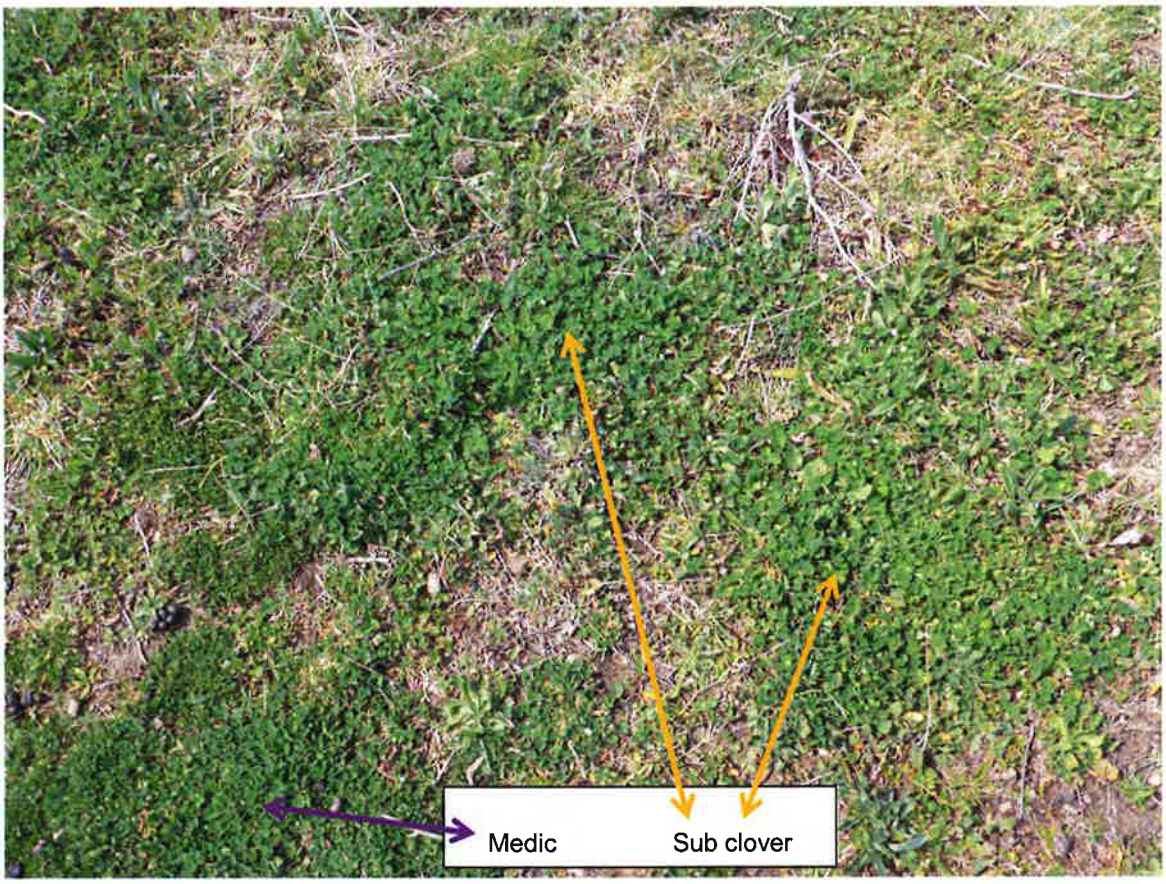

Plate 17: Site EP3 Enhance Place Mine (Morris Property) South – Pasture Composition

Table 8 below describes the soil nutrient descriptors which are limiting plant establishment and production in the rehabilitation areas for site EP3.

Table 8 EP3 Soil Test Summary

Site	Soil Element	Descriptor 0-10 cm	Descriptor 20-30 cm
EP3 Morris South	pH		
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies limiting pasture growth at EP3 are sulfur, nitrogen, zinc and calcium, whilst potassium and sodium levels are marginal. The main constraint for pasture growth and persistence at the Morris property is constant overgrazing by horses with the pasture not given any rest period

3.2.2 Crown Land Block

Plate 18 below shows the landscape setting at EP2 on the Crown land, with good pasture groundcover.

Plate 18: Site EP2 Enhance Place Mine (Crown Land) – Landscape Setting

The Crown land area adjacent to the Morris property is being grazed by kangaroos with domestic stock being excluded, and as such this area has better pasture composition and groundcover than both EP1 and EP3, with satisfactory populations of phalaris, cocksfoot and sub clover.

Plate 19 following shows phalaris and sub clover in good populations at EP2.

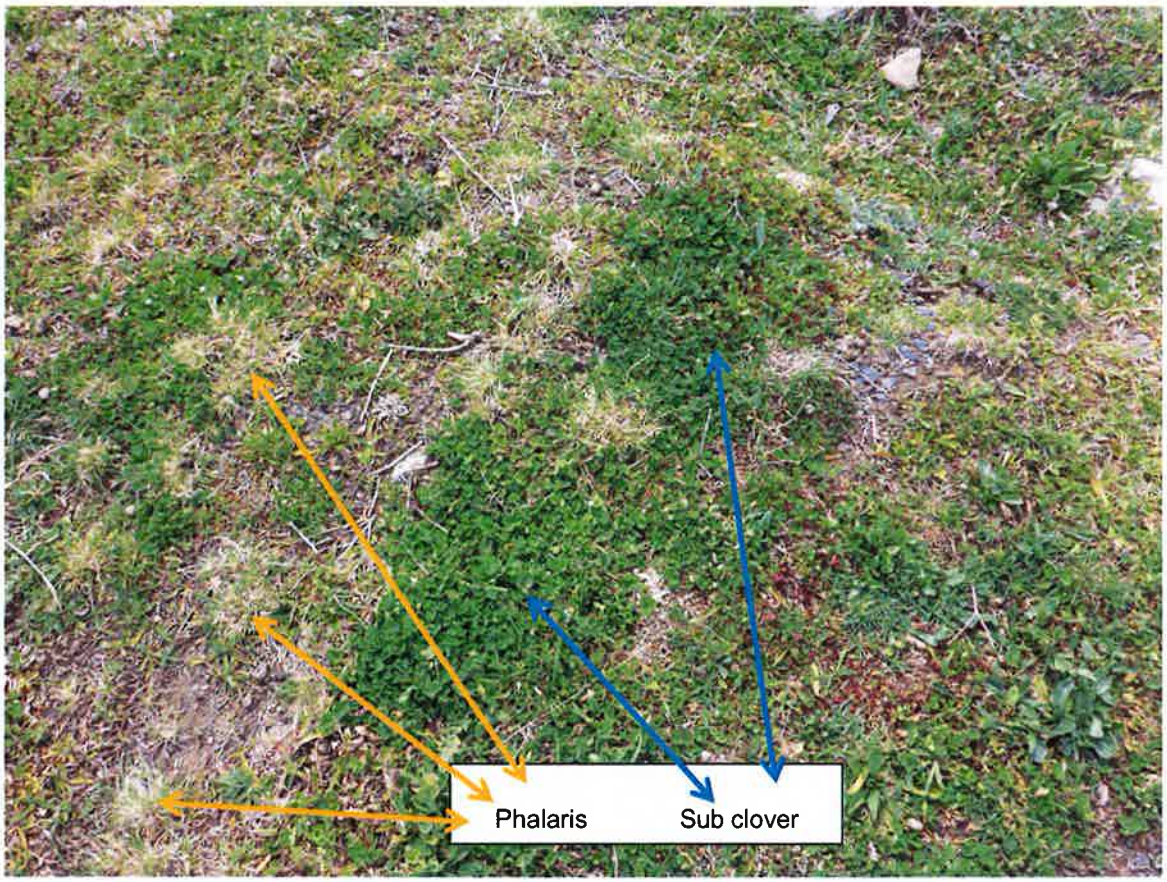

Plate 19: Site EP2 Enhance Place Mine (Crown Land) – Pasture Composition

Table 9 below describes the soil nutrient descriptors which are limiting plant establishment and production in the rehabilitation areas for site EP3.

Table 9 EP2 Soil Test Summary

Site	Soil Element	Descriptor 0-10 cm	Descriptor 20-30 cm
EP2 Crown Land	pH		
	Potassium		
	Sodium		
	Aluminium		
	Sulfur		
	Nitrogen		
	Zinc		
	Calcium		

Nutrient deficiencies limiting pasture growth at EP2 are sulfur, nitrogen, zinc and calcium, whilst sodium levels are marginal.

As EP2 has sufficient groundcover, a desirable pasture species composition and is not grazed by domestic livestock no further remediation work is necessary.

When compared to the undisturbed site at PD3, levels of pH, potassium, sodium and aluminium at EP2 are all comparable, rating as either green or amber, indicating a suitable growth medium for desirable pasture species.

4 SUMMARY

All areas tested at Pine Dale Mine and Enhance Place Mine showed good to excellent levels of phosphorus (refer **Appendix A**), indicating previous phosphorus fertiliser application; however sulfur, nitrogen, zinc and calcium are generally deficient and are limiting plant establishment and growth.

There are significant areas of African lovegrass which will require control in autumn or spring with *Taskforce* before any pasture improvement program is undertaken. *Taskforce* will provide residual control for further germinations of African lovegrass for 2-3 years post-application.

It is recommended to apply *Taskforce* during autumn or spring by boom spray at 3 litres/ha using a minimum of 150 litres/ha of water. The plant back period for sowing new pasture or crop is a total of 100 mm of rainfall in greater than 5 mm increments.

SLR recommends that the pasture seed mix used to re-sow the poorly established areas should be cocksfoot dominant as this is the most successful species in Area C. The recommended mix is:

- Kasbah Cocksfoot 5 kg/ha
- Atlas Phalaris 1 kg/ha
- Zulu Arrowleaf Clover 2 kg/ha
- Goulburn Sub Clover 2 kg/ha

All pasture seed should be treated with an insecticide such as *Cosmos* (500 g/L Fipronil), trace element coating and clovers inoculated with rhizobium.

Re-sowing of poorly established areas should be undertaken and by broadcasting pasture seed and fertiliser into furrows that have been ripped by a narrow tyned chisel plough, scarifier or similar equipment. The seed and fertiliser should then be covered by mushroom compost/ lime/ gypsum mix and await rainfall for germination.

Once fertility is improved and competitive pasture species are introduced it is unlikely that African lovegrass will be able to re-infest the rehabilitation areas. This has been demonstrated in the Crown Land block at Enhance Place.

Where little or no topsoil has been used during previous rehabilitation attempts, performance has been very poor, especially in comparison to PD2, where 30 cm of topsoil was used and the subsequent pasture establishment has been highly successful.

The main factor hampering successful pasture establishment and growth on the Morris property is continual overgrazing by horses.

5 RECOMMENDATIONS

This section provides a summary of the recommendations for each rehabilitation area to ensure the growth medium development continues to move towards achieving the agreed rehabilitation completion criteria and final land use objectives.

5.1 Pine Dale Mine - Area A

Continue control of biddy bush with current spot-spraying regime. Continue with further application of mushroom compost/lime/gypsum at rates shown in **Table 10**. Potassium needs to be increased with Muriate of Potash (MOP) or similar. Rainfall will incorporate the lime, gypsum and MOP into the soil profile. Increased growth from the application of these nutrients will provide a nitrogen source for the eucalypts species.

Table 10 PD5 Area A Fertiliser Requirements

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
PD5 Area A Approx. 7 hectares	MOP	0.25	1.75
	Mushroom compost	10	70
	Lime	3	21
	Gypsum	2	14

5.2 Pine Dale Mine - Area C (Jenkins Property)

The initial rehabilitation of approximately 8 hectares does not currently require any remedial action, although this area will require soil nutrient maintenance once time control (rotational) grazing begins. The later rehabilitation areas with poor pasture establishment and growth require boom spray application of *Taskforce* for the control of African Lovegrass prior to any pasture establishment works being undertaken.

Once this has occurred the area needs to be ripped with a narrow tyned chisel plough to create furrows. The pasture seed mix, MOP and di-ammonium phosphate (DAP) is then spread and finally the mushroom compost/lime/gypsum mix spread over the top of the pasture seed mix, at rates shown in **Table 11**.

Table 11 PD2 Area C Fertiliser Requirements

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
PD2 Area C Approx. 14 hectares	MOP	0.25	3.5
	DAP	0.20	2.8
	Mushroom compost	10	140
	Lime	4	56
	Gypsum	1	14

5.3 Pine Dale Mine - Area 8

Area 8 requires a boom spray application of *Taskforce* for the control of African Lovegrass prior to any pasture establishment works being undertaken.

Once this has occurred the area needs to be ripped with a narrow tyned chisel plough to create furrows. The pasture seed mix, MOP and DAP should then be spread over the area prior to applying the mushroom compost/lime/gypsum mix over the top at rates shown in **Table 12**.

Table 12 PD4 Area 8 Fertiliser requirements

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
PD4 Area 8 Approx. 7 hectares	DAP	0.20	1.4
	Mushroom compost	10	70
	Lime	1	7
	Gypsum	3	21

5.4 Enhance Place Mine - Morris Property

The Morris property requires a boom spray application of *Taskforce* to control African lovegrass and also broadleaf weed control prior to any pasture renovation being undertaken.

Once this has occurred apply DAP and MOP to supply nitrogen and potassium, along with gypsum to supply calcium and sulfur at rates shown in **Table 13**. However, if the current grazing practices are not altered to a time control or rotational grazing system, allowing each paddock to have a period of rest and growth, the fertiliser application will have little impact on pasture improvement.

Table 13 EP 1 & EP 3 Morris Property Fertiliser Requirements

Site	Fertiliser Requirement	Tonnes/ha	Total tonnes
EP1&3 Morris Property Approx. 23 hectares	DAP	0.20	4.6
	MOP	0.25	5.75
	Gypsum	3	69

5.5 Enhance Place Mine - Crown Land

The Crown Land (EP 2) blocks do not currently require any remedial action as it has satisfactory pasture groundcover and appears to be only grazed by kangaroos. It is recommended that this area continues to be monitored against agreed rehabilitation completion criteria.

6 GRAZING PASTURE COMPLETION CRITERIA

Enhance Place proposes the following completion criteria for the grazing areas at Enhance Place Mine and Pine Dale Mine

Enhance Place proposes the following completion criteria to be achieved within five years for the grazing areas at Enhance Place Mine and Pine Dale Mine:

- Establishment of a vigorous perennial grass and annual legume pasture, comprising approximately 70% perennial grass and 20% annual legume.
- Obtain a year round pasture groundcover of greater than 70%.
- African lovegrass to comprise less than 10% of the pasture sward.
- Soil nutrient levels tested to meet the minimum completion targets shown in **Table 14**.

Soil element completion target measures we developed using a combination of the ideal range for soil elements and those measured at the undisturbed Site PD3 in Area C (**Appendix A**), where there is a vigorous perennial grass and annual clover based pasture established.

Table 14 Soil Nutrient Level Completion Targets

Soil Element	Measure & Test	Site PD3 Soil Test	Ideal Soil Element Range	Completion Target Measure
pH	1:5 $CaCl_2$	4.94	Between 5.2 – 8.0	Greater than 4.9
Potassium	% of Total CEC	3.17	Greater than 2%	Greater than 2%
Sodium	% of Total CEC	1.90	Less than 3%	Less than 3%
Aluminium	% of Total CEC	0.53	Less than 5%	Less than 5%
Sulfur	mg/kg KCl 40 S	6.8	Greater than 8	Greater than 6.8
Nitrogen	mg/kg Water Extract	4.6	Greater than 10	Greater than 4.6
Zinc	mg/kg DTPA	0.7	Greater than 1	Greater than 0.7
Calcium	Calcium to Magnesium Ratio	2.14	Greater than 3	Greater than 2.1

Appendix A

Pine Dale Mine and Enhance Place Mine

Rehabilitated Areas

Laboratory Soil Test Results

SOILTEC

SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s14-0897 (1)

Client: ***SLR***
Account: **Pdk 1**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.03	<0.15
pH	(1:5 $CaCl_2$)		6.60	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	9.15	See Percentage
Magnesium:		(Mg)(meq/100g)	5.66	See Percentage
Potassium:		(K)(meq/100g)	0.26	0.5-1.0
Sodium:		(Na)(meq/100g)	0.39	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**15.46**	
Exchangeable Cations (as a % of Total)				
Calcium:			59.18	65-80%
Magnesium:			36.61	15-20%
Potassium:			1.68	2-5%
Sodium:			2.52	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	13.5	
Sulphur	(mg/kg)	(KCl 40 S)	5.4	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	6.9	At least 10
Organic Carbon	(%)	(Walkely & Black)	1.8	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.7	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	14.6	
Iron		(mg/kg) (DTPA)	36.2	
Boron		(mg/kg) (Hot CaCl)	0.9	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			1.62	3-5

SOILTEC

SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s14-0897 (2)

Client: ***SLR***
Account: **Pdk 1**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 30-40cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.05	<0.15
pH	(1:5 $CaCl_2$)		4.20	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.99	See Percentage
Magnesium:		(Mg)(meq/100g)	5.32	See Percentage
Potassium:		(K)(meq/100g)	0.19	0.5-1.0
Sodium:		(Na)(meq/100g)	0.66	Zero
Aluminium:		(Al)(meq/100g)	0.63	Zero
Total Cation Exchange Capacity (CEC):			**13.79**	
Exchangeable Cations (as a % of Total)				
Calcium:			50.69	65-80%
Magnesium:			38.58	15-20%
Potassium:			1.38	2-5%
Sodium:			4.79	<3%
Aluminium:			4.57	<5%
Phosphorus:	(mg/kg)	(Bray-1)	13.7	
Sulphur	(mg/kg)	(KCl 40 S)	3.6	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	0.3	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.5	
Zinc		(mg/kg) (DTPA)	0.4	
Manganese		(mg/kg) (DTPA)	3.5	
Iron		(mg/kg) (DTPA)	9.4	
Boron		(mg/kg) (Hot CaCl)	0.6	
Calculations:				
Lime Requirement (Cregan)			0.82	(see notes on page 2)
Calcium/Magnesium Ratio:			1.31	3-5

SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s14-0897 (3)

Client: ***SLR***
Account: **Pdk 2**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.04	<0.15
pH	(1:5 $CaCl_2$)		4.57	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	7.78	See Percentage
Magnesium:		(Mg)(meq/100g)	4.25	See Percentage
Potassium:		(K)(meq/100g)	0.22	0.5-1.0
Sodium:		(Na)(meq/100g)	0.30	Zero
Aluminium:		(Al)(meq/100g)	0.59	Zero
Total Cation Exchange Capacity (CEC):			**13.14**	
Exchangeable Cations (as a % of Total)				
Calcium:			59.21	65-80%
Magnesium:			32.34	15-20%
Potassium:			1.67	2-5%
Sodium:			2.28	<3%
Aluminium:			4.49	<5%
Phosphorus:	(mg/kg)	(Bray-1)	30.5	
Sulphur	(mg/kg)	(KCl 40 S)	6.0	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	4.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	2.0	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.6	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	16.2	
Iron		(mg/kg) (DTPA)	28.4	
Boron		(mg/kg) (Hot CaCl)	0.8	
Calculations:				
Lime Requirement (Cregan)			0.77	(see notes on page 2)
Calcium/Magnesium Ratio:			1.83	3-5

SOILTEC

SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s14-0897 (4)

Client: ***SLR***
Account: **Pdk 2**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 20-30cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.04	<0.15
pH	(1:5 $CaCl_2$)		3.78	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	3.92	See Percentage
Magnesium:		(Mg)(meq/100g)	2.66	See Percentage
Potassium:		(K)(meq/100g)	0.14	0.5-1.0
Sodium:		(Na)(meq/100g)	0.55	Zero
Aluminium:		(Al)(meq/100g)	0.65	Zero
Total Cation Exchange Capacity (CEC):			**7.92**	
Exchangeable Cations (as a % of Total)				
Calcium:			49.49	65-80%
Magnesium:			33.59	15-20%
Potassium:			1.77	2-5%
Sodium:			6.94	<3%
Aluminium:			8.21	<5%
Phosphorus:	(mg/kg)	(Bray-1)	26.2	
Sulphur	(mg/kg)	(KCl 40 S)	3.0	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	0.3	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.5	
Zinc		(mg/kg) (DTPA)	0.5	
Manganese		(mg/kg) (DTPA)	5.8	
Iron		(mg/kg) (DTPA)	11.7	
Boron		(mg/kg) (Hot CaCl)	0.5	
Calculations:				
Lime Requirement (Cregan)			0.85	(see notes on page 2)
Calcium/Magnesium Ratio:			1.47	3-5

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SOILTEC SOIL AND PLANT ANALYSIS

2/37 OWENS CR (PO BOX 374) ALSTONVILLE NSW 2477
PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s14-0897 (5)

Client: ***SLR***
Account: **Pdk 3**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 30-40cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.04	<0.15
pH	(1:5 $CaCl_2$)		4.60	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	7.26	See Percentage
Magnesium:		(Mg)(meq/100g)	5.93	See Percentage
Potassium:		(K)(meq/100g)	0.16	0.5-1.0
Sodium:		(Na)(meq/100g)	0.81	Zero
Aluminium:		(Al)(meq/100g)	0.11	Zero
Total Cation Exchange Capacity (CEC):			**14.27**	
Exchangeable Cations (as a % of Total)				
Calcium:			50.88	65-80%
Magnesium:			41.56	15-20%
Potassium:			1.12	2-5%
Sodium:			5.68	<3%
Aluminium:			0.77	<5%
Phosphorus:	(mg/kg)	(Bray-1)	24.9	
Sulphur	(mg/kg)	(KCl 40 S)	4.2	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	0.3	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.4	
Zinc		(mg/kg) (DTPA)	0.3	
Manganese		(mg/kg) (DTPA)	6.9	
Iron		(mg/kg) (DTPA)	15.6	
Boron		(mg/kg) (Hot CaCl)	0.4	
Calculations:				
Lime Requirement (Cregan)			0.14	(see notes on page 2)
Calcium/Magnesium Ratio:			1.22	3-5

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Soil Test Report #s14-0897 (6)

Client: ***SLR***
Account: **Pdk 3**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.06	<0.15
pH	(1:5 $CaCl_2$)		4.94	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.08	See Percentage
Magnesium:		(Mg)(meq/100g)	2.84	See Percentage
Potassium:		(K)(meq/100g)	0.30	0.5-1.0
Sodium:		(Na)(meq/100g)	0.18	Zero
Aluminium:		(Al)(meq/100g)	0.05	Zero
Total Cation Exchange Capacity (CEC):			**9.45**	
Exchangeable Cations (as a % of Total)				
Calcium:			64.34	65-80%
Magnesium:			30.05	15-20%
Potassium:			3.17	2-5%
Sodium:			1.90	<3%
Aluminium:			0.53	<5%
Phosphorus:	(mg/kg)	(Bray-1)	14.7	
Sulphur	(mg/kg)	(KCl 40 S)	6.8	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	4.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	1.5	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.8	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	19.3	
Iron		(mg/kg) (DTPA)	30.8	
Boron		(mg/kg) (Hot CaCl)	0.8	
Calculations:				
Lime Requirement (Cregan)			0.07	(see notes on page 2)
Calcium/Magnesium Ratio:			2.14	3-5

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Soil Test Report #s14-0897 (7)

Client: ***SLR***
Account: **Pdk 4**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	*OPTIMAL*
Conductivity (dS/m)(1:5 water)			0.10	<0.15
pH	(1:5 $CaCl_2$)		5.71	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.80	See Percentage
Magnesium:		(Mg)(meq/100g)	2.57	See Percentage
Potassium:		(K)(meq/100g)	0.34	0.5-1.0
Sodium:		(Na)(meq/100g)	0.14	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**9.85**	
Exchangeable Cations (as a % of Total)				
Calcium:			69.04	65-80%
Magnesium:			26.09	15-20%
Potassium:			3.45	2-5%
Sodium:			1.42	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	32.6	
Sulphur	(mg/kg)	(KCl 40 S)	7.4	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	4.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	1.9	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.7	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	23.8	
Iron		(mg/kg) (DTPA)	33.7	
Boron		(mg/kg) (Hot CaCl)	0.9	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.65	3-5

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Soil Test Report #s14-0897 (8)

Client: ***SLR***
Account: **Pdk 5**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.11	<0.15
pH	(1:5 $CaCl_2$)		4.08	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	5.14	See Percentage
Magnesium:		(Mg)(meq/100g)	3.26	See Percentage
Potassium:		(K)(meq/100g)	0.27	0.5-1.0
Sodium:		(Na)(meq/100g)	0.71	Zero
Aluminium:		(Al)(meq/100g)	0.62	Zero
Total Cation Exchange Capacity (CEC):			**10.00**	
Exchangeable Cations (as a % of Total)				
Calcium:			51.40	65-80%
Magnesium:			32.60	15-20%
Potassium:			2.70	2-5%
Sodium:			7.10	<3%
Aluminium:			6.20	<5%
Phosphorus:	(mg/kg)	(Bray-1)	14.4	
Sulphur	(mg/kg)	(KCl 40 S)	6.3	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	6.9	At least 10
Organic Carbon	(%)	(Walkely & Black)	1.2	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.6	
Zinc		(mg/kg) (DTPA)	0.9	
Manganese		(mg/kg) (DTPA)	20.2	
Iron		(mg/kg) (DTPA)	39.2	
Boron		(mg/kg) (Hot CaCl)	0.8	
Calculations:				
Lime Requirement (Cregan)			0.81	(see notes on page 2)
Calcium/Magnesium Ratio:			1.58	3-5

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Soil Test Report #s14-0897 (9)

Client: ***SLR***
Account: **Pdk 5**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 20-30cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.13	<0.15
pH	(1:5 $CaCl_2$)		5.91	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	7.28	See Percentage
Magnesium:		(Mg)(meq/100g)	5.15	See Percentage
Potassium:		(K)(meq/100g)	0.20	0.5-1.0
Sodium:		(Na)(meq/100g)	1.06	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**13.69**	
Exchangeable Cations (as a % of Total)				
Calcium:			53.18	65-80%
Magnesium:			37.62	15-20%
Potassium:			1.46	2-5%
Sodium:			7.74	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	13.3	
Sulphur	(mg/kg)	(KCl 40 S)	3.4	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	0.4	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.3	
Zinc		(mg/kg) (DTPA)	0.5	
Manganese		(mg/kg) (DTPA)	11.2	
Iron		(mg/kg) (DTPA)	12.8	
Boron		(mg/kg) (Hot CaCl)	0.5	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			1.41	3-5

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Soil Test Report #s14-0897 (10)

Client: ***SLR***
Account: **EP1**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.07	<0.15
pH	(1:5 $CaCl_2$)		7.17	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.18	See Percentage
Magnesium:		(Mg)(meq/100g)	2.29	See Percentage
Potassium:		(K)(meq/100g)	0.27	0.5-1.0
Sodium:		(Na)(meq/100g)	0.16	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**8.90**	
Exchangeable Cations (as a % of Total)				
Calcium:			69.44	65-80%
Magnesium:			25.73	15-20%
Potassium:			3.03	2-5%
Sodium:			1.80	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	14.9	
Sulphur	(mg/kg)	(KCl 40 S)	7.0	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.2	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.8	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	24.7	
Iron		(mg/kg) (DTPA)	26.4	
Boron		(mg/kg) (Hot CaCl)	0.9	

Calculations:

Lime Requirement (Cregan)	0.00	(see notes on page 2)
Calcium/Magnesium Ratio:	2.70	3-5

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Soil Test Report #s14-0897 (11)

Client: ***SLR***
Account: **EP1**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 30-40cm **INTENDED USE:**
TEXTURE

			RESULT	OPTIMAL
Conductivity (dS/m)(1:5 water)			0.09	<0.15
pH	(1:5 $CaCl_2$)		5.53	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	7.56	See Percentage
Magnesium:		(Mg)(meq/100g)	3.81	See Percentage
Potassium:		(K)(meq/100g)	0.21	0.5-1.0
Sodium:		(Na)(meq/100g)	0.38	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**11.96**	
Exchangeable Cations (as a % of Total)				
Calcium:			63.21	65-80%
Magnesium:			31.86	15-20%
Potassium:			1.76	2-5%
Sodium:			3.18	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	11.4	
Sulphur	(mg/kg)	(KCl 40 S)	4.2	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	0.2	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.4	
Zinc		(mg/kg) (DTPA)	0.3	
Manganese		(mg/kg) (DTPA)	8.0	
Iron		(mg/kg) (DTPA)	13.3	
Boron		(mg/kg) (Hot CaCl)	0.4	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			1.98	3-5

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PHONE 02 66281411 FAX 02 66285868 EMAIL : chemist@soiltec.com.au

Soil Test Report #s14-0897 (12)

Client: ***SLR***
Account: **EP2**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.09	<0.15
pH	(1:5 $CaCl_2$)		7.12	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	4.37	See Percentage
Magnesium:		(Mg)(meq/100g)	2.05	See Percentage
Potassium:		(K)(meq/100g)	0.27	0.5-1.0
Sodium:		(Na)(meq/100g)	0.14	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**6.83**	
Exchangeable Cations (as a % of Total)				
Calcium:			63.98	65-80%
Magnesium:			30.01	15-20%
Potassium:			3.95	2-5%
Sodium:			2.05	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	19.7	
Sulphur	(mg/kg)	(KCl 40 S)	6.5	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	4.6	At least 10
Organic Carbon	(%)	(Walkely & Black)	3.0	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.7	
Zinc		(mg/kg) (DTPA)	0.7	
Manganese		(mg/kg) (DTPA)	26.4	
Iron		(mg/kg) (DTPA)	21.3	
Boron		(mg/kg) (Hot CaCl)	0.7	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			2.13	3-5

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Soil Test Report #s14-0897 (13)

Client: ***SLR***
Account: **EP2**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 20-30cm **INTENDED USE:**
TEXTURE

			RESULT	***OPTIMAL***
Conductivity (dS/m)(1:5 water)			0.09	<0.15
pH	(1:5 $CaCl_2$)		6.70	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	6.84	See Percentage
Magnesium:		(Mg)(meq/100g)	4.87	See Percentage
Potassium:		(K)(meq/100g)	0.30	0.5-1.0
Sodium:		(Na)(meq/100g)	0.28	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**12.29**	
Exchangeable Cations (as a % of Total)				
Calcium:			55.66	65-80%
Magnesium:			39.63	15-20%
Potassium:			2.44	2-5%
Sodium:			2.28	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	12.9	
Sulphur	(mg/kg)	(KCl 40 S)	3.3	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	0.4	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.5	
Zinc		(mg/kg) (DTPA)	0.5	
Manganese		(mg/kg) (DTPA)	11.7	
Iron		(mg/kg) (DTPA)	8.4	
Boron		(mg/kg) (Hot CaCl)	0.5	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			1.40	3-5

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Soil Test Report #s14-0897 (14)

Client: ***SLR***
Account: **EP3**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 0-10cm **INTENDED USE:**
TEXTURE

			RESULT	*OPTIMAL*
Conductivity (dS/m)(1:5 water)			0.09	<0.15
pH	(1:5 $CaCl_2$)		6.80	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	8.44	See Percentage
Magnesium:		(Mg)(meq/100g)	5.21	See Percentage
Potassium:		(K)(meq/100g)	0.35	0.5-1.0
Sodium:		(Na)(meq/100g)	0.54	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**14.54**	
Exchangeable Cations (as a % of Total)				
Calcium:			58.05	65-80%
Magnesium:			35.83	15-20%
Potassium:			2.41	2-5%
Sodium:			3.71	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	21.0	
Sulphur	(mg/kg)	(KCl 40 S)	5.9	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	2.8	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.8	
Zinc		(mg/kg) (DTPA)	0.8	
Manganese		(mg/kg) (DTPA)	25.1	
Iron		(mg/kg) (DTPA)	26.8	
Boron		(mg/kg) (Hot CaCl)	0.7	

Calculations:

Lime Requirement (Cregan)	0.00	(see notes on page 2)
Calcium/Magnesium Ratio:	1.62	3-5

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Soil Test Report #s14-0897 (15)

Client: ***SLR***
Account: **EP3**

Sample Received: 3.10.2014 Report Reply: 9.10.2014
SAMPLE I.D: 20-30cm **INTENDED USE:**
TEXTURE

			RESULT	*OPTIMAL*
Conductivity (dS/m)(1:5 water)			0.10	<0.15
pH	(1:5 $CaCl_2$)		5.38	5.2-5.5
Exchangeable Cations: (Measured)				
Calcium		(Ca)(meq/100g)	5.28	See Percentage
Magnesium:		(Mg)(meq/100g)	4.28	See Percentage
Potassium:		(K)(meq/100g)	0.29	0.5-1.0
Sodium:		(Na)(meq/100g)	0.34	Zero
Aluminium:		(Al)(meq/100g)	0.00	Zero
Total Cation Exchange Capacity (CEC):			**10.19**	
Exchangeable Cations (as a % of Total)				
Calcium:			51.82	65-80%
Magnesium:			42.00	15-20%
Potassium:			2.85	2-5%
Sodium:			3.34	<3%
Aluminium:			0.00	<5%
Phosphorus:	(mg/kg)	(Bray-1)	12.7	
Sulphur	(mg/kg)	(KCl 40 S)	2.8	8-10
Nitrate Nitrogen	(mg/kg)	(water extract)	2.3	At least 10
Organic Carbon	(%)	(Walkely & Black)	0.3	2% or more
Trace Elements				
Copper		(mg/kg) (DTPA)	0.4	
Zinc		(mg/kg) (DTPA)	0.3	
Manganese		(mg/kg) (DTPA)	10.2	
Iron		(mg/kg) (DTPA)	11.1	
Boron		(mg/kg) (Hot CaCl)	0.5	
Calculations:				
Lime Requirement (Cregan)			0.00	(see notes on page 2)
Calcium/Magnesium Ratio:			1.23	3-5

Appendix C

DRAFT Enhance Place Mine Draft Stock Management Plan

Enhance Place Mine
Draft Stock Management Plan

1449 Castlereagh Highway
Blackmans Flat NSW 2790

Report prepared for Mr & Mrs Morris
by First Field Environmental
on behalf of Enhance Place Mine Pty Ltd

February 2016

Revision history			
Version	Date	Author	Authorised by
Draft	10 February 2016	Michelle Evans /Anna Douglas Morris	Michelle Evans

This report has been prepared by First Field Environmental for Enhance Place Mine Pty Ltd. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report.

First Field Environmental

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Introduction

This Stock Management Plan has been developed by First Field Environmental, on behalf of Enhance Place Mine Pty Ltd, to provide guidance in relation to stock management on the Morris property.

The Morris property is located on land formerly comprising Enhance Place Mine. The property is on the southern side of Castlereagh Highway at Blackmans Flat, 15km north of Lithgow.

The land to which this report relates is shown on Figure 1 and Figure 2 and covers an area of approximately 16.2 ha. Enhance Place Mine operated as an open cut coal mine from 1997 until its closure in June 2005. Rehabilitation of the former Enhance Place Mine has included the importation of soil and creation of a landform similar to that of the surrounding area. Catchment drains and sediment retention basins have been installed. The land is currently fenced and gated and internal trails have been constructed.

The pasture area is part of a larger area which includes treed rehabilitation areas on steeper slopes of the landscape. These areas are adjacent to the pasture area but do not form part of the Stock Management Plan.

Although still under mining license to Enhance Place Mine, the land is utilised by Mr and Mrs Morris of 1449 Castlereagh Highway, Blackmans Flat. The land is currently grazed by miniature horses, horses, ponies and cows.

This report aims to provide Mr and Mrs Morris with a plan for maintaining the land as pasture for grazing and to promote appropriate stocking rates in accordance with land capability. The preliminary report will be provided to Enhance Place Mine and Mr and Mrs Morris and will facilitate discussion regarding the feasibility of land management practices in terms of desired land use. The preparation of a final Stock Management Plan will be informed by the outcomes of these discussions.

How to use this document

This document has been prepared for use in ongoing stock and grazing management for the property. Section one contains information about the property, including landuse and property characteristics, and provides background information related to the condition of the pasture areas.

Section two provides recommendations for achieving appropriate landuse and includes a Trigger Action Response Plan for addressing issues as they are observed. The land management schedule recommends the completion of specific activities on a regular basis.

Detailed information relating to stocking rates, fertiliser application and weed control is provided in the Appendices.

2. Property information

1.1 Previous landuse

Enhance Place Mine was established in 1997 to recover remnant coal from areas previously open cut mined in the 1950's. Open cut operations ceased in June 2005 when economically feasible coal reserves were exhausted.

Rehabilitation of the land by Enhance Place Mine Pty Ltd has been conducted in accordance with completion criteria contained within the Care and Maintenance Mining Operations Plan (Enhance Place Mine 2014) and has included:

- Land forming;
- Erosion management;
- Pasture establishment;
- Soil stabilisation; and
- Weed management.

Rehabilitation of the land by Enhance Place Mine Pty Ltd is ongoing. The most recent assessment of rehabilitation completion criteria (Enhance Place Mine 2014) determined the following:

Land forming - The final landform shaping and drainage control structures have been completed. The rehabilitated landform is considered to have no greater management requirements than the surrounding landforms and land uses.

Erosion management –The potential for major erosion (gully or tunnel erosion or mass movement) is considered to have been mitigated as there is no evidence of significant erosion occurring at the site. Surface erosion may occur in areas where vegetation rehabilitation has not been successful, or as a result of overgrazing.

Pasture establishment – The current proportion of annual legume and perennial grass species within the pasture areas is representative of species composition in adjoining unmined land. Ground cover in pasture rehabilitation areas is >70% however areas of sparse to no ground cover do exist.

Soil stabilisation – Cracking soils and waterlogging may occur in areas of overgrazing or where rehabilitation has not been successful.

Weed management – Noxious weeds have been controlled in accordance with the principles of an integrated weed management plan.

1.2 Current and future landuse

The land is currently utilised by Mr and Mrs Morris for grazing and generally supports combinations of the following livestock:

- Miniature horses;
- Horses;
- Ponies; and
- Cows.

Livestock grazing is a common activity in the Blackmans Flat region and it is the intention of Mr and Mrs Morris to continue to graze these animals in the future.

Figure 1 Enhance Place Mine

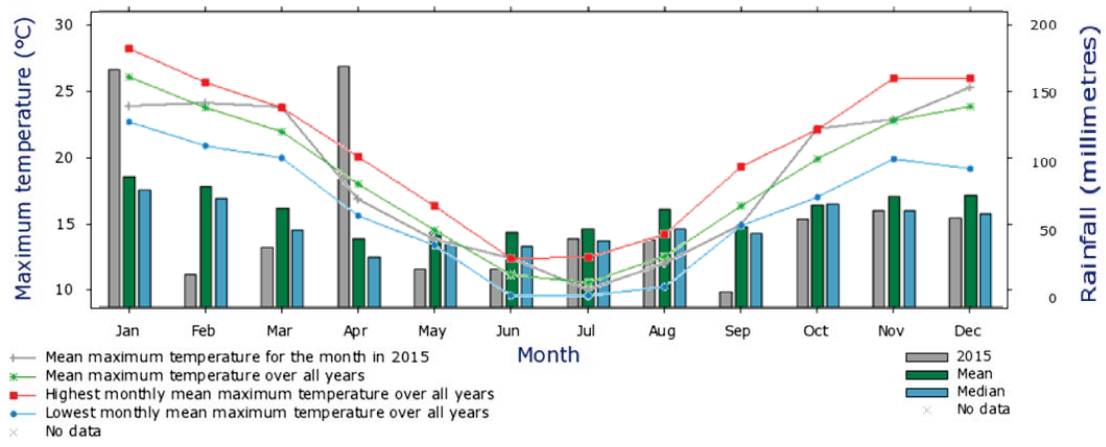
Figure 2 Property characteristics

1.3 Property characteristics

1.3.1 Climate

Blackman's Flat is located within the central tablelands of NSW, a region with a temperate cool-season wet climate (Stokes & Howden 2010). The area is characterised by warm summers, cool to cold winters and generally consistent rainfall. Mean maximum temperatures of around 23°C are experienced from November to March. Mean minimum temperatures of below 5°C are experienced from May to September. The area received a mean annual rainfall of 700 mm in 2015. January and April received the highest monthly rainfall of approximately 157 mm per month, while September had the lowest monthly rainfall of approximately 9 mm (Bureau of Meteorology 2016).

Mean monthly temperature and rainfall statistics from each station indicate strong seasonality in average temperatures, with relatively similar average rainfall patterns throughout the year. The following average rainfall and temperature data (Figure 3) has been sourced from Bureau of Meteorology records for Lidsdale (Maddox Lane) and Lithgow (Cooerwull) and is considered indicative of conditions experienced on the property.



Source: Bureau of Meteorology (2016)

Figure 3 Mean maximum temperature rainfall for 2015 compared to data from 2006-2015

1.3.2 Topography

Blackman's Flat is located on the western side of the Blue Mountains and is at 900 m (Australian Height Datum). The landscape is characterised by rolling hills. Slopes vary between 10% and 25% with a local relief of less than 50m. The study area was filled and contoured prior to 2014 and the shape and form of the landscape is considered to be visually similar to the adjacent landscape.

1.3.3 Soils

Soils on the property are highly disturbed, resulting from rehabilitation activities including filling of the open cut coal mine, soil importation and land forming. As a result; soil physical and chemical characteristics are not consistent with unmined soils of the region.

Unmined soils adjacent to the property are generally mapped as Cullen Bullen soil landscape (*Soil landscapes of the Wallerawang 1:100,000 sheet* King 1993).

Soil characteristics

Various soil components have been surveyed as part of rehabilitation monitoring undertaken by First Field Environmental. Soil samples to a depth of 20 cm were taken randomly from ten points throughout the pasture area, and physical characteristics including soil structure, ped shape and ped surface characteristics were assessed in accordance with the *Australian soil and land survey field handbook* (CSIRO 2009).

Soil was found to have very low texture / buffering capacity (soil acidification hazard class 4) and a pH of 5.38 – 7.17 ($CaCl_2$).

Soil nutrient analysis was undertaken for topsoil and subsoil samples from two locations on the property (SLR Global Environmental Solutions November 2014). Results indicated good to excellent levels of phosphorus, suggesting previous phosphorus fertiliser application.

Soil nutrient testing has identified the following nutrients as being deficient from the pasture soils:

- Potassium (K);
- Sodium (Na);
- Sulfur (S);
- Nitrogen (N);
- Zinc (Zn); and
- Calcium (Ca).

1.3.4 Drainage

Contour drains and sediment retention basins were established prior to 2014 and generally remain in good operational condition with little evidence of surface water flow occurring outside of established contour drainage lines.

Isolated areas accounting for less than 1% of the rehabilitated pasture area show evidence of seasonal waterlogging.

1.3.5 Erosion and sedimentation

There are no significant erosion features that compromise landform stability within the rehabilitation areas. The landform is considered to be stable and is suitable for grazing horses.

There is some evidence of active, minor to moderate wind erosion where pastures are poorly established or absent (see Figure 4 and Figure 5). Minor rilling is occurring on exposed soils of the sediment retention basins and can be seen in Figure 6.

Figure 4 Patchy exposed soils in south-western corner of pasture area

Figure 5 Exposed soils in southern portion of pasture area

Figure 6 Minor erosion of sediment retention basin wall

Surface cracking to 20 cm is evident along slope crests in the northern extent of the pasture area (see Figure 7). Soil samples taken to a depth of 20 cm indicate that soils are not prone to cracking through swelling and shrinking and suggest that cracking is indicative of soil settling.

Figure 7 Example of soil cracking on slope crests

1.3.6 Pasture species

Pastures were established with Cox's River seed mix prior to 2014 and are considered to be representative of species composition of grazing pastures on adjacent, unmined soils.

Cox's River seed mix consists of 70% perennial grasses and 20% annual legumes, sown at the following rates:

- 40% Fescue
- 25% Cocksfoot
- 20% Subterranean clover
- 6% Perennial rye grass
- 5% White clover
- 4% Phalaris

Within this region, cold temperatures (especially in July and August) restrict pasture growth and areas are prone to severe frosts, with the frost-free period varying from 150 to 240 days per year.

Provided there is adequate moisture, pasture growth increases with warmer temperatures. Frost sensitive species such as Kangaroo Grass (*Themeda australis*) stop growing at warmer winter temperatures than most frost tolerant, winter green species such as Phalaris (*Phalaris aquatica*) and Perennial Ryegrass (*Lolium perenne*).

In summer, evaporation exceeds rainfall, reducing pasture growth. In winter rainfall exceeds evaporation, but cooler temperatures slow pasture growth. Heavy summer rains face higher evaporation rates than rain falling mid-autumn when evaporation rates are lower. The response of pastures to summer moisture rates varies with the species. Tall Fescue (*Festuca arundinacea*) responds well to summer rainfall, however Phalaris has a heat dormancy mechanism and does not respond well (NSW Agriculture 2003).

The phases of pasture growth are described in Appendix .

1.3.7 Weeds

Weeds with the potential to occur in the region are defined as those which are listed under the Noxious Weeds Act 1993; Weeds of National Significance and Environmental Weeds. Also included in this report are species that have been identified as being harmful to horses.

The following weeds species meeting this definition have been observed on the property during previous surveys:

- African Lovegrass (Eragrostis curvula);
- Blackberry (*Rubus fruticosus* aggregate);
- St John's Wort (*Hypericum perforatum*);
- Sweet Briar (*Rosa rubiginosa*);
- Crofton Weed (*Ageratina adenophora*);
- Fireweed (*Senecio madagascariensis*);
- Wild Radish (*Raphanus raphanistrum*);
- Flatweed (*Hypochaeris radicata*); and
- Paterson's Curse (*Echium plantagineum*).

Recent outbreaks of African Lovegrass have been subjected to ongoing chemical control. The extent of African Lovegrass infestation can be seen in Figure 2. These areas were treated in late 2015 in accordance with control methods listed in Appendix A and are currently not observed to be growing or producing seed.

A full list of noxious weeds declared in the Upper Macquarie County Council is provided in Appendix B. Best practice integrated weed control methods are described in Appendix B.

1.3.8 Fencing and access

The location and extent of current fencing and access trails is shown in Figure 2. All fences and gates appear to be in good condition.

Access trails within the study area are generally in good condition; however minor wind and water erosion is evident in steeper areas of trails.

1.3.9 Land and soil capability

Land capability refers to the suitability of land for particular agricultural activities and is determined by the relationship between the physical and chemical properties of soils. An assessment of these properties conducted in accordance with the *Land and Soil Capability Assessment Scheme* (NSW Office of Environment and Heritage, 2012) is summarised in Table 1.

The resulting classification indicates that the pastures are consistent with **Land and Soil Capability Class V** and are suitable for grazing.

Class V land has severe limitations for high impact land management uses such as cropping, and is generally more suitable for grazing with some limitations or very occasional cultivation for pasture establishment. It is important to minimise soil disturbance, maintain cover and maintain good organic matter levels. The limiting factors for land use are generally related to wind erosion hazard.

Table 1 Rural land capability assessment

Class	Description
Water erosion hazard class	3 3 - <10% slope
Wind erosion hazard class	5 Moderate wind erodibility class of surface soil, high winds erosive power, high exposure to wind, average annual rainfall >500mm
Soil structural decline class	4 Fragile light textured soil - hardsetting
Soil acidification hazard class	4 Very low texture /buffering capacity, pH 5.38 – 7.17 ($CaCl_2$)
Salinity hazard class	1 Moderate to high recharge potential, low discharge potential, low salt store
Waterlogging hazard class	2 0 – 0.25 months typical waterlogging duration, moderately well drained soils
Shallow soils and rockiness hazard class	1 Nil rocky outcrop, soil depth >100 cm
Mass movement hazard class	1 No mass movement present

3. Property management

2.1 Stocking rates

The grazing area (see Figure 2) within the property is comprised of three fenced paddocks with a combined area of ~16.2 ha:

- Paddock 1 (~9.4 ha);
- Paddock 2 (~1.9 ha); and
- Paddock 3 (~4.9 ha).

The success of pastures in supporting current stocking rates has been determined in relation to the pasture and soil condition at the time the field survey was conducted (11th September 2015).

Carrying capacity refers to the 'dry sheep equivalent' (DSE) per hectare supported by the class of pasture. DSE is a standard unit used to measure the feed requirements of different animal classes. Table 2 below shows the DSE ratings of different stock classes.

The paddocks have been classified as 'top-dressed pasture with some clover', which according to the NSW Department of Primary Industries (2005) has a DSE rating of 7-10.

The carrying capacity is the number of hectares required for a particular animal on a pasture type and is determined as the livestock DSE divided by the pasture DSE:

Horse – light horse in current top-dressed pastures with some clover = 10.0/(7-10) = 1.42 – 1.0

A light horse therefore requires 1.42-1.0 hectares of top-dressed pasture with some clover to survive. The current capacity of each fenced pasture area on the property is summarised in Table 2.

Table 2 DSE ratings of different stock classes and current carrying capacity of pasture in present and improved conditions

Livestock (DSE rating)	Number of hectares required	Fenced area 1 (9.4 ha)	Fenced area 2 (1.9 ha)	Fenced area 3 (4.9 ha)
Top-dressed pasture with some clover (present state of pasture) (average DSE /ha = 7-10)				
Horses – light horse (DSE = 10)	1.43-1.0	6-9	1-2	3-5
Horse – under light work (DSE = 13.5)	1.93-1.35	5-7	1	2-4
Pony (DSE = 6)	0.86-0.6	11-15	2-3	5-8
Miniature horse (DSE = 3.5)	0.5-0.35	19-27	4-5	10-14
Cow – dry stock (450 kg) (DSE = 6)	0.86-0.6	11-15	2-3	5-8

Livestock (DSE rating)	Number of hectares required	Fenced area 1 (9.4 ha)	Fenced area 2 (1.9 ha)	Fenced area 3 (4.9 ha)
Cow – bull (800 kg) (DSE = 10)	1.43-1.0	6-9	1-2	3-5
Alpaca – wether (DSE = 1)	0.14-0.1	67-94	13-19	35-49
Alpaca – pregnant (DSE = 1.5)	0.21-0.15	44-62	9-12	23-32
Alpaca lactating (DSE = 2)	0.29-0.2	32-47	6-9	17-24
Improved pasture, paspalum, kikuyu and clover on good fertility soils + fertiliser (average DSE /ha = 14-24)				
Horses – light horse (DSE = 10)	0.71-0.42	13-22	3-4	7-11
Horse – under light work (DSE = 13.5)	0.96-0.56	10-17	2-3	5-9
Pony (DSE = 6)	0.43-0.25	22-37	4-7	11-21
Miniature horse (DSE = 3.5)	0.25-0.15	37-62	7-12	21-32
Cow – dry stock (450 kg) (DSE = 6)	0.43-0.25	22-37	4-7	11-21
Cow – bull (800 kg) (DSE = 10)	0.71-0.42	13-22	3-4	7-11
Alpaca – wether (DSE = 1)	0.07-0.04	134-235	27-47	70-122
Alpaca – pregnant (DSE = 1.5)	0.1-0.06	94-156	19-31	3-81
Alpaca lactating (DSE = 2)	0.14-0.08	67-117	13-24	35-61

Note: All calculations are based on the pasture rehabilitation area do not include the treed rehabilitation areas or dams. Calculations of top-dressed pasture are based on an average of 87.5% total living cover. Calculations of improved pasture are based on 100% total living cover. DSE ratings for horses and ponies sourced from NSW DPI (2009); for miniature horses Landform Research (2014); for cows NSW DPI (2005); for Alpacas AAA (2013).

2.2 Grazing management

Grazing management is a cost-effective tool to obtain the most from a pasture (NSW Agriculture 2003). Benefits of good grazing management include:

- Optimisation of pasture growth;
- Maximisation of feed quality; and
- Maintenance of adequate ground cover that in turn prevents erosion and resists weed invasion.

A number of factors influence pasture including soil type and depth, nutrient transfer and fertiliser inputs, and aspect and topography, all of which are likely to cause differences in pasture composition both within and between the paddocks. The different grazing habits and dietary preferences of stock will also affect pasture composition.

Recent monitoring by First Field Environmental revealed an average total living ground cover of 87.5% within the established quadrats of pasture rehabilitation area. Establishing and maintaining near 100% ground cover across the paddocks can ensure that optimal rainfall is retained in the landscape and concurrently sediments (potential resources) are trapped within the farm-scape, rather than lost through erosive processes (Gleeson & Gleeson 2012).

The establishment and persistence of good ground cover will reduce various forms of soil degradation, including soil acidification, rising water tables and dryland salinisation, as well as increasing beneficial soil micro-organisms and improving soil structure, pasture composition and fertility (NSW Agriculture 2003).

2.3 Pasture species

The pastures currently support a mix of summer and winter-growing species palatable to horses and cattle. Re-sowing is required when favourable pasture cover decreases to <70%, which may occur as a result of overgrazing, seasonal changes in pasture growth, waterlogging or loss of topsoil. A list of summer and winter-growing pasture species is provided in Appendix C and includes the method, rate and optimal timing for sowing each species.

2.4 Nutrient availability

Soils currently exhibit a pH of 6.7-7.9. While this is within the range of adjacent, unmined soils, a decrease in availability of certain nutrients in slightly acid soils may be mitigated through appropriate fertiliser application. Other nutrients may decline as a result of the removal of biomass through grazing and may require regular application. Application rate, method and optimal timing relevant to the property is provided in Appendix D.

2.5 Paddock rotation

The temporary exclusion of livestock from paddocks is required in order to conduct sediment and erosion control works, re-sowing and weed treatment. Livestock may be excluded from one of three fenced paddocks in the pasture area and may also be housed temporarily in the home paddock or stables. Activities requiring the exclusion of livestock are addressed in the Trigger Action Response Plan (see Section 2.6). Regular paddock rotation is addressed in the Land Management Schedule (Section 2.7).

2.6 Trigger Action Response Plan

Table 3 summarises the actions required when certain triggers are observed. Whilst some of these actions need to be conducted at specific times, others can be implemented as needed. A schedule of land management actions to be conducted at regular intervals is provided in the following section.

Table 3 Trigger Action Response Plan

Goal	Trigger	Action	Optimal timing
Appropriate stock rate	The number of stock grazing in pastures should be in accordance with the grazing capability of each pasture.	Refer to Section 2.1 for appropriate stocking rates. Match number of stock to specific paddock recommendations provided in Table 2.	Ongoing.
Weeds including African Lovegrass to comprise <10% of the pasture sward with no significant infestations.	More than 10% of the pasture sward composed of weeds. Weeds outcompeting preferred species.	Identify and map the location of noxious weeds, weeds hazardous to horses and weeds of national significance (see Appendices A and B). Treat weeds in accordance with Appendices A and B. Install temporary fencing around outbreaks to restrict grazing pressure during weed treatment and regrowth of preferred species.	As required. Determine optimal timing of weed control in accordance with Appendix A. Spray weeds during target species' growth period and when the desirable species are dormant (refer to Appendices A and E).
Maintenance of ground cover (vegetation, leaf litter, mulch, cryptograms) at or above 70%.	Less than 70% ground cover.	Rip along contours of poorly established pasture rehabilitation areas and re-sow pasture mix and fertiliser. Increase and maintain groundcover in pasture rehabilitation areas to at least 95% to minimise run-off and loss of nutrients and soil, and limit erosion.	As required. Select appropriate seasonal species for re-sowing (refer to Appendix C).
Sustainable growth medium.	Topsoil measured to be less than 50 mm deep.	Apply topsoil to 50 mm depth. Sow a cover crop of oats or short-term rye grasses to protect the soil surface (sub-surface root system remains even after grass has died off). Install temporary fencing to restrict grazing pressure during regrowth.	As required.
No loss of topsoil.	Presence of active surface erosion. Combined bare surfaces of more than 20 m^2 per hectare.	Remove livestock and install temporary fencing to restrict grazing pressure during regrowth. Sow a cover crop of oats or short-term rye grasses to protect the soil surface (sub-surface root system remains even after grass has died off).	As required.

Goal	Trigger	Action	Optimal timing
Limited areas of high concentration of soil cracking due to soil settling.	Broad areas of cracking soils associated with soil settling.	Mechanically improve the soil surface in areas where cracking is more than 20 cm in depth.	As required.
Minimal waterlogging and ponding in pastures.	Presence of surface water pooling more than 48 hours after rainfall. Yellowing of pasture. When holes are dug 20-30 cm below the surface, water flows into them.	Intercept water upslope with earthworks and redirect into farm dams. Clear impediments from contour drains. Install temporary fencing to restrict grazing pressure and prevent damage to pasture and soil. Plant deep-rooted temperate perennial grass species in areas prone to waterlogging. Graze taller pastures (>10 cm) as it enables animals to eat their allocation quicker and will prevent the need for stock to walk in search of food.	As required. Install drains when soils are moist e.g. after summer or autumn rains.
Stable sediment retention basins.	Active erosion of sediment retention basins.	Revegetate exposed sediment retention basin walls with perennial species.	As required. Select appropriate seasonal species for re-sowing (refer to Appendix C).
Stable trail surfaces	Water ponding, active erosion and minor rilling on trail surfaces.	Construct a roll-over drain above existing rill erosion on sloping trails to divert water off trail surface more effectively.	Install drains when soils are moist e.g. after summer or autumn rains.
No symptoms of overgrazing are evident	Symptoms of overgrazing evident e.g. pasture grazed lower than 3 cm; ground cover below 70%.	Locate water points and fences to manipulate grazing distribution, ensure even pasture utilisation and reduce selective grazing. Keep paddock records of stock numbers and use in conjunction with land condition monitoring to help determine suitable stocking rates.	Assess available feed and adjust stocking rates at the end of the growing season (refer to Appendix E).

2.7 Land management schedule

Table 4 Land management schedule

Goal	Description	Activity	Timing	Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
Appropriate soil nutrient levels and pH range	Soils should be within a pH range of >5.0 and <8.5 to facilitate availability of soil nutrients consistent with soils on adjacent, unmined properties. Soil nutrients deficiencies (as determined by agricultural soil testing) should be balanced to within appropriate ranges as indicated in Section 2.4.	Apply lime and fertilisers in accordance with Appendix D. Re-sow exposed soils with a seasonally appropriate pasture mix (see Appendix C). Fence area to exclude grazing until the pasture is established and then only lightly graze the pasture in the first growing season.	As part of initial pasture regeneration activities. Then once every three years. Note: see Appendix D for appropriate timing of fertiliser application.												
Erosion control	Less than 20% of the pasture area should have exposed soils.	Identify and map areas of active surface soil erosion. Re-sow exposed soils with a seasonally appropriate pasture mix (see Appendix C). Fence area to exclude grazing until the pasture is established and then only lightly graze the pasture in the first growing season.	As part of pasture regeneration activities.												

Goal	Description	Activity	Timing	Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
		Plant trees where mid-slope soils are exposed and fence area to exclude grazing until trees are established.													
Seasonally appropriate pasture growth	More than 70% favourable species in winter pastures. More than 70% favourable species in summer pastures.	Determine % species presence in pastures (see Appendix C). Move stock to prevent overgrazing and decline of desirable pasture species.	Seasonally.				Winter pasture species						Summer pasture species		
Weed control	No noxious weeds. No weeds hazardous to horses. No weeds of national significance. Less than 10% of pasture supporting African Lovegrass.	Identify and map the location of noxious weeds, weeds hazardous to horses and weeds of national significance (see Appendices A and B). Treat weeds in accordance with Appendices A and B. Heavily graze annual weeds to remove seed heads and reduce seed set.	During seasonal periods of weed establishment (see Appendix E). As part of pasture regeneration activities. See Appendix A for appropriate timing of weed treatment. See Appendix E to determine optimal timing for grazing during seed production and set.												

Goal	Description	Activity	Timing	Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
Pasture regeneration	Maintenance of pasture comprising approximately 70% perennial grass and 20% annual legumes.	Identify priority pasture areas for regeneration. Exclude stock from regenerating pasture. Ensure that stocking rates in remaining pasture areas is consistent with Section 2.1. Only lightly graze newly sown pasture areas in the first season. Rest pastures for seed set and re-establishment e.g. delay grazing of sub-clover in autumn until the 2-3 leaf stage where feasible.	For pasture regeneration, spelling must occur after effective rainfall has fallen, when the plants are actively growing and restoring their root reserves.												

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Appendix A Weed management plan

Introduction

This Plan has been prepared to meet the requirements for noxious weed control in the Upper Macquarie County Council area.

Legal requirements

Individuals, landholders and Government have a responsibility to control noxious weeds on their land under the *Noxious Weeds Act* 1993, which is regulated in the area by the Upper Macquarie County Council. Weeds under this Act include Weeds of National Significance (WoNS) and Environmental Alert Weeds (EAW).

The following legislation and strategies may require consideration when undertaking various weed management activities.

Legislation relevant to weed control

Legislation	Summary
Noxious Weeds Act 1993	The *Noxious Weeds Act* 1993 defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. The Act sets up categorisation and control actions for the various noxious weeds, according to their potential to cause harm to the environment. Landowners or occupiers of land are required to control noxious weeds on the property and to prevent the spread of noxious weeds to adjoining land.
Pesticides Act 1999	The NSW Department of Environment and Conservation restricts the application of certain pesticides near or within waterways.
Work Health and Safety Act 2011	The Act is administered by Workcover NSW. There are specific requirements relating to use of pesticides and certification of pesticide operators.
Australian Weeds Strategy – A national strategy for weed management in Australia (Department of the Environment and Water Resources 2006)	The Strategy provides a national framework to complement state, territory, regional and local government strategies and industry initiatives and legislative controls; and identifies the Weeds of National Significance (WONS) for priority weed management efforts.
Threat Abatement Plans	Statutory plans under the NSW *Threatened Species Conservation Act* 1995 for control of Key Threatening Processes, which includes some weed species.

Weeds to which this Plan applies

This Plan has been developed for the control and management of Class 4 noxious weeds listed for the Upper Macquarie County Council area (Appendix B).

In addition, this Plan identifies noxious weeds for which there are specific control and notification requirements:

- Control Class 1 and 2 – Plants which must be eradicated from the land and whose presence must be notified to the local control authority;
- Control Class 3 – Plants which must be fully and continuously suppressed and destroyed; and
- Control Class 5 – Outbreaks of which must be reported to the local control authority within three days of discovery.

Weeds listed as WoNS have been determined by the Australian Government based on their invasiveness, potential for spread, and their environmental, social and economic impacts. Listed WoNS have been and continue to be responsible for significant agricultural, forestry and environmental damage.

The EAW list has been compiled by the Australian Government Department of Environment and Heritage in conjunction with other experts and complements the WONS list. Weeds that have been placed on the National Environmental Alert List have been identified as having the potential to become a significant threat to biodiversity if they are not managed in the early stages of establishment.

Implementation

Weed control

Weed control on the site will include:

- Identification of noxious weeds across the property;
- Determination of control class of noxious weeds observed on the property;
- Weed management scheduling in accordance with the aims of integrated weed management; and
- Monitoring the occurrence and extent of noxious weeds.

Note: Scheduled weed treatment may be determined in accordance with:

- *Weed control in pastures and lucerne 2010* (NSW Industry and Investment, 2010)
- *Noxious and environmental weed control handbook: a guide to weed control in non-crop, aquatic and bushland situations* (NSW DPI, 2011);
- *Calendar of growth cycle and control times for weeds of the Southern* Tablelands (NSW DPI, n.d); and
- *Weed Alerts* (NSW DPI, n.d.).

Integrated weed management

Weed competition is a major cause of pasture establishment failure and may lead to a loss of pasture production. Cultivation, cropping, slashing, herbicides and pasture manipulation can all be effectively used to control weeds (NSW Agriculture 2003). When using herbicides, it is important to remember that selection and correct use of herbicide is crucial.

Grazing by livestock may also be used as a form of weed control, by helping to suppress and reduce weed growth and seed production and/or prevent weed domination (Gleeson & Gleeson 2012).

However this technique varies in effectiveness depending on the palatability of the weed species. A combination of grazing and weed control (through the use of a herbicide application or other techniques to remove unpalatable weeds) can be an effective solution.

Integrated weed management control methods have been sourced from the *Noxious and environmental weed control handbook: A guide to weed control in non-crop, aquatic and bushland situations* (NSW DPI 2011). Chemical control methods may differ between life stages and application method for each species.

Integrated weed management of Control Class 4 noxious weeds

Note: species in **bold** have been recorded on the property

Common name ***Scientific name***	**Physical**	**Biological**	**Cultural**	**Chemical**
African boxthorn *Lycium ferocissimum*	Mechanically remove the top growth and as many of the roots as possible when soil is wet (winter) and burn the removed material.			A number of herbicides may be used for treatment. Regrowth should be sprayed.
African lovegrass ***Eragrostis curvula***			Pasture improvement and grazing management will reduce re-establishment. Main control principle is to ensure it is replaced by better species.	
Arrowhead *Sagittaria montevidensis*	Excavation with machinery or manual digging by hand from waterways. Steam application.		Maintain good hygiene and containment during physical control.	Use of a herbicide registered to control arrowhead. Herbicide treatment will often only suppress infestations and regeneration will occur.
Asparagus weeds *Asparagus* species	Carefully dig out the entire crown of *A. aethiopicus*, leaving the roots and tubers in situ; the crown and any fruiting stems should be bagged and burnt. The entire plant (including root system) of *A. declinatus* can be dug out in small to medium sized infestations. Sheep grazing may be effective on *A. asparagoides.*	Biological control agents are available for *Asparagus asparagoides.*		A number of herbicide options are available, most of which require a permit for use.

Common name *Scientific name*	Physical	Biological	Cultural	Chemical
Bathurst/Noogoora/ Hunter/ South American/ Californian/ Cockle burr *Xanthium* species	Hoe, chip or slash before flowering or seed set.	Biological control agents are available.	Maintaining ground cover in pastures to reduce burr germination and seedling survival. Prevent overgrazing of pastures in spring and summer. Seedling form is toxic to livestock.	A range of foliar and residual herbicide options are available.
Blackberry ***Rubus fruticosus* species *aggregate***	Slashing of juvenile bushes and use of goats (and potentially sheep depending on availability of other feed) will give some control, however these techniques are best used in a combination with herbicides (due to the root structure of the blackberry).	Biological control agents are available.	Improve pastures with a vigorous perennial species. Strong, actively growing pasture will help prevent invasion from weeds.	Herbicides are the most reliable method for achieving local eradication of blackberry, and a number of herbicides are registered for use on this weed.
Chilean needle grass *Nassella neesiana*			Good grazing management combined with a pasture improvement program to reduce the soil seed bank.	Herbicide application may be used in combination with other management techniques.
Lippia *Phyla canescens*		The *National Lippia Working Group* is currently investigating biological control options.	Requires an integrated approach of suppression, pasture improvement and pasture maintenance.	Herbicide application should be used in conjunction with cropping, pasture improvement and grazing management where appropriate.
Long-leaf willow primrose *Ludwigia longifolia*	Small plants may be manually removed, taking care not to spread seed.			
Nodding thistle *Carduus nutans* subsp. *nutans*	Grubbing on scattered plants. Remove at least the top 10 cm of the root system and invert the sod to	Biological control agents are available.	Good perennial pastures with sound grazing management to prevent invasion.	Herbicide application at the early seedling stage or when passing from the seedling to the rosette stage.

Common name *Scientific name*	Physical	Biological	Cultural	Chemical
	expose the plant roots and prevent regrowth.			
Pampas grass *Cortaderia* species	Mechanical removal where possible. Remove the seed heads of large plants and slash before grubbing.	Readily grazed by stock when it is young (which prevents the development of flowers and seed set), before it becomes too abrasive.		May be treated with a Glyphosate-based herbicide such as Roundup.
Prickly pear *Opuntia* species		*Cochineal* and *Cactoblastis* biological control agents are available.		
Prickly pear *Cylindropuntia* species	Small plants can be carefully mechanically removed.			
Sagittaria *Sagittaria platyphylla*	Isolated plants can be manually removed.			
Scotch broom *Cytisus scoparius*		Biological control agents may be available.	Use of goats as grazing management tool.	
Scotch, Stemless, Illyrian and Taurian thistles *Onopordum* species	Grub out single plants, removing at least 50 mm of root.	Biological control agents are available.	Establish a strong, perennial, grass-based pasture.	
Serrated tussock *Nassella trichotoma*	Grub out single plants.		Establish perennial pasture with good grazing management.	
Silverleaf nightshade *Solanum elaeagnifolium*			Use strong, competitive crops or pasture. Quarantine infestation and prevent seeding. Do not cultivate.	Seedlings are readily controlled by all registered herbicides.

Common name *Scientific name*	Physical	Biological	Cultural	Chemical
Spiny burrgrass *Cenchrus incertus /Cenchrus longispinus*			Establish a strong, competitive summer pasture. Ensure equipment hygiene is used to prevent seed dispersal. Quarantine infestations.	Herbicides are best used in a strategy incorporating cultivation, crop rotation and pasture improvement.
St. John's wort ***Hypericum perforatum***		Biological control agents are available.	Prevent invasion. Establish perennial pasture with good grazing management.	Spot-spraying using a registered herbicide can be used on isolated infestations.
Star thistle *Centaurea calcitrapa*	Hoe or chip individual plants or small infestations, removing at least 50 mm of the root.		Improve pasture stand.	Foliar application of a registered herbicide at seedling or rosette stage for best results.
Sweet briar ***Rosa rubiginosa***	Remove mechanically or grub out established plants. Graze with goats. Young seedlings may be grazed with sheep to help prevent establishment.		Vigorous perennial pastures provide competition to reduce invasion.	Registered herbicide may be applied by foliar spray, basal bark treatment, cut stump treatment or root application.
Wild radish ***Raphanus raphanistrum***	Young plants may be easily removed by hand. Older plants develop a taproot that makes physical removal difficult. Slashing may reduce seed production but won't destroy the plant.	Biological control is risky as the plant is closely related to many agricultural and horticultural species.	Maintain a well-balanced pasture with good grazing management. Stock should be removed from Wild Radish infested areas.	Herbicide treatment may be used, however some populations have developed herbicide resistance.
Willows *Salix* species	Seedlings may be pulled by hand.			Registered herbicides may be applied by foliar spray, cut stump application or stem injection.

Chemical weed control methods

Species	Weed type /Noxious weed control class	Control method	Effect on grazing	Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
African Lovegrass *Eragrostis curvula*	4	Flupropanate 745 g/L **(*Taskforce*)** 300 mL per 100 L of water. **Non-chemical options:** appropriate grazing management.	4 month stock withholding period for boom spraying. 14 day stock withholding period for spot spraying.	✓	✓	✓							✓	✓	✓
Blackberry *Rubus fruticosus* aggregate species	4	Triclpyr 300 g/L + Picloram 100 g/L + Aminopyralid 8 g/L **(*Grazon Extra*)** 350 or 500 mL per 100 L water. **Non-chemical options:** slashing of young bushes and use of biological control agents.	No stock withholding period required.	✓	✓	✓	✓								
Crofton Weed *Ageratina adenophora*	Weed of horse pastures	MCPA 340 g/L + Dicamba 80 g/L **(Banvel M, Kamba M)** 2.8 L or 4 L per 100 L water. **Non-chemical options:** small plants can be dug out with mattock, slashing, and biological control agents.	7 days stock withholding period. The slashed and dried plant is still attractive and toxic to horses. Keep horses away until the plant has been completely removed from the paddock.	✓	✓	✓	✓						✓	✓	✓
Fireweed *Senecio madagascariensis*	Weed of horse pastures	Bromoxynil 200 g/L **(Various trade names)** 1.4 L or 2.8 L per 100 L water. Diflufenican g/L + Bromoxynil 250 g/L **(Jaguar, Barracuda)** 500 mL per 100 L water. Paraquat 250 g/L **(Gramoxone 250, Paraquat 250, Nuquat 250)** 1.2 L per 100 L water. Paraquat 135 g/L + Diquat 115 g/L **(Spray Seed 250)** 1.6 or 2.4 L per 100 L water.	Bromoxynil has 14 days stock withholding period. Diflufenican + Bromoxynil has 56 days stock withholding period. Paraquat has 7 days stock withholding period for horses. MCPA + Diflufenican has 7 days stock withholding period.				✓	✓	✓						

Species	Weed type /Noxious weed control class	Control method	Effect on grazing	Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
		MCPA 250 g/L + Diflufenican 25 g/L **(Tigrex, Nugrex)** 1 L per 100 L water. Triclopyr 300 g/L + picloram 100 g/L **(Grazon Extra)** 350 mL per 100 L water. **Non-chemical options:** slashing, hand weeding, and biological control agents.	No stock withholding period required for Triclopyr + picloram.												
Flatweed *Hypochaeris radicata*	Weed of horse pastures	Bromoxynil 200 g/L **(Various trade names)** 1.4 L or 2 L per 100 L water. Paraquat 250 g/L **(Gramoxone, Paraquat, Nuquat)** 1.2 L. Paraquat 135 g/L + Diquat 115 g/L **(Spray Seed)** 1.6 L to 2.4 L.	Bromoxynil has 14 days stock withholding period. Paraquat has 7 days stock withholding period for horses.										✓	✓	✓
Paterson's Curse *Echium plantagineum*	Weed of horse pastures	2,4-D dma amine 625 g/L **(Amicide 625, Amicide Lo-625A)** 1.1 L or 1.7 L per 100 L water. Glyphosate 450g/l **(Glyphosate ct, Roundup ct)** 800 mL or 1.6 L per 100 L water. Glyphosate 540 g/L **(Roundup Power Max)** 630 mL or 1.37 L per 100 L water. Glyphosate 500 g/L **(Touchdown, Hitech)** 660 mL or 1.32 L per 100 L water. Paraquat 250 g/L **(Gramoxone, Paraquat, Nuquat)** 1.2 L.	2,4-D dma amine has 7 days stock withholding period. No stock withholding period required for Glyphosate. Paraquat has 7 days stock withholding period for horses. Bromoxynil has 14 days stock withholding period. Flumetsulam has 3 days stock withholding period.				✓	✓	✓						

Species	Weed type /Noxious weed control class	Control method	Effect on grazing	Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
		Paraquat 135 g/L + Diquat 115 g/L **(Spray Seed)** 1.6 L to 2.4 L. Bromoxynil 200 g/L **(Various trade names)** 2 L per 100 L water *(Add 1.5–2.0 L/ha 2,4-DB (500 g/L)* Flumetsulam 800 g/L **(Broadstrike)** 25 g *(Add 0.7 L/ha bromoxynil (200 g/L); Add wetter + 0.1 L/ha diuron (500 g/L); Add 0.3 L/ha terbutryn (500 g/L) + wetter).* 2,4-DB 500 g/L trifolamine **(Buttress)** 1 L or 3.2 L per 100 L water. Diflufenican g/L + Bromoxynil 250 g/L **(Jaguar, Barracuda)** 500 mL or 750 mL per 100 L water. Imazethapyr 700 g/kg **(Spinnaker, WDG)** 70 g or 140 g. **Non-chemical options:** slashing and hand weeding, burning, grazing management, and biological control agents.	2,4-DB has 7 days stock withholding period. Diflufenican + Bromoxynil has 14 days stock withholding period. Imazethapyr has 14 days stock withholding period.												
St. John's Wort *Hypericum perforatum*	4	Triclpyr 300 g/L + Picloram 100 g/L + Aminopyralid 8 g/L **(*Grazon Extra*)** 500 mL per 100 L of water. **Non-chemical options:** appropriate grazing management and use of biological agents.	No stock withholding period required.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
				Twiggy flowering growth stage.			Spindly stem growth stage.						Twiggy flowering growth stage.		

Species	Weed type /Noxious weed control class	Control method	Effect on grazing	Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
Sweet Briar *Rosa rubiginosa*	4	Triclpyr 300 g/L + Picloram 100 g/L + Aminopyralid 8 g/L **(*Grazon Extra*)** 500 mL per 100 L of water. **Non-chemical options:** mechanical removal or grubbing.	No stock withholding period required.	✓	✓	✓							✓	✓	✓

Source: NSW WeedWise, NSW Dept. Primary Industries, <http://weeds.dpi.nsw.gov.au/>

Appendix B Noxious Weeds declared in the Upper Macquarie County Council

Class 4 noxious weeds

Note: species in **bold** have been recorded within the property.

Common Name	Scientific Name	Control Class
African boxthorn	*Lycium ferocissimum*	4; WoNS
African lovegrass	***Eragrostis curvula***	**4**
Arrowhead	*Sagittaria calycina* var. *calycina*	4
Asparagus - climbing asparagus fern	*Asparagus plumosus*	4
Asparagus - ground asparagus	*Asparagus aethiopicus*	4
Asparagus weeds	*Asparagus* species	4
Blackberry	***Rubus fruticosus* species aggregate**	**4; WoNS**
Bridal creeper	*Asparagus asparagoides*	4; WoNS
Burr - Bathurst burr	*Xanthium spinosum*	4
Burr - Californian burr	*Xanthium orientale*	4
Burr - Italian cockleburr	*Xanthium italicum*	4
Burr - Noogoora burr	*Xanthium occidentale*	4
Burr - South American burr	*Xanthium cavanillesii*	4
Chilean needle grass	*Nassella neesiana*	4; WoNS
Columbus grass	*Sorghum x almum*	4
Fireweed	***Senecio madagascariensis***	**4**
Flax-leaf broom	*Genista linifolia*	4
Giant reed	*Arundo donax*	4
Golden dodder	*Cuscuta campestris*	4
Harrisia cactus	*Harrisia* species	4
Illyrian thistle	*Onopordum illyricum*	4
Johnson grass	*Sorghum halepense*	4
Leafy elodea	*Egeria densa*	4
Lippia	*Phyla canescens*	4
Mother-of-millions	*Bryophyllum* species	4
Nodding thistle	*Carduus nutans* subsp. *nutans*	4
Pampas grass	*Cortaderia* species	4
Prickly pear - common pear	*Opuntia stricta*	4; WoNS

Common Name	Scientific Name	Control Class
Prickly pear - Hudson pear	*Cylindropuntia rosea*	4; WoNS
Prickly pear - smooth tree pear	*Opuntia monacantha*	4; WoNS
Prickly pear - tiger pear	*Opuntia aurantiaca*	4; WoNS
Prickly pear - velvety tree pear	*Opuntia tomentosa*	4; WoNS
Privet - broad-leaf	*Ligustrum lucidum*	4
Privet - narrow-leaf	*Ligustrum sinense*	4
Rhus tree	*Toxicodendron succedaneum*	4
Sagittaria	*Sagittaria platyphylla*	4; WoNS
Scotch broom	*Cytisus scoparius* subsp. *scoparius*	4
Scotch thistle	*Onopordum acanthium*	4
Serrated tussock	*Nassella trichotoma*	4; WoNS
Silverleaf nightshade	*Solanum elaeagnifolium*	4; WoNS
Spiny burrgrass - longispinus	*Cenchrus longispinus*	4
Spiny burrgrass - spinifex	*Cenchrus spinifex*	4
St. John's wort	***Hypericum perforatum***	**4**
Star thistle	*Centaurea calcitrapa*	4
Stemless thistle	*Onopurdum acaulon*	4
Sweet briar	***Rosa rubiginosa***	**4**
Taurian thistle	*Onopurdum tauricum*	4
Tree-of-heaven	*Ailanthus altissima*	4
Wild radish	***Raphanus raphanistrum***	**4**
Willows	*Salix* species	4; WoNS

Plants requiring eradication

Note: species in **bold** have been recorded within the property

Common Name	Scientific Name	Control Class
Alligator weed	*Alternanthera philoxeroides*	2; WoNS
Anchored water hyacinth	*Eichhornia azurea*	1
Black knapweed	*Centaurea X moncktonii*	1
Black willow	*Salix nigra*	2
Boneseed	*Chrysanthemoides monilifera* subsp. *monilifera*	1; WoNS
Bridal veil creeper	*Asparagus declinatus*	1
Broomrapes	*Orobanche* species	1
Cat's claw creeper	*Dolichandra unguis-cati*	2
Chinese violet	*Asystasia gangetica* subsp. *micrantha*	1
Eurasian water milfoil	*Myriophyllum spicatum*	1
Frogbit	*Limnobium laevigatum*	1
Grey sallow	*Salix cinerea*	2
Hawkweeds	*Hieracium* species	1
Horsetails	*Equisetum* species	1; EAW
Hydrocotyl	*Hydrocotyle ranunculoides*	1
Hymenachne	*Hymenachne amplexicaulis* and hybrids	1; WoNS
Karroo thorn	*Vachellia karroo*	1
Kidney-leaf mud plantain	*Heteranthera reniformis*	1
Kochia	*Bassia scoparia*	1
Koster's curse	*Clidemia hirta*	1
Lagarosiphon	*Lagarosiphon major*	1
Mesquite	*Prosopis species*	2; WoNS
Mexican feather grass	*Nassella tenuissima*	1
Miconia	*Miconia* species	1
Mikania vine	*Mikania micrantha*	1
Mimosa	*Mimosa pigra*	1; WoNS
Parkinsonia	*Parkinsonia aculeata*	2; WoNS
Parthenium weed	*Parthenium hysterophorus*	1; WoNS

Common Name	Scientific Name	Control Class
Pond apple	*Annona glabra*	1; WoNS
Prickly acacia	*Vachellia nilotica*	1; WoNS
Rubber vine	*Cryptostegia grandiflora*	1; WoNS
Salvinia	*Salvinia molesta*	2; WoNS
Senegal tea plant	*Gymnocoronis spilanthoides*	1; EAW
Siam weed	*Chromolaena odorata*	1
Spongeplant	*Limnobium spongia*	1
Spotted knapweed	*Centaurea stoebe* subsp. *micranthos*	1
Tropical soda apple	*Solanum viarum*	1
Water caltrop	*Trapa* species	1
Water hyacinth	*Eichhornia crassipes*	2
Water lettuce	*Pistia stratiotes*	1
Water soldier	*Stratiotes aloides*	1
Witchweeds	*Striga* species	1
Yellow burrhead	*Limnocharis flava*	1

Plants requiring full and continuous suppression

Common Name	Scientific Name	Control Class
Cape broom	*Genista monspessulana*	3
Gorse	*Ulex europaeus*	3; WoNS
Green cestrum	*Cestrum parqui*	3
Long-leaf willow primrose	*Ludwigia longifolia*	3

Plants requiring full and continuous suppression

Common Name	Scientific Name	Control Class
Athel pine	*Tamarix aphylla*	5; WoNS
Cabomba	*Cabomba caroliniana*	5; WoNS
African feather grass	*Cenchrus macrourus*	5
African turnip weed - eastern	*Sisymbrium thellungii*	5
African turnip weed - western	*Sisymbrium runcinatum*	5
Annual ragweed	*Ambrosia artemisiifolia*	5
Artichoke thistle	*Cynara cardunculus*	5
Bear-skin fescue	*Festuca gautieri*	5
Burr ragweed	*Ambrosia confertiflora*	5
Cayenne snakeweed	*Stachytarpheta cayennensis*	5
Clockweed	*Oenothera curtiflora*	5
Corn sowthistle	*Sonchus arvensis*	5
Dodder	*Cuscuta* species	5
Espartillo - broad kernel	*Amelichloa caudata*	5
Espartillo - narrow kernel	*Amelichloa brachychaeta*	5
Fine-bristled burr grass	*Cenchrus brownii*	5
Fountain grass	*Cenchrus setaceus*	5
Gallon's curse	*Cenchrus biflorus*	5
Gamba grass	*Andropogon gayanus*	5
Glaucous starthistle	*Carthamus leucocaulos*	5
Golden thistle	*Scolymus hispanicus*	5
Mexican poppy	*Argemone mexicana*	5
Mossman River grass	*Cenchrus echinatus*	5
Red rice	*Oryza rufipogon*	5
Smooth-stemmed turnip	*Brassica barrelieri* subsp. *oxyrrhina*	5
Soldier thistle	*Picnomon acarna*	5
Texas blueweed	*Helianthus ciliaris*	5
Yellow nutgrass	*Cyperus esculentus*	5

Control requirements

Control Class	Legal requirements	Notifiable
1	The plant must be eradicated from the land and the land must be kept free of the plant	All outbreaks must be reported to the local control authority and NSW DPI (phone 1800 680244) within three days of discovery
2		
3	The plant must be fully and continuously suppressed and destroyed	Not notifiable
4	The growth of the plant must be managed in a manner that reduces its numbers, spread and incidence and continually inhibits its reproduction	
5	The requirements in the *Noxious Weeds Act* 1993 for a notifiable weed must be complied with	All outbreaks must be reported to the local control authority and NSW DPI (phone 1800 680 244) within three days of discovery

Appendix C Pasture sowing guide

Summer pasture species	Winter fodder species	Sowing method[1]	Sowing rate[2]	Sowing period											
				Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
Fescue		Sow 5–15 mm deep. Broadcast and harrow or drill into a clean, firm seedbed.	4-5 kg/ha										✓	✓	✓
Cocksfoot (European type)	Cocksfoot (Mediterranean type)	Sow into a clean seedbed, no more than 2 cm deep.	1-3 kg/ha				✓	✓	✓				✓	✓	✓
	Subterranean clover	Sow in the better drained parts of the paddock (sow white clover separately in wetter areas to reduce competition).	4 kg/ha				✓	✓	✓						
	Perennial ryegrass	Direct-drill after suppression of existing growth by herbicide. Drill or broadcast following mulching or into a clean seedbed (NSW Agriculture 1997).	3-20 kg/ha. Restrict sowing rate of annual ryegrass to no more than 7 kg/ha when sown with perennial ryegrass										✓	✓	✓

[1] From Rejuvenating Perennial Pastures (NSW Department of Primary Industries 2009)
[2] From Graziers' Guide to Pastures (NSW Agriculture 2003)

Summer pasture species	Winter fodder species	Sowing method[1]	Sowing rate[2]	Sowing period											
				Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
	Annual ryegrass	Broadcast or drill into clean seedbeds. Direct-drill into clean seedbeds or after suppression of summer pasture growth with herbicides.	15 kg/ha when sown alone or 5-10 kg/ha in mixture				✓								
	White clover	Sow on the surface, cover and roll. Avoid sowing too deep Sow in wetter areas of the paddock (sow sub clover in the better drained parts to reduce competition).	0.5-1 kg/ha										✓	✓	✓
	Phalaris		2 kg/ha				✓	✓	✓				✓		
Japanese Millet		Sow into clean seedbed.	8-10 kg/ha	✓	✓									✓	✓
	Cereal Rye										✓	✓	✓	✓	
Red Clover			1-4 kg/ha				✓	✓	✓				✓	✓	✓

Summer pasture species	Winter fodder species	Sowing method[1]	Sowing rate[2]	Sowing period											
				Summer			Autumn			Winter			Spring		
				December	January	February	March	April	May	June	July	August	September	October	November
Rhodes Grass		Sow into a clean seed bed.	1-4 kg/ha			✓	✓						✓	✓	✓
	Oats	Drill or broadcast into a clean seedbed. Direct-drill early sowings after suppression of summer pasture with herbicides.	80-120 kg/ha; reduce rate when sowing with Annual ryegrass			✓	✓	✓							
	Triticale		100-120 kg/ha				✓	✓	✓						
	Barley	Ideal depth is 3-6 cm. Seed should always be sown into moist soil.	Up to 100 kg/ha or reduced rates in a mix with forage legumes.					✓	✓	✓					

Appendix D Fertiliser guide

Fertiliser (including lime)	Application rate	Application method	Summer			Autumn			Winter			Spring		
			December	January	February	March	April	May	June	July	August	September	October	November
SULFUR (S)														
Superphosphate	An application of 91 kg of superphosphate per hectare is required to achieve a rate of 10 kg of sulfur per hectare and will include 8 kg of phosphorus and 18 kg of calcium.	Apply when pastures are actively growing. Avoid applying in autumn if pastures are not actively growing.				✓	✓	✓						
Gypsum (calcium sulfate)	An application of 69 kg of gypsum per hectare is required to achieve a rate of 10 kg of sulfur per hectare and will include 69 kg of phosphorus and 13 kg of calcium.					✓	✓	✓						
Note: S-deficient plants accumulate N which may cause N poisoning in livestock.														
CALCIUM (Ca)														
Agricultural lime (calcium carbonate)	An application of 25-29 kg of agricultural lime per hectare is required to achieve a rate of 10 kg of calcium per hectare.	Surface spread or incorporate into the soil to a depth of 10 cm. Incorporate into seed bed when sowing a new pasture or forage crop.	Apply approximately once every ten years. Can be applied at any time of year.											
Note: Blanket applications of nitrogen fertiliser every 6–8 weeks for perennial ryegrass – clover pastures are not recommended as they will alter the balance between grasses and clovers. **Do not apply lime and nitrogen fertilisers at the same time (the lime will cause freshly applied nitrogen to be lost as gas).**														
POTASSIUM (K)														

Fertiliser (including lime)	Application rate	Application method	Summer			Autumn			Winter			Spring		
			December	January	February	March	April	May	June	July	August	September	October	November
Potassium chloride (KCl) (MOP - muriate of potash)	Apply 15 kg of potassium per hectare annually (for dry pasture with 0.2-0.3 meq/100g). An application of 40 kg of potassium chloride (muriate of potash) is required to achieve a rate of 20 kg of potassium.	Apply to moist soils.												
Note: Do not graze pastures within 28 days of potassium application.														
NITROGEN (N)														
Urea	Apply up to 400 kg of nitrogen per hectare per year. An application of 88 kg of urea per hectare is required to achieve 40 kg of nitrogen per hectare. A subsequent application of 72 kg per hectare of lime is required to reduce soil acidity.	Best applied within 3 days of last grazing or slashing. Apply to actively growing pasture. Soils must be moist - coincide application with rain or irrigation. Avoid applying when soils are either waterlogged or dry, or if substantial rain is predicted.				✓						✓		
Notes: Urea will only last 6 weeks in the soil. **Do not graze pastures between for 14 days after nitrogen application.** **Increasing the cover and abundance of legumes (clovers, medics) which fix nitrogen from the air is another means to supply the pasture with nitrogen.**														
PHOSPHOROUS (P) (including mixed nutrients)														
Mono ammonium phosphate (MAP)	An application of 364 kg of MAP per hectare is required to achieve a rate of 40 kg of nitrogen per hectare and will include 80 kg of phosphorus.	Phosphorus can be applied to dry soil. Avoid applying if substantial rain is predicted.	✓			✓	✓	✓				✓		

Fertiliser (including lime)	Application rate	Application method	Summer			Autumn			Winter			Spring		
			December	January	February	March	April	May	June	July	August	September	October	November
	A subsequent application of 216 kg per hectare of lime is required to reduce soil acidity.													
Di ammonium phosphate (DAP)	An application of 224 kg of DAP per hectare is required to achieve a rate of 40 kg of nitrogen per hectare and will include 44 kg of phosphorous. A subsequent application of 144 kg per hectare of lime is required to neutralise acidity.		✓			✓	✓	✓				✓		
Poultry litter	An application of 1540 kg of poultry litter per hectare is required to achieve a rate of 40 kg of phosphorus per hectare and will include nitrogen, potassium, sulfur, calcium and magnesium.					✓	✓	✓				✓		
Note: The application of poultry litter will result in a build-up of phosphorus over time. **Do not apply phosphorous fertilisers to holding yards or effluent treated paddocks.**														

Appendix E Phases of pasture growth

Phases of pasture growth	Characteristics
Phase 1 – Early growing season	• Short, leafy growth • Moderate pasture growth rate • High forage quality but low yield • High sensitivity to grazing pressure
Phase 2 – Mid growing season	• Well-developed leafy-tussock phase • High pasture growth rate • Good forage quality with moderate to increasing yield • Moderate sensitivity to grazing pressure
Phase 3 – Mid to late growing season	• Reproductive phase • Low pasture growth rate • Moderate to low forage quality and maximum yield has been reached • Low to moderate sensitivity to grazing pressure
Phase 4 – Beyond the growing season	• Dormant phase • Little or no growth • Low to very low forage quality and plants have withdrawn protein into their roots • Low sensitivity to grazing pressure

Source: QLD Department of Agriculture, Fisheries and Forestry (2013)