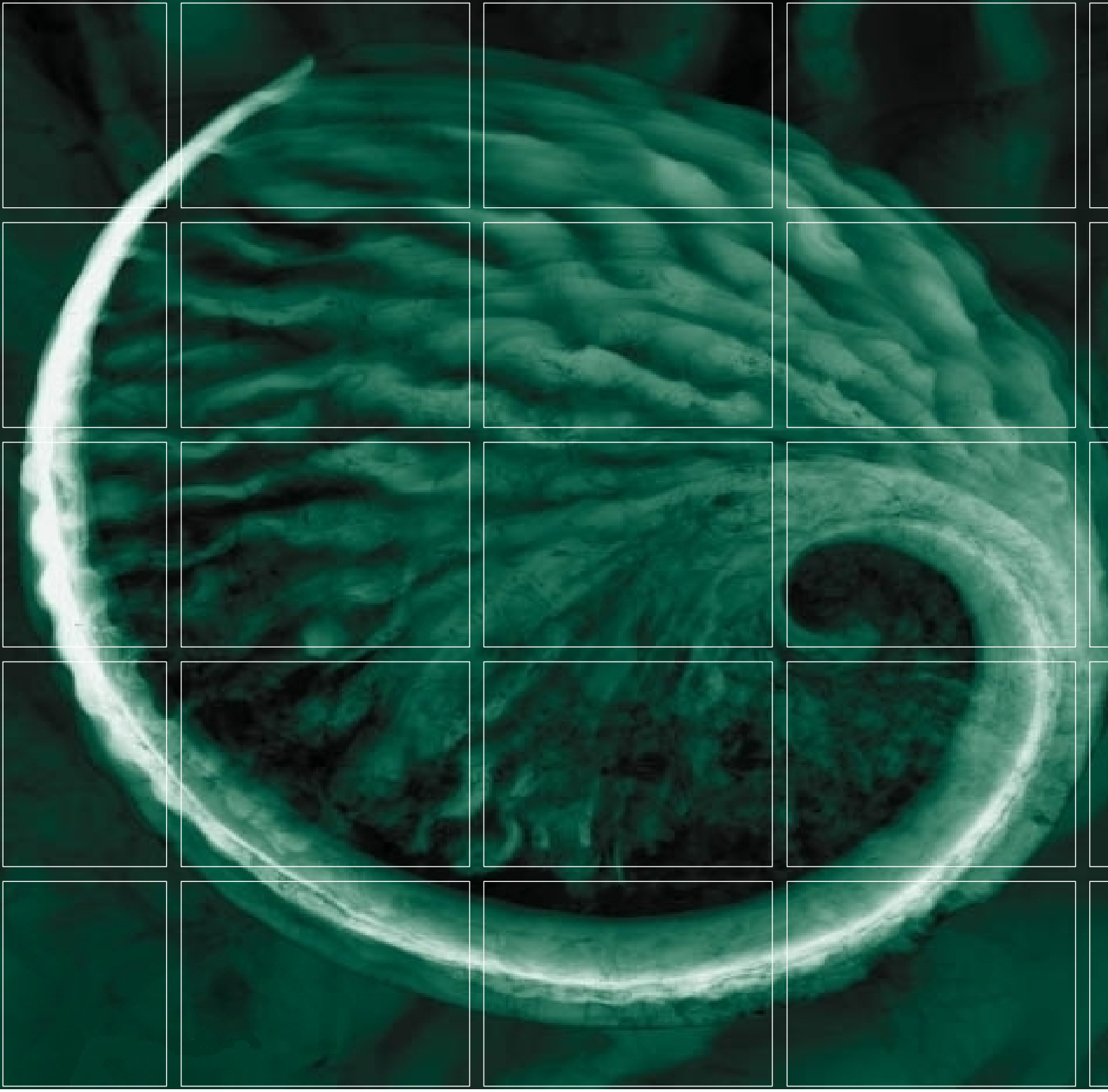
ANNEX D

Vegetation Management Plan DECC



Fern Bay Seaside Village Offset Package:

Worimi Regional Park Vegetation Management Plan

Aspen Group Pty Ltd

0065580VMP Final 1
February 2009

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Delivering sustainable solutions in a more competitive world

ERM

Approved by:	*Naomi Buchhorn*
Position:	Project Manager
Signed:	
Date:	*11 February, 2009*
Partner:	
	Paul Douglass

Environmental Resources Management Australia Pty Ltd Quality System

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BACKGROUND TO OFFSET PACKAGE

Winten (20) Pty Limited lodged a detailed Master Plan for the proposed Fern Bay Estate residential subdivision with the Department of Planning in April 2005. The Master Plan was prepared in accordance with Part 5 of State Environmental Planning Policy No. 71 Coastal Protection and was adopted by the Minister for Planning on the 8 August 2006. The Master Planning process envisaged that the subdivision would comprise approximately 950 residential lots. Approval for the Fern Bay Seaside Village as defined in the Master Plan is currently being considered under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act).

As part of the approval process for the Master Plan, an agreement for offset for the loss of wet heath habitat and hollow bearing trees in the Fern Bay Seaside Village was negotiated with the Department of Environment and Conservation (DEC) (now known as Department of Environment and Climate Change (DECC)) and the Aboriginal Negotiating Panel (ANP) for the Stockton Bight joint management land. A copy of the agreement is provided in Annex A. The subject land is identified in the agreement for conservation offsets as the Ministerial Part 11 lands to the south of the proposed Fern Bay Seaside Village.

With gazettal of the Worimi Conservation Lands in February 2007 the Ministerial Part 11 lands are now known as the Worimi Regional Park and the ANP no longer exists. Consultation is now to be undertaken with the Worimi Conservation Lands Board of Management.

Environmental Resources Management Australia Pty Ltd (ERM) has been engaged by Aspen Group Pty Ltd to prepare this Vegetation Management Plan (VMP) to address the objectives of the compensatory package. The VMP has been prepared in accordance with draft guidelines for a vegetation management plan provided by DECC and relevant legislation.

Following endorsement of the final VMP approvals for the works for the beach access four-wheel drive track will be sought under Part 5 of the EP&A Act.

The VMP shall form part of the approval for the Fern Bay Seaside Village. Implementation of this VMP will be triggered by approval of the Project Plan.

1 INTRODUCTION

1.1 PLAN TITLE

This plan is referred to as "*Worimi Regional Park Vegetation Management Plan*" (VMP).

1.2 AREA OF OPERATION

This VMP applies to that part of the Worimi Regional Park directly to the south of the proposed Fern Bay Seaside Village as identified in *Figure 1*. An aerial photograph of the site is provided in *Figure 2*.

Worimi Regional Park extends along the whole of the Stockton Bight and is part of the Worimi Conservation Lands which also includes Worimi State Conservation Area and Worimi National Park. The Worimi Conservation Lands are Aboriginal owned land leased back to the Crown and managed under the *National Parks and Wildlife Act 1974* by the Department of Environment and Climate Change (DECC) (Parks and Wildlife Division) on behalf of the Worimi Conservation Lands Board of Management.

1.3 PLAN PERIOD

This VMP covers management measures and identifies a framework of works and costs for ongoing maintenance and rehabilitation works in the Worimi Regional Park for a period of 20 years.

1.4 AIM

The main aim of this VMP is to offset the loss of wet heath habitat and the loss of hollow bearing trees from the Fern Bay Seaside Village residential subdivision.

1.5 TARGET

The target of this VMP is to improve the habitat value of the Worimi Regional Park though rationalisation of tracks, weed and waste removal and rehabilitation of the wet heath.

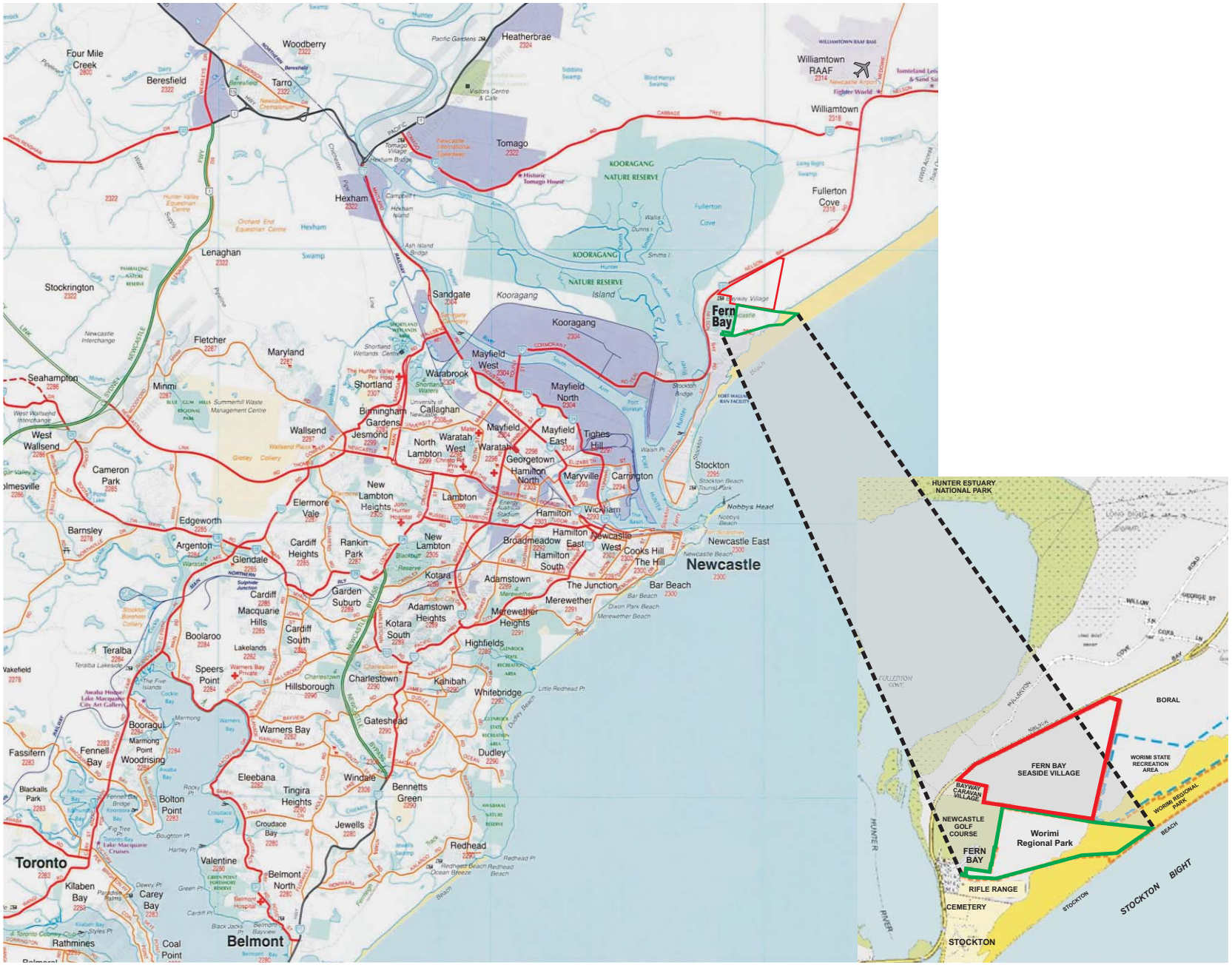

Figure 1

Locality Plan

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_07		
Date:	10/02/09	Drawing size:	A4
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Not to Scale		

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ERM

1.6 OBJECTIVES

The VMP aims to address and/or achieve the following offsets as set out in DECC letter, 25 May 2006 (see *Annex A*) and the approved Master Plan (8 August 2006):

1. Fencing of the northern boundary of the Ministerial Part 11 lands (now known as Worimi Regional Park) and the construction of a four-wheel drive track adjacent to this boundary and associated infrastructure (hard stand, car parks, pedestrian pathway, lighting, signage, etc);

2. Rubbish removal (car bodies, asbestos dumps, etc) and implementation of weed control program on the Ministerial Part 11 lands (Worimi Regional Park);

3. Rehabilitation of approximately 31.7 hectares of wet heath habitat on the Ministerial Part 11 lands (Worimi Regional Park);

4. Closure and rehabilitation of numerous tracks on the Ministerial Part 11 lands (Worimi Regional Park); and

5. Provision of funding to maintain the rehabilitation works for at least 20 years.

The VMP must be provided to the satisfaction of DECC. The VMP shall form part of the approval for the Fern Bay Seaside Village. Implementation of this VMP will be triggered by approval of the Project Plan.

1.7 RESPONSIBILITY FOR SITE MANAGEMENT

Aspen will have primary responsibility for implementation of the VMP up to and including year 5, in consultation with DECC to ensure that the contracts and works meet DECC standards and are consistent with the Worimi Conservation Lands Lease Agreement.

Aspen's Fern Bay Seaside Village site representative is:

Mr Peter Fagan
Project Manager
Aspen Group
Level 3, York Street
Sydney NSW 2000
Ph: (02) 8916 6747
Mobile: 0417 335 922
Email: peterf@aspengroup.com.au

Responsibility for implementing the VMP in years 6 to 20 will transfer to DECC with funding provided by Aspen Group.

Throughout the plan period, engagement of suitable contractors is to consider members of the local Aboriginal community to facilitate ownership of the Worimi Regional Park.

Additional contacts and details for implementation of the VMP are identified in *Section 10.5.*

1.8 REPORT STRUCTURE

The VMP has been structured to address the five offsets as identified in *Section 1.6* with consideration of DECC's internal guidelines for development of VMP.

Chapter 1 outlines the purpose and overall objective of the Plan and responsibilities for implementing management strategies.

Chapter 2 provides a description of relevant legislation, policies and strategies.

Chapter 3 describes the assessment methodology for the site.

Chapter 4 describes the existing environment including the climate, geology, topography, soils, drainage, fire history, vegetation and threatened species and ecological communities, weeds and fauna habitat.

The offsets are addressed in the order of works with consideration of the requirement to remove waste and weeds throughout the site prior to rationalisation of tracks.

Chapter 5 describes waste material identified on site and management of removal.

Chapter 6 identifies the invasive exotic species (weed) on site and develops a management plan for removal.

Chapter 7 identifies tracks throughout the site and a program for rationalisation of existing tracks and the formalisation of the four-wheel drive access track along the northern boundary of the Worimi Regional Park lands.

Chapter 8 describes the threats to the wet heath and identifies management measures to improve the habitat value of the wet heath over time.

Chapter 9 provides a brief discussion of bush fire management and pest management for the Worimi Regional Park and the relationship to respective plans that will be prepared by DECC and the Worimi Conservation Lands Board of Management.

Chapter 10 discusses rehabilitation works, responsibilities, monitoring and other management considerations.

2 POLICY FRAMEWORK

This VMP has been prepared to ensure that the control of weeds, restoration works and management is undertaken in a manner that is consistent with relevant National, State and Local Government legislation, policies, strategies and guidelines. The following is a summary of the key points of the legislation, policies, strategies and guidelines relevant to the VMP for the site.

2.1 COMMONWEALTH

2.1.1 National Weeds Strategy 1999

The National Weeds Strategy was produced by the Commonwealth Government in 1999 to reduce the impact of weeds on the sustainability of Australia's productive capacity and natural ecosystems by adopting a more coordinated and integrated approach to weed management. The National Weeds Strategy also defines the roles and responsibilities of various stakeholders in weed management.

Two of the principles upon which this Strategy is based relate to the roles and responsibilities of those involved in weed management. These principles are reproduced below.

- '*Successful weed management requires a coordinated national approach which involves all levels of government in establishing appropriate legislative, educational and coordination frameworks in partnership with industry, landholders and the community.*'; and

- '*The primary responsibility for weed management rests with landholders/land managers but collective action is necessary where the problem transcends the capacity of the individual landholder/land manager to address it adequately.*'

Accordingly, the landholder or manager has a responsibility to detect and report weed occurrences then implement management measures to control weed occurrences and minimise development of weed problems.

A central component of the National Weeds Strategy 1999 is the identification of Weeds of National Significance (WONS). WONS are listed in *Table B.1* of *Annex B*. WONS are prioritised using a series of questions that measure each weeds invasiveness, impact, potential for spread and socioeconomic and environmental values. WONS identified on site are Bitou Bush (*Chrysanthemoides monilifera* subsp *rotundata*), Blackberry (*Rubus fruiticosus*) and Lantana (*Lantana camara*).

2.1.2 *Agricultural and Veterinary Chemicals Code Act 1994*

All pesticides (herbicides, insecticides and fungicides) used, supplied or distributed in Australia must be registered under the *Agricultural and Veterinary Chemicals Code Act 1994* by the Australian Pesticides and Veterinary Medicines Authority (APVMA: formerly the National Registration Authority for agricultural and veterinary chemicals (NRA). All APVMA approved chemicals (or products) have affixed product labels, which contain specific usage requirements and application rates. Label breaches can result in prosecutions under this Act.

All herbicides to be used on site in weed management should adhere to relevant requirements under this Act.

2.1.3 *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) requires approval of the Commonwealth Minister for the Environment, Heritage and the Arts for actions that may have a significant impact on matters of national environmental significance. The EPBC Act also requires Commonwealth approval for certain actions on Commonwealth land.

Matters of national environmental significance under the Act include the following:

- World Heritage properties;
- National Heritage places;
- Ramsar wetlands of international importance;
- threatened species or ecological communities listed in the EPBC Act;
- migratory species listed in the EPBC Act;
- Commonwealth marine environment; and
- nuclear actions.

There are no World Heritage properties, National Heritage places, Commonwealth marine areas, Commonwealth listed ecological communities or nuclear actions on or near the proposed development area.

Fullerton Cove is part of the Ramsar listed Hunter Estuary Wetland and is located approximately 400 metres to the west of Nelson Bay Road. This Ramsar wetland covers approximately 2971 hectares including part of the Hunter Estuary National Park area which was previously known as Kooragang Nature Reserve and the Shortland Wetlands Centre.

Commonwealth land (former Fern Bay Rifle Range) directly adjoins the southern boundary of the Worimi Regional Park. Other areas of Commonwealth land in the locality include Fort Wallace to the north of Stockton and the Williamtown RAAF base.

There are a number of migratory species and Commonwealth listed threatened species that may occur on site and these are discussed in *Section 4.7*. In particular care must be taken on site to avoid the impacts associated with weeds and vegetation management activities particularly on the nationally vulnerable *Eucalyptus parramattensis* subsp *decadens* a hybrid of which has been recorded on site by Bell (2006). Further investigations have identified this species as *Eucalyptus parramattensis* subsp *decadens* x *E. robusta*. While not listed as vulnerable, the hybrid is considered to have high conservation significance and is discussed further in *Section 4.7.2*.

2.2 NEW SOUTH WALES

2.2.1 *Threatened Species Conservation Act 1995*

The *Threatened Species Conservation Act 1995* (TSC Act) lists a number of species and ecological communities protected under this Act that should not be disturbed without a permit. This Act regulates significant environmental impacts on listed species. A hybrid of the threatened *Eucalyptus parramattensis* subsp *decadens* listed under the TSC Act has been recorded on site.

There have been no recent flora and fauna surveys conducted in Worimi Regional Park. Surveys undertaken on the adjoining Fern Bay Seaside Village have identified a number of threatened flora and fauna species that are likely to occur in Worimi Regional Park. These are discussed in *Section 4.7*.

The NSW Scientific Committee established by the TSC Act, has listed 'the invasion of native plant communities by exotic perennial grasses', 'invasion of native plant communities by Bitou Bush and Boneseed', 'invasion, establishment and spread of Lantana' and 'invasion and establishment of exotic vines and scramblers' as key threatening processes under the TSC Act. These threatening processes are operating in Worimi Regional Park and are considered in the VMP.

In addition DECC has approved a threat abatement plan for Bitou Bush. This plan seeks to control the invasion of native plant communities by Bitou Bush/Boneseed (*Chrysanthemoides monilifera*). The site is not identified in the threat abatement plan.

2.2.2 *Noxious Weeds Act 1993*

The *Noxious Weeds Act 1993* identifies, classifies and guides the control of noxious weeds in NSW. The Act defines the roles of government, councils,

private landholders and public authorities in the management of noxious weeds. It also determines control actions for the various noxious weeds, according to their potential to cause harm to our local environment. There are five different "control classes" listed under the Act. Landowners are obliged to control all noxious weeds on their land according to specified "control classes".

The current list of noxious weeds within the Port Stephens local government area (LGA) is reproduced in *Annex B*.

2.2.3 National Parks and Wildlife Act 1974

The objectives of the *National Parks and Wildlife Act 1974* (NP&W Act) include:

(a) 'the conservation of nature, including, but not limited to, the conservation of:

(i) habitat, ecosystems and ecosystem processes, and

(ii) biological diversity at the community, species and genetic levels, and,

(b) the conservation of objects, places or features (including biological diversity) of cultural value within the landscape, including, but not limited to:

(i) places, objects and features of significance to Aboriginal people.

Under this Act a person must not intentionally cause damage to any habitat of or pick a threatened or protected species unless authorised under the Act.

Care must be taken to minimise the impacts associated with weed and vegetation management activities on threatened species, protected flora (listed in Schedule 13 of the Act) and fauna, and cultural value of the site.

2.2.4 Heritage Act 1977

In NSW, historical heritage is primarily protected under the *Heritage Act 1977*. This Act is designed to protect items of heritage significance, which are defined as a place, building, work, relic or precinct. Under Section 139 of the Act, it is an offence to disturb or excavate land where it is known that this activity will result in the discovery, exposure, movement, damage or destruction of heritage relics, unless the activity is conducted under an excavation permit. Items of heritage significance are identified in Worimi Regional Park and are considered further in *Section 4.2*.

2.2.5 Agricultural and Veterinary Chemicals Code Act 1994

All pesticides (herbicides, insecticides and fungicides) used, supplied or distributed in Australia must be registered under the *Agricultural and Veterinary Chemicals Code Act 1994* by the Australian Pesticides and Veterinary Medicines Authority (APVMA: formerly the National Registration Authority

for Agricultural and Veterinary Chemicals (NRA)). All APVMA approved chemicals (or products) have affixed product labels, which contain specific usage requirements and application rates. Label breaches can result in prosecutions under this Act.

All herbicides to be used on site in weed management should adhere to relevant requirements under this Act.

2.2.6 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act 1997* (PoEO Act) provides a framework for environment protection in New South Wales. Under the PoEO Act it is an offence to pollute water. The selection and use of herbicides should be undertaken in such a manner that prevents the pollution of water.

2.3 PLANS AND STRATEGIES

Other plans, strategies and documents that relate to weed management and restoration within the Worimi Regional Park include:

- the NSW Weeds Strategy (NSW Agriculture 1998) which aims to reduce the negative impacts of weeds on the economy, community, industries and environment. One outcome of the Strategy is the development and implementation of programs to reduce environmental degradation and the loss of biodiversity through weed invasion; and

- the NSW Bitou Bush Strategy (NSW National Parks and Wildlife Service 2000a) which is designed to assist in reducing the impacts on Bitou Bush on NSW coastal ecosystems.

With regard to the removal of waste material from the site, there are a number of regulations and codes that need to be considered. These are:

- the NSW Occupational Health and Safety Regulation (2001) under which there is a requirement for the Controller of Premises to provide information on hazards associated with site activities to ensure safety of the workers, environment and general public through appropriate disposal of hazardous materials;

- the National Occupational Health and Safety Commission Code of Practice for the Safe Removal of Asbestos; and

- the National Occupational Health and Safety Commission Synthetic Mineral Fibre National Standard and National Code of Practice.

3 METHODOLOGY

3.1 DESKTOP ASSESSMENT

A review of relevant documents was undertaken to provide background information on the existing environment of the Worimi Regional Park, in particular:

- the vegetation survey by Clements *et al* (1992) of this site as part of a large investigation encompassing the Fern Bay Seaside Village and the two areas of Worimi Regional Park to the east and south of the development;
- cultural heritage assessment of the Worimi Regional Park as part of an assessment of the Worimi Conservation Lands along the Stockton Bight;
- a waste material survey of the former Fern Bay Armour Plate Proofing Range (ERM 2006a);
- vegetation surveys for the Lower Hunter and Central Coast Region Environmental Management Strategy (LHCCREMS) by NPWS (2000b) and House (2003); and,
- an assessment of the status, distribution and habitat of the state and Commonwealth listed threatened tree *Eucalyptus parramattensis* subsp *decadens* (Bell 2006).

3.2 FIELD INVESTIGATIONS AND DATA ANALYSIS

Field investigations were conducted to assess the wet heath, tracks, weed species, and rubbish dumping across the site in mid 2006. The location of rubbish concentrated on the area external to the earlier assessment of the former Fern Bay Armour Plate Proofing Range (ERM 2006a).

The boundaries of the wet heath, track routes, occurrences of weeds and/or boundaries of areas of weed infestation and rubbish dumping were located in the field using a hand held Geographic Positioning System (GPS). The data was imported into a Geographic Information System (GIS) and is presented in figures and annexures in this report.

Field investigations were also undertaken to identify species characterising the wet heath communities. Flora survey used 20 metre by 20 metre quadrats located randomly (12 in total) throughout the five areas of wet heath mapped by Clements *et al* (1992). The vegetation map prepared by Clements is provided in *Annex C: Figure C.1*.

4 EXISTING ENVIRONMENT

4.1 SITE DESCRIPTION

The Worimi Regional Park is located towards the southern end of the Stockton Bight. It is located south of the proposed Fern Bay Seaside Village (see *Figure 1*), north of Commonwealth land (the former Rifle Range) and to the east of the Newcastle Golf Course and the existing residential development of Fern Bay. The Worimi Regional Park extends to the high water mark. The site is zoned under the Port Stephens Local Environmental Plan 2000 as Environment Protection 7(a) with General Recreation A Zone 6(a) along the active dunes and beach.

4.2 LANDSCAPE HISTORY

Vegetation on site has been subjected to several human disturbances including activities during World War II, off-road vehicle recreation and illicit dumping of cars and rubbish, including garden refuse. As a result of human activity, the stability of the transgressive sand dune system has been affected, leading to a reduction in vegetation cover in some areas. Garden and non–compostable household rubbish dumping is currently occurring on site primarily along the electricity easement tracks.

The cultural heritage assessment identified the Fern Bay Armour Plate Proofing Range and associated infrastructure as an area of historical heritage on site (ERM 2006a). An extract from the heritage assessment report including a location figure, description and photographs is included in *Annex D* of this report. The report identified eight structures clustered along a concrete road associated with the use of the area as an armour plate and artillery proofing range during and after World War II (ERM 2006a). The concrete road extends from near the former Fern Bay Rifle Range to amongst the identified structures. The structures have been assessed as being of heritage significance on a national, state and local level. The cultural heritage value of this area including the concrete access road needs to be considered in development of the vegetation management plan.

Fire frequency on site is currently higher than in pre-European settlement times and is likely related to illicit dumping and human activity (Clements *et al* 1992). There have been two fires on site in the last year (2006). Prior to this there have been three recorded fires between 1995 and 2005 (ERM 2005).

4.3 CLIMATE

The site is situated in an area that experiences a warm temperate climate. According to data obtained from the Bureau of Meterology's Williamtown

weather station (approximately six kilometres to the north of the site) for the period 1942 to 2003, mean temperature ranges from a minimum of 6.4 degrees Celsius in July to a maximum of 27.8 degrees Celsius in January. Average rainfall is 1124 millimetres, with 137 mean number of raindays per year. The period of highest rainfall is from January to June.

During summer, the predominant wind direction is from the east and south east with stronger winds during the afternoon. In autumn and winter months, morning breezes are predominantly from the west and north west, with south and south east breezes increasing in the afternoons. In winter, strong winds generally blow from the west to north west. The impact of prevailing winds is decreased by the undulating topography of the site and surrounding area.

4.4 GEOLOGY, TOPOGRAPHY AND SOILS

The site is situated on the lower north coast of New South Wales in the North Coast Biogeographic Region and the botanical subdivision of the north coast. The Central Coast botanical subdivision and the Sydney Basin Bioregion occur to the south of the Hunter River, just to the south of the site.

The site is dominated by Quaternary sands and does not contain any naturally occurring outcrops (Matthei 1995). The Stockton Bight is a dune barrier system composed of an inner barrier of Pleistocene age and an outer barrier of Holocene age that are separated by a low-lying swampy area referred to as the inter-barrier depression (Roy and Thom 1981, Thom *et al* 1992).

The transgression of dunes across the site has resulted in a series of prominent ridges and distinct sandy knolls, parallel to the shore line. Soils on site consist of a narrow topsoil layer of silty sand over a sand layer with a thickness that varies from 13 to 27 metres that overlays sandy clay. The soils are underlain by rock at a depth of approximately 60 metres. The site comprises three aeolian landscapes as mapped and defined by Matthei (1995) being Boyce's Track, Hawks Nest and Stockton Beach.

Boyce's Track landscape unit occurs in two ridges through the site separated by lower lying Hawks Nest landscape unit. Boyce's Track unit is characterised by steep Quaternary Holocene sand dunes on the Tomago coastal plain, with uncleared tall open forest. Soils are deep (>300 centimetres) well-drained, weakly developed podzols. Hawks Nest landscape unit is widely distributed over the site. It is characterised by low Holocene sandsheets and low transgressive dunes on the Tomago coastal plain, with dry scrubland, woodland and tall open forest. Soils are deep (> 300 centimetres) well-drained podzols and siliceous sands and podzols on dunes. The elevated active dunes and beach are mapped as Stockton Beach soil landscape unit (Matthei 1995).

According to the Williamtown Acid Sulfate Soil Risk Map (Naylor 1995) the majority of the site is mapped as having a low probability of acid sulfate soils greater than three metres below the surface with low lying areas mapped as having a low probability of containing acid sulfate soils between one and three metres below the surface. Elevated dunes to the east of the former Fern Bay Armour Plate Proofing Range are identified as no known occurrence. Sulfate soils are not likely to be exposed during works outlined in the VMP given that excavation of soils at depths of greater than one metre below the surface is not proposed.

4.5 VEGETATION COMMUNITIES

The site is dominated by Coastal Sand Apple-Blackbutt forest with low lying swales supporting areas of wet heath and coastal scrub at the rear of the active dunes. The vegetation communities on site were mapped by Clements *et al* (1992) (see *Figure C.1 Annex C*) and in the regional vegetation mapping (NPWS 2000b and House 2003). The following description is based on these three reports, the Species Impact Statement for the Fern Bay Estate (ERM 2005) and studies conducted in the nearby Boral land holding (ERM 2006b).

Clements *et al* (1992) delineated three distinct vegetation communities on site:

- hind dune vegetation dominated by Lemon-scented Tea-tree (*Leptospermum laevigatum*) thicket heavily infested with Bitou Bush (*Chrysanthemoides monilifera*);
- wet heath separated into two transgression ages, formed 2000 and 4000 years ago, dominated by Red Bloodwood (*Corymbia gummifera*) on the seaward side (2000 year transgression) and Swamp Mahogany (*Eucalyptus robusta*) on the landward side (4000 year transgression); and
- dry sclerophyll forest (see *Figure C.1 Annex C*).

The site is identified in regional vegetation mapping as supporting only one vegetation community being Coastal Sand Apple–Blackbutt Forest (House 2003).

Coastal Sand Apple–Blackbutt Forest dominates the site. The canopy within this community is typically dominated by Smooth-barked Apple (*Angophora costata*) and Blackbutt (*Eucalyptus pilularis*) with occasional Red Bloodwood (*Corymbia gummifera*). Structurally it is an open forest with a moderately open shrubby understorey of *Banksia serrata*, *Acacia ulicifolia* and *Dillwynia retorta* with a ground layer composed of grasses, herbs and Bracken (*Pteridium esculentum*) (NPWS 2000b).

The wet heath community identified by Clements *et al* (1992) across this site and the Fern Bay Seaside Village were divided into heath occurring on a 2000 year sand transgression, dominated by Red Bloodwood (*Corymbia gummifera*),

and a 4000 year sand mass dominated by Swamp Mahogany (*Eucalyptus robusta*) that occurs further inland.

The wet heath in Worimi Regional Park is more representative of the landward side heath with emergent Swamp Mahogany and some Smooth-barked Apple (*Angophora costata*) and *Banksia serrata*. The shrub stratum is dominated by *Melaleuca nodosa* with *Leptospermum polygalifiolium* subsp. *cismontanum* and understory species include *Restio tetraphyllus*, *Lomandra longifolia* and *Dianella caerulea* (Clements *et al* 1992). This community is most strongly aligned with the LHCCREMS mapping unit of Tomago Sand Swamp Woodland (NPWS 2000b).

4.6 FAUNA HABITATS

The following discussion on fauna habitat is based on fauna surveys conducted for the adjoining development site and the discussion of fauna habitats provided in the Species Impact Statement (ERM 2005) as both sites support similar fauna habitats.

The site supports dry sclerophyll open forest habitat in the form of tree hollows, logs and ground cover such as grasses and bracken. Logs and ground cover provide shelter and foraging habitat for reptiles and small terrestrial mammals. The sandy substrate enables small to medium sized terrestrial mammals to create burrows for shelter. Tree hollows of this community provide suitable roosting and or dens sites for threatened species recorded from the adjoining Fern Bay Seaside Village including Squirrel Gliders (*Petaurus norfolcensis*) and tree roosting microchiropteran bats. The presence of *Banksia serrata* in the shrub strata and mid storey provides potential foraging resources for nectivorous birds and the Squirrel Glider.

The heath supports a diversity of shrubs including *Acacia* spp., *Banksia serrata* and *Leptospermum* spp. These provide foraging resources for a variety of species including nectivorous birds and Squirrel Gliders. The dense shrub strata provide shelter for small birds. There is no permanent or ephemeral wetland suitable for frogs in this habitat. The groundwater table is close to the surface and the soil may remain moist at times of higher rainfall.

No habitats in the form of bush rock, rock platforms, swamp forest, rainforest elements or drainage lines occur on site.

The Port Stephens Council Comprehensive Koala Plan of Management identifies the site as supplementary Koala habitat, based on broad scale mapping, which identifies the site as Coastal Sand Apple-Blackbutt Forest (Port Stephens Council 2001). The Fern Bay Estate Species Impact Statement identifies that the heath community provides preferred Koala habitat in the areas of wet heath (ERM 2005).

Koala habitat in Worimi Regional Park lands has not been quantified as part of this VMP. Extrapolating the results from the adjoining Fern Bay Seaside

Village it is likely that the wet heath may support preferred Koala habitat. As the VMP will not clear existing native vegetation (excepting for the four-wheel drive access along the northern boundary) it is unlikely to affect the provision of potential Koala habitat on site.

The site is towards the southern end of the corridor of vegetation that extends along the sand dunes of Stockton Bight to Tomaree Peninsula and the Tomago Sandbeds. The majority of this area is now identified as conservation lands and managed by DECC as the Worimi Conservation Lands. It is also part of the regional corridor from the coastal forests of Stockton Bight, to estuarine habitats in Fullerton Cove and further west to wetland habitats on Kooragang Island and Hexham Swamp. While not part of the proposed Watagans Ranges to Port Stephens reserve through Hexham Swamp identified in the Draft Lower Hunter Regional Conservation Plan (DEC 2006b), the site is continuous with this reserve through the regional corridor.

4.7 THREATENED SPECIES

4.7.1 Records in the Locality

No formalised fauna surveys have been undertaken in preparation of the VMP. An indication of threatened species that may occur on the site was determined based on a review of habitats available in the Worimi Regional Park, a literature review and searches of the DECC wildlife database.

A number of threatened species have been identified in the Fern Bay Estate SIS (ERM 2005) and/or are considered to have potential to occur on site or in the locality. These are listed in *Table 4.1*.

Table 4.1 ***Threatened Species with Potential to Occur in the Worimi Regional Park and Adjoining Land.***

Common Name / Scientific Name	EPBC Act Status	TSC Act Status	Recorded Fern Bay Estate
Plants			
Leafless Tongue Orchid (*Cryptostylis hunteriana*)		V	N
Sand Doubletail (*Diuris arenaria)*	V	V	N
Rough Doubletail (*Diuris praecox*)	V	V	Y
Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*)	V	V	Y (hybrid)
Heath Wrinklewort (*Rutidosis heterogama*)	V	V	N
Dwarf Kerrawang (*Rulingia prostrata*)	E	E	N
Netted Bottlebrush (*Callistemon linearifolius)*	-	V	N
Birds			
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	-	V	N
Brown Treecreeper (eastern subspecies) (*Climacteris picumnus victoriae*)	-	V	N
Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)	-	V	N
Swift Parrot (*Lathamus discolor*)	E,M	E	N
Regent Honeyeater (*Xanthomyza phrygia*)	E, M	E	N
Square-tailed Kite (*Lophoictinia isura*)	-	V	N
Powerful Owl (*Ninox strenua*)	-	V	Y
Barking Owl (*Ninox connivens*)	-	V	N
Masked Owl (*Tyto novaehollandiae*)	-	V	Y
Osprey (*Pandion haliaetus*)	-	V	N
Wompoo Fruit-dove (*Ptilinopus magnificus*)	-	V	N
Rose-crowned Fruit-dove (*Ptilinopus regina*)	-	V	N
Superb Fruit-dove (*Ptilinopus superbus*)	-	V	N
Mammals			N
Large-eared Pied Bat (*Chalinolobus dwyeri*)	V	V	N
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)	-	V	Y
Little Bentwing-bat (*Miniopterus australis*)	-	V	Y
Large-footed Myotis (*Myotis adversus*)	-	V	N
Spotted-tail Quoll (*Dasyurus maculatus maculatus*)	E	V	N
Hoary Wattled Bat (*Chalinolobus nigrogriseus*)	-	V	Y
Eastern Falsistrelle (*Falsistrellus tasmaniensis*)	-	V	N
Eastern Freetail-bat (*Mormopterus norfolkensis*)	-	V	Y
Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)	-	V	Y
Greater Broad-nosed Bat (*Scoteanax rueppellii*)	-	V	Y
Squirrel Glider (*Petaurus norfolcensis*)	-	V	Y
Koala (*Phascolarctos cinereus*)	-	V	N
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	V	Y
Frogs			
Green and Golden Bell Frog (*Litoria aurea*)	V	E	N
Wallum Froglet (*Crinia tinnula*)	-	V	Y

1. V = vulnerable; E = endangered; M = migratory species.
2. Species recorded in Fern Bay Estate (ERM 2005).

4.7.2 *Eucalyptus parramattensis* subsp *decadens* x *E. robusta*

Of the threatened species identified in *Table 4.1,* putative hybrids of *Eucalyptus parramattensis* subsp *decadens* have been identified in Worimi Regional Park (Bell 2006). Specimens collected in the Fern Bay Seaside Village and Worimi Regional Park have been determined as a hydrid between this taxon and either *Eucalyptus resinifera*, *E. scias* or *E. punctata* (Bell 2006).

Further taxonomic investigations of flowering specimens collected in June 2008 have been identified as *Eucalyptus parramattensis* subsp *decadens* x *E. robusta.* This species is not listed as threatened under State or Commonwealth legislation but is considered to have a very high conservation value.

Figure C.2 in *Annex C* shows the location of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* as identified by Bell (2006) and by ERM in January 2007 during targeted surveys in wet heath and low lying deflated swales in the dune forest (ERM 2007). Given the multi-stemmed habit of the tree and resprouting in response to fires, each location as shown in *Figure C.2* may represent more than one individual. The estimated size of the population in the Fern Bay area is 74 of which 67 individuals occur in the Worimi Regional Park (ERM 2007).

The following threatening processes have been identified for *Eucalyptus parramattensis* subsp *decadens* and are considered to be relevant to management of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* in Worimi Regional Park:

- rubbish dumping;
- weed invasion (in particular Bitou Bush and Lantana);
- high frequency fire over a long period;
- indiscriminate logging and clearing;
- habitat loss and fragmentation from developments such as sand mining, road construction and residential development; and
- modification of drainage regimes through draining, filling and groundwater use (Bell 2006, DECC NSW threatened species website).

Through the retention of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* on site and incorporation of management measures with respect to weeds, rubbish dumping and fire management, as outlined within this VMP, it is considered that the VMP would reduce threatening processes thereby enhancing the habitat value of the area.

5 WASTE REMOVAL

This chapter describes waste material identified on site during a preliminary waste material survey of the former Fern Bay Armour Plate Proofing Range and site investigations across the Worimi Regional Park in 2006. It also identifies recommendations for removal, monitoring and maintenance.

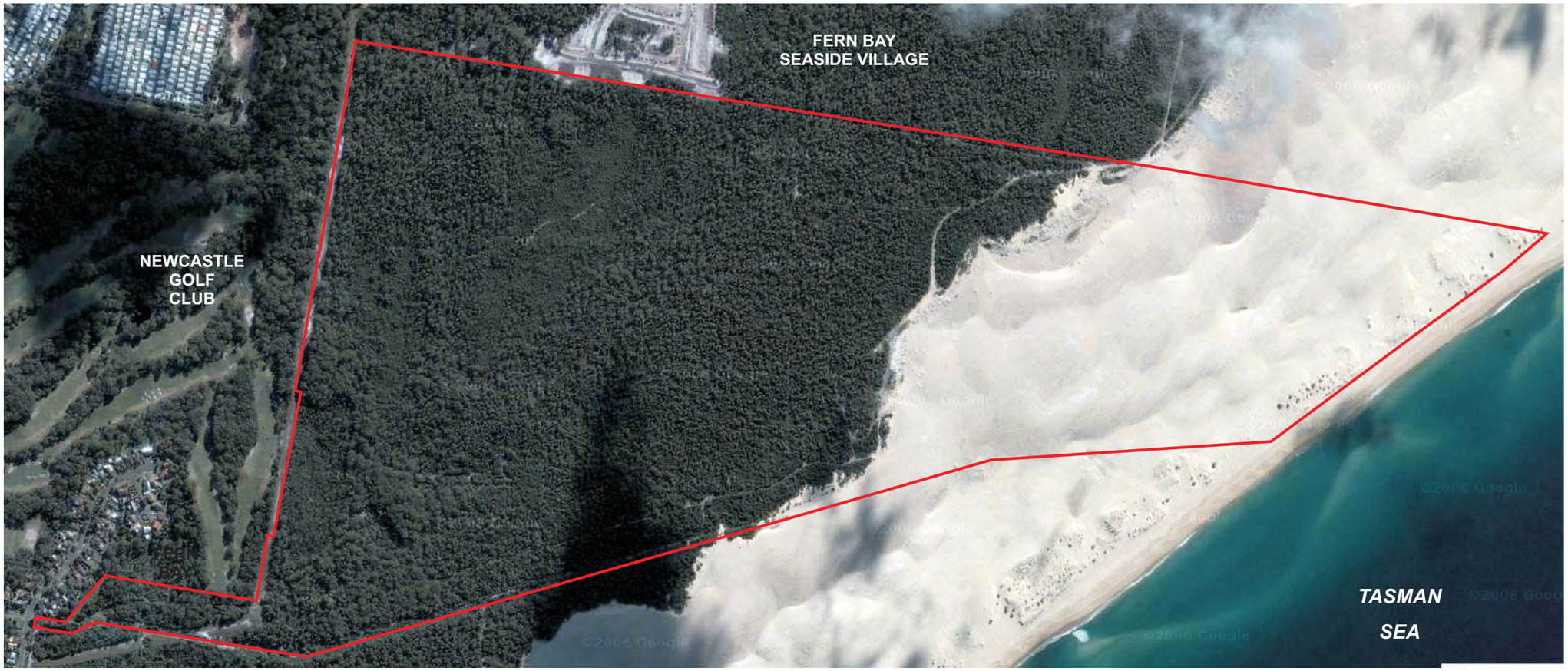
5.1 EXTENT OF WASTE

A preliminary waste material survey at the former Fern Bay Armour Plate Proofing Range was undertaken by ERM (2006a). This survey identified the location, type and extent of waste within readily accessible portions of the site. The survey is included in *Annex E* of the VMP. At the time of the 2006 field investigation, it was noted that the waste described in the waste material survey had not been removed. However, large amounts of the waste (approximately 70%) in the area of the Fern Bay Armour Plate Proofing Range had been removed at the end of 2007. Waste removed was mainly car bodies and asbestos waste material.

An inventory of additional waste material was compiled during the site investigations and waypoints are shown in *Figure 3* with descriptions provided in *Annex F*. The waste recorded was limited to readily accessible, visible and above ground portions of the site. Burnt areas allowed for increased detection of waste.

Waste material identified on site included general household waste material, dumped cars, and garden waste. Areas of potential asbestos waste and potential synthetic mineral fibre were also identified (see *Annex E* waste register and *Annex F*). Waste material was primarily situated along access tracks in particular the electricity transmission line easement and access tracks to the former Fern Bay Armour Plate Proofing Range. Sites of garden waste were also associated with weed species in particular garden escapes such as Cotoneaster (*Cotoneaster glaucophyllus*) trees and Mother-of-Millions (*Bryophyllum delagoense*). Waypoints for weed infestations are shown in *Figure 4* with a description of the waypoints provided in *Annex G*.

Baseline surveys of waste, as identified in this plan, will be updated at the commencement of the plan. This survey will aim to identify any additional waste and to update waste registers in *Annex E* and *Annex F* including confirmation of extent of waste removal in the vicinity of the former Fern Bay Armour Plate Proofing Range.



Legend

Worimi Regional Park

Figure 2

Aerial Photograph of Site

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_09		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

N

0 100 200 300m

Environmental Resources Management Australia Pty Ltd
53 Bonville Avenue, Thornton, NSW 2322
Telephone +61 2 4964 2150

ERM

NELSON BAY ROAD

FERN BAY
SEASIDE VILLAGE

NEWCASTLE
GOLF
CLUB

FERN
BAY

POPPLEWELL ROAD

NAGLE CL

TASMAN
SEA

Legend

Worimi Regional Park

6 Waste Material (former Fern Bay Armour Plate Proofing Range) ERM 2006. For description of waypoints 1 to 64 *see Annex E.*

67 Waste Material ERM Oct 2006. For description of waypoints 65 to 121 *see Annex F.*

Notes:

Some of the waste material associated with the waypoints 1 to 64 removed late 2007.

Figure 3

Extent of Waste in Worimi Regional Park

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_06		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

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5.2 *REMOVAL RECOMMENDATIONS*

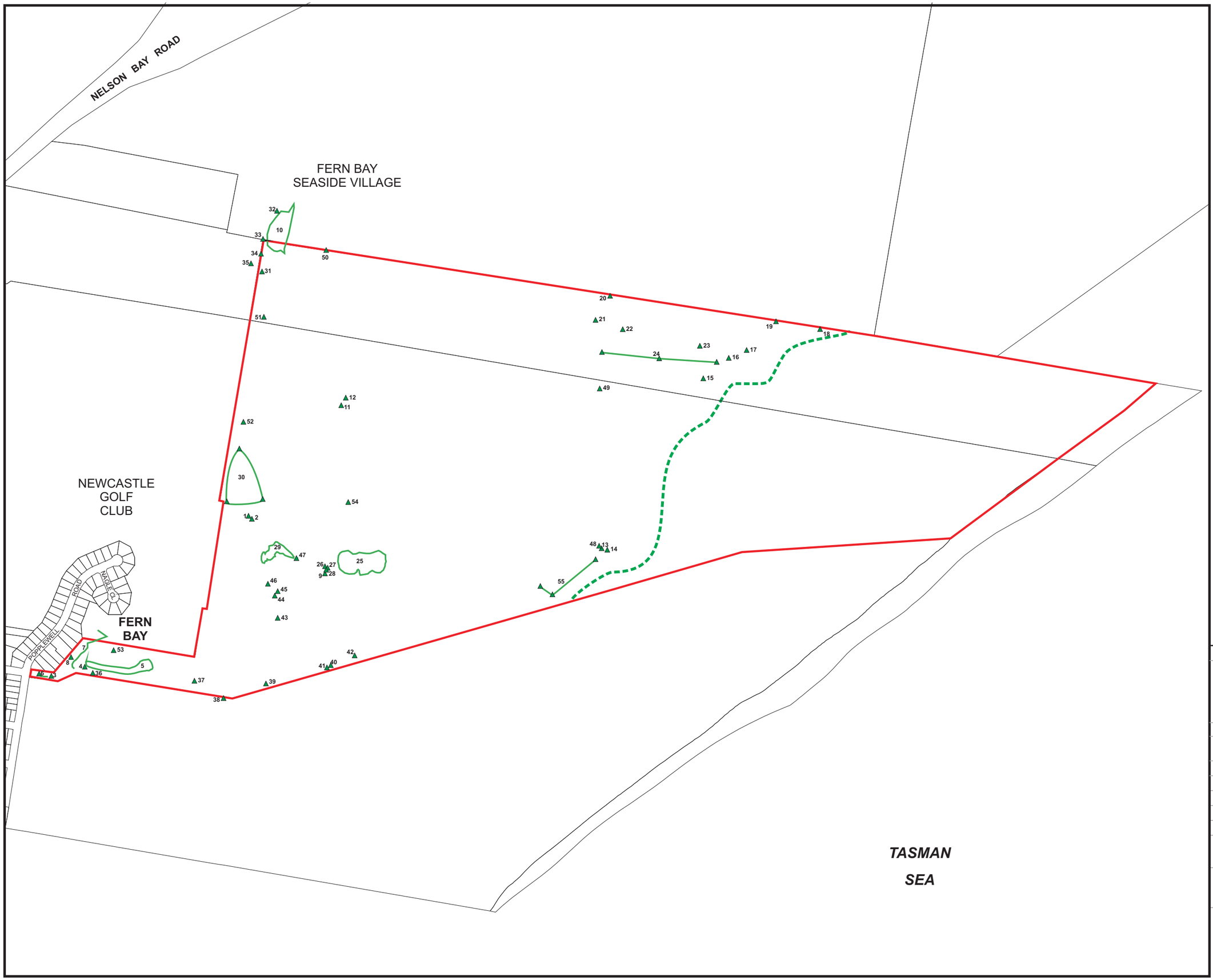
Waste removal is to be the initial stage of rehabilitation works in the Worimi Regional Park. Upon completion of the initial waste removal contract, weed management works and track rationalisation works shall commence.

The timeframe of the initial waste removal will depend on the availability of waste contractors and licensed asbestos waste contractors. It is estimated that waste removal may take at least a month depending on accessibility and should be completed within the first six to 12 months of the plan.

A number of general recommendations for the removal of potential hazardous waste material in the area of the former Fern Bay Armour Plate Proofing Range are provided in *Annex E*. There has been no laboratory analysis of waste material to identify the presence of potentially hazardous material and the identification of waste material has been restricted to above ground. Therefore, removal of all waste shall be handled as potentially hazardous material and recommendations include:

- engagement of a suitably qualified, licensed asbestos removal contractor for the removal of asbestos containing material or synthetic mineral fibre;
- analysis of potential hazardous material to confirm the presence of asbestos containing material or synthetic mineral fibre will be carried out;
- due care shall be taken including a more thorough inspection of waste locations that may include potentially hazardous material;
- use of appropriate personal protection equipment and maintenance of a safe work environment;
- removal of waste shall be undertaken in a manner to minimise area of disturbance of native vegetation. Where necessary native vegetation should be temporarily fenced; and
- removal works and disposal shall be carried out in accordance with the Occupational Health and Safety Regulations 2001 and in accordance with the relevant codes of practices.

The accessible areas for waste removal are generally restricted to those access tracks identified in *Figure 5*. Larger vehicles could be used by waste contractors along the main electricity easement track. Where necessary waste should be removed using the least intrusive method such as via four-wheel drive motorbikes with trailers rather than large vehicles or machinery. Some areas of waste (eg waypoints 91, 92, 115 and 116) occur along narrow tracks that are currently regenerating. Waste removal should be limited in these relatively undisturbed and inaccessible areas as removal of waste may result in more damage than the benefit of removing the waste may have on the localised ecosystem. Retaining these areas of waste is unlikely to affect significantly the habitat value of these areas. A decision as to the risks and



Legend

- Wormi Regional Park
- Weeds
- Bitou Bush along dunes

Notes:

Description of weeds for each waypoint provided in Annex G.

Figure 4

Extent of Weeds in Worimi Regional Park

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_05		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

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ERM

benefits of removing rubbish from these more undisturbed and inaccessible locations should be reached by DECC (Parks and Wildlife Division) officer responsible for the works.

Large amounts of the waste (approximately 70%) in the area of the Fern Bay Armour Plate Proofing Range had been removed at the end of 2007. Waste removed was mainly car bodies and asbestos waste material. Care shall be taken during removal of the remaining surface rubbish and asbestos material from the former Fern Bay Armour Plate Proofing Range to minimise disturbance of vegetation and the heritage structure. Recommendations identified in *Annex D* to minimise impact on heritage structures shall be adopted including:

- no excavation or topsoil removal to occur in areas surrounding heritage items or potential heritage items;
- the removal of waste materials associated with heritage structures should not involve damage or modification to the structure in any way; and,
- potential heritage items in addition to the structures identified in *Annex B*, should not be moved, damaged or destroyed.

5.3 MAINTENANCE AND MONITORING

After initial waste removal works, follow up inspections will be conducted immediately to confirm removal and then after six months to determine the success of removal works, identifying impacts of removal and where required measures to be implemented to rectify any disturbance that may have resulted from accessing the more remote areas of waste. In particular it is anticipated that weed management measures will be required as waste sites are often also associated with invasive introduced flora species.

Waste material removal sites will be monitored annually for up to 20 years as part of the weed management programme. Monitoring of the Worimi Regional Park for new areas of waste material points will be undertaken annually to identify additional waste waypoints.

Retention of some tracks for emergency access by DECC will provide access for potential dumping of waste as will the construction of the formal four-wheel drive track. DECC will remove 'litter' along the four-wheel drive track during service activities as required with implementation of removal program for larger waste dumps undertaken by Aspen in consultation with DECC during years 1 to 5 with consideration given to the type and quantity of waste material.

6 WEED MANAGEMENT

This chapter identifies the invasive exotic species (weed) on site and develops a management plan for removal, maintenance and monitoring of the target species. These measures would be applied across all vegetation types in the Worimi Regional Park and incorporated where required into track rationalisation strategy.

6.1 DESCRIPTION AND EXTENT OF WEEDS

As part of the compensatory package, investigations were conducted across the site in August and September 2006 to identify areas of extensive weed encroachment. It should be noted that in this report weeds are those species identified as noxious weeds in Port Stephens Council (PSC) and weeds of national significance.

Commonly encountered weeds include Lantana (*Lantana camara*), Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*), Fireweed (*Senecio madagascariensis*), Blackberry (*Rubus* sp.) and Mother-of-Millions (*Bryophyllum* sp.). Weeds encountered during field investigations were mapped and described (see *Annex G* and *Figure 4*). Species identified on site during current investigations and Clements *et al* (1992) are listed in *Table 6.1.*

Table 6.1 Introduced Plant Species Identified on Site during Present Investigations and Clements et al (1992)

Common Name	Scientific Name	Noxious Weed Listing PSC	Weed of National Significance
Mother-of-Millions	*Bryophyllum delagoense*	Class 3	No
Bitou Bush	*Chrysanthemoides monilifera* subsp. *rotundata*	Class 4	Yes
Fleabanes	*Conyza* species	Not declared	No
Cotoneaster	*Cotoneaster glaucophyllus*	Not declared	No
	Cyperus dubius and *C. flavus*	Not declared	No
African Lovegrass	*Eragrostis curvula*	Not declared	No
Coral Tree	*Erythrina* X *sykesii*	Not declared	No
Toothed Hebenstretia	*Hebenstretia dentata*	Not declared	No
Lantana	*Lantana camara*	Class 5	Yes
Blackberry	*Rubus* sp.	Class 4	Yes
Fireweed	*Senecio madagascariensis*	Not declared	No

Port Stephens Council noxious weed listing in *Annex B*.
Class 3 = must be fully and continuously suppressed and destroyed;
Class 4 = growth and spread of plant must be controlled;
Class 5 = requirement in the Noxious Weeds Act 1993 for a notifiable weed must be complied with.

In addition to species identified in *Table 6.1*, DECC have identified an infestation of Madeira Vine (*Anredera cordifolia*) in the south west of Worimi Regional Park near the corner of Varden Road and Popplewell Road. Madeira Vine is not listed as a noxious weed in the PSC local government area

however, invasion and establishment of Madeira Vine is identified as a key threatening process for native vegetation communities under the TSC Act.

Weed occurrences are generally associated with access tracks and other disturbed areas. Heavy Bitou Bush infestations were observed along the golf course boundary and along the dunes to the east (see *Figure 4*). Recent fire enabled higher visibility in some parts of the Worimi Regional Park. Bitou Bush in these areas is regenerating and requires prompt removal. At seedling stage, the Bitou Bush can be hand-pulled to prevent reproduction from seed production.

6.2 CONTROL METHODS

Fact sheets outlining control methods for the weeds of national significance and noxious weeds are provided in *Annex H*.

The main methods for weed removal include 'cut and paint method' using herbicide (round-up) and hand-pulling. Fact sheets on these techniques are provided in *Annex I*. Another method of control is aerial spraying. The selection of each method is dependent on the extent of weed infestation and potential affects on surrounding native vegetation.

A log should be maintained by the weed contractor describing baseline density of species based on age (eg seedlings or mature plants), removal methods used and time spent.

In areas containing significant infestations of target weed species such as Bitou Bush and Lantana consideration should be given to the provision of erosion control structures if large areas of sand are likely to be exposed. This should be determined at the discretion of personnel undertaking the weed management activities. Appropriate control methods may include keeping dead plants insitu, the provision of fences, brush matting, planting of tube stock and synthetic ground covering for larger areas of exposed sand. It is particularly important that such erosion control strategies be adopted in areas in close proximity to wetlands and steeper dune slopes.

6.2.1 Bitou Bush

Invasion of native plant communities by *Chrysanthemoides monilifera* (Boneseed and Bitou Bush) is identified as a key threatening process under the TSC Act. Bitou Bush is a noxious weed in the PSC area and is a weed of national significance. Vigorous growth of Bitou Bush enables it to strongly compete with and displace native vegetation communities.

A factsheet is provided in *Annex H* with regard to appropriate removal methods for this species.

Areas of extensive Bitou Bush infestation parallel to the western easement boundary and concentrated towards the dune areas will require cut and paint method of removal. Given that these plants are mature, a broad scale removal program will be required to suppress weed spread. Removal will be undertaken from the edges towards the middle of the infestation to allow native plant regeneration. As a general principle, removal of Bitou Bush will commence in the areas of light infestation and isolated occurrences first.

The areas of heavy infestation (eg waypoint 5, 25 and 30) and the active dune interface will require a multi-stage strategy using spraying and removal. In the first instance, large scale infestation should be controlled with a ground application of herbicide in winter. This should be followed by a respray before seedlings start to set seed. This should be combined with selective hand pulling of isolated occurrences of small seedlings. Dead Bitou Bush will be left in situ and trampled. This will limit access to these areas provide protection from erosion of the dune and protection for seedlings. Seeds should be removed from site.

Aerial spraying may be considered for the infestation along the dune interface. This should follow best practice guidelines as prepared by Broese van Groenou and Downey (2006). Costs associated with aerial spraying of low rates of glyphosate (0.76kg active ingredient per hectare) are approximately $100 to $190 per hectare (DEC 2006a).

The regenerating Bitou Bush affected by fire will require a less labour intensive approach with juvenile seedlings enabling a rapid hand pull method. Collection of all vegetative parts of the bush will need to be thorough to prevent re-infestation. Fire affected Bitou Bush should be controlled by a prompt program of hand pulling juveniles and seedlings (not flowering) in spring.

Smaller areas of Bitou Bush can be controlled using the cut and paint method or hand pulling, depending on their size and success of root removal (see *Annex H*). Hand pulling is used for small to medium sized plants. The cost of hand pulling is approximately $600 per hectare depending on topography, elevation, density of vegetation and extent of infestation (DEC 2006a). Herbicides should be applied in winter as foliar spray (average cost $300 to $500 per hectare) or cut and paint (average cost $800 per hectare).

6.2.2 Lantana

Invasion, establishment and spread of Lantana is identified as a key threatening process under the TSC Act. Lantana is a noxious weed in the PSC area and is a weed of national significance.

Prolific Lantana infestation is restricted to land beneath the electricity easement along the western boundary of the Worimi Regional Park. Small sections of infestation are associated with the western section of heath section 1.

A factsheet is provided in *Annex H* with regard to appropriate removal methods for this species. The recommended method for the larger scale infestation is to cut and paint using herbicide taking care to remove any broken branches from the site to avoid aerial rooting. Alternatively the option of spraying or splatter-gun application of a herbicide could be considered for some infestations but only in consultation with DECC. Foliar application of herbicides is most effective when applied to actively growing plants between summer and autumn.

6.2.3 Blackberry

Blackberry (*Rubus* sp.*)* is identified as a class 4 noxious weed in the Port Stephens LGA. Blackberry was identified in two locations associated with the western boundary of the Worimi Regional Park beneath the electricity easement. Removal techniques are discussed in the factsheet provided in *Annex H*. Given the maturity of this species, removal techniques should include a combination of manual (slashing) and herbicide control. Control will require ongoing measures where dense thickets occur.

6.2.4 Mother-of-Millions

Mother-of-Millions (*Bryophyllum delagoense*) is identified as a class 3 noxious weed in the Port Stephens LGA and the plant must be fully and continuously suppressed and destroyed. A fact sheet on control of this species is provided in *Annex H*.

This species was associated with garden refuse dumping and was found near the heritage structures. It should be removed using a combination of manual and herbicide control. This should be undertaken after waste removal.

6.2.5 Madeira Vine

Madeira Vine (*Anredera cordifolia*) is not listed as a noxious weed in the PSC local government area however, invasion and establishment of Madeira Vine is identified as a key threatening process for native vegetation communities under the TSC Act. An infestation of Madeira Vine has been identified by DECC in the south west of Worimi Regional Park near the corner of Varden Road and Popplewell Road, Fern Bay.

Madeira Vine is a vigorous climber covering the canopy of trees and either smothering them or causing smaller trees to collapse. Madeira Vine produces drooping flower spikes from December to April. It rarely fruits and propagates mainly from the aerial tubers along the length of the vine that will fall to the ground. A fact sheet on this species is provided in *Annex H*.

There are a number of methods of control including removal at the roots and leaving the vine in place but this requires care to avoid displacement of aerial tubers and the tubers can survive for an extended period. Laying a tarp or

sheet under the vine will allow for collection of tubers when removing the vine. Herbicide treatment could use cut and paint method to vine, or young vines without tubers can be sprayed with a herbicide (glyphosate (360g/L)) in early autumn with follow up treatment.

6.3 MAINTENANCE AND MONITORING

Initial weed removal will be undertaken within the first year of the rehabilitation works and/or subsequent to waste removal with the weed removal program ongoing over the 20 years of the plan. Treatment will commence in areas of low infestation using species appropriate treatment techniques as identified in *Section 6.2* and *Annex H*. A sustained control effort of at least 10 years is recommended by the Cooperative Research Centre for species such as Bitou Bush (CRC 2003) as this is the period that seed may persist in the soil. Beyond the initial 10 years, the aim of the program is to minimise weed invasion and re-invasion.

The weed management program should be conducted as follows:

- primary weed management to be conducted for up to ten weeks per year, for the first three years of weed management works;
- follow-up weed management to be conducted for up to three weeks per year, for the next five years; and
- weed maintenance to be conducted for up to two weeks per year for the remaining 12 years.

Any weed control works should target reproductive potential of each species and provide appropriately timed inspections and removal prior to seedset.

6.3.1 Primary Weed Management

Baseline Assessment and Treatment

Baseline field survey and review of available recent aerial photographs would be undertaken at commencement of the VMP to update the data presented in *Annex G* and to identify additional areas of weed infestation.

For each area of weed infestation a baseline assessment would be undertaken to provide a benchmark for measurement of success of treatment. Baseline survey would include the establishment of photo points and/or quantitative surveys. Quantitative surveys would be either plot based or transects and would be replicated in treated and untreated areas. Quantitative surveys would measure the density (number of plants per unit area) over different age classes where scattered or light weed populations or cover abundance for dense infestations. Priority native species as identified in the Bitou Bush

Threat Abatement Plan would also be identified. The presence or absence of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* or threatened flora species would be noted.

Other features such as size and shape of area to be treated, accessibility and topography should be noted.

The baseline assessment would identify target weed species and appropriate treatment regime (method of application, choice of herbicide, timing of treatment) and develop an operational plan for each infestation. Where flora species of conservation significance are present appropriate management measures would be identified to avoid impacts (eg no foliar spray to avoid spray drift). The treatment regime would identify benchmarks against which post treatment monitoring would be scored.

Primary weed removal will be undertaken within the first year of the VMP and is recommended to occur in winter. With herbicides such as glyphosphate and metsulfuron methyl, optimum treatment success is achieved in winter and this timing also has been proven to have less impact on native species. Where weed infestations are associated with waste dumps, weed removal would commence after waste removal. Treatment will commence in areas of low infestation using species appropriate treatment techniques as identified in *Section 6.2* and *Annex H*. Treatment would avoid disturbance of heavy weed infested areas during flowering or seeding. Where weed seeds and/or fruit are present in treatment areas these would be bagged and disposed off site.

All treatment and records of herbicide use would be logged and maintained for annual reporting.

Monitoring

A follow up inspection is to be undertaken at eight weeks and six months after treatment or prior to seed production. At both inspections, the treated and untreated replicate plots would be resurveyed noting the following:

- species presence and abundance;
- density in age classes (juvenile (under 50 cm tall) and mature plants) and/or flowering;
- photographic record;
- success of treatment (eg number of dead plants, regrowth, seedling recruitment);
- any adverse impacts on non-target species; and
- response of other weed species.

Monitoring would be undertaken by a suitably qualified contractor that is independent from the weed control contractor.

As a minimum 90% of weed coverage should be assessed as treated. It is anticipated that seedling population would have increased significantly at the end of year 1 and a benchmark of 40% reduction in mature plants is proposed for the end of primary treatment year 1.

All monitoring data would be logged and maintained for annual reporting. Monitoring data would provide the basis for planning of treatment for the next year. The annual report will re-evaluate the benchmark to provide realistic targets for treatment.

Monitoring would also provide data on condition and regeneration of native species. Natural regeneration of native plants will be encouraged in preference to active revegetation. This may not be possible in some areas especially if Bitou Bush has been established for a while. Decision to implement active regeneration (see *Section 10.12*) in some areas could be undertaken as determined during the monitoring. It is possible that the seed bank will be too severely depleted in some areas and the need for supplementary planting will be assessed after 12 months.

Years 2 and 3 of the VMP

It is anticipated that the primary weed treatment will be conducted over a ten week period in years 1, 2 and 3 of the VMP. Years 2 and 3 would build on the initial weed treatment, retreating areas that were treated in year 1 and any additional weed infestations noted at the six month inspection. The pre-treatment assessment outlined above would be repeated for each infestation and previous control programs noted.

At the end of the primary treatment period, all weed infestations as identified in this VMP and the baseline surveys will have been treated.

In addition to ongoing primary treatment, regular surveys will be required to identify any new infestations of weeds especially in areas near to major infestations of Bitou Bush and Mother-of-Millions, and along retained tracks. This will be undertaken annually in conjunction with waste inspections and weed removal works and will be concentrated along the main access tracks, formalised four-wheel drive track and in areas around heavy infestations of weeds.

6.3.2 Follow-Up Weed Management and Maintenance

Follow-up weed management would be conducted for up to three weeks per year, for years four to eight of the VMP using methodologies and monitoring program as identified in *Section 6.3.1* and as revised by the annual report.

It is anticipated that at the end of year eight of the program that there will be a significant reduction in coverage of mature weed plants for each area treated. The annual report will re-evaluate the benchmark to provide realistic targets for treatment.

Maintenance inspections and treatment will be undertaken annually (two weeks per year) to remove any seedlings for the life of the VMP.

Mechanisms identified in *Section 6.3.1* for pre treatment assessment and monitoring would continued to be implemented and or revised as identified in monitoring reports/reviews. This would be combined with regular surveys to identify any new infestations.

7 TRACK CLOSURE AND REHABILITATION

The VMP identifies tracks throughout the site and a program for rationalisation of existing tracks and the formalisation of the four-wheel drive access track along the northern boundary of the Worimi Regional Park lands. The aim of track rationalisation is to enhance habitat values by reducing uncontrolled access, reducing risk of weed spread, predator access and the fragmentation of habitats.

7.1 EXISTING TRACKS

The tracks within the Worimi Regional Park have been mapped using a hand held GPS and are shown in *Figure 5*.

One of the main tracks in the south west of the Worimi Regional Park lands is a concrete based road that was constructed to provide access from the former Rifle Range to the former Fern Bay Armour Plate Proofing Range. In the north east is another concrete based track that may have previously provided access for sand mining operations.

Along the western boundary is an access track, with deviations, under the electricity transmission line. Sections of this track have imported gravel to improve all weather access.

The remaining tracks are sand four wheel drive tracks created between the utility service track and concrete based track to provide access to the beach. Some of these tracks may be relict of previous land use. These tracks are used by uncontrolled recreational four wheel drive cars and bikes.

7.2 TRACK RATIONALISATION

An assessment of existing tracks was undertaken to identify which tracks should be maintained and which tracks should be closed. Tracks to be closed and rehabilitated are indicated on *Figure 6*. This assessment considered provision of formalised public access, heritage values, access for ongoing service of utility infrastructure, and rehabilitation requirements. The concrete and/or bitumen based road surfaces will not be removed.

Track closure will commence as soon as possible after waste removal and primary weeding. Track closure will be undertaken in consultation with DECC.

7.2.1 *Formalised Four-Wheel Drive Track*

Aspen Group will construct a formalised four-wheel drive track to the beach along the northern boundary of the Worimi Regional Park along the route

NELSON BAY ROAD

FERN BAY
SEASIDE VILLAGE

NEWCASTLE
GOLF
CLUB

POPPLEWELL ROAD

NAGLE CL

FERN
BAY

TASMAN

SEA

Legend

Worimi Regional Park

Existing Tracks

Figure 5

Existing Tracks within Worimi Regional Park

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_01		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
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Scale:	Refer to Scale Bar		

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agreed to in consultation with DECC and the Worimi Conservation Lands Board of Management (see *Figure 6*). For a large part of its length (approximately 1350 metres) the track is aligned along an existing four-wheel drive track thereby reducing vegetation clearance and soil disturbance.

The proposal includes construction of a class 3 walking track within Worimi Regional Park to the south of the four-wheel drive track. A vegetated buffer strip would be retained to provide for separation between the vehicular track and pedestrian access track.

The four-wheel drive track and pedestrian access will be fenced to minimise illegal access and provide safety. Fencing will include a bollard and wire fencing along the northern boundary of the track and around the car park to minimise vehicular access to the Worimi Regional Park.

The proposal also includes the construction of a parking area in Worimi Regional Park at the start of the four-wheel drive track, erection of appropriate signage and facilities at the car park as approved by DECC and the Board of Management.

In addition to the formalised four-wheel drive track, the proposal includes erection of bollard and wire fencing to restrict illegal access from the subdivision and the beach. Fencing would be erected along the eastern boundary of Fern Bay Seaside Village and Worimi State Recreation Area and along the eastern interface of active dune and vegetated area in Worimi Regional Park south to the Commonwealth land boundary (see *Figure 6*). The aim of the fencing is to limit vehicular access thereby facilitating rehabilitation of existing tracks, reducing opportunities for dumping of waste and spread of weeds.

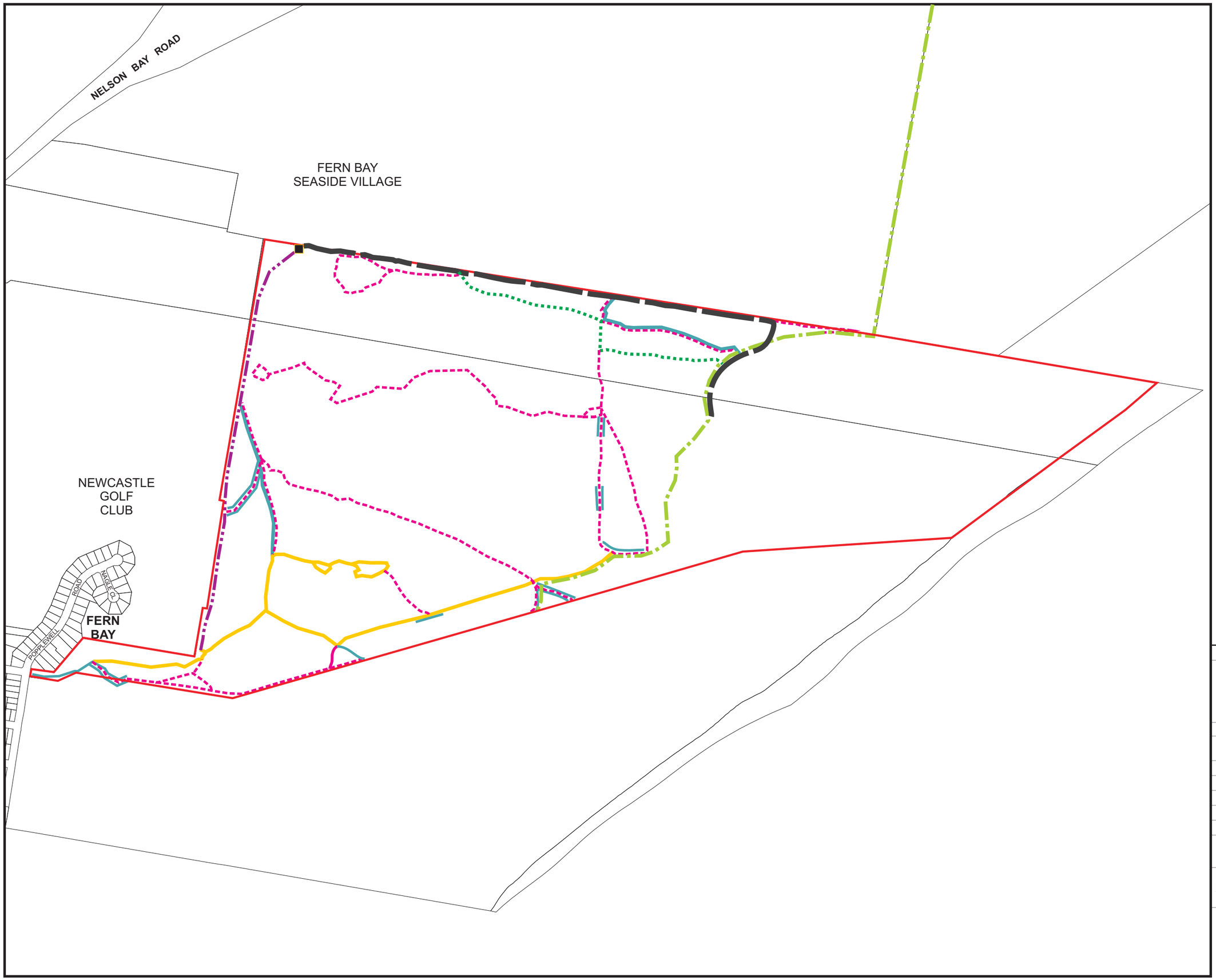
The final details of the track including fencing, car parking and signage will be addressed at the design and construction stage in consultation with DECC and the Board of Management. Construction of the four-wheel drive track, pedestrian track and fencing will be subject to the completion of and approval of a Review of Environmental Factors (REF) under Part 5 of the EP&A Act.

Construction of the four-wheel drive track, walking track and fencing has a high priority and will be completed within 12 months of the project plan approval.

7.2.2 *Access*

The main public access point to the dunes and Worimi Regional Park will be via the formalised four-wheel drive track to be constructed along the northern boundary.

The main access point will be controlled to restrict vehicle access and chronic impacts associated with this. Fencing and gates using 'bollard and cabling' structures are to be established to limit access. Access through this point to



Legend

- Worimi Regional Park
- Track to be Retained
- Utility Service Access
- Track to be Closed
- Track for Rehabilitation

Formalised Access:

- Four-wheel Drive Track
- Walking Track
- Bollard Fencing
- Car Park (approx. 20 x 20m)

Figure 6

Tracks to be Rehabilitated, Retained or Closed

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_02		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
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Scale:	Refer to Scale Bar		

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Worimi Regional Park is to be controlled and restricted to approved personnel and utility providers.

The four-wheel drive and car park would be inspected regularly to ensure that fencing and gates have not been damaged or removed and that unrestricted access is not occurring. Should there be any damaged maintenance is be carried out immediately. Maintenance will be the responsibility of the DECC.

Access to the park off Popplewell Road Fern Bay will be maintained for DECC management purposes only. Access by utility providers for maintenance of their infrastructure across the park, would be managed by the utility providers in consultation with DECC and the Board and this agreement is separate to the VMP.

7.2.3 Tracks to be Retained

A number of existing tracks have been identified as not for closure. In particular the concrete based track from the former Fern Bay Rifle Range to the heritage structures in the former Fern Bay Armour Plate Proofing Range. This track is part of the heritage values of the proofing range and should be retained.

Access would be retained along the southern boundary, with the Commonwealth land for fire fighting purposes. Access would also be retained along the electricity transmission line for utility supply contractors. This track would also provide access for fire fighting personnel and equipment. Large sections of the utility track under the electricity easement require rehabilitation and/or maintenance works to improve accessibility. This particularly applies to the steeper section over the dune where deviations have been previously formed. The section of this service track near the Fern Bay Seaside Village boundary needs to improve all weather accessibility to minimise impacts on the wetland to the west. The costs for maintenance and management of this track as a functional service track would need to be negotiated with the utility providers.

A review of the sections of existing track to be retained in the north west corner of the Worimi Regional Park would be undertaken at the design and construct phase and through the environmental assessment process for the formal four-wheel drive track.

7.2.4 Tracks to be Closed

A number of tracks will be closed. Those tracks or sections of tracks that will require active rehabilitation are identified in *Figure 6*. This is generally to control heavy infestations of Bitou Bush and prevent further degradation by illegal access on site. As a part of track closure and rehabilitation it is important to note that no soil or vegetation is to be sourced from the nearby Fern Bay development due to the risk of introducing weeds. Brush (cleared

shrubs and small trees) will be sourced from areas adjacent to the treatment area.

Those tracks on *Figure 6* without active rehabilitation indicated, are low usage narrow tracks and appear to be naturally regenerating with species from adjoining areas. Rehabilitation programme for these tracks will commence with closure of vehicle access using barriers such as brush matting sourced from the local area.

Rehabilitation of the tracks will be monitored every twelve months to assess percentage cover of native species and diversity of species noting presence of introduced species in particular weed species listed as noxious in Port Stephens LGA and/or as weeds of national significance.

Wider more heavily utilised tracks may require more active rehabilitation. Sections of the tracks, near the electricity line, where soil has been heavily compacted, may require physical ripping and spreading of brush. Ripping has the potential to encourage weed growth/seed germination within these areas. In many cases the native vegetation along the sections of track identified for active rehabilitation in *Figure 6* is currently heavily weed invested with Bitou Bush. This increases the requirement for weed management and maintenance to be integrated into the tracks rationalisation program. Weed management would be undertaken in accordance with the weed management program developed for the site.

7.3 PROGRAM FOR TRACK CLOSURE AND REHABILITATION WORKS

Track rationalisation would be timed to ensure access is available for primary waste and weed removal within the site. Track closure and rehabilitation should commence as soon as possible after primary waste and weed removal.

The program for rationalisation of all tracks would be determined based upon success of waste removal and weed management as determined by annual weed monitoring program. In addition, in year 1 of the VMP, a review of available aerial photography and an inspection of existing tracks would be undertaken to identify any additional tracks and to provide a condition assessment of the tracks post waste removal.

The program for track closure and rehabilitation will be developed in year 1 of the plan after the primary waste and weed removal identifying the:

- condition and type of track (eg sand track, compacted, eroded);
- methodology for closure, in particular whether ripping is required;
- weed management and maintenance regime; and
- timing.

The program would be developed by Aspen in consultation with DECC and the Board of Management. Track closure and rehabilitation works would be commenced in year 2 of the VMP or earlier where access is not required for waste and/or weed managment.

7.4 MAINTENANCE AND MONITORING

Monitoring of the success of track closure is to be undertaken on an annual basis in conjunction with weed and waste monitoring. Monitoring will assess percentage cover of native species and diversity of species noting presence of introduced species in particular weed species listed as noxious in Port Stephens LGA and/or as weeds of national significance.

Monthly access point assessments, as discussed in *Section 7.2.2*, would identify uncontrolled site access providing for the notification of impacts such as newly created tracks and track erosion. Scale of works and priority of maintenance works would also be identified.

Weed management and maintenance would be undertaken in accordance with the weed management and monitoring program developed for the site (see *Section 6.3*). The requirement for plantings within tracks will be assessed upon completion of and in conjunction with the weed removal programme. The need for revegetation will be assessed after 12 months of assisted natural regeneration ie weed control and/or in accordance with the track closure program.

8 WET HEATH REHABILITATION

The VMP describes the areas of wet heath in the Worimi Regional Park and identifies management measures to improve the habitat value of the wet heath such as weed management, track rationalisation and bush fire management.

8.1 DESCRIPTION OF WET HEATH

Four sections of vegetation previously mapped as wet heath by Clements *et al* (1992) (see *Annex C*) were verified during field investigation. The location of the wet heath was defined using aerial photograph interpretation and the boundaries were defined in the field using a GPS. The data was imported into the GIS and the heath areas mapped by ERM are shown in *Figure 7.*

Three sections of wet heath were mapped during the current survey. A fourth area previously mapped as wet heath by Clements *et al* (1992) was identified as Coastal Scrub or Coastal Sand Apple-Blackbutt open forest (see *Figure 7*).

8.2 HEATH SECTION 1: TOMAGO SAND SWAMP HEATH

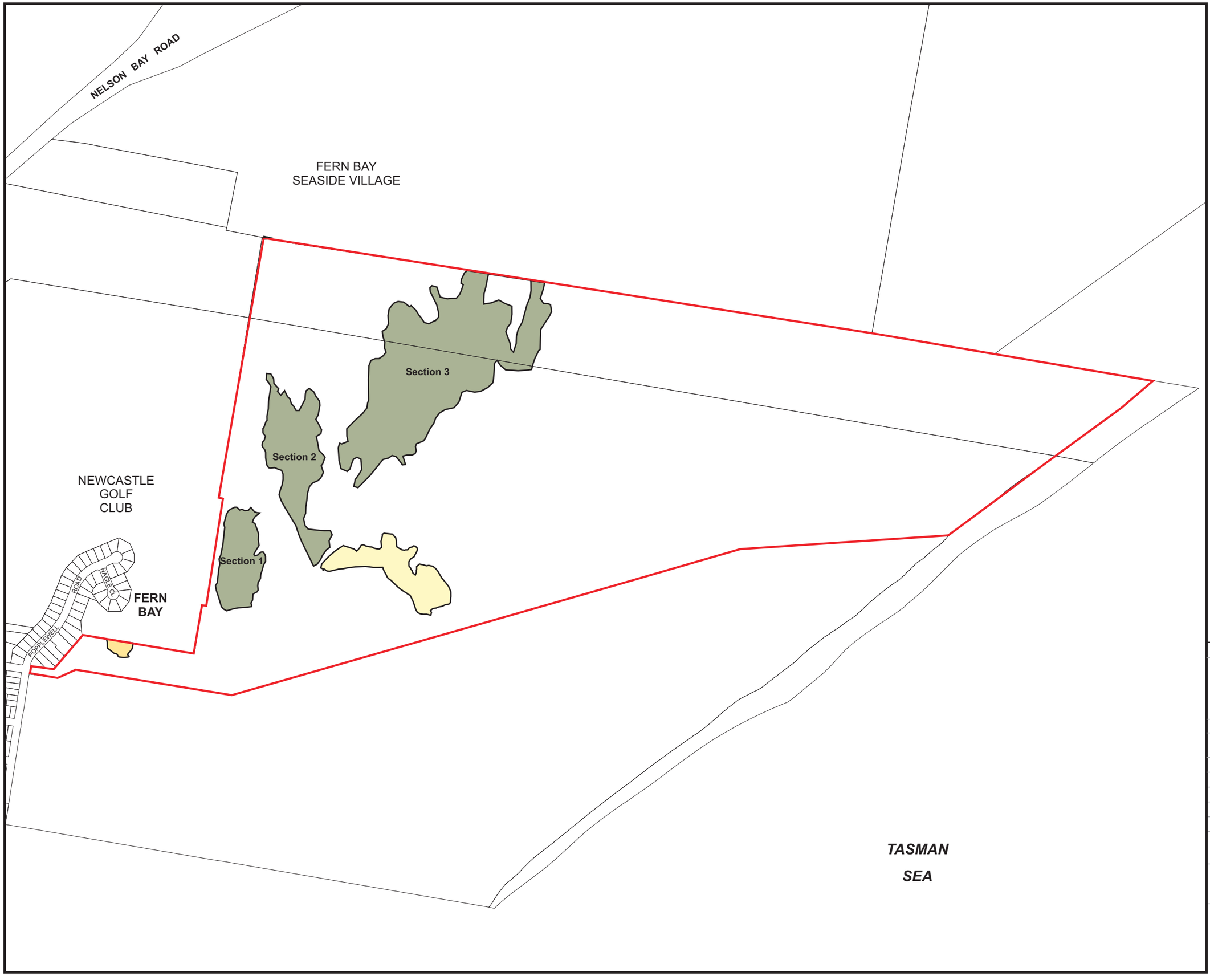
8.2.1 Description

The boundaries and description of Section 1 of wet heath was consistent with Clements *et al* (1992) mapping. The overstorey stratum comprised emergent *Banksia serrata* to a height of five metres. The dominant stratum is the shrub layer which is dominated by *Melaleuca nodosa* and *Leptospermum laevigatum* to 2.5 metres with *Dillwynia retorta.* The twiner *Cassytha pubescens* covers large areas of the shrub strata. In the north western corner of the heath dominant species included *Banksia serrata, Acacia longifolia* with *Pteridium esculentum* and *Lomandra longifolia* in the understorey.

There are six records (approximately 15 individuals) of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* identified in this area of wet heath (ERM 2007). A number of these individuals had been burnt in 2006 and/or were juveniles (ERM 2007).

The wet heath is representative of Tomago Sand Swamp Heath as described in the Lower Hunter Central Coast Regional Environmental Management Strategy (LHCCREMS) classification (NPWS 2000b).

Where the wet heath borders the electricity transmission line easement, a low to moderate occurrence of weed species was noted, concentrated along the track with isolated occurrences up to 20 metres from the track (see *Figure 4*). One car body was identified on the northern boundary of this heath.



Legend

- Worimi Regional Park
- Wet Heath

Areas previously mapped as wet heath now identified as:

- Coastal Scrub
- Coastal Sand Apple Blackbutt Forest

Figure 7

Wet Heath Mapping on Worimi Regional Park

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_03		
Date:	10/02/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

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8.2.2 Rehabilitation Program

There is potential for successful rehabilitation of the wet heath in this section. It is recommended that weeds be hand pulled from the centre of the site and removed via the cut and paint method from the heath boundary. A car body and tyres were identified beside the electricity transmission line easement access track and can be removed without disturbing the heath.

There are no tracks traversing this area of wet heath and the tracks either side will be retained to provide access for fire fighting and utility services.

Eucalyptus parramattensis subsp *decadens* x *E. robusta* individuals within this section of heath will be identified in the field and fenced where required to protect them from damage during waste and weed removal. More details on protecting this species are provided in *Section 10.10.2*.

Waste removal should be conducted prior to weed removal to ensure any weed spread by vehicles is eliminated. Given the small amount of waste in this section of heath, removal can be expected to take one week. With weed removal and follow up waste and weed management works subject to the timetable outlined in *Section 6.3.*

8.2.3 Monitoring

Monitoring will be undertaken annually in conjunction with the ongoing weed management activity to assess revegetation and monitor weed management progress as identified in *Section 6.3*. Photo points and quantitative plots/transect sites are to be established at designated locations including treated and control replicates.

Monitoring will also assess the response of the population of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* including number of individuals and recruitment. More details on monitoring this species are provided in *Section 10.10.2*.

8.3 HEATH SECTION 2: TOMAGO SAND SWAMP WOODLAND

8.3.1 Description

Section 2 is located to the east of the electricity transmission line. The boundaries and description of Section 2 of wet heath was consistent with Clements *et al* (1992) mapping. Dominant flora within this heath includes *Leptospermum polygalifolium* and *Melaleuca nodosa* and occasional emergent *Banksia serrata* to eight metres. The lower stratum was dominated by *Pteridium esculentum*.

There are four records (approximately 25 individuals) of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* identified in this area of wet heath (ERM 2007). A number of these individuals had been burnt in 2006 (ERM 2007).

There is a minor interconnecting track passing through the middle of the heath however there appears to be no rubbish dumping or weeds associated with this access point. There was a lack of weeds noted in this section of wet heath during inspection and this is likely to be a result of previous fire and reduced access and therefore disturbance.

A large amount of rubbish dumping was observed around the edges of the heath (see *Figure 3*). In particular, barbed wire coils were scattered throughout the southern half of the heath. Car bodies, sheets of galvanised iron and other building materials were also encountered along the heath boundaries. The southern section of this heath supported potential asbestos material (see *Figure 3*). This waste will need to be handled by a waste contractor licensed to handle asbestos.

8.3.2 Rehabilitation Program

Given that the majority of disturbance is associated with the edges of this section of wet heath it is considered that there is a high potential for successful rehabilitation of the wet heath in this section.

Eucalyptus parramattensis subsp *decadens* x *E. robusta* individuals within this section of heath will be identified in the field to protect them from damage during waste (in particular waypoints 82, 83 and 84) and weed removal.

Waste removal should be conducted prior to weed removal to ensure any weed spread by vehicles is eliminated. Waste removal and management for this area would be undertaken in accordance with the procedures developed for the park as outlined in *Section 7.3* and *Section 7.4.* The weed removal and maintenance works for this section of wet heath would be subject to the timetable outlined in *Section 6.3*.

All waste should be removed unless DECC staff advise that the potential impacts from removal would be unacceptable.

The minor interconnecting track through the heath is expected to naturally regenerate when access is blocked at the western junction. It should be noted that there is no weed invasion and minimal rubbish dumping along this track (waypoint 82) within the wet heath. However determination of timing of the closure may need to be delayed until an assessment is made of the best access route to remove waste associated with this track to the east of the heath. This would need to be determined by the approved contractor responsible for the works and the waste contractor in consultation with DECC. Access to waste occurring within this section of heath and along the minor track may be restricted to four-wheel motorbikes to minimise damage to the track.

8.3.3 Monitoring

Monitoring will be undertaken annually in conjunction with the ongoing weed management activity to assess revegetation and monitor weed management progress as identified in *Section 6.3*. Photo points and quantitative plots/transect sites are to be established at designated locations including treated and control replicates.

Monitoring will also assess the response of the population of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* including number of individuals and recruitment. More details on monitoring this species are provided in *Section 10.10.2*.

8.4 HEATH SECTION 3: TOMAGO SAND SWAMP WOODLAND

8.4.1 Description

The largest section of heath in the northern portion of the Worimi Regional Park is relatively intact. Eleven records (approximately 28 individuals) of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* have been identified in this area of wet heath. The community exhibited a high regeneration of native species post fire with isolated overstorey species of *Angophora costata* and *Eucalyptus pilularis*. The dense midstorey comprised *Leptospermum polygalifolium* and groundcover comprised *Pteridium esculentum* and *Restio* species. This community is consistent with Tomago Sand Swamp Heath with elements of woodland scattered throughout this heath community. In the lower lying areas of the heath *Eucalyptus robusta* occurred as isolated individuals. Other less common species included *Actinotus helianthi, Banksia serrata* and *Blechnum camfieldii.*

Bitou Bush was not encountered during the mapping of this community with disturbance limited to waste dumping and extensive fire. The absence of Bitou Bush may be an artefact of the recent fire and will need to be reassessed. A number of car bodies, galvanised iron sheeting and coils of barbed wire were concentrated on the north eastern boundary and south western boundary (see *Figure 3*). Potential asbestos material was identified in the south western corner of the heath. Removal of this material will need to be undertaken by a licensed asbestos waste contractor.

There is a minor track through the middle of this section of heath. There was no waste or weed invasion noted along the track. The four-wheel drive track through the northern boundaries of the wet heath will be formalised.

8.4.2 Rehabilitation Program

Given that the majority of disturbance is associated with the edges of this section of wet heath it is considered that there is a high potential for successful rehabilitation of the wet heath in this section.

Eucalyptus parramattensis subsp *decadens* x *E. robusta* individuals within this section of heath do not occur near any areas of waste or weed identified during site investigations. The locations of individual may need to be identified in the field to protect them from damage during any future works.

There is only one car body identified in the northern section of the heath (waypoint 67) with other areas of waste occurring at the southern tip (waypoints 26, 68 and 69). Waste should be removed prior to weed removal to ensure any weed spread by vehicles is eliminated. Waste removal and management for this area would be undertaken in accordance with the procedures developed for the park as outlined in *Section 7.3* and *Section 7.4.* The weed removal and maintenance works for this section of wet heath would be subject to the timetable outlined in *Section 6.3*.

The minor interconnecting track through the heath is expected to natural regenerate when access is blocked at the western and eastern junctions. It should be noted that there is no weed invasion and or rubbish dumping along this track within the wet heath or beyond it to the east. Therefore, closure of this track could be scheduled early in the program.

8.4.3 Maintenance and Monitoring

Monitoring and maintenance will be undertaken annually in conjunction with the ongoing weed management activity as defined in the VMP, to assess revegetation along the track and success of revegetation and monitor weed management progress where treatement applied. Monitoring would be undertaken using methodologies as identified in *Section 6.3* including establishment of photo points and/or quantitative plots/transect sites at designated locations.

At this stage, it is envisaged that management works are not in the vicinity of any identified individuals of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta.* Therefore monitoring of impact (positive or negative) on this species is not required for this area at this stage. This may be revised with review of the VMP. Further, the locations of individual occurrences of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* will be identified and the plants protected prior to the commcement of any works associated with the construction of the four-wheel drive track and associated walking track.

8.5 AREAS PREVIOUSLY MAPPED AS HEATH

8.5.1 Coastal Sand Apple-Blackbutt Forest

The previously mapped wet heath surveyed in the south western corner of the Worimi Regional Park supported a moderate to high density of weed species dominated by Bitou Bush. No waste was evident in this section of open forest. This previously disturbed area has regrowth dominated by scattered *Angophora costata* with *Banksia serrata* and *Leptospermum laevigatum.* The community is defined by LHCCREMS mapping as Coastal Sand Apple-Blackbutt open forest (NPWS 2000b, House 2003).

Rehabilitation Program

Rehabilitation works would concentrate on removal of Bitou Bush and other weed species. No waste was evident within this section of the site.

Monitoring and Maintenance

Follow up monitoring and maintenance will be undertaken annually in conjunction with the ongoing weed management activity for the entire park to assess revegetation and monitor weed management progress.

8.5.2 Coastal Scrub

An area of coastal scrub previously mapped as wet heath (see *Annex C Figure C.1*) was identified in the eastern extent of the Worimi Regional Park. The midstorey was dominated by *Leptospermum laevigatum* and scattered occurrences of *Acacia binervia* with *Banksia serrata* emergents. Bitou Bush was scattered throughout the scrub. No rubbish was observed in this section of land. Groundcover was sparse supporting *Dianella carulea, Chloris ventricosa* and *Panicum simile.*

An additional section of coastal scrub not previously mapped was surveyed east of heath section 2 (see *Figure 7)*. This community was dominated by *Leptospermum laevigatum* with less frequent occurrences of *Acacia suaveolens, Acacia ulicifolia, Monotoca ellipticum* and *Acacia longifolia.* Groundcover comprised *Themeda australis, Pteridium esculentum, Wahlenbergia communis* and *Endiandra sieberi.*

This area is close to the former Fern Bay Armour Plate Proofing Range and there is significant weed (waypoint 25, 26, 27, 28 and 9) and waste material within the western half.

Rehabilitation Program

Rehabilitation works would concentrate on removal of Bitou Bush and other weed species associated with the waste near the former proofing range.

Waste removal should be conducted prior to weed removal to ensure any weed spread by vehicles is eliminated. Waste removal and management for this area would be undertaken in accordance with the procedures developed for the park as outlined in *Section 7.3* and *Section 7.4*. The weed removal and maintenance works for this section of wet heath would be subject to the timetable outlined in *Section 6.3*.

The concrete roads will not be removed. However it is proposed that the sand track to the east of the range will be closed at both ends to restrict access. This track does not traverse the scrub community.

Maintenance and Monitoring

Maintenance and monitoring of the rehabilitation of the wet heath would be undertaken in accordance with the methodologies identified for the entire park.

9 RELATIONSHIP TO OTHER MANAGEMENT PLANS FOR THE WORIMI CONSERVATION LANDS

9.1 BUSH FIRE MANAGEMENT

In accordance with the guidelines for bush fire prone land mapping the Worimi Regional Park is identified as Category 1 bushfire prone land in recognition of the land use and management regime (NSW Rural Fire Service 2004). With regard to bush fire management, Section 63 of the *Rural Fires Act, 1997* states that:

> *(1) It is the duty of a public authority to take the notified steps (if any) and any other practicable steps to prevent the occurrence of bush fires on, and to minimise the danger of the spread of a bush fire on or from:*
>
> *(a) any land vested in or under its control or management, or*
>
> *(b) any highway, road, street, land or thoroughfare, the maintenance of which is charged on the authority.*
>
> *(2) It is the duty of the owner or occupier of land to take the notified steps (if any) and any other practicable steps to prevent the occurrence of bush fires on, and to minimise the danger of the spread of bush fires on or from, that land..*

DECC as managers of the park have a responsibility to manage fire and its effects on the cultural and environmental assets of the Worimi Regional Park and to protect life and neighbouring properties in Fern Bay Seaside Village to the north and Fern Bay to the west.

A Reserve Fire Management Strategy (RFMS) is to be prepared for the overall Worimi Conservation Lands (including this section of the Worimi Regional Park). The RFMS is to be developed by DECC in accordance with the requirements of the NSW *Rural Fires Act 1997* and the *EP&A Act* 1979.

The RFMS should address the implementation of appropriate fire regimes for the flora and fauna species and vegetation communities within the Worimi Regional Park lands, while managing risks to property and safety within the area.

This VMP identifies broad management considerations as relates to access. The VMP does not aim to provide specific recommendations with regard to hazard reduction management. DECC would be responsible for implementation of fire management measures in the Worimi Regional Park.

Development of the Fern Bay Seaside Village incorporates bush fire management measures within the boundaries of the development in accordance with the relevant legislation and Planning for Bush Fire Protection 2006 (previously Planning for Bushfire Protection (NSW Rural Fire Service 2001)). Asset protection zones are provided within the Fern Bay Seaside

Village property between residential developments and any potential hazards retained within the development and/or associated with the adjoining Worimi Regional Park.

Within Fern Bay Seaside Village as it is developed perimeter roads will be constructed to provide ready access for fire fighting personnel and equipment to the hazard interface.

In addition, in keeping with DECC's responsibility to manage fire on its land, there are a number of tracks that may be available for access for fire fighting equipment and personnel within the Worimi Regional Park. These include the proposed formalised four-wheel drive track, the electricity easement track and the access track along the southern property boundary.

The access track under the electricity easement provides access for managing fire spread to or from the properties to the west of the park including the golf course and/or residential areas off Popplewell Road Fern Bay. The access track retained along the southern boundary with the Commonwealth land would also provide access for fire fighting personnel and equipment.

Fires in the Worimi Regional Park are expected to be largely as a result of arson or activities associated with uncontrolled access. Controlling access is crucial for managing the frequency of fires in the park. There is currently an access control point off Popplewell Road, Fern Bay. Control of access on the northern boundary will not be provided until the formalised four-wheel drive track is constructed.

Fire is an important factor in the ecology of many plant communities. An important factor to be considered in bush fire management of the Worimi Regional Parks is the frequency of fires and interval between recurrent fires. The vegetation communities present on site were classified into broad fuel groups in line with the Bush Fire Environmental Assessment Code as dry sclerophyll forests (shrubby subformation) and heathlands. These communities have a prescribed minimum fire interval of seven to ten years (NSW Rural Fire Service 2006b).

Survival of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* in Worimi Regional Park is threatened by too high fire frequency. The Environmental Assessment Code's Threatened Species Hazard Reduction List identifies that *Eucalyptus parramattensis* subsp *decadens* requires that there is no fire more than once every seven years. A large number of the individuals surveyed in January 2007 had been burnt recently. Frequency of fire for this species and the communities would need to be managed to reduce high intensity fires until 2012 especially in the sections of heath.

All hazard reduction management works within the Worimi Regional Park would be undertaken in accordance with the Worimi Conservation Lands RFMS.

9.2 VERTEBRATE PEST MANAGEMENT

The Worimi Regional Park lands are known to support feral animals including foxes, wild dogs, cats and rabbits. Impacts associated with these species would include predation on native fauna species by dogs, foxes and cats and impacts on native vegetation due to rabbits including damage to native flora as a result of feeding and erosion and ground instability associated with rabbit warrens. If left unmanaged these species can potentially affect the viability of native fauna populations and damage the natural integrity of native plant communities within the site Worimi Regional Park.

Any vertebrate pest management works within the Worimi Regional Park Lands should be conducted in accordance with feral animal management works currently being undertaken within the Port Stephens area by Port Stephens Council and DECC.

The subdivision at Fern Bay Seaside Village is a potential source of vertebrate pests such as cats and dogs within the Worimi Regional Park Lands. To manage this source of potential feral animals residents should be educated on their responsibilities with regard to the management and control of pets and should act in accordance with the Port Stephens Companion Animal Management Plan (2005).

Signage will be designed in consultation with DECC and erected in the estate, at the start of the four-wheel drive track and at intervals along the boundary of the Worimi Regional Park. The signs will highlight the conservation values and goals of the Worimi Conservation Lands and promote control of pets in particular measures such as keeping cats indoors at night and not feeding native animals.

10 PROCEDURES AND RESPONSIBILITIES

10.1 ORDER OF REHABILITATION WORKS

Rehabilitation works are to be undertaken in the following order to ensure minimal weed seed transfer and allow for full rehabilitation of the Worimi Regional Park:

- removal of all waste along roads and within accessible heath;
- removal or control of all weeds; and
- closure and rehabilitation of tracks as soon as possible after primary weed removal.

Aspen propose to construct the formalised four wheel drive track and erect the fencing concurrently within the first 12 months of project approval.

10.2 RESPONSIBILITIES

As discussed in *Section 1.7* Aspen will have primary responsibility for implementation of the VMP for the first five years in consultation with DECC. DECC, who inturn are required to consult with the Board, will have a role in monitoring and briefing of contractors to ensure that the contracts and works meet DECC standards and are consistent with the Worimi Conservation Lands Lease Agreement. Responsibility for implementing the VMP in years 6 to 20 will transfer to DECC.

Throughout the plan, engagement of suitable contractors is to consider members of the local Aboriginal community to facilitate ownership of the Worimi Regional Park.

Funding for the duration of the management period (20 years) is to be provided by Aspen.

10.3 SITE INDUCTION RESPONSIBILITIES

The Site Representative is responsible for ensuring that all persons involved in the rehabilitation works and waste removal are given a site induction prior to the commencement of work on site.

The site induction is to cover the following issues:

- the requirements of this management plan;
- Aboriginal cultural heritage;

- European heritage;
- management of threatened species and species of conservation significance, in particular *Eucalyptus parramattensis* subsp *decadens* x *E. robusta*; and
- all persons working within the site are responsible for taking appropriate action to prevent and control the spread of noxious weeds, undertake appropriate waste removal and track rehabilitation in accordance with this Plan.

A record of all inductions and retraining, including the name and date completed is to be prepared by the Site Representative (or nominated representative). The Site Representative is responsible for ensuring that retraining sessions are provided for all persons working within the area within one week of any changes to procedures.

10.4 OCCUPATIONAL HEALTH AND SAFETY

All contractors are to be appropriately trained. A hazard assessment is to be carried out by all personnel prior to entering the Worimi Regional Park and implemented. This would include the use of appropriate personal protective equipment and ensure the contractors are aware of risks.

The removal of waste including potential hazard materials (asbestos or synthetic fibre material) should be undertaken by licensed contractors. As discussed in *Section 5.2* and *Annex D*, removal of waste and disposal shall be carried out in accordance with the Occupational Health and Safety Regulations 2001 and in accordance with the relevant codes of practices.

10.5 CONTACTS

Port Stephens Council
116 Adelaide Street, Raymond Terrace NSW 2324

Senior Weeds Officer/Pest Manager - Graham Prichard
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mobile: 0408 673 093
Email: graham.prichard@portstephens.nsw.gov.au

Department of Environment and Climate Change:

Planning Officer – Adam Faulkner
ph (02) 4984 8204
Email: Adam.Faulkner@environment.nsw.gov.au

Senior Ranger Pest
ph (02) 4984 8200

Hunter Coast Area Manager
ph (02) 4984 8200

Conservation Planning Officer
ph (02) 4908 6829

10.6 MONITORING AND REPORTING

Monitoring reports for the weed, waste and track rehabilitation will be prepared annually and provided to the Site Representative for review by the DECC. At that time all milestones and targets will be reviewed to assess progress.

The monitoring methodology in the VMP is based upon a review of available literature for Bitou Bush control including DECC's Bitou Bush Threat Abatement Plan. DECC are currently developing and testing monitoring methodology for the Bitou Bush Threat Abatement Plan. When available the methodology proposed in this VMP would be reviewed if required.

The Site Representative will ensure that any weeds or waste found within the Worimi Regional Park lands at this time are controlled and disposed of in accordance with recognised techniques. Rehabilitation measures will be monitored to ascertain whether active rehabilitation and bush regeneration techniques are required.

The main objective of the VMP is to improve the condition of the wet heath as an offset for development of the neighbouring Fern Bay Seaside Village. Rehabilitation works will include the removal of weeds and waste from Worimi Regional Park land and rehabilitation of tracks. Performance indicators for each of the offsets are provided in *Table 10.1*.

Table 10.1 Performance Indicators

Objective	Action	Timeframe	Performance Indicator	Secondary Action
Formalisation of beach access	Review of Environmental Factors completed and approved. Construction of the 4WD access track and associated infrastructure.	Within first 12 months.	• constructed in accordance with plans and used for designated purpose.	• repair of breaks in fence; • monitor access track for rubbish dumping and weed dispersal.
Improve condition of wet heath	Remove waste, manage weeds, close tracks through wet heath.	• initial treatment <12 months; • primary treatment for first 3 years; and • monitor and manage issues (waste dumping, weed reoccurrence) annually for 20 years.	• weeds are not being established; • tracks are naturally regenerating; and • waste is removed to the satisfaction of DECC.	• monitor wet heath for illegal dumping, track use and weed dispersal. • if natural regeneration is not occurring employ assisted regeneration techniques (see *Section 10.12*).
Protection of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta*	• identification of individuals in the field; • temporary fencing while working in the immediate area; and • manage bush fire frequency.	• initial treatment (weed and waste removal) of surrounding areas within first 12 months; • primary treatment of weeds for first 3 years; and • monitor annually for 20 years.	• population persists in park; and • evidence of recruitment.	• amend management measures as required.
Weed removal	• remove large infestations of noxious weeds and WONS; • reduce recruitment of weed seeds	• initial treatment <12 months; • primary treatment for first 3 years; and • monitor and treat reoccurrence annually for 20 years.	• mature weeds are not being established; and • visible reduction in cover of weeds and recruitment rates.	• repeated removal/control techniques are applied.
Waste removal	Remove all identified waste where accessible	• initial treatment <6 months; and • monitor annually.	• waste has been removed to the satisfaction of DECC; and • no additional dumping has occurred.	• monitor accessible areas for illegal dumping.

Objective	Action	Timeframe	Performance Indicator	Secondary Action
Rehabilitation of tracks	Close/rehabilitate identified tracks	• condition assessment and development of track closure program in year 1; • close tracks not required for access for waste and/or weed removal in year 1; • closure as soon as possible after waste removal and after first round of primary weed treatment, to commence in year 2 of the plan; and • monitor annually.	• closure of tracks, prohibits illegal use of tracks; • natural regeneration of native vegetation along tracks in cover and abundance; and • tracks closed. No use of illegal tracks.	• if not naturally regenerating assisted regeneration will be conducted using native seed collected on site.

10.7 REVIEW OF THE VMP

This VMP will be reviewed annually by suitably qualified persons in consultation with DECC, the Worimi Conservation Lands Board of Management and the contractors to determine the efficacy of the plan and schedule of works. In this way the document will become flexible.

Independent audit should be conducted at the following intervals:

- within three years of commencement of works;
- at 4.5 years (prior to hand over of responsibility of implementation of VMP from Aspen to DECC);
- at year 8; and
- then every four years thereafter (year 12, year 16 and year 20).

The audit shall review project design and technical briefs, monitoring results and schedule and include an assessment of adequacy of the plan.

10.8 HERITAGE SITES

To preserve cultural heritage values of the site it is recognised that it is illegal to remove, disturb or destroy any archaeological site or material. Care shall be practiced when removing waste material from the identified heritage sites associated with the Fern Bay Armour Plate Proofing Range (see *Annex D* and *Annex E*).

Any works that invoke disturbance to existing soils shall be monitored by representatives of the local Aboriginal community.

10.9 PROTECTION OF FLORA AND FAUNA

All works on site shall protect flora and fauna through implementation of the following measures:

- firearms not permitted in work site;
- dogs and other domestic animals are not permitted;
- all native fauna are protected and shall not be unnecessarily disturbed;
- feeding of native animals is prohibited;
- picking or possession of native plants is prohibited unless by authorised contractors; and,
- movement of vehicles restricted to existing access tracks.

10.10 PROTECTION OF THREATENED SPECIES

10.10.1 Management and Protection of Threatened Species

As works described do not require the removal of ecologically mature trees, fallen dead timber or areas of native vegetation that may provide habitat for threatened species, it is anticipated that the Plan should not disturb any threatened species or their habitat. The following strategies are to be adopted to ensure threatened species are not affected by the management works:

- care should be taken to ensure that areas of native vegetation are not disturbed during waste removal activity;
- any identified threatened species or habitats should be clearly marked on site prior to any rubbish removal or weed management activities being undertaken within the vicinity of that species or habitat. Where appropriate, sensitive areas should be cordoned off with safety fencing to ensure threatened species or habitats are not affected.
- vehicles are to remain on site roads and tracks at all times and personnel are to use tracks wherever possible to avoid disturbing native vegetation; and
- should any threatened species be identified the species location should be recorded and marked.

Any threatened species identified during works will be located and protected from disturbance. Any unknown flora identified during the works will be collected and sent to the herbarium for identification subject to DECC granting a permit where appropriate.

10.10.2 Eucalyptus parramattensis subsp decadens x E. robusta

As discussed in *Section 4.7.2* hybrids of the threatened *Eucalyptus parramattensis* subsp *decadens* have been identified in wet heath and low lying deflated swales in the dune forest in Worimi Regional Park. Further taxonomic investigations of flowering specimens collected in June 2008 have been identified as *Eucalyptus parramattensis* subsp *decadens* x *E. robusta*. This species is not listed as threatened under State or Commonwealth legislation but is considered to have a very high conservation value.

A number of species specific management measures have been discussed throughout the VMP and are summarised here. These measures have been designed with consideration of the threatening processes as identified for *Eucalyptus parramattensis* subsp *decadens* in Bell (2006):

- rubbish dumping;

- weed invasion (in particular Bitou Bush and Lantana);
- high frequency fire over a long period;
- indiscriminate logging and clearing;
- habitat loss and fragmentation from developments such as sand mining, road construction and residential development; and
- modification of drainage regimes through draining, filling and groundwater use (Bell 2006, DECC NSW threatened species website).

Inductions for rehabilitation and waste contractors will include educational material on *Eucalyptus parramattensis* subsp. *decadens* x *E. robusta* including a photograph, description of this species and a summary of species specific management measures.

As discussed in *Sections 8.2*, *8.3* and *8.4*, the known locations of *Eucalyptus parramattensis* subsp. *decadens* x *E. robusta* are to be protected in the wet heath during waste and weed removal works. Prior to conducting waste removal and weed treatment the record database will be checked to identify whether individuals are in the immediate area, if so these are to be marked and fenced to protect them. If no records in the immediate area an inspection of the area will be conducted to identify any sightings noting the form and number of individuals.

Protection of individuals will include erection of temporary fencing during works. Fencing type will be selected in consultation with DECC and will be dependent on works proposed and anticipated extent of disturbance with consideration given to the location of individuals relative to the works.

Monitoring of the impact of waste removal and success of weed treatments should target whether this species has been adversely impacted and this should be noted in annual reports. Where there is an adverse impact on the species seed collection would be undertaken (see *Section 10.12.2* for further details).

The works proposed in the Worimi Regional Park are not anticipated to impact on this species through logging, clearing, habitat fragmentation or modifications of drainage regimes. As discussed in *Section 9.1* survival of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* in Worimi Regional Park is threatened by too high fire frequency. The Environmental Assessment Code's Threatened Species Hazard Reduction List identifies that this species requires that there is no fire more than once every seven years. A large number of the individuals surveyed in January 2007 had been burnt recently. Frequency of fire for this species and the communities would need to be managed to reduce high intensity fires until 2012 especially in the sections of heath. Bush fire management of this species would be addressed in the

Worimi Conservation Lands Reserve Fire Management Strategy being developed by DECC.

Through the incorporation of management measures with respect to weeds, rubbish dumping and fire management, as outlined within this VMP, it is considered that the VMP would reduce threatening processes thereby enhancing habitat value of the area for this species.

10.11 WEED WASTE TREATMENT

Herbicide treated dead Bitou Bush will be trampled and left in situ to protect the dune from erosion and provide protection for seedlings. All seed material if possible should be removed.

Where debris from weeds or invasive species (eg Lantana) is likely to self propagate then the debris will be removed to a local landfill or treated to prevent propagation.

All waste material from contractors is to be removed from site.

10.12 BUSH REHABILITATION

10.12.1 Principles of Regeneration

The approach to regeneration is to encourage natural regeneration rather than active planting however direct planting may be required where natural regeneration is not occurring. The decision to commence any active planting should be based on an analysis of the progress of the natural regeneration through analysis of photo points or transect data. In all cases appropriate time must be given for areas to achieve natural regeneration.

The following principles of regeneration and reconstruction should be applied to the restoration of the site:

- re-establish native vegetation cover as required after earthworks for the formalised four-wheel drive track;
- apply the minimum intervention necessary for success;
- carefully assess potential for natural regeneration prior to determining whether an active regeneration or reconstruction approach is necessary;
- planting and or direct seeding may be necessary for establishing indigenous vegetation where regeneration potential is severely depleted;

- collection of seed and vegetative material from either site to be grown for use in active restoration and reconstructive landscaping;

- commencement of weed control and regeneration in areas of natural bushland; and,

- engagement of approved bushland regeneration contractors.

10.12.2 Species Selection and Seed Collection

Rehabilitation areas should be seeded with local provenance seed. The species utilised in revegetation and landscaping along the four-wheel drive track, will be dependent on the vegetation community present and/or likely to be present and local conditions.

Seed stock and vegetative material will be collected from native species present on the site (this will maximise the recreation of as much of the structural and floristic diversity present in the original vegetation). It is important that seeds and vegetative material are collected from healthy, vigorous plants. Similar quantities of seeds will be collected from several well-spaced plants to encourage genetic diversity.

DECC advises that seed collectors:

- need to be licensed either under *National Parks and Wildlife Act 1974* or under *Threatened Species Conservation Act 1997*;

- should be experienced;

- should adhere to the FloraBank: Model Code of Practice for Community-based Collectors and Suppliers of Native Plan Seed; and

- protocols must be in accordance with the best practice measures and specifications outlined in the Flora Bank Guidelines (1998-2000, http://www.florabank.org.au/default.asp?V DOC 113.755:) and the collection of seed, vegetative material and the translocation of sods should also be in accordance with the following National accepted guidelines:

    - Germplasm Conservation Guidelines for Australia –Germplasm Working Group 1997; and

    - Vallee *et al* 2004 Guidelines for the Translocation of Threatened Plants in Australia.

If seed collection and propagation of material is required it is likely that this would occur following primary weeding and monitoring. A registered seed collector and/or bush regenerator would be engaged to collect seed and vegetative material and to propagate the same. Material would need to be collected over a number of seasons.

10.12.3 Watering

Watering will only be required if natural regeneration techniques are not considered adequate and assisted regeneration is required. At least three watering events will be required in the initial stages of rehabilitation works. Deep watering is required to encourage deep root system that can withstand dry periods. The number of watering events may change depending on prevailing weather conditions.

10.12.4 Weed Removal

The following weed control measures should be employed:

- weed removal and construction work should be avoided during wet weather;
- no vehicles or machinery used in weed affected areas are permitted to enter the Worimi Regional Park lands unless all soil and plant matter has been removed from the vehicles and machinery;
- the method selected for controlling and disposing of weeds depends on the characteristics and densities of the weed species. Only recognised techniques for weed control and disposal must be applied. Recognised techniques for the control and disposal of weeds are included in *Annex G* and *Annex H*; and,
- removed weeds must be appropriately disposed.

Once weeds are removed competition for light, water and nutrients is lowered and native plants may naturally establish from the soil seed bank. Natural regeneration is an effective management technique in areas of natural bushland that are likely to regenerate when weeds are removed.

10.13 COST ESTIMATES

The following assumptions have been made regarding the costs to undertake rehabilitation of the Worimi Regional Park lands:

- total weed affected area of the site is 20 hectares; and
- follow up action will aim for up to 100% reduction in the total weed affected area.

It should be noted that the costs will be based on assumptions that may change according to the amount of waste estimated and the success of weed control measures.

Cost estimates are provided under a separate cover and will be finalised when the extent of work and materials required is determined.

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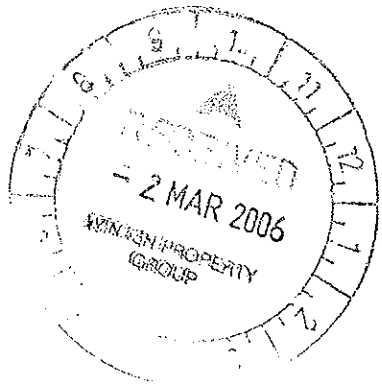
Annex A

DECC Correspondence

Department of
Environment and Conservation (NSW)

Your reference :
Our reference : DOC06/03496.bd.02/04865
Contact : Brendan Diacono 6659 8220
Date : 24 February 2006
27

Mr B Sarkis
Winten Property Group
PO Box 55
Cammeray NSW 2062
DX3510 Milsons Point



Dear Mr Sarkis

Proposed off sets for the Fern Bay Estate Master Plan

I refer to your letter dated 16 February 2006 and the meeting held in the National Parks and Wildlife Service (NPWS), Hunter Region office at Nelson Bay on 22 February 2006. The letter and meeting discussed proposed off sets for the loss of wet heath habitat and hollow bearing trees that will arise if your Master Plan and residential sub-division is approved.

I note from the meeting that off sets in the surrounding locality, but not on the Ministerial Part 11 (of the *National Parks and Wildlife Act, 1974*) (NP&W Act) lands, were sought. Off sets were not feasible due to a range of reasons. These reasons include the lack of wet heath habitat and numerous small holdings with many of the landholders expecting to develop their land in time.

As indicated in the meeting, I now confirm that the Department of Environment and Conservation supports in principle the off set package consisting of:

1. The fencing of the northern boundary of the Ministerial Part 11 lands and the construction of a four-wheel drive track adjacent to this boundary and associated infrastructure (hard stand, car parks, pedestrian pathway, lighting, signage, etc).
2. Rubbish removal (car bodies, asbestos dumps, etc) and weed control program on the Ministerial Part 11 lands.
3. Rehabilitation of approximately 31.7ha of wet heath habitat on the Ministerial Part 11 lands.
4. Closure and rehabilitation of numerous tracks on the Ministerial Part 11 lands (in doing so you will be better protecting current and future hollow bearing trees).
5. Provision of funding to maintain the rehabilitation works for at least 20 years.

The details of the off set proposal are specified in your letter dated 16 February 2006.

The DEC can only grant in-principle support for the off set package at this stage as the management of the Ministerial Part 11 lands is subject to formal co-management negotiations with the Stockton Bight Aboriginal Negotiating Panel under Part4A of the NP&W Act. I suggest the following steps to affirm the off set proposal:

1. The proposal will be put to the Panel for their consideration and endorsement.
2. Following the endorsement by the Panel then a rehabilitation plan, including funding arrangements is to be developed by Winten in consultation with staff from the NPWS Hunter Regional office (contact Rob Gibbs, Area Manager, Hunter Coast).

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Federation House Level 7, 24 Moonee St Coffs Harbour NSW 2450
Telephone (02) 6651 5946
Facsimile (02) 6651 6187
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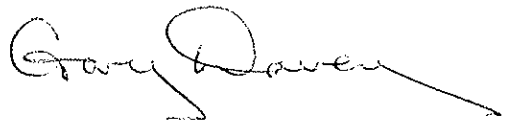
www.environment.nsw.gov.au

3. Following endorsement of the rehabilitation plan by all parties then approvals for the works (Review of Environmental Factors, Aboriginal heritage licensing, etc) are to be sought.

I would like to thank the Winten Group for its responsibility in seeking off sets for impacts of their development and its willingness to consider a range of options for the offset package.

Should you wish to discuss planning matters further please contact Brendan Diacono, Manager Planning and Aboriginal Heritage on 6659 8220. Should you wish to discuss details of the off set proposal then please contact Rob Gibbs, Area Manager Hunter Coast on 4984 8256.

Yours sincerely



GARY DAVEY
Director North East Branch
Environment Protection and Regulation

Cc Chris Wilson, Department of Planning.

Department of
Environment and Conservation (NSW)

Our reference : DOC06/06079; NEF 19085
Contact : Karen Thumm, 4908 6829
Date : 25 May 2006

Mr B Sarkis
Winten Property Group
PO Box 55
CAMMERAY NSW 2062
DX3510 Milsons Point

Dear Mr Sarkis

Agreement for conservation off sets at Fern Bay

I refer to the our meeting at Nelson Bay on the 22 February 2006 and to the letter sent by the Department of Environment and Conservation (DEC) on the 24 February 2006. At the meeting we discussed potential off-sets for the loss of wet heath habitat and hollow bearing trees that will arise if your Master Plan and residential sub-division is approved. The letter detailed the off set package and gave it in principle support pending endorsement from the Aboriginal Negotiating Panel (ANP) for the Stockton Bight joint management land.

Mr Adam Faulkner, the DEC Ranger responsible for the joint management agreement, has now confirmed that the Stockton Bight ANP considered the off set matter 7 of April 2006. The ANP has endorsed the off-sets proposed for the development of the Winten land, as long as the success of the compensatory works is evident and documented prior to consent being granted for the development. The unratified minutes from the meeting on the 7th April 2006 include the ANP's position on the development of the habitat compensation package, and is included below.

> "[The ANP] *agree to DEC in-principle support of Winten Property Group's proposal to develop a compensation package which includes a detailed plan based on the best National Park Management Ecological Restoration Principles and Practices and a trial to be undertaken to evaluate the success of these principles and practices with an evaluation report to be prepared and considered prior to habitat loss caused by stage 2 Fern Bay Estate."*

The offsets forming the basis of discussion with the ANP were set out in DEC's letter of the 24th of February 2006 and include:

1. The fencing of the northern boundary of the Ministerial Part 11 lands and the construction of a four-wheel drive track adjacent to this boundary and associated infrastructure (hard stand, car parks, pedestrian pathway, lighting, signage, etc).
2. Rubbish removal (car bodies, asbestos dumps, etc) and weed control program on the Ministerial Part 11 lands.
3. Rehabilitation of approximately 31.7ha of wet heath habitat on the Ministerial Part 11 lands.

4. Closure and rehabilitation of numerous tracks on the Ministerial Part 11 lands (in doing so you will be better protecting current and future hollow bearing trees).
5. Provision of funding to maintain the rehabilitation works for at least 20 years.

The ANP have agreed to the development of the package, but also noted their concerns over the loss of habitat that will result from the development. There is a desire from the ANP that Winten provide some detail and evidence that the package (once developed) will deliver improvements to habitat on the adjacent lands.

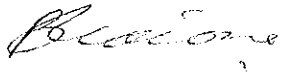
Now that all the parties (Winten, ANP and DEC) all agree, in principle, to the off sets, I invite you to develop a detailed off set proposal. The proposal should include a list and full description of the proposed off-sets, the timing of the implementation of the off-sets, and costings. In accordance with discussions at our meeting on 22 February 2006, the off-sets will comprise two main parts: Firstly, there will be initial works including construction of the beach access, rubbish removal, bush regeneration and track rehabilitation. Secondly, there will need to be funding provided for the management of this area in perpetuity. The agreement should include a summary, preferably in the form of a Gantt chart, which clearly sets out the objectives of the actions to be taken, the time frame over which they will be implemented and the performance targets to be satisfied at each stage of the project. Please indicate how you envisage that the timing of the trade-offs link in with the consent process.

I recommend the preparation of a "Vegetation Management Plan" using a template produced by the Department of Primary Industries to guide you in this process. This template can be modified easily to fit specific circumstances, and can be submitted at Masterplan stage to support the application. We can provide you with this template for consideration.

Copies of the draft of the offset proposal should be provided to Dr Karen Thumm and Mr Adam Faulkner for review. If conflicting opinions arise in regard to aspects of the proposal then we should meet to discuss and resolve. The final draft of the off set proposal should be presented to the ANP for endorsement. Finally, the off set proposal should be incorporated into the Development Consent as a Planning Agreement.

Should there be any matters you would like to discuss, please contact Karen Thumm, Conservation Planning Officer, on (02) 49086829.

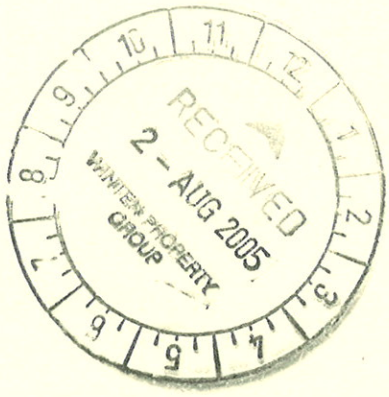
Yours sincerely



BRENDAN DIACONO
Manager Planning and Aboriginal Heritage – North East
Environment Protection and Regulation Division

TRIM Ref: 05/02624

29 July 2005



Bill Sarkis
Development Manager
Winton Property Group
Level 10, 61 Lavender Street
Milsons Point NSW 2061

NSW NATIONAL PARKS AND WILDLIFE SERVICE

NPWS is now part of the Department of Environment and Conservation

ABN 30 841 387 271

Dear Bill

Fern Bay beach access

I am writing on behalf of the Interim Management Subcommittee for the Stockton Bight lands (with representation from Dept. Environment and Conservation, Worimi Local Aboriginal Land Council and the Stockton Bight Aboriginal Negotiating Panel).

The Subcommittee has considered your proposal to construct a beach access to Stockton Bight. It understands that the access would be built on DEC lands adjacent to the Fern Bay development proposal site, and that entry would be via the public road network as outlined in the Fern Bay Master Plan.

Agreement on your proposal is subject to the access being constructed to an acceptable standard in light of the future management of the area by the Board of Management and DEC.

The design and standard of the access would need to provide for four wheel drive vehicle access only, and incorporate a degree of 'improvement' such as a gravel surface. It is the Subcommittee's position that the access include the following:

- a sealed carpark with lighting
- signage (interpretation and safety)
- secure fencing (such as bollard and cable) for the length of the access; and a
- incorporate a safe, designated pedestrian component for the length of the access.

The members of the Subcommittee would welcome the opportunity to discuss this matter with you further. To organise a time to meet or to discuss this matter further please contact Adam Faulkner on 49848204.

Yours sincerely

ROBERT QUIRK
Manager, Hunter Region
Parks and Wildlife Division

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Annex B

Noxious and Nationally Significant Weeds

Class 2 Regionally Prohibited Plants
Control Requirements- The plant must be eradicated from the land and the land must be kept free of the plant.

Common name	Scientific name
Hygrophila	*Hygrophila costata*

Class 3 Regionally Controlled Plants
Control Requirements-The plant must be fully and continuously suppressed and destroyed.

Common name	Scientific name
Alligator Weed	*Alternanthera philoxeroides*
Groundsel Bush	*Baccharis halimifolia*
Mother-of-millions	*Bryophyllum* species and hybrids
Green Cestrum	*Cestrum parqui*
Salvinia	*Salvinia molesta*
Giant Parramatta Grass	*Sporobolus fertilis*


Alligator Weed


Groundsel Bush


Green Cestrum


Mother of Millions


Salvinia

Class 4 Locally Controlled Plants
Control Requirements-The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
*The plant may not be sold, propagated or knowingly distributed.

Common name	Scientific name
Crofton Weed	*Ageratina adenophora*
Mistflower	*Ageratina riparia*
Spiny Burrgrass	*Cenchrus incertus**
Spiny Burrgrass	*Cenchrus longispinus**
Boneseed	*Chrysanthemoides monilifera* subspecies *monilifera*
Bitou Bush	*Chrysanthemoides monilifera* subspecies *rotunda*
Pampas Grass	*Cortaderia* species
Prickly Pear	*Cylindropuntia* species*
Paterson's Curse,Vipers Bugloss, Italian Bugloss	*Echium* species
Water Hyacinth	*Eichhornia crassipes*
Spiny emex	*Emex australis*
Harrisia Cactus	*Harrisia* species*
St. John's Wort	*Hypericum perforatum*
Long-leaf Willow Primrose	*Ludwigia longifolia*
African Boxthorn	*Lycium ferocissimu*m
Cape Tulip	*Moraea* species
Chilean Needle Grass	*Nassella neesiana**
Serrated tussock	*Nassella trichotoma**
Prickly pear	*Opuntia* species except *O. ficus-indica**
Blackberry	*Rubus fruticosus* aggregate species*
Johnson Grass	*Sorghum halepens*e
Columbus Grass	*Sorghum x almum*
Rhus Tree	*Toxicodendron succedanea*
Bathurst/Noogoora/ Californian/Cockle Burrs	*Xanthium* species

Local control plans for class 4 noxious plants can be viewed on the council website at http://portstephens.local-e.nsw.gov.au/

Weedbuster Week 6 - 13 October 2007

Port Stephens COUNCIL ... a community partnership

Noxious Weeds List


Bitou Bush

This brochure contains a list of plants declared noxious for the Port Stephens Council area. There are five classes of noxious weeds with differing control requirements. Classes 1, 2 and 5 are notifiable weeds and new outbreaks must be reported to council.
Occupiers of land have obligations to control noxious weeds in accordance with the control requirements for the class the weed is in.
To report known or suspected noxious weeds and for information on controlling noxious weeds contact 49800392.


Chinese Violet


Lantana

Class 1 State Prohibited Plants
Control Requirements- The plant must be eradicated from the land and the land must be kept free of the plant.

Common name	Scientific name
Karoo Thorn	*Acacia karroo*
Prickly Acacia	*Acacia nilotica*
Pond Apple	*Annona glabra*
Chinese Violet	*Asystasia gangetica* subspecies *micrantha*
Kochia	*Bassia scoparia*
Spotted Knapweed	*Centaurea maculosa*
Black Knapweed	*Centaurea nigra*
Siam Weed	*Chromolaena odorata*
Rubbervine	*Cryptostegia grandiflora*
Anchored Water Hyacinth	*Eichhornia azurea*
Horsetail	*Equisetum* species
Senegal Tea Plant	*Gymnocoronis spilanthoides*
Hawkweed	*Hieracium species*
East Indian Hygrophila	*Hygrophila polysperma*
Hymenachne	*Hymenachne amplexicaulis*
Lagarosiphon	*Lagarosiphon major*
Yellow Burrhead	*Limnocharis flava*
Miconia	*Miconia* species
Mimosa	*Mimosa pigra*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Mexican Feather Grass	*Nassella tenuissima*
Broomrapes	*Orobanche species except the native O. cernua variety australiana and O. minor*
Parthenium Weed	*Parthenium hysterophorus*
Water Lettuce	*Pistia stratiotes*
Water Soldier	*Stratiotes aloides*
Witchweed	*Striga species except native species and Striga parviflora*
Water Caltrop	*Trapa* species


Senegal Tea Plant


Horsetail


Water Lettuce

Class 5 Restricted Plants
Control Requirements- The requirements in the Noxious Weeds Act 1993 for a notifiable plant must be complied with (the plants must not be purchased, sold or moved without a written permit).

Common name	Scientific name
Espartillo	*Achnatherum brachychaetum*
Dodder	All *Cuscuta* species except the native species *C. australis, C. tasmanica* and *C. victoriana*
Oxalis	All Oxalis species and varieties except the native species *O. chnoodes*, *O. exilis*, *O. perennans*, *O. radicosa, O. rubens*, and *O. thompsoniae*
Onion Grass	All *Romulea* species and varieties except *R. rosea* var. *australis*
Annual Ragweed	*Ambrosia artemisiifolia*
Burr Ragweed	*Ambrosia confertiflor*a
Mexican Poppy	*Argemone mexicana*
Bridal Creeper	*Asparagus asparagoide*s
Sand Oat	*Avena strigosa*
Smooth-stemmed Turnip	*Brassica barrelieri* subspecies *oxyrrhina*
Cabomba	*Cabomba caroliniana*
Glaucous Star Thistle	*Carthamus glaucus*
Gallon's Curse	*Cenchrus biflorus*
Fine-bristled burr grass	*Cenchrus brownii*
Mossman River Grass	*Cenchrus echinatus*
Artichoke Thistle	*Cynara cardunculus*
Yellow Nutgrass	*Cyperus esculentus*
Leafy Elodea	*Egeria densa*
Clockweed	*Gaura lindheimeri*
Clockweed	*Gaura parviflora*
Texas Blueweed	*Helianthus ciliari*s
Lantana	*Lantana* species
Long-leaf Willow Primrose	*Ludwigia longifolia*
Red Rice	*Oryza rufipogon*
African Feather Grass	*Pennisetum macrourum*
Fountain Grass	*Pennisetum setaceum*
Soldier Thistle	*Picnomon acarna*
Arrowhead	*Sagittaria montevidensis*
Sagittaria	*Sagittaria platyphylla*
Willows	*Salix* species except *S. babylonica, S.* x *reichardtii, S.* x *calodendron*
Golden Thistle	*Scolymus hispanicu*s
African Turnip Weed	*Sisymbrium runcinatum*
African Turnip Weed	*Sisymbrium thellungii*
Corn Sowthistle	*Sonchus arvensis*
Cayenne Snakeweed	*Stachytarpheta cayennensis*
Athel Tree/Athel Pine	*Tamarix aphylla*


Long Leaf Willow-primrose

Notifiable plants in other parts of NSW. A person must not sell or purchase the plant, or any animal or thing which has on it or contains such plant material.

Common name	Scientific name
Mesquite	*Prosopis* species
Parkinsonia	*Parkinsonia aculeata*
Blue Hound's Tongue	*Cynoglossum creticum*
Cape Broom	*Genista monspessulana*
Gorse	*Ulex europaeus*

Port Stephens Council

Class 4 Noxious Weed Control Plan

Local Weed Control Plan for BITOU BUSH- (*Chrysanthemoides monilifera* subspecies *monilifera*) and BONESEED- (*C. monilifera* subspecies *rotundata*) ("The weed").

Bitou Bush and Boneseed are a notifiable weed (class 2) in another part of the state and as such parts of sections 28 and 29 of the Noxious Weeds Act also apply.

This plan is published in accordance with Order no.19 (made under the Noxious Weeds Act 1993) and outlines requirements to control class 4 noxious weeds by private occupiers and or owners of land in the Port Stephens Council area.

Objective of class 4 noxious weed declaration.

To minimise the negative impact of class 4 noxious weeds on the economy, environment and community of NSW.

Plan period

This plan commences on **12 July 2006** and remains in force until 11 July 2011. Council reserves the right to review, revoke, vary or amend this plan at any time by publication of a revised control plan.

Obligations of landholders (Section 12, Noxious Weeds Act 1993)

Private occupiers of land must control noxious weeds on land.

An occupier (other than a public authority or a local control authority) of land to which a weed control order applies must control noxious weeds on the land as required under the order.

Note: If an occupier fails to comply with obligations under a weed control order, those obligations may be enforced against the owner of the land as well as the occupier by a weed control notice issued under section 18.

Prescribed Control Measures as per Weed Control Order no. 19 made under the Noxious Weeds Act 1993

The growth and spread of the weed must be controlled to the extent specified in the following control measures.

- The weed must be prevented from seeding unless being managed in accordance with a management plan approved in writing by council weed officers.

- The weed must be prevented from spreading by any human assisted means, such means to include but not limited to the following;
  Slashing, cutting or cultivating; or
  Excavation works; or
  Transport of hay or other fodder; or
  Movement of vehicles, machinery and implements

Treat all weeds annually prior to seed set by;

- applying a registered herbicide as per label
- or by physical removal

Correspondence contact: General Manager
Port Stephens Council
Po Box 42
Raymond Terrace, NSW 2324

Telephone inquiries: Weed Office 49800239

Plan authorisation

Signed: **Position:** **Date authorised:**

Port Stephens Council

Class 4 Noxious Weed Control Plan

Local Weed Control Plan for BLACKBERRY- *Rubus fruiticosus* (aggregate species)("The weed").

This plan is published in accordance with Order no.19 (made under the Noxious Weeds Act 1993) and outlines requirements to control class 4 noxious weeds by private occupiers and or owners of land in the Port Stephens Council area.

Objective of class 4 noxious weed declaration.
To minimise the negative impact of class 4 noxious weeds on the economy, environment and community of NSW.

Plan period
This plan commences on **12 July 2006** and remains in force until 11 July 2011. Council reserves the right to review, revoke, vary or amend this plan at any time by publication of a revised control plan.

Obligations of landholders (Section 12, Noxious Weeds Act 1993)

Private occupiers of land must control noxious weeds on land.
An occupier (other than a public authority or a local control authority) of land to which a weed control order applies must control noxious weeds on the land as required under the order.
Note: If an occupier fails to comply with obligations under a weed control order, those obligations may be enforced against the owner of the land as well as the occupier by a weed control notice issued under section 18.

Prescribed Control Measures as per Weed Control Order no. 19 made under the Noxious Weeds Act 1993

The growth and spread of the weed must be controlled to the extent specified in the following control measures **and the plant may not be sold, propagated or knowingly distributed.**

- Prevent the spread and growth of the weed by treating all weeds prior to seeding.
- All weeds growing within 10 metres of a property boundary or watercourse must be treated with a registered herbicide or physically destroyed.
- Occupiers of land may submit a noxious weed management plan to council for approval.

Correspondence contact: General Manager
Port Stephens Council
Po Box 42
Raymond Terrace, NSW 2324

Telephone inquiries: Weed Office 49800239

Plan authorisation

Signed: **Position:** **Date authorised:**

Table B.1 Weeds of National Significance

Scientific Name	Common Name
Alternanthera philoxeroides	Alligator Weed
Tamarix aphylla	Athel Pine
Chrysanthemoides monilifera	Bitou Bush / Boneseed
Rubus fruticosus agg.	Blackberry
Asparagus asparagoides	Bridal Creeper
Cabomba caroliniana	Cabomba
Nassella neesiana	Chilean Needle Grass
Ulex europaeus	Gorse
Hymenachne amplexicaulis	Hymenachne
Lantana camara	Lantana
Prosopis spp.	Mesquite
Mimosa pigra	Mimosa
Parkinsonia aculeata	Parkinsonia
Parthenium hysterophorus	Parthenium Weed
Annona glabra	Pond Apple
Acacia nilotica spp. indica	Prickly Acacia
Cryptostegia grandiflora	Rubber Vine
Salvinia molesta	Salvinia
Nassella trichotoma	Serrated Tussock
Salix spp. except S. babylonica, S. X calodendron and S. X reichardtiji	Willows except Weeping Willows, Pussy Willow and sterile Pussy Willow

Annex C

Vegetation Mapping

Figure C1

Vegetation Communities (Clement et al 1992)

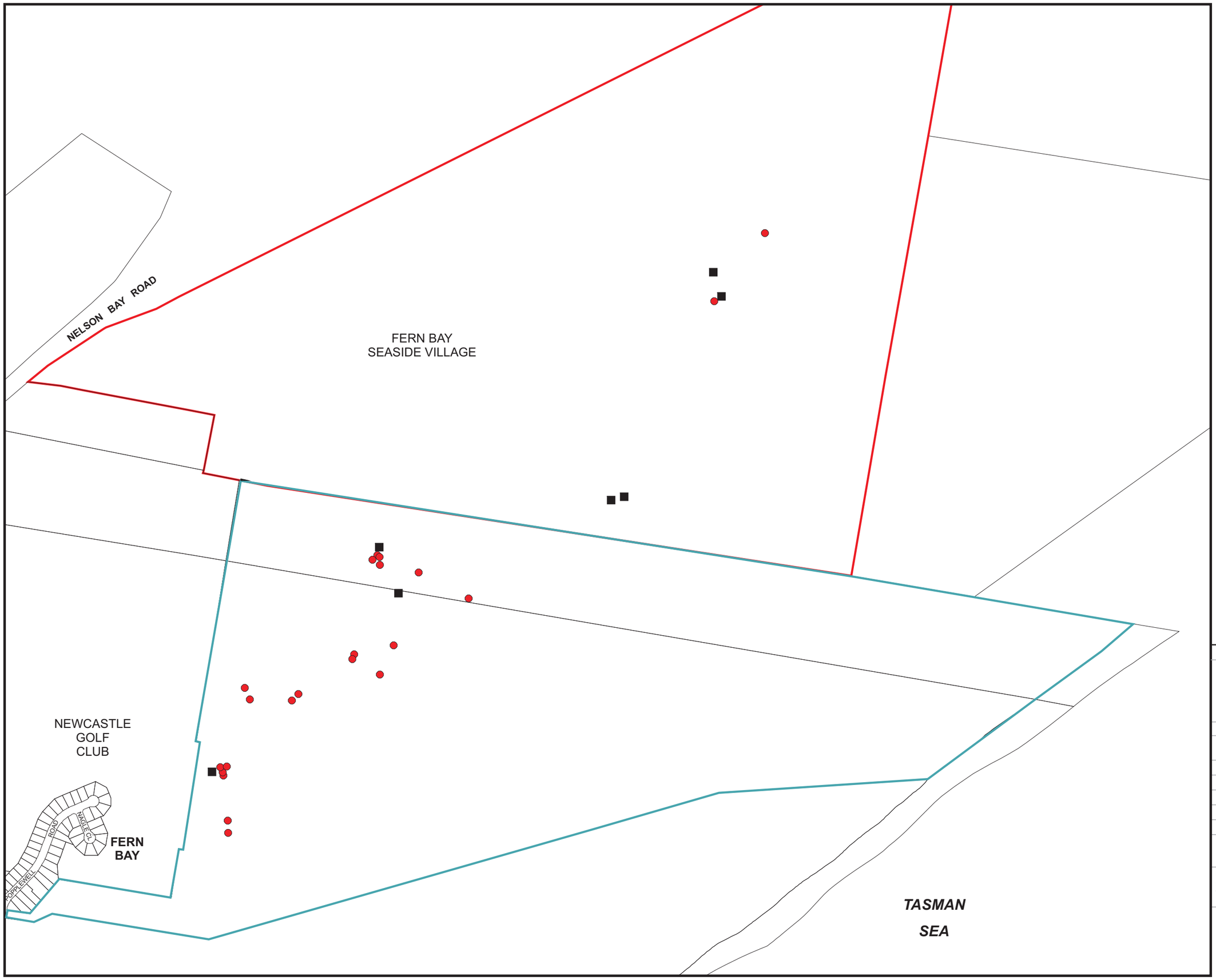
Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_10		
Date:	19/07/06	Drawing size:	A4
Drawn by:	SP	Reviewed by:	NB
Source:	Clements et al 1992		
Scale:	Refer to Scale Bar		

N

0 100 200 300m

Environmental Resources Management Australia Pty Ltd
53 Bonville Avenue, Thornton, NSW 2322
Telephone +61 2 4964 2150

ERM



Legend

- Fern Bay Seaside Village
- Worimi Regional Park
- *Eucalyptus parramattensis* subsp. *decadens x E.robusta* (Bell 2006)
- *Eucalyptus parramattensis* subsp. *decadens x E.robusta* Additional Records (ERM 2007)

Figure C2

***Eucalyptus parramattensis* subsp. *decadens x E. robusta* Locations**

Client:	Aspen Group		
Project:	Fern Bay Seaside Village DECC Vegetation Management Plan		
Drawing No:	0065580hv_DECC_VMP_12		
Date:	23/10/08		A3
Drawn by:	SP	Reviewed by:	NB
Source:	-		
Scale:	Refer to Scale Bar		

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0 100 200 300m

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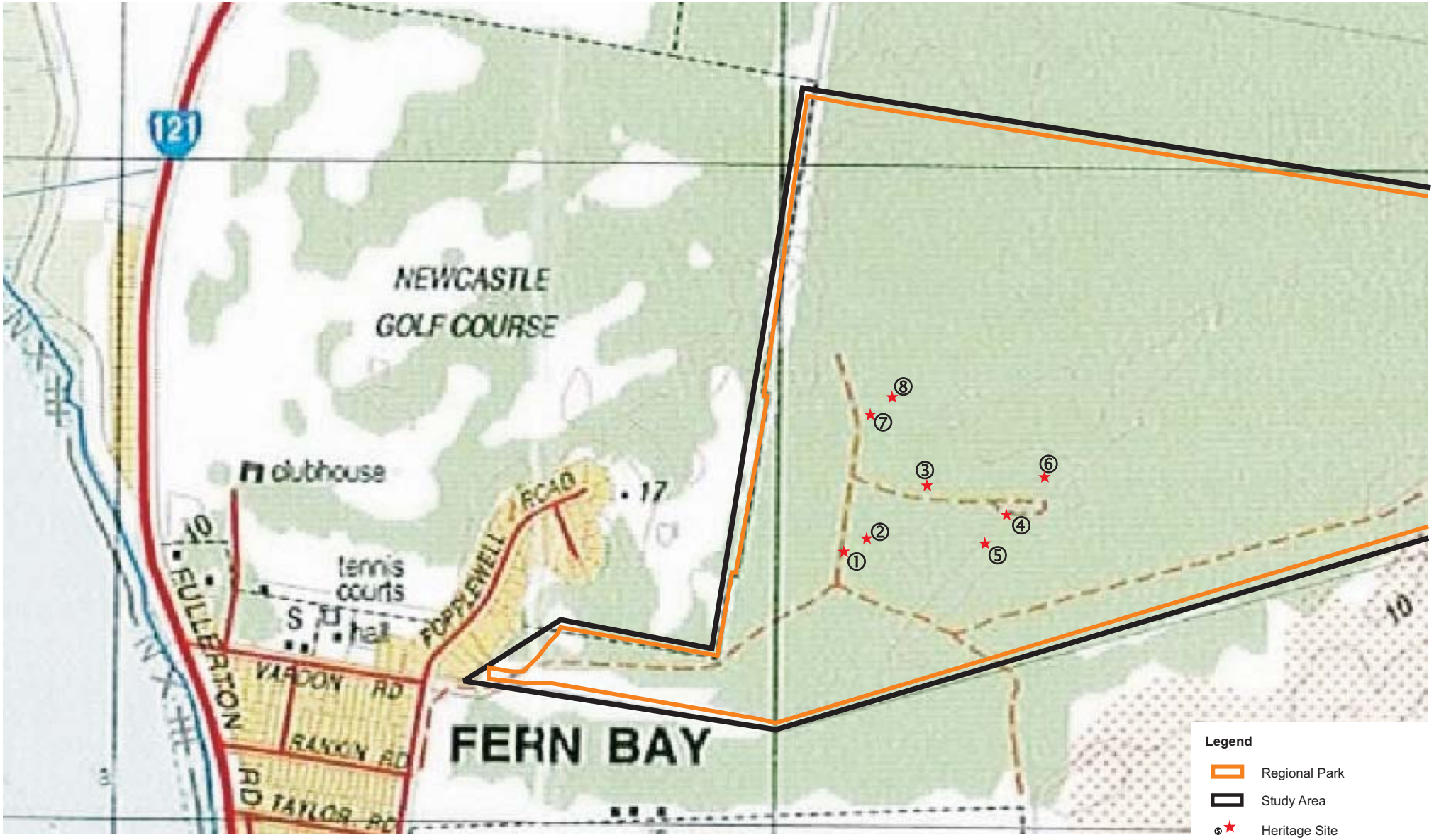
ERM

Annex D

Extract from the Cultural Heritage Assessment – Description of Fern Bay Armour Plate Proofing Range Heritage Site



Source: 1:25,000 Topo Series, Williamtown Sheet

ERM

0 250m

Figure 6.4 **Historical Heritage Structures at the FBAPPF**

National Parks & Wildlife Services
Stockton Bight ,NSW

Table 6.1 Historical Structures Recorded in Area A

Structure	Description	Condition	Interpretation
1	Two red brick and mortar pillars with brick courses alternating between header and footer coursing. The pillars are approximately 1.5 metres high and 0.7 metres wide (refer to *Photograph 6.2*). There are two sets of circular holes in a triangular pattern midway up the southern face of each of the pillars. Metal (iron?) hinges are present on the side of each of the pillars that is closest to the road.	Good.	Gate posts that would have supported gates opening onto the proofing range facilities. The holes in the southern face of the gates may have held name plates identifying the facility.
2	Concrete and red brick foundations measuring approximately 25 metres by 30 metres. The foundations are covered by broken bonded asbestos roofing tile and broken glass (refer to *Photograph 6.3*). Dumped rubbish is present across the site. A small septic tank is present approximately one metre from the southern corner of the foundation. Small concrete pillars are situated in a row to the east of the foundation. A small shed is located to the north of the foundation and is approximately one metre square with a single piece iron door (refer to *Photograph 6.4*). An additional sub-surface feature composed of brick and concrete is situated next to the small shed and abuts the foundations (refer to *Photograph 6.5*).	Structure 2 is in very poor condition and has been demolished down to the foundations. Large quantities of rubbish are present across the area. Asbestos roofing tile is present across the area and is heavily fragmented.	The foundations are the remains of the married quarters/caretaker's residence and its associated outbuildings.
3	Square brick and concrete structure that is rectangular in shape with an open face to the south west and a small slit consisting of two sheets of iron set in the eastern face of the structure at an angle of approximately 45 degrees to allow vision from within the structure facing east (refer to *Photograph 6.6*). A small wooden bench was situated under the slit inside the structure at approximately chest height.	Good.	An observation post to permit occupants to watch the explosion of ordnance from a protected position.
4	Two adjoining concrete block structures consisting of a narrow opening broadening in a semi-circular shape before forming two parallel walls that are not roofed (refer to *Photograph 6.7*). The opposite end of the feature is a concrete wall with a small rectangular gap recessed to approximately one metre. The wall is covered with heavy iron sheets that have large penetration marks across them. The recess has a concrete roof with a slit that is approximately 50 centimetres thick. A thick sheet of iron with two rounded hooks attached is located within the slit and is backed by the remains of large wooden beams. The second structure also contains a large iron sheet in the centre of the structure that has large penetration marks along it. A set of stairs on the southern side of the second structure allow access to the top of the structure. A series of wooden and iron posts are present in the area at the top of the stairs (refer to *Photograph 6.8*).	Fair. The structures have been heavily graffitied and the recent fire has burnt the wooden posts.	Facility for the proofing of armour plating.

Structure	Description	Condition	Interpretation
5	Concrete block structure extending from Structure 4 to the south-east. Initially consists of a small wall several courses high but increases in height. At the highest point (approximately half-way along its length) there is a small room approximately four metres square which contains a wooden slat bench at approximately knee height (refer to *Photographs 6.9* and *6.10*). The wall then decreases in height moving away from the room.	Very good. Limited graffiti is present inside the room.	Facility used as shelter by individuals involved in activities on the armour proofing range.
6	Two parallel concrete block walls that start at one course in height and increase in height at an approximately 45 degree angle before levelling out at a height of approximately three metres and again descending in height at a 45 degree angle.	Good.	Possible gantry.
7	Rectangular brick and cement building with a set of stairs descending below ground level to a room measuring approximately 10 metres by 10 metres. Abutting this on the side opposite the stairs are two parallel cement block walls approximately 2.5 metres in height. Three rectangular concrete footings are visible spaced equidistant apart and orientated parallel to each other are present in close proximity to the walls.	Good. Rubbish and graffiti are present in the sub-surface room.	Ordnance store (possibly the fuse and tube store) associated with Structure 6.
8	Building foundations composed of concrete and red brick.	Good.	Structures associated with the proofing range.

Photograph 6.2 Eastern Pillar of Structure 1

Photograph 6.3 View of Debris at Structure 2 Facing East

Photograph 6.4 Small Structure to the North of the Foundations of Structure 2

Photograph 6.5 Subsurface Structure Associated with Structure 2

Photograph 6.6 Structure 3 Facing North

Photograph 6.7 Structure 4 Internal View

Photograph 6.8 Structure 4 External View Showing Adjacent Structures and Wooden Posts

Photograph 6.9 Structure 5 Entry to Small Shelter

Photograph 6.10 Structure 5 View Along Low Wall Leading to Structure 4

Photograph 6.11 Tank Traps at Salt Ash (from ERM 2003: Photograph 38)

Annex E

Waste Material Survey Former Fern Bay Armour Proofing Range (ERM 2006a)

Environmental Resources Management Australia

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Thornton NSW 2322
PO Box 71 Thornton
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Telephone (02) 4964 2150
Facsimile (02) 4964 2152
www.erm.com

26 April, 2006

Adam Faulkner
National Parks and Wildlife Service – Hunter Region
Locked Bag 99
NELSON BAY MAIL DELIVERY CENTRE NSW 2315

Our Reference: 0047866_LTR_070406 - FINAL.DOC

Dear Adam,

RE: WASTE MATERIAL SURVEY AT THE FORMER FERN BAY ARMOUR PROOFING RANGE

1. INTRODUCTION

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by the Department of Environment and Conservation (DEC) to undertake a limited waste material survey of sections of a former Armour Proofing Range at Fern Bay, New South Wales (the survey area). ERM's Stefan Everingham conducted the survey on Wednesday and Thursday the 5th and 6th April 2006. The survey area is shown in *Figure 1, Appendix A*.

This letter presents the findings from the limited waste material survey, a limited description of risks associated with the potential hazardous materials identified and recommendations for their management during removal to help protect workers and to help preserve heritage items during removal of waste material.

1.1 SCOPE OF WORKS

For the purpose of this survey, 'potential hazardous materials' refer to potential asbestos-containing materials (ACM), potential synthetic mineral fibre (SMF) and other hazardous wastes. ERM's role was limited to surveying and mapping where waste materials were apparent, estimating their areal extent, and providing National Parks and Wildlife Service (NPWS) with their general description. ERM understands this information will be used by NPWS and its preferred waste disposal contractor to prepare a scope for the removal of potential hazardous materials. NPWS and its waste disposal contractor will be responsible for evaluating whether or not ACM, SMF or other hazardous wastes

are present (including sampling as required). They will also determine what methods are appropriate to handle, transport and dispose such wastes.

The survey included the following tasks:

- walk over readily accessible, visible and aboveground portions of the site to undertake a limited visual inspection of waste materials;
- broadly record the distribution of waste material piles or areas across the survey area; and
- preparation of a brief letter style report and a waste materials register.

The survey area was vegetated with regrowth type bushland with leaves and other organic debris covering the ground. Due to the limited visibility and and the time constraints of the project, it is possible that waste material areas other than those identified during this survey may be present in the survey area. ERM made an attempt to complete the survey within the parameters of the project scope.

1.2 LIMITATIONS

The findings of this report are based on the Scope of Work described in ERM's letter dated 31 March 2006 and summarised above. ERM performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental auditing profession. No warranties express or implied, are made.

Subject to the Scope of Work, ERM's assessment is strictly limited to identifying typical conditions associated with the survey area and does not include evaluation of any other issues.

The objective of the survey was to locate waste materials aboveground and not covered in debris as requested in the NPWS project brief on 29 March 2006. The survey was a visual inspection and only those waste materials that were readily accessible could be described. Identification of ACM, SMF or other hazardous material must be verified by sampling and analysis (which is outside the present scope of work). Therefore, it is possible that materials that may be concealed (eg within inaccessible areas/voids) may not have been located during the survey.

Due to the scope of this survey and the presence of inaccessible areas, it is not possible to guarantee that every source of hazardous materials has been included

in this survey. Therefore, waste removal should be undertaken by qualified professionals capable of identifying potential ACM, SMF or other hazardous material. Care should be exercised when entering any previously inaccessible areas and it is imperative that work ceases pending further sampling if potential ACM, SMF or other unknown hazardous materials are encountered.

This report is not intended to be used for the purposes of tendering or programming of works unless used in conjunction with a specification detailing the extent of the works. To ensure its contextual integrity, the report must be read in its entirety and should not be copied, distributed or referred to in part only.

The results of the assessment are based upon a survey conducted by ERM personnel. The conclusions and recommendations regarding the site area are the professional opinions of the ERM personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, ERM assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of ERM, or developments resulting from situations outside the scope of this project.

ERM is not engaged in environmental auditing and reporting for the purpose of advertising, sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes. The client acknowledges that this report is for the exclusive use of the client, its representatives and advisers and any investors, lenders, underwriters and financiers who agreed to execute a reliance letter, and the client agrees that ERM's report or correspondence will not be, except as set forth herein, used or reproduced in full or in part for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular.

2. WASTE MATERIAL SURVEY

Waste materials apparent during the survey included:

- potential ACM (28 locations);
- potential SMF (three areas, including two areas combined with potential ACM); and
- general waste material (64 areas, including the 29 areas containing potential ACM and/or potential SMF).

A summary of each category of waste material is provided below (refer also to *Figure 1, Appendix A*, *Photographs* in *Appendix B* and the *Waste Materials Register* provided in *Appendix C)*. Photographs have been provided for each of the 29 areas where potential ACM and/or potential SMF were apparent. Representative photographs of the other general waste materials apparent during the survey (eg car bodies, household debris etc) have also been provided in *Appendix B.*

2.1 POTENTIAL ASBESTOS CONTAINING MATERIAL

Materials that potentially contain asbestos were identified in 28 areas across the survey area. The presence of asbestos has not been confirmed by laboratory analysis. The materials identified were typically around historical structures (eg former building locations) and along the edge of access tracks. Potential ACM identified across the survey area was fragmented and likely to be friable.

2.2 SYNTHETIC MINERAL FIBRE

Potential SMF materials were identified at three locations amongst waste dumped at the edge of access tracks. The presence of SMF has not been confirmed by laboratory analysis.

2.3 GENERAL WASTE MATERIAL

There were 64 areas containing general waste material apparent during the survey. These areas were primarily situated around access tracks and historical structures. The presence of hazardous materials amongst the general waste material has not been confirmed by laboratory analysis.

3. RECOMMENDATIONS

3.1 GENERAL REQUIREMENTS

Under the *NSW Occupational Health & Safety Regulation (2001),* there is a requirement for the Controller of Premises to provide information on hazards associated with site activities. This is to help ensure hazardous materials do not pose health and environmental risks to site workers, the surrounding environment, the general public and to help ensure hazardous materials are

disposed of appropriately. The following sections contain a description of risks associated with the materials identified during the survey and recommendations to help protect workers and to protect heritage items during removal of waste material.

3.2 POTENTIAL ASBESTOS-CONTAINING MATERIAL

The health effects associated with asbestos exposure relate to the inhalation of airborne respirable asbestos fibres. In general, asbestos fibres cannot be released or become airborne in significant quantities unless the asbestos-containing material is disrupted, for example in the case of cutting asbestos-cement (AC) products with power saws, etc.

A range of control measures is available for the removal of asbestos hazards. The *Code of Practice for the Safe Removal of Asbestos [National Occupational Health and Safety Commission, NOHSC 2002 (2005)]* provides useful guidance to safe work practice for asbestos removal operations.

Licensed asbestos removal contractors should confirm (through sampling and analysis) the presence of ACM and perform removal of ACM. Occupational hygiene services including air monitoring, independent of the removal contractor, should be performed in accordance with relevant NOHSC guidance (noted above) to help maintain a standard of safe and thorough work.

Removal works and disposal should be carried out in accordance with Parts 8.7, 10 and 11 of the *Occupational Health & Safety Regulations, 2001* and in accordance with the *Code of Practice for the Safe Removal of Asbestos [NOHSC 2002 (2005)]*.

3.3 POTENTIAL SYNTHETIC MINERAL FIBRE

In the late 1980s, the International Agency for Research on Cancer (IARC) evaluated certain SMF materials as being possibly carcinogenic to humans. The similarity to asbestos in application and appearance has resulted in some community concern regarding the health effects associated with exposure to SMF.

Caution should be exercised when handling SMF products in order to reduce disturbance of the materials and the likelihood for airborne SMF fibres. Where SMF materials are to be installed or removed, then suitable controls and appropriate personal protection are to be provided.

It is recommended that the *Synthetic Mineral Fibre National Standard & National Code of Practice* (NOHSC, May 1990) be closely adhered to when handling such materials.

The presence of SMF material should be confirmed (through sampling and analysis as required) and SMF material should be removed using appropriate work and disposal methods. Due to the similarity to asbestos removal control measures, a licensed asbestos removal can be used to undertake these works (see above comments regarding asbestos removal contractor in *Section 3.2.2*).

3.4 GENERAL WASTE MATERIALS

Considering the scope of this assessment, due care should be taken in considered for the removal of the waste materials. Prior to collecting general waste materials, a more thorough inspection of waste locations is recommended to assess whether hazardous materials are present (via waste characterisation, sampling and analysis). Suspicious or unknown materials should be treated as being hazardous unless laboratory analysis demonstrates otherwise.

3.5 PROTECTION OF HERITAGE ITEMS

The site contains a number of structures associated with the use of the area as an armour plate and artillery proofing range during and after World War II. The main structure locations are shown in *Figure 1* and include the remains of houses, armour proofing facilities and ordnance stores. These structures have been assessed as being of heritage significance on a national, state and local level. Additional items identified during the current survey may have heritage value and are identified in the *Waste Materials Register (Appendix C)*.

In New South Wales, historic heritage is primarily protected by the *Heritage Act 1977*. This piece of legislation is designed to protect items of heritage significance, which are defined as a place, building, work, relic or precinct. Under Section 139 of the Act, it is an offence to disturb or excavate land where it is known that this activity will result in the discovery, exposure, movement, damage or destruction of heritage relics, unless the activity is conducted under an excavation permit.

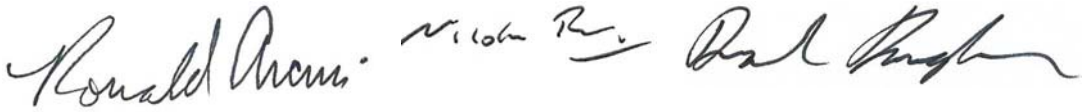
The following recommendations have been formulated in light of the presence of heritage structures and the potential for buried relics to be associated with these structures throughout the site and the intentions of the *Heritage Act 1977*. The

recommendations relate only to the proposed removal of waste materials and are not made in relation to any other activities:

- no excavation or topsoil removal should occur in areas surrounding heritage items or potential heritage items;
- the removal of waste materials associated with heritage structures should not involve damage or modification to the structure in any way; and
- potential heritage items (as noted in the *Waste Materials Register*) should not be moved, damaged or destroyed.

If you have any queries please do not hesitate to contact the undersigned.

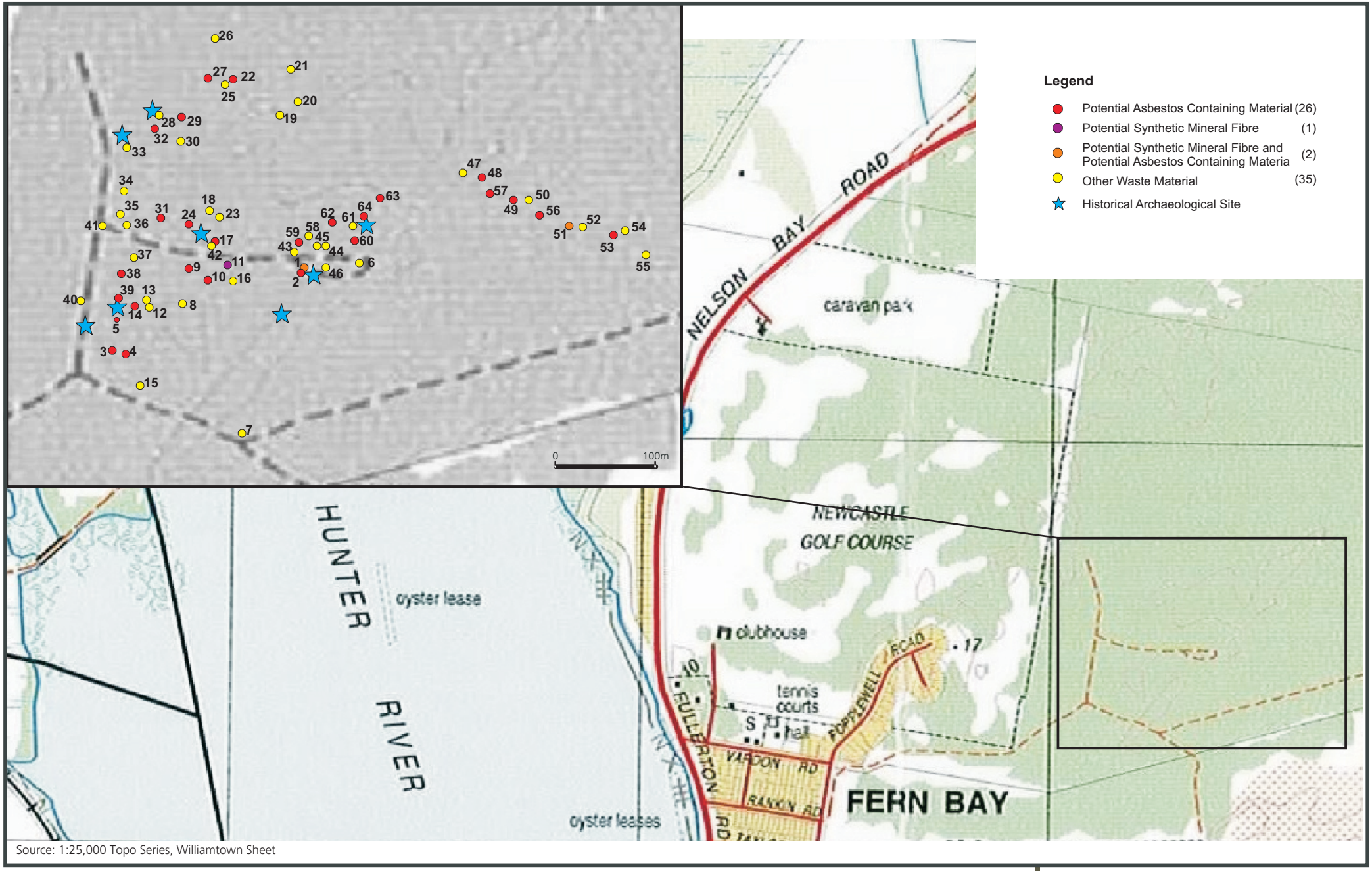
Yours sincerely,
for Environmental Resources Management Australia Pty Ltd



Ronald Arcuri	Nicola Roche	Paul Douglass
Principal Consultant	Project Manager	Partner

Appendix A

FIGURE



Source: 1:25,000 Topo Series, Williamtown Sheet

Figure 1 **Waste Site Location Plan**

National Parks & Wildlife Services -Stockton Bight ,NSW

Appendix B

PHOTOGRAPHS

Photograph 1

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 1.

Photograph 2

Fragments of glass-fibre type material (potential asbestos containing material). Corresponds to Mark 1.

Photograph 3

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 3.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Survey

Photograph 4

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 3.

Photograph 5

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 4.

Photograph 6

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 4.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Survey

Photograph 7

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 5.

Photograph 8

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 9.

Photograph 9

Burnt out car and fragments of cement fibre sheeting (potential asbestos containing material), building rubble, corrugated metal water tank. Corresponds to Mark 10.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Survey

Photograph 10

Fragments of potential synthetic mineral fibre. Corresponds to Mark 11.

Photograph 11

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 14.

Photograph 12

Fragments of cement fibre sheeting and cement fibre pipe (potential asbestos containing material). Corresponds to Mark 17.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Assessment

Photograph 13

Fragments of cement fibre sheeting and pipe (potential asbestos containing material). Corresponds to Mark 17.

Photograph 14

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 22.

Photograph 15

Fragments of cement fibre sheeting and pipe (potential asbestos containing material). Corresponds to Mark 24.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Assessment

Photograph 16

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 24.

Photograph 17

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 27.

Photograph 18

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 28.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Assessment

Photograph 19

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 31.

Photograph 20

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 32.

Photograph 21

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 38.

Photograph 22

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 39.

Photograph 23

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 48.

Photograph 24

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 49.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Assessment

Photograph 25

Fragments of cement fibre sheeting (potential asbestos containing material) and insulation (potential synthetic mineral fibre). Corresponds to Mark 51.

Photograph 26

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 53.

Photograph 27

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 56.

Photograph 28

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 57.

Photograph 29

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 59.

Photograph 30

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 60.

Photograph 31

Fragments of plasterboard and chipboard and other building materials (potential asbestos containing material). Corresponds to Mark 62.

Photograph 32

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 63.

Photograph 33

Fragments of cement fibre sheeting (potential asbestos containing material). Corresponds to Mark 64.

Photograph 34

Burnt out cars, piles of rusted barbed wire. Corresponds to Mark 20.

Photograph 35

Area with coils of old rusted barbed wire. Corresponds to Mark 25.

Photograph 36

Household rubbish. Corresponds to Mark 6.

ERM

Photographs

National Parks & Wildlife Services
Stockton Bight, NSW - Waste Assessment

Appendix C

WASTE MATERIAL REGISTER

Waste Materials Register

Date 5 and 6 April 2006

Former Fern Bay Armour Proofing Range, Fern Bay NSW

Assessed by Stefan Everingham

Location (Mark) Number, Description, Comments (refer to Figure 1 for location)	Photo No.	Status	Approx Extent /Possible Condition	Control Recommendations
1. Fragments of cement fibre sheeting (potential ACM), some glass fibre type material (potential SMF).	**1 and 2**	**Potential ACM, potential SMF**	**10 m² / friable**	**Follow safe work methods during removal**
2. Burnt car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
3. Heavy scattering of cement fibre sheeting (potential ACM). Located within section of large area of concern around historical structures located at south western portion of study area.	**3 and 4**	**Potential ACM**	**225 m² / friable**	**Follow safe work methods during removal**
4. Light scattering of cement fibre sheeting (potential ACM). (section of large area of concern around historical structures located at south western portion of study area).	**5 and 6**	**Potential ACM**	**600 m²**	**Follow safe work methods during removal**
5. Very heavy scattering of cement fibre sheeting (potential ACM). (section of large area of concern around historical structures located at south western portion of study area).	**7**	**Potential ACM**	**900 m²**	**Follow safe work methods during removal**
6. Burnt car body (not shown in photograph) and scattered household rubbish.	36	No obvious ACM	**--**	Inspect area thoroughly during removal for potential hazardous materials.
7. Concrete, sheet metal and car parts (approx 20 m to the west).	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials.
8. Concrete water tank, old corrugated iron tanks to south east. Possible pit toilet to north of concrete tank, scrap steel to east and west of concrete tank.	--	No obvious ACM	--	Possible heritage items. Do not remove.
9. Fragments of cement fibre sheeting (potential ACM).	**8**	**Potential ACM**	**35 m²**	**Follow safe work methods during removal**
10. Fragments of cement fibre sheeting (potential ACM) amongst other building rubble, a car body and corrugated metal water tank.	**9**	**Potential SMF**	**100 m²**	**Follow safe work methods during removal**
Note: Bold type indicates potential ACM or SMF				

Waste Materials Register

Date 5 and 6 April 2006

Former Fern Bay Armour Proofing Range, Fern Bay NSW

Assessed by Stefan Everingham

Location (Mark) Number, Description, Comments (refer to Figure 1 for location)	Photo No.	Status	Approx Extent /Possible Condition	Control Recommendations
11. Small patch of insulation material (potential SMF), located at the eastern extent of building rubble from above mark 10.	**10**	**Potential ACM**	**0.25 m²**	**Follow safe work methods during removal**
12. Waste from old power pole, includes scrap metal, burnt wood and cable.	--	No obvious ACM	--	Possible heritage item. Do not remove
13. Small concrete slab with some old corrugated iron and brick waste.	--	No obvious ACM	7 m²	Possible heritage item. Do not remove
14. Fragments of cement fibre sheeting (potential ACM) within a section of large area of concern around historical structures located at south western portion of study area.	**11**	**Potential ACM**	**100 m²**	**Follow safe work methods during removal**
15. Small pile of corrugated iron.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
16. Two burned telegraph poles.	--	No obvious ACM	--	Possible heritage items. Do not remove
17. Fragments of cement fibre sheeting and a section of cement fibre pipe (both potential ACM) amongst other waste that included ceramic, glass, concrete, some scrap metal and bricks.	**12 & 13**	**Potential ACM**	**100 m²**	**Follow safe work methods during removal**
18. Burnt car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
19. Concrete blocks and some galvanised iron.	--	No obvious ACM	--	Possible heritage item. Do not remove
20. Burnt old cars (approx 8) and piles of rusted old barbed wire.	34	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
21. Burnt car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
22. Pile of cement fibre fragments (potential ACM), some very old barbed wire.	**14**	**Potential ACM**	**15 m²**	**Follow safe work methods during removal**
Note: Bold type indicates potential ACM or SMF				

Waste Materials Register

Date 5 and 6 April 2006

Former Fern Bay Armour Proofing Range, Fern Bay NSW

Assessed by Stefan Everingham

Location (Mark) Number, Description, Comments (refer to Figure 1 for location)	Photo No.	Status	Approx Extent /Possible Condition	Control Recommendations
23. Old car body	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
24. Fragments of cement fibre sheeting and cement fibre pipe (both potential ACM) amongst brick rubble and scrap metal.	**15 & 16**	**Potential ACM**	**375 m²**	**Follow safe work methods during removal**
25. Coils of old barbed wire.	35	No obvious ACM	400 m²	Possible heritage item. Do not remove
26. Old garbage bin.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
27. Fragments of cement fibre sheeting (potential ACM).	**17**	**Potential ACM**	**9 m²**	**Follow safe work methods during removal**
28. Fragments of cement fibre sheeting (potential ACM) amongst other waste that included household rubbish, wire and scrap metal.	**18**	**Potential ACM**	**35 m²**	**Follow safe work methods during removal**
29. Burnt out car.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
30. Corrugated iron, some brick waste.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
31. Fragments of cement fibre sheeting (potential ACM) scattered around slab along with some scrap metal.	**19**	**Potential ACM**	**400 m²**	**Follow safe work methods during removal**
32. Fragments of cement fibre sheeting (potential ACM) on and around slab.	**20**	**Potential ACM**	**500 m²**	**Follow safe work methods during removal**
33. Brick Rubble	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
34. Three car bodies.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials

Note: Bold type indicates potential ACM or SMF

Waste Materials Register

Date 5 and 6 April 2006

Former Fern Bay Armour Proofing Range, Fern Bay NSW

Assessed by Stefan Everingham

Location (Mark) Number, Description, Comments (refer to Figure 1 for location)	Photo No.	Status	Approx Extent /Possible Condition	Control Recommendations
35. Pieces of sheet metal.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
36. Car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
37. Old corrugated metal.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
38. Fragments of cement fibre sheeting (potential ACM), located within a section of a large area of concern around historical structures located at south western portion of study area). Also contains small concrete slabs, corrugated iron and metal pipe.	**21**	**Potential ACM**	**875 m²**	**Follow safe work methods during removal**
39. Fragments of cement fibre sheeting (potential ACM) amongst bricks and some metal.	**22**	**Potential ACM**	**625 m²**	**Follow safe work methods during removal**
40. Car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
41. Car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
42. Mattress springs.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
43. Car body and washing machine.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
44. Car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
Note: Bold type indicates potential ACM or SMF				

Waste Materials Register

Date 5 and 6 April 2006

Former Fern Bay Armour Proofing Range, Fern Bay NSW

Assessed by Stefan Everingham

Location (Mark) Number, Description, Comments (refer to Figure 1 for location)	Photo No.	Status	Approx Extent /Possible Condition	Control Recommendations
45. Scrap steel.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
46. Two car bodies, scrap steel, old drums and wire.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
47. Brick and concrete rubble	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
48. Brick and tile rubble with some fragments of cement fibre sheeting (potential ACM)	**23**	**Potential ACM**	**16 m²**	**Follow safe work methods during removal**
49. Concrete tile waste (potential for fragments of cement fibre sheeting based on above and thus potential ACM)	**24**	**Potential ACM**	**9 m²**	**Follow safe work methods during removal**
50. Old barbed wire and bottles (east and west of track)	--	No obvious ACM	--	Possible heritage items. Do not remove
51. Old hot water heater, insulation (potential SMF) and some fragments of cement fibre sheeting (potential ACM)	**25**	**Potential ACM, potential SMF**	**--**	**Follow safe work methods during removal**
52. Tile waste	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
53. Concrete rubble with some fragments of cement fibre sheeting (potential ACM)	**26**	**Potential ACM**	**--**	**Follow safe work methods during removal**
54. Large concrete blocks / cylinders.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
55. Remains of car body.	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
56. Fragments of cement fibre sheeting (potential ACM)	**27**	**Potential ACM**	**4 m²**	**Follow safe work methods during removal**
Note: Bold type indicates potential ACM or SMF				

Waste Materials Register

Date 5 and 6 April 2006

Former Fern Bay Armour Proofing Range, Fern Bay NSW

Assessed by Stefan Everingham

Location (Mark) Number, Description, Comments (refer to Figure 1 for location)	Photo No.	Status	Approx Extent /Possible Condition	Control Recommendations
57. Small section containing fragments of cement fibre sheeting (potential ACM) and brick waste.	**28**	**Potential ACM**	**1 m²**	**Follow safe work methods during removal**
58. Car bonnet	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
59. Fragments of cement fibre sheeting (potential ACM), very sparse.	**29**	**Potential ACM**	**25 m²**	**Follow safe work methods during removal**
60. Fragments of cement fibre sheeting (potential ACM), sparse	**30**	**Potential ACM**	**50 m²**	**Follow safe work methods during removal**
61. Car body	--	No obvious ACM	--	Inspect area thoroughly during removal for potential hazardous materials
62. Plasterboard and chip board (potential for other building materials and hence potential for ACM).	31	No obvious ACM	15 m²	Inspect area thoroughly during removal for potential hazardous materials
63. Fragment of cement fibre sheeting (potential ACM)	**32**	**Potential ACM**	**0.25 m² however potential for more nearby**	**Follow safe work methods during removal**
64. Fragment of cement fibre sheeting (potential ACM)	**33**	**Potential ACM**	**0.25 m² however potential for more nearby**	**Follow safe work methods during removal**
Note: Bold type indicates potential ACM or SMF				

Annex F

Waste Register

Table F.1 List of Waste Waypoints and Descriptions from Current Survey

Waypoint	Easting WGS	Northing 84	Description
65	388002	6362617	car body
66	388298	6363294	car parts, galvanised iron sheet
67	388807	6363148	car body
68	388328	6362694	car body
69	388332	6362700	coils of barbed wire, fibro
70	387745	6362245	concrete rubble
71	387645	6362293	galvanised iron
72	388241	6362739	aluminium rubbish bin,
73	388239	6362707	coils of barbed wire approximately 20 ($10m^2$)
74	388218	6362694	tyre, wire
75	388201	6362632	car body, 1 sheet galvanised iron
76	388200	6362614	approximately 7 sheets of galvanised iron, crushed pavers
77	388371	6362527	concrete pillar, fibro sheeting ($3m^2$)
78	388521	6362359	asbestos, crushed bricks
79	388395	6362475	concrete road at Bunker
80	388251	6362465	rusting metal, brick rubble, galvanised iron tank, car body, roof tiles
81	388145	6362632	car body, potential asbestos, galvanised iron ($10m^2$), brick foundations
82	388143	6362700	yellow old car
83	388124	6362731	barbed wire coils
84	388098	6362748	barbed wire coils $10m^2$
85	388095	6362816	barbed wire coils $5m^2$
86	388127	6362934	rusted car body
87	388279	6363307	2 car bodies, 40 gallon drums, car batteries
88	388119	6363393	car body, potential asbestos material ie. Fibro, 6 car tyres, 7 44 gallon drums, old carpet
89	388153	6363315	car body
90	388956	6362896	car body
91	388958	6362722	car coils, pole, concrete, old car parts
92	388959	6362612	car tyre
93	388993	6362527	car axil
94	389216	6362832	car body
95	388864	6362403	overgrown short track to dunes (previously burnt), car body
96	388710	6362425	rusted metal car body
97	388097	6362502	car body
98	388111	6362538	car body
99	388112	6362545	rusted tin (old car body parts)
100	387645	6362293	galvanised iron
101	388102	6362421	old tyre
102	388102	6362421	old tyre
103	388086	6363252	Beer bottles, household waste, wood, glass, laminex, plastic roofing, pipe and tyres beneath easement.
104	388087	6363259	Crushed tiles, bricks, masonite
105	388108	6363349	car tyre
106	388127	6363392	empty car, fibro building material, rubber, tyre
107	388057	6363273	wood slats, gutter material, tiles.
108	388098	6362427	Asbestos, rusted metal
109	388205	6362451	galvanised iron sheeting, tank bases (corrugated iron).
110	388512	6362363	Building rubble south side of track
111	388956	6362897	Car body near track junction.
112	388280	6362909	Concrete block, old tin trolley.
113	388230	6362965	2 Car bodies.

Waypoint	Easting WGS	Northing 84	Description
114	388963	6362890	Galvanised iron sheeting, fibro sheeting.
115	388959	6362723	Coil, concrete.
116	388960	6362613	Car tyre
117	388122	6363275	Car body.
118	388160	6363349	3 car bodies.
119	388234	6362678	coils of barbed wire (2), crushed asbestos (2 piles).
120	388332	6362644	6 car bodies
121	388326	6362649	concrete sheets.

1. Waste waypoints 1 to 64 are included in Annex C Waste material survey former Fern Bay Armour Proofing Range ERM (2006a).

Annex G

Weed Register

Table G.1 List of Weed Waypoints and Descriptions

Waypoint	Easting WGS	Northing 84	Description
1	388049	6362612	Bitou bush extent (4m^2 diameter)
2	388054	6362613	Bitou bush extent (5m^2 diameter)
3	387509	6362201	weed invasion lantana, bitou bush (8m^2)
4	387620	6362227	weed invasion lantana, bitou bush (8m^2), bamboo species
5	387620	6362228	Bitou bush
6	387508	6362201	Bitou bush
7	387588	6362221	Weed infestation including mainly garden escapees, lantana, fireweed, cottoneaster and bitou bush
8	387594	6362233	Blackberry, lantana, highly disturbed area beneath easement along fenceline.
9	388251	6362465	Bitou bush
10	388153	6363351	weed infestation mainly small herbs such as *Hebenstretia*, fireweed, cottoneaster and grasses including kikuyu.
11	388164	6363361	weed invasion mainly bitou bush and lantana
12	388306	6362923	Banksia over track, very narrow road, few weeds
13	388978	6362531	Bitou bush (5m^2) regenerating after fire
14	388993	6362527	start of bitou bush on either side of road regenerating after fire
15	389245	6362973	scattered fireweed either side of road
16	389312	6363027	Bitou bush
17	389359	6363047	Bitou bush extends either side of road back to dune, extends to north to meet up with other track
18	389552	6363102	Bitou bush extensive on dunes
19	389436	6363122	Bitou bush (5m^2)
20	388996	6363196	Bitou bush invasion
21	388962	6363126	Bitou bush invasion
22	389033	6363101	Bitou bush invasion
23	389236	6363058	Bitou bush invasion
24	389269	6363015	Bitou bush previously burnt however extensive resprouting obvious
25	388387	6362524	Bitou bush on weapons store
26	388251	6362484	Bitou bush (10m^2)
27	388258	6362480	Bitou bush
28	388254	6362475	Bitou bush
29	388166	6362508	Bitou bush (3 clumps)
30	388023	6362789	Bitou bush infestation
31	388086	6363252	Bitou along fence.
32	388125	6363410	Blackberry, lantana, highly disturbed area beneath easement along fenceline.
33	388088	6363337	Bitou bush
34	388083	6363298	Bitou bush
35	388057	6363273	Bitou bush
36	387641	6362206	Bitou bush
37	387908	6362185	Bitou bush
38	387985	6362140	Bitou bush 10m by 2m.
39	388096	6362178	Bitou bush 3m by 2m.
40	388256	6362220	Bitou bush 3m by 1m.
41	388258	6362225	Bitou bush 2m^2.
42	388330	6362250	Bitou bush along track between DEC 4m wide for distance of 50m.
43	388127	6362349	Bitou bush along main road distance of 2m.
44	388119	6362407	Mother of millions (*Bryophyllum delagoense)* 3m^2, cotoneaster *(*3m^2, >20 bitou bush 10m wide. Generally extensive bitou bush infestation around concrete foundation.
45	388127	6362419	Bamboo

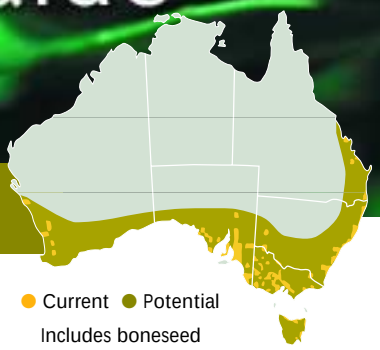
Waypoint	Easting WGS	Northing 84	Description
46	388101	6362438	Mother of millions, Bitou bush.
47	388174	6362505	*Hebenstretia* along concrete road between historical structure 2 and 7 and again at historical site 3.
48	388976	6362532	Bitou bush 1m².
49	388973	6362947	Bitou bush.
50	388254	6363308	Bitou bush.
51	388092	6363131	Bitou bush
52	388037	6362860	Bitou bush either side of track 10m by 4m wide.
53	387696	6362265	Coral tree.
54	388312	6362651	Bitou bush.
55	388955	6362501	Bitou bush.

Annex H

Noxious and Nationally Significant Weed Profiles

Weed Management Guide

Bitou bush – *Chrysanthemoides monilifera* ssp. *rotundata*



Bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*)

The problem

Bitou bush is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Bitou bush threatens coastal dune vegetation along Australia's east coast. It can outcompete and in many cases totally replace native flora, and it invades undisturbed as well as disturbed areas. Infestations of bitou bush drastically alter the environment for many native birds and animals. It can also create a favourable environment for other highly invasive weeds, such as asparagus fern, lantana and glory lily.

Ironically, one of the plants being choked by bitou bush along the New South Wales coast, golden wattle (*Acacia longifolia*) has become a major pest of coastal dunes in South Africa, where it was introduced to serve much the same purpose as bitou bush in Australia.

The weed

Bitou bush is a perennial, evergreen shrub, normally 1–2 m high although it can form canopies up to 10 m high. Unlike its close relative boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*), which grows as an erect bush, bitou bush is a sprawling shrub.

Bitou bush aggressively invades both intact natural bushland and disturbed areas, particularly coastlines.
Photo: Paul Weiss

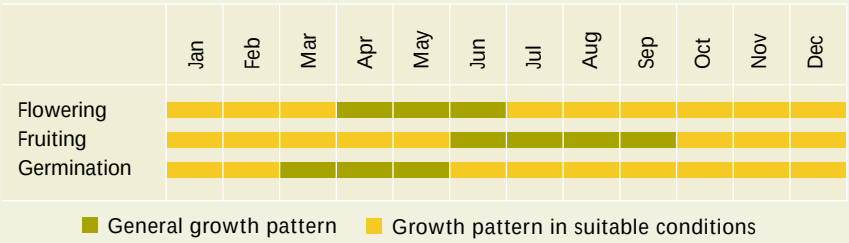
Its stems are branched and woody and the upper stems are often purple. The leaves, which are about 20–80 mm long, oval to oblong in shape and tapering at the base, alternate along the stems. Unlike boneseed, which has leaves with serrated edges, bitou bush has leaves with smooth edges. Bitou bush also has an extensive root system and appears more aggressive and more difficult to control than boneseed. The yellow, chrysanthemum-like flowers, up to 20 mm in diameter, are clustered at the ends of the branches. The small berries have green, fleshy skin that changes to brown and black on maturity. The fruit contains a single egg-shaped seed 5–7 mm long which is dark brown to black when dry.

Key points

- Prevention and early intervention are the most cost-effective forms of weed control. It is vital to keep clean areas free of bitou bush.
- Bitou bush infestations leave a large and persistent seedbank in the soil, so for long-term control infested areas must be treated repeatedly for several years.
- Integrated management using a range of control measures (eg mechanical, chemical and biological control, and the careful use of fire and/or grazing) is required to successfully control bitou bush.
- Monitor treated areas annually to detect and eradicate regenerating seedlings before they have a chance to produce seed.

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

Growth calendar



Seeds germinate at any time of the year but mostly in autumn. Most seeds remain viable for at least two years. The seedlings grow rapidly during winter and a few plants may flower in the first year, particularly on burnt areas where there is little competition. However, plants are usually at least 18 months and sometimes three years old before flowering. Bitou bush can flower almost year round, but peak flowering occurs between April and June, unlike boneseed which forms flowers in late winter and spring. Bitou bush fruits ripen during winter and the start of spring.

On the south coast of New South Wales, seedlings usually reach flowering age after three years (earlier if growing in burnt or favourable conditions), while on the north coast growth is much more rapid and flowering within one year is more usual.

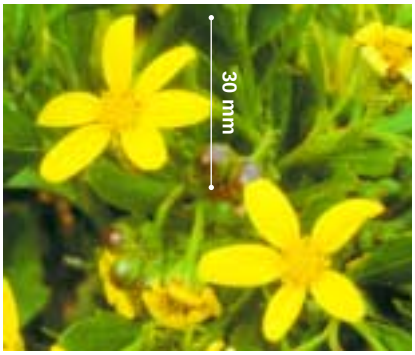
How it spreads

Bitou bush spreads primarily by seed, with each plant producing up to 50,000 seeds a year. In established infestations, soil seedbanks can contain up to 5000 seeds per square metre. Soil disturbance (eg after bulldozing), fire and ingestion of seed by birds and animals promote seed germination but seeds can still germinate in undisturbed situations.

Birds are important in spreading seed as they readily eat the fruit and then pass the seed, sometimes many kilometres from the original source. Rabbits and foxes also eat the fruit and spread the seed in their droppings. Seeds are also spread by water, in ocean currents or through coastal creeks and waterways. Human activities can lead to the spread of bitou bush by vehicles and equipment. On a local scale, seeds may be spread in windblown sand.

Bitou bush can resprout after fire, slashing and herbicide application.

Flowering can occur year round. This specimen was flowering in November near Byron Bay, NSW.
Photo: Kate Blood



The closely related boneseed has 5–8 yellow petals on its flowers and serrated-edged leaves. For more information see other guide in this series.
Photo: Colin G. Wilson

Where it grows

Bitou bush was first recorded in Australia near Newcastle, New South Wales, about 1908, probably introduced through dumping of ships' ballast. From 1946 to 1968 it was planted along the coast to revegetate areas after sandmining. It was also planted on sand dunes near Menindee in western New South Wales where a small infestation still persists.

Bitou bush is naturalised in all states and territories except the Northern Territory. It is mainly restricted to coastal ecosystems with summer rainfall, similar to its range in South Africa.

Bitou bush grows in a range of environments – from open exposed dunes to shaded forests. It is tolerant of shade, salinity, strong wind, wind-blown sand and water, drought, low nutrients and, to some extent, disturbances such as fire. It grows poorly in wet or swampy soils and has a low tolerance to frost.

A recent survey recorded bitou bush on 900 km, or 80%, of the NSW coastline, with an estimated 36, 000 ha infested. Around Sydney there are mixed populations of boneseed and bitou bush. National containment zones for bitou bush have been established in New South Wales on the far north coast and the south coast. In Queensland bitou bush occurred on coastal sandmining areas

Bitou bush threatens coastal dunes and rainforests across southern Australia.
Photo: John Vranjic

but has been targeted for eradication for the past decade. Smaller isolated infestations occur on Lord Howe Island and near Melbourne.

Potential distribution

Bitou bush is spreading further into the understorey of forests and woodlands next to the coastal strip. Recent mapping has recorded infestations up to 10 km inland. There are still large areas outside its current distribution which are potentially at risk, including the whole of Tasmania and much of southern Australia.

The sprawling bitou bush plants have branched, woody stems, which are often purple near the top.
Photo: Kate Blood

What to do about it

Preventing spread

It is important to keep clean areas free of bitou bush. Once an infestation is established, preventing the spread of seeds into surrounding areas should be a priority. This means destroying established plants before they flower and produce fruit.

Any bitou bush plants in gardens should be destroyed since they represent a seed source and hence potential for further spread.

Much of southern Australia including the whole of Tasmania is climatically suitable for bitou bush

Raising awareness amongst recreational vehicle users is important, particularly in coastal areas where seed may be spread by their activities.

Management strategies

In order to minimise the amount of seed produced, it is necessary to detect as many plants as possible. In areas where access is difficult, tracks may need to be cut to make control efforts easier. The greatest difficulty is the large area infested and the rapid reinvasion of an area after initial attempts at control. A sustained control effort is required for up to ten years.

Bitou bush responds much more quickly than native plants after burning or land clearing, and with a large seed bank in the soil it will quickly form a dense growth of seedlings, swamping native species.

Shallow roots make mechanical control easier

Unlike many other woody weeds, bitou bush has a shallow root system with no distinct taproot, so pulling the bushes is possible. Seedlings and plants up to 1 m in height can be hand pulled.

Bitou bush does not persist when grazed or cultivated. Slashing alone is not effective as regrowth occurs from the stump, but applying herbicide to stems immediately after cutting should prevent regrowth. The removal of adult plants stimulates seed germination so new seedlings must be removed before they produce further seeds.

Herbicides are effective

Herbicides registered for bitou bush can be applied in winter at low rates that effectively kill the weed, yet have minimal impacts on coastal vegetation. However, in northern parts of the weed's range where it matures more quickly, two spraying programs a year may be necessary to prevent seeding.

Herbicides registered for bitou bush can be applied from the air, from the ground or by a cut and paint method. Plants coated with dust or seaspray (eg those close to tracks or the beach) will be less affected by herbicides.

Isolated plants can be treated with herbicide applied by spot spraying. As infestations become larger, a strategically staged approach for removal is advisable to ensure that treated areas are not reinfested.

In New South Wales low dosages of herbicides have been applied from helicopters in winter, allowing large areas to be treated rapidly with minimum impact on native species. Reports indicate better than 95% control.

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control bitou bush and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

There are several effective biological control agents

The lack of natural enemies attacking bitou bush in Australia is one of the reasons it has become a serious weed. In classical biological control these natural enemies are introduced into Australia if they are shown not to attack Australian native species or other valuable plants. Biological control is a slow process and will not eradicate bitou bush. It is useful as part of an integrated approach and in areas where the application of conventional control methods is inappropriate due to economic, practical or environmental constraints.

Since 1987, when the first biocontrol agents for bitou bush and boneseed were released in Australia, seven control agents have been released. Two are well established and require no further distribution: the bitou tip moth (*Comostolopsis germana*) which destroys developing leaves, buds and flowers and reduces seed production; and the bitou seed fly (*Mesoclanis polana*) which destroys developing seeds. Leaf-feeding beetles (*Chrysolina* and *Cassida* spp.) were also released but have either not established or are colonising only slowly.

In 2001 the bitou leaf rolling moth (*Tortrix* sp.) was released on boneseed in the You Yangs in Victoria and on bitou bush in New South Wales. Although it has failed to establish on boneseed, it has established well at two sites on bitou bush. Another agent, the boneseed leaf-buckle mite, is being tested for release.

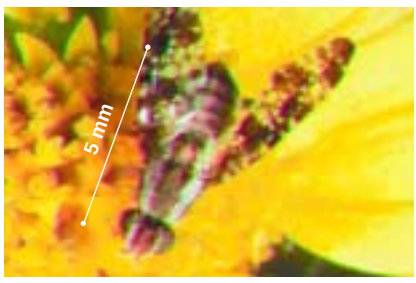
Fire can kill mature bitou bush

Intense fire kills most mature bitou bush, although a small proportion resprout. Fire also kills bitou bush seeds in the litter and topsoil and stimulates germination of seeds from lower in the soil profile. These new seedlings must be removed before they produce further seeds.

Trials have shown that the seedbank in the soil is significantly reduced following burning of mature plants previously killed with herbicide. In areas where a large proportion of the remnant vegetation is known to be fire-sensitive, fire should not be used. Fire can also cause other problems such as increased erosion potential, increased traffic and access by humans and pest animals, and further invasion by weeds. Note that permission of the landowners and a permit from the relevant state or territory fire authority are generally required to authorise the use of fire, and that the fire should be undertaken by properly trained and equipped personnel.

Grazing

Cattle eat bitou bush and this limits its spread onto grazed properties next to heavily infested areas. But grazing in many bitou bush infested areas is not appropriate due to problems associated with stock, such as browsing of native plants, erosion from stock movement and the spread of other undesirable weeds.



The bitou seed fly (*Mesoclanis polana*) destroys developing seeds.
Photo: Weeds CRC

The caterpillar stage of the bitou leaf rolling moth (*Tortrix* sp.).
Photo: Royce Holtkamp

...case study

Restoration of native vegetation at Iluka Bluff on the north coast of New South Wales

A collaborative project at Iluka Bluff on the north coast of New South Wales is helping to restore a badly degraded, bitou-infested coastline.

Iluka Bluff is next to the largest remaining coastal rainforest in New South Wales, the Iluka Rainforest World Heritage Area.

With funding from the Commonwealth Government's Natural Heritage Trust, the Iluka Land and Dune Care Group and the New South Wales National Parks and Wildlife Service (NPWS) began working in 1996 to restore the natural vegetation of the Iluka Bluff area.

Most of the 5 ha project site consisted of dense bitou on the Iluka Bluff headland with small areas of remnant kangaroo grass (*Themeda triandra*) on the eastern and southeastern slopes. The beachfront in the project site was almost exclusively bitou bush as well.

The project involved a number of weed control methods and also saw a new biological control agent, the bitou bush seed fly (*Mesoclanis polana*), established at the site.

The initial treatments for the dense bitou infestations used a Greencorp team to cut access tracks to clear the way for high volume spraying, which was done by contractors and NPWS staff. Bitou amongst the sensitive remnant grassland was either hand removed or cut and painted, with limited spraying.

Several months later, the dead standing mass on the hillside was burnt under controlled conditions. This was done to make follow-up treatment easier, and to destroy a portion of the bitou seedbank and stimulate the remaining seedbank to germinate. Afterwards, mats of cut tea-tree were placed on the bare hillside to help reduce erosion risks.

The bitou on the beachfront was sprayed and, after a suitable time, crushed with a tractor. Areas on the hillside and the beachfront with little native regeneration were then planted by the landcare group and other volunteers. Since then the site has been treated periodically to control regrowth of bitou and other weeds.

As a result of this work, native vegetation cover from natural regeneration and plantings is now dominant over 40% of the 5 ha site.

The project has complemented other regeneration work in the rainforest and has played a large part in Iluka Bluff being named as New South Wales' cleanest beach for 2002.

Integrated management

Wherever possible, an integrated management approach needs to be adopted using several control measures. As with most weed control programs in natural ecosystems, natural regeneration or over-sowing with locally collected seed of native species is an important part of the rehabilitation process. If bitou bush is eradicated without follow-up, other weeds such as glory lily quickly fill the gaps.

Rainforests require special treatment

A combination of spot spraying, mechanical removal and biocontrol may be the most appropriate for rainforest infestations. Fire is not recommended because of the sensitive nature of rainforest plants to burning. The number of new weed seedlings in the forest may be low, as bitou bush does not flower well under heavy shade conditions. Treat vigorous infestations of bitou bush surrounding the rainforest.

Disposal

The stands of dead bitou bush left after spraying can be removed by trampling, compacting or, if appropriate, fire. If they are left standing they may provide some protection to dune environments until they eventually decompose. Small amounts of bitou bush removed by hand pulling or mechanical clearing can also be left to decompose but, if possible, the seeds should be removed and burnt.

Legislation

The Australian Quarantine and Inspection Service prohibits the entry of bitou bush into Australia. The plant is declared in New South Wales, Queensland, South Australia, Victoria and Western Australia. Landholders in these states are required to control it. Check with your local council or state/territory government agency about the latest requirements for bitou bush control.

Acknowledgments

Information and guide revisions: Richard Carter (NSW Agriculture/Weeds CRC), Nigel Ainsworth (DPI Vic/Weeds CRC), Jeff Thomas (NSW NPWS), Royce Holtkamp (Agriculture NSW/Weeds CRC), Rhonda James (Coordinator North Coast NSW Bitou Bush Strategy), Paul Downey (NSW NPWS) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.

In northern parts of its range, two spraying programs a year may be needed to prevent bitou bush seeding.
Photo: Rhonda James

How to control bitou bush

Quick reference guide

Bitou bush – *Chrysanthemoides monilifera* ssp. *rotundata*

Applying herbicide to stems immediately after cutting should prevent regrowth.
Photo: Rhonda James

For large infestations

A sustained control effort is required for large infestations. Hand pull seedlings and plants up to 1 m tall. For larger plants, apply a recommended herbicide immediately after cutting. Match treatment areas to the resources available for follow-up works. Under the right conditions, infested areas can be burnt to encourage germination of the seedbank. New seedlings must be removed before they flower.

For small infestations

Destroy established plants before they flower and produce fruit, to prevent the spread of seed. Treat isolated plants with a recommended herbicide applied by spot spraying.

In rainforests

A combination of spot spraying, mechanical removal and biocontrol may be the most effective for rainforest infestations. Keep soil disturbance to a minimum to reduce the risk of stimulating germination.

Treat healthy infestations of bitou bush near the edges of the rainforest. Once bitou bush is removed, fast-growing rainforest species will regenerate.

Revegetation in other areas

Once bitou bush is controlled other weeds may invade, so only tackle areas where follow-up control is possible. Follow up with direct seeding or planting of indigenous species.

Follow-up control

Because of the large and persistent seedbanks in the soil, follow-up control is required for about ten years.

Disposal

Remove seeds and burn them. Stands of dead bitou bush can either be left until they decompose or are physically removed.

Control options

Type of infestation	Herbicide	Biological	Physical	Burning
Large infestation – large area, many plants	Spray to kill seedlings before flowering. Contact authorities for information about registered herbicides.	The bitou tip moth and bitou seed fly are distributed along most of the range of bitou bush.	Hand pull or cut woody plants in spring.	Fire can be used to reduce the large soil seedbank.
Isolated plants or small infestations	Spot spray or use cut and paint treatment.	Not suitable.	Remove plants before they set seed.	Not suitable.
Rainforests	Spray to kill seedlings before flowering. Contact authorities for information about registered herbicides.	Use in combination with spot spraying and mechanical removal.	Hand pull or cut woody plants in spring.	Not recommended because of sensitive nature of rainforest plants to burning.

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CRC Weed management

best practice management guide

3

BEST PRACTICE MANAGEMENT GUIDE FOR ENVIRONMENTAL WEEDS

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Bitou bush, *Chrysanthemoides monilifera* subsp. *rotundata*

Bitou bush fruit.
Photo: K. Blood.

Bitou bush infestation.
Photo: J. Vranjic.

Bitou bush being sprayed.
Photo: J. Vranjic.

Taxonomy and status

Botanical name: *Chrysanthemoides monilifera* subspecies *rotundata* (DC.) T.Norl. - Family Asteraceae (daisy family).

Standard common name: bitou bush. Other common names applied in Australia include South African star bush and Mort's curse.

Relationship to other species in Australia: The introduced weed boneseed, *Chrysanthemoides monilifera* subsp. *monilifera* is the only close relative. There are no closely-related indigenous species.

Legislation: Bitou bush is declared noxious in Queensland and a Category 2 or 3 listed plant for Lord Howe Island and certain shires in NSW. It is listed as a *Key Threatening Process to Biodiversity* in NSW and as a *Weed of National Significance* in Australia. Keep up to date with the latest legislation through local and State/Territory government weed agencies or on the web at www.weeds.org.au

Description

Habit/lifeform: spreading woody shrub with succulent stems, often prostrate on the ground.

Description: Shrub dimensions are typically 1-2 m tall and 2-6 m wide. Bitou bush develops a creeping habit under shade and may smother canopies up to 10 m in height. Its leaves are bright green, succulent, oval in shape with a tapering base and irregular teeth along the edge, 3-8 cm long. Young growth is typically covered by a cottony down. Mature plants produce lots of bright yellow daisy-like flowers with 11-13 'petals' (*Figure 1*). Fruits are green, becoming black when ripe and contain only a single seed. The seeds are egg-shaped, 5-7 mm long, fleshy externally with an internal hard bone-like shell which is dark brown to black when dry.

Figure 1. Bitou bush flowers and fruit.
Photo: K. Blood.

Bitou bush differs from boneseed by its sprawling growth habit (versus the erect habit of boneseed), rounder and less obviously toothed leaves (*Figure 2*), flowers with more 'petals' (11-13 for bitou bush versus 5-8 for boneseed) and egg-shaped ribbed seeds (versus round, smooth seeds for boneseed) (*Figure 3*).

Figure 2. Bitou bush (right) leaves, flower and fruit compared with boneseed (left).
Photo: K. Blood.

Figure 3. Bitou bush leaves and fruits (right) compared with boneseed (left).
Photo: P. Weiss.

Origin and distribution

Origin: Bitou bush is native to coastal regions of South Africa.

Introduction: The exact date and manner of introduction of bitou bush into Australia are unknown. The introduction probably was accidental through dumping of ballast by ships arriving from South Africa. Earliest herbarium records indicate an introduction to the Stockton area near Newcastle, NSW, in about 1908. From 1946-1968 bitou bush was planted deliberately along the NSW coast by the Soil Conservation Service of NSW to aid in erosion control and post-mining rehabilitation.

Distribution: Bitou bush has invaded coastal habitats in south-eastern Queensland, NSW and Lord Howe Island. Bitou bush is particularly prevalent on the central and north coasts of NSW (*Figure 4*). A population was also planted and has persisted near Menindee in western NSW and a small population is present near Melbourne, Vic. The total area infested is estimated currently to be over 70 000 ha in Australia.

Figure 4. Distribution of bitou bush in Australia.
Map based on Parsons and Cuthbertson, 1992.

Ecosystems invaded: Bitou bush primarily invades disturbed and undisturbed coastal ecosystems (*Figure 5*). A variety of ecosystem types have been invaded including sand dune heathlands and grasslands, headland heathlands and grasslands, coastal woodlands, coastal dry sclerophyll forests, and littoral rainforests. Mallee vegetation in western NSW has also been affected by bitou bush.

Figure 5. Bitou bush infestation (paler green vegetation) along coastal dunes.
Photo: K. Blood.

Impacts

Species and ecosystems at risk: In 1999, bitou bush was listed as a *Key Threatening Process to Biodiversity* in NSW and as a *Weed of National Significance*. No species is known to have become extinct as a result of bitou bush invasion but its distribution does overlap with those of some rare and endangered plant species, notably *Pimelea spicata*, *Zieria prostrata*, *Cynanchum elegans* and *Thesium australe.* Bitou bush displaces the dominant plants in communities it invades, for instance *Acacia sophorae* on coastal dunes *(Figure 6)*, and leads to a decline in floral biodiversity, as well as changes in the diversity of birds, indigenous mammals and ground-dwelling insects. Stands of bitou bush may also foster sites that harbour pest animals, such as foxes and introduced birds, which feed on and disperse the seeds or shelter under bitou bush canopies.

Figure 6. Dense stand of bitou bush showing extent of infestation.
Photo: J. Vranjic.

Economic impact: No figures are available for the total cost of bitou bush to the Australian community. The costs of large-scale management to date are high as they involve considerable amounts of labour from Dunecare and Landcare groups, aerial spraying with herbicides, bulldozing and establishing a biological control program.

Dispersal and establishment

Reproductive techniques: Bitou bush spreads primarily by seed. Germination appears to be promoted by fire, soil disturbance (eg. after bulldozing), and ingestion of seeds by birds and mammals. Seeds also appear to germinate better after a period of weathering and leaching in the soil. Unlike boneseed, mature plants of bitou bush may resprout after fire, slashing and herbicide application. The seeds ripen from June to September and most usually shrivel, dry and fall off or are taken by animals. Some seed can stay on the parent plant for up to a year.

Vectors and dispersal mechanisms: Dispersal occurs primarily by animals such as birds and foxes eating seeds and passing them in faeces. This can spread seed over distances of kilometres. Some seeds may also be dispersed by ocean currents or through coastal creeks and waterways. Localised dispersal can occur through movement of sand blown by wind. Human-assisted dispersal was a factor in the initial spread of bitou bush via deliberate planting for early erosion-control programs. Seeds may be transmitted by tyre treads or soil adhering to vehicles and equipment. Seeds otherwise fall to the ground under the parent plants.

Persistence: Mature plants may produce up to 48 000 seeds per plant per year. The soil seed bank usually consists of 2 000 to 5 000 seeds per square metre. The viability of seeds in the soil is variable but generally low: 2-30%. The maximum longevity of seeds is unknown but viability of most seeds is considerably reduced after 2-4 years. Dormancy mechanisms are not fully understood but it is likely that the fleshy cover surrounding the seed contains chemicals that inhibit germination and must be leached or decomposed away for germination to commence. Fire, exposure and soil disturbance appear to enhance germination.

Tolerances: Bitou bush grows in a range of environments from open exposed dunes to shaded forests. It is tolerant of shade, salinity, strong wind, wind-blown sand, salt and water, drought, low nutrients and, to some extent, of disturbances such as fire. Bitou bush grows poorly in wet or swampy soils and has a low tolerance to frost.

Properties

Health risks and other undesirable traits: Cattle graze bitou bush with no significant toxic effect. Bitou bush affects indigenous plants mainly through competition, its high growth rate and, possibly, by releasing chemical inhibitors. Dense stands of bitou bush exclude other indigenous plants leading to decreasing floral biodiversity and, consequently, changes in faunal diversity. Stands of bitou bush also reduce the aesthetic appeal of natural environments and reduce recreational access to beaches and along walking trails.

Cultural uses: Bitou bush is not used for ornamental, culinary or medicinal purposes in Australia although it is possible to make jam from the fruits. Although formerly used for revegetation purposes in the 1940s-1960s, this practice was discontinued when its undesirable weedy attributes were recognised.

Biology and ecology

Biology and ecological notes: An Australian native organism known to attack bitou bush is the fungus *Sclerotinia sclerotiorum* that causes shoots to rot. There is a low incidence of fungi beneficial to plant growth forming associations on the roots. The weed appears to be quite vigorous and competitive in its interactions with indigenous flora and tolerant of a range of growing conditions and disturbances. Boneseed will hybridise with bitou bush to produce fertile plants with intermediate characteristics.

Growth calendar: Seed germination can occur throughout the year though most seed germinates after autumn rains. On the south coast of NSW, seedlings usually reach flowering age after three years, or earlier if germinated in burnt or favourable exposed sites. On the north coast of NSW, seedling growth is much more rapid and flowering within one year is more usual. Peak flowering occurs from April to June. Peak fruiting occurs from June to September.

Management

Prevention: It is important to keep uninfested areas clear of bitou bush. Once an infestation is established, preventing its spread into surrounding areas should be a priority. This requires integrated management to reduce seed production and the control of undesirable dispersal vectors, notably foxes. The control of indigenous or introduced birds or other pest animals as dispersal vectors is usually not practicable. A gradual replacement of bitou bush by indigenous plants that produce the "normal" food supply of indigenous seed-feeding birds could help to reduce dispersal of weed seeds.

The quarantining of an area to stop movement of seeds in sand on vehicles and equipment may be necessary. Raising awareness amongst recreational vehicle users particularly in coastal areas is advisable where this form of dispersal is a problem.

Integrated management: When treating bitou bush in a natural ecosystem, it is essential to consider its management in light of other management issues so that they can be integrated to get the best results. When using these guidelines, it is essential to realise their limitations and modify them in light of experience and local knowledge. Each situation should be considered individually. Weeds need to be treated as part of larger land and water management issues.

If the weed occurs in small isolated infestations, removal to prevent expansion is advisable. Larger infestations require planning to efficiently reduce the population to an acceptable

level. That level will be determined by the management objectives of the area and the resources available to tackle the problem.

Treatment techniques: There are a number of different treatment techniques that can be used but it is often better to combine a number of techniques for the best results:

Mechanical treatment: Mature plants can be slashed, whilst seedlings can be hand-pulled to remove the entire root system. Plants are liable to resprout after slashing alone, but applying herbicide to stems immediately after cutting should prevent regrowth. Mechanical techniques are laborious and impractical for infestations that are extensive or in areas that are difficult to access and may also cause soil disturbance and erosion problems, particularly when large roots are removed.

Herbicide information: **When using chemicals always read the label and follow all instructions carefully. Consult a specialist for advice on registered chemicals in your particular State or Territory. Herbicide information is available at the National Registration Authority web site at** www.affa.gov.au/nra/pubcris.html

Herbicides registered for bitou bush can be applied in winter at low rates that effectively kill the weed, yet have minimal impacts on coastal vegetation *(Figure 7)*. Herbicides can be applied from the air, from the ground or by a cut-and-paste method. Plants which are coated with dust or seaspray (eg. those close to tracks or the beach) could be less affected by herbicides. Glyphosate and metsulfuron methyl have been the herbicides most widely and successfully used against bitou bush.

Figure 7. Impacts of herbicides on bitou bush and indigenous species. *Photo: J. Vranjic.*

Biological control: Two insects that attack bitou bush in South Africa have been released and established very well in Australia. These are the bitou tip moth (*Comostolopsis germana*) which destroys the growing tips, and the bitou seed fly (*Mesoclanis polana*) that destroys developing seeds. Both agents are now distributed along most of the range of bitou bush and, together, are reducing seed production of bitou bush. Leaf-feeding beetles (*Chrysolina* and *Cassida* spp.) also were released but have either not established or are colonising only slowly. Research is continuing into other South African insects and fungi that attack bitou bush.

Figure 8. The bitou seed fly (*Mesoclanis polana*) (top) and the Bitou tip moth (*Comostolopsis germana*) (bottom), effective biological control agents for bitou bush. *Photos: P. Edwards.*

Fire: An intense fire kills most mature plants although a small proportion of plants resprout. Fire also kills bitou bush seeds in the litter and topsoil and stimulates germination of seeds from lower in the soil profile. Fire, therefore, can be useful in reducing the large numbers of bitou bush seeds present in the soil but much depends on the intensity of the fire which is determined in part by fuel load, season and fire history. Fire can cause additional problems such as increased erosion potential, increased traffic and access by humans and pest animals, and further invasion by weeds. Note that permission of the land owners and a permit from the relevant State fire authority is generally required to authorise the use of fire and that the fire should be undertaken by properly trained and equipped personnel.

Grazing: Cattle eat bitou bush. This limits the spread of bitou bush onto grazed properties adjacent to heavily infested areas. Management of bitou bush through grazing, however, usually is not practised on public lands because of problems associated with stock such as browsing of desirable indigenous species, erosion from stock movement, fouling of areas by dung and the spread of other undesirable weed species.

Management guidelines: The major objectives for integrated management schemes are to: remove existing weeds, run down the amount of weed seeds in the soil, reduce the opportunities for reinvasion by the same or other weeds, and rehabilitate and revegetate with desirable indigenous species. The nature of invasion by bitou bush means that these objectives must be long-term, as considerable time is required to properly apply some of the management techniques. A lack of appropriate follow-up will quickly lead to reinfestation of bitou bush. The following guidelines are some general strategies to manage bitou bush in particular ecosystems.

Isolated plants or small infestations: Ensure that you have correctly identified the plant before removal. Isolated plants can be physically removed, preferably before they have seeded, or treated with herbicide such as glyphosate applied by spot-spraying. As infestations become larger, a strategically staged approach for removal is advisable to ensure that treated areas are not reinfested.

Large and extensive infestations in coastal heath, woodlands and grasslands on hind dunes: A multi-stage spray-burn-spray strategy incorporating biocontrol agents is recommended as a general strategy. Most sites or all now harbour at least one biocontrol agent. Spray large patches of bitou bush in winter with herbicide. This can be applied aerially *(Figure 9)* or from the ground. Leave some areas unsprayed to allow biocontrol agents to persist and subsequently disperse from.

Next, burn portions of sprayed patches. This should remove unsightly patches of dead bitou bush and stimulate the germination of both weed and certain indigenous species which are present in the soil. On the south coast of NSW, an autumn fire is best but on the north coast, a spring fire may be more appropriate.

Monitor sites for bitou bush, biocontrol agents and indigenous plants. In particular, determine the extent of re-emergence of bitou bush, impact of biocontrol agents on bitou bush seedlings and any regeneration of desirable indigenous plants.

Respray as necessary to control regrowth and bitou bush seedlings which have escaped damage by biocontrol agents. Again, leave some patches unsprayed to harbour biocontrol agents. The timing of the respray depends on the region but in general it is best to spray before seedlings start producing seeds but after they have grown sufficiently tall and self-thinned. The time for bitou seedlings to reach maturity is at least a year on the south coast but as short as six months on the north coast of NSW.

Figure 9. Large area of coastal bush aerially sprayed. Note only dead bitou bush plants.
Photo: K. Blood.

Note that the full implications of a biocontrol-spray-burn-spray strategy to coastal grasslands have not yet been determined but many such ecosystems are known to be fire-adapted. In areas where a large proportion of the remnant vegetation is known to be fire-sensitive, fire should not be adopted.

Large and extensive infestations on coastal foredunes: Fire is not recommended because of the sensitive nature of this ecosystem to erosion. Instead, a combination of biocontrol-spraying-mechanical removal may be most appropriate. Follow-up spraying may need to be undertaken regularly, as noted above for the hind dunes.

Rainforests: Fire is not recommended because of the sensitive nature of rainforest plants to burning. A combination of biocontrol, spot-spraying and mechanical removal may be most appropriate for infestations within the forest. The numbers of new weed seedlings in rainforests may be low, due mainly to poor flowering of bitou bush under heavy shade. Most seedlings probably will originate from external infestations. It is important, therefore, to give priority to managing healthy infestations of bitou bush in areas surrounding rainforests.

Given the likelihood of scarce resources and the complexity of management issues, the following considerations should also be taken into account when adopting a strategy. Attention must focus on all weeds at a site as bitou bush is unlikely to be the only weed present. The possibility of new and more vigorous weeds filling the gaps left after removing bitou bush must be minimised. Many bush regenerators first manage the smallest weed infestations and gradually work towards larger infestations. Smaller infestations in which much of the indigenous vegetation is intact have a greater potential for natural restoration. Strategies will need to be modified to accommodate special requirements such as the management of endangered plant and animal species. For example, it is possible that bitou bush could provide shelter for certain indigenous fauna. In other cases, endangered indigenous plants may be particularly sensitive to management techniques (eg. *Pimelea spicata* is very sensitive to herbicides). Exercise judgement to address the specific management objectives additional to the control of bitou bush. It is impractical to aim for complete eradication of the weed. Instead, aim at minimising weed infestations to a level where it is easier and cheaper to manage. For instance, target specific sections of the weed population such as seedlings that have not yet reached flowering age in heavily disturbed sites, or only heavily flowering plants.

Disposal: The unsightly stands of dead bitou bush that occur after spraying can be eliminated by compacting, trampling or fire, in appropriate ecosystems. If allowed to stand, the dead canes help to deter undesirable traffic and afford some physical protection to dune environments until they eventually decompose. Small amounts of bitou bush removed by clearing or hand-pulling also can be left in place to decompose naturally but, if practical, seeds should be removed and incinerated.

Community awareness: Being a prolific coastal weed, bitou bush has a relatively high profile, especially among members of the public involved with Dunecare, Landcare and Coastcare groups. These volunteer groups are very effective in assisting with follow-up work, systematic searches for new infestations and preventing weeds from spreading. Erecting simple signs at beach entrances that provide information on what bitou bush plants and seedlings look like and how to help control it are a good way of informing the general public. The bitou bush problem also has received occasional media attention.

Consider running activities as part of national Weedbuster Week in October each year to increase local community awareness of the problem. See the web site at www.weedbusterweek.info.au for more information.

Follow-up: Monitoring should concentrate on the number of regenerating bitou bush seedlings, any impacts of biocontrol agents on those seedlings, and the numbers of regenerating indigenous plant seedlings. The most appropriate time to monitor is in late winter to early spring after the autumn-winter rains have stimulated germination. As some seeds of bitou bush may persist for years in the soil because of dormancy mechanisms, monitoring and follow-up should also be implemented over the long-term. The use of community groups to assist with simple follow-up and monitoring procedures should be encouraged.

Management calendar: The recommended integrated management strategy essentially incorporates biocontrol, winter herbicide sprays, a possible fire in autumn or spring for appropriate ecosystems, monitoring in winter-spring and follow-up winter sprays. The spray-burn-spray strategy should be applied within three successive years to account for the fact that stimulation of massive weed germination by fire will lead to a natural reduction in the numbers of emergent seedlings and allow time for biocontrol agents and indigenous plants to establish or have an impact. In all cases, it is important to remove immature plants of bitou bush before they reach flowering age, which is a minimum of six months to one year on burnt areas and 1-3 years on unburnt sites. If seedlings are to be hand-pulled this is best achieved when they have grown sufficiently tall, say to 1 m in height, as by that stage they have self-thinned and can be pulled out more effectively.

Replacement plants: The indigenous plant species used to revegetate sites invaded by bitou bush depends on the composition of local flora present at each site or habitat. The existing indigenous vegetation at a site should be conserved as far as is practicable as these plants provide a natural seed-source. If active revegetation is to be implemented, seeds or plants from species and populations endemic to a region ideally should be used. Do not introduce native species that were never present at a locality as some native plants can become weeds in the wrong circumstances. Widespread coastal species that could be useful for revegetation include *Acacia sophorae, Banksia integrifolia, B. serrata, Lomandra longifolia, Spinifex sericeus* and *Themeda australis*. It is best to seek the advice of local flora and revegetation experts for suitable indigenous plants of local provenance for revegetation. Revegetation by sowing indigenous seed is best implemented in winter after applying the spray or burn so that emerging seedlings are not destroyed by the techniques used to manage weeds.

WeedWatch: There are several simple things that can be done if bitou bush plants are found at new sites in the field. Make sure they are identified correctly as bitou bush. If uncertain about identification, send a specimen to the State or Territory Herbarium with details on where and when it was found and the contact details of the person who sent the specimen (see the *White Pages* or the *Weed Navigator* for address details of herbaria).

Isolated smaller plants can be pulled out and left in the field to die. Mature plants and large patches of bitou bush are more difficult to completely remove. It is best to notify the person responsible for weed management on that land, usually a National Parks or district weeds officer or local community Coastcare representative. These can be contacted at the nearest National Parks or shire offices.

Further reading

Holtkamp, R. (ed.) (1993) *Proceedings of a national workshop on* Chrysanthemoides monilifera. Port Macquarie, NSW, 28-30 April 1993. NSW National Parks and Wildlife Service, NSW Department of Agriculture, and NSW Department of Conservation and Land Management, Port Macquarie.

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Parsons, W.T. and Cuthbertson, E.G. (1992) *Noxious weeds of Australia*. Inkata Press, Melbourne.

Weiss, P.W., Adair, R.J. and Edwards, P.B. (1998) *Chrysanthemoides monilifera* (L.) T.Norl., **in** Panetta, F.D., Groves, R.H. and Shepherd, R.C.H. (eds.) *The biology of Australian weeds*. Volume 2. R.G. and F.J Richardson, Melbourne, pp. 49-61.

There are a number of management guides on different weeds being published by the Weeds CRC (see contact details below). Other CRC publications include the *Weed Navigator* (lists many weed publications, information resources and contacts in Australia and New Zealand), workshop proceedings, field and management guides, brochures and posters.

Further contacts: Contact your local National Parks and Wildlife Service office or the district weeds officers for your local shire. Many people interested in environmental weeds communicate regularly through the *Enviroweeds* email discussion group established in Australia. If you would like to join this group free of charge, send this message <subscribe> to the following email address: enviroweeds@majordomo.nre.vic.gov.au

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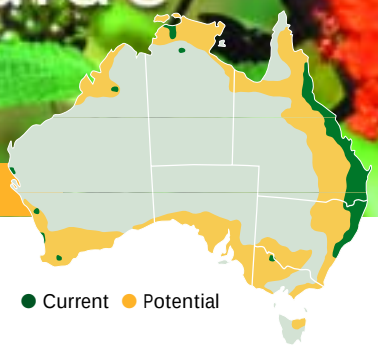
More copies available from the Cooperative Research Centre for Weed Management Systems (Weeds CRC) at University of Adelaide, PMB1 Glen Osmond, South Australia, Australia 5064, ph 08/8303 6590, fx 08/8303 7125, email: crcweeds@waite.adelaide.edu.au, web: www.waite.adelaide.edu.au/CRCWMS

Weed Management Guide

Lantana – *Lantana camara*



Lantana (*Lantana camara*)

The problem

Lantana is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Lantana forms dense, impenetrable thickets that take over native bushland and pastures on the east coast of Australia. It competes for resources with, and reduces the productivity of, pastures and forestry plantations. It adds fuel to fires, and is toxic to stock.

Lantana is a serious threat to biodiversity in several World Heritage-listed areas including the Wet Tropics of northern Queensland, Fraser Island and the Greater Blue Mountains. Numerous plant and animal species of conservation significance are threatened. It is listed as the most significant environmental weed by the South-East Queensland Environmental Weeds Management Group.

It is a problem in gardens because it can cross-pollinate with weedy varieties to create new, more resilient forms.

The weed

There are two main forms of lantana in Australia: a cultivated form planted in gardens and a weedy variety found in bushland and pastures. The cultivated form of lantana is non-thorny, produces few seeds and is compact in shape. The weedy form is a prolific seeder with straggly, thorny stems. Both forms include many varieties, which differ from each other in shape, flower colour, prickliness, response to enemies and toxicity.

Lantana is a significant weed of woodlands and pastures east of the Great Dividing Range.
Photo: Qld DNRM

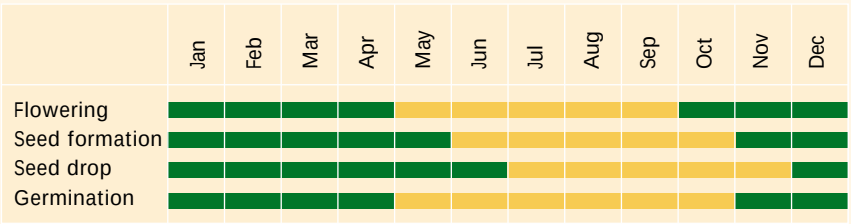
Weedy lantana is a much branched, thicket-forming shrub, 2–4 m tall. The woody stems are square in cross-section and hairy when young but become cylindrical and up to 150 mm thick with age. The ovate (ie tear-shaped) leaves (20–100 mm long) occur in opposing pairs along the stem. The leaves are rough and finely hairy and emit a pungent odour when crushed. Each flower head is made up of 20–40 flowers, ranging in colour from white, cream or yellow to orange, pink, purple and red. The fruit has many berries, which ripen from green to shiny purple-black and contain a single pale seed. Lantana has a short taproot and a mat of many shallow side roots.

Key points

- Lantana is a thicket-forming shrub that has spread from gardens into pastures, woodlands and rainforests on the east coast.
- It typically invades disturbed land and river margins, extending its range in response to rainfall.
- It threatens agriculture and pastoral production, forestry and biodiversity of conservation areas, and may be toxic to stock.
- The highest priority for lantana control is preventing its spread into northern Australia and west of the Great Dividing Range.
- Integrated control should combine fire, mechanical, chemical and biological methods, and revegetation.

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

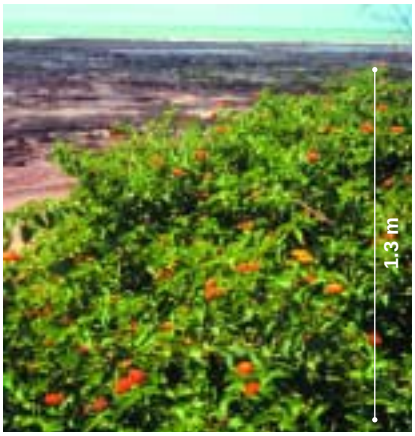
Growth calendar



Lantana flowers whenever the soil is moist and the air is warm and humid. For much of its range along the Queensland and New South Wales coasts, this results in almost continuous flowering and fruiting. Further inland, peak flowering occurs several weeks after soaking rain (25 mm or more) and is usually accompanied by good fruit set.

Germination most frequently occurs following the first summer storms, but may occur at any time of the year when sufficient moisture is present. Initial seedling growth is slow until the roots become established, after which close stems intertwine and begin to form thickets. Flowering does not usually commence until early in the following summer and then continues until March or April.

Lantana can resprout from the base if the shoot dies, extending the life of individual plants.



Flowering lantana infestation in Darwin, NT, in December.
Photo: Colin G. Wilson

How it spreads

Lantana spreads in two ways. Layering is a form of vegetative reproduction where stems send roots into the soil, allowing it to quickly form very dense stands and spread short distances. Also, birds and other animals such as foxes consume and pass the seed in their droppings, potentially spreading it over quite large distances. The germination rate of fresh seed is generally low, but improves after being digested.

Butterflies, bees and other insects are attracted by the nectar and pollinate lantana flowers. About half of the flowers produce seeds, typically 1–20 seeds on each flower head. Mature plants can produce up to 12,000 seeds every year. Seeds are thought to remain viable for several years under natural conditions.

Lantana is allelopathic and can release chemicals into the surrounding soil which prevent germination and competition from some other plant species.

First recorded in the Adelaide Botanic Gardens in 1841, lantana spread to east coast gardens and was recorded as a weed in Brisbane and Sydney in the early 1860s. It is now found across four million hectares of land east of the Great Dividing Range, from Mount Dromedary in southern New South Wales to Cape Melville in northern Queensland. Isolated infestations exist in the Top End of the Northern Territory, around Perth in Western Australia, and on Lord Howe and Norfolk Islands. Although present Australia wide as a garden ornamental, it has not naturalised to any serious extent elsewhere.

When ripe, birds and animals consume fruit and spread seed.
Photo: Colin G. Wilson

Where it grows

Lantana can grow in high-rainfall areas with tropical, subtropical and temperate climates. It does not tolerate salty or dry soils, waterlogging or low temperatures (<5ºC). It thrives on rich, organic soils but also grows on well-drained clay and basalt soils. Sandy soils tend to dry out too rapidly for lantana unless soil moisture is continually replenished. It has been reported at altitudes up to 1000 m in Queensland.

Lantana invades disturbed sites, especially open sunny areas, such as roadsides, cultivated pastures and fencelines. From there it can invade the edges of forests, but it does not fare as well under a heavy canopy as it is not very shade tolerant. Therefore, it is not a problem in intact tropical rainforest but can quickly spread there if the canopy opens out.

Lantana occurs naturally in Mexico, the Caribbean and tropical and subtropical Central and South America. It is considered a weed in nearly 50 countries.

Another weedy species of lantana

Another species of lantana is a popular ornamental that is considered a weed when present in natural ecosystems. Creeping lantana (*Lantana montevidensis*) occurs in coastal and subcoastal Queensland and as far south as Sydney. It is fairly similar to *Lantana camara* but does not have thorns, has mainly pink or purple flowers and trails along the ground, only growing to a height of half a metre. It is also toxic and readily displaces native vegetation.

Creeping lantana (*Lantana montevidensis*) is naturalised in coastal and subcoastal Qld and only grows to a height of half a metre. It is toxic and readily displaces native vegetation. Photo: John Swarbrick

Potential distribution

Lantana may be able to spread west of the Great Dividing Range, and could expand its range throughout southern Victoria, South Australia and southwestern Western Australia.

What to do about it

Lantana is extremely widespread and abundant. Because it is so well established on the east coast, and prevention of spread is the most cost-effective weed management tool, the highest priority for lantana management is to prevent its spread into uninfested areas. This will require three main actions.

1. Restricting further importation of lantana into Australia. Any new varieties brought in could escape cultivation and naturalise, or could cross-breed with naturalised varieties, leading to hardier new varieties more resistant to control.
2. Restricting the sale and use of lantana in gardens as these are potential sources of new infestation and new varieties. There are native and less weedy exotic ornamental alternative species.
3. Strategically controlling infestations that threaten areas where lantana is not yet a weed. Control methods are outlined below.

Integrated management

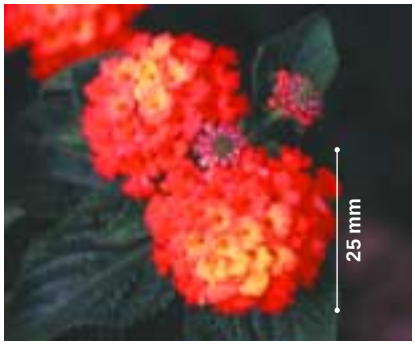
An integrated approach that uses a variety of control methods gives best results when dealing with lantana. A range of methods including herbicides, mechanical removal, fire, biological control and revegetation should be used. Best results are obtained by working from areas of light infestation towards heavier infestation, and long-term follow-up control is required after initial attempts. Minimise both disturbance to land and excessive use of fire to retain vigorous native vegetation and reduce the opportunity for lantana to become established.

Herbicide control – effective but expensive

There are many herbicides registered for lantana control and three main application techniques. Spraying the entire plant (foliar spraying) usually kills plants that are less than 2 m high. Herbicides applied to the lower bark of the stems (the basal bark technique) or immediately painted onto a freshly cut stump (the cut-stump technique) are useful for larger plants. Both of these techniques are time consuming because they require treatment of each stem, which can be difficult to access in large stands of lantana. High costs make herbicide control uneconomical for large infestations, except when there are no other options (eg on steep slopes, where helicopter spraying may be required).

For best results, integrate fire, mechanical, chemical and biological control and revegetation

Herbicides, especially those that are foliar applied, are most effective when plants are actively growing. With lantana, best results are obtained six weeks after good rains (at least 35 mm) when minimum temperatures exceed 15ºC. In Queensland the spraying season generally lasts from early summer to autumn, but earlier control will potentially allow follow-up in the same growing season.



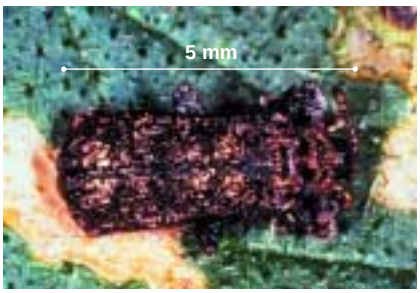
Lantana flowers can be one colour (*left*), or a mix of two (*centre*) or more colours (*right*). Photos: Colin G. Wilson

Weed control contacts

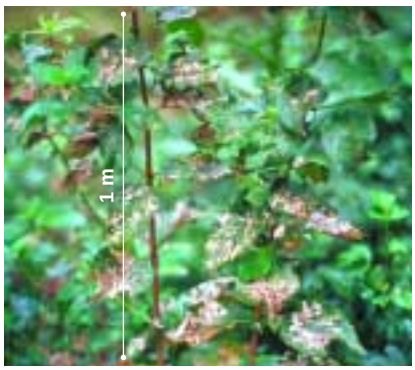
State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Infrastructure, Planning and Environment	(08) 8999 5511	weedinfo.ipe@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

Note that herbicides vary in their effectiveness on different lantana varieties. The red flowered varieties are normally the least susceptible to herbicides while the pink forms are the easiest controlled. Consult your local council or state/territory weed management agency about which herbicides and applications are most suitable for your infestation of lantana. State and territory contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.



Both adults (*above*) and larvae of the leaf-mining beetle *Octotoma scabripennis* feed on lantana leaves. It is present in most lantana infestations, particularly where it is shady and wet in subtropical, coastal areas.
Photo: Michael Day, Qld DNRM



Damage to lantana leaves caused by the leaf-mining beetle *Octotoma scabripennis*.
Photo: Michael Day, Qld DNRM

Mechanical and physical control – suitable for small infestations

Lantana can be removed mechanically or physically in several ways, including stickraking, bulldozing, ploughing and grubbing. These techniques are mainly suited to medium-sized infestations and require extensive follow-up, as they invariably lead to regrowth if the rootstock is not removed, or seedling germination when heavy machinery disturbs the soil. Any soil disturbance should be avoided on steep inclines or in gullies. A permit may be required if native plants are to be affected by mechanical control – check with your local council or state/territory weed management agency.

Fire – inexpensive but caution must be exercised

Fire is often used prior to mechanical or herbicide control to improve their effectiveness, or as a follow-up to such methods. It can also provide some control when used on its own under the right conditions. It is most effective when fires are hot and the lantana is actively growing. In southeastern Queensland best results from fire are achieved during early summer. In New South Wales controlled burns are used opportunistically, mainly in late winter and spring before conditions become too dry and fires could escape control.

Fire is relatively inexpensive and well suited to dense infestations, but the risks to people and property must be carefully managed. Burning is not recommended in rainforest and vine thickets because they are highly sensitive to fire. Disturbance in these habitats may actually promote lantana if the canopy is opened up. A permit may be required to burn – check with your local council or state/territory weed management agency.

Biological control

In 1902 the first attempt at biological control of a weed targeted lantana in Hawaii. In Australia biological control agents were first introduced in 1914; so far, 30 species have been introduced. Research into biological control is ongoing, and several agents are currently being examined for suitability of release.

Of the 16 species that have established, four insects have had a major impact on lantana. They are:

- a sap-sucking bug (*Teleonemia scrupulosa*) (Sydney to northern Queensland).
- a leaf-mining beetle (*Uroplata girardi*) (northern Queensland to Sydney).
- a leaf-mining beetle (*Octotoma scabripennis*) (Sydney to south of Rockhampton).
- a seed-feeding fly (*Ophiomyia lantanae*) (southern New South Wales to northern Queensland).

The biological control agents vary in their effectiveness against the many different types of lantana. For example, lantana can drop its leaves when stressed, depriving some agents of their food.

Revegetation – useful in pastures and forests

Revegetation of a treated site is a key component of a lantana management program. Revegetation helps to reduce erosion, adds fuel for future burning in pastures and is vital in limiting the re-establishment of lantana and other weeds. Sowing an improved pasture that outcompetes and smothers lantana seedlings is assisted by withholding grazing for the first six months, and only allowing light grazing for the next 12–18 months. In forested areas either planting trees or encouraging naturally occurring seedlings will help to shade out lantana in the longer term. Check with your local council or state/territory weed management agency about appropriate species for revegetating pastures or forests in your area.

Follow-up

Follow-up control after an initial effort may include any or all of the above methods. Established pastures can be burnt to control significant lantana regrowth, and any small patches can be spot sprayed with a registered herbicide or grubbed out. In forested areas herbicides are recommended to control regrowth, typically requiring three follow-up sprays after the initial control effort.

Legislation

Landholders are required to reduce lantana infestations throughout some regions of Queensland, New South Wales and the Northern Territory. The sale of lantana in Queensland was banned in late 2003. Lantana importation is prohibited in Western Australia. Check with your local council or state/territory weed management agency for relevant details.

Acknowledgments

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Maps: Australian Weeds Committee.

...case study

Lantana control at Towra Point, Botany Bay, New South Wales

Towra Point Nature Reserve in Botany Bay contains habitats of high conservation status, including wetlands of international importance and open woodlands that are unique in the Sydney region. A coastal rainforest in the region was recently listed as an endangered ecological community under the New South Wales *Threatened Species Conservation Act 1995*. It includes the magenta brush cherry (*Syzygium paniculatum*), a vulnerable tree species.

By the 1990s, lantana made up almost 75% of the vegetation cover in some parts of the reserve and was limiting the regeneration of native species, particularly around a freshwater wetland called Weedy Pond. The Friends of Towra, a volunteer group, commenced weed control in the Weedy Pond rainforest in 1996. In 1998 the Sutherland Shire Environment Centre, working in conjunction with the National Parks and Wildlife Service, gained Coastcare funding to supplement the volunteer program.

Beginning in March 1998, weed control focused on a corridor connecting the rainforest and a casuarina/banksia forest, following up on previous control and initiating new efforts. Lantana was controlled by a combination of cut-stump herbicide application and manual removal of smaller plants. Other weeds were also controlled when they were encountered.

Work was undertaken about every two months throughout 1998 by volunteers and members of local community groups. Follow-up hand weeding and spot spraying, and further control of primary lantana infestations, were also undertaken throughout 1999. This work involved international backpackers, unemployed people from Green Corps 2000, students and personnel from private enterprise, all of whom volunteered their time. The total area cleared of lantana and other weeds was approximately 75 m wide and 100 m long.

In May 2000 the cleared areas were planted with native vegetation by local Cub Scouts and Venturers and members of the Friends of Towra. Approximately 200 banksias were planted. The training of volunteers and community groups on such issues as weed control techniques, bush regeneration and plant identification was another significant outcome.

At each quarterly follow-up visit to the site, approximately 24 man-hours are required to keep on top of any reshooting and newly germinated lantana, and encourage regeneration of native species. It is expected that lantana will become disadvantaged as canopy cover and shade increases, and less work will be required in the future.

How to control lantana

Quick reference guide

Lantana – *Lantana camara*

Minimise spread and future impacts

Although lantana is widespread on the east coast of Australia, it is still absent from parts of its potential range. These areas should be protected by:

- preventing the importation of further varieties and species of lantana
- stopping more planting of lantana in gardens
- strategically controlling infestations which threaten uninfested areas.

A control program for dense infestations in pastures

The Queensland Department of Natural Resources and Mines has produced a pest series fact sheet on lantana (PP#34). They advise that herbicides are too expensive to treat large lantana infestations.

A combination of fire and mechanical control makes spot treatment of small patches with herbicides more cost-effective. The following suggested control program for dense infestations in pastures is based on the fact sheet:

1. Exclude stock to allow a fuel load to build up.
2. Bulldoze, stickrake or plough the infestation to add to the fuel load.
3. Burn the infestation after obtaining a permit. Summer burns are more effective than winter burns.
4. Sow an improved pasture. Seek advice of local council or state/territory government agencies for selection of non-weedy pasture species.
5. Continue stock exclusion until pasture has established and set seed.
6. Burn the infestation again after obtaining a permit.
7. Spot spray or grub out any regrowth or seedlings. Spraying is most effective between summer and autumn.
8. Follow-up burning, spraying and/or grubbing will be required for several years.

Lantana can escape from garden plantings into surrounding bushland.
Photo: Tim Schultz

Control options

Type of infestation	Physical	Mechanical	Chemical	Fire	Biological
Small (few plants, small area)	Hand grubbing only suitable for seedlings. Wear gloves for protection from thorns.	Not suitable.	Spot spray plants less than 2 m in height between summer and autumn with a registered herbicide.	Not suitable.	There are four useful biological control agents. They are already distributed throughout their potential range.
Medium (medium density, medium total area)		Bulldoze, plough, stick-rake or slash infestations. Soil disturbance will lead to mass seed germination, so follow up with further controls. Do not use mechanical control in areas susceptible to erosion. A permit may be required.	Spraying is uneconomical for medium or large infestations. Helicopter spraying is used when there is no access for mechanical control, eg very steep slopes.	Under permit, burn in summer with good fuel load of grass and/or mechanically cleared lantana. Also use as follow-up. Do not burn in rainforests.	
Large (many plants, many ha)					

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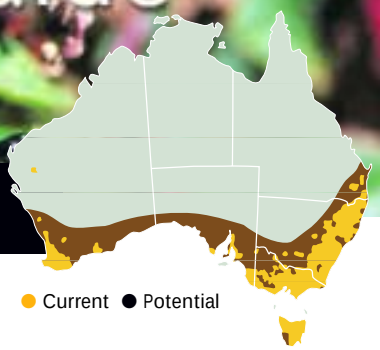
CRC Weed management

Weed Management Guide

Blackberry –
***Rubus fruticosus* aggregate**



Blackberry (*Rubus fruticosus* aggregate)

The problem

Blackberry is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Blackberry has invaded the banks of watercourses, roadsides, pastures, orchards, plantations, forests and bushland throughout temperate Australia. On farms blackberries reduce pasture production, restrict access to water and land, and provide food and shelter for pest animals such as foxes. In some cases the cost of plantation forestry may be increased, especially during establishment, because blackberries impede access for manual operations.

Other impacts are increased fire hazards caused by the large amount of dead material present in blackberry thickets and a substantial decrease in property values where heavy infestations occur. Control costs are often high.

Weeds such as blackberries also affect tourism, reducing the natural attraction of the bush and hindering recreational activities where thickets prevent access to natural features.

The weed

The name 'blackberry' covers at least 14 different but closely related species, some of which may be hybrids, that have become naturalised in Australia.

Blackberries hinder recreational activities by preventing access to natural features: Loddon River in central Vic.
Photo: Kate Blood

Blackberry is a perennial, semi-deciduous shrub with prickly stems (canes) that take root where they touch the ground, often forming thickets up to several metres high. It varies from sprawling to almost erect. The stems, which grow up to 7 m long, may be green, purplish or red, and are generally thorny and moderately hairy. Young canes emerge from buds on the woody root crown each spring and grow very rapidly (50–80 mm a day).

Leaves are usually dark green on top with a lighter green underside. The leaf veins and stalks are covered with short prickles. Clusters of flowers are white or pink.

The berries change colour from green to red to black as they ripen. The plant is semi-deciduous and sheds its leaves in winter.

Key points

- At least 14 different but closely related species of blackberry are naturalised in Australia.
- Some species could spread further within the climatic limits of blackberry's range.
- Blackberry management programs must be planned and sustained over a number of years.
- Biological control will not eradicate blackberry, but will slow the rate of spread and allow more time for control by other means. Rust has been the most successful biocontrol so far.
- In revegetation programs, native seedlings that are able to germinate and actively grow over winter have a competitive advantage.

Natural Heritage Trust
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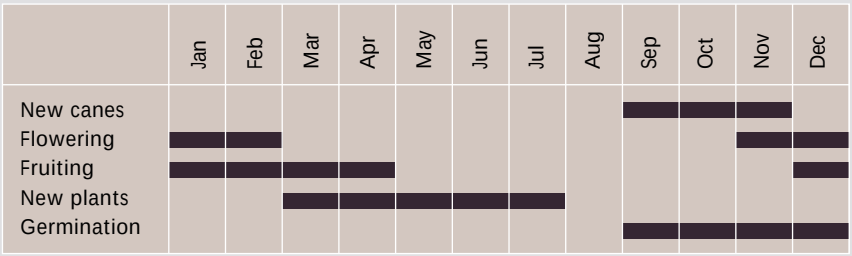
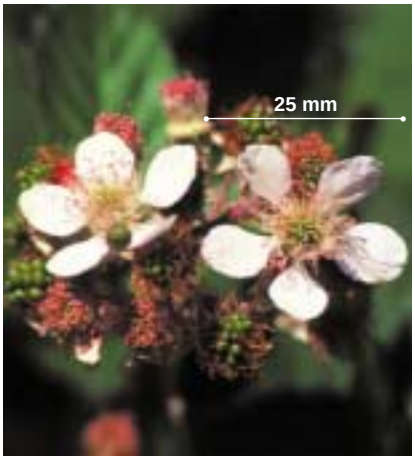
Growth calendar



Blackberry has a two-year growth pattern. Young canes start growing in spring, flowering occurs from late November to late February and fruiting from late December to April. New (daughter) plants develop at the tips of first-year canes throughout autumn and winter. Most germination takes place during spring and early summer.



Blackberry plants produce clusters of white or pink flowers.
Photo: Kate Blood

How it spreads

One berry may contain as many as 80 seeds which are easily spread by birds, mammals (especially foxes) and water. Bushwalkers and other recreational users can also spread seeds, as can moving soil from one place to another. Blackberry roots can be spread to clean areas by cultivation.

Blackberry will persist indefinitely in an area unless it is treated. Plants that die are replaced by seedlings or daughter plants produced by nearby individuals. Plants may produce up to 13,000 seeds per square metre.

Where it grows

About 8.8 million ha of Australia is infested with blackberry, which thrives in a wide range of habitats. It can dominate pastures and native ecosystems as well as invade disturbed sites in urban areas. In badly affected areas, dense infestations often fill whole gullies and can extend for a width of tens of metres along both sides of streams.

The plant is restricted to temperate climates with an annual rainfall of at least 700 mm, and can occur at any altitude in Australia. Blackberry plants grow above the snowline in Victoria at about 1950 m altitude.

Potential distribution

Blackberry has probably reached the climatic limits (in terms of temperature and rainfall) of its potential range in Australia. However, individual species may spread further within these climatic limits. A few scattered infestations exist outside of the projected range under ideal conditions in Western Australia.

Berries change colour from green to red to black as they ripen.
Photo: Kate Blood

Blackberry bushes often form thickets up to several metres high.
Photo: John Hosking

What to do about it

The major challenges in managing blackberry are to prevent its spread, control and reduce existing infestations, and rehabilitate treated areas to prevent reinfestation.

In its long history as a noxious weed, blackberry has been managed by a range of control techniques, including burning, slashing, grazing, grubbing, chemical spraying and biological control.

Blackberry management programs must be planned and sustained over a number of years to prevent the rapid return of the infestation.

Apply herbicides to healthy plants

In general, the best time to spray blackberry is during the flowering–fruiting period, but the effective spraying season can start before flowering and extend long after fruiting, into autumn.

It is easy to kill young blackberry seedlings with herbicide. However, well established blackberry thickets have a large number of root crowns of different ages, and the older and bigger ones are usually hard to kill.

If using herbicides taken up by the leaves, avoid slashing in the season before application; it can reduce the effectiveness since only the new canes will be available to take up the herbicide.

The prickly stems, known as canes, may grow up to 7 m long. The leaves are usually dark green on top with a lighter green underside.
Photo: John Hosking

Do not apply herbicides to stressed plants. Conditions such as drought or severe low or high temperatures can decrease the effectiveness of herbicide action. As a guide, look at the tips of the canes. In times of active growth (the best time to spray) these will be producing fresh new leaves, and any new growth should be healthy, not wilted.

The success of herbicide treatment can also vary between the different groups of blackberry. Some produce fewer crowns per square metre than others and fewer canes per crown. Other features such as larger leaves and canes and hairier leaf surfaces (which may reduce absorption) can also affect herbicide uptake.

Methods of herbicide application

High-volume spraying is recommended for spot spraying, particularly in dense infestations or large blackberry thickets. If using this method, spray the inside of bushes first, ensuring good coverage of stems and leaves. Then spray outside leaves, runners and tips. Take particular care with this method because it is very easy to overdose and affect off-target species or contaminate waterways. Likewise, mist blowers or air blast sprayers can be effective but allow little control over spray distribution due to spray drift. None of these methods are suitable for use near susceptible native species.

In remote areas where water for herbicide application is not available, pellets or granular herbicides can be effective. These are applied to the soil surface and the chemical is leached by rain into the root zone where the roots take it up. This method is not suitable for use near native vegetation. Results of some trials have shown that slashing before application of granular herbicide gives better results than using granules alone.

The use of a gas-powered gun has been suggested as a method which enables very accurate application of herbicide onto target plants. It can be used to control scattered blackberries to a height of 1.5 m. Knapsack units are most suitable for spraying small scattered bushes and seedlings.

For small areas of high conservation significance, the 'cut and paint' method is recommended. This involves cutting blackberry canes close to ground level and immediately painting cut stems with herbicide. However, it should be used only on small plants and retreatment is likely to be necessary.

Slashing will not kill blackberry

Although cutting blackberry plants off at ground level does not kill them, slashing can help open up dense stands for follow-up control by other methods. Regular (fortnightly or monthly) slashing or mowing forces the plant to regrow, using up root reserves and making it weaker. Slashing in summer can enhance the effect of blackberry leaf rust because regrowth stimulated by the slashing is very susceptible to the rust fungus.

Hand weeding

This is only effective in very small infestations. Even seedlings and small plants are difficult to pull out by hand. If possible, all of the root system should be removed using a mattock or shovel because blackberry will regrow from any root fragments left in the soil.

Dense infestations may require mechanical control

In dense infestations mechanised weeding with large earthmoving equipment may sometimes be necessary. Remove plants and surface soil with a bulldozer ('scalping') to ensure crowns and most of the roots are dug out. Afterwards, rake roots and leave them to dry out in the sun or collect them in piles for burning. Regrowth from crowns, root fragments and seed is inevitable, so follow-up treatment and site rehabilitation are essential.

Grazing with goats

Goats at high stocking rate can be used to control blackberry in pasture but their use must be continuous to prevent regrowth occurring.

Regrowth is inevitable after mechanical removal so follow-up treatment is necessary.
Photo: Ian Walton, DPI Vic

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.a	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control blackberry and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

Biological control with the blackberry leaf rust

The program with the greatest likelihood of success in the foreseeable future includes biological control, particularly on large, inaccessible infestations of blackberry. The blackberry leaf rust *Phragmidium violaceum*, which attacks the leaves, is now present throughout all areas of southern Australia where blackberries are a problem. It affects the leaves and can also grow on flowers, unripe fruit and young canes. The rust is harmless to native *Rubus* species and varieties of commercial raspberry and brambleberry such as loganberry, boysenberry and youngberry. The rust alone will not eradicate blackberry but it slows its rate of spread and allows more time for control by other means.

The rust appears as purple-brown blotches, 2–3 mm in diameter, on the upper surface of the leaf. Corresponding powdery yellow or sticky black pustules of spores appear on the leaf's lower surface.

Epidemics of rust caused by summer spores initially kill leaves in summer and autumn, forcing the plants to grow new leaves, which in turn are attacked by the rust. Rust epidemics result in fewer fruit and seeds, shorter canes and fewer new plants.

This continuous attack on the leaves weakens plants by depleting root reserves. Light can start penetrating the thicket, which helps revegetation by other plants, especially in autumn and winter. Competing plants can then grow through the blackberry and in turn limit its growth by shading.

The blackberry rust has been so effective in the Gippsland region of Victoria that farmers complained about having to re-do their fencing when blackberry hedges fell down! However, the rust seems to be severe only in regions where the annual rainfall is greater than 800 mm and the average daily maximum temperature for January is close to 20ºC.

Different blackberry species vary in their susceptibility to the rust, from very susceptible to highly tolerant. The effectiveness also varies between years, according to seasonal conditions. A sufficiently high level of infection is not always present early enough to prevent seed production and tip rooting of canes. Although the rust has had a big impact on the more common and widespread blackberry strains, some less widespread groups are resistant, giving them an advantage, and resulting in their gradual takeover and a continuation of the overall blackberry problem.

Slashing can help open up dense stands of blackberry for follow-up control by other methods. Photo: Adam Whitchurch, DPI Vic

Blackberry control strategies must address all the strains present in a region. Management actions which target only some of the species will result in one strain replacing another, with no net decrease in blackberry cover. For example, while the blackberry leaf rust is successfully controlling one species in the Strzelecki Ranges of Victoria, another rust resistant group is rapidly spreading to fill the niche.

To address this issue, additional rust strains are being tested in CSIRO's quarantine facility in Canberra before their expected release throughout Australia during 2003–04. Matching virulent rust strains to susceptible blackberry species is essential for successful biological control. Just as important are suitable weather and blackberry growing conditions for development of rust disease.

Although rust epidemics can look spectacular, blackberry is a very vigorous plant and can survive repeated attacks over a number of years before its root system begins to be depleted. It can take up to five years of rust infection for large well-established blackberry infestations to open up enough to allow other plants to grow through.

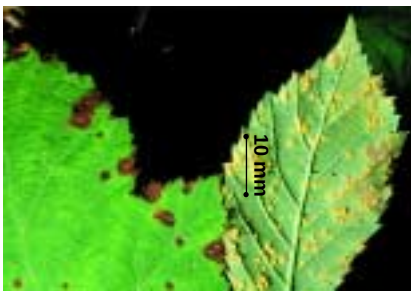
Integrated control

Blackberry should be inspected during summer–autumn and herbicide treatment planned for any infestations that are not attacked heavily by rust. Research has shown that spraying herbicides after the rust has killed some leaves gives equal or better control than application earlier in the season.

Where rust is having little impact, the use of herbicides is usually necessary since mature blackberry is able to regenerate readily from roots following burning or slashing.

Use of competitive native species

Maintaining good quality groundcover can help control blackberry seedlings. If rapid regeneration of fast-growing native species can be achieved, these can out-shade seedlings and outcompete them for water and nutrients. Blackberry roots do not develop much over winter so native seedlings able to germinate and actively grow during this period will have a definite competitive advantage.



The blackberry rust appears as purple-brown blotches on the upper leaf (*left*) and powdery yellow or sticky black pustules of spores on the lower surface (*right*).
Photo: John Hosking

Careful use of prescribed fire

This is used mainly as a follow-up to herbicide application to clear areas of dead canes and re-establish access for rehabilitation of the treated area.

Follow-up

Once an area has been treated it will be necessary to monitor it for many years and destroy new plants.

Legislation

Blackberry is declared noxious in all states and territories except the Northern Territory. Landowners are required to control it. Check with your local council or state/territory government agency about its requirements for blackberry control.

Acknowledgments

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Maps: Australian Weeds Committee.

...case study

Keeping Western Australia's Porongurup National Park blackberry free

In Western Australia's Porongurup National Park an integrated approach has been adopted to tackle blackberries, involving government departments, landholders and volunteer groups.

The aim of the program, which is targeting satellite infestations on the northeastern edge of the park, is to move the blackberry front 20 km away from the park. This involves controlling infestations both on farms (to stop them entering the park) and in the park (to stop them spreading to farmland).

Agriculture WA provides herbicide to landholders, who contribute the labour.

"While from an individual point of view, there may not be a great incentive to get rid of blackberries, the community is proud of the park, and neighbours will put pressure on each other to clear up infestations", says coordinator of the program, John Moore of Agriculture WA.

The program runs training days and equipment is available for loan. The landowners include hobby farmers with small holdings where infestations are too large to tackle using hand-held equipment.

The program includes a number of approaches, including the use of specific herbicides for large infestations, which are different from herbicides used in gardens, vineyards and other sensitive areas. Some people don't want to use herbicides at all so they may be using other techniques such as mowing, cultivation, burning or grazing with goats before seed sets.

Landholders can see the impact of blackberries and where they have been controlled in the park. For example, in some unsprayed areas tall karri (*Eucalyptus diversicolor*) trees rise through the blackberries, which dominate the undergrowth. In comparison, native grasses and understorey plants are growing in some sprayed areas where all blackberries and a small amount of native vegetation have been killed.

How to control blackberry

Quick reference guide

Prevention

Keep uninfested areas clear of blackberry and remove isolated plants before they have a chance to seed.

Herbicide control

Consult a specialist for advice on registered herbicides in your state or territory (see the contacts table on p. 4). Apply herbicide to actively growing plants – look at the tips of the canes and spray when they are producing fresh new leaves.

Physical control

Slashing can help open up dense stands for follow-up control by other methods, and in summer can enhance the effect of blackberry leaf rust.

Mechanical control is difficult and most of the root system must be removed for effective control – blackberry will regrow from any root fragments left in the soil. In dense infestations bulldozers may be used to remove plants but follow-up treatment is essential.

Biological control

Biological control offers the greatest likelihood for success in large, inaccessible infestations. The existence of at least 14 different groups or strains of blackberry in Australia makes biological control difficult as some groups are more susceptible to the blackberry leaf rust than others.

Rust fungi have established well in some high rainfall areas but have failed to have an impact elsewhere. Additional rust strains are being tested in quarantine and are expected to be released in 2003–04.

Blackberries are easily spread by birds, mammals and water.
Photo: Kate Blood

The blackberry rust is most effective during late summer and autumn in cool, moist environments such as Gippsland, Vic.
Photo: El Bruzzese, DPI Vic

Control options

Control option	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herbicide application	✓	✓	✓	✓					✓	✓	✓	✓
Mechanical removal (incl. grazing)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Burning			✓	✓	✓	✓	✓	✓	✓	✓		
Biological control (release rust)	✓										✓	✓

✓ Optimum times for blackberry control methods

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Mother of millions

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THE PROBLEM

Mother of millions (*Bryophyllum delagoense*) is a native of Africa and Madagascar and was introduced to Australia as a garden plant. It is a serious weed on the coast and the northwest slopes and plains of New South Wales. Consequently, it is a declared noxious weed in these areas (see map).

As the name suggests, mother of millions reproduces rapidly, producing hundreds of tiny plantlets which quickly form new colonies. It is adapted to dry conditions and can survive long periods of drought. This increases the plant's potential to persist and spread.

Mother of millions is toxic when ingested by livestock; it is also poisonous to humans and household pets.

Mother of millions is commonly found growing on gravelly and sandy soils. It is a weed of bushland and disturbed sites such as roadsides, along fence lines, around rubbish tips and abandoned rural dwellings.

It also occurs frequently along creeks and rivers where it is spread by floodwaters.

THE PLANT

Mother of millions belongs to the genus *Bryophyllum*.

Mother of millions is a succulent perennial plant growing 30 cm to 1 m in height.

Photo: L Tanner

1. A typical infestation of mother of millions (*Bryophyllum delagoense)*

Photo: L Tanner

2. A close up of the flower of mother of millions (*Bryophyllum delagoense)*

Photo: L Tanner

3. A mother of millions plantlet which develops when a projection on the leaf is broken off.

The stems are pinkish-brown or greyish in colour.

The leaves are pencil-shaped, pale green to pale brown in colour with dark green patches and a shallow groove on the upper surface. There are up to seven projections at the tip of each leaf which when broken off can develop into new plants.

The flowers are orange-red in colour and occur in a cluster at the top of a single stem. Flowering can occur from May to October.

Look-a-like species

In NSW, there are also two less common *Bryophyllum* species. These are hybrid mother of millions (*Bryophyllum daigremontianum* x *Bryophyllum delagoense*) and resurrection plant (*Bryophyllum pinnatum*).

These plants also produce small plantlets along the edges of their leaves, are adapted to dry conditions, are poisonous and are declared noxious in various parts of the State.

Hybrid mother of millions can be distinguished from mother of millions by the shape of its leaves. See Table 1 and photograph 5.

Resurrection plant is also a *Bryophyllum* species, growing sometimes up to 2 m. It can also be distinguished from mother of millions by its leaves and flowers. See Table 1.

Photo: J Hosking

4. Leaves and flower of hybrid mother of millions (*Bryophyllum daigremontianum* x *Bryophyllum delagoense*).

Table 1: Comparison of the three Bryophyllum species found in NSW

	MOTHER OF MILLIONS *B. delagoense*	HYBRID MOTHER OF MILLIONS *B. daigremontianum x B. delagoense*	RESURRECTION PLANT *B. pinnatum*
Height (cm)	30–100	30–100	60–200
Leaves	Pencil-shaped, pale green to pale brown with dark green patches, shallow groove on the upper surface.	Boat-shaped, thick stalks, with notches along the edges of the leaves.	Dull blue-green and up to five oval leaflets per leaf with wavy edges.
Flowers	Orange-red in colour, occur in a cluster at the top of a single stem. Flowering occurs from May to October.	Orange-red in colour, occur in a cluster at the top of a single stem. Flowering occurs from May to October.	Reddish colour often tinged with pink, occur in loose clusters on stalks growing along the upper portion of the stem. Flowering occurs from June to August.

Photo: L Tanner

5. A comparison of the leaves of mother of millions (*Bryophyllum delagoense)* on the left and hybrid mother of millions (*Bryophyllum daigremontianum* x *Bryophyllum delagoense*) on the right.

REPRODUCTION

The common name 'mother of millions' is based on the plant's ability to reproduce vegetatively in large numbers. Each plant produces small plantlets along the edges of its leaves which detach and form new plants. See photograph 3.

This makes mother of millions hard to eradicate and follow up controls are necessary.

Mother of millions also produces numerous seeds which can survive in the soil for a number of years before germinating.

MOTHER OF MILLIONS POISONING

Mother of millions, hybrid mother of millions and resurrection plant are all poisonous when ingested. The toxic effects of these plants are due mainly to **bufadienolides** which cause heart failure. The toxins are present in all parts of the plant however, flowers are five times more poisonous than the leaves and stems.

Mother of millions and hybrid mother of millions are the most toxic however, livestock access should be restricted to all three.

Ingestion of the toxins can be cumulative and livestock eating small amounts, several times within a few days may suffer poisoning. Eating about 5 kg of mother of millions would kill an adult cow. Where the plants are thick, this amount would grow in a square metre.

Poisoning generally occurs when the plants are flowering – between May and October. Livestock are at a greater risk of poisoning if they have been moved to a new paddock, there is a feed shortage or during droving because they are more likely to eat the plant.

If livestock have eaten a large amount of plant, they may die suddenly of heart failure.

If they have eaten smaller amounts over several days, they may develop diarrhoea (sometimes bloody), drool saliva, dribble urine and then die of heart failure. Some affected livestock will recover slowly if small amounts of plant material have been eaten and their hearts are not badly damaged.

Poisoned stock must be treated within 24 hours of consuming the plant. After this period heart function is severely disturbed and stock may be too badly affected to survive. If you suspect livestock could have mother of millions poisoning, consult a vet immediately.

Mother of millions is also toxic to humans and household pets with dogs being particularly susceptible. It is unlikely that humans or pets would eat enough plant material to become poisoned. However, because mother of millions can be found in many gardens, the likelihood of human or pet poisoning is increased.

CONTROL TECHNIQUES

Preventing the spread of mother of millions is the best control measure.

Learn to identify mother of millions and regularly check for it in winter when the plants are in flower and are easier to see. If found remove immediately using a combination of control methods including hand removal, fire, herbicide application and rehabilitation.

Regularly check creek lines after floods for new infestations.

Hand removal

For small infestations, mother of millions can be removed by pulling up individual plants by hand. Once the plants have been removed they should be burnt; stored in black plastic bags until completely decayed or buried. All of these procedures will prevent regrowth from leaf fragments.

Care needs to be taken when using this method of control as plantlets may detach from the leaves during removal and establish as new plants. Some regrowth will therefore occur and follow-up treatment will be required.

Fire

Permits may be required to light fires – check with your local NSW Rural Fire Service for permit details.

For large infestations, fire is the most economical control option available and will kill the plants and much of the seed stored in the soil. Using fire first will reduce the cost of any spray applications.

When using fire, fence off infested areas to limit stock access and build up a fuel load. Control burn the area using a hot fire. In following years any regrowth should be spot sprayed.

Some groups have reported a 30% reduction in mother of millions each year by using control burning with follow-up spot spraying.

Herbicide application

Thorough spraying of mother of millions with herbicides is effective if sufficient wetting agent (non ionic surfactant) is used to penetrate the waxy outer covering of the plants – especially that of the plantlets.

Mother of millions may be controlled with herbicides at any time of the year if the plants are not stressed, but infestations are easiest to see in winter when the plants are in flower. Spraying during flowering also prevents new seeds from developing.

Late autumn or early spring may be a better option if the plants are lush and growing well, because they are more likely to readily absorb the chemical. In areas that regularly flood, avoid spraying when flooding is likely.

After spraying, plants may be more palatable to livestock so exclude them from the treated infestation by resting the paddock or erecting temporary fencing. Exclusion of livestock should continue until the plants are dead. It should be noted that dead plants are still toxic and still present a poisoning risk to livestock if eaten.

A number of herbicides are available for treating mother of millions. Only a registered herbicide used according to the direction on the label should be used to control this weed. Refer to the NSW DPI publication, *Noxious and Environmental Weed Control Handbook*, for the recommended chemicals to control mother of millions. Always refer to the label when using agricultural chemicals for rates, methods and safety precautions.

Spraying with herbicides may not be 100% successful therefore, the site should be monitored for regrowth and an appropriate follow up treatment carried out.

Rehabilitation

Once removal of the infestation is complete the infested area should be revegetated with more desirable plants to provide competition to future mother of millions seedlings and plantlets.

This can be achieved by soil preparation, replanting, fertilising, controlling pests and grazing appropriately.

Some herbicides have a residual effect and this should be checked before attempting to revegetate.

Biological Control

Four insects have been imported into Australia for testing as biological control agents for mother of millions. Testing of the first and most promising insect, *Osphilia tenuipes*, a stem-boring weevil, has been completed. However, this agent appears to also attack closely related exotic ornamental plants. Therefore, approval for the field release of this agent has been delayed until issues surrounding the potential impact of this insect on the non-target ornamental plants have been addressed.

WHO IS RESPONSIBLE

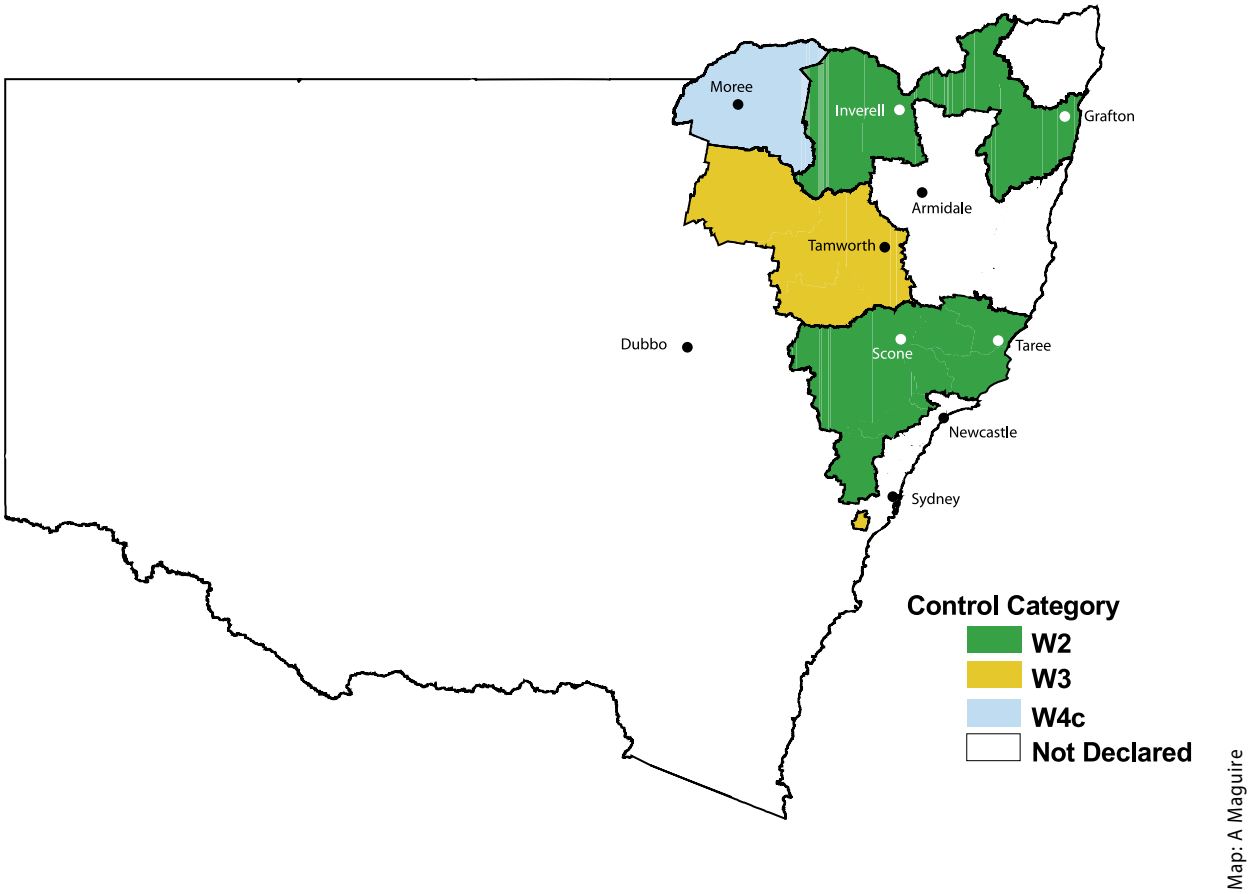
Mother of millions is a declared noxious weed in many areas of NSW. See www.dpi.nsw.gov.au/noxweed/ for a complete list of declared noxious weeds for each control area.

It has a W2, W3 or W4c Weed Control Category depending on the infestation and control area. See www.dpi.nsw.gov.au/noxweed/ for a definition of each control category and the actions required.

The Noxious Weeds Act, 1993 is enforced by the local control authority, usually local government.

The responsibility for control of noxious plants and appropriate disposal of weed plant material on private land rests with the owner or occupier of the land. Failure to do so could result in the local control authority issuing a weed control notice, court action and a fine.

Local control authorities must adequately control noxious weeds on land under their control to prevent them infesting adjoining land. The community can assist the control of this weed by notifying the local control authority of any known infestation of mother of millions on public land.



Areas of NSW where mother of millions (*B. delagoense)* is declared noxious, June 2005

FURTHER INFORMATION

For further information on mother of millions contact your local office of NSW Department of Primary Industries or your local government weeds officer.

FURTHER READING

Flora of New South Wales, G. W. Harden (ed), Royal Botanic Gardens, Sydney. UNSW Press.

Poisonous plants: handbook for farmers and graziers, E. J. McBarron (ed.), Inkata Press, Melbourne.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the comments made by Steve Ottaway and Carol Rose regarding the technical content of this publication and the assistance provided by Annette McCaffery in coordinating its production.

ALWAYS READ THE LABEL

Users of agricultural (or veterinary) chemical products *must always* read the label and any Permit before using the product, and strictly comply with the directions on the label and the conditions of any Permit. Users are not absolved from compliance with the directions on the label or the conditions of the permit by reason of any statement made or not made in this publication.

DISCLAIMER

The information contained in this publication is based on knowledge and understanding at the time of writing, August 2005. However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of New South Wales Department of Primary Industries or the user's independent adviser.

WARNINGS

Pasture improvement may be associated with an increase in the incidence of certain livestock health disorders. Livestock and production losses from some disorders are possible. Management may need to be modified to minimise risk. Consult your veterinarian or adviser when planning pasture improvement.

Legislation covering conservation of native vegetation may regulate some pasture improvement practices where existing pasture contains native species. Inquire through your office of the Department of Natural Resources for further information.

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Job number 5984

Hunter Central Coast Weed Management Committee

Mother of Millions

weed information sheet

What is it?

Mother of Millions is an introduced plant that was used extensively as a garden plant. It is low maintenance and can survive in many different conditions. It is this trait that causes concern.
Propagation of Mother of Millions is by vegetative means. The fleshy leaves are easily shaken off and can produce new roots. The disposal of garden waste on roadsides and along bush tracks has been responsible for many infestations. As Mother of Millions is toxic to stock, care should be taken to ensure they cannot graze near the plants, as it appears that only a small quantity can be lethal.

Mother of Millions
Byrophyllum delagoense
A Category W 2 weed in all areas except Newcastle, Port Stephens, Wyong and Lake Macquarie Council areas. The weed must be continuously suppressed and destroyed.

What does it look like?

Mother of Millions is a perennial herb that can produce several erect succulent stems. They are a mottled green in colour and can grow to 60cm high. Flowers form as a bell shape in clusters at the top of stems. Colour ranges from red through to orange.

Control Measures

Physical control:
Hand removal if done carefully can be successful. Plants should be placed in plastic bags and left to dry out. Note: this could take some considerable time.

Herbicide control:
Products registered for control include *Grazon DS* and *2,4-D amine* (various trade names.). Contact your local supplier for details of registered herbicides.

Produced by the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS).
Design by Carlena Payne (carlenadesigns@hotmail.com).

LHCC REMS

Source: www.esc.nsw.gov.au/Weeds/Sheets/vines

Madeira vine or Lamb's Tail (*Anredera cordifolia*)

Family: Basellaceae

Status:

Description:
A large vine with rather fleshy, glossy, slightly heart shaped leaves, and long pendulous spikes of tiny cream flowers. Seed is probably not formed in southern Australia. The plant grows from large underground tubers. It also forms aerial tubers along the branches, which will sprout to form new plants when they fall to the ground. These tubers are similar in appearance to the ginger root used in cooking.

Preferred habitat and impacts:
More common in the northern parts of the region, but present at least as far south as Bega. Generally in moist sunny sites such as river banks and gully edges. Dies back over winter in the southern part of the region, and re-sprouts from the tuber in spring. Climbs over shrubs and trees, smothering and breaking them down. Also spreads over the ground, smothering native groundcover plants and preventing regeneration.

Dispersal:
Spread by tubers, in dumped garden waste or contaminated soil, or by water, such as along rivers in floods. Aerial tubers will be shed from stems if the vine is cut, and remain viable in soil for at least 5 years.

Look-alikes:
The fleshy leaves and aerial tubers are distinctive, though the tubers may not always be present. Most other climbing plants with fleshy leaves are also weeds, such as cape ivy (*Delairea odorata*) and climbing groundsel (*Senecio angulatus*, *Senecio tamoides*).

One small native vine, climbing lignum (Muehlenbeckia adpressa) has slightly fleshy leaves, which may also have a heart-shaped base similar to Madiera vine. Climbing lignum leaves differ in having finely crisped margins. It only grows on sea cliffs and dunes.

Some native vines have glossy, but not fleshy, heart-shaped leaves: **snake vine** (*Stephania japonica*), **pearl vine** (*Sarcopetalum harveyanum*), **round-leaf vine** (*Legnophora moorei*) and giant pepper vine (*Piper novae-hollandiae*). Giant pepper vine clings to tree trunks with small suckers of aerial roots, unlike Madeira vine which twines. It only occurs north from Narooma.

Control:
Plants can be dug up, but large tubers may break up in the process. Careful collection and disposal of aerial tubers will be needed if pulling vines down, to avoid spreading the plant. Use a tarp laid under the working area to catch them. Spraying with herbicides is useful for plants without aerial tubers, and young regrowth. Scrape and paint method can be used on mature vines. This will kill aerial tubers slowly. Results need to be monitored for regrowth. Respraying needs to be done frequently, to prevent enough foliage recovering to support the development of new tubers.

Hunter Central Coast Weed Management Committee

Fireweed

weed information sheet

What is it?

Fireweed is an introduced plant originating from South Africa.

Fireweed is an aggressive weed that will compete with pasture plants for nutrients and moisture. Stock will not readily eat fireweed, ingestion is usually accidental where animals are grazing close to Fireweed plants. It is reported to have caused fatalities in stock. This seems to be in situations where animals are grazing continuously in areas where infestations occur.

Fireweed
Senecio madagascariensis
Not a Declared Noxious Plant in this region.

What does it look like?

Fireweed is a lay-lowing to erect herb depending on conditions, growing to 10-75 cm high. It can be multi branched, and leaf shape is variable. Flowering occurs throughout the year although peak time is winter to early spring. It produces numerous seeds that can be carried long distances in the wind. Seeds can survive for some time before germinating, so any control program will need to continue for a number of years. Note: there are native species that are similar in appearance but do not cause problems.

Control Measures

Physical control:
Slashing will reduce the top growth of the plants, but as fireweed is a perennial plant it will continue to grow and produce seeds. As the plant has a long flowering period, frequent slashing is needed to prevent seeding. In small areas, hand removal can be effective. Removed plants should be placed in bags and left to completely dry out.

Herbicide control:
There are several herbicides registered for the control of fireweed. The main consideration in choosing a herbicide is the situation in which the infestation occurs, and the protection of nontarget plants. For general pasture situations, herbicides containing *Bromoxinil* will give good control. Note: this will not prevent seeds in the soil germinating at a later date. Follow up applications will be required.

If pastures are degraded, an integrated program may be more beneficial in the long term, where pasture improvement and the use of herbicides is required.

LHCC REMS

Annex I

Weed Control Techniques

Port Stephens COUNCIL ... a community partnership

ENVIRONMENTAL FACT SHEET

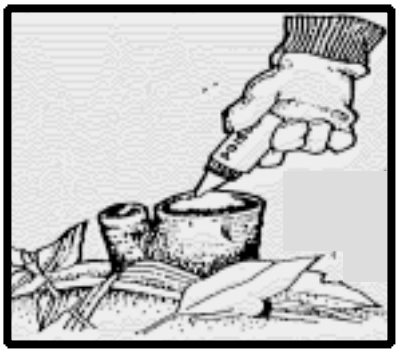
Weed Removal Techniques

Hand Removal

1. Gently remove any seeds or fruits and carefully place into a bag.
2. Hold the base of the stem firmly, then rock the plant backwards and forwards to loosen roots. Pull plant out gently, taking care not to snap the root (try to pull it out with the roots in tact, as some plants can re-sprout from only a small part of the plant).
3. Carefully tap the roots to dislodge any soil. Replace disturbed soil and pat down.
4. Where possible, leave the weeds so that the roots do not make contact with the soil eg. on a rock, or hung in a tree. It may be necessary to remove weeds from the site.

Cut and Paint

1. Useful for small to medium sized woody weeds up to 10cm in diameter.
2. Make a horizontal cut as close to the ground as possible using secateurs, loppers or a bush saw.
3. Immediately apply herbicide to the exposed flat stump surface. Ensure the stem is cut parallel to the ground so the herbicide doesn't run off.
4. If plants re-sprout, repeat the cut and paint procedure after sufficient regrowth has occurred (plant must be actively growing in order for the herbicide to be transported through its tissues).

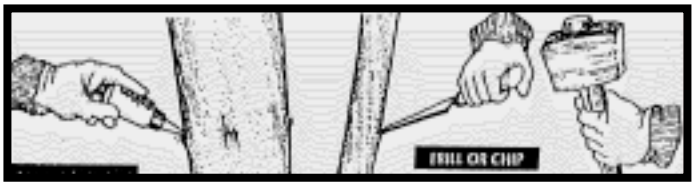


Stem Injection

1. This method is used for plants whose stem is greater than 10cm in diameter, or where the site will be exposed to severe erosion if the whole bush is removed.
2. At the base of the tree, drill holes (using a cordless drill, or hammering a large nail into the trunk) at the base of the tree at a 45^0 angle into the sapwood at 5cm intervals around the diameter of the tree.
3. Fill each hole with herbicide immediately.

Frill / Chip

1. As for stem injection, this method is used for plants whose stem is greater than 10cm in diameter, or where the site will be exposed to severe erosion if the whole bush is removed.
2. At the base of the tree, make a cut into the sapwood with a chisel / axe.
3. Fill each cut immediately with herbicide.
4. Repeat the process at 5cm intervals around the tree.



Control of Woody Weeds

Examples of woody weeds include:

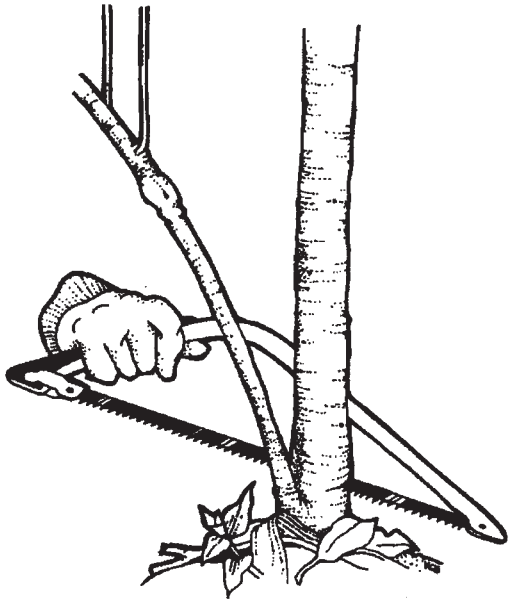
- **lantana, bitou bush, cotoneaster, privet (cut and paint)**
- **camphor laurel, Mickey Mouse bush (ochna) and cassia/senna (stem scrape)**

METHODS OF REMOVAL

1 ***CUT AND PAINT*** **—Useful for small to medium sized woody weeds up to 10cm basal diameter**

STEP 1 Make a horizontal cut as close to the ground as possible with secateurs, loppers or a bush saw.

STEP 2 Immediately apply herbicide to the exposed flat stump surface.



SAFETY CONSIDERATIONS

The following general precautions should be made when using herbicides:

- **Read the label before opening the container and follow the instructions.**
- **Wear protective clothing as directed on the label.**
- **Wash hands after use and before eating or smoking.**

considerations

- Cuts should be horizontal to prevent herbicide from running off the stump. Sharp angle cuts are hazardous.
- Herbicide must be applied immediately before the plant cells close and translocation of herbicide ceases.
- If plants resprout, cut and paint the shoots after sufficient regrowth has occurred.
- Stem scraping can be more effective on some woody weeds.

NATIONAL TRUST

NSW NATIONAL PARKS AND WILDLIFE SERVICE

AABR
Australian Association of Bush Regenerators

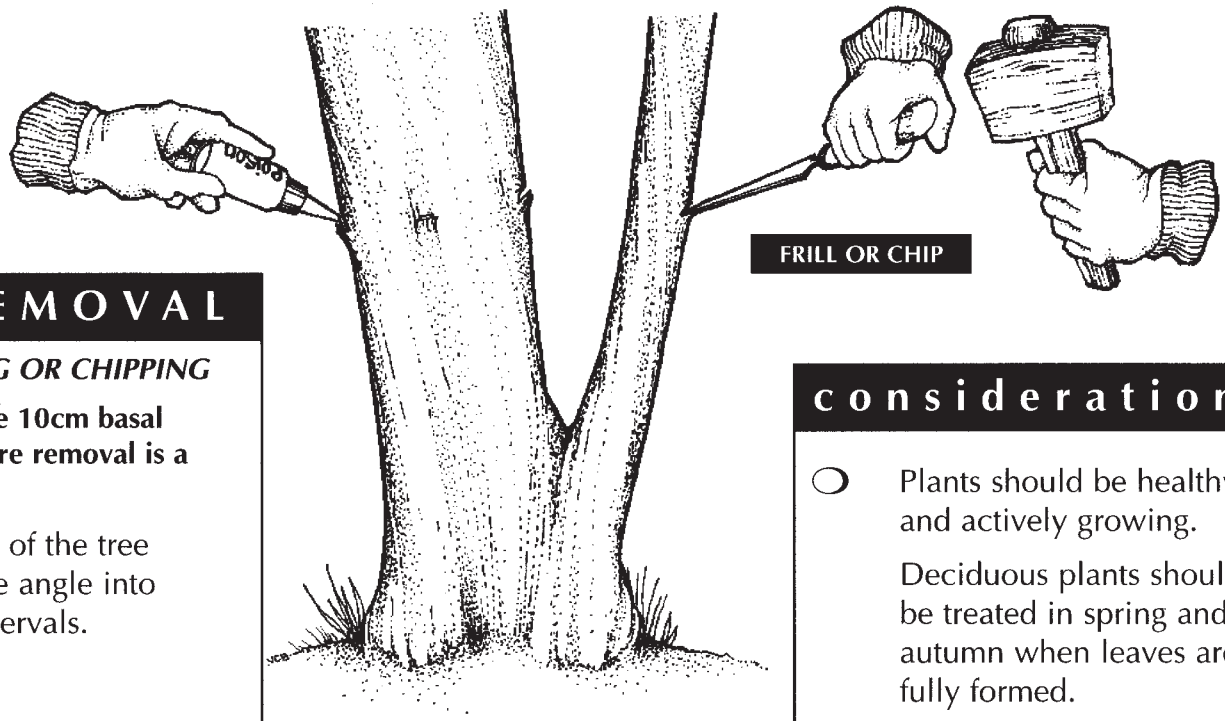
Illustrations: V.Bear

Control of Woody Weeds cont..

NATIONAL TRUST

NSW NATIONAL PARKS AND WILDLIFE SERVICE

AABR
Australian Association of Bush Regenerators



METHODS OF REMOVAL

❷ *STEM INJECTION* ❸ *FRILLING OR CHIPPING*

For use on larger shrubs or trees above 10cm basal diameter and in inaccessible sites where removal is a problem.

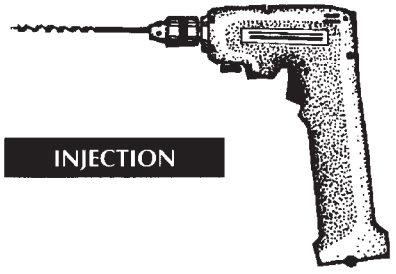
STEP 1 **INJECTION**: At the base of the tree drill holes at a 45 degree angle into the sapwood at 5 cm intervals.

OR

FRILL/CHIP Make a cut into the sapwood with a chisel or axe.

STEP 2 Fill each hole/cut with herbicide immediately.

STEP 3 Repeat the process at 5 cm intervals around the tree.



considerations

- Plants should be healthy and actively growing.

  Deciduous plants should be treated in spring and autumn when leaves are fully formed.
- For multi-stemmed plants, inject or chip below the lowest branch or treat each stem individually.
- Herbicide must be injected immediately before the plant cells close (within 30 seconds) and translocation of herbicide ceases.

Illustrations: V.Bear

Annex J

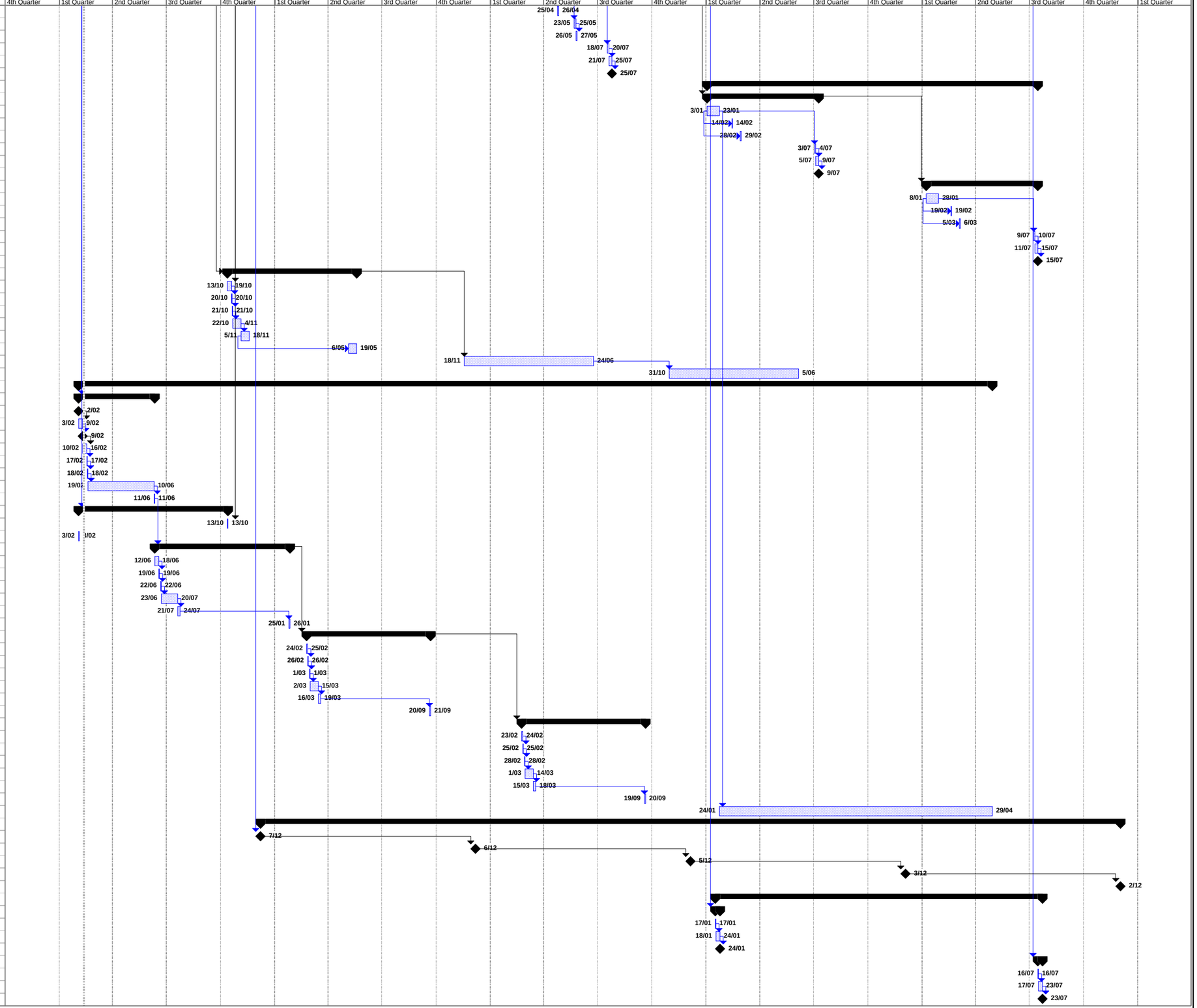
Gannt Chart

ID	Task Name	Resource Names
1	**DECC VMP**	
2	Project commencement	
3	Develop induction material	Aspen in consultation with DECC
4	**Waste Removal**	
5	**Establish Baseline Waste Data**	
6	Site inspection to identify extent of waste	Aspen
7	Produce figure and update waypoint register	Aspen
8	Baseline figure and waypoint register	
9	**Initial Waste Removal (Year 1)**	
10	Tender and contract document development	Aspen in consultation with DECC
11	Contract awarded	Aspen in consultation with DECC
12	Induction	Aspen and DECC
13	Works	Aspen
14	Confirmation and assessment	Aspen and DECC
15	Reporting	Aspen
16	Follow up inspection (6 months later)	Aspen
17	Reporting and recommendations	Aspen
18	Provide plan for waste removal for Year 2	
19	**Ongoing Waste Management (does not include disposal)**	
20	**Waste Management - Year 2**	**Aspen**
21	Engage contractor (includes induction)	Aspen in consultation with DECC
22	Removal of waste as per year 1 monitoring plan	Aspen
23	Inspection to confirm removal	Aspen and DECC
24	Inspection after 6 months	Aspen
25	Provide plan for waste removal for Year 3	Aspen
26	**Waste Management - Year 3**	
27	Removal of material as identified in year 2 plan	Aspen
28	Inspection to confirm removal	Aspen and DECC
29	Inspection after 6 months	Aspen
30	Provide plan for waste removal for Year 4	Aspen
31	**Waste Management - Year 4**	
32	Removal of material as identified in year 3 plan	Aspen
33	Inspection to confirm removal	Aspen and DECC
34	Inspection after 6 months	Aspen
35	Provide plan for waste removal for Year 5	Aspen
36	**Waste Management - Year 5**	**DECC**
37	Removal of material as identified in year 4 plan	Aspen
38	Removal of material as identified in field inspection	Aspen
39	Inspection to confirm removal	Aspen and DECC
40	Inspection after 6 months	Aspen
41	Provide plan for waste removal for Year 6	Aspen
42	**Weed Management**	
43	**Establish Baseline Weed Data**	
44	Review of air photo	Aspen
45	Site inspection to re-evaluate extent of weed infestation	Aspen
46	Produce figure and update waypoint register	Aspen
47	Baseline figure and waypoint register	Aspen
48	Baseline assessment and treatment plan	Aspen
49	Provide weed management plan for year 1 to DECC	
50	DECC approval of plan	DECC
51	**Primary weed management**	
52	**Year 1**	
53	Tender and contract document development	Aspen in consultation with DECC
54	Contract awarded	Aspen in consultation with DECC
55	Induction	Aspen and DECC
56	Works	Aspen
57	Inspection of works area to confirm 90% killed	Aspen and DECC
58	Monitoring 2 month post works	Aspen
59	Reporting	Aspen
60	Monitoring 6 months post works	Aspen
61	Reporting and recommendations	Aspen
62	Provide plan for weed management for Year 2	Aspen
63	**Year 2**	
64	Tender and contract document development	Aspen in consultation with DECC
65	Contract awarded	Aspen in consultation with DECC
66	Induction	Aspen and DECC
67	Baseline surveys	Aspen
68	Works	Aspen
69	Inspection of works area to confirm 90% killed	Aspen and DECC
70	Monitoring 2 month post works	Aspen
71	Reporting	Aspen
72	Monitoring 6 months post works	Aspen
73	Reporting and recommendations	Aspen
74	Provide plan for weed management for Year 3	Aspen
75	**Year 3**	
76	Tender and contract document development	Aspen in consultation with DECC
77	Contract awarded	Aspen in consultation with DECC
78	Induction	Aspen and DECC
79	Baseline surveys	Aspen
80	Works	Aspen

Project: 0065580 VMP Feb 09 Gantt Y
Date: Wed 11/02/09

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

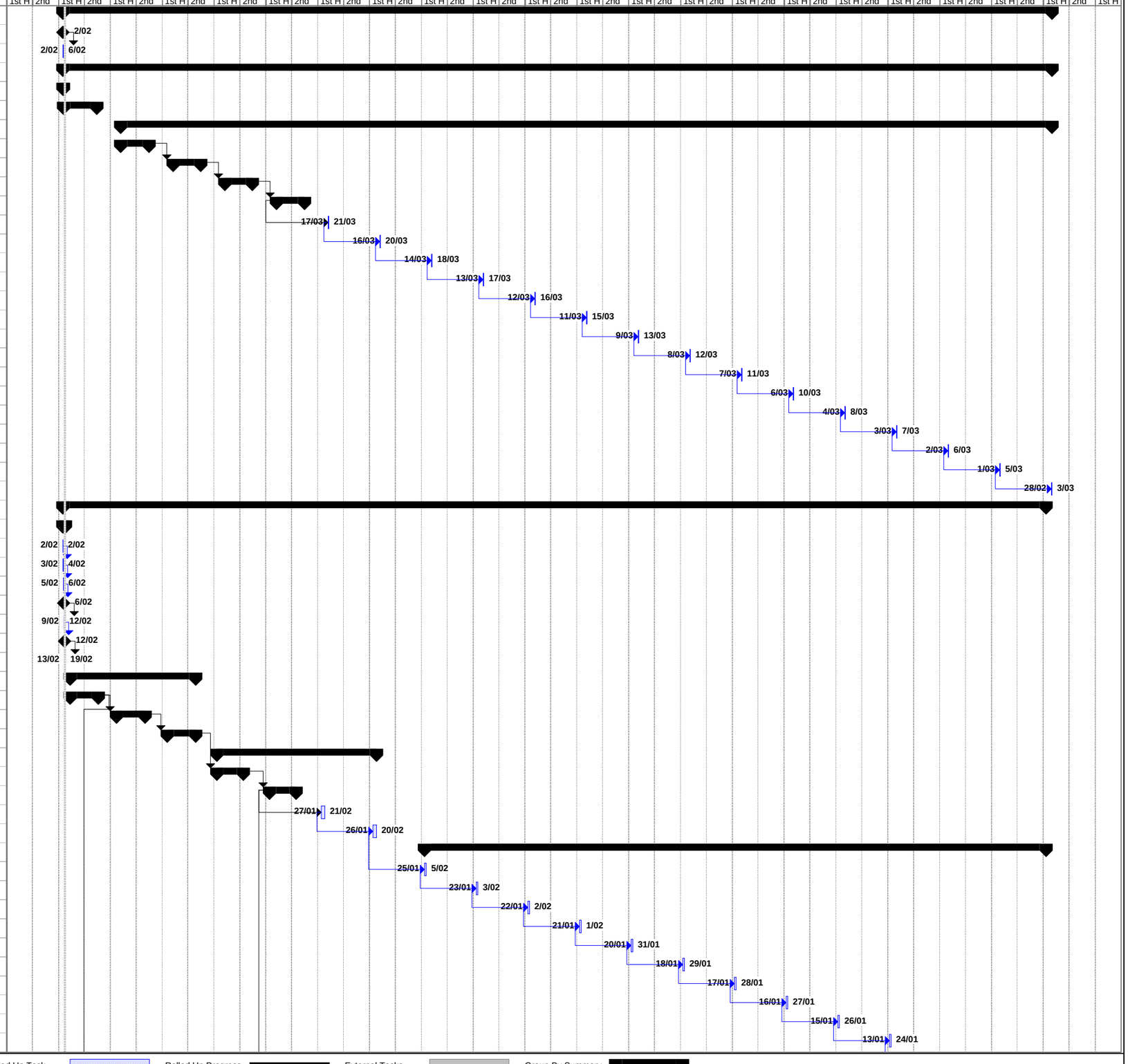
ID	Task Name	Resource Names
81	Inspection of works area to confirm 90% killed	Aspen and DECC
82	Monitoring 2 month post works	Aspen
83	Reporting	Aspen
84	Monitoring 6 months post works	Aspen
85	Reporting and recommendations	Aspen
86	Provide plan for weed management for Year 4	Aspen
87	**Follow up weed management**	
88	**Year 4**	
89	Weed management as per Year 3 report	Aspen in consultation with DECC
90	Inspection of works area to confirm 90% kill	Aspen and DECC
91	Monitoring 2 months post works	Aspen
92	Monitoring 6 months post works	Aspen
93	Reporting	Aspen
94	Provide plan for weed management for Year 5	Aspen
95	**Year 5**	
96	Weed management as per Year 4 report	Aspen in consultation with DECC
97	Inspection of works area to confirm 90% kill	Aspen and DECC
98	Monitoring 2 months post works	Aspen
99	Monitoring 6 months post works	Aspen
100	Reporting	Aspen
101	Provide plan for weed management for Year 6	Aspen in consultation with DECC
102	**Collection and propagation of vegetative material (Year 2)**	
103	Tender document and contract development	Aspen in consultation with DECC
104	Contract awarded	Aspen in consultation with DECC
105	Induction	Aspen and DECC
106	Seed collection (over several seasons)	Aspen
107	Propogation of materials	Aspen
108	Planting of seedlings (as required)	Aspen
109	**Collection and propagation of vegetative material (Year 3)**	
110	**Collection and propagation of vegetative material (Year 4)**	
111	**Track Rationalisation**	
112	**Beach access & Ancillary Works (REF, D&C)**	
113	Approval of REF	DECC
114	Finalisation of Design and Construction Details	Aspen
115	Approval of final design	Aspen and DECC
116	Develop tender and contract documents	Aspen and DECC
117	Contract awarded	Aspen and DECC
118	Induction	Aspen and DECC
119	Construction	Aspen
120	Inspection of work area	Aspen and DECC
121	**Track Closure**	
122	Review of air photo to provide baseline data	
123	Site inspection to confirm works required	
124	**Track rehabilitation Year 1**	
125	Tender document and contract development	Aspen in consultation with DECC
126	Contract awarded	Aspen in consultation with DECC
127	Induction	Aspen and DECC
128	Works	Aspen
129	Confirmation and reporting	Aspen and DECC
130	Monitoring and reporting	
131	**Track rehabilitation Year 2**	
132	Tender document and contract development	Aspen in consultation with DECC
133	Contract awarded	Aspen in consultation with DECC
134	Induction	Aspen and DECC
135	Works (may include bush regeneration works)	Aspen
136	Confirmation and reporting	Aspen and DECC
137	Monitoring and reporting	Aspen
138	**Track rehabilitation Year 3**	
139	Tender document and contract development	Aspen in consultation with DECC
140	Contract awarded	Aspen in consultation with DECC
141	Induction	Aspen and DECC
142	Works (may include bush regeneration works)	Aspen
143	Confirmation and reporting	Aspen and DECC
144	Monitoring and reporting	Aspen
145	Track rehabilitation Year 4 (with weed management)	
146	**Annual Reporting (4th qtr)**	
147	Annual Report Year 1	Aspen
148	Annual Report Year 2	Aspen
149	Annual Report Year 3	Aspen
150	Annual Report Year 4	Aspen
151	Annual Report Year 5	Aspen
152	**Independent Audit**	
153	**Year 3 Audit**	
154	Engage independent auditor	Aspen
155	Undertake audit	Auditor
156	Produce Year 3 Audit Report	Auditor
157	**Year 4.5 Audit (pre handover)**	
158	Engage independent auditor	Aspen
159	Undertake audit	Auditor
160	Produce Year 4.5 Audit Report	Auditor



Project: 0065580 VMP Feb 09 Gantt Y
Date: Wed 11/02/09

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

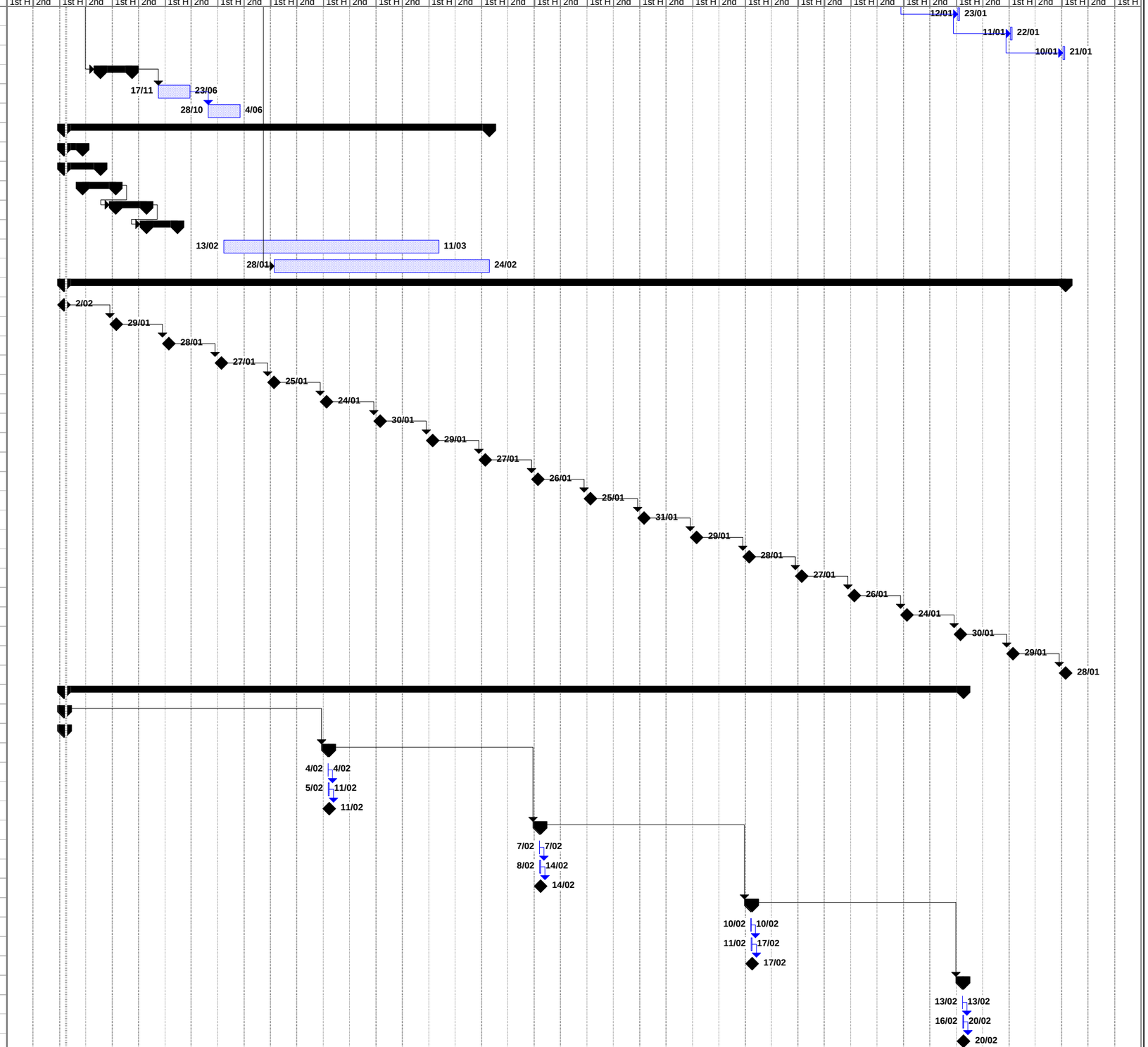
ID	Task Name	Resource Names
1	**DECC VMP**	
2	Project commencement	
3	Develop induction material	Aspen in consultation with DECC
4	**Waste Removal**	
5	**Establish Baseline Waste Data**	
9	**Initial Waste Removal (Year 1)**	
19	**Ongoing Waste Management (does not include disposal)**	
20	**Waste Management - Year 2**	**Aspen**
26	**Waste Management - Year 3**	
31	**Waste Management - Year 4**	
36	**Waste Management - Year 5**	**DECC**
42	Waste Management - Year 6	DECC
43	Waste Management - Year 7	DECC
44	Waste Management - Year 8	DECC
45	Waste Management - Year 9	DECC
46	Waste Management - Year 10	DECC
47	Waste Management - Year 11	DECC
48	Waste Management - Year 12	DECC
49	Waste Management - Year 13	DECC
50	Waste Management - Year 14	DECC
51	Waste Management - Year 15	DECC
52	Waste Management - Year 16	DECC
53	Waste Management - Year 17	DECC
54	Waste Management - Year 18	DECC
55	Waste Management - Year 19	DECC
56	Waste Management - Year 20	DECC
57	**Weed Management**	
58	**Establish Baseline Weed Data**	
59	Review of air photo	Aspen
60	Site inspection to re-evaluate extent of weed infestation	Aspen
61	Produce figure and update waypoint register	Aspen
62	Baseline figure and waypoint register	Aspen
63	Baseline assessment and treatment plan	Aspen
64	Provide weed management plan for year 1 to DECC	
65	DECC approval of plan	DECC
66	**Primary weed management**	
67	**Year 1**	
78	**Year 2**	
90	**Year 3**	
102	**Follow up weed management**	
103	**Year 4**	
109	**Year 5**	
115	Year 6	DECC
116	Year 7	DECC
117	**Ongoing Weed Management**	
118	Year 8	DECC
119	Year 9	DECC
120	Year 10	DECC
121	Year 11	DECC
122	Year 12	DECC
123	Year 13	DECC
124	Year 14	DECC
125	Year 15	DECC
126	Year 16	DECC
127	Year 17	DECC



Project: 0065580 VMP Feb 09 (detail 6
Date: Wed 11/02/09

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline

ID	Task Name	Resource Names
128	Year 18	DECC
129	Year 19	DECC
130	Year 20	DECC
131	**Collection and propagation of vegetative material (Year 2)**	
138	**Collection and propagation of vegetative material (Year 3)**	
139	**Collection and propagation of vegetative material (Year 4)**	
140	**Track Rationalisation**	
141	**Beach access & Ancillary Works (REF, D&C)**	
150	**Track Closure**	
153	**Track rehabilitation Year 1**	
160	**Track rehabilitation Year 2**	
167	**Track rehabilitation Year 3**	
174	Track rehabilitation Year 4 (with weed management)	Aspen
175	Track rehabilitation Year 5 (with weed management)	Aspen
176	**Annual Monitoring and Reporting (4th qtr)**	
177	Annual Report Year 1	Aspen
178	Annual Report Year 2	Aspen
179	Annual Report Year 3	Aspen
180	Annual Report Year 4	Aspen
181	Annual Report Year 5	Aspen
182	Annual Report Year 6	DECC
183	Annual Report Year 7	DECC
184	Annual Report Year 8	DECC
185	Annual Report Year 9	DECC
186	Annual Report Year 10	DECC
187	Annual Report Year 11	DECC
188	Annual Report Year 12	DECC
189	Annual Report Year 13	DECC
190	Annual Report Year 14	DECC
191	Annual Report Year 15	DECC
192	Annual Report Year 16	DECC
193	Annual Report Year 17	DECC
194	Annual Report Year 18	DECC
195	Annual Report Year 19	DECC
196	Annual Report Year 20	DECC
197	**Independent Audit**	
198	**Year 3 Audit**	
202	**Year 4.5 Audit (pre handover)**	
206	**Year 8 Audit**	
207	Engage independent auditor	DECC
208	Undertake audit	Auditor
209	Produce Year 8 Audit Report	Auditor
210	**Year 12 Audit**	
211	Engage independent auditor	DECC
212	Undertake audit	Auditor
213	Produce Year 12 Audit Report	Auditor
214	**Year 16 Audit**	
215	Engage independent auditor	DECC
216	Undertake audit	Auditor
217	Produce Year 16 Audit Report	Auditor
218	**Year 20 Audit**	
219	Engage independent auditor	DECC
220	Undertake audit	Auditor
221	Produce Year 20 Audit Report	Auditor



Project: 0065580 VMP Feb 09 (detail 6
Date: Wed 11/02/09

Task | Milestone | Rolled Up Task | Rolled Up Progress | External Tasks | Group By Summary
Progress | Summary | Rolled Up Milestone | Split | Project Summary | Deadline