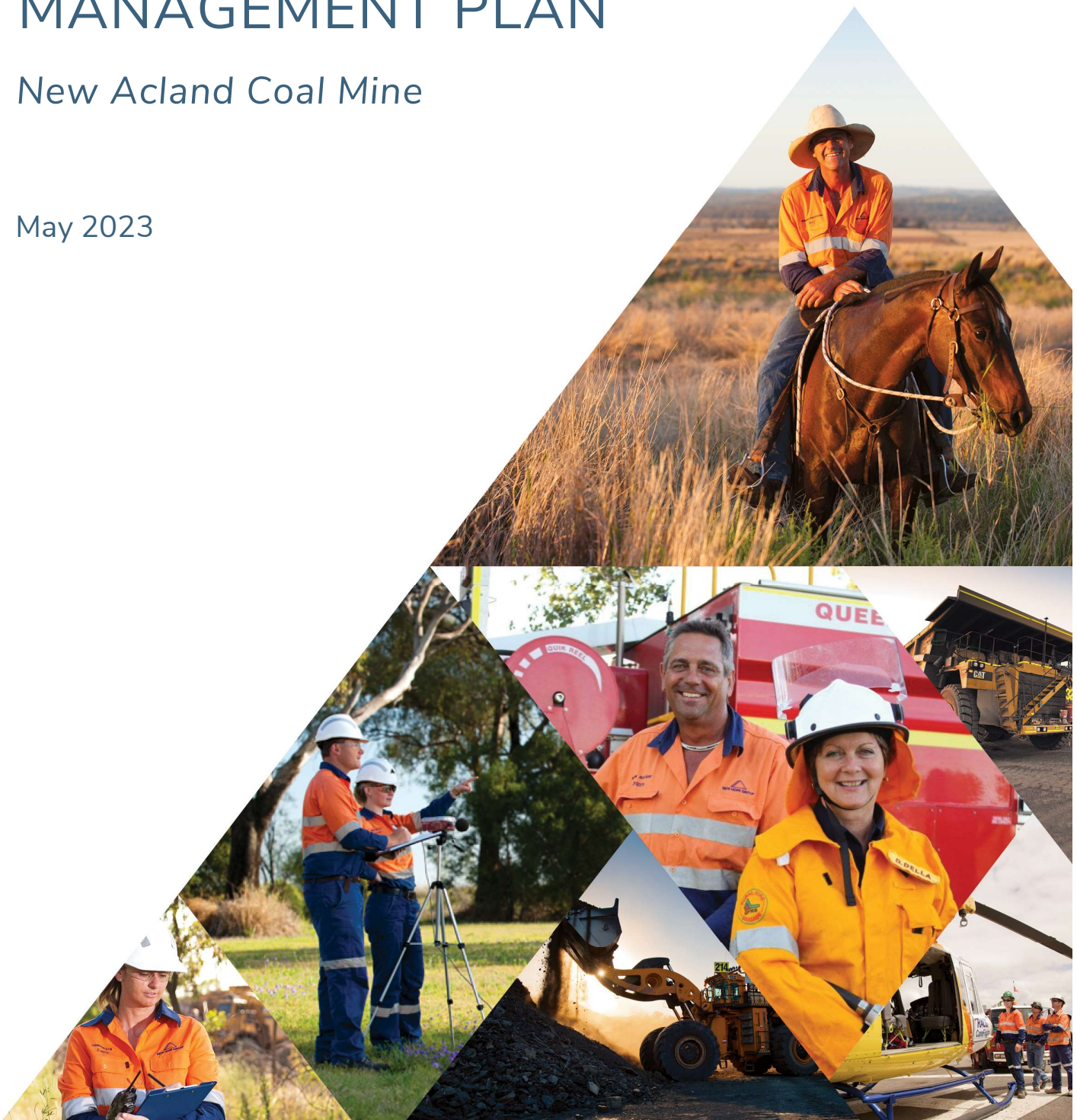
NEW ACLAND COAL

CONSERVATION ZONE MANAGEMENT PLAN

New Acland Coal Mine

May 2023



Document Detail	
Document Owner	Darren Andrews – Safety, Health, Training and Environment Manager
Document Name	EMP04: Conservation Zone Management Plan
Document Location	Objective Global Folder/1. NHG File Plan/Mining Business/New Acland Coal/Environment/ Environmental Management System – EMS/ 2.4 EMS - Planning – Environmental Management Plan/ EMP04 Conservation Zone Management Plan
Document Identification	A1470990

Document Review Frequencies	
Environmental Management Plans (EMP) have been created to manage site hazards identified in the Broad Brush Risk Assessment (BBRA), manage aspects and impacts identified in the Environmental Aspects & Impacts Register and to meet relevant statutory requirements. Statutory documents will be approved by the Document Owner. All documents shall be reviewed at regular frequencies based on risk or as otherwise directed by statutory documentation. WI-HSE-13 (Section 7, V4) lists triggers that will result in a document revision.	
Review Period (yrs):	1
Planned Review Date:	December 2023

Record of Review

Rev	Date	Revision Description	Author	Check	Approved
1.	11/04/2023	Consolidation of Conservation Zone Management Plans for the Stage 02 and Stage 03 projects. Inclusive of updates and relevant requirements relating to the *2022 Enforceable Undertaking* and updated Figures/maps.	NAC	MD	DA
2.	28/04/2023	Consolidation of Conservation Zone Management Plans for the Stage 02 and Stage 03 projects. Inclusive of updates and relevant requirements relating to the *2022 Enforceable Undertaking* and updated Figures/maps.	NAC	TC	DA

Acknowledgement – Document Review Team		
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Document Owner Approval		
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Darren Andrews		

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1. Introduction

1.1. Background

New Acland Coal Pty Ltd (NAC) currently operates the NAC open cut coal mine on Mining Lease (ML) 50170 and ML 50216 (NAC mine). The NAC mine is subject to the Stage 3 Environmental Authority (EA) EPML00335713[1], which came into effect on 26 August 2022 with the inclusion of MLs 50232 and 700002. While the EA outlines conditions for compliance, monitoring and management of the NAC mine, this document, the Conservation Zone Management Plan (CZMP), provisions the requirements of the EA.

This CZMP has also been developed in accordance with Imposed Condition 15 of the Coordinator-General's Evaluation Report (December 2014) to ensure the protection of significant landscape features, and the enhancement of associated environmental values (EVs), during the implementation of the revised New Acland Stage 3 Project (revised Project) at the NAC mine. In particular, the CZMP focuses on two key "Conservation Zones", namely 1) Lagoon Creek and 2) Bottle Tree Hill.

In April 2023, the existing Conservation Management Plan (CMP) (now referred to the CZMP), relating to the Stage 2 Project conservation commitments, was consolidated with the approved version of the Conservation Zone Management Plan (CZMP) relating to the Stage 3 conservation commitments to streamline the management of the Bottle Tree Hill and Lagoon Creek conservation areas.

All commitments of the January 2014 approved version of the CZMP (Appendix J.6 of the Environmental Impact Statement (EIS)) have been retained throughout this revision. In the instance of any contradictions, the commitments within the Stage 3 CZMP have taken precedence.

1.1.1. *Stage 2 Project Background*

The CMP was first required under the Stage 2 EA and was prepared and submitted to the Department of Environment and Science (DES) (i.e., the administering authority) under the Stage 2 EA requirement F2. The condition has been carried over into the Stage 3 EA, now Condition I2. In accordance with Condition I2 of the EA a CMP is required for the riparian area of Lagoon Creek and the existing stands of regional ecosystems RE 11.8.5 and RE 11.8.3 located on Bottle Tree Hill. The (original) CMP identified strategies and activities that will minimise the potential environmental impacts associated with the clearing of approximately 36 ha of remnant native vegetation during Stage 2, as defined by the Vegetation Management Act 1999 (VMA).

Lagoon Creek riparian zone and Bottle Tree Hill are contained within the boundaries of the Stage 2 area. A CMP was previously developed for the conservation areas (NAC 2008) and management actions including revegetation and fencing have been subsequently implemented.

This version of the CZMP has been updated to reflect current mining activities and rehabilitation outcomes relating to Lagoon Creek and Bottle Tree Hill, including further commitments as relevant under the 2022 *Enforceable Undertaking* (EU- DES Ref: EPML00335713 / MAN-E-100271643) (particularly around management of the Bottle Tree Hill area and associated rehabilitation outcomes).

[1] Note: At the time of drafting this CZMP the current date of the EA is 14 November 2023.

1.1.2. Stage 3 Project Background

Under this CZMP, NAC will develop and implement strategies and activities that fall within the revised Project and existing Mine areas, protect and enhance ecologically significant areas of remnant vegetation, and promote restoration of the Lagoon Creek riparian zone.

It is proposed that the CZMP will be distinct from the Final Land Use and Rehabilitation Plan (FLURP), and therefore, will be administered as a stand-alone plan by NAC. The final outcomes of the CZMP will be included in NAC's future Progressive Rehabilitation and Closure Plan (PRCP – due for submission 28 June 2024).

Under the Stage 3 project, NAC will focus conservation and rehabilitation efforts on selected sections of Lagoon Creek that are contained within the boundaries of the revised Project. NAC will also undertake additional conservation and rehabilitation measures around Bottle Tree Hill. Conservation measures relating to the Stage 2 project will continue to be undertaken and both programs will be undertaken simultaneously where practicable to ensure a streamlined approach to management.

This Plan's 10-year period for achieving rehabilitation targets will commence within 2 months from the date at which the EA and Mining Leases (ML) for the project are granted. If not approved concurrently, the commencement date will be from whichever is granted last, or as agreed with the administering authority.

1.2. Plan Scope

The scope of this CZMP includes:

- An assessment of current native vegetation status;
- Identification of suitable areas for rehabilitation;
- Determination of mechanisms for rehabilitation;
- Description of rehabilitation methods; and
- Development of native vegetation rehabilitation criteria.

1.3. Plan Objectives

1.3.1. Stage 2 Project Objectives

The objectives of this CZMP are to provide guidance for the protection, rehabilitation and management of significant vegetation and habitat for the riparian area of Lagoon Creek and existing stands of regional ecosystems (RE's) 11.8.5 and 11.8.3 located on Bottle Tree Hill.

This CZMP has been developed to satisfy Condition I2 of the EA (dated 14 November 2022) which requires NAC to:

- ensure the combined surface area to be protected and enhanced is no less than the surface area of the regional ecosystems proposed to be cleared by mining activities on ML 50170 and 50216 (Stage 2 project only);
- develop appropriate conservation / rehabilitation objectives;

- outline suitable conservation / rehabilitation techniques (including those where local native plant species / communities are to be re-established and / or enhanced);
- develop an action plan / rehabilitation schedule for the planned conservation / rehabilitation activities;
- propose specific conservation / rehabilitation acceptance criteria (including those where local native plant species / communities are to be re-established and / or enhanced);
- detail a suitable monitoring program to quantify conservation / rehabilitation success (including those where local native plant species / communities are to be re-established and / or enhanced); and
- propose appropriate remedial actions for conservation / rehabilitation areas not achieving the required conservation / rehabilitation objectives.

1.3.2. Stage 3 Project Objectives

The overall objectives of this CZMP are to ensure the protection of significant landscape features near the NAC mine, and to enhance the associated EVs, during the implementation of the revised Project. In particular, the CZMP focuses on two key landscape features, namely Lagoon Creek, and nearby Bottle Tree Hill.

More specifically, the CZMP aims to meet these objectives by providing guidance on the protection, rehabilitation and management of significant vegetation and habitat associated with the landscape features, including existing stands of regional ecosystems (REs) 11.8.5 and 11.8.3 located on Bottle Tree Hill and remnant patches of REs 11.3.1, 11.3.2, 11.3.17, 11.3.21, 11.9.5, 11.9.10 and 11.9.13 located within the riparian zone of Lagoon Creek.

1.4. Structure of the CZMP

Table 1-1 outlines the structure of the plan as per the requirements of the Imposed Condition 15.

Table 1-1 - CZMP Requirements

Lagoon Creek Conservation Zone Management Plan (CZMP) (a) The proponent is required to implement and maintain the Lagoon Creek Conservation Zone.	Noted
(b) The extent of the Lagoon Creek Conservation Zone is to be as described in Figure 4-1 Rehabilitation Plan, Appendix J6, EIS, January 2014. The CZMP specifically addresses the Lagoon Creek corridor and the remnant and rehabilitation zone on Bottle Tree Hill as shown on Figure 4-1.	Noted – defined in Figure 5-1 within Plan.
(c) The proponent must develop and implement a Lagoon Creek Conservation Zone Management Plan (CZMP) that aims to achieve:	(i) Section 8.2 (ii) Section 8.1

(i) control and management (including fencing) of stock from the area; (ii) a program of weed management to assist natural regeneration of native species and protect remnant areas from impacts of weed invasion; (iii) suitable monitoring and maintenance strategies.	(iii) Sections 7 and 8
(d) There is to be a revegetated area of at least 50 metres either side of the high bank of Lagoon Creek within the conservation zone. Should instream storage such as a dam or other infrastructure be constructed within the conservation zone, the proponent must ensure no net loss of the required buffer. The holder of the project's EA is authorised to construct and maintain an appropriately engineered haul road crossing of Lagoon Creek as part of the access route for coal haulage. The haul road crossing structure within Lagoon Creek must not significantly impede the ephemeral flow regime or create a barrier for fish movement during periods of flow within the creek.	Sections 2.7
(e) The date of commencement of the 10-year period for achieving the rehabilitation targets in Table A.2 is within 2 months of the issuing of the project's EA and the obtaining of the mining leases for the project.	Section 1.1
(f) Long term protection of values of the CZMP through establishing suitable tenure or other mechanism.	Section 11
(g) The CZMP is to ensure that suitable monitoring and maintenance strategies are implemented and that the outcomes and progress of revegetation and management programs are published and updated on the company website.	Section 12
(h) A progress report is to be provided to the authority administering the Environmental Protection Act 1994 on an annual basis, including any actions required to address unsuccessful revegetation or translocation efforts. The outcomes of these actions are to be reported on in subsequent report/s.	Section 12
DEHP is to have jurisdiction for this condition.	Progress Report to be provided to DES (formerly DEHP), or future equivalent department.

2. Current Status of Native Vegetation

2.1. Overview of the Existing Environment

The general topography of the NAC mine and surrounds comprises low undulating hills and alluvial plains with a small number of rocky hillocks. Lagoon Creek, an ephemeral creek with sections of poorly defined channels, flows across the mine and Project areas from the north-east corner to the south-west corner, supporting numerous man-made, in-stream dams and a patchy distribution of remnant vegetation. Some semi-permanent waterholes exist; however, farm dams are the only potentially permanent source of water on the creek's alignment. Within Bottle Tree Hill, several buildings exist within the conservation area. These structures were acquired by NAC in 2005 on purchase of the Stage 2 land and have remained unoccupied since.

Extant patches of remnant vegetation in the NAC mine and immediate surrounds largely consists of small, isolated patches of woodland amongst grazing and cropping lands and narrow strips retained along road reserves (refer Figure 1). The condition of the remnant vegetation is variable, with most areas being subjected to long-term grazing impacts, therefore, present moderate to low diversity of native flora. Native grassland occurs in paddocks not subject to regular ploughing, cropping and grazing, with better quality examples occurring in lightly grazed areas.

Most of the original vegetation has been cleared within the Project areas for agriculture, grazing and mining operations. Vegetation within the conservation areas consists of a mosaic of remnant and regrowth vegetation as well as cleared areas from previous land uses. Pre-clearing RE mapping indicates that the original pre-European vegetation of the Stage 2 project area consisted of woodlands and open forests of Poplar Box (*Eucalyptus populnea*), Brigalow (*Acacia harpophylla*) and Belah (*Casuarina cristata*) on low lying alluvial plains and low hills on clay soils.

The NAC mine is positioned high in the Lagoon Creek catchment, and as a result, the Creek possesses a relatively small upstream catchment area of approximately 300ha and only flows after significant rainfall events (i.e., an ephemeral system). A majority of Lagoon Creek's channel is poorly defined and difficult to ascertain in areas without detailed topographical survey information (i.e., LiDAR).

The presence of Forest Red Gum *Eucalyptus tereticornis* in low numbers suggests that this species was probably more common in the pre-European vegetation. Soils deriving from weathered igneous complexes on higher parts of the mine, and revised Project areas, are likely to have supported Mountain Coolibah *Eucalyptus orgadophylla* woodlands and dry rainforest vine thickets. The native grasslands comprising mostly Queensland Bluegrass *Dichantheum sericeum* are likely to have dominated heavy clay soils and interspersed amongst woodland vegetation.

Historical records for numerous threatened species occur within and surrounding the NAC project. In particular, the area is known to support populations of Belson's Panic (*Homopholis belsonii*).

The ecological and physical status of Lagoon Creek, as part of the Oakey Creek sub-catchment, was classed as 'poor' to 'very poor' in all the key parameters surveyed by the Department of Natural Resources and Water (NRW) for its last 'State of the Rivers' report on the Upper Condamine River catchment. The Lagoon Creek system has suffered a long history of disturbance from agricultural activities, such as grazing, and as a result, riparian and aquatic vegetation, channel diversity and bank stability are highly impacted and exotic weed species invasions are common.

Management activities undertaken to date within the conservation areas appear to have resulted in incremental improvements to their ecological condition and have successfully managed threatening processes such as cattle grazing. However further monitoring and potentially rehabilitation is required to ensure that the condition of these areas reach their target condition.

Three vegetation communities have been identified within the Stage 2 Project Area as determined by RE mapping and previous ecological surveys, while numerous vegetation communities have been identified within the Mine and Stage 3 Project Area.

2.2. Vegetation Communities present within the Stage 2 Project Area

Much of the stage 2 conservation area consists of non-remnant vegetation (

Figure 2-1). Remnant vegetation is currently restricted to Bottle Tree Hill where two RE's have been mapped. The extent of the regional ecosystems are described in **Table 2-1** and their distribution mapped in

Figure 2-1. No vegetation communities occurring on the site are analogous with Threatened Ecological Communities listed under the Environment Protection and Biodiversity Conservation Act 1999.

Table 2-1 - Vegetation Communities within Stage 2 Project Area

No.	Regional Ecosystem Code	Biodiversity Status	VM Act Status	Description
1	11.8.3	Of Concern	Of Concern	Semi-evergreen vine thicket on Cainozoic igneous rocks. Steep hillsides
2	11.8.5 / 11.8.5a	No concern at present	Least Concern	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks; *Eucalyptus orgadophila* woodland with a dense understorey of low trees species

2.2.1. *Lagoon Creek*

The riparian zone of Lagoon Creek has been heavily disturbed through historical agricultural management practices and currently supports no mapped remnant vegetation. Small patches of mature trees are scattered along the creek; however, these are currently too small (<0.5 ha) to be mapped as remnant vegetation. These patches are characterised by a canopy and mid-storey consisting of Poplar Box, Brigalow, Belah and Weeping Myall (*Acacia pendula*). Extant vegetation indicates that RE 11.3.17 originally occurred along the Lagoon Creek riparian corridor as suggested by pre-clearing RE mapping.

The periodic exclusion of cattle appears to have facilitated regeneration of native vegetation, in particular understorey species such as Wilga (*Geijera parviflora*) and Sally's Wattle (*Acacia salicina*) as well as canopy species such as Poplar Box and Brigalow in the southern extent of the conservation area near Acland Silverleigh Rd.

The Lagoon Creek conservation area provides a variety of habitat features. Studies undertaken in 2017 identified a population of nine Koala's that inhabit the small woodland patches and scattered mature trees in this area. Although the numerous man-made, in-stream impoundments may have compromised natural flows and impacted the hydrological regime of Lagoon Creek, they provide habitat and reliable water sources for a variety of native fauna species.

2.2.2. *Bottle Tree Hill*

Bottle Tree Hill contains remnant and regrowth vegetation consisting of RE's 11.8.3 and 11.8.5. Vegetation in this area is dominated by semi-evergreen vine-thicket species. Weed species such as Velvety Tree Pear (*Opuntia tomentosa*) occur throughout this area.

Figure 2-1 - Extent of Regional Ecosystems within Stage 2 Conservation Area

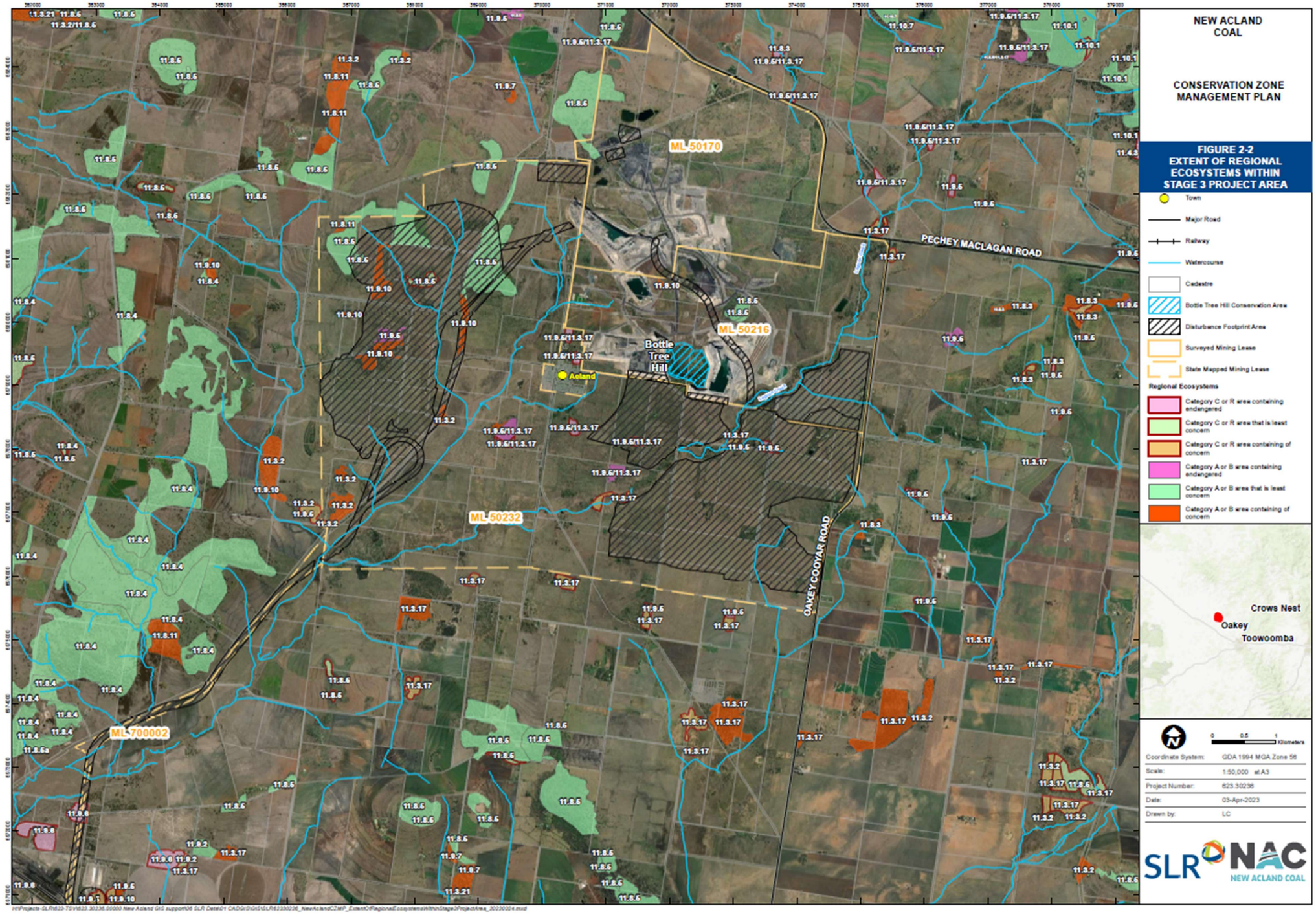
2.3. Vegetation Communities Present within the Stage 3 Project Area

The regional ecosystems found in the Stage 3 Project Area are shown in **Table 2-2** and their distribution mapped in shown on **Figure 2-2**. The location and extent of the community, a general description of species, structure and assessment of the conservation values of the community at a national, state and regional level are included.

Table 2-2 – Vegetation Communities within Stage 3 Project Area

No.	Regional Ecosystem Code	Biodiversity Status	VM Act Status	Description
1	11.3.1	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains
2	11.3.2; 11.3.2a	Of Concern	Of concern	*Eucalyptus populnea* woodland on alluvial plains
3	11.3.17	Endangered	Of concern	*Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains
4	11.3.21	Endangered	Endangered	*Dichanthium sericeum* and/or *Astrebla spp.* Grassland on alluvial plains. Cracking clay soils
5	11.8.3	Of Concern	Of Concern	Semi-evergreen vine thicket on Cainozoic igneous rocks. Steep hillsides
6	11.8.5; 11.8.5a	No concern at present	Least Concern	*Eucalyptus orgadophila* open woodland on Cainozoic igneous rocks; *Eucalyptus orgadophila* woodland with a dense understorey of low trees species
7	11.9.10	Endangered	Of Concern	*Acacia harpophylla*, *Eucalyptus populnea* open forest on Cainozoic fine-grained sedimentary rocks
8	11.9.3	Of Concern	Of Concern	*Eucalyptus moluccana* or *E. 10entricose* open forest on fine grained sedimentary rocks
9	11.9.5	Endangered	Endangered	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks

Figure 2-2 - Extent of Remnant Regional Ecosystems within Stage 3 Project Area



2.4. Stage 2 Pre-clearing Regional Ecosystem Extents

Pre-clearing vegetation mapping was obtained from the Queensland Herbarium to ascertain likely historical patterns of vegetation across the study area.

Pre-clearing vegetation mapping across the Stage 2 Project Area is presented in **Figure 2-3**.

2.4.1. Lagoon Creek

Pre-clearing RE mapping indicates that the Lagoon Creek riparian corridor consisted of RE 11.3.17 which has a Biodiversity Status of endangered and a VM Class as of concern. The Regional Ecosystem Description Database (REDD)[2] describes this RE as:

> *Eucalyptus populnea* woodland with *Casuarina cristata* and/or *Acacia harpophylla* clumps or scattered trees and a low tree layer dominated by *Geijera parviflora*. *Eucalyptus populnea* predominates forming a distinct but discontinuous canopy (15-18m high). *E. populnea* alone may form the canopy at a density of 25-75 trees/ha, or *Acacia harpophylla* and/or *Casuarina cristata* may be part of the canopy. Most frequently, *A. harpophylla* predominates a lower tree layer (8-14m high). A moderately dense, tall shrub layer is usually present, and dominated by species such as *Eremophila mitchellii*, *Geijera parviflora*, *Acacia melvillei* (Darling Downs), *Alectryon oleifolius* and *Acacia pendula*. Localised areas may be dominated by *Acacia harpophylla* or other understorey species. A sparse to open, low shrub layer is frequently present. The ground layer is usually sparse, and composed of grasses most frequently *Bothriochloa decipiens*, *Aristida 12entri*, *Enteropogon acicularis* and *Paspalidium* spp. With *Chloris 12entricose*, *Eragrostis lacunaria*, *Aristida jerichoensis*, *Paspalidium constrictum*, and *Tripogon loliiformis* on scalded areas. Occurs on back plains, levees and terraces formed on Quaternary alluvial deposits. Soils are generally deep texture contrast with thin sandy surfaces.

2.4.2. Bottle Tree Hill

Pre-clearing RE mapping indicates that the Bottle Tree Hill area consisted of RE's 11.8.3 and 11.8.5 which have a Biodiversity Status as of concern and no concern at present and a VM Class as of concern and least concern respectively.

The REDD describes 11.8.3 as:

> Semi-evergreen vine thicket which may have emergent *Acacia harpophylla*, *Casuarina cristata* and Eucalyptus spp. Occurs on Cainozoic igneous rocks. Generally restricted to steeper, rocky hillsides.

The REDD describes 11.8.5 as:

[2] Queensland Herbarium (2021) Regional Ecosystem Description Database (REDD). Version 12.1 (December 2021) (DES: Brisbane).

Eucalyptus orgadophila grassy open woodland. *Eucalyptus orgadophila* predominates and forms a distinct but discontinuous canopy sometimes with other sub-dominant species such as *Corymbia erythrophloia*, *E. melanophloia* and occasionally *E. crebra*. Shrubs are usually scarce and scattered although a well-defined shrubby layer does develop in some areas. On the lower slopes at better sites, softwood scrub species may form tall and low shrub layers under the canopy of *Eucalyptus orgadophila*. The ground layer is moderately dense to dense and dominated by species that include the grasses *Aristida lazaridis*, *A. ramosa*, *Bothriochloa ewartiana*, *Dichanthium sericeum*, *Chrysopogon fallax*, *Heteropogon contortus*, *Enneapogon gracilis*, *Themeda triandra* and *Tragus australianus* and the herbs *Brunoniella australis*, *Evolvulus alsinoides*, *Galactia tenuiflora* and *Indigofera linnaei*. Occurs on undulating plains, rises, low hills or sometimes flat tablelands on top of mountains, formed from basalt. Generally, soils are shallow to moderately shallow, often rocky or stony clays.

2.5. Stage 3 Pre-clearing Regional Ecosystem Extents

Pre-clearing vegetation mapping was obtained from the Queensland Herbarium to ascertain likely historical patterns of vegetation across the study area. The mapping indicates that a single Regional Ecosystem dominated the floodplain of Lagoon Creek, RE 11.3.17 – *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains.

This regional ecosystem is described in the Regional Ecosystem Description Database as follows.

"*Eucalyptus populnea* woodland with *Casuarina cristata* and/or *Acacia harpophylla* clumps or scattered trees and a low tree layer dominated by *Geijera parviflora*. *Eucalyptus populnea* predominates forming a distinct but discontinuous canopy (15-18m high). *E. populnea* alone may form the canopy at a density of 25-75 trees/ha, or *Acacia harpophylla* and/or *Casuarina cristata* may be part of the canopy.

Most frequently, *A. harpophylla* predominates a lower tree layer (8-14m high). A moderately dense, tall shrub layer is usually present, and dominated by species such as *Eremophila mitchellii*, *Geijera parviflora*, *Acacia melvillei* (Darling Downs), *Alectryon oleifolius* and *Acacia pendula*. Localised areas may be dominated by *Acacia harpophylla* or other understorey species.

A sparse to open, low shrub layer is frequently present. The ground layer is usually sparse, and composed of grasses most frequently *Bothriochloa decipiens*, *Aristida ramosa*, *Enteropogon acicularis* and *Paspalidium* spp. with *Chloris ventricosa*, *Eragrostis lacunaria*, *Aristida jerichoensis*, *Paspalidium constrictum*, and *Tripogon loliiformis* on scalded areas. Occurs on back plains, levees and terraces formed on Quaternary alluvial deposits. Soils are generally deep texture contrast with thin sandy surfaces."

2.6. Stage 3 Current Condition

The riparian zone of Lagoon Creek within the revised Project area currently supports limited isolated patches of mapped remnant vegetation. Field surveys found that this area contains patches of two REs listed as Endangered under the VM Act (11.3.1 and 11.3.21), and another two mapped as of concern (11.3.2 and 11.3.17). The riparian zone also contains several clumps of near-remnant

vegetation, including stands of Poplar Box *Eucalyptus populnea* and Brigalow *Acacia harpophylla* with scattered Belah *Casuarina cristata*.

In some areas, particularly towards Acland Road, there is significant recruitment of Brigalow and Poplar Box, whilst other areas support a dense growth of Wilga *Geijera parviflora*, with no canopy elements.

Lagoon Creek contains many man-made, in-stream impoundments which have compromised natural flows.

2.7. Stage 3 Potential Vegetation Clearing

Disturbance to vegetation within the immediate riparian zone (within 50 metres) of Lagoon Creek is only planned at one location within the revised Project area (Mining Lease Application 50232), located to the south of the existing Mine (Mining Leases 50170 and 50216). This disturbance will be associated with the construction of an 'at-grade' creek crossing for a planned mine haul road from the Willaroo Pit area to the Coal Handling and Processing Plants. The exact location of the crossing will be planned to avoid unnecessary disturbance to patches of remnant REs present, mapped as either Endangered (primarily 11.3.21), or as of concern (primarily 11.3.2).

NAC's Koala Species Management Plan (BAAM 2020) as approved by the Coordinator-General and accepted by the DES during 2020 details the design and management of the 'at-grade' crossing of Lagoon Creek for the revised Project.

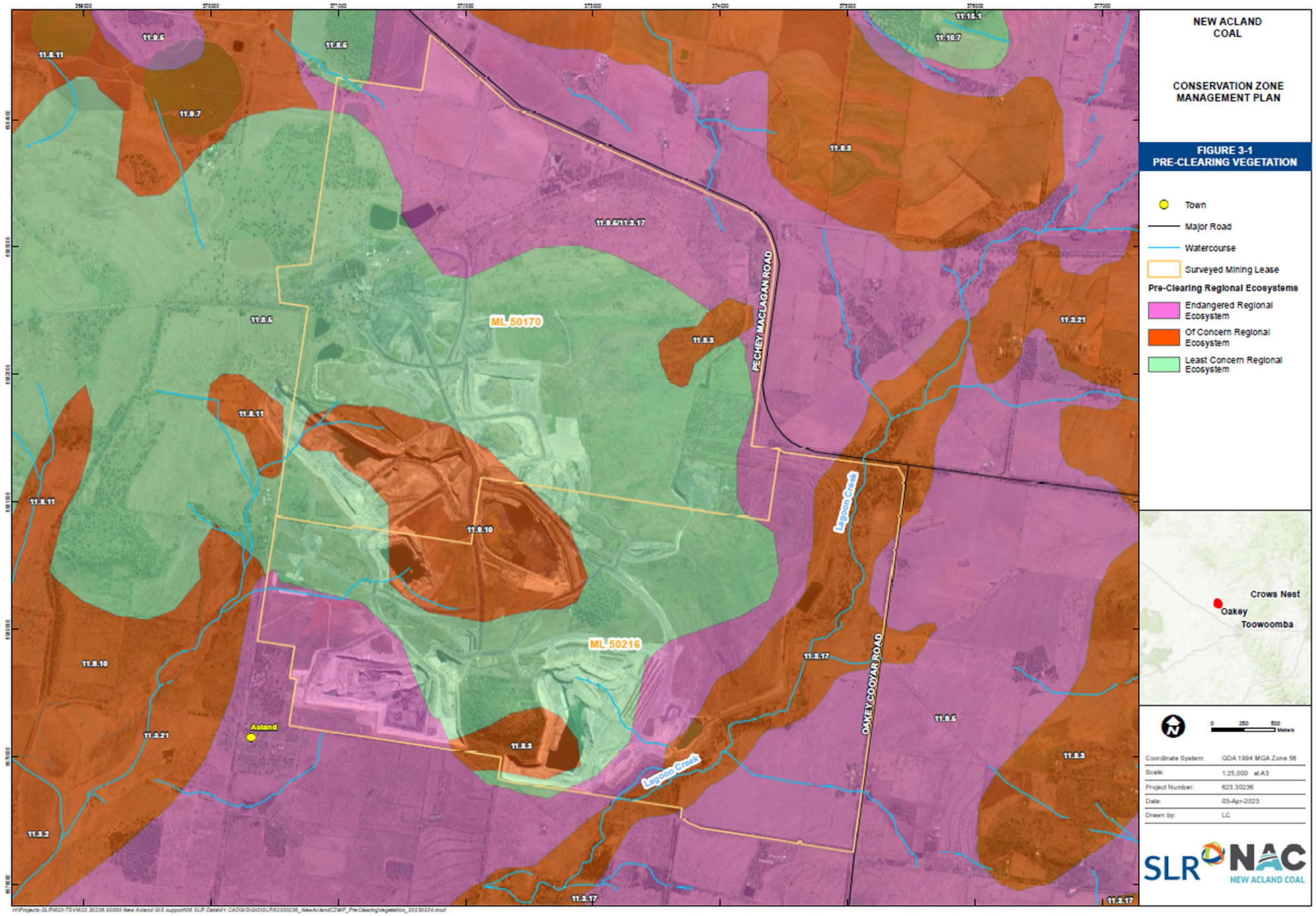
To date, there has only been some limited clearing of the eastern margins of Bottle Tree Hill, associated with the construction of a radio repeater station and access track. This clearing has been offset by excluding stock from the area and restricting vehicular access to the confines of the track. The conservation area will be extended beyond the existing vegetation boundary to the western edge of the patch.

The Acland Pastoral Company's grazing and other farming activities may require periodic crossing of the revised Project's conservation management zone. The Acland Pastoral Company will ensure that crossing of the revised Project's conservation management is kept to an operational minimum, that no excessive disturbance is caused by crossing events, and that crossing events will avoid sensitive areas (e.g., newly planted areas).

In general, NAC will fence and signpost the revised Project's conservation management zone to increase the level of protection and minimise the risk of accidental disturbance. In addition, NAC possesses a 'permit-to-disturb' system to prevent unauthorised disturbance within the revised Project site.

The following sections of the Plan review a number of potential rehabilitation methods which may be applied to the Lagoon Creek and Bottle Tree Hill conservation areas, an action plan for implementing the conservation measures and a monitoring program and assessment criteria for determining the efficacy of the conservation measures.

Figure 2-3 - Pre-Clearing Vegetation within Stage 2 Project Area



3. Rehabilitation Works Completed during Stage 2

Several rehabilitation activities have been completed within the conservation management area to date. These include:

- three tree planting programs in 2013, 2017 and 2018.

A summary of these activities is provided below.

3.1. Lagoon Creek Revegetation

Revegetation works has been undertaken along several reaches of Lagoon Creek between 2013 and 2018 within the Stage 2 Project area ML (ML50216) (**Figure 3-1**). This section of the creek is bordered in the North and East by the Oakey-Cooyar Road, in the South by the Acland-Silverleigh Road, and to the west by the active mine.

A total of approximately 3,900 native seedlings have been planted within the Lagoon Creek conservation management area to date (**Figure 3-1).** Plantings used species that are native to the area and consisted of canopy, shrub and groundcover species (Verterra 2017).

Other rehabilitation actions undertaken include:

- soil ripping;
- fertiliser application; and
- weed control (Verterra 2017).

3.2. Bottle Tree Hill

The perimeter of the Bottle Tree Hill conservation area has been fenced to exclude stock and limit potential vehicle access / disturbance. The fenced area includes a non-remnant area on the western side of Bottle Tree Hill which has been fenced to facilitate natural regeneration by preventing further disturbances. This area has been included to offset vegetation clearing for the construction of a radio repeater station and access track within remnant vegetation on Bottle Tree Hill. Fencing has been adequately signposted to ensure no disturbance within the conservation area occurs.

Figure 3-2 identifies the extent of remnant and non-remnant areas within Bottle Tree Hill Conservation Area and areas currently protected by the exclusion fencing.

Figure 3-1 - Existing Revegetation Areas within Stage 2 Project Area

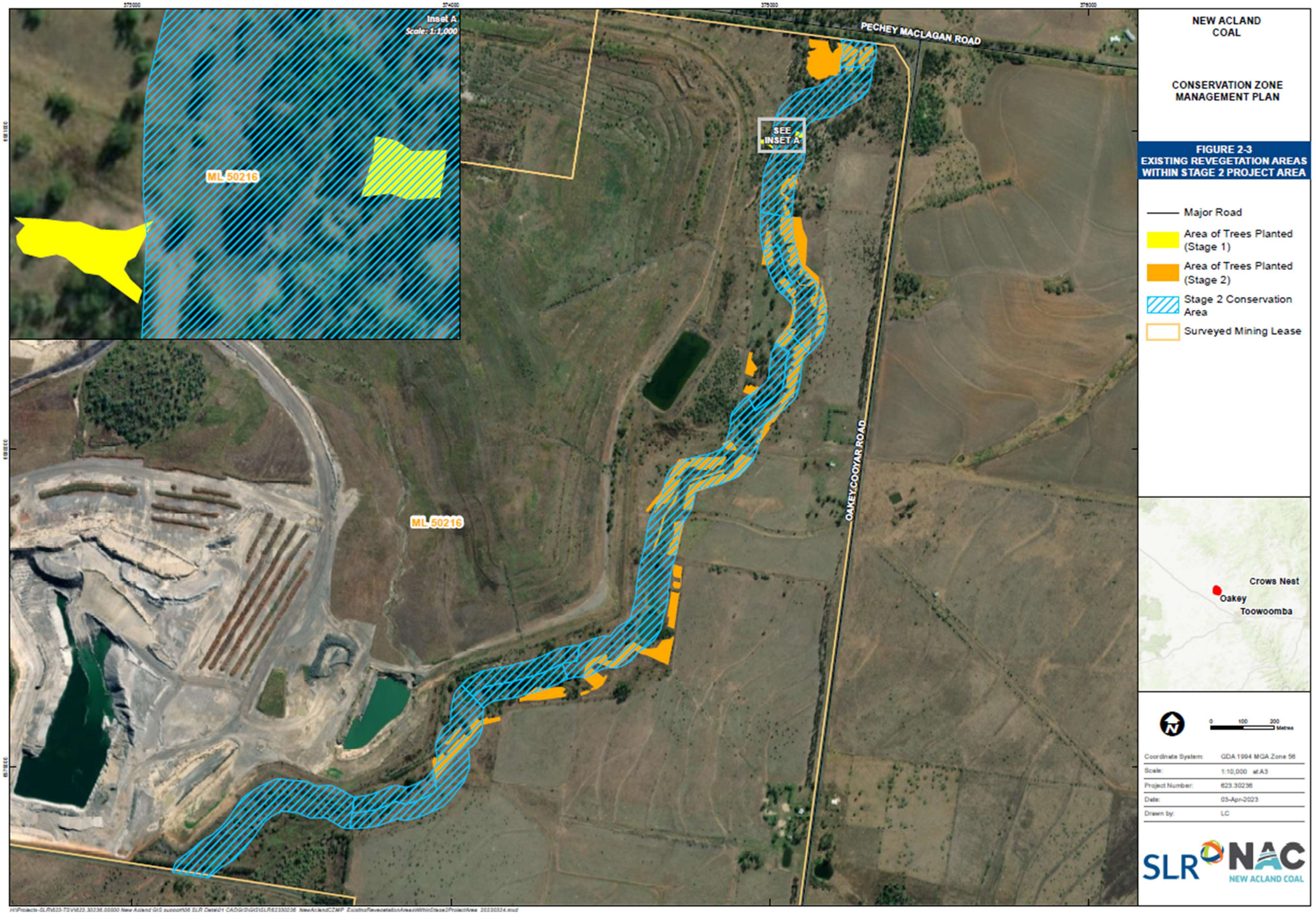


Figure 3-2 - Stage 2 Conservation and Rehabilitation Management Zones – Stage 2 Project Area

4. Rehabilitation Methods

4.1. Introduction

Natural regeneration, direct seeding and planting of seedlings are the three main techniques used in revegetation. Each technique has advantages and factors to consider when deciding whether it is suitable. These methods are discussed in the following sections.

The scope of revegetation around Lagoon Creek extends to an area generally 50m either side of the high bank of Lagoon Creek within the conservation zone.

4.2. Natural Regeneration

If remnant vegetation is present, whether as isolated trees in a paddock or grassland along a roadside, it is often the ideal starting point to encourage natural regeneration. For nature conservation on farmland, the priority is to fence off and manage these areas first, including encouraging natural regeneration events from seed dispersal and the existing soil seed bank (i.e., under the appropriate climatic conditions).

Natural regeneration is an effective, low-cost method of establishing large numbers of plants in a random design. It is an important part of the succession and ecology of vegetation. Characteristics of natural regeneration include the following:

- genetics are appropriate for the site (except for isolated trees with no out-crossing potential);
- low-cost in terms of labour and dollars;
- specialised equipment is not usually necessary;
- can be adapted for large and small scale projects;
- a large number of plants can be produced (they will self-thin over time or can be actively managed if required);
- ensures indigenous species are established rather than weeds;
- plants develop deep, strong root systems which help them establish quickly and withstand drought and wind;
- the random spacing of established plants will result in the re-creation of a clumped self-sustaining habitat; and
- usually used with remnant vegetation areas and provides further protection for these areas.

Without fencing to exclude livestock, new seedlings will not be established. Livestock readily eat young seedlings, particularly when there is no other food available, for example, during the autumn feed gap. Trampling and compaction by livestock also exacerbate this problem.

The seedbed can be improved in different ways to suit different species. Light cultivation, scalping, fire and the removal of weeds to increase light and soil moisture may be appropriate options.

4.3. Direct Seeding

Direct seeding involves the sowing of treated seeds directly onto a site to achieve germination and establishment and can be carried out mechanically or by hand. Advantages of direct seeding are as follows.

- this technique involves a plant growing from seed rather than propagated material. Direct seeded trees and shrubs develop deep, strong root systems that help them establish quickly and withstand drought and wind.
- the patchy spacing of established plants enables the re-creation of a 'natural' self-sustaining habitat.
- if conditions are not favourable for seeding, (for example, too dry), the seed can be stored for future sowing. Seedlings are harder to look after until the next season.
- mechanical direct seeding is the most efficient technique for broad scale revegetation.
- mechanical direct seeding is cost effective and labour efficient. Assuming the appropriate site preparation is completed, it is possible, with current technology, for one person to revegetate 10 to 15 hectares in one day (approximately 30 to 45 kilometres of seed line).

There are a range of direct seeding machines available for direct seeding native vegetation. Direct seeding machines are commonly mounted on tractor linkage or drawn by 4WD vehicles. The critical issue is ensuring the machine is suited to the site conditions and that it is set up to provide the right seedbed and seed placement.

Direct seeding by hand is another option for native vegetation establishment, and can be used for a range of purposes and in many different situations.

4.4. Planting

The planting of indigenous seedlings can be undertaken by machine or by hand. While there is an increase in labour, time and money with this technique compared to natural regeneration and direct seeding, a high level of efficiency can be achieved with the use of planting equipment and when planting is preceded by good planning and ground preparation, and follow up maintenance to reduce weed and grass competition during establishment.

Advantages of mechanical planting include the following:

- mechanical planting provides an efficient option for large-scale revegetation in the right conditions - flat to undulating country with friable soil conditions;
- suitable for planting specimens grown from cuttings or tissue culture or open-rooted seedlings;
- it is particularly suitable for projects which require regular, known, spacings of tree seedlings, such as farm forestry or narrow shelterbelts;
- for use in planting selected, high performance, provenance seedlings which would be too wasteful of seed or too expensive to direct seed;
- can commonly achieve planting rates of 500 to 1,000 plants per hour;
- enables older or infirm people to participate in planting;

- some machines water-in planted seedlings;
- it is a useful technique for establishing recalcitrant species that may possess special germination or other requirements; and
- much less tiring than manual planting.

Hand planting is a technique most suited to revegetation projects that:

- require selected plants at regular spacings, for example, farm forestry;
- require species that are difficult to direct seed;
- are establishing species for which there is a limited seed supply; hand planting can be valuable in setting up seed production areas to rectify this problem for the future;
- aim to provide a high level of community education at the planting stage;
- are inaccessible by machinery;
- are of a small scale;
- use a wide range of species; or
- require the planting of specimen trees.

4.5. Buildings

NAC have removed the (non-heritage listed) dilapidated buildings and (other) structures located within the Bottle Tree Hill conservation area (**Figure 4-1**) to improve the regeneration and final conservation outcome of the area. The work involved:

- temporarily re-establishing the access track to the buildings, to link with the existing internal NAC haul roads;
- the decommissioning and removal of the residential building, sheds and associated infrastructure (including footings) from the building area;
- the disposal of the removed material off-site to an appropriate receiving waste facility.

Now that decommissioning and removal is completed, NAC will:

- grade the area to tie in with the natural topography;
- install erosion and sediment controls to manage surface water flow over disturbed areas;
- block access to the area to enable natural regeneration (with the exception of access for monitoring and management of rehabilitation);
- monitor the area and manage any potential issues in accordance with this Conservation Zone Management Plan.

Figure 4-1 - Buildings and other structures to be decommissioned at Bottle Tree Hill

5. Conservation Zone Management Action Plan

5.1. Introduction

The following sections outline vegetation conservation measures planned for Lagoon Creek and Bottle Tree Hill. The plan identifies areas which are:

- Remnant and require protection;
- Non-remnant areas that will be encouraged to regenerate naturally; and
- Those areas which may require active revegetation through direct seeding and/or planting.

The conservation areas and likely methods of management are shown in **Figure** 5-1.

The rehabilitation strategies provided within NAC's Koala Species Management Plan (BAAM 2020) are consistent with the CZMP. Importantly, the implementation of the CZMP will support NAC's Koala Species Management Plan (BAAM 2020) by restoring potential Koala habitat along Lagoon Creek.

5.2. Remnant Protection

5.2.1. *Lagoon Creek*

When returning land back to a 'natural' landscape, the protection, enhancement and management of existing remnant native vegetation is the highest priority. Remnant vegetation will contain the remaining biodiversity and the elements of functioning ecosystems that are often the hardest to recreate through revegetation: the fungi and soil microorganisms, lichens, mosses, herbs and ground covers. Remnants, whether in good condition or degraded, are in most cases much easier and cheaper to restore than recreating new areas from scratch.

For the vast majority of revegetation, fencing is the most cost-effective way of protecting plants from livestock.

5.2.2. *Bottle Tree Hill*

Vegetation on Bottle Tree Hill is in relatively good condition, with limited weed invasion, a high level of natural recruitment and many elements of remnant vegetation. Minimal intervention is required across this area.

Vegetation will continue to be protected by the exclusion of stock and the restriction of vehicular access/disturbance within the area. A radio repeater station and access track that have been constructed on Bottle Tree Hill, which has resulted in some limited disturbance of vegetation. The area outside this limited disturbance footprint has been designated as a conservation zone.

As stock are restricted from the larger area due to mining operations, fencing of the conservation zone is not considered to be necessary. The boundary of the zone will be adequately signposted to ensure no accidental disturbance within the conservation zone. NAC also possesses a 'permit to disturb' system to prevent accidental disturbance at the Mine for cultural heritage and other purposes. This practice will be continued for the revised Project.

5.3. Natural Regeneration

5.3.1. *Lagoon Creek*

Several non-remnant areas exhibit strong natural recruitment of seedlings, and these areas are suited to natural regeneration with minimal intervention. Such areas will be monitored to determine the level of seedling recruitment over time. If required, some stimulation of soil seed banks may be appropriate by excluding grazing pressure, controlling weeds and light cultivation. shows areas of Lagoon Creek which will be allowed to naturally regenerate.

5.3.2. *Bottle Tree Hill*

The clearing of vegetation on the north-eastern side of Bottle Tree Hill for the repeater station access track (approximately 5 metres wide), has been offset by the extension of the conservation zone on the western side of the remnant area. The western side of the conservation zone is dominated by regrowth vegetation and natural regeneration of this area should be sufficient in restoring this area to remnant condition. Weed control may be undertaken throughout this area where required to remove and control invasive species that may compete with native vegetation. This will facilitate propagation and growth of native species in the area.

The cleared areas have been mapped and maintained on a site plan.

The exclusion of stock from this area, as part of the broader mine area, is now allowing natural regeneration.

5.4. Direct Seeding and Planting

5.4.1. *Lagoon Creek*

Areas currently lacking a remnant or near-remnant canopy and showing limited recruitment potential may require direct seeding and/or planting with appropriate groundcover, shrub and tree species. Initially, these areas should be fenced off to prevent stock assess and rates of natural regeneration assessed. Direct seeding/planting should then be undertaken in areas where natural regeneration is limited. A list of suitable species is provided in **Section 5.6**.

5.4.2. *Bottle Tree Hill*

No direct seeding or planting is proposed for Bottle Tree Hill.

5.5. Action Plan Timetable

5.5.1. *Lagoon Creek*

Stock exclusion has taken place since 2009. A program of direct planting along Lagoon Creek with appropriate groundcover, shrub and tree species is on-going. This program has commenced in the north-east corner of the current Mine site, and is progressing towards the south-west corner.

It is intended that the active restoration of Lagoon Creek will progress at a rate of approximately 1-2 km of creek line per year. This rate may be influenced by climatic conditions, for example, during drought periods.

5.5.2. *Bottle Tree Hill*

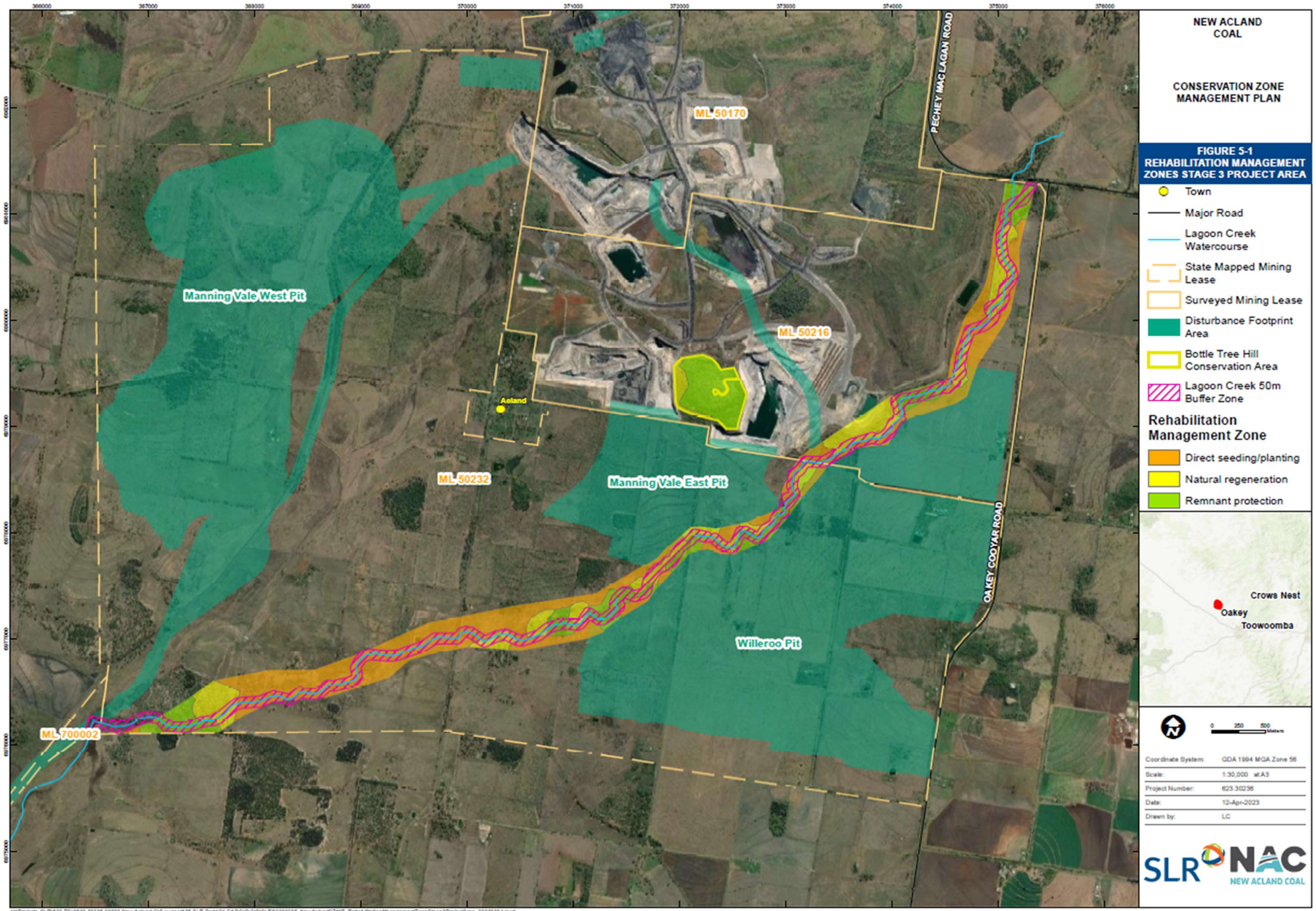
The exclusion of stock access to the conservation zone surrounding Bottle Tree Hill to allow natural regeneration has occurred since 2009.

5.6. Species for Seeding/Planting of Lagoon Creek

The suggested species list (**Table 5-1**) has been compiled from vegetation survey plot data obtained from reference sites for Regional Ecosystem 11.3.17.

This list should not be considered comprehensive but provides a reasonable guide to species selection. Where possible, seed would be sourced locally (local provenance) to maintain the genetic integrity of the flora. The final species selection used in the seeding/planting program will be determined by a number of factors including the availability of local provenance seed/plant stock, and local site conditions.

Figure 5-1 - Revised Project Rehabilitation Plan for Stage 3



Note: Bottle Tree Hill Conservation Area to be updated on finalisation of Covenant in 2023

Table 5-1 - Suggested Species for Revegetation for Stage 3

Scientific Name	Common Name	Life form	Propagation Best From	Months from Propagation to Field-Ready	Best Method of Establishment
Acacia harpophylla	Brigalow	Large Tree	Seed	3	Soil seedbank
Acacia melvillei	Myall	Small Tree	Seed	3	Direct Seeding
Casuarina cristata	Belah	Large Tree	Seed	3	Seedlings
Eucalyptus populnea	Poplar Box	Large Tree	Seed	No data	Seedlings
Eucalyptus orgadophila	Mountain Coolibah	Large Tree	Seed	No data	Seedlings
Geijera parviflora	Wilga	Small Tree	Seed	No data	Seedlings
Acacia salicina	Sally Wattle	Small Tree /shrub	Seed	3	Soil seedbank
Acacia pendula	Weeping Myall	Small Tree /shrub	Seed	3	Soil seedbank
Alectryon oleifolius	Western Rosewood	Small Tree	Seed	No data	Seedlings
Eremophila mitchellii	False Sandalwood	Small Tree	Seed	No data	Seedlings
Aristida leptopoda	White spear grass	Groundcover	Seed	No data	Direct Seeding
Aristida ramosa	Three-awned spear grass	Groundcover	Seed	No data	Direct Seeding
Aristida jerichoensis	Jericho Wiregrass	Groundcover	Seed	No data	Direct Seeding
Chloris ventricosa	Tall Chloris	Groundcover	Seed	No data	Direct Seeding
Enteropogon acicularis		Groundcover	Seed	No data	Direct Seeding
Eragrostis lacunaria	Purple Love Grass	Groundcover	Seed	No data	Direct Seeding
Paspalidium constrictum	Knottybutt Grass	Groundcover	Seed	No data	Soil seedbank
Tripogon loliiformis	Fiveminute Grass	Groundcover	Seed	No data	Soil seedbank
Bothriochloa decipiens	Pitted Blue grass	Groundcover	Seed	No data	Direct Seeding
Panicum decompositum	Native Millet	Groundcover	Seed	No data	Direct Seeding

6. Native Vegetation Rehabilitation Criteria

6.1. Introduction

A useful way of evaluating the progress of a revegetated site is to compare the monitoring results with:

(a) baseline data (describing the condition of a site before the revegetation was established); and

(b) survey data from one or more reference sites (i.e., sites representing the 'target condition', such as remnant forests of the type that may have occurred on a site prior to clearing).

Comparison with baseline data will show how much a site has changed following revegetation, while comparison with forest reference (benchmark) site(s) can show whether the revegetated site has achieved the target condition, and if not, what attributes require further development. Comparisons with reference sites are particularly useful, because many structural attributes vary between different forest types and regions.

This section presents information, protocols and proformas for monitoring 'basic indicators' at revegetated sites. Basic indicators include various aspects of forest structure which have been selected for survey because they:

- provide information on important stages of development of a revegetation project;
- can be measured relatively easily and rapidly, without specialist knowledge; and
- are correlated with the use of sites by wildlife.

6.2. Assessment Parameters

Ten attributes will be assessed to determine the performance and progress of the rehabilitation areas. Each attribute is weighted in accordance with the BioCondition methodology (**Table 6-1**). Each attribute is assessed against the benchmark values for the respective Regional Ecosystem.

Table 6-1 - BioCondition assessment criteria and weighting

Condition Attributes	Weighting (%)	Description
Large trees	15	Number of large trees per hectare measured over 100 x 50 m
Tree canopy height	5	Median canopy height in metres of the ecologically dominant layer within the 100 x 50 m assessment area
Recruitment of canopy species	5	The presence of regeneration of the dominant canopy species in the 100 x 50 m area
Tree canopy cover (%)	5	Vertical projection of the tree canopy crown cover over 100 m
Shrub layer cover (%)	5	Vertical projection of the shrub crown cover over 100 m

Condition Attributes	Weighting (%)	Description
Coarse woody debris	5	The length of fallen woody logs and other coarse woody debris (>10 cm diameter and >0.5 m in length) per hectare measured over 50 x 20 m
Native plant species richness	20	Native plant species richness, for four life-forms (trees, shrubs, grasses and forbs/other) assessed over 100 x 50 m (trees) and 50 x 10 m (shrubs, grasses, forbs/others)
Non-native plant cover	10	The percentage cover of the total vegetation cover that is comprised of exotic and non-indigenous species, assessed within 50 x 10 m
Native perennial grass cover (%)	5	The average percentage cover of native perennial grasses within five 1 x 1 m quadrats
Litter cover	5	The average percentage cover of organic material such as fallen leaves, twigs and branches <10 cm diameter within five 1 x 1 m quadrats

6.2.1. *Recruitment of Woody Perennial Species*

Recruitment or regeneration is essential to the sustainability of any ecosystem. Some land management practices such as burning and grazing, and natural processes such as drought, can degrade the ability of natural regeneration processes to take place. Regeneration is therefore an important component in assessing the health or condition of each zone.

The recruitment attribute will be used to assess the presence of recruitment of the dominant overstorey species. For ease and reliability of assessment, assessment of recruitment will be restricted to the dominant woody perennial species within the tree layer, due to the seasonal and therefore ephemeral nature of the lower layers.

Recruitment will be assessed as the proportion of overstorey species present at a site that are regenerating (<5 cm diameter at breast height [dbh]). For example, if four overstorey species occur at the site, but only two of these species are present as regeneration, then the proportion is 50%.

6.2.2. *Native Plant Species*

To simplify assessment, native plant species richness will be estimated for five life-forms: trees, shrubs, grass, forbs and others. Assessment will be based on the number of native species observed in the 50 x 10 m plot for each life form group. A total score for native plant species richness will be derived by adding together the scores identified for each of the five life-form groups, and dividing by 5.

6.2.3. *Tree Canopy Cover*

The vertical projection of the tree canopy over a 100 m transect will be recorded. The total length of the projected canopy will then be divided by the total length of the tape to give an estimate of percentage canopy cover, which will be compared with the benchmark data.

The tree canopy cover attribute score will be qualified by the health of the canopy of the trees assessed along the 100 m transect. Trees assessed along the transect, with canopies that fit into health categories 3, 4 and 5, having lower scores than those with scores of 1 or 2.

6.2.4. Tree Canopy Height

Tree canopy height refers to the median canopy height in metres, estimated for the tree layer within the 100 m x 50 m assessment area. The median canopy height is the height that has 50% of canopy trees larger and smaller than it. This is generally synonymous with average height, except when there are some trees that are substantially higher or lower than the median (Neldner et *al.* 2005).

6.2.5. Shrub Cover

Shrub canopy cover refers to the estimate of the percentage cover of native shrubs recorded along the 100 m transect (similar to the estimation of tree canopy cover using a vertical projection downwards).

6.2.6. Ground Cover

There is one ground layer, which may contain graminoids, forbs, sprawling vines and other plants that are short in stature and overlap in height with the grasses. Seedlings of trees and shrubs will be included in this layer, if not already allocated to a separate shrub layer. The ground layer most frequently extends from 0 cm to 100 cm (Neldner et *al.* 2005). The ground cover is measured by a vertical projection downwards of the living plant material.

Three components of the ground cover will be scored: perennial grass species cover; perennial herb and forb (non-grass) species cover and; annual grass, herb and forb species cover. Perennial ground cover species will be scored as a separate attribute from annual ground cover species.

6.2.7. Large Trees

Large trees are an important resource within forest and woodland ecosystems. They provide greater leaf material, nectar and bark-surface area for foraging purposes, and are more likely to contain hollows and crevices for nesting and sheltering purposes.

Large trees are defined as the number of large living trees per hectare. These trees will be counted within the 100 x 50 m assessment area to give a density per hectare. This number can then be compared with the RE benchmark, and placed in the appropriate category. Any large trees located during the assessment will also be assessed regarding its habitat value for hollow-dependent wildlife. If a large tree also contains an observable hollow with an opening > 10 cm diameter, then a higher score is given.

6.2.8. Fallen Woody Material

Fallen woody material is an important component in many aspects of ecosystem functioning. It is primarily measured as a habitat surrogate for ground dwelling fauna but can also be used as a variable in the estimate of carbon biomass, and as an indicator of fire disturbance.

Fallen woody material refers to coarse woody debris or dead timber on the ground > 10 cm diameter and > 0.5 m in length. Assessment will be conducted by counting the number of fallen woody logs and other debris that are found within the 50 m x 10 m plot. To be counted as in, 50% or greater of the log will have to be located within the plot.

6.2.9. Weed Cover

Weed cover refers to the percentage cover of non-native plant species, assessed within the 50 m x 10 m sub-plot. Where there are weeds present in more than one layer, e.g., a grass in the ground layer and shrub in the shrub layer then the percentage in each layer are added together to give a percentage weed cover for the site. The benchmark for weed cover in RE 11.3.17 is 18%.

6.2.10. Organic Litter

Organic Litter includes both fine and coarse organic material such as fallen leaves, twigs and branches < 10 cm diameter. Organic litter cover refers to the average percentage cover assessed within each of the five 1 m x 1 m quadrats. Within a quadrat, the sum of the native ground cover, weed ground cover, organic litter (including any coarse woody material) and bare ground/ rock cover, must equal 100 per cent.

6.3. Reference Sites

6.3.1. Rationale

Quantitative benchmark data can be derived by locating and setting up a local reference site. Reference site assessment does require good botanical and habitat assessment skills, and entails measurement and recording of vegetation floristics and structure.

The assessment methodology detailed in this document is for the location, establishment and recording of floristic and structural vegetation attributes specifically for the generation of benchmarks for rehabilitation.

The appropriate location and establishment of a reference site is paramount to the derivation of relevant benchmarks. Canopy height and cover vary within RE's according to environmental conditions. Therefore, areas to be assessed should be compared with a reference site that occurs as close as possible to the area to be assessed and has similar environmental conditions, i.e. the same regional ecosystem, vegetation community, similar climate (same subregion), similar landscape conditions (soil, slope, position in the landscape, geology, etc.) and similar natural disturbance (cyclone impacts or fire history).

For this reason, field measurements of the height, canopy cover and species composition of the area of interest are compared, where possible, to measurements from a local reference area, i.e., a nearby area of comparable vegetation that is known to be remnant, such as a shadeline or road reserve.

Reference sites are selected in RE's with no extensive chemical or mechanical disturbance to the predominant canopy evident on the aerial photograph archive (from 1960s to recent) or on the ground.

6.3.2. Methodology for Establishing the Reference Site

The assessment site constitutes a 100 m x 50 m nested plot design as per the BioCondition Assessment Methodology (Eyre et *al.* 2011), developed by the former DERM. The layout of the site and nested subplots is shown in **Figure 6-1** with further detail provided in **Appendix A**.

A series of subplots is used to sample the floristic, habitat and disturbance components, and is summarised as follows:

- 100 m x 50 m area: records all potential large trees > 20 or >30 cm diameter at breast height (DBH): depending on the tree species;
- 50 m x 10 m area: record all fallen woody material > 10 cm diameter, and number of floristic species by lifeform group i.e., Tree, Shrub, Grass, Forbs and other species;
- 100 m transect: record tree and shrub canopy cover; and
- five 1 m x 1 m subplots: record ground cover, litter, rock cover, and bare ground.

Demarcation of the reference site is established by positioning a 100 m tape, which constitutes the centre line of the plot. Flagging tape can be used to identify the outer boundaries of the plot, which is 25 m each side of the centre transect.

The plot boundary must be a minimum distance of 50 m from a major disturbance or discontinuity such as a road or disturbed edge. In topographically diverse areas, the plot should be oriented so that its long axis follows the contour, or topographic position (e.g., gully, midslope, ridge).

Plot location is recorded at its centre point (the 50 m point along the 100 m transect). A global positioning system (GPS) is recommended to record the position of the centre point in the field. This position should be checked against a 1:100 000 or larger scale topographic map for the area.

The altitude recordings on GPS can be inaccurate and are better derived from the topographic map. The use of star pickets or pegged down tyres at the beginning and end of the 100m transect will aid in relocating the site for future monitoring.

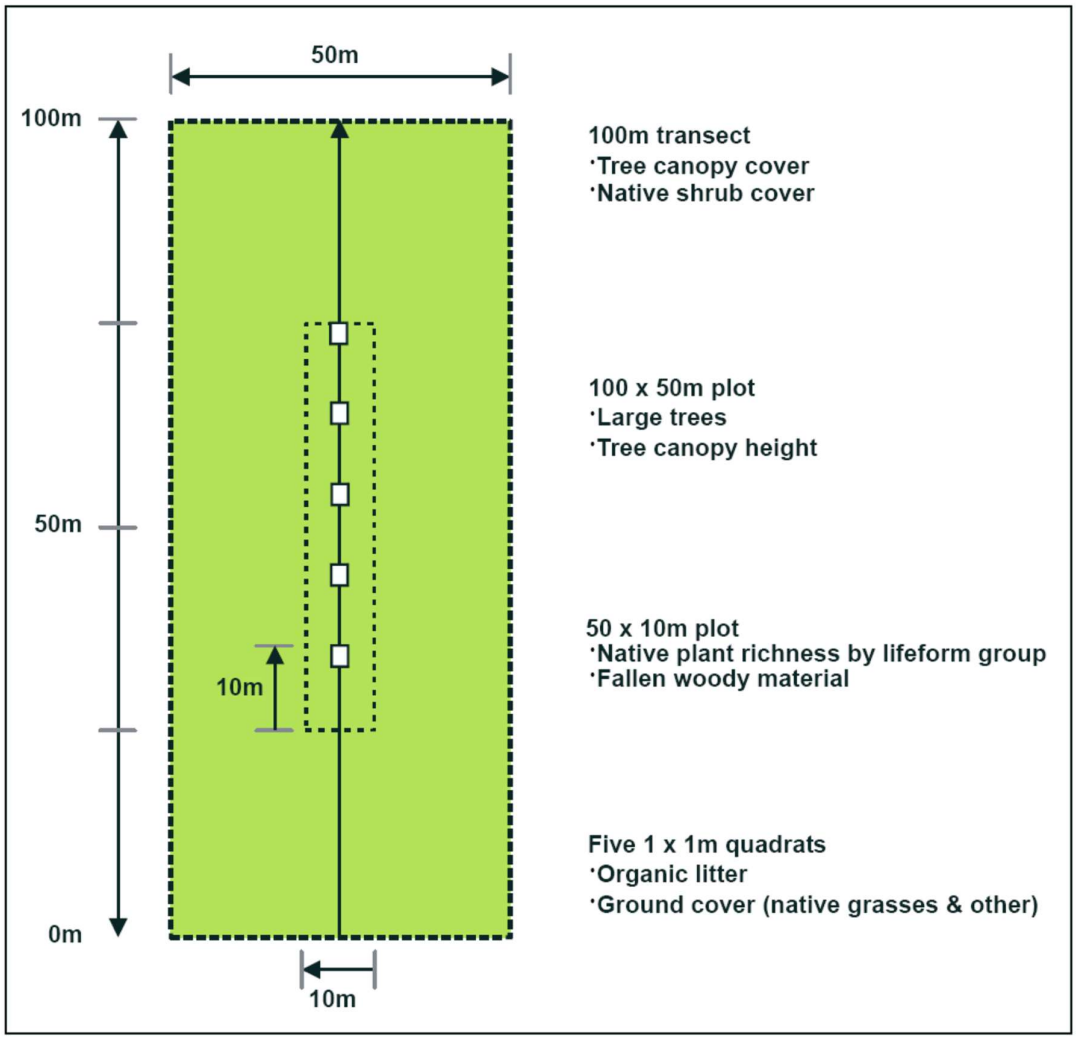


Figure 6-1 - Configuration of Reference Sites

A full methodology for data collection for reference sites is provided in **Appendix A**.

6.3.3. *Lagoon Creek Reference Site Results*

Based on the best available information (ie: pre-clearing RE mapping maintained by the Department of Environment and Heritage Protection) and site observations, the alluvial plains of Lagoon Creek within the study area historically supported a single regional ecosystem, characterised by Poplar Box *Eucalyptus populnea* and Brigalow *Acacia harpophylla*.

A reference site transect was established within a remnant patch of RE 11.3.17, to establish benchmark data. This reference site was located on Myall Creek, on the Maclagan-Cooyar Road (368858 E, 7007998 S), and it displayed the condition attributes listed below in **Table 6-2**.

Table 6-2 - Benchmark data for RE 11.3.17

Site Based Condition Attributes	RE 11.3.17
Recruitment of woody perennial species	100% of overstorey species present as natural recruitment, three species present
Native plant species richness	18
Tree canopy cover (%)	30-40%
Tree canopy height	19m
Shrub layer cover (%)	10%
Native perennial grass cover (%)	65%
Native perennial forb and non-grass cover (%)	15%
Native annual grass, forb and non-grass cover (%)	5%
Large trees	35
Fallen woody material	12
Weed cover (%)	18%
Litter cover (%)	10%

6.3.4. *Bottle Tree Hill Reference Site Results*

Bottle Tree Hill is dominated by remnant and non-remnant semi-evergreen vine-thicket vegetation that is analogous with RE's 11.8.3 and 11.8.5. A reference site will be established within remnant vegetation on Bottle Tree Hill (**Figure 6-1**). Once the reference site has been established and following the completion of reference site surveys, rehabilitation benchmark criteria will be developed and included in **Table 6-3**.

Table 6-3 - Benchmark data for RE 11.8.3 and RE 11.8.5

Condition Attributes	Criteria – 11.8.3	Criteria – 11.8.5
Recruitment of woody perennial species	100% of overstorey species present as regeneration	100% of overstorey species present as regeneration
Native plant species richness	9	10
Tree canopy cover (%)	T1 – 13% T2 – 3%	T1 – 62% T2 – 17%
Tree canopy height	T1 – 15 m T2 – 5 m	T1 – 7 m T2 – 3 m
Shrub layer cover (%)	2 %	27 %
Native perennial grass cover (%)	60 %	5%
Native perennial forb and non-grass cover (%)	-	-
Native annual grass, forb and non-grass cover (%)	-	-
Large trees	6 (Eucalypt)	70 (Non-eucalypts)
Fallen woody material	-	-
Weed cover	< 20 %	< 20%
Litter cover	25 %	45 %
Recruitment of woody perennial species	100% of overstorey species present as regeneration	100% of overstorey species present as regeneration

6.4. Rehabilitation Criteria

6.4.1. *Background*

The development of species composition in restored sites toward a state that resembles appropriate reference sites is, at best, extremely slow and as such there is little to be gained by setting unrealistic rehabilitation targets.

A full species survey or census to quantify the biodiversity values of a patch of vegetation is expensive to conduct and requires high levels of technical expertise. As such, use of indicators of biodiversity, or measurable surrogates of biodiversity, is a relatively reliable and cost-effective approach to assess or monitor biodiversity.

At the site scale, biodiversity indicators are either based on key or 'indicator' species or structural aspects of the vegetation that are known to be important for biodiversity. The approach using key indicator species is limited because relationships between species and biodiversity are yet to be

established, as well as other inherent issues with survey conditions and how these can influence detectability of species.

However, indicators based on key vegetative structural elements are proving to be a more reliable and cost-effective approach for the assessment of biodiversity, and form the basis of assessment of vegetation condition elsewhere in Australia.

6.4.2. Targets for Site-based Condition Attributes

Rehabilitation targets for each condition attributes within Lagoon Creek and Bottle Tree Hill have been derived from the benchmark data obtained for RE 11.3.17, RE 11.8.5 and RE 11.8.3 (**Error! Reference source not found.**).

Target values adopted are the minimum values which would score greater than zero, using the BioCondition Assessment Manual (Eyre *et al.* 2011), for each attribute (**Table 6-4**).

Table 6-4 - Rehabilitation Targets

Condition Attributes	Rehabilitation Targets	Lagoon Creek Target Values RE 11.3.17	Bottle Tree Hill Target Values RE 11.8.5	Bottle Tree Hill Target Values RE 11.8.3
Recruitment of woody perennial species	100% of overstorey species present as regeneration	3 species present	9 species present	10 species present
Native plant species richness	35% of benchmark species	6 species present	9 species present	12 species present
Tree canopy cover (%)	30% of benchmark canopy cover	10.5%	T1 – 3.9% T2 – 0.9%	T1 – 18.6% T2 – 5.1%
Tree canopy height	25% of tree canopy height	5m	T1 – 4.6 m T2 – 1.6 m	T1 – 5.0 m T2 – 1.5 m
Shrub layer cover (%)	30% of benchmark shrub cover	3%	0.6%	8.1%
Native perennial grass cover (%)	40% of benchmark perennial grass cover	26%	24%	2%
Native perennial forb and non-grass cover (%)	50% of benchmark perennial forb cover	7.5%	0%*	1.5%*
Native annual grass, forb and non-grass cover (%)	50% of benchmark annual grass, forb and non-grass cover	2.5%	0.8%*	17.5%*

Condition Attributes	Rehabilitation Targets	Lagoon Creek Target Values RE 11.3.17	Bottle Tree Hill Target Values RE 11.8.5	Bottle Tree Hill Target Values RE 11.8.3
Large trees	50% of benchmark number of large trees (comprised of species which will eventually become large trees)	17 large trees	3 large trees	35 large trees
Weed cover	Similar to benchmark weed cover	<20% weed cover	<20% weed cover	<20% weed cover

(*) denotes where there are no benchmark values available, therefore a percentage of field results from reference sites were used.

7. Monitoring program

7.1. Establishment of Monitoring Sites

Survey plots to monitor basic indicators will be established and permanently marked in a revegetated site, prior to the commencement of any on-ground works. The same plots will then be surveyed each time the site is monitored. A metal peg or star-picket will be used to permanently mark the location of the 0 m points on each transect and the location of the start and finish points will be recorded using a GPS.

7.2. Monitoring Frequency

Natural regeneration areas will be inspected at approximately six-monthly intervals, to determine the extent of weed invasion and natural recruitment, and to assess the requirement for further intervention or management.

Revegetation (active seeding/planting) areas will be visually monitored monthly for the first six months (or until the plants are self-sufficient), then annually thereafter until rehabilitation targets are reached for the first 10 years. The qualitative visual monitoring will include the following: presence of active rill/gully erosion and weed species, general assessment of seedling establishment, and quantification of any general failure of rehabilitation works.

Reference sites and revegetation areas will be quantitatively assessed (including species composition), every 3 years after establishment of the reference sites.

7.3. Belson's Panic

Belson's Panic (*Homopholis belsonii)* has been recorded within the vicinity of the NAC mine. The species occurs in woodlands including those on flat to gently undulating alluvial areas supporting Belah, Poplar Box, Brigalow, Myall (*A. melvillei)* and Weeping Myall (DEWHA 2008) which is typical of wooded vegetation communities along Lagoon Creek.

Monitoring will include searches for Belson's Panic within each monitoring location. If the species is recorded within the conservation area, long-term monitoring plots should be established to monitor individuals / populations.

8. Maintenance program

8.1. Rehabilitation maintenance

If monitoring demonstrates that natural regeneration or revegetation sites along Lagoon Creek or around Bottle Tree Hill are not achieving their designated rehabilitation criteria, NAC will investigate the cause of the negative variance or failure. Based upon the findings of these investigations, NAC will conduct specific maintenance rehabilitation activities to correct or improve the overall performance of the deficient sites, to ensure that the long-term objectives of the CZMP are achieved. If required, NAC may also adjust its standard revegetation techniques to correct any identified technical or other failings.

Maintenance activities may include supplementary plantings of selected species from one or more of the five identified life forms (using either direct seeding or planting), or the implementation of a targeted weed eradication program (herbicide spraying, mechanical removal, etc.).

8.2. General maintenance

General maintenance will involve a range of measures as required, including erosion and sedimentation maintenance, repair of any damaged infrastructure (e.g., fencing, signage, etc.), general weed control, and control of fire fuel loads following good growing seasons.

To control fire fuel loads efficiently, targeted grazing may be employed within the revised Project's conservation management zone. This specific use of grazing will be very limited in terms of application (timing and extent), will be closely managed and monitored, and will not be applied to any newly planted areas. NAC's sister company, the Acland Pastoral Company, will provide advice and manage all targeted grazing undertaken for fire control purposes within the revised Project's conservation management zone.

Apart from the purpose of efficient fire control, grazing will generally be excluded from the revised Project's conservation management zone (i.e., with the exception of periodic crossings by the Acland Pastoral Company's farming activities – see **Section 2.7**).

9. Long Term Protection of Values

Following achievement of the 10-year rehabilitation targets for the Lagoon Creek conservation zone required under Imposed Condition 15 of the Coordinator-General's Evaluation Report (December 2014), NAC in consultation with the Acland Pastoral Company, will assess the best available management option for the long-term protection of the rehabilitated conservation zone's environmental values (e.g., a voluntary nature refuge agreement).

NAC will be responsible for the establishment of the selected long-term protection mechanism for the rehabilitated Lagoon Creek conservation zone. As background landowner, the Acland Pastoral Company will be responsible for maintenance of the long-term protection mechanism for the established Lagoon Creek conservation zone (i.e., post closure of the revised Project).

10. Reporting

A Progress Report will be prepared annually and will be provided to the authority administering of the Environmental Protection Act 1994 (at the time of writing, the DES) and published on the company website, and/or, will be published in consideration of the future requirements of the NAC PRCP.

The Annual Progress Report will include an update on:

- The outcomes and progress of:
  - Monitoring and maintenance strategies;
  - Revegetation;
  - Management programs; and
- Any actions required to address unsuccessful revegetation and translocation efforts.

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Appendix A – Methodology for data collection – reference sites

Methodology for the Establishment and Survey of Reference Sites for BioCondition

T.J. Eyre
A.L. Kelly
V.J. Neldner

Version 1.4
August 2006

Queensland Government
Environmental Protection Agency
Queensland Parks and Wildlife Service

Methodology for the Establishment and Survey of Reference Sites for BioCondition

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ISBN: **1-920928-05-7**

This work may be cited as: Eyre, T.J., Kelly, A. L. and Neldner, V.J. (2006). Methodology for the Establishment and Survey of Reference Sites for BioCondition. Version 1.4. Environmental Protection Agency, Biodiversity Sciences Unit, Brisbane.

Acknowledgements

The 'BioCondition' team would like to acknowledge the input of the Environmental Protection Agency technical committee, including Juliana McCosker, Alex Kutt, Richard Johnson, Wendy Drake, Paul Williams, Tim Pulsford, Chris Hill, Richard Clarkson, Steven Howell, Peter Young and Doug Ward.

Many others contributed to the development of BioCondition and the reference site manual. In particular, thanks to Jeanette Kemp for testing the methodology and providing constructive suggestions for improvements. Bruce Wilson and Rod Fensham also provided advice. Thanks to Dan Ferguson for designing the datasheets. Thanks also to Jian Wang, Melanie Venz and David Akers for testing the methodology and suggesting improvements.

Front Cover:
Main photo: Glenrock, Southeast Queensland. Photo by M. Mathieson.

Cover design by William Smith

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1. Introduction

BioCondition is an assessment framework that provides a measure of how well a terrestrial ecosystem is functioning for the maintenance of biodiversity values (Eyre *et al.* 2006). It is a site-based, quantitative and therefore repeatable assessment procedure that provides a numeric score that can be summarised as a condition rating of 1, 2, 3 or 4, or good through to poor condition. The BioCondition assessment manual can be accessed at http://www.epa.qld.gov.au/nature_conservation/biodiversity.

The BioCondition score is based on a comparison between measurements of specific site-based attributes and a benchmark value for each of those attributes, specific to a particular Regional Ecosystem (RE). A benchmark value is based on the average or median value obtained from mature and long undisturbed sites or from Best on Offer (BOO) sites, given few ecosystems are totally free of impacts of threatening impacts (Michalk and Norton, 1980; Landsberg and Crowley, 2004). These BOO sites are termed "reference sites".

There are 10 attributes in BioCondition that require benchmarks for the scoring system (Table 1). However, not all attributes requiring assessment in BioCondition require measurement at reference sites. This is because their benchmarks are either effectively zero or scores are qualified in the BioCondition scoring system. Attributes that do not require assessment at reference sites include recruitment of woody perennial species, canopy health, hollow-bearing trees, decay status of fallen woody material, weed cover and the attributes relating to landscape context.

Table 1: Site-based attributes that are compared against benchmark values in BioCondition, and hence measured at reference sites

Attribute	Measure
Native plant species richness	number
Tree canopy cover	percentage
Tree canopy height	median
Shrub layer cover	percentage
Native perennial grass cover	percentage
Native perennial forb and non-grass cover	percentage
Native annual grass, forb and non-grass cover	percentage
Large trees	number
Fallen woody material	number
Litter cover	percentage

Benchmarks for REs in Queensland will be derived from quantitative data and expert elicitation and will be posted on the EPA BioCondition website[1]. However, due to the large number of REs, many have not yet been benchmarked. Where benchmarks are not yet available, or an assessment needs to be conducted during less than optimal conditions,

[1] http://www.epa.qld.gov.au/nature conservation/biodiversity

then quantitative benchmark data can be derived by locating and setting up a local reference site. Reference site assessment does require good botanical and habitat assessment skills, and entails measurement and recording of vegetation floristics and structure.
The assessment methodology detailed in this document is for the location, establishment and recording of floristic and structural vegetation attributes specifically for the generation of benchmarks for BioCondition. The benchmark data derived using this methodology is to be used in conjunction with the companion manual: *BioCondition: A terrestrial vegetation condition assessment tool for biodiversity in Queensland* (Eyre *et al.* 2006). The aim of the manual is to aid the standardisation and consistency of data collection spatially and temporally. Feedback on the methodology is sought and will help improve future versions (See Appendix 1 for contacts).

If more detailed assessments are required for biodiversity survey or monitoring by appropriately skilled operators, then the following methodologies are recommended:

Flora: Neldner, V.J., Wilson, B.A., Thompson, E.J. and Dillewaard, H.A. (2005). Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland. Version 3.1. Environmental Protection Agency, Brisbane.

Habitat and structure: Eyre, T.J., Jermyn, D. and Kelly, A.L. (2000). Forest condition and habitat assessment in Queensland. Version 2.0. Standards for Forest Assessment Technical Report 01/00, Department of Natural Resources, Brisbane. **NB**: *this manual is currently being updated by the authors.*

Fire impacts on vegetation: Williams, P. and Drake, W. (2006). Tool kit for assisting vegetation evaluation and monitoring on the QPWS estate. Environmental Protection Agency, Brisbane.

In addition, rainforest communities are floristically and structurally diverse, and also proceed through a number of seral stages after disturbance. Additional attributes are required to assess condition in these communities, and an assessment system has been developed by Kanowski and Catterall (2006) specifically for use in restoration projects, and is recommended for use in these systems.

2. What is required for the assessment

The assessment takes place within a 100 x 50m area.

Ideally you will need:

i. A 100m transect tape
ii. A 50m transect tape
iii. A compass
iv. A diameter tape or tree calipers
v. This manual
vi. A clinometer or hypsometer for measuring tree heights
vii. A digital or print film camera
viii. A $1m^2$ quadrat

ix. 2 star pickets or tyres and wire (to peg down tyre) to mark out each end of the transect line.
x. Clipboard, pencils and eraser.
xi. Pocket calculator
xii. Flagging tape
xiii. Global positioning system (GPS)
xiv. Plant press for collecting specimens
xv. Plant identification guides (see Appendix 2).

3. Locating reference sites

The appropriate location and establishment of a reference site is paramount to the derivation of relevant benchmarks. Canopy height and cover vary within RE's according to environmental conditions. Therefore areas to be assessed should be compared with a reference site that occurs as close as possible to the area to be assessed and has similar environmental conditions, i.e. the same regional ecosystem, vegetation community, similar climate (same subregion), similar landscape conditions (soil, slope, position in the landscape, geology etc) and similar natural disturbance (cyclone impacts or fire history). For this reason, field measurements of the height, canopy cover and species composition of the area of interest are compared, where possible, to measurements from a local reference area, i.e. a nearby area of comparable vegetation that is known to be remnant, such as a shadeline or road reserve.

Reference sites are selected in RE's with no extensive chemical or mechanical disturbance to the predominant canopy evident on the aerial photograph archive (from 1960s to recent) or on the ground.

When selecting a reference site, take into account that it must:

- Be homogenous with regard to RE and condition status
- Represent an undisturbed, late mature or BOO of the required RE. That is, the site must have minimal modification through timber harvesting, grazing, fire, erosion, dieback, flood, high recruitment of native species, and/or weed infestation.
- Ideally, be located within a reasonably large (> 5 ha) intact patch of remnant vegetation (to avoid issues of edge effects).
- Be located at least 50 m from a roadside.

To obtain a reasonable representation of the natural variation inherent in vegetation condition attributes within a specific RE, there must be a *minimum* of three local reference sites located and measured. It is preferable that the reference sites are not located proximally, and are established at least 3 km apart to account for potential geographic variation. In some cases, particularly in highly fragmented bioregions, it may not be possible to collect benchmark data for all attributes within the one reference site – e.g. a recent fire may have impacted upon shrub cover and the number of understorey species present, but not the number of large trees. It is acceptable to establish a reference site that provides benchmark data for one or more attributes only. However, it will need to be made clear on the datasheets that it is a *partial* reference site only.

4. Field assessment

4.1 When to assess

Reference site assessment during the peak of summer or following a period of drought is not recommended, as there is likely to be a reduction in plant diversity during these times. This obviously influences the collection of appropriate benchmark data. The best time for assessment, in the rangelands in particular, is considered to be May to June when plant diversity is generally at its greatest. However, this is a general rule and is obviously guided by local climate and knowledge.

As a further guide, in regions north of the tropic of Capricorn, site assessment should be conducted after the wet season, ideally between March and May to ensure adequate sampling of ground cover species (Neldner *et al*. 2004). South of the tropic of Capricorn – site assessment should be generally conducted in May or June following the wetter summer months. An exception would be following an unseasonably wet winter in spring when plant species are flowering.

4.2 Setting up the assessment site

The assessment site constitutes a 100 m x 50 m nested plot design. The layout of the site and nested subplots, is shown in Figure 1. The series of subplots are used to sample the floristic, habitat and disturbance components, and are summarised as follows;

1. 100 x 50 m area: records all potential large trees > 20 or >30 cm diameter at breast height (DBH); depending on the tree species, see Large tree section 4.3.4.
2. 50 x 10 m area: record all fallen woody material > 10 cm diameter, and number of floristic species by lifeform group i.e. Tree, Shrub, Grass, Forbs and Other species. This area can also be used as a Secondary Site for the detailed survey of RE's following Appendix 2 in the Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland (Neldner *et al.* 2005).
3. 100 m transect: record tree and shrub canopy cover;
4. Five 1x1 m subplots: record ground cover, litter, rock cover, and bare ground.

Demarcation of the reference site is established by positioning a 100 m tape, which constitutes the centre line of the plot. Flagging tape can be used to identify the outer boundaries of the plot, which is 25 m each side of the centre transect. The plot boundary must be a minimum distance of 50 m from a major disturbance or discontinuity such as a road or disturbed edge. In topographically diverse areas, the plot should be oriented so that its long axis follows the contour, or topographic position (e.g., gully, midslope, ridge). Plot location is recorded at its centre point (the 50 m point along the 100 m transect). A global positioning system (GPS) is recommended to record the position of the centre point in the field. This position should be checked against a 1:100 000 or larger scale topographic map for the area. The altitude recordings on GPS can be inaccurate and are better derived from the topographic map.

The use of star pickets or pegged down tyres at the beginning and end of the 100m transect will aid in relocating the site for future monitoring.

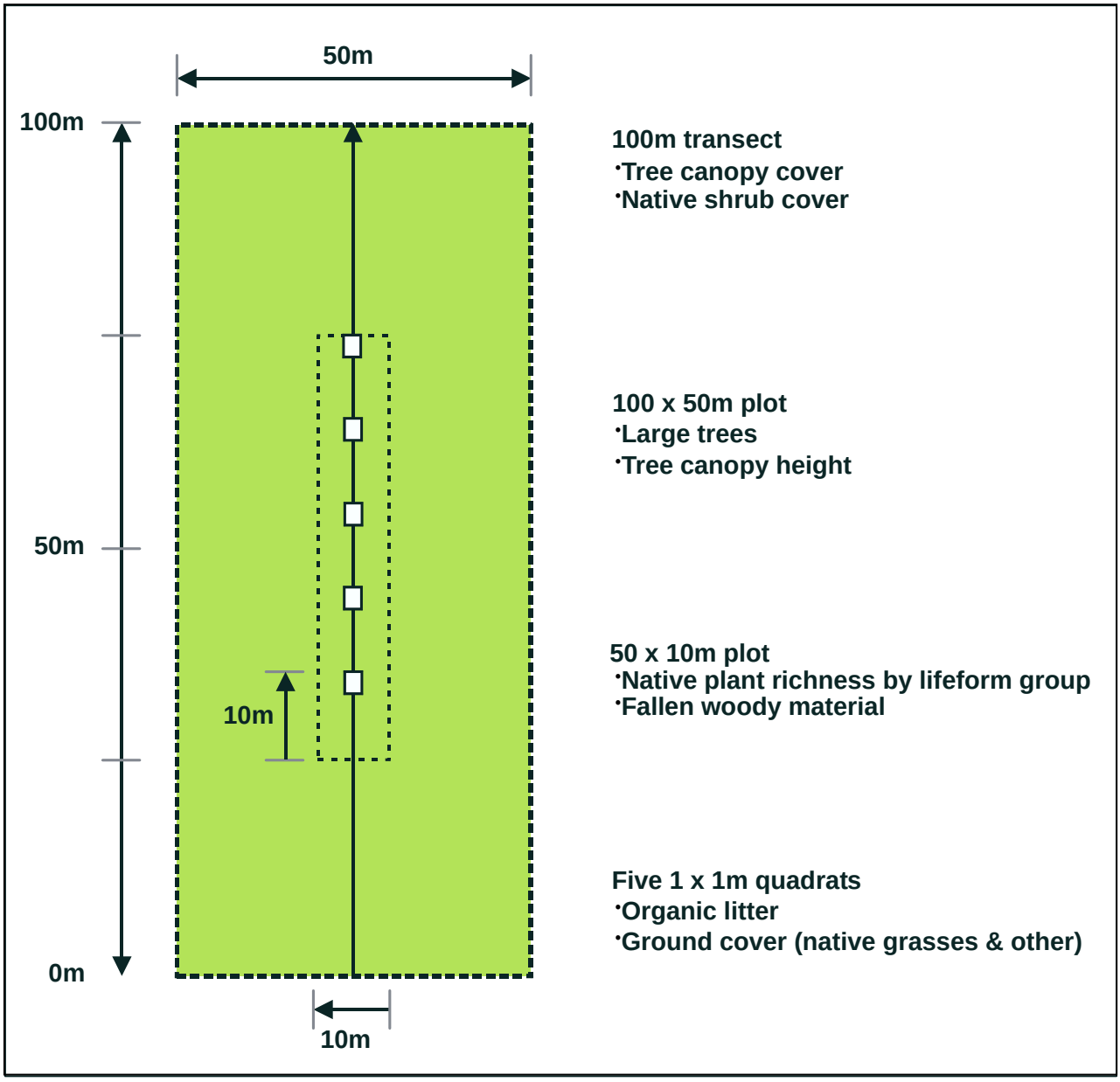

Figure 1: BioCondition reference site area and layout

4.3 Data collection

Five components form the basis for and approach to data collection:

1. Site information, disturbance and tree canopy height
2. Native plant species richness and fallen woody material
3. Ground cover vegetation and organic litter
4. Large trees
5. Tree and shrub canopy cover

Datasheets to aid the collection of reference site data for each of these five components is provided in Appendix 3.

4.3.1 Site information, disturbance and tree canopy height

This records site location, the general physical characteristics of the site and disturbance information relevant to the site. Fields marked with (O) can be recorded back in the office.

Location and site information

Plot location	Record two locations, one at a convenient road point and the other at the plot centre, the distance and bearing from the road to the plot centre and the plot alignment. Record location to the nearest metre using a Global Positioning System (GPS) receiver. Record the datum to which the GPS is set. It is recommended that GDA94 or if not available WGS84 is used as the datum..
Plot bearing	Refers to the compass bearing or direction the plot is oriented, lengthways.
Locality description	Record a general description of where the plot is situated. Include the state forest/national park number and/or name, or a property name or description, the name of the nearest road if applicable and any other information relevant to the locality.
Tenure (O)	Record the tenure of the land parcel on which the plot occurs by reference to the Digital Cadastral Data Base (DCDB) which is maintained by Department of Natural Resources, Mines and Water (NRM&W).
Property	Record the name of the state forest, National Park or property if known.
Bioregion	Record the Queensland bioregion name

Regional Ecosystem

Habitat description	Record a detailed description of the site including the key species and density of all tree, shrub and ground layers. Aim to include its structural form type (Table 2), as per the Queensland Herbarium (BRI) which uses the characteristic stratum, or the layer that contributes most to overall above-ground biomass (Neldner *et al.* 2005).
Regional Ecosystem	REs were defined by Sattler and Williams (1999) as Bioregional vegetation communities that are consistently associated with a particular combination of geology, landform and soil. The RE description database (REDD) is updated regularly and is available on the EPA website along with mapping that you can download[2]. A total of 1351 REs are currently defined (REDD v.5.0) and the system is frequently updated. NB: If vegetation has been mapped for the area it is possible to query the RE mapping to determine the RE (www.epa.qld.gov.au/REMAP). However, in some cases this will not be the actual RE for the plot area. Problems will invariably occur because: • Not all the state has mapping available; • Regional ecosystem mapping is usually at 1:100 000 scale;

2 Regional ecosystem mapping is available at:
http://www.epa.qld.gov.au/REMAP

- Vegetation mapping often uses the concept of mosaics where, again because of scale restraints, a single vegetation polygon is classed as being a mix of several different vegetation types (and thus REs).

For this reason the regional ecosystem maps should be used as a guide and the habitat description should be detailed enough to enable the classification of the actual community into a single RE.

Land form

Slope position	Record the slope position, using codes given on the datasheet.
Slope degree	Measure the general slope of the plot using a clinometer and record in degrees. For flat areas record slope as 0 degrees.
Slope aspect	Record the compass direction, in degrees, of the downward slope of the plot. For flat areas record a dash (-).

Site photos

At the start of the transect take two photos, one landscape, and one from a trayback or elevated position (if you are able to drive within 10 to 20 m of the start of your transect). At the 50 m centre point of the plot collect four photos, north, south, east and west. See Appendix 4 for description on how to take photos.

Tree canopy height

The height of woody vegetation is measured from the ground to the tallest live part of the tree (Neldner *et al.* 2005). The maximum heights of the crown of at least three trees that are estimated to represent the median canopy height are measured for height, using a hypsometer or clinometer and tape measure. The median canopy height is the height that has 50% of the canopy trees larger and smaller than it. If using a clinometer and tape measure, this includes measuring the horizontal distance to the point directly below the highest point of the tree canopy where the top of the tree is not directly above the base of the trunk. When using a clinometer, adjustments are also made for the height of the recorder and any slope in the land surface. A method for assessing tree heights is provided in Appendix 5.

Table 2: Structural formation classes qualified by height

Projective foliage cover	70-100%	30-70%	10-30%	<10%
Crown separation	closed or dense	mid-dense	sparse	very sparse
Field criteria	touching-overlap	touching – slight separation	clearly separated	well separated
Crown separation ratio[1]	<0	0-0.25	0.25-1	1-20
CROWN COVER %[2]	81-100%	52-81%	20-52%	0.2-20%
GROWTH FORM[3] ↓	Structural Formation Classes (qualified by height)			
Trees[4] > 30m	tall closed-forest TCF	tall open-forest TOF	tall woodland TW	tall open-woodland TOW
Trees[4] 10 – 30m	closed-forest CF	open-forest OF	woodland W	open-woodland OW
Trees[4] < 10m	low closed-forest LCF	low open-forest LOF	low woodland LW	low open-woodland LOW
Shrubs[5] 2 – 8m	closed-scrub CSC	open-scrub OSC	tall shrubland TS	tall open-shrubland TOS
Shrubs[5] 1 – 2m	closed-heath CHT	open-heath OHT	shrubland S	open-shrubland OS
Shrubs[5] <1m	-	Dwarf open-heath DOHT	dwarf shrubland DS	dwarf open-shrubland DOS
Succulent shrub[5]	-	-	succulent shrubland SS	dwarf succulent shrubland DSS
Hummock grasses			hummock grassland HG	open hummock grassland OHG
Tussock grasses	closed-tussock grassland CTG	tussock grassland TG	open-tussock grassland OTG	sparse-tussock grassland STG
Herbs[6]	closed-herbland CH	herbland H	open-herbland OH	sparse-herbland SH
Forbs	closed-forbland CFB	forbland FB	open-forbland OFB	sparse-forbland SFB
Sedges	closed-sedgeland CV	sedgeland V	open-sedgeland OV	

Neldner *et al.* 2005, modified from Specht (1970)

[1] Equivalent to Specht (1970) projective foliage cover (pfc) classes from Walker and Hopkins (1990) Table 14a.
[2] Equivalent crown cover from Walker and Hopkins (1998) Table 17.
[3] Growth form of the predominant layer (the ecologically dominant layer).
[4] Tree is a woody plant more than 5m tall usually with a single stem.
5 Shrub is a woody plant less than 8m tall either multi-stemmed or branching close to the ground, occasionally with a single stem.
6 Herbland refers to associations in which species composition and abundance is dependant on seasonal conditions and at any one time grasses or forbs may predominate

Disturbance

Disturbance is visually assessed over the whole reference site. These data are not actually required for benchmarking, but it is helpful to have a record of any disturbance if present. As outlined earlier, ideally the reference site should have minimal disturbance.

For each disturbance type a code is used to rank its relative severity (from 0 = no discernible disturbance to 3 = severe). Codes are also used to record an estimated time since the last event for each disturbance (A: <1 year; B: 1-3 years, C: 5-10years, D: 10-20 years, D: > 20years), and how the disturbance was estimated (1 = visual estimate, 2 = from historical records, 3 = from informant, 4 = from imagery or mapped source). Assessment of disturbance should be considered in the context of impact on the RE's structure, composition and function. Assessment needs to take into account the capacity of the community to recover after the event – that is, disturbances can appear to be severe soon after their occurrence. It is important to try to gauge how this event will affect the community beyond the short term.

Wildfire	Refers to major previous hot fire disturbance, the severity of which can be based on the extent of fire scars on standing trees relative to their height and diameter. Time since such an event can be estimated on the height of any post-burn regeneration, charring on ground woody material which may have fallen since the event, diameter growth around fire scars on standing live trees, extent of crown recovery or from the aerial photograph or satellite imagery archive or web fire mapping sites such as Northern Australian Fire Information (NAFI) website: www.firenorth.org.au, or the CSIRO Sentinel website: www.sentinel.csiro.au. Record also the mean height of fire scars on standing stems.
Prescribed Burn	Refers to the cool, frequent (annual or biennial) burns used to reduce fuel loads and/or increase grazing potential of the grassy understorey. The nature of these burns dictate that the intensity of this disturbance would rarely be recorded as severe.
Logging	Record information on past logging events. Severity should be the total of all logging events and time for the latest event. If there have been several logging events record details in the notes section.
Treatment	Treatment is defined as the destruction of individual trees by ringbarking or poisoning, in contrast to 'logging' of individual trees for product harvesting and 'clearing' by mechanical means. Standing dead and fallen trees should be examined closely for marks indicating past treatment. These can be at waist height (ringbarking or tomahawk cuts) or near ground level for basal injection treatment.
Grazing	Grazing impact can be assessed by the presence of manure, compaction, presence of stock trails, and eaten off grasses. It will probably not be possible to estimate grazing severity for older grazing events. However, inspection of fencing and stock infrastructure in the vicinity may give some indication of the time since grazing activity.

Weeds	Weeds are defined as exotic species, and those declared or assumed to be noxious (e.g. lantana, balloon cotton bush), but not native 'woody weeds' such as *Dodonaea, Eremophila*.
Erosion	Record information on erosion seen in the plot, e.g. gully erosion. Erosion outside the plot but in the vicinity should be noted.
Regeneration	Record information about regeneration resulting from disturbance e.g. *Acacia* following wildfire or regrowth following clearing. Detail in notes as required.
Other	Specify any other disturbance types noted e.g. dieback, soil disturbance, snig tracks.

4.3.2 Native plant species richness and fallen woody material

Native plant species richness and fallen woody material are both recorded within the 50 x 10 m plot. The number of native plant species are assessed into one of five life-form groups, to assist assessment and benchmarking; trees, shrubs, grass, forbs and other (see Appendix 6 for groupings).

Fallen woody material constitutes all branches and logs >10 cm diameter and >0.5 m in length. Any woody material smaller than this is included as litter cover. Assessment is conducted by counting the number of fallen woody logs and other debris that are found within the 50 x 10 m plot. To be counted as in, 50% or greater of the log must occur within the plot. This is basically a count of the number of fallen woody material in the subplot.

4.3.3 Ground cover vegetation and organic litter

Ground cover data are recorded from each of the five 1 x 1 m subplots centred along the middle transect. For benchmarking purposes, quantitative data are required only for litter and ground vegetation cover. However, it is recommended that all components of the ground cover are recorded, to ensure 100% of the ground cover is estimated. The datasheet provides space to record cover estimates for; native perennial grass, native perennial herbs and forbs and annual species cover. It is then possible to cross reference cover estimates made for the perennial and annual grasses and forbs, as required for BioCondition scoring. If a subplot is occupied by a log (woody debris) or a living trunk of a tree, the subplot can be slightly moved along the transect to avoid the log or trunk. Exposed tree roots should also be avoided if possible.

Figure 2 provides a visual indication of ground cover proportions for assessment purposes. A value for the reference site for each component is obtained by averaging the values from the five sub-plots. The sum of ground cover percentages, litter cover, bare ground, cryptogram and rock cover will equal 100 percent in each subplot.

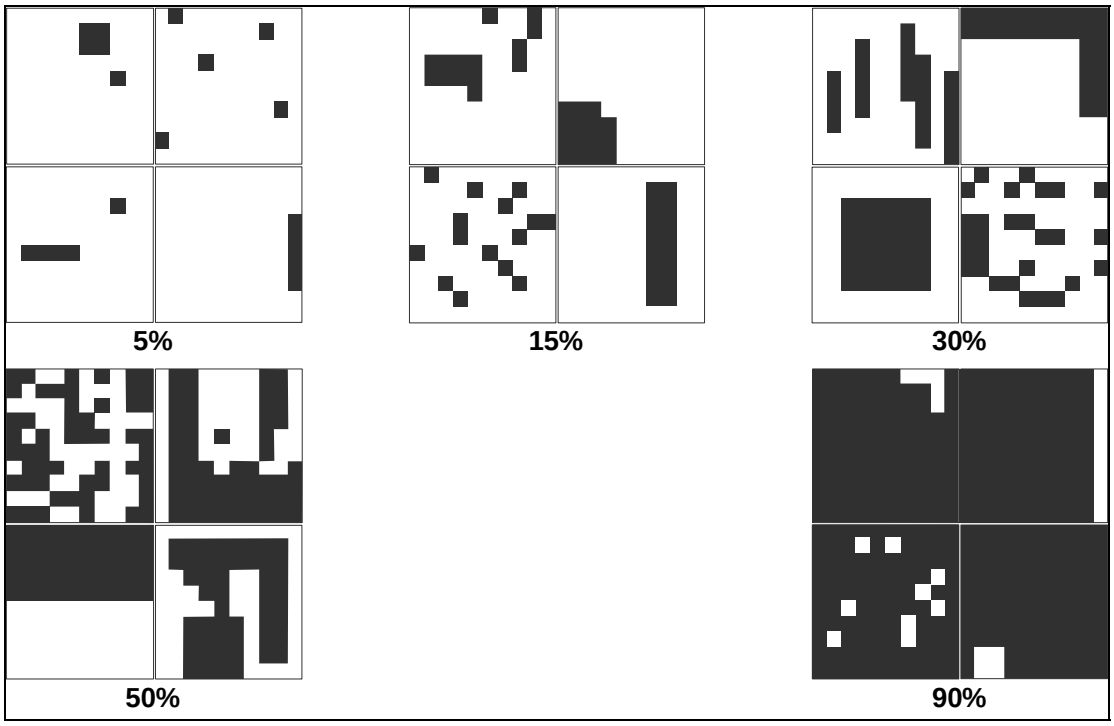

Figure 2: Stylised examples of ground cover proportions (Aisthorpe and Paton, 2004).

4.3.4 Large trees

In eucalypt forests and woodlands and rainforests (excluding vine thickets), the threshold DBH from which to record tree species and their diameters is 30 cm. In *Melaleuca*, *Acacia*, *Callitris* and all other non-eucalypt and vine thicket dominant ecosystems, the threshold is 20cm Diameter at Breast Height (DBH).

In some cases there will be exceptions to this rule, where it is acceptable to increase or decrease the threshold in response to the inherent structural characteristics of the ecosystem being assessed. For example, in most *Acacia harpophylla* dominated ecosystems the 20 cm threshold is appropriate, however in the *A. harpophylla* low woodland RE 4.9.19 mature trees rarely exceed 20cm, therefore a 15 cm threshold may be more appropriate from which to start recording large trees. In *Melaleuca viridiflora* low open-woodlands on Cape York Peninsula, the average tree DBH is only 12.2 cm, therefore all trees greater than 10 cm DBH need to be counted to determine the appropriate large tree threshold.

As a general guide, the trees counted should include all the mature trees in a stand. It is important to note that the 'large tree' benchmark is derived from calculating the average DBH of trees greater than the threshold, and then counting the number of trees greater than this average value (see section 5). Therefore, selecting an inappropriate threshold, which either over- or under-represents the mature tree component will lead to the derivation of an inappropriate benchmark for the large tree attribute.

The species identity and DBH of larger trees are recorded within either a 100 x 50 m; 100 x 20 m; or 100 x 10 plot area. The selection of plot area to record the number of large trees will be determined by the inherent stand structure of the RE being assessed. In general, the 100 x 50 m plot area should be used for eucalypt dominant REs, as large trees are often

widely dispersed. The smaller plot areas can be used for REs with many, and/or uniform sized trees. The selection of the plot area can be guided by an aim to obtain a reasonable sample (> 25) of trees larger than the DBH threshold (note that all trees above the threshold within the plot area selected are measured. i.e. don't cease measuring when 25 trees are recorded). Trees above the threshold are scored into 5 cm DBH classes up until 60 cm DBH. Trees larger than 60 cm DBH are measured and recorded *per se*.

4.3.5 Tree and shrub canopy cover

The methodology to assess the canopy cover of trees and shrubs follows that detailed in the BioCondition assessment manual (Eyre *et al.* 2006). Canopy cover refers to the estimation of the percent canopy cover of each tree and shrub whose projected canopy intersects the 100 m transect. The approach uses the line intercept method and treats each canopy as solid, i.e. continuous leaves with no light gaps) (Greig-Smith 1964). The vertical projection of the tree or shrub canopy over the 100 m transect is recorded. The total length of the projected canopy is then divided by the total length of the tape to give an estimate of % canopy cover for either the tree or shrub layer (Figure 3).

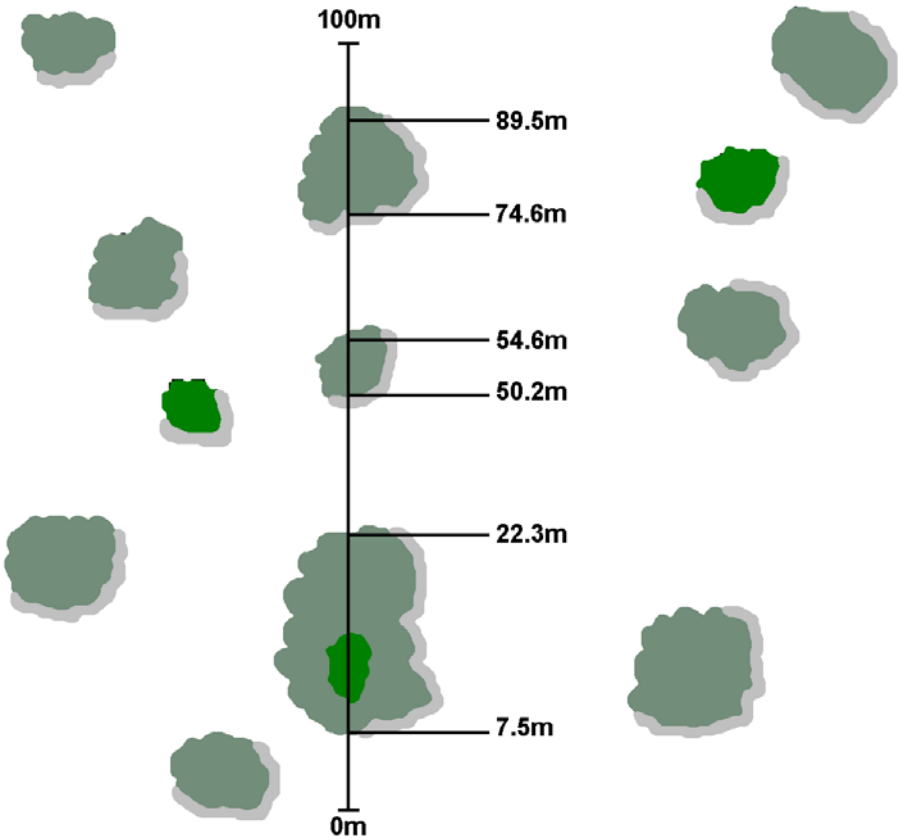

Figure 3: Example of assessing tree canopy cover (%).

Tree canopy cover = (22.3 – 7.5) + (54.6- 50.2) + (89.5 – 74.6) = 14.8 + 4.4 + 14.9 = 34.1. Therefore tree canopy cover is 34.1%.

5. Deriving Benchmarks from the data

If reference site data are collected and collated from more than one plot in a particular RE, then the benchmark for an attribute is derived by taking the median value for each attribute. The median is a measure of central tendency, and is the 50th percentile of the data collected from more than one site for a particular attribute. It is the value for which 50% of the values fall below the median and 50% of the values are greater than the median.

Box 1: Example for deriving benchmarks from reference site data

Reference site data has been collected from three sites in the one RE in a local area. The values collected for tree height, tree canopy cover, shrub canopy cover and perennial grass cover for the three sites, and the median values are shown below. The median values are the *benchmark* values for each attribute.

Values collected for four attributes across three reference sites within one RE, and the median values obtained:

Site	Tree height	Tree canopy cover	Shrub canopy cover	Perennial grass cover
1	33	25	12	25
2	30	25	10	35
3	32	23	7	20
Median	**32**	**25**	**10**	**25**

Therefore, for this RE, the benchmark for tree height = 32 m; tree canopy cover = 25 %; shrub canopy cover = 10 %; and perennial grass cover = 25 %.

To derive benchmarks for the large tree attribute, first the threshold DBH at which a tree is considered "large" needs to be determined. This threshold can be determined by calculating the average DBH for each genus measured from one or more reference sites within an RE. It is important to have a "large tree" threshold for each genus recorded in the reference site as different genera have varied growth habits e.g. in a mixed forest of cypress pine (*Callitris glaucophylla*) and poplar box (*Eucalyptus populnea*) (RE 11.10.11), a large cypress pine tree may be > 30 cm DBH, whereas a large poplar box may be > 50 cm.

As trees are measured into 5 cm DBH classes, the midpoint of each DBH class is used to provide the average as shown in an example in Box 1.

Once the large tree DBH threshold has been determined, the median value can be calculated as outlined above for other attributes.

Box 2: Example for determining a large tree threshold

Plot size: 100 x 50 m plot
Regional Ecosystem: 11.10.11

Data:

Species	20-25	26-30	31-35	36-40	41-45	46-50	51-55	Total trees
Eucalyptus populnea			5	3	1	3	2	14
Eucalyptus melanophloia						2	1	3
Callitris glaucophylla	10	4	4	1	-	-	-	19

Determining the large tree DBH threshold:

Average DBH for eucalypt trees > 30 cm DBH

= ((5 x 32.5) + (3 x 37.5) + (1 x 42.5) + (5 x 47.5) + (3 x 52.5)) /17 = 712.5 / 17 = 41.9 cm

Average DBH for *C. glaucophylla* trees > 20 cm DBH

= ((10 x 22.5) + (4 x 27.5) + (4 x 32.5) (1 x 37.5) / 19 = 26.5 cm

Therefore, for this reference site, the DBH threshold indicating a "large" tree is 42 cm DBH for the eucalypts, and 26.5 cm DBH for *Callitris*.

Determining the large tree benchmark from this reference site:

Number of eucalypt trees > 42 cm (round down to nearest DBH class i.e. > 41 cm)

= 9 trees

Number of non-eucalypt trees > 26.5 cm (round down to nearest DBH class i.e. > 26 cm)

= 17 trees

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7. Glossary of terms

Annual species	Annual species are short-lived plants, completing their life-cycle within a single vegetative period, which can vary from a few weeks to several months. Annuals usually die within one year. Annual grasses are generally characterized by short growth, not forming large tussocks or root mass, no evidence of previous seasons growth (i.e. remains of last years tiller bases, and absence of stolons or rhizomes), with reproduction generally from seed.
Benchmark	A description of a regional ecosystem that represents the median characteristics of a mature and relatively undisturbed ecosystem of the same type.
BioCondition Score	The score assigned to the assessed site that indicates its condition relative to the benchmarks set for the regional ecosystem being assessed. The score can be expressed as a percentage, on a scale of zero to one, or as a category of 1, 2, 3, 4.
Biodiversity	The diversity of life forms from genes to kingdoms and the interactions and processes between.
CORVEG	Queensland Environmental Protection Agency Herbarium database for field data.
Diameter at Breast Height (DBH)	DBH is a measure of the size of the tree and is consistently measured at 1.3m. On sloping ground, DBH is measured on the high side of the tree from bare earth ground level. Try and ensure that the tape is straight when reading the diameter. On leaning trees, on level ground, 1.3m is measured from the underside of the lean. If a whorl, bump scar or other abnormality occurs at the 1.3m mark, measure the diameter at a nominated height (measured in whole 0.1m increments) above the defect. If a representative measure as described above cannot be taken (e.g.: presence of strangler figs), a reasonable estimate of the diameter should be made viewing the tree from two different directions. For multiple stems, a diameter is recorded for each stem, when it forks below 1.3m.
Perennial species	Perennial species are long-lived plants, tending to persist for three or more years. Generally perennial grasses are characterised by larger bulk than annual grasses i.e. forming tussocks and large root mass with evidence of previous seasons growth i.e. remains of last years tiller bases, and presence of stolons or rhizomes.
Reference Site	An area that represents an example of a Regional Ecosystem in “Good” Condition, i.e. in a relatively undisturbed and mature state. As not all RE’s will have examples of totally undisturbed states, sites of this kind are meant to represent the “Best On Offer” for that RE in that area. Data obtained from Reference sites will be used to establish benchmarks for each of the attributes used within BioCondition.
Regional Ecosystem	Regional ecosystems were defined by Sattler and Williams (1999) as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. For up to date descriptions of regional ecosystems go to the Regional Ecosystem Description Database at: http://www.epa.qld.gov.au/REDD

Remnant vegetation	Remnant vegetation is defined in the *Vegetation Management Act 1999* as vegetation shown on a regional ecosystem or remnant map. A map showing remnant regional ecosystem is the same as a 'remnant endangered (or of concern or not of concern) regional ecosystem map' defined under the *Vegetation Management Act 1999.* Where there are no maps available, remnant vegetation is defined as vegetation where the dominant canopy has greater than 70% of the height and greater than 50% of the cover relative to the undisturbed height and cover of that stratum and dominated by species characteristic of the vegetation's undisturbed canopy. Free regional ecosystem maps for most of Queensland can be obtained from the EPA website http://www.epa.qld.gov.au/REMAP. If RE maps are not available, then remnant vegetation maps can be obtained from the same website.
Weed	Non-native plant species.
Woody non-remnant vegetation (regrowth)	Woody non-remnant vegetation is all woody vegetation that fails to meet the structural and/ or floristic characteristics of remnant vegetation. It may include regrowth, heavily thinned or logged and significantly disturbed vegetation. Non-remnant vegetation may retain significant biodiversity values.

Appendix 1: Contacts for further information

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Appendix 2: Plant identification guides

General plant collecting guidelines

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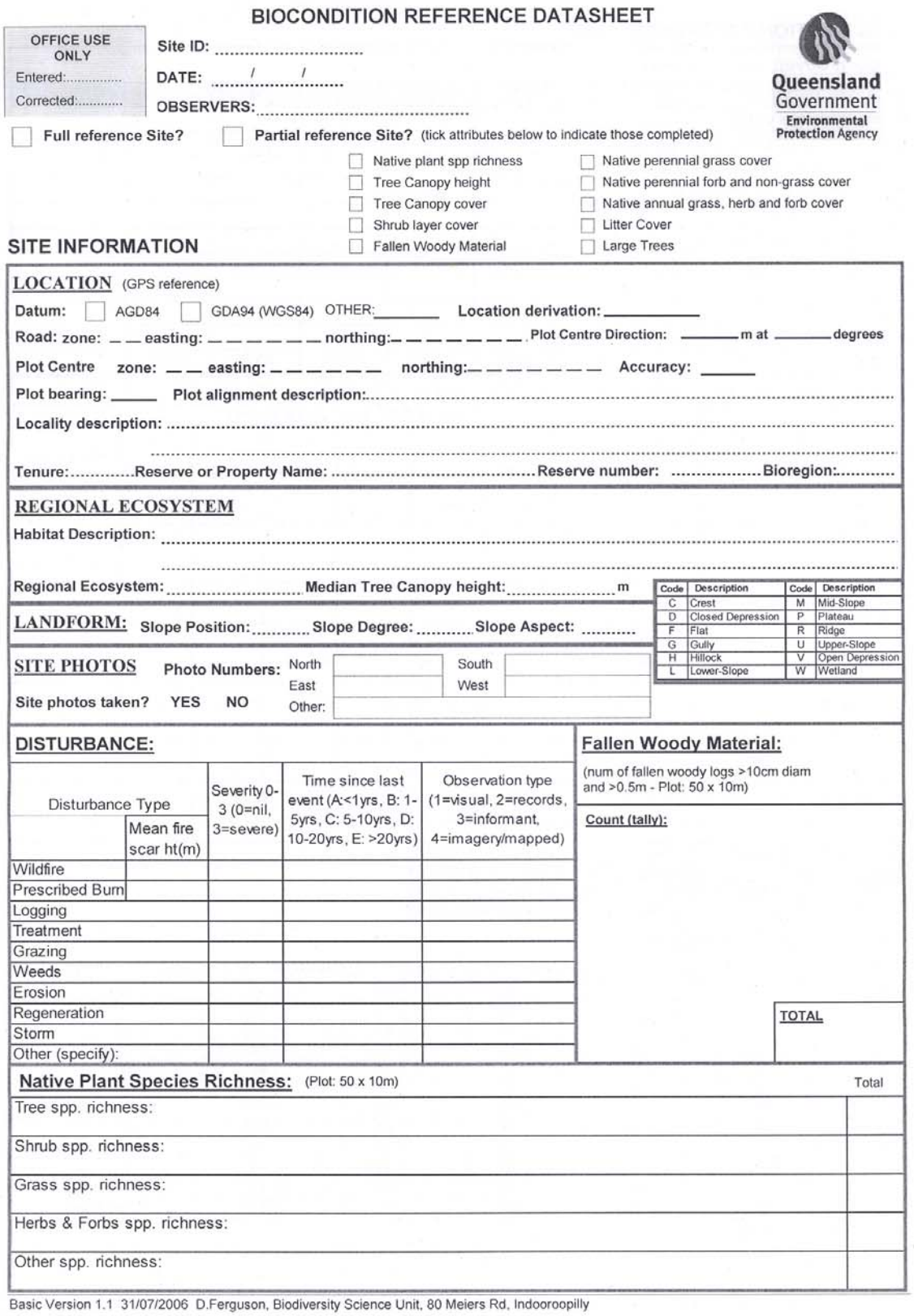
Appendix 3: Reference site datasheets



BIOCONDITION REFERENCE DATASHEET

OFFICE USE ONLY
Entered:.....
Corrected:.....

Site ID: .....
DATE: ..../..../....
OBSERVERS:.....

Queensland Government
Environmental Protection Agency

☐ Full reference Site? ☐ Partial reference Site? (tick attributes below to indicate those completed)

- ☐ Native plant spp richness
- ☐ Tree Canopy height
- ☐ Tree Canopy cover
- ☐ Shrub layer cover
- ☐ Fallen Woody Material
- ☐ Native perennial grass cover
- ☐ Native perennial forb and non-grass cover
- ☐ Native annual grass, herb and forb cover
- ☐ Litter Cover
- ☐ Large Trees

SITE INFORMATION

LOCATION (GPS reference)

Datum: ☐ AGD84 ☐ GDA94 (WGS84) OTHER:_____ Location derivation: _____

Road: zone: __ easting: _____ northing:_____ Plot Centre Direction: _____ m at _____ degrees

Plot Centre zone: __ easting: _____ northing:_____ Accuracy: _____

Plot bearing: _____ Plot alignment description:.....

Locality description: .....

.....

Tenure:.....Reserve or Property Name: .....Reserve number: .....Bioregion:.....

REGIONAL ECOSYSTEM

Habitat Description: .....

.....

Regional Ecosystem:..... Median Tree Canopy height:..... m

Code	Description	Code	Description
C	Crest	M	Mid-Slope
D	Closed Depression	P	Plateau
F	Flat	R	Ridge
G	Gully	U	Upper-Slope
H	Hillock	V	Open Depression
L	Lower-Slope	W	Wetland

LANDFORM: Slope Position:..... Slope Degree:..... Slope Aspect: .....

SITE PHOTOS Photo Numbers: North _____ South _____ East _____ West _____ Other: _____

Site photos taken? YES NO

DISTURBANCE:

Disturbance Type	Mean fire scar ht(m)	Severity 0-3 (0=nil, 3=severe)	Time since last event (A:<1yrs, B: 1-5yrs, C: 5-10yrs, D: 10-20yrs, E: >20yrs)	Observation type (1=visual, 2=records, 3=informant, 4=imagery/mapped)
Wildfire				
Prescribed Burn				
Logging				
Treatment				
Grazing				
Weeds				
Erosion				
Regeneration				
Storm				
Other (specify):				

Fallen Woody Material:

(num of fallen woody logs >10cm diam and >0.5m - Plot: 50 x 10m)

Count (tally):

TOTAL

Native Plant Species Richness: (Plot: 50 x 10m)

	Total
Tree spp. richness:	
Shrub spp. richness:	
Grass spp. richness:	
Herbs & Forbs spp. richness:	
Other spp. richness:	

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BIOCONDITION REFERENCE cont....

Ground Cover: (five 1 x 1m plots)

Ground Cover type	1	2	3	4	5	Mean
Native perennial grass						
Native perennial herbs & forbs (non-grass)						
Native annual grass, herbs & forbs						
Native shrubs (<1m in height)						
Non-native grass						
Non-native herbs & shrubs						
Litter						
Rock						
Bare ground						
Cryptograms						
Total	100%	100%	100%	100%	100%	

Large Trees: (Eucalypts >30cm dbh and Non-eucalypts >20cm) Plot size: ☐ 100 x 50m ☐ 100 x 20m ☐ 100 x 10m

Species	Tally of DBH size classes (cm)								
	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	>60 (record actual dbh)

Eucalypts: Average DBH (threshold)= cm
Number of trees >= benchmark:

Non-eucalypts: Average DBH (threshold)= cm
Number of trees >= benchmark:

Tree and Shrub Canopy Cover: (100m line intercept - T/S = tree or shrub)

	T/S	Distance		T/S	Distance		T/S	Distance		T/S	Distance		T/S	Distance		T/S	Distance		T/S	Distance
1			13			25			37			49			61			73		
2			14			26			38			50			62			74		
3			15			27			39			51			63			75		
4			16			28			40			52			64			76		
5			17			29			41			53			65			77		
6			18			30			42			54			66			78		
7			19			31			43			55			67			79		
8			20			32			44			56			68			80		
9			21			33			45			57			69			81		
10			22			34			46			58			70			82		
11			23			35			47			59			71			Shrub total:		
12			24			36			48			60			72			Tree total:		

Site visit comments: .....

.....

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Appendix 4: Taking Photos (Adapted from DNR, 1997 and DPIF 2004).

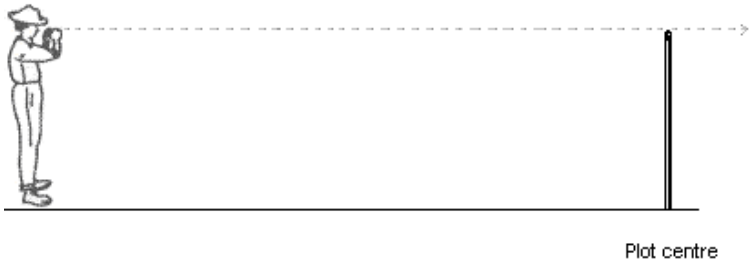
Photos should be taken every time you do a BioCondition reference site assessment. The best photos are taken on a clear day with the sun behind you, between 9am and 3pm with colour print film or a digital camera. By contrast, overcast days are better for photography for closed communities such as rainforests.

It is recommended that 6 photos be taken at each plot (with the last 2 as optional); 4 photos at the plot center in the direction of north (0^o), south (180^o), east (90^o) and west (270^o) and one landscape and one trayback photo at the start of the plot (If you are able to drive within 20m of the start of your transect). Landscape orientated photos pick up the general condition of the site, showing major changes in the shrub and tree layers. Photos taken from the trayback of a ute, looking down into the ground layer, visually capture soil and ground cover condition. An alternative to standing on the back of a ute is to stand on a small stepladder or drum to take the photo.

It is helpful to write the site name and date on a small sign for inclusion in photographs. A small chalkboard or whiteboard is suitable for this. Cameras that print the date on the photograph may also help with record keeping. Photos should either be scanned and stored in a database, or, kept in plastic holders with the monitoring record.

The landscape photo

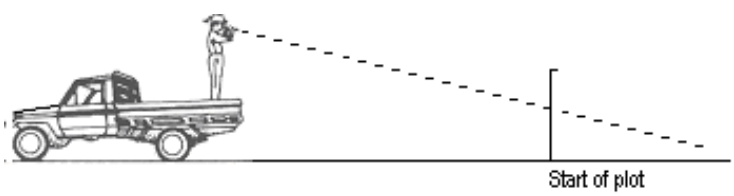
1.Stand on the ground close to the centre of the plot (or at 10m from the plot centre) and line up the camera with the central star picket (see figure below). Position the top of the star picket in the middle of the viewfinder, focus on a point in the distance, ensure the picture is level and take the photo at the start of the plot (or the series of plot center photos in a north, south, east and west direction in the center of the plot). Use the same or similar focal length lens each time to take the photograph so that the scope of the photograph is consistent.



The Tray back photo

1.If possible park your vehicle as close to the edge of the site as possible and stand on the back with the camera so you are looking in the direction of the plot (see below).

2. Aim the viewfinder down in the direction of the start of the plot, focus on the ground cover, make sure the picture is level and take the photo.



Appendix 5: Measuring Tree Height

Clinometer Method (extracted from Abed and Stephens 2002)
The Suunto clinometer (clino) is a tool commonly used by foresters to measure tree heights and also slope angles. At the rear of the clino is a peephole, which shows a percentage scale and a horizontal line (see Figure 4).

1. First measure the horizontal distance between the base of the tree and the operator.

2. Looking through the peephole (see Figure 5), line up the horizontal line with the top of the tree (the highest part of the tree, usually foliage) and read off the corresponding number from the percentage scale, which is on the right hand side. The scale on the left is in degrees and should not be used.

3. Line up the horizontal line with the base of the tree and again read off the corresponding number from the percentage scale.

4. If the base of the tree is above you (i.e. you're on the downward slope) then subtract the number from step 3 from the number in step 2 and multiply by the horizontal distance to get a total tree height.

5. If the base of the tree is level with you or below you (i.e. you're on the upward slope) then add the numbers together and multiply by the horizontal distance to get a total tree height.

6. If the tree is leaning, stand at right angles to the lean so the tree isn't leaning towards or away from you. If the highest part of the tree is not directly above the trunk, then adjust the horizontal distance so that it relates directly to the highest part of the tree.

Hint: If you can't see the bottom of the tree because of branches or understorey, sight to a point up the stem that can be seen and treat this as the base of the tree and continue with the procedure as described above. Then add the height from the base to the point you could see to get your estimate of total height.

Figure 4: Looking through a clinometer

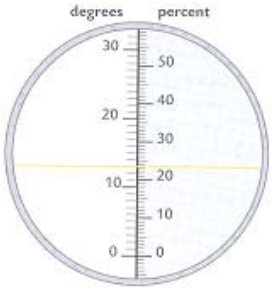


Figure 5: Using a clinometer

Appendix 6: Life-forms used in BioCondition

(modified from ESCAVI 2003).

Code	Name	Description	BioCondition Category
T	TREE	Woody plants, more than 2 m tall with a single stem or branches well above the base	Tree
M	TREE MALLEE	Woody perennial plant usually of the genus *Eucalyptus*. Multi-stemmed with fewer than 5 trunks of which at least 3 exceed 10 cm diameter at breast height (dbh). Usually 8m or more.	Tree
S	SHRUB	Woody plant multi-stemmed from the base (or within 200mm from ground level) or if single stemmed, less than 2 m.	Shrub
Y	MALLEE SHRUB	Commonly less than 8m tall, usually with 5 or more trunks, of which at least three of the largest do not exceed 10cm dbh.	Shrub
Z	HEATH SHRUB	Shrub usually less than 2 m, commonly with ericoid leaves (nanophyll or smaller). Often a member of one the following families: Epacridaceae, Myrtaceae, Fabaceae and Proteaceae. Commonly occur on nutrient-poor substrates.	Shrub
C	CHENOPOD SHRUB	Single or multi-stemmed, semi-succulent shrub of the family Chenopodiaceae exhibiting drought and salt tolerance.	Shrub
U	SAMPHIRE SHRUB	Genera (of Tribe Salicornioideae, viz: Halosarcia, Pachycornia, Sarcocornia, Sclerostegia, Tecticornia and Tegicornia) with articulate branches, fleshy stems and reduced flowers within the Chenopodiaceae family, succulent chenopods . Also the genus Sueda.	Shrub
G	TUSSOCK GRASS	Forms discrete but open tussocks usually with distinct individual shoots, or if not, then forming a hummock. These are the common agricultural grasses.	Grass
H	HUMMOCK GRASS	Coarse xeromorphic grass with a mound-like form often dead in the middle; genus *Triodia*	Grass
W	OTHER GRASS	Member of the family Poaceae, but having neither a distinctive tussock nor hummock appearance.	Grass
V	SEDGE	Herbaceous, usually perennial erect plant generally with a tufted habit and of the families Cyperaceae and Restionaceae.	Other
R	RUSH	Herbaceous, usually perennial erect plant. Rushes are grouped into families Juncaceae, Typhaceae, Restionaceae and the genus *Lomandra*.	Other
F	FORB	Herbaceous or slightly woody, annual or sometimes perennial plant; not a grass, and including ground orchids.	Forbs
D	TREE FERN	Spirally arranged crowns on erect trunks several metres high (U.N.E 1989), characterised by large and usually branched leaves (fronds), arborescent and terrestrial; spores in sporangia on the leaves.	Shrubs
E	FERNS AND FERN ALLIES	Characterised by large and usually branched leaves (fronds), herbaceous to arborescent and terrestrial to aquatic; spores in sporangia on the leaves.	Other
B	BRYOPHYTE	Mosses and Liverworts. Mosses are small plants usually with a slender leaf-bearing stem with no true vascular tissue. Liverworts are often moss-like in appearance or consisting of a flat, ribbon-like green thallus.	Other
N	LICHEN	Composite plant consisting of a fungus living symbiotically with algae; without true roots, stems or leaves.	Other

Code	Name	Description	BioCondition Category
K	EPIPHYTE	Epiphytes (including orchids), mistletoes and parasites. Plant with roots attached to the aerial portions of other plants. Often could also be another growth form, such as fern or forb.	Other
L	VINE	Climbing, twining, winding or sprawling plants usually with a woody stem.	Other
P	PALM	Palms and other arborescent monocotyledons. Members of the Arecaceae or the genus Pandanus. (Pandanus is often multi-stemmed).	Trees
X	XANTHORRHOEA	Australian grass trees. Members of the family Xanthorraceae.	Shrubs
A	CYCAD	Members of the families Cycadaceae and Zamiaceae	Shrubs
J	SEAGRASS	Flowering angiosperms forming sparse to dense mats of material at the subtidal and down to 30m below MSL. Occasionally exposed.	Grass
Q	AQUATIC	Plant growing in an inland waterway or wetland with the majority of its biomass under water for most of the year. Fresh, saline or brackish water.	Other
O	LOWER PLANT	Alga, fungus.	Other
UNK	UNKNOWN		Other