Government of Western Australia
Department of Parks and Wildlife

Interim Recovery Plan No. 338

Heath dominated by one or more of *Regelia megacephala, Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the chert hills of the Coomberdale Floristic Region (update)

Interim Recovery Plan
2013 – 2018

Department of Parks and Wildlife, Kensington
July 2013

Forword

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Parks and Wildlife (DPAW) Policy Statements Nos 44 and 50.

IRPs outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

DPAW is committed to ensuring that threatened ecological communities are conserved through the preparation and implementation of Recovery Plans or Interim Recovery Plans and by ensuring that conservation action commences as soon as possible and always within one year of endorsement of that rank by DPAW's Director of Nature Conservation.

This Interim Recovery Plan will operate from July 2013 but will remain in force until withdrawn or replaced. It is intended that, if the community is still listed as Endangered after five years, this Interim Recovery Plan will be replaced or updated.

This IRP replaces IRP number 65 'Hamilton-Brown, S. (2000). Heath dominated by one or more of *Regelia megacephala, Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the chert hills of the Coomberdale Floristic Region. 2000-2003. Department of Conservation and Land Management, Perth, Western Australia'

The IRP was approved by the Director of Nature Conservation on 9 September 2013. The provision of funds identified in this Interim Recovery Plan is dependent on budgetary and other constraints affecting DPAW, as well as the need to address other priorities.

Information in this IRP was accurate at July 2013.

Plan preparation

Monica Hunter	Conservation Officer, DPAW Species and Communities Branch (SCB) Locked Bag 104 Bentley Delivery Centre, WA 6983.
Jill Pryde	Ecologist, DPAW Species and Communities Branch (SCB) Locked Bag 104 Bentley Delivery Centre, WA 6983.

Acknowledgements

The following people provided valuable advice and assistance in the preparation of this Interim Recovery Plan:

Benson Todd	Previously DPAW, Nature Conservation Coordinator, Moora District
Malcolm Trudgen	Consultant botanist
Andrew Obal	Previously Health, Safety and Environment Superintendent, Simcoa
Colin Headland	Yued Aboriginal Elder
Colin, Robbie and Julian Gardiner	Landholders
Roger Tonkin	Landholder
Stuart Ridgway	Landholder
Jeffrey Wheeler	Land Manager

Valerie English	Principal Ecologist, DPAW, Species and Communities Branch
Greg Keighery	Senior Principal Research Scientist

Cover photographs: Main (Cairn Hill; view from the top of the ridge over the TEC) by Jill Pryde.
Inset (flowering *Regelia megacephala*) by Benson Todd.

Citation

This Interim Recovery Plan should be cited as:

Department of Parks and Wildlife (2013). Interim Recovery Plan 2013-2018 for Heath dominated by one or more of *Regelia megacephala, Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the chert hills of the Coomberdale Floristic Region (update). Interim Recovery Plan No. 338. Department of Parks and Wildlife, Perth.

Summary

Name: Heath dominated by one or more of *Regelia megacephala*, *Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the chert hills of the Coomberdale floristic region (herafter called the Coomberdale Chert threatened ecological community (TEC); also known as the 'Vegetation alliances on ridges and slopes of the chert hills of the Coomberdale Floristic Region).

Description: Vegetation alliances of *Allocasuarina campestris* shrubland, *Allocasuarina microstachya* scrub, *Regelia megacephala* shrubland, *Kunzea praestans* shrubland and scrub, *Melaleuca calyptroides* heath, *Hibbertia subvaginata* shrubland and *Xanthorrhoea drummondii* shrubland on the ridges and slopes of the chert hills of the Coomberdale Floristic Region.

DPAW Region: Midwest

DPAW District: Moora

IBRA Bioregion: Avon Wheatbelt

Local Government Authority: Moora

Current status: This community was assessed as Endangered by the Threatened Ecological Communities Scientific Advisory Committee on 29 October 1999 and this rank was endorsed by the Minister for Environment on 6 November 2001.

Habitat requirements: The Coomberdale Chert TEC is restricted to the exposed quartzite ridges of the Noondine chert in the Coomberdale region from Jingemia to Moora.

Affected interests: Land owners and managers of all occurrences may be affected by actions in this plan, in particular where the TEC occurs on lands not managed by DPAW or not intended to be transferred to DPAW management.

Indigenous interests: There have been discussions with the local Yued indigenous group about the actions included in this plan. The indigenous group noted that if recovery actions involved potentially damaging ground disturbance, then consultation would be required with the South West Aboriginal Land and Sea Council (SWALSC) and in particular, the Yued Working Party who have an active interest in the areas covered by the Coomberdale Chert TEC. Table 2 identifies areas of the ecological community that contain sites that are known to have particular aboriginal significance.

Social and economic impacts and benefits: The Coomberdale Chert TEC is mainly on private land subject to a series of other land uses apart from conservation, including mining and grazing. Where specific activities such as mining are prevented through the environmental impact assessment process, this will be a potential impact on development and thus would be an economic impact, however, such controls also help to prevent the continued degradation of the community and hence maintains other social benefits.

Related biodiversity impacts and benefits: Recovery actions implemented to improve the quality or security of the community are likely to improve the status of any species within the community and other associated vegetation types within managed areas of remnant vegetation. Five threatened flora (declared rare flora – DRF), eight priority flora taxa and one threatened fauna species occur within remnant vegetation that contains this community, or occur close by. The underlying Noondine Chert may also contain a rich stygofauna. Recovery actions implemented to improve the status of the Coomberdale Chert TEC will benefit these associated flora and fauna.

Habitat critical to survival and important occurrences: The habitat critical to survival for the Coomberdale Chert TEC is the chert hills on which the community occurs. Occurrences that contain vegetation alliances 13, 14, 15, 16, 17, 18 and 19 (as defined by Trudgen *et al.* 2006) are considered the 'core' Coomberdale Chert TEC and are considered critical to the survival of this ecological community.

Term of plan: The plan will operate from 2013 to 2018 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked Endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be evaluated.

IRP Objective(s): To conserve the ecological and conservation values of the Coomberdale Chert TEC by:

- Attaining conservation management of core vegetation alliances of the Coomberdale Chert TEC,
- Ensuring the permanent protection and conservation of self sustaining representative samples of the community across its range, and
- Minimising the loss and maximising the conservation of all remaining community occurrences as far as possible, including recovering degraded community occurrences where it is cost effective and practical to do so.

Criteria for success:

- An increase in the number of occurrences identified as 'core areas' in this plan that are managed for conservation and/or with conservation included in the purpose.
- Representative areas of core vegetation alliances as identified in this plan with condition rank maintained, or with improved condition rank (Bush Forever scales).
- An increase in the number of occurrences of the community for which formal strategies are in place to minimise loss and maximise conservation (such as fencing from stock or fire management strategies in place and being implemented)

Criteria for failure:

- No increase in the number of core areas managed for conservation.
- Complete loss or decline to degraded condition or poorer, of any core vegetation alliance as identified in this plan across its range.
- Failure to develop and implement formal strategies to manage key threats such as weed invasion, or inappropriate fire regimes.

Summary of recovery actions:

Coordinate recovery actions
Support private land managers to conserve the community
Clarify extent, and habitat critical to survival of the community
Seek to acquire occurrences to help protect the diversity of the community
Design and implement a monitoring program
Design and implement a weed control program
Implement a fire regime within an adaptive management framework
Develop and implement a fire management strategy
Implement replanting and rehabilitation where necessary
Determine the community's hydrological requirements
Obtain biological and ecological information
Seek to amend community name
Report on recovery plan implementation

1 Background

1.1 History, defining characteristics of ecological community, and conservation significance

The Noondine Chert is a geological formation visible as a discontinuous, narrow band of low hills or outcroppings of the Moora group of Proterozoic rocks, up to 14km wide, to the east of the Perth Basin. The formation stretches from Carnamah to Moora, a distance of approximately 150km. The largest most extensive outcrop is between Coomberdale and Dalaroo (Appleyard 2002, Baxter and Lipple 1985, Carter and Lipple 1982). The Noondine Chert was originally named the Coomberdale Chert by Logan and Chase (1961), and Griffin (1992) referred to the area as the Coomberdale Floristic Region.

The vegetation that occurs on the Coomberdale Chert was originally defined by Griffin (1992, 1994) and encompassed three closely related vegetation sub-types occurring on exposed chert ridges and gravelly slopes of the chert hills. From a series of surveys, Griffin recognised the distinctiveness of these vegetation types both within the Coomberdale Floristic Region and when compared to other floristic regions. Three vegetation sub-types he identified included dense heath dominated by *Regelia megacephala* or *Allocasuarina campestris* on the exposed chert ridges (sub-type 1); dense heath or open low woodland over dense to mid-dense heath dominated by *Kunzea praestans* (sub-type 2) and *Allocasuarina campestris* on shallow loamy rocky soil over chert on the slopes and ridges (sub-type 3). Other species common to all three sub-types included *Banksia fraseri* var. *fraseri, Banksia sessilis, Hibbertia subvaginata, Xanthorrhoea drummondii, Calothamnus quadrifidus* and *Calytrix leschenaultii*. This original description of the Coomberdale Chert TEC was based on limited information and a more recent survey by Trudgen *et al.* (2006) noted that "many of the heath stands are in fact high shrubland or high open scrub…" (Trudgen *et al.* 2006, p. 41).

Trudgen *et al.* (2006) surveyed plant communities occupying the outcropping areas of the Noondine Chert (Coomberdale Chert) and differentiated and mapped 101 vegetation associations. These associations were then grouped into 30 alliances that reflect soil depth and location on the slopes. The landscape varies from low ranges to a catena of woodlands, shrublands and low heath. The occurrences within Watheroo National Park, the water reserve and on private land west of The Midlands Road (refer Table 2) were not surveyed by Trudgen *et al.* (2006).

Based on the work done by Trudgen *et al.* (2006), the Coomberdale Chert TEC was reviewed by the Western Australian Threatened Ecological Community Scientific Committee (TECSC) which recommended that the Coomberdale Chert TEC be renamed and the interim recovery plan be updated. It was recommended that the vegetation alliances 13, 14, 15, 16, 17, 18 and 19 be considered the 'core' parts of the Coomberdale Chert TEC (Table 1), with some of the 'buffer units' and 'sub-types', as listed in Table 2, representing more peripheral parts of the TEC but still associated with the catena of the vegetation defined as the TEC.

Table 1: Vegetation Alliances from Trudgen *et al.* (2006) that reflect the 'core' Coomberdale Chert TEC

Vegetation Alliance	Description	Vegetation Associations (see Appendix 4 for full descriptions)
13	*Allocasuarina campestris* high shrublands to open and closed scrub	Ac, AcAa, AcAh, AcAhu, AcAs, AcB, AcCq, AcDs, AcEe, AcEl, AcEw, AcHa, AcHs, AcId, AcMr, AcMs, AcRm
14	*Allocasuarina microstachya* open scrub	Am
15	*Regelia megacephala* high shrubland to open and closed scrub	Rm, RmAh, RmB, RmDs, RmEe, RmHs, RmKp, RmKpMc
16	*Kunzea praestans* high shrubland to open and closed scrubscrub	KpAh, KpAhB, KpAhMc, KpAhDs, KpDs, KpDsMc, KpEe, KpHs, KpXd
17	*Melaleuca calyptroides* open to closed heath	Mc

18	*Hibbertia subvaginata* low shrublands to low open heath	Hs, HsAh, HsDs
19	*Xanthorrhoea drummondii* shrubland	Xd

Vegetation Alliances 4, 9 and 11 appear to be lower in the catena compared to the 'core' TEC but contain elements of the TEC and species restricted to the Coomberdale Chert. These units are not considered to be part of the TEC but act as a buffer to the TEC. These woodland and mallee communities occur on deeper soils on the slopes of the Coomberdale Chert and are dominated by widespread species but still contain elements of the TEC due to their position in the landscape.

.

Table 2: Vegetation Alliances from Trudgen *et al.* (2006) identified as "buffer units" and included in the Coomberdale Chert TEC

Vegetation Alliance	Description	Vegetation Associations (see Appendix 5 for full descriptions)
4	*Eucalyptus eudesmoides* mallee	EeKp, EeId, EeRM
9	*Allocasuarina huegeliana* woodlands	AhDs, AhDsKp, AhHr, AhHs, AhKp, AhRm, AhTl, AhXd
11	*Acacia acuminata* low woodlands	AaDs, AaDsKp, AaEl, AaHr, AaHs, AaKp, AaMcor, AaMr, AaTl

Vegetation Alliances 1, 2, 3, 5, 6, 7, 8, 10, 12, 20 and 21 are excluded from the definition and extent of the TEC. These units comprise forests, woodlands, shrublands and heath communities. The vegetation is dominated by species that will mostly be found elsewhere (Trudgen *et al.* 2012).

The substrate on which the Coomberdale Chert TEC is located is highly restricted and confined to the Noondine chert formation. Major threats to the TEC are mining, weed invasion, grazing, altered fire regimes, clearing, and potentially drying climate and altered hydrology. Ten occurrences of this TEC were initially recorded on the corporate TEC database, however following the survey undertaken by Trudgen *et al.* (2006), a further 55 considerably smaller occurrences have been mapped and recorded. These additional occurrences vary in condition (Trudgen 1988 condition scale) and size, and contribute an additional 120ha to the total area of the TEC.

1.2 Description of Occurrences

All the known occurrences are located in the Shire of Moora along the Noondine chert hills that extend discontinuously from Jingemia south to Moora and make up the Coomberdale Floristic Region. Table 2 below summarises the occurrence information.

There is a total of approximately 785 hectares of the community recorded on the DPAW's TEC database, in 65 occurrences.

Of the area of the community mapped on the TEC database at the time of writing this plan:

- About 192 ha (~24%) occurs on land managed for conservation (National Park and Nature Reserve)
- About 382.6 ha (~49%) occurs on private land covered by mineral tenements
- About 183 ha (~23%) occurs on private freehold land not within mineral tenements
- About 15.6 ha (~2%) occurs on a water reserve
- About 11.8 ha (~1.5%) occurs on Unallocated Crown Lands (UCL) – currently under pastoral/grazing lease

Table 2: Summary of occurrence information

Occurrence Number (Site Identifiers)	Location	Land vesting/ ownership, management and purpose	Estd area (ha)	Major current threats	Quadrat Analysis/ Surveys	Indig-enous sites	Condition*	Threatened and priority flora	Core vegetation alliances, and buffer types	Comments
1 **(CH02, CH03, CH04, CH05 and Chert1)**	Cairn Hill and immediate surrounds, Midlands Road, Moora	Nature Reserve (Conservation Commission) for conservation of flora and fauna UCL (Department Regional Development and Lands) Private land (pastoral and livestock) Mining tenement (northern section on private property)	142 4 95 (60ha of the private land) Total: 241ha	Grazing, mining, fire and weed invasion	Quadrats and releves (Trudgen *et al.* 2006)	None record ed	good to very good (northern) Very good to excellent (Cairn Hill)	*Acacia aristulata* (DRF) *Acacia congesta* subsp. *cliftoniana* (P1) *Baeckea* sp. Moora (P3) *Daviesia dielsii* (DRF) *Goodenia arthrotricha* (DRF) *Regelia megacephala* (P4) *Stylidium* sp. Moora (P2) *Synaphea quartzitica* (DRF)	Core: 13, 15, 16, 17 Buffer: 4, 9, 11	Fenced
2 **(Chert2b and Chert2c)**	South of Cairn Hill and East of Midlands Road, Moora	Private land (pastoral and livestock)	11.6	Grazing, fire and weed invasion	Releve (Trudgen *et al.* 2006)	None record ed	Poor to very poor	*Acacia aristulata* (DRF) *Regelia megacephala* (P4)	Core: 13, 15 Buffer: 4	
3 **(CH06 and Chert3)**	East of The Midlands Road and north of Dalaroo East Road, Moora	Private land (pastoral and livestock)	56.8	Grazing, fire and weed invasion	Quadrats and releves (Trudgen *et al.* 2006)	None record ed	Mostly very good to excellent	*Acacia aristulata* (DRF) *Daviesia dielsii* (DRF) *Goodenia arthrotricha* (DRF) *Melaleuca sclerophylla* (P3) *Regelia megacephala* (P4)	Core: 13, 14, 15, 16 Buffer: 9, 11	Fenced
4 **(Chert4)**	South of Kiaka Road and east of The Midlands Road, Moora	Private land (mining tenement)	92	Mining, grazing, fire and weed invasion	Quadrats and releves (Trudgen *et al.* 2006)	Kiaka Brook artefac ts/scat ter	good to excellent	*Acacia aristulata* (DRF) *Daviesia dielsii* (DRF) *Regelia megacephala* (P4)	Core: 13, 15, 16, 18 Buffer: 9, 11	Currently being mined

						Kiaka Road Scarred Tree				
5 **(Chert5a and Chert5b)**	North of Kiaka Road and east of The Midlands Road, Moora	Private land (mining tenements, pastoral and livestock)	45.89	Mining, grazing, fire and weed invasion	Quadrats and releves (Trudgen *et al.* 2006)	None recorded	Ranging from degraded to excellent	*Acacia aristulata* (DRF) *Daviesia dielsii* (DRF) *Regelia megacephala* (P4)	Core: 13, 15, 16, 17 Buffer: 9, 11	Central west section of occurrence in good to excellent condition, 3 Threatened/Priority taxa - recommended to be conserved and fenced.
6 **(Chert6)**	Atbara St, Moora	Water Corporation (water supply) Road reserve	12 1 Total: 13ha	Weed invasion, fire and trampling	Griffin (1992, 1994)	Gingin Brook Waggyl Site	Highly disturbed. Some pockets of good condition	None recorded	Sub-type 3 (*Allocasuarina campestris* on shallow loamy rocky soil over chert on the slopes and ridges)	
7 **(Chert7)**	Watheroo National Park, Boothendarra	National Park (Conservation Commission) Small portion on road reserve Small portion on private land	46.6 3 1 Total: 50.6ha	Fire and weed invasion.	Griffin (1992, 1994)	Jingemia Hill	Mostly good to very good.	*Calothamnus accedens* (P4) *Acacia aristulata* (DRF)	Sub-type 3	
8 **(Chert8)**	West of The Midlands Road, approximately 2km south west of Cairn Hill	Private land (pastoral and livestock)	9.8	Grazing, fire and weed invasion	Griffin (1992, 1994)	None recorded	Unknown	None recorded	Sub-type 3	Recommended that this occurrence be remapped on ground.
9 **(Chert9)**	North of Kiaka Road and east of The Midlands	Private land (mining tenement)	12.5	Grazing, fire and weed invasion	Releves (Trudgen *et al.* 2006)	None recorded	Mostly poor to good, some degraded	*Acacia aristulata* (DRF)	Core: 13 Buffer: 9, 11	

	Road									
10 **(Chert2a)**	South of Cairn Hill and East of The Midlands Road, Moora	Private land	5.3	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Degraded	*Regelia megacephala* (P4) nearby	Core: 13	
11 **(Chert11)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	4.8	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Poor to good	None recorded	Core: 13, 18 Buffer: 9, 11	Contains 1 of 3 occurrences of core veg alliance 18
12 **(Chert12)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	1.6	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Very poor to good	None recorded	Core: 13	
13 **(Chert 13)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	1.47	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Good	None recorded	Core: 13	
14 **(Chert14)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	0.69	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Good	None recorded	Core: 13	
15 **(Chert15)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	2.90	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Good to very good	None recorded	Core: 13 Buffer: 11	
16 **(Chert16)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	13.71	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Poor to very good	None recorded	Core: 13, 16 Buffer: 9, 11	
17 **(Chert17)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	4.09	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Good to very good	None recorded	Core: 13, 15	
18 **(Chert18)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	2.66	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Poor to good	None recorded	Core: 16, 18, 19 Buffer: 9	Only occurrence containing core veg alliance 19
19 **(Chert19)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	11.88	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Very poor to good	None recorded	Core: 13, 16 Buffer: 9, 11	Fenced on northern property
20 **(Chert20)**	South of Kiaka Road and East of The Midlands	Private land	5.43	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Poor to very good	None recorded	Core: 13, 16 Buffer: 9	

	Road, Moora									
21 **(Chert21)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	8.89	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Very poor to very good	None recorded	Core: 13, 16, 18 Buffer: 9	
22 **(Chert22)**	East of The Midlands Road and east of Cairn Hill Nature Reserve	UCL (Department Regional Development and Lands), pastoral/grazing lease	1.5	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Very poor to poor, some good	None recorded	Core: 13, 16 Buffer: 1	
23 **(Chert23)**	East of The Midlands Road and east of Cairn Hill Nature Reserve	UCL (Department Regional Development and Lands), pastoral/grazing lease	6.0	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Poor to very good	None recorded	Core: 16, 18 Buffer: 9	
24 **(Chert24)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	4.9	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Poor to very good	None recorded	Core: 16, 18 Buffer: 9	
25 **(Chert25)**	South of Kiaka Road and East of The Midlands Road, Moora	Private land	3.7	Grazing, fire and weed invasion	Releves (Trudgen *et al*. 2006)	None recorded	Poor to good	None recorded	Core: 13	
26 **(Chert6)**	East of The Midlands Road	Private land	1.7688	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al*. 2006)	None recorded	Very poor to poor	None recorded	Core: 13	
27 **(Chert27)**	East of The Midlands Road	Private land	0.3048	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al*. 2006)	None recorded	Good to very good	None recorded	Core: 13	
28 **(Chert28)**	East of The Midlands Road	Private land	13.35	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al*. 2006)	None recorded	Range from poor to very good	None recorded	Core: 13, 16	
29 **(Chert29, Chert30 and Chert31)**	East of The Midlands Road	Private land	1.4856	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al*. 2006)	None recorded	Range from poor to very good	None recorded	Core: 13, 18	
30 **(Chert32)**	East of The Midlands Road	Private land	0.1162	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et*	None recorded	Poor to good	None recorded	Core: 13	

					al. 2006)					
31 **(Chert33 – Chert39)**	East of The Midlands Road	Private land	5.6921	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Range from poor to very good	None recorded	Core: 13, 16 and 18 Buffer: 9	
32 **(Chert40)**	East of The Midlands Road	Private land	1.47	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Poor to good	None recorded	Core: 16	
33 **(Chert41)**	East of The Midlands Road	Private land	0.4274	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Poor to good	None recorded	Core: 13	
34 **(Chert42)**	East of The Midlands Road	Private land	0.6383	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Poor to good	None recorded	Core: 13	
35 **(Chert43 and Chert44)**	East of The Midlands Road	Private land	1.3745	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Good	None recorded	Core: 13	
36 **(Chert45)**	East of The Midlands Road	Private land	1.2104	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Poor to good	None recorded	Core: 16 Buffer: 9	
37 **(Chert46)**	East of The Midlands Road	Private land	0.2442	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Poor to good	None recorded	Core: 16	
38 **(Chert47)**	East of The Midlands Road	Private land	0.3244	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Poor to good	None recorded	Core: 13	
39 **(Chert48)**	East of The Midlands Road	Private land	1.98	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Very poor to poor	None recorded	Core: 13 Buffer: 11	
40 **(Chert49)**	East of The Midlands Road	Private land	1.96	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Very poor to poor	None recorded	Core: 15 Buffer: 9	

41 **(Chert50)**	East of The Midlands Road	Private land	1.1525	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Very poor	None recorded	Core: 15	
42 **(Chert51)**	East of The Midlands Road	Private land	2.47	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Very poor	None recorded	Core: 15 Buffer: 9	
43 **(Chert52)**	East of The Midlands Road	Private land	0.43	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Degraded to very poor	None recorded	Core: 13	
44 **(Chert53)**	East of The Midlands Road	Private land	0.2784	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Very poor to poor	None recorded	Core: 15 Buffer: 4	
45 **(Chert54)**	East of The Midlands Road	Private land	1.7669	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Good	None recorded	Core: 13	
46 **(Chert55)**	East of The Midlands Road	Private land	0.3563	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Very poor to poor	None recorded	Core: 13	
47 **(Chert56)**	East of The Midlands Road	Private land	0.09	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Good	None recorded	Core: 13	
48 **(Chert57)**	East of The Midlands Road	Private land	1.43	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Good to very good	None recorded	Core: 13	
49 **(Chert58)**	East of The Midlands Road	Private land	0.397	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Good to very good	None recorded	Core: 13	
50 **(Chert59 – Chert64)**	East of The Midlands Road	Private land	3.876	Grazing, fire and weed invasion	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Degraded to very good	None recorded	Core: 13, 15 and 16	
51	East of The Midlands Road,	Private land	45.289	Grazing, fire, weed invasion	Releves and quadrats	None record	Degraded to poor	*Acacia aristulata* (DRF) and *Daviesia dielsii*	Core: 13 and 16	

(NorthKiaka01)	North of Kiaka Road			and proposed mining.	(Trudgen *et al.* 2006)	ed		(DRF)	Buffer: 9 and 11	
52 **(NorthKiaka02)**	East of The Midlands Road, North of Kiaka Road	Private land	3.21	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Good to poor	None recorded	Core: 13	
53 **(NorthKiaka03)**	East of The Midlands Road, North of Kiaka Road	Private land	11.35	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Degraded to very poor	*Acacia aristulata* (DRF)	Core: 13 and 16 Buffer: 9 and 11	
54 **(NorthKiaka04)**	East of The Midlands Road, North of Kiaka Road	Private land	5.6	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Degraded to very poor	None recorded	Core: 13 Buffer: 9 and 11	
55 **(NorthKiaka05)**	East of The Midlands Road, North of Kiaka Road	Private land	11.69	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Good to degraded	*Regelia megacephala* (P4)	Core: 13 and 16 Buffer: 9 and 11	
56 **(NorthKiaka06)**	East of The Midlands Road, North of Kiaka Road	Private land	11.39	Grazing, fire, weed invasion, proposed mining.	Releves and quadrats (Trudgen *et al.* 2006)	None recorded	Good to very good with very small area in poor condition	*Acacia aristulata* (DRF) *Daviesia dielsii* (DRF) *Regelia megacephala* (P4)	Core: 13, 15 and 16	
57 **(NorthKiaka07)**	East of The Midlands Road, North of Kiaka Road	Private land	1.76	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Poor	None recorded	Core: 13	
58 **(NorthKiaka08)**	East of The Midlands Road, North of Kiaka Road	Private land	0.55	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Poor	None recorded	Core: 13 and 16	
59 **(NorthKiaka09)**	East of The Midlands Road, North of Kiaka Road	Private land	6.187	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Very poor to very good	*Acacia aristulata* (DRF) *Daviesia dielsii* (DRF) *Regelia megacephala* (P4)	Core: 13, 15 and 16	
60 **(NorthKiaka10)**	East of The Midlands Road, North of Kiaka Road	Private land	3.47	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Poor to good	*Acacia aristulata* (DRF)	Core: 13 and 16	
61	East of The Midlands Road,	Private land	2.64	Grazing, fire, weed invasion,	Releves and quadrats	None record	Poor to good	None recorded	Core: 13 and 16	

(NorthKiaka11)	North of Kiaka Road			proposed mining.	(Trudgen *et al.* 2006)	ed				
62 **(NorthKiaka12)**	East of The Midlands Road, North of Kiaka Road	Private land	0.72	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Very poor to good	None recorded	Core: 13 and 16	
63 **(NorthKiaka13)**	East of The Midlands Road, North of Kiaka Road	Private land	1.78	Grazing, fire, weed invasion, proposed mining.	Releves (Trudgen *et al.* 2006)	None recorded	Good to very poor	None recorded	Core: 13 and 16	
64 **(NorthKiaka14)**	East of The Midlands Road, North of Kiaka Road	Private land	3.82	Grazing, fire, weed invasion, proposed mining.	Unmapped by Trudgen *et al.* 2006	None recorded	Unmapped by Trudgen *et al.* 2006	None recorded	Unmapped by Trudgen *et al.* 2006	
65 **(North Kiaka 15)**	East of The Midlands Road, North of Kiaka Road	Private land	13.66	Grazing, fire, weed invasion, proposed mining.	Quadrat and releves (Trudgen *et al.* 2006)	None recorded	Poor to very poor	None recorded	Core: 13 Buffer: 9	

* Condition scale as per Trudgen (1988). Equivalent condition in Bush Forever (BF) as follows: Excellent (Trudgen 1988) = Pristine (BF); very good = excellent (BF); good = very good (BF); poor = good (BF); very poor = degraded (BF)

Additional information about some occurrences occurs below:

Occurrence 1 extends across an unnamed nature reserve (referred to as 'Cairn Hill'), and private property in the northern section. There are small areas of the TEC on the adjoining unallocated Crown land, rail reserve and road reserves. The northern section is fenced off from the surrounding agricultural paddocks. This northern section of the TEC has been subject to significant grazing pressure, has diminished cover of native herbs and is infested with weeds. Some areas have been impacted by grid lines, which have been bulldozed to facilitate access for drilling for the chert mine (Trudgen *et al.* 2006). Despite these disturbances, Trudgen *et al*. (2006) rated the condition in this portion of the TEC as good to very good, with some areas in excellent condition.

The central portion of occurrence 1 (142 ha, known as 'Cairn Hill') is now a nature reserve but was previously managed by Westrail. Cairn Hill is considered to contain the most outstanding example of the Coomberdale Chert TEC. It contains a number of threatened and priority flora including *Synaphea quartzitica*. Two radio and television towers are located on the highest parts of the hills, and the reserve is accessed by a number of stakeholders. The reserve contains the most intact portion of the TEC in the best condition (excellent to very good) and is dominated by *Allocasuarina campestris*, *Regelia megacephala* and *Kunzea praestans*. In the past, the low land on the eastern and southern portion was under a grazing lease (Hamilton-Brown 2000) and the Moora Shire and other contractors extracted gravel from the area. The removal of excess gravel piles and dumped soil was undertaken in 2004 and 2005 and the gravel pits are no longer in use. As the reserve is not fenced, there is the potential for illegal extraction of gravel. There is easy access to the nature reserve from the Midlands Road and although there is a sign advising of the TEC and requesting that rubbish not be dumped, there is evidence of rubbish dumping and camp fires.

Occurrence 2 is located approximately 0.7km south of occurrence 1. It is entirely surrounded by paddocks, is not fenced and is heavily grazed.

Occurrence 3 is located on private land approximately 7 km north-east of Moora. Although this occurrence is fenced there are apparently signs of grazing according to Trudgen *et al.* (2006).

Occurrence 4 is located on private land approximately 0.25 km north of occurrence 1 and is currently being mined for chert. Exploration tracks and gridlines cleared for drilling traverse the remaining vegetation and Trudgen *et al.* (2006) rated the condition as varying from poor to excellent. The areas in better condition were generally situated on rocky slopes, which were likely to be protected from grazing, and/or were further from margins and less affected by weed invasion. Parts of the occurrence are still subject to grazing (Trudgen *et al.* 2006).

Occurrence 5 covers 3 private properties 0.5 km north of occurrence 4 and north of Kiaka Road. The vegetation varies from heavily grazed with very little herb/grass layer, except for weeds, to areas in very good condition. Trudgen *et al*. (2006, pp 103-104) states "Vegetation condition was generally better in the vegetation types on rockier sites, steeper sites and where the *Regelia megacephala* or *Allocasuarina campestris* was denser". The occurrence is slightly fragmented in the northern parts, with cropping and grazing lands between hills and on the lower slopes. Twenty one hectares of the occurrence has been fenced for conservation and covenanted under the *Soil and Land Conservation Act 1945* (through the Remnant Vegetation Protection Scheme). In 1981 a fire swept through the south eastern side of the occurrence affecting the fenced portion and the hill dominated by *Acacia acuminata*.

Occurrence 6 is located in a water reserve in the eastern part of the town of Moora. The reserve is managed by the Water Corporation and is completely surrounded by agricultural land. The area has been disturbed by clearing for gravel extraction, access tracks, weed infestation and trampling by recreational users. Griffin (1994) described vegetation sub-type 3 (*Allocasuarina campestris* on shallow loamy rocky soil over chert on the slopes and ridges) as occurring in the reserve. *Regelia megacephala* was historically thought to occur on the reserve however has not been recorded recently.

Occurrence 7 is located in Watheroo National Park, around Jingemia Cave. This occurrence has been described as vegetation sub-type 3 as per Griffin (1994) and was not surveyed by Trudgen *et al*. (2006). The vegetation surrounding the TEC includes extensive, intact *Eucalyptus loxophleba* and mallee woodlands. Small portions of this occurrence are located on private land and may be subject to grazing by livestock (Hamilton-Brown 2000).

Occurrence 8 is located on private land 2 km west of occurrence 4. The TEC comprises 9.8 ha of the 46 ha of remnant vegetation and the remainder is *Eucalyptus loxophleba, E. salmonophloia* and *E. wandoo* woodland (Hamilton-Brown 2000). Griffin's vegetation subtype 3 is recorded for the occurrence (Hamilton-Brown 2000), however, there has been no recent survey of the occurrence and current condition is unknown.

Occurrence 9 is located 0.5km north of Kiaka Rd. This occurrence is fenced off from the surrounding agricultural paddocks and Trudgen *et al*. (2006) rated its condition as good to degraded.

Occurrence 10 is located approximately 0.7km south of Cairn Hill Nature Reserve It is mapped as being in very poor to poor condition, possibly due to access by livestock.

Occurrence 12 is entirely vegetation alliance 13. The north eastern section of the occurrence is in poor condition and the south west section is in good condition as per Trudgen *et al*. (2006). There is a degraded area in the northern and central sections of the occurrence.

Occurrence 13 is entirely core vegetation alliance 13. The North West section of the occurrence is separated by a small section of paddock and is in poor to good condition.

Occurrence 14 is entirely core vegetation alliance 13. The occurrence is situated at the northern tip of remnant vegetation within this TEC.

Occurrence 19 occurs over two properties. The section of this occurrence on the northern property was fenced recently and the occurrence was burnt in a wildfire in 2009.

Occurrence 20 occurs on both UCL and private property. The condition of the occurrence ranges from very good in the southern portion to poor and degraded in the central and northern portions as per Trudgen *et al*. (2006). The UCL is currently under a pastoral lease.

Occurrence 21 occurs over two properties.

Occurrence 23 is mostly in very good condition with a small portion in poor condition as per Trudgen *et al*. (2006).

Occurrences 26-50 are small disjunct occurrences, varying in condition from degraded to very good as per Trudgen *et al*. (2006).

Occurrences 51-65 occur north of Kiaka Road over 8 properties. The vegetation conditions range from completely degraded to very good (occurrence 64 has not been mapped on ground). The occurrences are separated by cropping and grazing lands between hills and on the lower slopes. Areas of the vegetation vary from heavily grazed with very little herb/grass layer, except for weeds, to areas in very good condition with little grazing evidence. Some areas in good or better condition have lower species richness however this could be related to the 2010 drought (Trudgen *et al*. 2006, pp110-111).

1.3. Habitat, biological and ecological characteristics

This Coomberdale Chert TEC is restricted to the Coomberdale (or Noondine) chert formation which extends from Jingemia to Moora (Carter and Lipple 1982). "The largest and most extensive area of outcrops of this chert, and hence the largest representation of the vegetation … occurs between Dalaroo and Coomberdale…" (Trudgen *et al* 2006, p. 40). The particular floristic composition of the heath community is assumed to relate to the soil/substrate types and depths. For example, "*…Regelia megacephala* stands are present only over massive chert...it is a highly habitat specific species and that habitat is not replicated on the waste dumps…" (Trudgen and Adam 2011, p. 29). The geological chert material that supports this very distinctive and restricted assemblage of plants is also Western Australia's best supply of high quality quartz which is mined predominantly for the production of silicon (Environmental Protection Authority 2001).

The soils on the chert ridges vary in depth from skeletal on the chunky outcropping chert, to gravelly, loamy sands lower down the slopes (Griffin 1992). The surface soil is commonly pale grey, silty, fine sand. The topography of the TEC habitat ranges from gentle to steep slopes, fault-lines and ridges (Trudgen *et al.* 2006). As the surveys of the area indicate the chert hills on which the TEC occurs is habitat critical to survival of the community.

Plant taxa that make up the core vegetation alliances of this TEC are listed in Appendix 4.

Little is known about the biological and ecological characteristics of the community, and gaining more information is included in the recommended actions in this plan.

1.4 Related biodiversity impacts and benefits

Recovery actions implemented to improve the quality or security of the Coomberdale Chert TEC will also improve the status of associated native vegetation, as well as five threatened and eight priority flora species that are either totally or largely confined to these chert hills. There are also records of the threatened Carnaby's cockatoo (*Calyptorhynchus latirostris*) in and around the TEC. The Noondine Chert may also contain a rich stygofauna (Appleyard 2002). Recovery actions implemented to improve the status of the Coomberdale Chert TEC will benefit these associated flora and fauna.

Table 3: Threatened and priority flora that occur in the TEC

Species name	Conservation status (WA)	Conservation status (EPBC Act 1999)
Acacia aristulata	DRF (EN)	EN
***Baeckea* sp. Moora**	P3	-
Calothamnus accedens	P4	-
Cryptandra glabriflora	P2	-
Daviesia dielsii	DRF (EN)	EN
Eucalyptus pruiniramis	DRF (EN)	EN
Goodenia arthrotricha	DRF (EN)	-
Guichenotia tuberculata	P3	-
Melaleuca sclerophylla	P3	-
Regelia megacephala	P4	-
Stylidium glabrifolium	P2	-
Synaphea quartzitica	DRF (EN)	EN
***Tricoryne* sp. Wongan Hills**	P2	-

For a description of priority categories see Smith (2010).

Habitat critical to survival and important occurrences

The habitat critical to survival for the Coomberdale Chert TEC is the chert hills on which the community occurs. Occurrences that contain vegetation alliances 13, 14, 15, 16, 17, 18 and 19 (as defined by Trudgen 2006) are considered the "core" Coomberdale Chert TEC and are considered critical to the survival of this ecological community.

1.5 International Obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that Convention. However, as this community is not listed under any specific international agreement, the implementation of other international environmental responsibilities is not affected by this plan.

1.6 Indigenous interests

There have been discussions with the Yued local indigenous group about the actions included in this plan. As illustrated in Table 2, there are four areas of Aboriginal significance within or near occurrences of the Coomberdale Chert TEC. The indigenous group noted that if recovery actions involved potentially damaging ground disturbance, then further consultation would be required with the South West Aboriginal Land and Sea Council and in particular, the Yued Working Party who have an active interest in the areas covered by the Coomberdale Chert TEC ([1]C. Headland personal communication).

[1] Colin Headland, Yued Working Party, Moora.

1.7 Social and economic impacts and benefits

The implementation of this recovery plan has the potential to have some social and economic impact as most occurrences are located on private property and many are on land not specifically managed for conservation. The habitat of the Coomberdale Chert TEC may be regarded by landholders and stakeholders as having potential for uses other than conservation. These uses include chert mining, gravel extraction, shelter and fodder for stock, firewood and fence posts. Where specific activities such as mining are prevented, for example, through the process of environmental impact assessment, this will be a potential impact on development and thus would be an economic impact if alternative options are not available. Such controls also help to prevent the continued degradation of the community, however, and hence maintain other social benefits. Where specific active recreational pursuits such as four wheel driving are prevented through access control, this may be a social impact, however such access control also helps to prevent the continued degradation of the community and maintain other social benefits.

1.8 Affected interests

Occurrences of the Coomberdale Chert TEC are found within the local government authority of the Shire of Moora. Other land managers include DPAW, Westnet Rail, Water Corporation, Main Roads WA and private mining and agricultural businesses. These land managers may be affected through the restriction on land management activities associated with areas of the TEC.

1.9 Term of plan

The plan will operate from 2013 to 2018 but will remain in force until withdrawn or replaced. It is intended that, if the ecological community is still ranked endangered in Western Australia after five years, the need for further recovery actions and the need for an updated recovery plan will be assessed.

1.10 Strategy for recovery

To identify, and influence the management of, the areas in which the community occurs, so maintaining natural biological and non biological attributes of the sites and the current area covered by the community.

To conduct appropriate investigations into the ecological characteristics and management requirements of the community to develop further understanding about the actions required to maintain or improve its condition.

2. Threatening processes

All occurrences are surrounded by cleared agricultural land, many with very little or no native vegetation buffer. The major threatening processes relevant to individual occurrences are indicated in Table 2 and are discussed in greater detail below.

Clearing

Clearing for agriculture in the Shire of Moora has been extensive with less than 12% of the original Coomberdale vegetation remaining (DPAW Comprehensive Adequate Representative (CAR) Reserve Analysis 2007). Trudgen *et al.* (2006) notes that "the Noondine Chert has suffered significant clearing, apparently greater than 60% in the Marchagee to Moora area, with the [vegetation] types on the lower slopes (mostly dominated by *Allocasuarina campestris*) being preferentially cleared". Historical clearing was for activities including gravel extraction, tracks and roads, trees for fence posts, grazing paddocks in the less rocky areas, and small scale mining. Current and future clearing is likely to be associated with chert mining, and mining tenements currently exist over occurrences 4, 5 and 9.

Some of the substrate on which the Coomberdale Chert TEC occurs is currently being mined as it is the best, most suitable quality chert resource in Western Australia (EPA 2001). At present, occurrence 4 is being mined with long-term plans for mining other occurrences currently in negotiation. There are mineral tenements over occurrences 5 and 9. Mining proposals are subject to assessment by the Environmental Protection Authority in accordance with the *Environmental Protection Act 1986*.

Mining for chert requires the complete removal of plants (EPA 2001) therefore there is a total loss of the vegetation, which apparently cannot then be regenerated on the sites mined or on waste dumps because of the change to the soil profile (Trudgen *et al.* 2011). The Environmental Protection Authority (2001) noted "Rehabilitation trials thus far have shown that *Regelia* can be successfully regenerated but individual plants are unlikely to survive in the long term in the modified environment after mining, although the seed can be sustained" (EPA, p. 1).

On the occasions where *Regelia megacephala* has been successfully regenerated in waste rock material, after a number of years *R. megacephala* has been out-competed by *Allocasuarina* species. This is because *Regelia megacephala* is specifically adapted to growing in the very fine joints of the unmined chert rock and can send its roots for a long distance into very fine spaces. When grown on waste rock, other plants that are not able to grow on the undisturbed rock, can grow more rapidly and out compete the *Regelia megacephala*. It is believed however, that the regeneration of *Regelia megacephala* is still valuable as it generates an ongoing source of seed and maximises maintenance of genetic diversity within *Regelia* populations (Robinson 2001).

It is not possible to replace the substrate on which the Coomberdale Chert TEC relies, post-mining, therefore it is important to seek long term conservation of important occurrences. Conservation initiatives should focus on protecting areas from disturbance and adding areas to the conservation reserve system. The recovery actions detailed in this plan will guide such initiatives. The mining company currently mining the chert has continued to rehabilitate waste dumps but has experienced a number of difficulties doing so. Details of the rehabilitation program, including difficulties experienced and recommendations, are elaborated in Trudgen and Adam (2011). Regeneration techniques such as returning the topsoil and controlling weeds may be useful in reducing native species loss and provide linkages and buffers for remaining Coomberdale Chert TEC occurrences.

The mining company currently operating in the area has carried out additional reconnaissance exploration to identify other parts of the Coomberdale Chert, both within and outside current lease areas, which may contain sufficiently high grade quartz in areas where the Coomberdale Chert TEC is already absent or is completely degraded. Three of the currently mapped occurrences (6, 7 and 8) were not surveyed by M. Trudgen, and other areas outside of the immediate TEC area which appear to be a continuation of the Noondine Chert Formation according to geological maps were also not surveyed.

Other impacts associated with mining include the clearing of grid lines for exploration and vehicle movements which can spread weed seeds or crush and compact vegetation and soil (Trudgen *et al*. 2006).

Hydrological change

There is potential for the dewatering in order to mine below the watertable if additional chert resources are not located. The potential for hydrological change due to dewatering to affect the TEC is not known and requires investigation. The Noondine Chert may contain aquifers with a particularly rich subterranean fauna, and this requires assessment (Appleyard 2002).

Grazing

The grazing of plant communities such as the Coomberdale Chert TEC can cause alterations to species composition through the selective removal of the more palatable species, soil compaction and erosion, and the introduction of weed seed and nutrients.

Trudgen *et al*. (2006) notes that the lower shrubs, herbs and sedge layers located on the edges of occurrences that are not rocky and where the vegetation is more open, are heavily impacted by livestock. Observations on-ground also suggest that areas dominated by *Allocasuarina campestris* are more heavily affected by grazing than areas dominated by *Kunzea praestans* (Trudgen *et al*. 2006). The least affected areas were generally those dominated by *Regelia megacephala* as they are mostly dense vegetation and very rocky, making access more difficult for livestock.

Grazing contributes to the introduction and spread of weeds via animal faeces, paws, hooves and coats, and can also lead to the trampling and compaction of soil and smaller plants. Grazing and subsequent weed invasion can have a negative effect on native species regeneration after fire or other disturbances (Trudgen *et al*. 2006).

Most occurrences of the Coomberdale Chert TEC have been or are still actively grazed and the impact of this grazing has not been quantified through monitoring. Current grazing pressures are from both native animals such as kangaroos and emus, which are often restricted to unnaturally small areas due to roads, paddocks and fences, as well as livestock and rabbits. Occurrences completely fenced off from livestock include occurrences 1, 3 and 7 and most of the southern portion of occurrence 5.

Weed invasion

Weeds can have significant impacts on vegetation through competition with the native species, prevention of regeneration and alteration of fire regimes (Hobbs and Mooney 1993). Disturbances such as fires and grazing can predispose areas to weed invasion if weed propagules are present. All of the occurrences of the Coomberdale Chert TEC are close to agricultural areas which act as a weed source through carrying agents including wind and animals, and are vulnerable to weed invasion following any disturbance. Occurrence 4 in particular experiences a great deal of soil movement due to the mining and associated tracks and trucks.

Trudgen *et al*. (2006) identified twenty-five weed species in the survey area. Most of the weeds recorded are not highly aggressive species, however, the number of weed species recorded was high. The edges of occurrences and occurrences rated as poor condition appear to be more affected by weed species (Trudgen *et al*. 2006).

A weed control program may be necessary to maintain or improve the current condition of occurrences of the community in the long term. Brown and Brooks (2002) state that the generic aims of weed control are to maintain the pre-invasion condition of the habitat (prevention), control or arrest ongoing weed invasion (intervention), and reverse the degraded condition of the habitat where applicable (rehabilitation).

Altered fire regimes

Fire can influence the species composition in vegetation in a number of ways. Some species depend on the heat and smoke generated by fire for their seeds to germinate (Knox *et al*. 2001), and Mediterranean ecosystems are usually fire responsive and may require a particular fire regime to assist regeneration (Abbott and Burrows 2003). If an appropriate fire frequency is exceeded, however, species that are obligate seeders may not have sufficient time to mature, flower and produce sufficient seed to regenerate the community. If the time between fires is too long, obligate seeders may senesce and be unable to regenerate. Therefore, bushfires or prescribed burns must occur at appropriate intervals, and if possible at the appropriate season and intensity, to sustain the integrity of plant communities.

The risk of fire is generally increased by the presence of grassy weeds in the understorey which are likely to be more flammable than the naturally occurring herb layer. Many of the weeds recorded in the Coomberdale Chert TEC are in fact grassy weeds (Trudgen *et al*. 2006). The disturbance caused by fires can also provide optimum opportunities for weed species to outcompete native species, however, the disturbance caused by fire can promote diversity (Knox *et al*. 2001).

It may be possible that the species composition within occurrences of the Coomberdale Chert TEC has been affected by long periods of fire absence. Research into the ecological attributes and fire responses of this community is therefore important in ensuring the most appropriate burning regime is adopted.

Burrows (2008) notes that there is no single optimum fire regime that will meet all management objectives, but that there are fire regimes that can be applied based on available evidence. Burrows (2008) recommends fire regimes based on vital attributes, regimes that provide for diversity of frequency, season and intensity, and provide habitat diversity, and a fine-grain mosaic of habitats. Burrows (2008) suggest that if these fire regimes are implemented in an adaptive management framework, they provide good data and can lead to better fire management.

The juvenile period of many species that occur in the community is listed in Appendix 3. Although the juvenile periods of many taxa are not known, the data included in Appendix 3 can be used as a guide for the community. Burrows *et al*. (2008) recommend a minimum period between fires that are lethal to fire-sensitive plants (obligate seeders with long juvenile periods) of at least twice the juvenile period of the slowest maturing species. That is, the juvenile period of plant taxa that are killed by fire and only reproduce from seed can be used as a guide to determine minimum inter-fire intervals. In fire sensitive habitats, this may be increased to 3-4 times the juvenile period for fire sensitive species (Barrett *et al*. 2009). In this particular community, *Allocasuarina campestris* and *Allocasuarina huegeliana* which are core components of the TEC, are serotinous species that are killed by fire, hold seed in the canopy, and reproduce only from seed. The juvenile period for each of these two species is 60 months (5 years), therefore a minimum inter-fire period of ten years would be recommended for occurrences that contain these species. It is important to note at this point that the juvenile period for other important taxa, in particular, the rare plants occurring in the Coomberdale Chert TEC is not known, therefore the precautionary principle applies until such time that more ecological information is known for these species. Long juvenile periods of important component species should be taken into account when designing appropriate fire regimes for this community.

Drying climate also needs to be considered when designing appropriate fire regimes. It is likely that reduced rainfall will cause diminishing growth rates, and plant maturation times may also increase. Longer inter-fire intervals may therefore be required under such scenarios.

The Department of Parks and Wildlife fire records based on satellite imagery since 1972 suggest that there have been no fires through the Coomberdale Chert TEC since 1972. Some private landholders, however, have records of fires occurring since 1972. A fire swept through occurrence 5 in December 1981 damaging the community (G. Ridgeway, personal communication[2]). Hamilton-Brown (2000) suggested that some of the species have still not recovered from the 1981 fire, including *Regelia megacephala*. No post fire assessment, however, has been carried out to confirm and determine the factors responsible for the apparent loss of species. A lightning strike started a fire in occurrence 4 in 2009 (J. Wheeler, personal communication, 2011[3]). Many of the other occurrences on private property have had a fire interval of at least 13-20 years (C. Gardiner and R. Tonkin, personal communication[4], 2011).

Additional potential threats

Trudgen *et al*. (2006) noted that the cropping of agricultural lands involves the use of herbicides and artificial fertilisers which could spread into the TEC and cause death or weakening of susceptible species including soil fungi and associated symbiotic relationships. There are also a small number of disused rubbish dumps within occurrences and these "are often foci for the introduction of weeds into native vegetation and can also be a localised source of pollutants" (Trudgen *et al*. 2006 p. 106). There is also very little known about the effects of hydrological changes and climate change, in particular, drying climate on the community. All of these potential threats need to be considered during the implementation of the recovery actions stated in this plan, in particular in monitoring to help determine the level of potential impact and to help identify required amelioration.

3. Guide for decision-makers

Section 2 of this IRP provides details of current and possible future threats. Developments in the immediate vicinity of the occurrences require assessment. No developments should be approved unless the proponents can demonstrate that they will have no significant impact on the ecological community. Actions that could result in any of the following may result in a significant impact to the community:

- land clearing leading to loss of locations defined as 'core areas' of the TEC
- clearing leading to significant increase in fragmentation of the community
- a significant increase in opportunity for introduction or increase in density of weeds or introduced /feral animals known to damage the community
- a significant increase in fire frequency

[2] George Ridgeway: Landholder, Coomberdale
[3] Jeffrey Wheeler: Land manager, Coomberdale
[4] Colin Gardiner and Roger Tonkin: Landholders, Coomberdale

4. Conservation status

The 'community meets the following criteria for Endangered (EN) ecological communities:

> *B) Current distribution is limited, and*
> *ii) There are few occurrences, each of which is small and/or isolated and all or most occurrences are very vulnerable to known threatening processes*

5. Recovery objectives and criteria

5.1. Objectives

To conserve the ecological and conservation values of the Coomberdale Chert TEC by:

- Attaining conservation management of core vegetation alliances of the Coomberdale Chert TEC;
- Ensuring the permanent protection and conservation of self sustaining representative samples of the community across its range; and
- Minimising the loss and maximising the conservation of all remaining community occurrences as far as possible, including recovering degraded community occurrences where it is cost effective and practical to do so.

5.2 Criteria for success:

- An increase in the number of occurrences identified as 'core areas' in this plan that are managed for conservation and/or with conservation included in their purpose.
- Representative areas of core vegetation alliances as identified in this plan with condition rank maintained, or with improved condition rank (Bush Forever scales).
- An increase in the number of occurrences of the community for which formal strategies are in place to minimise loss and maximise conservation (such as fencing from stock or fire management strategies in place and being implemented).

5.3 Criteria for failure:

- Failure to achieve an increase in the number of core areas managed for conservation.
- Complete loss or decline to degraded condition or poorer, of any core vegetation alliance across its range as identified in this plan.
- Failure to develop and implement formal strategies to manage key threats such as weed invasion, or inappropriate fire regimes.

6. Recovery actions

6.1. Existing recovery actions

The then Department of Mines, and Department of Conservation and Land Management successfully negotiated with the holder of the Mineral Tenement to have the most significant occurrence of the community at Cairn Hill declared a nature reserve.

All land managers/owners have been notified of the presence and importance of the TEC.

Detailed mapping of the eastern occurrences of the community has been completed by Trudgen *et al.* (2006).

The gravel pit below Cairn Hill has been closed and partially rehabilitated.

The component threatened flora that occur in the community have been surveyed regularly.

Occurrences 3, 9, part of occurrence 5, and the northern portion of occurrences 1 and 19 have been fenced from stock.

Occurrence 3 and part of occurrence 5 are covenanted under the *Soil and Land Conservation Act 1945* (through the Remnant Vegetation Protection Scheme).

Articles were published about the community in *Landscope* magazine in 2000 and 2011.

6.2. Recommended recovery actions

Only two occurrences of the Coomberdale Chert TEC are managed for conservation by the Department of Parks and Wildlife (DPAW). All other occurrences are on land not managed by DPAW. Permission and cooperation will be sought from the appropriate land managers/owners prior to any recovery actions being undertaken on their land.

The responsible agency is frequently listed as the relevant DPAW District. This refers largely to initiating and guiding actions. In general, however, the relevant DPAW District, and the recovery team have the primary responsibility for securing resources for recovery actions, with consideration for resourcing limits and other high priority conservation work.

1. Continue to coordinate recovery actions

The Midwest threatened flora and communities recovery team consider all threatened ecological communities and threatened flora in DPAW's Midwest Region. The team will continue to assist DPAW in coordinating recovery actions for the community and other threatened flora and TECs in their region. They will include information on progress in their annual reports to DPAW's Corporate Executive and funding bodies.

Responsibility:	DPAW (Moora District, Midwest Region)
Cost:	$4,000 per year
Completion date:	meetings ongoing

2. Support private land managers to conserve the community

All of the occurrences of the community apart from occurrence 7 and part of occurrence 1 are privately owned. Three occurrences (4, 5 and 9) have mining tenements over them. The involvement of land managers, local indigenous people (Yued language group) and community groups (e.g. Northern Agricultural Catchments Council) and industry in the recovery of the community will be important to the recovery process.

Landowners that have this community on their lands will be advised of incentives (financial and otherwise, such as through the provision of technical information) that are available to ensure long term protection of the community. Incentives for protection are available through a number of programs, including Nature Conservation Covenant Programs, Land For Wildlife and other funding schemes which may be available (e.g. 'Caring for our Country'). Occurrence 3 and part of occurrence 5 are covenanted under the *Soil and Land Conservation Act 1945* (through the Remnant Vegetation Protection Scheme).

Fencing is necessary to prevent degradation due to grazing. Occurrences 2, 5, 8 and 10, along with a number of other small occurrences are currently unfenced and are grazed. Occurrence 2 in particular is heavily grazed. For those occurrences that are already fenced (occurrences 3, 9, part of occurrence 5, and the northern portion of occurrences 1 and 19), the requirement for fence maintenance should be determined.

To prevent accidental destruction of the community, and gain public support for its conservation, information about the community will continue to be provided to all stakeholders including landholders, and managers of land containing the community. This would include information from the TEC database, maps indicating the location of the community, and this plan. Information about private land should only be provided to the landholders, unless permission is granted by them to allow wider dissemination of the land details.

Presentations to the local community may be useful to foster a sense of ownership of the Coomberdale Chert TEC, in particular, 'Cairn Hill' Nature Reserve, and efforts should be made to engage students from the district high school and two primary schools in the town of Moora.

District DPAW staff should ensure regular liaison with landowners and managers of land that contain the community to ensure TEC information is up-to-date.

Responsibility:	DPAW (Moora District and Species and Communities Branch (SCB)) in consultation with land owners and managers
Estimated cost:	$5,000 pa for all liaison (not including vehicle costs)
Completion date:	Ongoing

3. Clarify extent, and habitat critical to survival of the community

As noted previously, the habitat critical to the survival of the Coomberdale Chert TEC is the Coomberdale, or Noondine, chert formation. There are a number of vegetated areas of the Noondine chert formation evident from geological maps that may not have been surveyed for presence of the Coomberdale Chert TEC. These areas should be investigated utilising a combination of high quality orthophotography and ground-truthing.

If any additional occurrences are located, then these will be accurately mapped and added to the corporate TEC database.

As there have been failed attempts to grow some of the component species of the Coomberdale Chert TEC on mined areas, further investigation is required into the presence of chert as being critical for the survival of this community. This may have implications relating to the mining of chert in the core TEC.

Responsibility:	DPAW (Moora District and SCB) in consultation with land owners and managers
Cost:	$15,000 in year one, $2,000 pa thereafter
Completion date:	Years 1 and 2

4. Seek to acquire occurrences to help protect the diversity of the community

All of the occurrences of the community apart from occurrence 7 and part of occurrence 1 are privately owned. Occurrences 4, 5 and 9 have mineral tenements over them, and all other privately owned occurrences are on agricultural land. One occurrence is in a water reserve.

If management for conservation seems unlikely to result from actions in this plan, and if properties containing occurrences of the community become available for purchase or new occurrences are identified, DPAW will seek to acquire occurrences and adequate buffer areas as Class A reserves for the purpose of 'Conservation of Flora and Fauna' and place them under the care, control and management of the Conservation Commission.

DPAW will continue to negotiate to seek transfer of unmanaged land that contains the community that has been identified as containing the highest conservation value occurrences to the Conservation Commission of WA as Class A reserves as follows:

i) *The northern section of occurrence 1*
This area should be included as a continuation of the 'Cairn Hill' Nature Reserve in exchange for the unallocated Crown land (UCL) east of Cairn Hill

ii) *Occurrence 3*
This occurrence has been fenced off for many years and is mostly in very good to excellent condition

iii) *Any other occurrences which contain the 'core' vegetation associations* as described in this plan

Responsibility:	DPAW (Midwest Region, Land Unit and SCB); with assistance from the Recovery Team
Cost:	Market price of land at time of purchase.
Completion date:	When land and resources become available

5. Design and implement a monitoring program

A Monitoring Protocol (MoP) should be developed based on relevant protocols such as "Monitoring the effects of stock access and weed invasion on vegetation units within the Billeranga System threatened ecological community" (Hunter and Harding 2009).

The monitoring should be linked to areas where active management or impacts are anticipated, so that the analysis of results can be incorporated to improve management (e.g. of mining, fire, weed control and limiting livestock access) as is recommended for an adaptive management framework.

Monitoring should encompass the installation of permanent quadrats and photo points. Permanent quadrats have been set up in most occurrences (Trudgen *et al.* 2006) except occurrences 6, 7 and 8. Where vegetation is in suitable condition, permanent quadrats should be established in these additional areas, utilising methods as described in Trudgen *et al.* (2006). Data collected should include weed levels, flora species diversity and composition as well as density or cover for each flora species. Monitoring should be undertaken every five years to provide information on composition and condition change. This information will then be added to the TEC database.

Remote sensing data such as 'Vegetation Trend' from Landsat™ provides a coarse measure of change in vegetation cover and may be useful for this community. The interpretation of these data requires ground truthing as factors such as recovery from fire may not otherwise be evident. This remote sensing method may be suitable for some aspects of monitoring in future.

The extent and boundaries of occurrences also require monitoring. Most occurrences have been accurately mapped by Trudgen *et al.* (2006) using aerial photography, and ground-truthed with Global Positioning System (GPS) recordings. Extent and boundary information should be monitored regularly, stored in a Geographic Information System database and continue to be updated on the TEC database. Occurrences 6, 7 and 8 in particular require improved mapping on-ground.

Responsibility:	DPAW (Moora District, Science Division and SCB) in consultation with land owners and managers
Cost:	$20,000 in the first and 5th years
Completion date:	Ongoing

6. Design and implement a weed control program

As all occurrences are adjacent to cleared farmland and most have some level of weed infestation, a weed control strategy is required that takes into account the nature of the community and the need for continuing maintenance. Most weed species infesting this community are not considered aggressive, however. The weed control program should involve the following:

1. Identifying and mapping the major weed species.
2. Designing a weed control program detailing strategies/plans for each occurrence based on information from weed mapping. Each plan needs to identify the highest priority weed species that pose the greatest threat to the community.
3. The selection of the appropriate weed control methods, which may include hand weeding, localised application of herbicide or even fencing to avoid livestock access. Methods of weed control can be found in Brown and Brooks (2002) and the Standard Operating Procedure SOP 22: *Techniques for mapping weed distribution and density in bushland and wetlands* by Brown *et al.* (2011).
4. The opportunistic control of invasive weeds by hand or spot spraying as soon as the weeds emerge.

Rehabilitation through reintroduction of local native species may be necessary if areas are no longer capable of regenerating following weed control. Piles of weed-contaminated soil should be removed and the areas replanted. Tracks excess to requirements should be blocked, and left to revegetate naturally. Only seed from the same occurrence should be used for rehabilitation. No seed from other areas should be introduced into occurrences.

Weed monitoring should include the monitoring of success of any weed control undertaken. Methods for such a monitoring program can be sourced from Brown and Clarke (2009). Detailed monitoring is required to quantify the effects of on-ground management. Determining the impact of factors such as changed fire frequency would require a monitoring program such as that established by Clarke (2009).

Responsibility:	DPAW (Moora District and SCB) in consultation with land owners and managers
Estimated cost:	$10 000 per year
Completion date:	Ongoing

7. Implement a fire regime within an adaptive management framework

There is a need for research into the recovery of the community from fire, and to determine the implications of findings for management. This includes developing a fire history map of the occurrences, which is updated annually.

Burrows *et al.* (2008) recommend a minimum period between fires that are lethal to fire-sensitive plants (obligate seeders with long juvenile periods) of at least twice the juvenile period of the slowest maturing species. Burrows (2008) also recommends that fire regimes be determined based on vital attributes, a diversity of frequency, season and intensity, and provide for habitat diversity and a fine-grain mosaic of habitats.

The juvenile periods for some taxa in the community that may be fire-sensitive are not known. Appendix 3 contains a list of species for which there is data available with regard fire response. The species *Allocasuarina campestris* and *Allocasuarina huegeliana* both occur in the Coomberdale Chert TEC, and both are killed by fire, store seed in the canopy and have a maturation time of five years. As a start point it is therefore recommended that an absolute minimum inter-fire interval of ten years be implemented in the community, and this should be applied in a variety of seasons, and intensities, for example 60-80% of an occurrence to be burnt in a low intensity spring burn. This should be interspersed with much longer inter-fire intervals such as 3-4 times the juvenile period of the slowest maturing species, which on currently available information for taxa in the community would be 15 – 20 years. In addition, the drying climate needs to be considered when designing appropriate fire regimes. It is likely that reduced

rainfall will cause diminishing growth rates, and plant maturation times will also be prolonged. Longer inter-fire intervals will therefore be desirable in the current drier climatic scenario.

The outcomes of implementation of this regime on the composition and structure of the community should be quantitatively monitored and results and data analysis incorporated into an adaptive management framework to assess the requirement to modify the fire regime over time.

Responsibility:	DPAW (Moora District, Science Division, SCB) in consultation with stakeholders
Estimated cost:	$5,000 per year for monitoring and annual review
Completion date:	Ongoing

8. Develop and implement a fire management strategy

A fire management strategy should be developed with landowners and the relevant authorities. The strategy should deal with minimising wildfires, the location of firebreaks/fire-fighting access tracks, fire management (including the need for and design of prescribed burns), and fire suppression. The strategy should include an annual fire monitoring and reporting schedule.

Maintenance of existing firebreaks is appropriate where firebreaks are already constructed, unless maintenance is likely to degrade the community. No new firebreaks should be constructed in intact vegetation and most occurrences are already surrounded by cleared land which could be used for this purpose. Local DPAW staff should provide advice where appropriate in the planning, construction and maintenance of fire breaks for all occurrences of the community. The use of heavy machinery to create new fire breaks within the community should be avoided because additional disturbance would encourage further weed invasion, and chemicals that may be toxic to the community should not be used.

Local DPAW staff should maintain contact with landholders in relation to information about wildfires and controlled burns and when possible, a local DPAW staff member should be present during controlled burns in remnants that contain occurrences of the community to provide advice on protecting the conservation values of the community.

Local DPAW staff will liaise with owners and surrounding landholders to prevent burning at inappropriate times when fires are likely to spread to the community or surrounding property.

Responsibility:	DPAW (Moora District, Science Division SCB) in consultation with land owners and managers of land containing, or adjacent to, the community
Estimated cost:	Cost of firebreaks $5,000 pa
Completion date:	Ongoing

9. Implement replanting and rehabilitation where necessary

Occurrences will be rehabilitated, as required where they have suffered disturbance due to gravel extraction, grazing, weed invasion, damaging fires and impacts due to mining activity. For example some grid lines or tracks have become new drainage lines (Pringle *et al*. 2004) and have altered the local hydrology. Gravel pits and waste dumps should be re-contoured and rehabilitated. Rehabilitation

undertaken so far on disused mine waste has not been successful in fully re-establishing the suite of species and vegetation within this community. The appropriate species to use for rehabilitation can be identified from plot data collected by Trudgen *et al.* (2006) for each occurrence. These species should be propagated from stock from surrounding areas to preserve local provenance.

Responsibility:	DPAW (Moora District) in consultation with land owners and managers
Estimated cost:	$5,000 per year
Completion date:	Ongoing

10. Determine the community's hydrological requirements

There is little known about the hydrological requirements of plant species of the Coomberdale Chert TEC. The drying climate could possibly cause some species or particular vegetation units to suffer from drought stress, and it is also possible that mining below the water table may impact the community. The underlying Noondine Chert may also contain a rich stygofauna that may potentially be impacted by hydrological changes such as dewatering..

Historical and current data from suitable bores in occurrences likely to be remote from most human-induced changes, and in some in which hydrological change is suspected will be examined to determine trends in groundwater levels and quality. This will provide a description of the normal range and fluctuation in water levels and quality. Data may also be indicative of tolerance levels when linked with monitoring of the composition of the community. There are a number of bores for agricultural and household purposes around the area, however, they are all located low in the landscape. According to a DPAW file note, there are two bores on Cairn Hill which were used to sample stygofauna, however, these bores are yet to be re-located. Hydrological monitoring should include the installation of data loggers and a weather station at Cairn Hill, to help relate the data to local climatic variations.

Hydrology needs to be managed within an adaptive management framework, with detailed quantitative monitoring of floristic composition and structure linked to areas where there is likely to be significant hydrological change in terms of groundwater or surface water levels or quality. This is particularly pertinent in relation to possible future mining for chert below the water table.

Once the hydrological requirements of the Coomberdale Chert community are better understood, careful monitoring and appropriate management of the groundwater levels may be required to minimise long-term impacts to the community.

Responsibility:	DPAW (Moora District, SCB, Natural Resources Branch) in consultation with landholders, land managers
Cost:	$10,000pa to investigate available data, set up hydrological monitoring, undertake measurements and analyse data (possibly a PhD project).
Completion date:	Ongoing

11. Obtain biological and ecological information

Little is known about the biology and ecology of the community restricted to the Coomberdale (or Noondine) chert formation. In addition to Recovery Actions 7 and 10, an understanding of the biology of the dominant, rare and sensitive flora species and the ecological relationship between species (flora and fauna), substrate, hydrology and fire, will help to guide the future management of the TEC.

Responsibility:	DPAW (Moora District, SCB, Science Division) in consultation with landholders, land managers
Cost:	$10,000 per year to research the biological and ecological characteristics of the community components and to collate data collected in Recovery Actions 7 and 10 (possibly an Honours, Masters or PhD project).
Completion date:	Year 5

12. Seek to amend community name

The Western Australian TEC Scientific Committee recommend that 'Vegetation alliances on ridges and slopes of the chert hills of the Coomberdale Floristic Region' more accurately reflects the nature of the Coomberdale Chert TEC than the currently accepted name. DPAW will seek to change the name of the community through the WA Minister for Environment when enabling legislation is in place.

Responsibility:	DPAW (SCB)
Estimated cost:	Minimal costs
Completion date:	Ongoing

13. Report on recovery plan implementation

Reporting on recovery actions will form part of annual reports prepared by the Recovery Teams for DPAW's Corporate Executive, and will include results of analysis of monitoring results within an adaptive management framework. Summaries of annual reports are provided in *WATSNU,* the newsletter of Species and Communities Branch and are published on DPAW's internet site. A final report will be completed as part of the review of this plan, which will include a review of outcomes against the plan's success criteria. The recovery plan will be updated at the end of the five year term, if deemed necessary.

Responsibility:	DPAW (Moora District, SCB)
Cost:	$3,000 pa
Completion date:	Year 5

7. REFERENCES

Abbott, I. and Burrows, N. (eds) (2003). *Fire in ecosystems of south-west Western Australia: impacts and management*. Bachhuys Publishers, Leiden, Netherlands.

Appleyard, S. (2002). Palaeokarst in the Noondine Chert in Southwestern Australia: Implications for Water Supply and the Protection of Biodiversity. *Helictite 38*(1): *17-19*.

Barrett, S., Comer, S., McQuoid, N., Porter, M., Tiller, C. and Utber, D. (2009). Identification and Conservation of Fire Sensitive Ecosystems and Species of the South Coast Natural Resource Management Region. Department of Environment and Conservation, South Coast NRM. Albany, Western Australia.

Baxter, J. L. and Lipple, S. L. (1985). *Perenjori, Western Australia*. 1:250,000 Geological Series – Explanatory Notes. Geological Survey of Western Australia, Perth.

Brown, K. and Brooks, K. (2002) *Bushland weeds; a practical guide to their management*. Environmental Weeds Action Network (Inc), Western Australia.

Brown, K., Bettink, K., Paczkowska, G., Cullity, J., and French, S. (2011). *Standard Operating Procedure: Techniques for mapping weed distribution and cover in bushland and wetlands SOP No:22*. Department of Environment and Conservation, Perth.

Brown, K. and Clarke, V. (2009). Weed control within Brixton Street Wetlands Herb Rich Shrublands in Clay Pans (FCT 8) Threatened Ecological Community. Unpublished report prepared for Significant Native Species and Ecological Communities – Resource Condition Monitoring Project. Department of Environment and Conservation, Perth.

Burrows N.D. (2008). Linking fire ecology and fire management in south-west Australian forest landscapes. *Forest Ecology and Management*. 255: 2394–2406.

Burrows N.D., Wardell-Johnston, G. and Ward, G. (2008). Post fire juvenile periods of plants in south-west Australian forests and implications for fire management. *Journal of the Royal Society of Western Australia*. 91: 163-174.

Carter, J. D. and Lipple, S. L. (1982). *Moora, Western Australia*. 1:250,000 Geological Series – Explanatory Notes. Geological Survey of Western Australia, Perth.

Clarke, V. (2009). Monitoring the impacts of fire and *Phytophthora* within the shallow soil plant communities of the Mt Lindesay Threatened Ecological Community, Denmark WA. Unpublished report prepared for Significant Native Species and Ecological Communities – Resource Condition Monitoring Project. DEC, Perth.

Environmental Protection Authority (2001). Extension of Quartz Mining and Strategy for Resource Access and Biodiversity Conservation. Section 46 Report and Recommendations of the Environmental Protection Authority. Proponent Simcoa Operations Pty Ltd. *EPA Bulletin, 1027*, 3 September 2001.

Department of Environment and Conservation (2007). *Comprehensive Adequate Representative (CAR) Reserve Analysis*. Perth, Western Australia.

Griffin, E. A. (1992). Floristic survey of remnant vegetation in the Bindoon to Moora area, Western Australia. *Agriculture Western Australia Resource Management Technical Report 142*. Perth.

Griffin, E. A. (1994). Floristic Survey of Northern Sandplains between Perth and Geraldton, Western Australia. *Agriculture Western Australia Resource Management Technical Report 144*. Perth.

Government of Western Australia (2000). *Bush Forever*. Department of Environmental Protection, Perth.

Hamilton-Brown, S. (2000). Heath dominated by one or more of *Regelia megacephala, Kunzea praestans* and *Allocasuarina campestris* on ridges and slopes of the chert hills of the Coomberdale Floristic Region. Interim Recovery Plan No. 65; 2000-2003. Department of Conservation and Land Management, Perth, Western Australia.

Hobbs, R. J. and Mooney, H. A. (1993). Restoration ecology and invasions. In *Nature Conservation 3: Reconstruction of Fragmented Ecosystems*. pp 127-133, Saunders, D. A., Hobbs, R. J. and Ehrlich, P. R. (eds). Surrey Beatty and Sons: NSW.

Hunter, M. and Harding, C. (2009). *Monitoring Protocol: Monitoring the effects of stock access and weed invasion on vegetation unit within the Billeranga System threatened ecological community*. Version Number 1.0 (June 2009). Prepared for the Resource Condition Monitoring - Significant Native Species and Ecological Communities Project, Department of Environment and Conservation.

Knox, I., Bruce, R., Ladiges, P., Evans, B., and Saint, R. (2001). *Biology* (2nd ed.). McGraw-Hill: Australia.

Logan, B. W. and Chase, R. L. (1961). The stratigraphy of the Moora Group. *Journal of the Royal Society of Western Australia 44: 14-31*.

Pringle, H.J., Carter, G.A., James J.L and O'Conner, R.E.Y. (2004). The impact of mining and mining exploration activity on range resources and pastoral pursuits in the Pilbara, Gascoyne Murchison and Goldfields Regions of Western Australia. Resource Management Technical Report No. 116. Department of Agriculture W.A.

Robinson, S. (2001). Variation to the Moora Quartz Mine on M70/191 (Western Ridge pit): Amendment to Conditions under s.46 of the Environmental Protection Act. Consultant's report prepared for Simcoa Operations Pty Ltd.

Smith, M. (2010) *Declared Rare and Priority Flora List for Western Australia*. Department of Environment and Conservation, Perth, Western Australia.

Trudgen, M.E., and Adam, C. (2011). *A report on the rehabilitation of mine waste at the Simcoa Moora Chert Mine based on monitoring in October and November 2011*. Prepared for Simcoa Operations Pty Ltd.

Trudgen, M.E., Morgan, B., and Griffin, E.A. (2006). *A flora survey, floristic analysis and vegetation survey of the Coomberdale Chert TEC*. Prepared for Simcoa Operations Pty Ltd. Perth.

APPENDIX 1

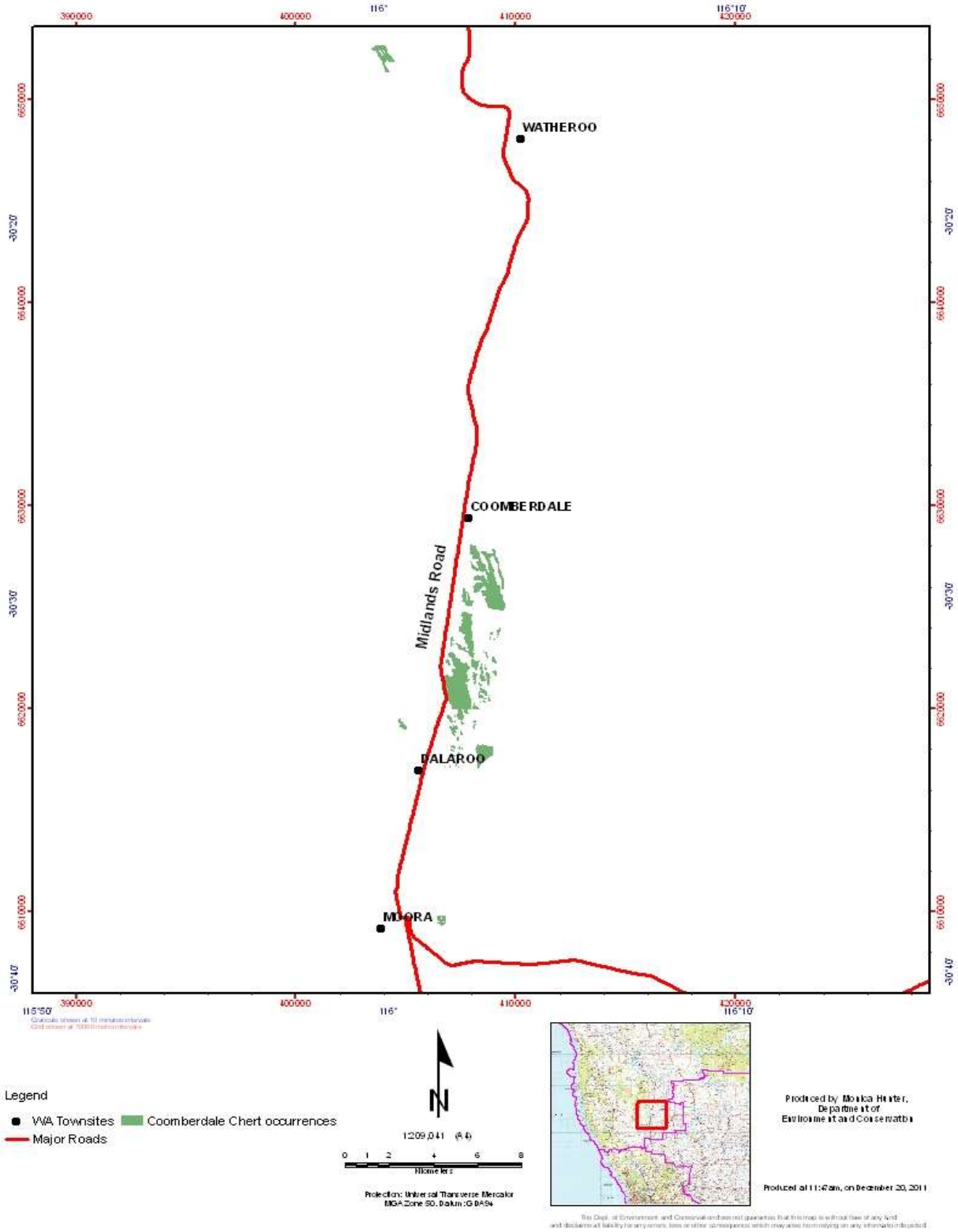
Summary of costs

Recovery Action	Year 1	Year 2	Year 3	Year 4	Year 5
Continue to coordinate recovery actions	$4,000	$4,000	$4,000	$4,000	$4,000
Support private land managers to conserve the community	$5,000	$5,000	$5,000	$5,000	$5,000
Clarify extent, and habitat critical to survival of the community	$15,000	$2,000	$2,000	$2,000	$2,000
Seek to acquire occurrences to help protect the diversity of the community	TBD	TBD	TBD	TBD	TBD
Design and implement a monitoring program	$20,000	-	-	-	$20,000
Design and implement a weed control program	$10,000	$10,000	$10,000	$10,000	$10,000
Implement a fire regime within an adaptive management framework	$5,000	$5,000	$5,000	$5,000	$5,000
Develop and implement a fire management strategy	$5,000	$5,000	$5,000	$5,000	$5,000
Implement replanting and rehabilitation where necessary	$5,000	$5,000	$5,000	$5,000	$5,000
Determine the community's hydrological requirements	$10,000	$10,000	$10,000	$10,000	$10,000
Obtain biological and ecological information	$10,000	$10,000	$10,000	$10,000	$10,000
Seek to amend community name	-	-	-	-	-
Report on recovery plan implementation	$3,000	$3,000	$3,000	$3,000	$3,000
Totals	**$92,000**	**$59,000**	**$59,000**	**$59,000**	**$79,000**

Overall total over 5 years: $348,000

Appendix 2

Location of the Coomberdale Chert TEC, Moora, Western Australia



APPENDIX 3

Ecological characteristics of flora from the seven core vegetation alliances of the Coomberdale Chert TEC

Taxon	Fire Response (Source-NatureMap)	Months to first flowering (Source-NatureMap)	Longevity (Source-NatureMap)	Dieback response (Source-NatureMap)
Acacia hemiteles	100% scorch kills, in soil seed storage	36	Perennial	Inferred evidence of resistance
Acacia microbotrya	100% scorch kills, in soil seed storage	48	Perennial	Inferred evidence of resistance
Acacia pulchella	100% scorch kills, in soil seed storage	24	Perennial	Some evidence of resistance
Acacia saligna	100% scorch kills, in soil seed storage	36	Perennial	Inferred evidence of resistance
Acacia stenoptera	100% scorch kills, in soil seed storage	36	Perennial	Inferred evidence of resistance
Agrostocrinum scabrum	100% scorch kills, in soil seed storage	22	Perennial	ND
Allocasuarina campestris	100% scorch kills, on plant seed storage	60	Perennial	Inferred variable susceptibility
Allocasuarina huegeliana	100% scorch kills, on plant seed storage	60	Perennial	Inferred moderate susceptibility
Allocasuarina humilis	Survives 100% scorch, basal sprouts	36	Perennial	Inferred high susceptibility
Allocasuarina microstachya	Survives 100% scorch, basal sprouts	48	Perennial	Inferred high susceptibility
Astroloma serratifolium	Survives 100% scorch, soil suckers	24	Perennial	ND
Austrodanthonia caespitosa	Survives 100% scorch, basal sprouts	20	Perennial	ND
Austrostipa compressa	100% scorch kills, in soil seed storage	6	Annual	Good evidence of resistance
Austrostipa macalpinei	100% scorch kills, in soil seed storage	12	Perennial	ND
Burchardia umbellata	Geophyte (Survives 100% scorch)	18	Perennial	Some evidence of resistance
Caladenia flava* subsp. *flava	Geophyte (Survives 100% scorch)	9	Perennial	ND

Calandrinia calyptrata	100% scorch kills, in soil seed storage	6	Annual	ND
Calothamnus sanguineus	Survives 100% scorch, basal sprouts	36	Perennial	ND
Calytrix depressa	Survives 100% scorch, basal sprouts	ND	Perennial	ND
Calytrix leschenaultii	100% scorch kills, in soil seed storage	36	Perennial	ND
Comesperma volubile	Survives 100% scorch	20	Perennial	ND
Cyanicula deformis	Geophyte (Survives 100% scorch)	18	Perennial	ND
Cyrtostylis huegelii	Geophyte (Survives 100% scorch)	12	Perennial	Inferred evidence of resistance
Dianella revoluta* var. *divaricata	Survives 100% scorch, soil suckers	36	Perennial	ND
Dichopogon capillipes	Survives 100% scorch, soil suckers	ND	Perennial	ND
Dioscorea hastifolia	Survives 100% scorch, basal sprouts	ND	Perennial	ND
Drosera pallida	Geophyte (Survives 100% scorch)	12	Perennial	Good evidence of resistance
Dryandra fraseri	100% scorch kills, on plant seed storage	48	Perennial	Inferred variable susceptibility
Dryandra sessilis	100% scorch kills, on plant seed storage	48	Perennial	Inferred moderate susceptibility
Elythranthera brunonis	Geophyte (Survives 100% scorch)	24	Perennial	Inferred evidence of resistance
Eriochilus dilatatus	Geophyte (Survives 100% scorch)	12	Perennial	Inferred evidence of resistance
Eucalyptus salmonophloia	Survives 100% scorch, epicormics	60	Perennial	ND
Eucalyptus wandoo* subsp. *wandoo	Survives 100% scorch, epicormics	48	Perennial	Good evidence of resistance
Haemodorum paniculatum	Geophyte (Survives 100% scorch)	6	Perennial	ND
Haemodorum simulans	Geophyte (Survives 100% scorch)	12	Perennial	ND
Hakea incrassata	Survives 100% scorch, basal sprouts	24	Perennial	ND
Hakea lissocarpha	Survives 100% scorch, basal sprouts	29	Perennial	Some evidence of variable susceptibility
Hyalosperma cotula	100% scorch kills, in soil seed storage	12	Annual	ND

Isotoma hypocrateriformis	100% scorch kills, in soil seed storage	12	Annual	ND
Kennedia prostrata	100% scorch kills, in soil seed storage	18	Perennial	Inferred evidence of resistance
Lagenophora huegelii	Survives 100% scorch	12	Perennial	ND
Laxmannia omnifertilis	100% scorch kills, in soil seed storage	ND	Perennial	ND
Lechenaultia biloba	Survives 100% scorch, soil suckers	24	Perennial	ND
Lepidobolus chaetocephalus	Survives 100% scorch, basal sprouts	ND	Perennial	ND
Lepidosperma leptostachyum	Survives 100% scorch, soil suckers	24	Perennial	Inferred evidence of resistance
Lepidosperma tenue	Survives 100% scorch, basal sprouts	12	Perennial	ND
Leporella fimbriata	Geophyte (Survives 100% scorch)	12	Perennial	Inferred evidence of resistance
Melaleuca radula	Survives 100% scorch, basal sprouts	36	Perennial	ND
Millotia myosotidifolia	Killed by 100% scorch	12	Annual	ND
Muehlenbeckia adpressa	100% scorch kills, in soil seed storage	30	Perennial	ND
Neurachne alopecuroidea	Survives 100% scorch, soil suckers	13	Perennial	Inferred evidence of resistance
Nuytsia floribunda	Survives 100% scorch, epicormics	24	Perennial	ND
Opercularia vaginata	100% scorch kills, in soil seed storage	24	Perennial	ND
Orthrosanthus laxus var. gramineus	Survives 100% scorch, soil suckers	ND	Perennial	ND
Pimelea imbricata* var. *piligera	100% scorch kills, in soil seed storage	18	Perennial	Some evidence of variable susceptibility
Podolepis gracilis	Killed by 100% scorch	12	Annual	ND
Podotheca gnaphalioides	100% scorch kills, in soil seed storage	ND	Perennial	ND
Pterochaeta paniculata	100% scorch kills, in soil seed storage	ND	Annual	ND

Pterostylis recurva	Geophyte (Survives 100% scorch)	24	Perennial	Inferred evidence of resistance
Pterostylis scabra	Geophyte (Survives 100% scorch)	12	Perennial	Inferred evidence of resistance
Pterostylis vittata	Geophyte (Survives 100% scorch)	9	Perennial	Inferred evidence of resistance
Quinetia urvillei	100% scorch kills, in soil seed storage	9	Annual	ND
Scaevola anchusifolia	100% scorch kills, in soil seed storage	18	Perennial	ND
Sowerbaea laxiflora	Survives 100% scorch, soil suckers	7	Perennial	ND
Stackhousia monogyna	Killed by 100% scorch	12	Perennial	ND
Stylidium calcaratum	100% scorch kills, in soil seed storage	7	Ephemera	ND
Stylidium repens	Survives 100% scorch, soil suckers	7	Perennial	Good evidence of resistance
Stypandra glauca	Survives 100% scorch, soil suckers	18	Perennial	ND
Thomasia grandiflora	Survives 100% scorch, basal sprouts	20	Perennial	ND
Thysanotus dichotomus	Survives 100% scorch, soil suckers	ND	Perennial	ND
Thysanotus manglesianus	Survives 100% scorch, soil suckers	6	Perennial	ND
Thysanotus multiflorus	Survives 100% scorch, soil suckers	12	Perennial	ND
Trachymene pilosa	100% scorch kills, in soil seed storage	12	Annual	ND
Tricoryne elatior	100% scorch kills, in soil seed storage	24	Perennial	ND
Tripterococcus brunonis	Survives 100% scorch, soil suckers	8	Perennial	ND
Wahlenbergia gracilenta	100% scorch kills, in soil seed storage	9	Annual	ND
Xanthorrhoea drummondii	Survives 100% scorch, large apical bud	6	Perennial	ND

Source: NatureMap (accessed 2011)
ND = no data available in NatureMap

Appendix 4

Vegetation Association descriptions for "core" communities as per Trudgen *et al.* (2006)

Vegetation Alliance 13: *Allocasuarina campestris* high shrublands to open and closed scrub.	
Association	**Description**
Ac	*Allocasuarina campestris* open to closed scrub over scattered sedges/grasses/herbs
AcAa	*Acacia acuminata* subsp. *acuminata*, *Allocasuarina huegeliana* low woodland over *Allocasuarina campestris* high open shrubland to high shrubland.
AcAh	*Allocasuarina huegeliana*, (*Acacia acuminata* subsp. *acuminata*) low open woodland to low open forest over *Allocasuarina campestris* high open shrubland to open to closed scrub.
AcAhu	*Banksia sessilis* var. *sessilis* scattered tall shrubs over *Allocasuarina campestris*, *Allocasuarina humilis* open scrub over *Hibbertia subvaginata* shrubland.
AcAs	*Acacia scirpifolia*, *Acacia saligna* high open shrubland over *Allocasuarina campestris*, (*Calothamnus quadrifidus* var. Moora-Watheroo) closed scrub over *Melaleuca calyptroides*, *Acacia congesta* subsp. *congesta* open shrubland.
AcB	*Allocasuarina campestris* open scrub over *Baeckea* sp. Moora (R.Bone 1993/1) low open shrubland to open heath.
AcCq	*Allocasuarina campestris*, *Calothamnus quadrifidus* var. Moora-Watheroo open to closed scrub.
AcDs	*Allocasuarina huegeliana*, (*Acacia acuminata* subsp. *acuminata*) low open woodland scattered low trees to low open woodland over *Banksia sessilis* var. *sessilis* scattered tall shrubs to high open shrubland over *Allocasuarina campestris* open to closed scrub.
AcEe	*Eucalyptus eudesmioides* subsp. *eudesmioides* scattered low mallees to low mallee woodland over *Allocasuarina campestris* open scrub over *Baeckea* sp. Moora (R. Bone 1993/1) scattered low shrubs to low shrubland.
AcEl	*Eucalyptus loxophleba* subsp. *loxophleba* low open woodland to low open forest over *Allocasuarina campestris* open scrub.
AcEw	*Eucalyptus wandoo* subsp. *wandoo* low open woodland over *Allocasuarina campestris* open to closed scrub.
AcHa	*Allocasuarina campestris* scattered tall shrubs over *Hypocalymma angustifolium* low open shrubland over *Pityrodia dilatata* low open shrubland.
AcHs	*Allocasuarina campestris* open to closed scrub over *Hibbertia subvaginata* scattered low shrubs to low open shrubland.
AcId	*Allocasuarina campestris* open to closed scrub over *Isopogon divergens* open shrubland.
AcMr	*Allocasuarina huegeliana*, *Acacia acuminata* subsp. *acuminata* low open woodland to low woodland over *Allocasuarina campestris*, (*Melaleuca radula*) open scrub.
AcMs	*Acacia acuminata* subsp. *acuminata* scattered low trees over *Allocasuarina campestris* open to closed scrub over *Melaleuca sclerophylla* open shrubland.
AcRm	*Regelia megacephala* high open shrubland to shrubland over *Allocasuarina campestris* open to closed scrub.
Vegetation Alliance 14: *Allocasuarina microstachya* open scrub	
Association	**Description**
Am	*Allocasuarina huegeliana* scattered low trees *over Allocasuarina microstachya*, *Kunzea praestans* open scrub over *Calytrix leschenaultii*, *Calytrix depressa* scattered low shrubs over

	scattered sedges/grasses and open herbland.
Vegetation Alliance 15: *Regelia megacephala* high shrubland to open and closed scrub	
Association	**Description**
Rm	*Regelia megacephala* open scrub
RmAh	*Allocasuarina huegeliana* low open woodland to low open forest over *Regelia megacephala* open scrub over scattered sedges and herbs.
RmB	*Regelia megacephala*, (*Kunzea praestans*) open scrub over *Baeckea* sp. Moora (R.Bone 1993/1) low open shrubland.
RmDs (RmBs)	*Regelia megacephala*, (*Banksia sessilis* var. *sessilis)* open scrub.
RmEe	*Eucalyptus eudesmioides* subsp. *eudesmioides* scattered low trees to low woodland over *Regelia megacephala* open to closed scrub.
RmHs	*Regelia megacephala* open scrub over *Hibbertia subvaginata* low open shrubland to low shrubland.
RmKp	*Regelia megacephala* high shrubland to open scrub over *Kunzea praestans* high open shrubland to open scrub over *Hibbertia subvaginata* scattered shrubs to low open shrubland.
RmKpMc	*Regelia megacephala* open to closed scrub and *Kunzea praestans* high open shrubland to open scrub over *Melaleuca calyptroides*. open shrubland to shrubland over *Hibbertia subvaginata* low open shrubland.
Vegetation Alliance 16: *Kunzea praestans* high shrubland to open and closed scrub	
Association	**Description**
KpAh	*Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) low open woodland to low woodland over *Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* scattered shrubs to low open shrubland.
KpAhB	*Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered trees to low open woodland over *Kunzea praestans* high shrubland to open scrub over shrubland including *Melaleuca calyptroides* and *Baeckea* sp. Moora (R. Bone 1993/1) scattered shrubs to open shrubland.
KpAhDs (KpAhBs)	*Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered trees to low open woodland over *Banksia sessilis* var. *sessilis* scattered tall shrubs over *Kunzea praestans*, (*Xanthorrhoea drummondii*) high shrubland to open scrub over *Hibbertia subvaginata* low open shrubland.
KpAhMc	*Allocasuarina huegeliana* (*Acacia acuminata* subsp. *acuminata*) scattered trees to low open woodland over *Kunzea praestans* open scrub over *Melaleuca calyptroides* open shrubland to shrubland.
KpDs (KpBs)	*Banksia sessilis* var. *sessilis* high open shrubland over *Kunzea praestans*, (*Xanthorrhoea drummondii*) open scrub over *Hibbertia subvaginata* scattered low shrubs.
KpDsMc (KpBsMc)	*Banksia sessilis* var. *sessilis* scattered tall shrubs to high open shrubland over *Kunzea praestans* high shrubland to open scrub over *Melaleuca calyptroides* ms. scattered shrubs to shrubland over *Hibbertia subvaginata* scattered low shrubs to low open shrubland.
KpEe	*Eucalyptus eudesmioides* subsp. *eudesmioides* low woodland over *Kunzea praestans* open scrub over *Melaleuca calyptroides* and *Baeckea* sp. Moora (R. Bone 1993/1) open shrubland.
KpHs	*Kunzea praestans* high shrubland to open scrub over *Hibbertia subvaginata* (low) open shrubland to (low) open heaths over scattered to very open sedgeland/grassland/herbland.
KpXd	*Xanthorrhoea drummondii* high open shrubland over *Kunzea praestans* high open shrubland.

Vegetation Alliance 17: *Melaleuca calyptroides* ms open to closed heath	
Association	**Description**
Mc	*Kunzea praestans* high open shrubland over *Melaleuca calyptroides* open to closed heath over *Hibbertia subvaginata*, *Calytrix leschenaultii* scattered low shrubs to low open shrubland.
Vegetation Alliance 18: *Hibbertia subvaginata* low shrublands to low open heath	
Association	**Description**
Hs	*Hibbertia subvaginata* open heath.
HsAh	*Allocasuarina huegeliana* scattered trees over Hibbertia subvaginata (low open shrubland) open heath.
HsDs (HsBs)	*Nuytsia floribunda* scattered low trees over *Banksia sessilis* var. *sessilis* high open shrubland over *Hibbertia subvaginata* low shrubland.
Vegetation Alliance 19: *Xanthorrhoea drummondii* high open shrubland	
Association	**Description**
Xd	*Xanthorrhoea drummondii* high open shrubland.

Appendix 5

Vegetation Association descriptions for "buffer" communities as per Trudgen *et al.* (2006)

Vegetation Alliance 4: *Eucalyptus eudesmioides* low mallee woodlands to low mallee open forests	
Association	**Description**
EeKp	*Eucalyptus eudesmioides* low mallee woodland over *Kunzea praestans* scattered tall shrubs to high shrubland
EeId	*Eucalyptus eudesmioides* low mallee woodland over Xanthorrhoea drummondii and Isopogon divergens scattered shrubs
EeRm	*Eucalyptus eudesmioides* low mallee open forest over *Calothamnus* aff. *quadrifidus* (Moora-Watheroo), *Regelia megacephala* high open shrubland
Vegetation Alliance 9: *Allocasuarina huegeliana* low woodlands to low open forests	
Association	**Description**
AhDs	*Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis var. sessilis* scattered tall shrubs to high open shrubland
AhDsKp	*Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis var. sessilis* scattered tall shrubs to high shrubland over *Kunzea praestans* scattered tall shrubs to high open shrubland
AhHr	*Allocasuarina huegeliana* low open forest over *Hakea recurva* subsp. *recurva* scattered tall shrubs
AhHs	*Allocasuarina huegeliana* low open woodland to low woodland over *Hibbertia subvaginata* low open shrubland to low shrubland
AhKp	*Allocasuarina huegeliana* low woodland to low open forest over *Kunzea praestans* scattered tall shrubs to high open shrubland
AhRm	*Allocasuarina huegeliana* low open forest over *Regelia megacephala, Allocasuarina campestris* high open shrubland
AhTl	*Allocasuarina huegeliana* low woodland to low open forest over *Trymalium ledifolium* var. *rosmarinifolium, Hibbertia subvaginata* scattered shrubs to low open shrubland over scattered sedges and grasses, with *Xanthosia fruticulosa* very open herbland and *Cheilanthes adiantoides* scattered ferns
AhDs	*Allocasuarina huegeliana* low woodland to low open forest over *Dryandra sessilis var. sessilis* scattered tall shrubs to high open shrubland
AhXd	*Allocasuarina huegeliana* low open woodland to low woodland over *Xanthorrhoea drummondii* scattered tall shrubs to high open shrubland over scattered low shrubs including *Trymalium ledifolium* var. *rosmarinifolium* and *Hibbertia subvaginata* shrubs
Vegetation Alliance 11: *Acacia acuminata* low woodlands to low open forests	
Association	**Description**
AaDs	*Acacia acuminata* subsp. *acuminata*, *Allocasuarina huegeliana* low woodland over *Dryandra sessilis* var. *sessilis* (*Xanthorrhoea drummondii*) scattered tall shrubs over very open herbland
AaDsKp	*Acacia acuminata subsp. acuminata* low woodland over *Dryandra sessilis* var. *sessilis (Xanthorrhoea drummondii)* scattered tall shrubs over *Kunzea praestans* scattered tall shrubs to high open shrubland over very open herbland

AaEl	*Acacia acuminata* subsp. *acuminata, Eucalyptus loxophleba* subsp. *loxophleba* low woodland to low open forest over very open grassland/herbland
AaHr	*Acacia acuminata* subsp. *acuminata, (Eucalyptus loxophleba* subsp. *loxophleba)* scattered low trees over *Hakea recurva* subsp. *recurva* scattered tall shrubs to high open shrubland over very open herbland
AaHs	*Acacia acuminata* subsp. *acuminata, Allocasuarina huegeliana, (Eucalyptus loxophleba* subsp. *loxophleba)* low woodland over *Allocasuarina campestris* scattered tall shrubs over *Hibbertia subvaginata* low open shrubland to low shrubland
AaKp	*Acacia acuminata* subsp. *acuminata, Allocasuarina huegeliana* low woodland to low open forest over *Kunzea praestans* scattered tall shrubs to high open shrubland over very open herbland
AaMcor	(*Eucalyptus* wandoo scattered trees) over *Acacia acuminata* subsp. *acuminata* scattered low trees over *Melaleuca coronicarpa* low open shrubland over very open herbland
AaMr	*Acacia acuminata* subsp. *acuminata, Allocasuarina huegeliana* low woodland over *Melaleuca radula* scattered tall shrubs to high shrubland
AaTl	*Acacia acuminata* subsp. *acuminata* scattered low trees over *Trymalium ledifolium* var. *rosmarinifolium* open shrubland