BEAGLE BAY *BIG TREE COUNTRY* PLANTATION PROJECT

PUBLIC ENVIRONMENTAL REVIEW

Tropical Timber Plantations Pty Ltd
(ACN 099 305 718)

19 Deanery Mews
CHURCHLANDS WA 6018

Prepared by

ecologia
ENVIRONMENT

76 Thomas Street
West Perth 6005

INVITATION TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

Tropical Timber Plantations Pty Ltd proposes the development of the Beagle Bay *Big Tree Country* Plantation Project on the Dampier Peninsula in the Kimberley region of Western Australia. In accordance with the State *Environmental Protection Act 1986* a Public Environmental Review (PER) document has been prepared which describes this proposal and its likely effects on the environment. The PER document is available for a public review period of six (6) weeks from **Monday 21st February 2005 closing on Monday 4th April 2005**.

Comments from government agencies and from the public will help the EPA to prepare an assessment report in which it will make recommendations to government.

WHY WRITE A SUBMISSION?

A submission is a way to provide information, express your opinion and put forward your suggested course of action including any alternative approach. It is useful if you indicate any submissions you have to improve the proposal. All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents unless provided and received in confidence subject to the requirements of the *Freedom of Information Act,* and may be quoted in full or in part in the EPA's report.

WHY NOT JOIN A GROUP?

If you prefer not to write your own comments, it may be worthwhile joining with a group or other groups interested in making a submission on similar issues. Joint submissions may help to reduce the work for an individual or group, while increasing the pool of ideas and information. If you form a small group (up to 10 people) please indicate the names of all participants. If your group is larger, please indicate how many people your submission represents.

DEVELOPING A SUBMISSION

You may agree or disagree with, or comment on, the general issues discussed in the PER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal more environmentally acceptable.

When making comments on specific elements of the PER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable;
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- attempt to list points so that the issues raised are clear. A summary of your submission is helpful;
- refer each point to the appropriate section, chapter or recommendation in the PER;
- if you discuss different sections of the PER, keep them distinct and separate, so there is no confusion about which section you are considering;
- attach any factual information you want to provide and give details of the source. Make sure your information is accurate.

REMEMBER TO INCLUDE:

- your name;
- address;
- date; and
- whether you want your submission to be confidential.

The closing date for submissions is: **Monday 4th April 2005**.

Submissions should be emailed to: murray.hogarth@environment.wa.gov.au

OR addressed to:
Environmental Protection Authority
PO Box K822
PERTH WA 6842

Environmental Protection Authority
Westralia Square
141 St Georges Terrace
PERTH WA 6000
Attention: Murray Hogarth

Document Status						
Rev No.	Author	Reviewer/s	Date	Approved for Issue		
				Name	Distributed To	Date
1	S. Waldeck A. Maxwell M. Ladyman	G. Connell J. Brennan	14/04/04	G. Connell	TTP	01/05/04
2	S. Waldeck A. Maxwell	G. Connell J. Brennan	8/06/04	G. Connell	TTP	15/06/04
3	S.Waldeck	G. Connell				
4	B. Barnett	G. Connell J. Brennan	17/09/04			
5	B. Barnett			G. Connell	Stakeholders	08/10/04
6	B. Barnett	J. Brennan, N. Patel	20/12/04			
7	B. Barnett		11/01/05			
8	B. Barnett, S. Waldeck	G. Connell	13/02/05	G. Connell	Public Release	16/02/05

76 Thomas Street
WEST PERTH WA 6005
Phone: 08 9322 1944
Fax: 08 9322 1599
Email: ecologia@ecologia.com.au

Table of Contents

TABLES

FIGURES

PLATES

EXECUTIVE SUMMARY

In 2000 Beagle Bay Community (BBC) Inc. and Capricorn Timber Pty Ltd entered into a joint venture agreement to establish a tropical timber plantation of Teak *Tectona grandis*, Indian Rosewood *Dalbergia latifolia*, Indian Sandalwood *Santalum album* and African Mahogany *Khaya senegalensis* within the Beagle Bay Aboriginal Reserve. The proposed area for development is located approximately 20 km SE from the BBC, on the Dampier Peninsula. Beagle Bay is 120 kilometres north of Broome, Western Australia.

In 2001, a four hectare trial plantation of Teak and Indian Sandalwood was established. The trial plantation indicates that the venture is both economically viable and environmentally sustainable. The Proponent, Tropical Timber Plantations Pty Ltd. (TTP) therefore proposes the staged development of a 900 ha plantation to be implemented progressively over a three-year period. The infrastructure required for this development is largely already in place and the development will constitute the expansion of existing facilities (Table S1).

Tree density will be:

African Mahogany	625 trees/ha
Teak	1,000 trees/ha
Sandalwood	315 trees/ha
Rosewood	315 trees/ha

BIOPHYSICAL

The project area lies in the Dampier Botanical District within the Northern Botanical Province described as "Pindan woodland on extensive monotonous sandplain". Pindan woodland is generally characterised by an open layer of trees 12-15 metres in height above a layer of dense *Acacia,* up to five metres, and a relatively sparse grassy ground layer (Beard, 1979).

Flora and fauna attributes, including species and taxa level biodiversity, Rare and Priority flora and fauna and other taxa of conservation significance, vegetation communities and fauna habitats of the project area are summarised in Table S2.

Very substantial groundwater resources occur in the locality. Extractable groundwater is principally within a regional unconfined aquifer.

HERITAGE

The project is located within the Beagle Bay Aboriginal Reserve. There are no registered Aboriginal heritage sites. No non-indigenous heritage sites exist in the project area.

PROJECT IMPACTS AND MANAGEMENT

Table S3 provides a summary of potential environmental issues and proposed management associated with the Beagle Bay *Big Tree Country* Plantation Project (the project) proposal. Environmental factors considered under Biophysical generally relate to direct impacts on the physical and biological environment. Pollution Management within the context of this proposal relates primarily to water quality and general pollution issues. Social Surroundings refer to heritage issues.

TABLE S1: SUMMARY OF KEY CHARACTERISTICS ASSOCIATED WITH THE PROPOSAL

Component	Key Aspect	Characteristic Description
Plantation Operations	Proposed Site Location	Dampier Peninsula 120 km north of Broome
	Estimated Area of Plantation	967 ha (total disturbance)
	Planting Density	Mahogany 625 trees/ha Teak 1,000 trees/ha Sandalwood 315 trees/ha Sandalwood hosts 315 trees/ha
	Species to be Cultivated	Teak *Tectona grandis,* Indian Rosewood *Dalbergia latifolia,* Indian Sandalwood *Santalum album,* African Mahogany *Khaya senegalensis*, Australian Ebony *Diospyros ferrea* and Gubinge *Terminalia latipes*.
	Planting Rate	Planting will be undertaken in 3 stages of 300 ha each.
	Total Estimated Production	57,300 m^3 timber
	Project Life Span	20 years
	Anticipated Year of Project Closure	2025
	Water Supply Requirements	4.5 GL/a
Transport Requirements	Road Train Movements	2700 loads hauled to Broome
General	Workforce	25
	Workforce Accommodation	Accommodation Village for 25 people Area of disturbance 2 ha
	Infrastructure	Power source – Beagle Bay power station. Water source – Groundwater from site.
Plantation Facilities	Nursery Storage Shed Site Office etc.	Area of disturbance – 5 ha

TABLE S2: BIODIVERSITY ATTRIBUTES SUMMARY TABLE

Attribute	Project Area Characteristics	Regional Area Characteristics
Flora	180 taxa 56 Families 117 Genera	717 Taxa 122 Families 361 Genera
Fauna	Sampling within the proposed plantation area identified: 101 vertebrate species 61 birds 28 reptiles 8 mammals (6 native and 2 introduced) 4 amphibians	206 vertebrates potentially occur in the wider project area: 117 birds 60 reptiles 21 mammals (17 native and 4 introduced) 8 frogs
Rare Flora (DRF)	Nil	One Species
Priority Flora	Nil within plantation site	Eight species have been recorded in the wider project area: *Aphyllodium parvifolium* P1 *Gomphrena pusilla* P2 *Aphyllodium glossocarpum* P3 *Glycine Pindanica* P1 *Nymphoides beaglensis* P2 *Stylidium costulatum* P3 *Phyllanthus aridus* P3 *Triodia acutispicula* P3
Weeds	Nil within plantation site	Twelve species have been recorded from the Bobby's Creek area including the declared weeds; *Parkinsonia aculeata* and *Sida acuta,* and the highly invasive tropical weed *Passiflora foetida*
Fauna Protected Under International Agreements	<u>*Recorded*</u> Rainbow Bee-eater - *Merops ornatus* Fork-tailed Swift - *Apus pacificus*	<u>*Potentially Occur*</u> White-bellied Sea Eagle - *Haliaeetus leucogaster* Yellow Wagtail - *Motacilla flava* Oriental Cuckoo - *Cuculus saturatus*
Rare Fauna		Species potentially occurring within the project area: Bilby *Macrotis lagotis* Golden bandicoot *Isoodon auratus auratus* Red goshawk *Erythrotriorchis radiatus* Gouldian Finch *Erythrura gouldiae* Australian Painted Snipe *Rostratula benghalensis australis* Peregrine Falcon *Falco peregrinus*
Priority Fauna	<u>*Recorded*</u> Bush Stone-curlew *Burhinus grallarius* Australian Bustard *Ardeotis australis*	<u>*Potentially Occur*</u> Little North-western Mastiff Bat *Mormopterus loriae cobourgiana* Grey Falcon *Falco hypoleucos* *Simoselaps minimus* (elapid snake) *Lerista separanda* (skink)
Vegetation Communities	Savannah Woodland or Pindan Woodland	Wetlands - *Melaleuca* open to closed forest over sedges and grasses associated with a wet habitat or sedgelands and sedgeland/ grasslands Terrestrial - *Melaleuca* scattered trees to woodlands over flood plains of grasses such as *Chrysopogon* sp. Savannah Woodland
Threatened Ecological Communities	Nil	The assemblages of the Lolly Well Springs wetland complex, which occur within the Bobby's Creek system, have been listed as Priority 4 on the CALM Priority Ecological Communities list
Bioregion	Dampier	

ENVIRONMENTAL MANAGEMENT SYSTEM

TTP have developed an Environmental Management System (EMS) for their plantation operations at Beagle Bay. This is the principal supporting document for the PER.

COMMITMENTS

The following environmental commitments have been made by TTP in order to manage the Beagle Bay Plantation Project:

1. Weeds

TTP will develop a weed management plan, including implementation of weed hygiene procedures.

2. Dust

TTP will develop and implement dust management plan for plantation construction and operation, which will include a dust monitoring program.

3. Wetland Groundwater Monitoring

TTP will monitor ground water levels within the Bobby's Creek wetland system to the north of the project area.

4. Monitoring of Groundwater Dependent Ecosystems

TTP will monitor the Groundwater Dependent Ecosystems (GDEs) north of the project area.

5. Aquatic Flora and Fauna Monitoring

TTP, in consultation with CALM and the DoE, will monitor flora and fauna aquatic indicator species of the Groundwater Dependent Ecosystems (GDEs) north of the project area.

6. Rare and Priority Flora Surveys

Undertake Rare and Priority flora surveys in areas to be cleared prior to disturbance.

A Priority Flora Management Plan will be implemented if necessary.

7. Fire Management

TTP will develop and implement a bushfire management plan.

8. Groundwater and Irrigation

TTP will undertake:

- A monitoring plan to ensure that groundwater levels are not significantly reduced; and
- Research to more accurately determine tree water demand of the plantation species.

9. Closure Plan

TTP will develop a detailed Closure Plan for the plantation. The Plan will address rehabilitation actions to be taken for the plantation and associated infrastructure and will provide the basis for an eventual 'walk away' strategy for the Project. It will also accommodate potential project failure.

10. Aboriginal Site Survey

TTP will ensure that (an) Aboriginal custodian (s) of the Beagle Bay Community will examine the project area for anthropological/ethnographic and archaeological sites prior to clearing.

If any new sites are discovered, clearing will cease and the Department of Indigenous Affairs (DIA) will be notified.

11. Environmental Management System

TTP have developed and will implement a formal EMS for the Project that embraces the ISO 14001 standards and incorporates the following:

- Environmental policy and corporate commitment to the EMS;
- Mechanisms and processes to ensure:
  - Planning to meet environmental requirements,
  - Implementation and operation of actions to meet environmental requirements,
  - Measurement and evaluation of environmental performance,
  - Review and improvement of environmental outcomes;
- Monitoring of key environmental aspects;
- Management of environmental impacts from clearing, planting and operation;
- Rehabilitation and revegetation of the project area;
- An overview of timing for implementation of commitments; and
- Reporting requirements.

TABLE S3: ISSUES AND MANAGEMENT FOR THE BEAGLE BAY PLANTATION PROJECT

Issue/Factor	EPA Objective	Scope of Work for PER	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
BIOPHYSICAL						
Vegetation Communities	Maintain the general abundance and diversity of species. Maintain the geographic distribution and productivity of vegetation communities.	Baseline studies to identify existing vegetation communities. Assessment of potential impacts (direct and indirect) on vegetation communities as a result of plantation. Proposed measures to manage impacts	Vegetation and flora surveyed throughout the project area. Vegetation community primarily Pindan woodland on monotonous sandplain. No vegetation of significant conservation value identified.	Loss of 967 ha of natural vegetation. Weed invasion. Loss through fire.	Retain vegetation between plots and allow regeneration of the understorey. All clearing operations to be kept to a minimum. Firebreaks around the 5000 ha Lease Option Area.	Loss of 967 ha of natural vegetation, less than 0.26 % of Reserve, less than 0.001 % of Dampier Peninsula and less than 0.001 % of Dampier Botanical District. Weed establishment minimised by retention of native understorey within plots. Protection of flora in the event of a fire.
Declared Rare and Priority Flora /Flora of Conservation Significance	Protect Declared Rare Flora (DRF) and Priority Flora, consistent with the provisions of the *EPBC Act* 1999 and the *Wildlife Conservation Act* 1950. Protect other flora species of conservation significance.	Baseline studies to identify any DRF, Priority Flora or other species of conservation significance and discussion of the results in a regional/ecosystem context.	No DRF identified. One Priority Flora species was identified adjacent to the plantation.	Negligible.	Any significant flora species (DRF and Priority Flora) within the plantation and adjacent areas will be demarcated and avoided where practicable.	Negligible.
Terrestrial Fauna	Maintain the general abundance, species diversity and geographical distribution of terrestrial fauna.	Baseline studies to identify existing terrestrial fauna throughout the project area and discussion of the results in a regional / ecosystem context. Assessment of potential	Surveys of the proposed plantation area identified 105 vertebrate species, including 65 birds, 28 reptiles, 4 amphibians and 8 mammals (6 native and 2 introduced).	Loss of fauna and fauna habitat due to clearing and ongoing plantation practices. Influence of fertilisers and sprays on local fauna.	Retention of habitat corridors, which bisect the plantation, to facilitate movement of fauna species. The timber plantation will be cultivated to maintain a degree of low	Some limited loss of fauna habitat. Maintenance of fauna populations in the area. Protection of vegetation in the event of a fire.

Issue/Factor	EPA Objective	Scope of Work for PER	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
		impacts (direct and indirect) on terrestrial fauna as a result of the plantation. Proposed measures to manage impacts		Increased numbers of feral fauna. Influence on the dynamics of invertebrate pests (native termites). Loss through fire	to mid storey vegetation and fauna microhabitat within the plantation plots. Where possible, the use of pesticides and fungicides will be applied directly to the root zone through the irrigation system to minimise risk of contact with local fauna. Clearing will be staged in order to allow mobile fauna species to relocate into surrounding habitats. Firebreaks around the 5000 ha Lease Option Area.	
Specially Protected (Threatened) Fauna	Protect Specially Protected (Threatened) Fauna consistent with the provisions of the *Wildlife Conservation Act*, the EBPC Act and CAMBA and / or JAMBA.	Baseline studies to identify Specially Protected (Threatened) Fauna found within the area affected by the proposal.	Fauna Present: Rainbow bee-eater *Merops ornatus*. Fork-tailed swift *Apus pacificus.* Bush Stone-curlew *Burhinus grallarius* Australian Bustard *Ardeotis australis*	Loss of fauna and fauna habitat from ongoing plantation practices. Increased numbers of feral fauna.	Retention of habitat corridors, which bisect the plantation, to facilitate movement of fauna species. The timber plantation will be cultivated to maintain a degree of low to mid storey vegetation and fauna microhabitat within the plantation plots.	Rare Fauna conservation status maintained.
Decommissioning and Rehabilitation – in the event of project failure.	Ensure that decommissioning and rehabilitation are carried	Prepare an integrated decommissioning and rehabilitation strategy	Some existing land degradation due to previous pastoral	Rehabilitated areas inconsistent with existing environment.	The natural landform shall be retained throughout the plantation	Post plantation landscape will either resemble pre-impact status or as

Issue/Factor	EPA Objective	Scope of Work for PER	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
	out in a planned sequential manner. Ensure ecosystem function is maintained following plantation closure. Avoid state liability. Ensure that the post-plantation landform is safe, stable, non-erodible, and is integrated into the surrounding environment.	which ensures a stable and functioning ecosystem consistent with the surrounding landscape and other environmental values is achieved following project completion. Additionally, it will detail the commitments of the Proponent in the event of project failure.	activities, frequent fires and feral animal grazing.		period. Native vegetation shall be retained, where practicable, throughout the duration of the planting period. The plantation shall be decommissioned at handover to comply with the agreed end land use.	deemed appropriate by the Beagle Bay Community.
Wetlands	Maintain the integrity, functions and environmental value of wetland areas.	Baseline studies to identify and map the groundwater dependent ecosystems within the greater project area. Condition Assessment of the wetland systems north of the plantation area. Proposed measures to manage impacts.	Wetland systems, including those around Bobby's Creek and Lolly Well.	Modelling suggests that after 20 years of abstraction at 4.5 GL/a, groundwater levels at Bobby's Creek will be lowered by 19 mm.	Compliance with DoE Licence and Operating Strategy. Monitoring groundwater levels. Monitoring of the seasonal variation of the water table at the wetland systems.	Maintenance of Ecological Water Requirements for all groundwater dependent ecosystems.
Groundwater Quantity	Maintain (sufficient) quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.	Details of the hydrogeological system of the project area and existing uses of groundwater (including ecosystem maintenance). Assessment of the potential short-term and long-term impacts on	One bore currently in operation (pumpage 11,225 kL/a in 2002-2003).	Over a 20 year period at an abstraction rate of 4.5 GL/a, a cone of depression of 0.6 to 1.0 m below the static groundwater level will develop beneath the plantation.	Monitoring of groundwater quantity and quality at extraction sites. Compliance with DoE Licence and Operating Strategy.	Maintenance of sufficient groundwater resources. Groundwater draw will not exceed annual recharge rate. No impacts on dependent ecosystems during Stage

Issue/Factor	EPA Objective	Scope of Work for PER	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
		groundwater systems as a result of the proposed draw. Proposed measures to manage impacts, including managing impacts on dependent vegetation.				1.
POLLUTION MANAGEMENT						
Water Quality	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the Australian and New Zealand Water Quality Guidelines.	Details of the existing water quality of groundwater aquifers. Assessment of the impacts on surface water and groundwater quality. Proposed measures to manage impacts.	Water resources are generally fresh with a salinity less than 250 mg/L.	Contamination of water resources by fertilisers, herbicides and/or pesticides.	Use of biodegradable chemicals only, on an as-needed basis. Targeted application of herbicides and pesticides at appropriate times. Nutrient application proportional to tree uptake capability. Analysis of groundwater for presence of agro-chemicals as part of Groundwater Licence Operating System	Groundwater quality maintained.
Soil quality	Maintain soil quality to ensure that existing and potential uses, including ecosystem maintenance are protected.	Assessment of the impacts on soil. Proposed measures to manage impacts.	Low lying Quaternary sandplains and low hills of deep red sandy soils. Red sandplains.	Contamination of soils by fertilisers, herbicides and/or pesticides.	Use of biodegradable chemicals only, on an as-needed basis. Targeted application of herbicides and pesticides at appropriate times. Nutrient application proportional to tree uptake capability. Ongoing soil monitoring.	Concentration of nutrients and chemicals in the soil maintained at an appropriate level.

Issue/Factor	EPA Objective	Scope of Work for PER	Existing Environment	Potential Impacts	Proposed Management	Predicted Outcome
Greenhouses gases	Reduce greenhouse gas emissions to a level which is as low as practicable.	Assessment of carbon retention within existing Pindan vegetation. Proposed measures to reduce greenhouse gas emissions.	Carbon retention quite low due to vegetation types and sparse nature of community.	No long term change in greenhouse gas emissions.	Implementation of fire management practices. Research to assess carbon storage capacity of plantation trees.	No net increase in greenhouse gas emissions.
SOCIAL SURROUNDINGS						
Heritage	Ensure project does not adversely affect heritage sites.	Identification of Aboriginal cultural and heritage sites of significance within the project area. Effects of the proposal on the environment, health, land uses or welfare of the local indigenous community. Proposed measures to manage impacts.	No heritage sites identified.	Negligible.	Any sites identified within the project area will be registered and avoided.	No impact to sites of indigenous heritage or non-indigenous significance.
Visual amenity	Manage and mitigate impacts to landscape values.	Ensure that layout design has adequate consideration for visual amenity, including buffers. Ensure that rehabilitation achieves a stable and functioning landform which is consistent with the surrounding landscape and other environmental values.	Reasonably undisturbed.	Negligible.	The plantation will retain a buffer between public access points and the plantation. Native understorey will be permitted to regenerate within plantation. Broad habitat corridors will be retained between the plantation plots. Conservation areas will be set aside where necessary.	No impact to visual amenity of the area.

1.0 INTRODUCTION

1.1 Background

In 2000 BBC Inc. and Capricorn Timber Pty Ltd entered into an agreement to establish a tropical timber plantation of Teak *Tectona grandis*, Indian Rosewood *Dalbergia latifolia*, Indian Sandalwood *Santalum album* and African Mahogany *Khaya senegalensis* within the Beagle Bay Aboriginal Reserve. In 2003 Tropical Timber Plantations Pty Ltd (TTP) was formed as a joint venture agreement between the parties.

The legal structure of the agreement is detailed below:

1. The venture is being conducted by Tropical Timber Plantations Pty Ltd ("Company") in the capacity as trustee for and on behalf of the Tropical Timber Plantation Unit Trust ("Trust").
2. The unitholders in the Unit Trust are Capricorn Timber Pty Ltd ("Capricorn") as to 90 % Beagle Bay Burrdunk Inc ("BBB") as to 10 %.
3. Capricorn is the Company of Naresh Patel. BBB is an association established by and for members of the Beagle Bay Community. It is the representative body for the Beagle Bay Community in the plantation.
4. The affairs of the Unit Trust are regulated by the Deed creating the trust as well as a Unitholders Agreement (also known as Joint Venture Agreement) between the parties.
5. The legal operations of the joint venture are conducted by the Company as trustee for the trust.
6. The Beagle Bay Community Inc ("BBC") is the lessee of land on the Dampier Peninsula from Aboriginal Lands Trust pursuant to lease number H538458L and has sub-leased an area of 25 ha to the company for the purpose of conducting the trial timber plantation.
7. The sub-lease to the company is for a term of five years and commenced 1 January 2001.
8. There is an option within the sub-lease for a further sub-lease to be granted of up to 5,000 ha for a term of 50 years following the agreement being reached by the parties (BBC, the Company and the lessor, the Aboriginal Lands Trust).
9. Legal agreements between BBC, BBB, the Company and Capricorn commit Capricorn to making all expenditures on behalf of the trial timber plantation within the trial period.

In 2001 a trial plantation was established with the planting of three hectares of Indian Sandalwood with secondary hosts *Acacia trachycarpa* and *Sesbania formosa*, and tertiary hosts, *Casuarina equisetifolia* and *Dalbergia latifolia*. The 0.4 hectare Teak trial plot was planted out between February and April 2002, comprising of clonal material and selected seed from superior provenances.

As part of the project, local medicinal, bush tucker and potential timber crops are to be developed and researched.

In December 2002, trial plantings of the Australian Ebony *Diospyros ferrea* and Gubinge *Terminalia latipes* were undertaken. Investigation into propagation techniques of four local medicinal plants is to be initiated in 2005.

The trial plantation indicates that the venture is both economically viable and environmentally sustainable. The Proponent therefore proposes the development of a 900 ha plantation to be progressively implemented over a three-year period. The infrastructure required for this development is largely already in place and any development will constitute the upgrade of existing facilities.

1.2 The Proponent

Contact persons for the proposed Beagle Bay *Big Tree Country* Plantation Project are:

Tropical Timber Plantations Pty Ltd ACN 099 305 718 19 Deanery Mews Churchlands WA 6018 Site Office PO Box 2415 Broome WA 6725	Contact: Naresh Patel Telephone: 0411 568 442 Email: patnaresh@hotmail.com Contact: John Brennan Telephone: 9192 4029 / 0429 907 358 Email: capricorn.ttp@bigpond.com
Beagle Bay Community Inc. PO Box 326 Broome WA 6725	Contact: John Cox, CEO Telephone: 9192 4913 Email: billard@bigpond.com
Beagle Bay Burrdunk	Contact: William Smith Telephone: 9192 4913

The Proponent's consultant for the preparation of this PER document is:

- Mr Garry Connell, Manager Environment – Major Projects, at *ecologia* Environment, 76 Thomas Street, West Perth, WA 6005 or e-mail: garry.connell@ecologia.com.au.

1.3 Location

The proposed area for development is located approximately 20 km SE from the BBC, on the Dampier Peninsula. The Dampier Peninsula covers about 14,000 square kilometres. The Project site represents less than 0.001 % of the Dampier Peninsula and the Dampier Botanical District. Beagle Bay lies 120 km by road north of Broome, Western Australia (Figure 1.1). Access to the plantation is *via* the Broome-Cape Leveque Road.

1.4 Project Scope and Timing

This PER document examines the environmental implications associated with the proposed Beagle Bay *Big Tree Country* Plantation Project.

Development of the existing site is proposed to commence in 2005, with annual plantings of 300 ha to be undertaken over a three-year period. Teak will be thinned and harvested at age six to eight. The first Sandalwood harvest will be in year thirteen, African Mahogany, Rosewood and Teak will be harvested from year 16-20. The life span of the project is estimated to be up to twenty years.

This PER document relates to Stage 1 of the project, comprising a 900 ha plantation (and associated infrastructure) with water requirements of 4.5 GL/a over a lifespan of 20 years. Details of a potential Stage 2 of the project are included for information in Section 11.

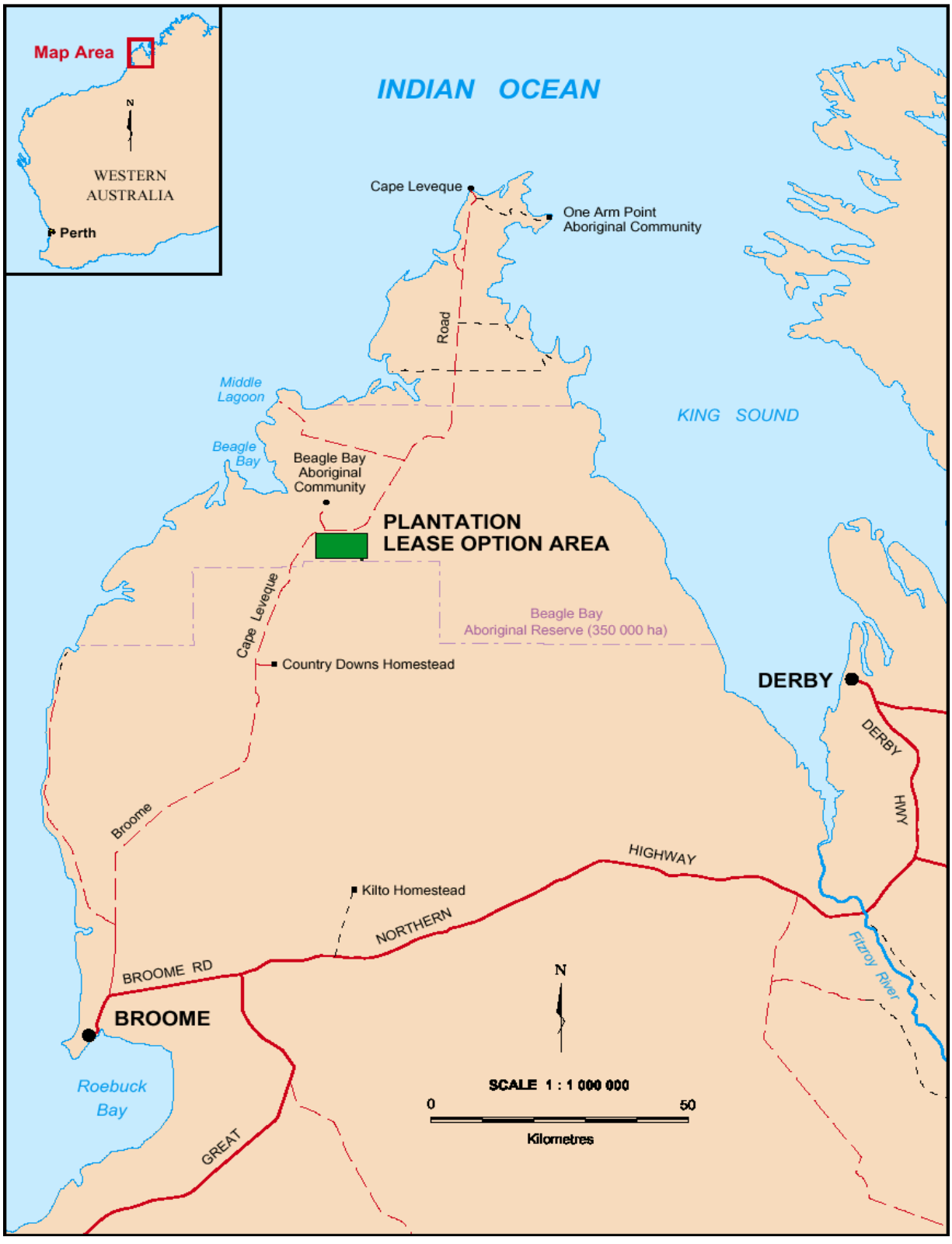


FIGURE 1.1 LOCATION OF PLANTATION LEASE AREA WITHIN THE DAMPIER PENINSULA

1.5 Legislative Framework

TTP acknowledges the requirement to comply with relevant Commonwealth and State legislation that will apply to the development and operation of the project. This legislation includes, though is not necessarily limited to, the following:

TABLE 1.1: LEGISLATION AND RESPONSIBLE GOVERNMENT AGENCIES

Legislation	Responsible Government Agency
Commonwealth	
Native Title Act 1993	National Native Title Tribunal
Customs Act 1901	Australian Customs Service
Quarantine Act 1908	Australian Quarantine and Inspection Service
Trade Practices Act 1974	Commonwealth of Australia
State	
Aboriginal Affairs Planning Authority Act 1972	Department of Indigenous Affairs
Aboriginal Heritage Act 1972	Department of Indigenous Affairs
Agricultural and Related Resources Protection Act 1976	Department of Agriculture
Agriculture Protection Board Act 1950	Department of Agriculture
Bushfires Act 1954-1981	Bush Fires Board
Conservation and Land Management Act 1984	Department of Conservation and Land Management
Country Areas Water Supply Act 1947	Waters & Rivers Commission
Environmental Protection Act 1986	Department of Environment
Explosives and Dangerous Goods (Dangerous Goods Handling and Storage) Regulations 1992	Department of Industry and Resources
Health Act 1911	Department of Health Western Australia
Health (Pesticides) Regulations 1956	Department of Health Western Australia
Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974	Department of Health Western Australia
Heritage of Western Australia Act 1990	Heritage Council of Western Australia
Land Act 1933	Department of Land Information
Land Administration Act 1997	Department of Land Information
Local Government Act 1995	Department of Local Government/Shire of Broome
Occupational Health and Safety Act 1984	Worksafe WA Commission
Rights in Water and Irrigation Act 1914	Department of Environment
Soil and Land Conservation Act 1945	Department of Agriculture
Spray Restriction Regulations 1979	Department of Health Western Australia
Timber Industry Regulations Act 1926	Department of Conservation and Land Management
Town Planning and Development Act 1928	Department of Planning and Infrastructure
Wildlife Conservation Act 1950	Department of Conservation and Land Management
Wildlife Protection (Regulation of Imports and Exports) Act 1982	Department of Conservation and Land Management
Water Authority Act 1984	Department of Environment

1.6 Environmental Assessment and Approval Process

This PER has been prepared in accordance with the Scoping Document (*ecologia* 2003) approved by the EPA on 28 August 2003 (Appendix A). This PER is based on the Environmental Protection Authority (EPA) assessment and approval process, which is illustrated in Figure 1.2 and summarised below.

At the State Government level the EPA is required to assess all development proposals that may have a significant environmental effect. In this instance, the EPA has decided to formally assess the proposal at the level of Public Environmental Review, pursuant to the provisions of Part IV of the *Environmental Protection Act 1986.*

In setting the level of environmental impact assessment for the proposed Beagle Bay *Big Tree Country* Plantation Project, the EPA has required that the PER document be released for a six (6) week public review period. During this period any interested individual, community group, organisation, or Government agency can peruse the document and lodge a submission on the proposal with the EPA. This PER is a public document and is part of the statutory public environmental impact assessment process established by the *Environmental Protection Act 1986.*

The EPA's formal environmental impact assessment process allows members of the public to obtain details of the proposal being assessed and to comment on any matters of interest or concern. It also enables Government authorities to consider the environmental and social implications of the proposal and provide comments as appropriate to the EPA. Government agencies involved in the approvals process may include:

- Conservation and Land Management (CALM)
- Department of Environment (DoE)
- Department of Indigenous Affairs (DIA)
- Department of Land Information (DLI)
- Department of Industry and Resources (DoIR)
- Conservation Commission (CC)
- Western Australian Museum (WAM).

The EPA considers all comments received from government agencies and the public, and a summary of submissions is made.

Following completion of the public review period and receipt of the Proponent's response to the summary of submissions, the EPA will complete its assessment of the proposal and submit its report to the Minister for the Environment and Heritage. The EPA's report to the Minister provides advice to the State Government about whether the proposal meets the EPA's objectives for environmental protection.

The EPA's Assessment Report is released for a two week period during which the public can scrutinise the conclusions and, if warranted, appeal to the Minister against the recommendations made in regard to the proposal. The Minister for the Environment and Heritage will assess any appeals received and ultimately determine whether or not the proposal can proceed. If the Minister determines that the proposal can proceed, legally binding conditions dictating the environmental requirements with which the Proponent has to comply will be set pursuant to Section 45 of the *Environmental Protection Act 1986.*

In order for the proposed project to proceed, the following statutory requirements need to be completed:

- release of the PER document for a six (6) week public review period;
- DoE prepares a summary of submissions;
- Proponent provides the DoE with written responses to all issues raised in submissions received during the public review period. Where appropriate, the Proponent may amend the proposal and/or change the management commitments in response to comments raised during the public review period, provided those changes do not significantly increase environmental impacts;
- the EPA provides its advice to Government on the proposal through its Assessment Report made to the Minister for the Environment and Heritage. The Report and Recommendations are released to the public, and there is a 14-day appeal period regarding the Report;

- the Minister determines any appeals against the EPA's Report and if the proposal is regarded as environmentally acceptable, sets legally binding conditions on the Proponent; and
- the project is commenced according to the Ministerial Conditions and Proponent Commitments set out in the Statement that a Proposal may be implemented (Pursuant to the Provisions of the Environmental Protection Act).

1.7 PER Structure and Objectives

This PER document is divided into three sections:

Part One: The proposed project. This section serves as an introduction to the project, describing the project background, the Proponent, relevant legislation, project justification and an overview of the plantation operations.

Part Two: Existing Environment. This section is primarily concerned with describing the existing physical, biological and cultural environment prior to development of the project and discusses relevant aspects such as groundwater, surface hydrology, vegetation and flora, fauna, geology and cultural heritage.

Part Three: Environmental Impacts and Management. This section is concerned with the impact of the proposed development on the existing environment and the mitigation measures and management system that are proposed to prevent and/or reduce any resulting impacts, direct or indirect.

The objectives of this PER are principally to:

- provide information concerning the proposal to the EPA, government agencies, interested parties and the general public so that an informed decision can be made as to the environmental suitability of the project; and

- stipulate the Proponent's commitments to environmental management.

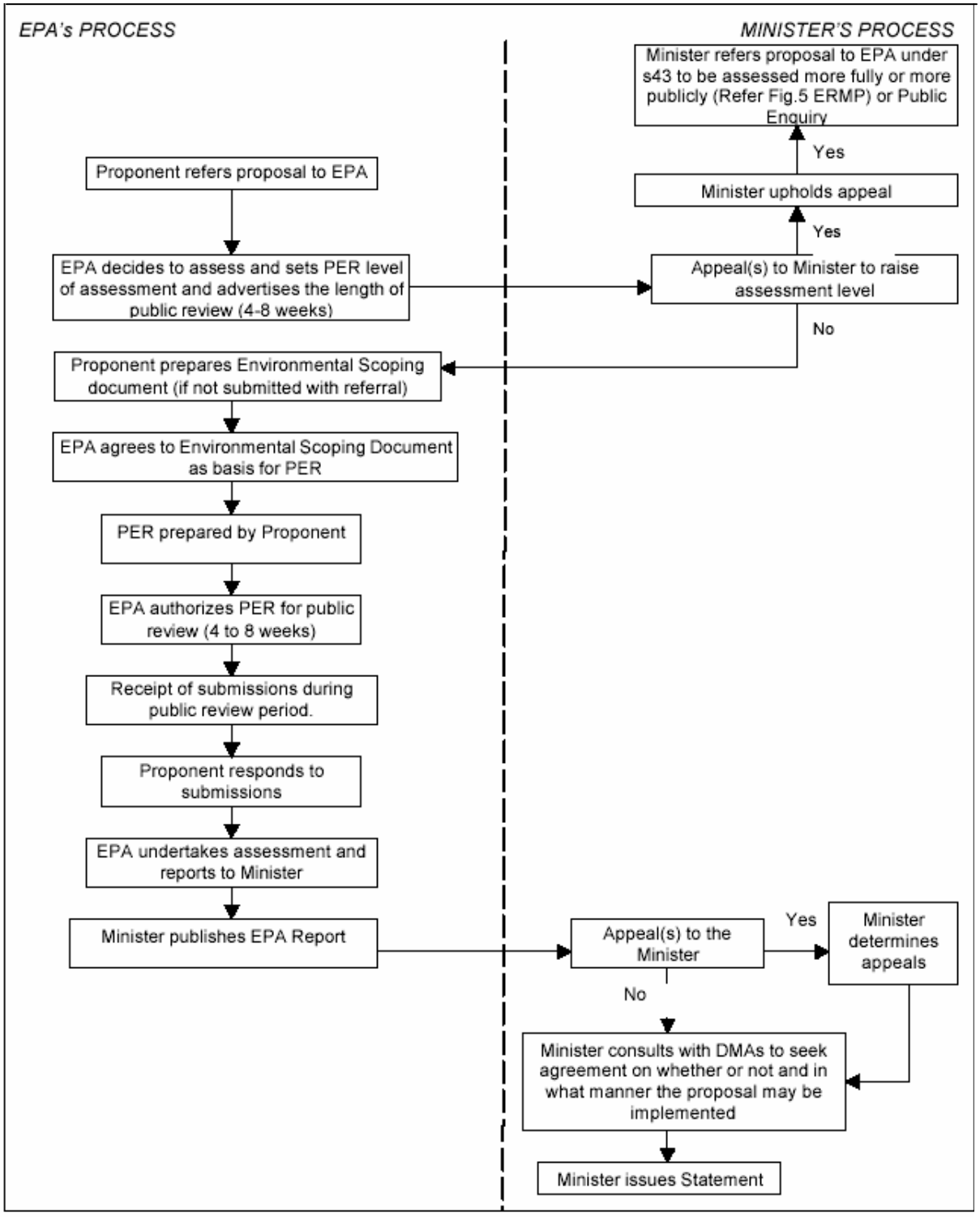


FIGURE 1.2 OUTLINE OF PROCEDURE FOR PER ASSESSMENT

2.0 PROJECT JUSTIFICATION & EVALUATION OF ALTERNATIVES

2.1 Project Justification

The exotic timber 4 ha trial plantation has demonstrated financial viability and represents a unique opportunity for industry development in the region. The projected gross income for the project is up to $450 million over the lifespan of the project. With an injection of $20 million in the development phase, significant expenditure will be delivered into the regional community within the first year. Hence, the timber plantation will provide significant long-term economic prospects for the BBC, assisting to facilitate financial independence and security for its people. The Proponents have undertaken extensive liaison with local community groups to ensure that all community development options are fully explored.

Development of the project will provide a source of quality timber and sandalwood products, which are currently limited with demand exceeding supply capabilities.

2.1.1 State / National and Local Community Benefits

The establishment of the project will result in a number of benefits to the State of Western Australia including:

- Injection of up to $450 million into the Australian economy;
- Increased export value of Western Australian wood products to international customers;
- Import replacement;
- Additional Commonwealth and State Government revenue through collection of royalties, taxes and other charges;
- Stable, direct employment in the Kimberley region for at least 20 years, peaking at around 25 people;
- Carbon sequestration. Regional rate of uptake of carbon dioxide will increase and carbon will be locked up in high quality timber for many years;
- An increased level of conservation management on the Peninsula, especially in respect to fire;
- Increased demand for goods and services creating business and employment opportunities;
- Training and job skilling across a broad range of professions; and
- Potential for development of downstream processing, allowing the produce to be sold as high value dried, milled timber rather than low value logs.

TTP has offered their planning skills to local communities and organisations in the Peninsula in order to, where possible, assist in effective development within the area. This support extends to the BBC in assisting them (at no cost) with proposals for tourism and other potential commercial ventures.

From an economic standpoint, the project will provide both direct and indirect employment opportunities in the Kimberley region and produce flow-on benefits on a local and regional scale due to a boost in the economy. The venture will provide a significant income to the BBC, enhancing their social, economic and environmental status.

2.1.2 Need for the Proposal

To date there has been a paucity of commercial development on the Dampier Peninsula and little opportunity for the BBC to develop sustainable industries. While gas deposits have been discovered offshore, the only commercial industries that have been undertaken in the general region are pearling and pastoralism. These are, however, non-indigenous enterprises. The region has been identified as having

the potential for more intensive forms of agriculture (Anon, 2000) and aquaculture. Small-scale development of these is currently underway.

The Project will provide training and employment opportunities. The majority of labour used in the plantation will be sourced from the BBC, adjacent indigenous communities and Broome.

2.2 Evaluation of Alternatives

2.2.1 Plantation Site Selection

Several sites throughout the Kimberley Region were investigated as potential locations for a tropical timber plantation. These included the Ord River Irrigation Area (ORIA), sections of the lower Fitzroy River valley, sites in the central and north Kimberley and south of Broome.

The Beagle Bay reserve location was selected on both environmental and economic criteria (summarised below). Primarily, there are no areas of cleared land available in the West Kimberley, and even though the proposed site has not been subjected to clearing, it has become degraded due to frequent bush fires and a history of cattle and feral animal grazing over an extended period of time. An alternative site approximately 25 km NNW of Beagle Bay was suggested by the Beagle Bay Aboriginal Community, but was rejected as it was deemed to have greater environmental and cultural significance to the area (John Brennan pers. comm.), due to its proximity to the coast.

Site selection was based on the following criteria:

- Suitability of soil type as a growing medium for the tree crops;
- Relatively flat land with deep soils and low water table;
- Uniformity and representative size of the natural woodland (in that clearing would not impact significantly in a bioregional sense);
- Favourable climate;
- Large, under-utilised aquifer for irrigation;
- High quality water;
- No indigenous, cultural or heritage issues attached to the plantation site;
- Proximity to the BBC;
- Proximity to a major port;
- Relatively degraded area (on a regional scale) due to a history of frequent fires and cattle and feral animal grazing; and
- The opportunity to partner with the Beagle Bay Aboriginal Community Inc to develop a sustainable new industry in the region along with the environmental, social and economic benefits to be had.

The plantation will result in the disturbance of natural vegetation and the farming of local groundwater resources. However, site selection has been based on that which constitutes the least disturbance to the natural environment and native fauna. Thus, the project will provide a combination of both social and economic benefits to the local BBC, whilst also minimising any adverse impacts on the natural environment.

2.3 No Development Option

The consequences of not proceeding with the project are that the employment, economic and social benefits of the proposal will not be achieved. There will be a direct loss to the BBC in terms of employment, training opportunities and income derived through royalties. The opportunity to develop a

sustainable new industry for the region and potentially, northern Australia with close connection to the land will be lost. The potential to commercialise local bush tucker and medicinal plants will be lost.

The BBC suffers chronic unemployment and currently has no other enterprises with the potential to provide the benefits of the project, in terms of personnel training, revenue or employment.

3.0 PROJECT DESCRIPTION

3.1 Overview

The assessment of project feasibility commenced with a trial plot of approximately four hectares of Teak *Tectona grandis* and Indian Sandalwood *Santalum album* with hosts *Sesbania formosa*, *Acacia trachycarpa* (secondary), *Casuarina equisetifolia* and *Dalbergia latifolia* (tertiary) on a site that is now formally identified as the Trial Lease Area, in the southeast corner of the 5000 ha Lease Option Area. Over recent years the Trial Lease Area has indicated that the venture is economically viable and environmentally sustainable. As such, the TTP proposes full development of the plantation to commercial production.

The final products, including sawn timber and Sandalwood products, will be trucked to the Port of Broome for marketing within Australia and overseas. Further downstream processing may be implemented at a later stage, converting the final product from sawn timber to high value furniture products and speciality timbers and extraction of essential oils.

The scope of the project also includes research and development of potential local species of medicinal value, in addition to, bush tucker species.

3.1.1 Plantation Timber Species

TEAK

Teak *Tectona grandis* is a tall deciduous hardwood tree to 25 metres. Teak forests occur as moist natural formations (annual rainfall of 1300 mm – 2500 mm) or dry natural formations (annual rainfall 760 mm - 1500 mm) with a marked dry season of 3 to 5 months (John Brennan and Associates, 2003). The most suitable soils are deep, well-drained porous loam or sandy loams with a pH range of 6.5 – 8 (Phengklai *et al,* 1997). Very moist conditions (*e.g.* plantations in Malaysian Borneo) lead to faster growth but also to a thick sapwood and poor overall quality, including lower average density, less attractive colour, poor texture and loss of strength (Centeno, 1997).

INDIAN SANDALWOOD

Indian Sandalwood *Santalum album* site specificity is highly variable. It occurs in a rainfall range of 300 mm to 3000 mm and grows on a range of soil types including loam, laterite, sand, clay and black soils, tolerating a pH range from 6 – 8. Sandalwood also has a wide temperature tolerance with a range in its natural habitats from 4 ºC to 46 ºC (John Brennan and Associates, 2003). Successful cultivation and growth is dependent on the provision of suitable host plants from which the sandalwood can effectively translocate minerals and trace elements (Singh, 1995). *S. album* is an evergreen tree to 15 metres in height.

AFRICAN MAHOGANY

African mahoganies are large evergreen trees growing to 20 metres plus. *Khaya senegalensis* is the most drought–hardy of the species. It grows in a mean annual rainfall range of 400 mm – 1750 mm with a dry season of 4-7 months (John Brennan and Associates, 2003). Although tolerant to a wide range of soil types and conditions, it prefers neutral, well-drained, deep sandy loams (Ashvini, 2001).

INDIAN ROSEWOOD

This species of *Dalbergia* is a tall deciduous hardwood tree up to 25 metres in height. Annual rainfall in *Dalbergia latifolia*'s native habitat ranges from 750 mm to 5000 mm (John Brennan and Associates, 2003). Whilst growing on a range of soil formations it prefers deep, well-drained soils. It is highly

tolerant of extreme temperature variations – from 0 ºC to 50 ºC. The species is drought tolerant (Prasad, 1994).

CORKWOOD and ACACIA

Corkwood *Sesbania formosa* is widespread throughout the Kimberleys and also occurs in Northern Territory and Queensland (John Brennan and Associates, 2003). It prefers moist soils and performs well on the cracking clays of the ORIA. *Acacia trachycarpa* occurs in the Dampier and Fitzgerald Botanical Districts of the Kimberley and is widespread throughout the Pilbara. It is drought-hardy and grows well on Pindan sands (John Brennan and Associates, 2003).

3.2 Plantation Layout

The Lease Option Area for the proposed plantation encompasses 5,000 ha of land, of which 900 ha are required for plantation plots. The various plot layout options that have been considered are discussed in Sections 3.2.1 and 3.2.2.

Following consideration of all possible plantation layout options by the Proponent, the plantation is to be arranged in a clustered 9 x 100 ha option, as depicted in Figure 3.1. The reasoning for this is described below.

Economic Justification

- Lower costs involved in clearing a continuous strip than separate cells. Access and drainage requirements are reduced;
- The irrigation system is one that relies on a ringmain system with a single control unit operating the whole system. If there were separate cells then a ringmain system would not be practicable or affordable. In addition, the increased capital cost in pipework, individual control systems etc would be prohibitive;
- The cost of reticulating power to separate cells would be a major cost impost. The loss of voltage through long cable runs would result in greater costs and inefficient power usage; and
- The chosen development plan, as it stands, will be more efficient to manage and operate.

Irrigation Water Management Justification

A borefield is to be located on a central corridor (east-west) approximately 1 km apart at right angles to the direction of groundwater flow (north). This design is to ensure the maximum interception of groundwater throughflow. This layout, and the irrigation design facilitates access, minimises infrastructure and enables the tree plots to be watered in the event of a one-off pump or bore failure.

Environmental Justification

Development of a mosaic plantation layout would increase both the risk of fire affecting the tree plots and fire management. It is proposed to firebreak the entire 5000 ha lease area and the development site to minimise fire risk and to protect all of the retained vegetation.

In the trial area, where fire has been excluded for more than 3 years, the middle storey vegetation is regenerating, benefiting the local fauna.

Clearing the land over a three-year period will provide the more mobile fauna the opportunity to relocate. As observed in the trial site, as the tree crops grow and certain species of native vegetation regenerate, specific taxa (including birds, frogs and reptiles) will occupy the tree plots.

An additional attraction to the plots for some species may be the presence of water made available through the trickle irrigation system. This will be most prominent in the dry season and during fire events as evidenced to date in the trial plot (J. Brennan, pers. comm.).

3.2.1 'Clustered' Options

Two 'clustered' layout designs have been considered for the plantation. The first 'clustered' layout comprises 9 x 100 ha plots, all placed along the southern border of the Lease Option Area (see Figure 3.1). The second 'clustered' layout comprises 18 x 50 ha plots, also placed along the southern border of the Lease Option Area (see Figure 3.2). Figure 3.3 illustrates the design of the habitat corridors.

The benefits of the 'clustered' layout designs include:

- Requires the least amount of clearing of natural vegetation for access roads and fire-breaks;
- Retains the largest area of uninterrupted and undisturbed natural habitat;
- Efficient plantation operations with all the trees in close proximity and minimal time spent travelling between plots;
- Economical plantation establishment and operations in terms of service and infrastructure requirements such as power, irrigation and drainage;
- Reduced risk of fire owing to manageable size of flammable material in bush/wildlife corridors; and
- Reduced 'edge effects' associated with reduced amount of clearing for access roads and fire-breaks. ('Edge effects' refer to the ecological impacts associated with disturbance of a land that abuts natural vegetation, for example - increased potential for weed infestation, changes to natural sunlight regimes and increased potential for soil erosion).

The drawbacks of the 'clustered' layout designs include:

- Habitat corridors between plots are narrow and it is unlikely that the complete array of potential species will be present within the corridors, *i.e.* low biodiversity in the corridors; and
- Increased risk of pathogens and pests spreading throughout the plantation due to minimal spacing and separation between the plots.

3.2.2 'Checkerboard Mosaic' Options

Two 'checkerboard mosaic' layouts have been considered for the plantation. The first 'checkerboard mosaic' layout comprises 9 x 100 ha plots spread across the entire Lease Option Area (see Figure 3.4). The second 'checkerboard mosaic' layout comprises 18 x 50 ha plots spread across the entire Lease Option Area (see Figure 3.5).

The benefits of the 'checkerboard mosaic' layout designs include:

- Retention of 'habitat squares' that are likely to support a more diverse range of species than narrow 'habitat corridors'; and
- Placement of plots over larger area with fire-breaks surrounding each plot reduces the risk of loss of the entire plantation to wild fire.

The drawbacks of the 'checkerboard mosaic' layout designs include:

– 'Habitat' squares are not connected by habitat corridors, therefore movement between the squares is limited to the four points of contact at the corners of the squares and through the adjoining plantation plots;

460000mE
465000mE
470000mE
475000mE
8120000mN
8115000mN
8110000mN

Beagle Bay Community

To Cape Leveque

Beagle Bay Access Road

Airstrip

N

1:50 000

0 2.5

Kilometres

MAP GRID of AUSTRALIA

GRID BASED ON TRANSVERSE MERCATOR PROJECTION

BROOME CAPE LEVEQUE ROAD

OLD CAPE LEVEQUE ROAD

5000 ha Lease Option Area

Site Access Road

Habitat Corridors

Plantation Development Site

50 ha

Proposed Access Track and Fire Break - dual 4m wide tracks separated by 40m wide Bush Corridor

Proposed Access Track and Fire Break - dual 4m wide tracks separated by 40m wide Bush Corridor

Trial Lease Area

Station Track and Fence Line

Station Track and Fence Line

Country Downs Station

To Broome

JOHN BRENNAN AND ASSOCIATES
Project Managers

Author: J.B. / S.C. Drawn: S.Coleman

Client: **TROPICAL TIMBER PLANTATIONS PTY LTD**

Project: **BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION**

PROPOSED SITE ACCESS TRACKS AND FIRE BREAKS

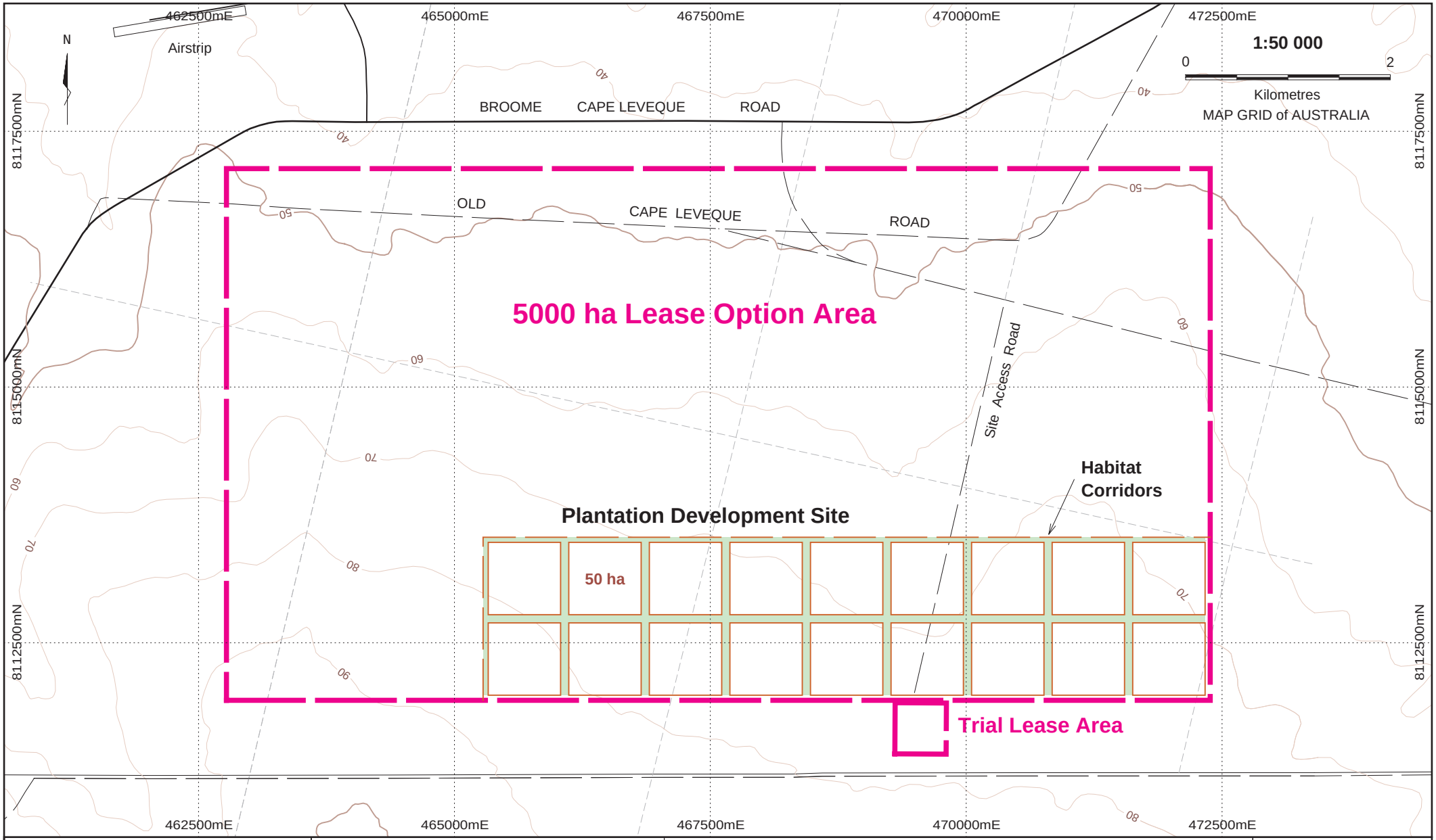
A3

Date: 14 February 2005

Scale: 1: 50 000

Figure No. **3.1**

Plan No. **BB-018**



JOHN BRENNAN AND ASSOCIATES Project Managers	Client: TROPICAL TIMBER PLANTATIONS PTY LTD	PLANTATION DEVELOPMENT PLAN 50 ha PLOT WITH 80m WIDE HABITAT CORRIDORS	Date: 14 February 2005
			Scale: 1: 50 000
	Project: BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION		Figure No. 3.2
Author: J.B. / S.C. — Drawn: S.Coleman		A4	Plan No. BB-009

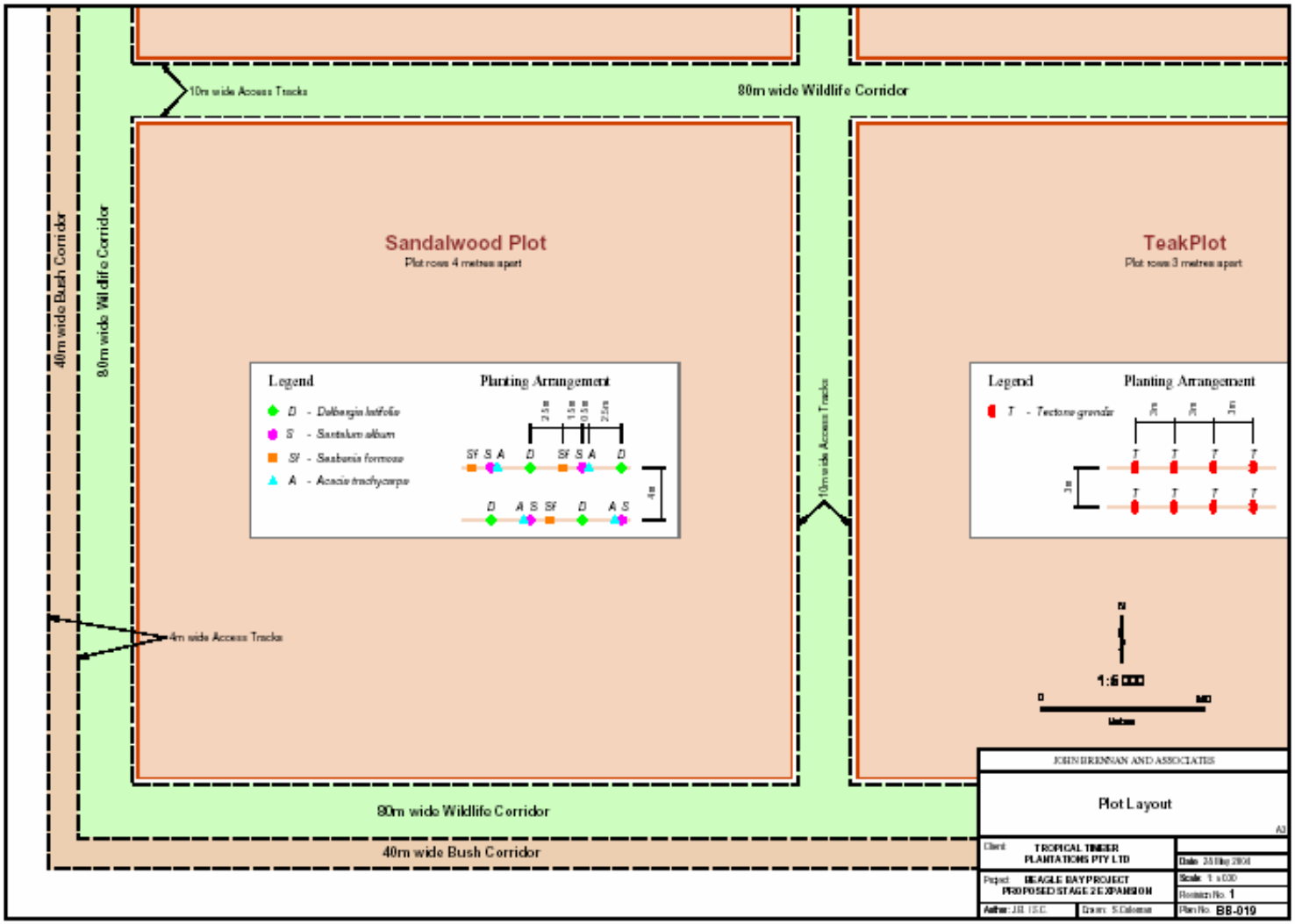
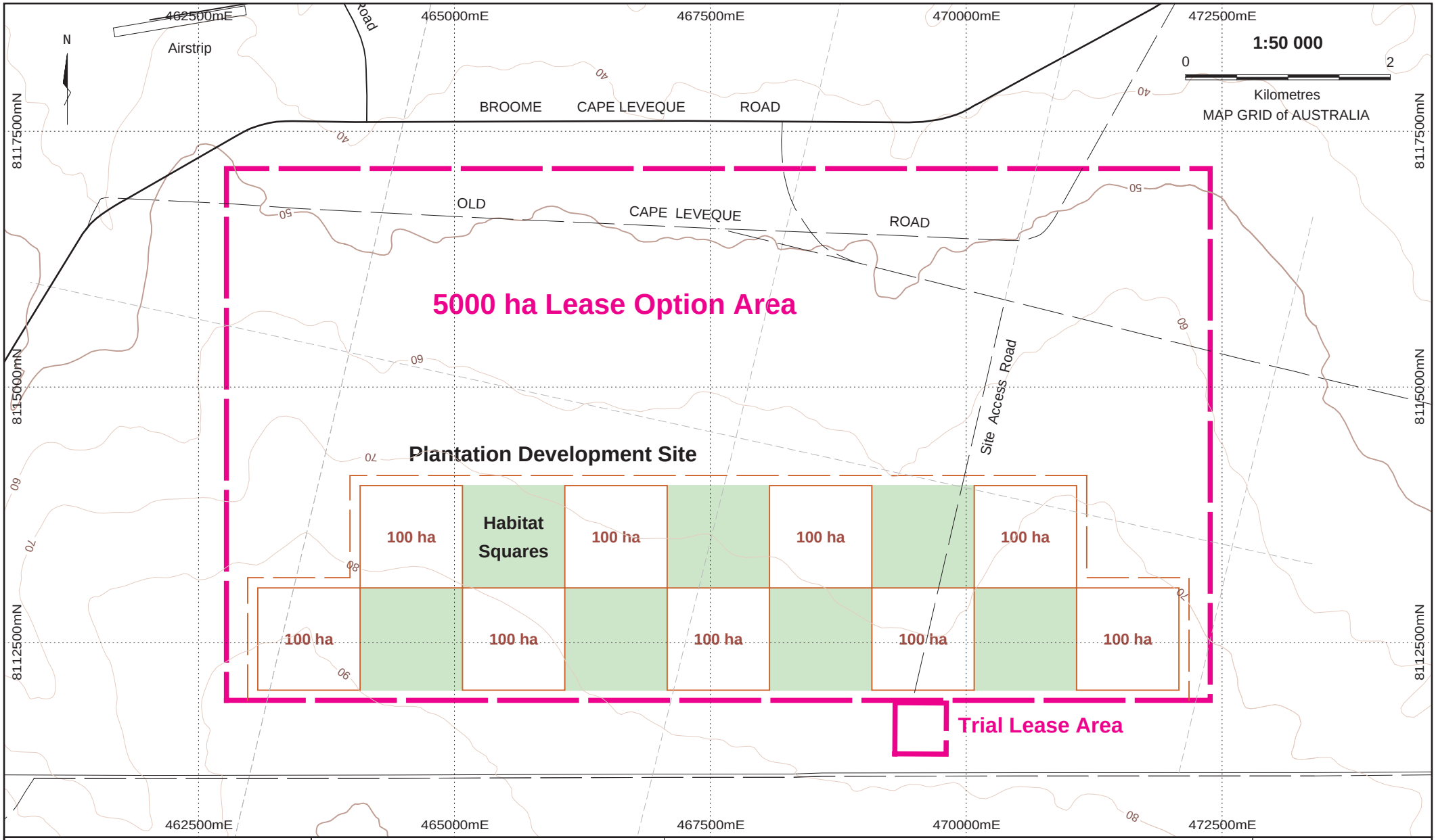
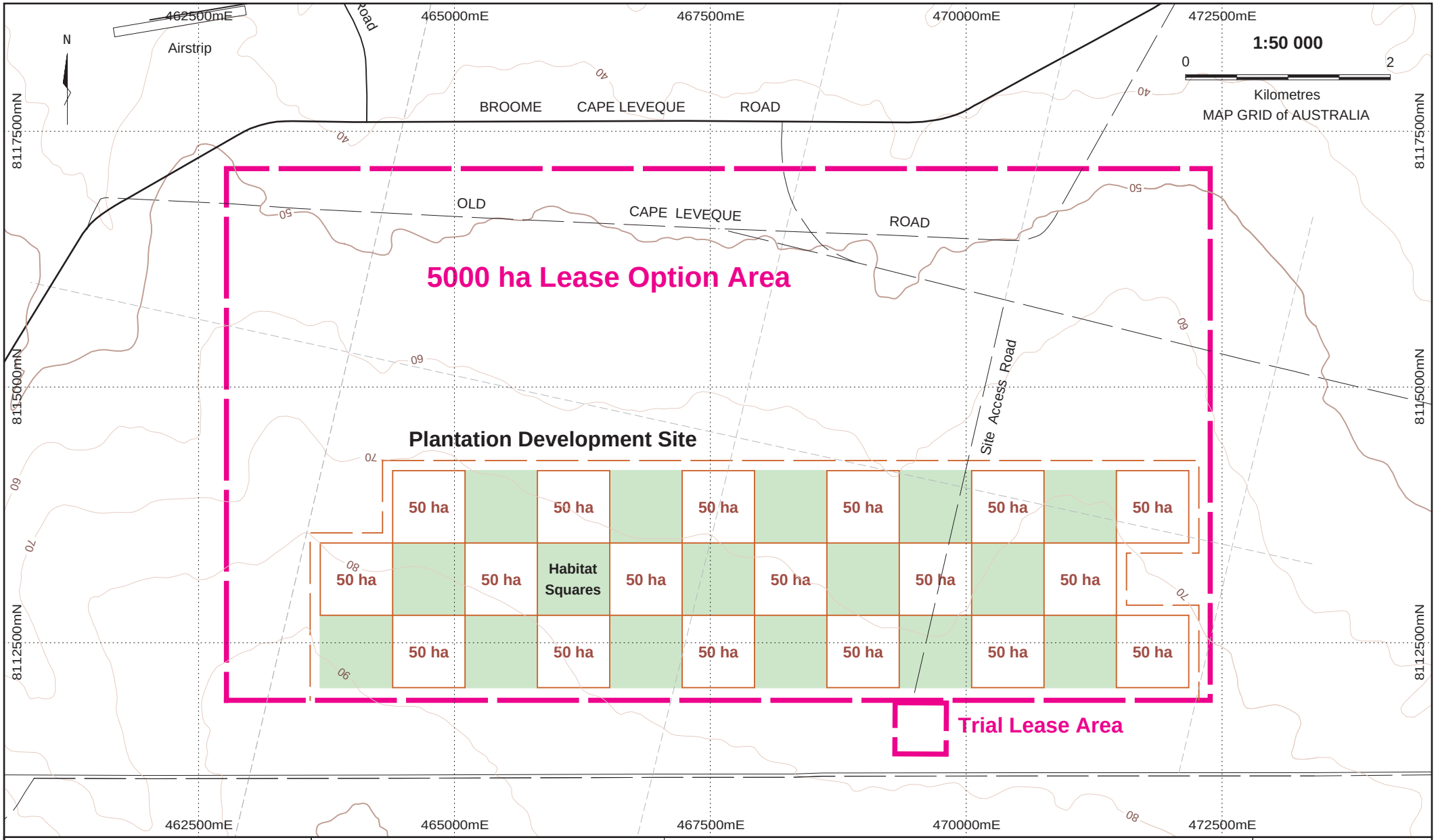


FIGURE 3.3: LAYOUT OF THE HABITAT CORRIDORS TO BE SITUATED BETWEEN THE INDIVIDUAL PLOTS OF THE PLANTATION.



JOHN BRENNAN AND ASSOCIATES Project Managers	Client: TROPICAL TIMBER PLANTATIONS PTY LTD	PLANTATION DEVELOPMENT PLAN 100 ha PLOT WITH 100 ha HABITAT SQUARES	Date: 14 February 2005
			Scale: 1: 50 000
	Project: BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION		Figure No. 3.4
Author: J.B. / S.C. — Drawn: S.Coleman		A4	Plan No. BB-010



JOHN BRENNAN AND ASSOCIATES Project Managers	Client: TROPICAL TIMBER PLANTATIONS PTY LTD	PLANTATION DEVELOPMENT PLAN 50 ha PLOT WITH 50 ha HABITAT SQUARES	Date: 14 February 2005
			Scale: 1: 50 000
	Project: BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION		Figure No. 3.5
Author: J.B. / S.C. — Drawn: S.Coleman		A4	Plan No. BB-011

- Less economical establishment and operations of the plantation than the 'clustered' design, because of time required to travel between plots and additional requirements for power, and installation and operation of irrigation system;
- Requirement for a greater area of natural vegetation to be cleared than the 'clustered' layout and associated edge-effects;
- Greater risk of weed dispersal, spread of pathogens throughout the entire 5000 ha lease option area; and
- Increased costs associated with additional access roads, drainage, irrigation and power supply.

3.3 Plantation Operations

3.3.1 Nursery Operations

Sourcing seedlings for each subsequent planting area will be made well in advance of the proposed planting date. The majority of stock will be sourced from superior tissue-cultured materials obtained in-vitro from a WA based supplier. De-flasking and planting into tubes will be undertaken by a nursery in Perth. The plants will be transported to the project area and hardened-off before being planted. All stock supplied will have been screened for pathogens such as dieback and fusillarium, and the grower will administer pathogen and weed control within the potting mix prior to shipping.

On arrival, the seedlings will be progressively shifted from the shadehouse facilities to weed mats in the field to harden-off. The health of the seedlings and the presence of pests, diseases and weeds will be monitored throughout.

3.2.2 Pre Planting Requirements

During each stage of plantation development, sites within the plantation will be appropriately prepared prior to planting:

- Following clearing the surface will be deep ripped to 1.5 m to aerate the soil and improve water infiltration;
- The irrigation system will be installed and tested;
- A lime/phosphorus mix will be applied prior to planting; and
- Plantation personnel will be inducted into the identification of plant malformations such 'root spiral' and 'j curve', to ensure that only healthy specimens are planted.

3.2.3 Planting

Establishment of the plantation will be carried out in 3 stages of 300 ha plantings per annum over 3 years.

Planting density will be dependent on the tree species. Teak will be planted at 1,000 trees/ha, Mahogany 625 trees/ha, Sandalwood 315 trees/ha and its hosts, Rosewood, Acacia and Sesbania at 315 trees/ha. Irrigation lines will be evenly distributed within each plantation plot, with drippers placed at intervals appropriate to the planting density of each species.

The project will comply with the Code of Practice for Timber Plantations in Western Australia.

Seedlings will be planted by hand. Mulch will be removed from around each trickle line and a hole larger that the plant pot will be prepared at each dripper. Seedlings will be removed from their nursery containers and checked for root defects. Trees with defective or poorly developed root systems will be returned to the nursery.

In the case of sandalwood, planting of the host species is to occur with the sandalwood seedling positioned on the shadiest side of the host so that it may be offered some protection.

The soil removed to plant seedlings will be mounded into a crater profile to trap the water that is delivered via the drip irrigation system and mulch will be re-applied.

Following planting, each plant will receive a pre-determined amount of slow release fertiliser.

An identification number will be established for each plot.

3.4 Plantation Maintenance

3.4.1 Irrigation

The irrigation system will be designed to deliver up to 30 L per tree per day in a 16 hour period over an extended 'wet' season. Water will be applied directly to the root zone of the trees (and host plants in the sandalwood plots) via an in-line drip irrigation system.

The in-line drip system will consist of 2 laterals per tree row for the sandalwood and a single lateral for teak and mahogany. The double lateral system is designed to efficiently supply water to both the sandalwood tree and the host plants. The drip emitters (for sandalwood) will be spaced at 0.6 m spacing to create a wetted strip along the full length of the row. Given that the teak and mahogany do not have hosts that require irrigation, the drip system will consist of a group of three drippers spaced 0.5 m apart at every tree. In this way water is being conserved and applied only to the root zone of the tree.

The system will be fully automated with central computer control located at the site office. It will be controlled using low power VHF radio units powered by solar power. The system will incorporate a number of features such as rain day auto shutdown, in-line sensors to detect leaks and/or line failure as well as system efficiency by monitoring system flow rates. The use of in-line sensors such as flow meters enables the control system to react quickly to system faults. Should a pipeline be damaged, the system will record the event and can react by shutting down the irrigation and fertilisation programs.

3.4.2 Pruning

Frequent clearwood pruning and form pruning will be undertaken to improve the quality of timber produced by the plantation. Clearwood pruning aims to minimise the diameter of the knotty core within the trunk. Form pruning aims to correct the form of young trees by removing faults such as forks and large branches (Department of Agriculture, 1998b).

Pruning will be undertaken from approximately 6 months after planting for 3 to 4 years.

Prior to pruning, personnel will be inducted into proper pruning methods and use of pruning equipment and safety requirements. The induction will incorporate a practice period to ensure that personnel skills are at an acceptable level prior to commencement on the plantation trees.

Form pruning shall not be done higher than the point on the stem where the diameter is 10 cm or no higher than 50 % of the tree height. The trees will be pruned close to the trunk without damaging the collar (wrinkly wood around the base of the branch). The collar contains tissue which produces new wood cells. If it is removed or torn, the pruning scar can take longer to heal, leaving the tree vulnerable to fungal attack which can reduce to the quality of the wood.

Branches will be removed while they are still alive and green and prior to exceeding 2.5 cm in diameter. Stubs on trees will be removed to reduce the knotty core size and the time taken for the tree to grow over the stubs.

Prunings will be mulched on site.

3.4.3 Weed and Pest Control

Roundup (glyphosate) will be applied as a spray to weeds and, selectively, to regrowth between the planted rows. No fungicides have been used in the trial plantation; however if they are required advice will be sought from the Department of Business, Industry and Resource Development and Department of Agriculture. Where practicable, the use of pesticides and fungicides will be applied directly to the root zone through the irrigation system.

Termite control will be achieved through a program of baiting especially during the early stages of the plantation when the trees are most susceptible to attack from termites. Termidor (fipronil) will be applied as a highly diluted solution to baited aggregation drums. A permit will be obtained from the Australian Pesticides and Veterinary Medicines Authority.

Baiting Stations will be established prior to planting on the boundaries of each 100 ha tree plot. These stations will be maintained over the lifetime of the project to manage these pests. Where major infestation occurs, baiting sites will be treated with pesticide directly injected into the soil beneath the bait station, or applied directly to the termites.

Material Safety Data Sheets (MSDS) for all chemicals used in the plantation are provided in the EMS.

3.4.4. Timber Thinning / Harvesting

Timber harvesting on site will comply with the provisions of the *Occupational Health and Safety Act 1984*, the *Conservation and Land Management Act 1984*, the *Forest Management Regulations* 1993, the *Safety Code for Western Australian Logging Operations* and the Code of Practice for Timber Plantations in WA.

Twenty-five percent of the Teak crops will be harvested as thinnings when deemed appropriate (anticipated to be around Years 6 to 8). The balance of the crops will be harvested at approximately Year 16 or progressively through to Year 20. Harvest trees will be selected for their size, health, straight form, and lack of large branches, forks or malformations.

Trees to be thinned will be marked with paint or flagging tape prior to felling. Tree felling will be undertaken by a mechanical harvester and hygiene methods will be employed to prevent the spread of pathogens, insects or weeds during harvest. Logs will be loaded onto trailers or trucks using a back-hoe with forks and sawn timber will be air-dried on site.

Immediately following harvest, the debris generated by felling operations will be cleared from roads, firebreaks and harvesting tracks for mulching. Groundwork will be undertaken to restore the integrity of the soil and remaining understorey vegetation.

3.4.5 Transport

Harvested timber will be containerised and transported to the Port of Broome *via* road trains operated by a contracted haulage company, on the Broome to Cape Leveque Road. It is currently anticipated that 1800 road train loads will be required to haul the 57,300 m^3 of timber produced over the life of the project.

Staff will use private transport to commute to and from the plantation, though as the majority of staff will be accommodated on site, commuting will be infrequent. During peak employment periods such as planting and harvesting, a bus may be used to transport additional staff in from the BBC.

3.4.6 Support Infrastructure

Support infrastructure will include:

- A private, unsealed access road from the Broome to Cape Leveque Main Road to the plantation site office and car-park;
- Unsealed roads/fire-breaks within the plantation to access tree plots for planting, maintenance and harvesting;
- A vehicle washdown facility to prevent the spread of weeds, insects or pathogens and to prevent soil contamination by hydrocarbons;
- An accommodation village to house 25 staff;
- Fire tender and first aid areas to be located within the accommodation village;
- Shadehouse (2,500 m^2);
- Potting Shed;
- Machinery and Storage Shed (150 m^2);
- Potable water requirements for facilities will be sourced from one of the production bores; and
- Power will be supplied by the Beagle Bay powerhouse.

3.4.7 Work Force

The number of employees required for project operation is estimated to be around 25. It is anticipated that the majority of employees will be sourced from the BBC, adjacent aboriginal communities and Broome. The proposed plantation will help to reduce Beagle Bay's very high unemployment rate.

The plantation will require an input of on-site labour for an average of 6-8 hours a day, 312 days a year. Generally, employees will work on a three week rotated roster system with one week off.

During the establishment phase and at harvesting periods there will be an increased requirement for on-site labour.

TABLE 3.1: SUMMARY OF KEY CHARACTERISTICS ASSOCIATED WITH THE PROPOSAL

Component	Key Aspect	Characteristic Description
Plantation Operations	Proposed Site Location	Dampier Peninsula 120 km north of Broome
	Estimated Area of Plantation	967 ha
	Planting Density	Mahogany 625 trees/ha Teak 1,000 trees/ha Sandalwood 315 trees/ha Sandalwood hosts 315 trees/ha
	Species to be Cultivated	Teak *Tectona grandis,* Indian Rosewood *Dalbergia latifolia,* Indian Sandalwood *Santalum album,* African Mahogany *Khaya senegalensis*, Australian Ebony *Diospyros ferrea* and Gubinge *Terminalia latipes*.
	Planting Rate	Planting will be undertaken in 3 stages of 300 ha each.
	Total Estimated Production	57,300 m^3 Timber
	Project Life Span	20 years
	Anticipated Year of Project Closure	2025
	Water Supply Requirements	4.5 GL/a
Transport Requirements	Road train movements	1800 loads hauled to Broome
General	Workforce	25
	Workforce Accommodation	Accommodation Village for 25 people Area of disturbance 2 ha
	Infrastructure	Power source – Beagle Bay power station. Water source – Groundwater from site.
Plantation Facilities	Nursery Storage Shed Site Office etc.	Area of disturbance – 5 ha

4.0 PUBLIC CONSULTATION

4.1 Stakeholder & Public Consultation

TTP has undertaken consultation directly with a wide range of stakeholders including government agencies, local authorities, Aboriginal communities of the Peninsula and other parties with an interest in the project. TTP has also provided opportunities for members of the public to comment on the proposal prior to the release of the PER document. These opportunities were provided in addition to the level of consultation required by the EPA assessment process. Table 4.1 identifies the government agencies, landholders, stakeholders and community groups consulted in the formative stages of the proposal.

The consultation initiatives detailed in Table 4.1 were carried out prior to public release of the PER document for the formal public review period, in order that the key stakeholders be consulted to ensure that the range of environmental issues associated with the project were identified and adequately addressed.

The project has also had media coverage in the *Kimberley Business Bulletin* (April 2002); ABC Regional Radio (August & December 2002; April & May 2003); ABC TV news (December 2002); *The Sunday Times* (December 2002); *The West Australian* (December 2002) and the *Broome Advertiser* (December 2002, June 2003 and January 2004).

An information pamphlet describing the proposal was published in the local Broome newspaper, the *Broome Advertiser,* on 1st May 2003. Contained within the pamphlet was a reply paid envelope and comment form. A public meeting was extensively advertised in the Broome Advertiser and on local radio (Star FM) and held at the Broome Civic Centre on 1st May 2003 inviting public comment. In attendance were representatives from local and state government departments (*e.g.* Broome shire, Broome TAFE); relevant industries and associations (*e.g.* Environs Kimberley, Kimberley Primary Industries Association); local and state media (*e.g.* ABC radio and TV); and communities from the Dampier Peninsula (*e.g.* Beagle Bay, La Djardarr Bay).

The main issues arising from the public meetings and submissions were:

1. Queries regarding the potential benefits to the community;
2. Concern regarding the extent of clearing of natural vegetation;
3. Queries regarding the scale of proposed fire management;
4. Concern regarding the rapid rate of development;
5. Queries regarding sustainability, both economic and environmental;
6. Concern regarding the impact on groundwater in the region, in particular, the volume of water to be used by the plantation and the potential impacts on downstream communities;
7. Concern regarding the potential introduction of exotic pests (particularly weed species); and
8. Queries/ concern regarding potential upgrading of infrastructure in the area, for example upgrading of the Broome-Cape Leveque Road.

Additionally, a stakeholder meeting was held at Beagle Bay in August 2003. Here, discussions covered proposed environmental management for the project in addition to groundwater resources and proposed investigations. Economic and social aspects of the project were also covered.

TABLE 4.1 SUMMARY OF PUBLIC CONSULTATION

Date	Stakeholder Group	Consultation Format	Issues Raised
	Minister for Industry and Resources	Project Stage 2 Briefing Meeting	
28.1.03	Kimberley Regional Fire Management Project	Project update	
28.1.03	BBC Councillors & CEO	Project update	• Groundwater investigations and PER progress
5.3.03	Kimberley Development Commission (KDC)	Project Briefing Meeting	
10.3.03	Department of Environment (DoE)	Project Briefing Meeting	• Likely requirements for groundwater investigations. • Impact on mound springs.
10.3.03	Member for the Kimberley	Project Stage 2 Briefing Meeting	• Employment and training. • Culture and heritage.
13.03.03	Environmental Protection Authority (EPA)	Project Briefing Meeting	• Project Overview and Summary
13.3.03	EPA	Project Stage 2 Briefing Meeting	• Land clearing. • Water resources and usage. • Pest management. • Mound springs. • Threatened ecological communities.
13.3.03	AusIndustry	Project Stage 2 Briefing Meeting	
14.3.03	Department of Industry and Resources	Project Stage 2 Briefing Meeting	• Government assistance to project. • Project costs / revenues. • Infrastructure. • Transport. • Marketing.
21.3.03	Department of Conservation and Land Management (CALM) Kununurra and Broome	Project Stage 2 Briefing Meeting	
25.3.03	Forest Products Commission (FPC)	Project Stage 2 Briefing Meeting	• Tropical forestry potential. • Information sharing. • Collaborative projects. • Carbon trading. • Foreign investment.
28.3.03	Kimberley Primary Industry Association (KPIA)	Project Stage 2 Briefing Meeting	• New industry potential. • Local regional economics. • Employment and training. • Transport and infrastructure. • Government assistance. • Research & Development.
28.3.03	Broome Shire	Project Stage 2 Briefing Meeting	• Planning. • Infrastructure. • Transport.
1.4.03	Office of Major Projects (OMP)	Project Stage 2 Briefing Meeting	
3.4.03	Broome Chamber of Commerce (BCC)	Project Briefing Meeting	• Project Overview and Summary
3.4.03	Broome Chamber of Commerce (BCC)	Project Stage 2 Briefing Meeting	• New Kimberley industry potential.

Date	Stakeholder Group	Consultation Format	Issues Raised
			• Employment. • Training. • Local contractor and suppliers opportunities. • Use of Broome port. • Export income.
7.4.03	Broome Shire Council	Project Briefing Meeting	• Project Overview and Summary
7.4.03	Broome Shire	Project Stage 2 Briefing Meeting	• New Kimberley industry potential. • Employment. • Training. • Local contractor and suppliers opportunities. • Use of Broome port. • Export income.
7.4.03	Beagle Bay Community Inc Annual General Meeting (BBC)	Project Stage 2 Briefing Meeting	• Employment opportunities. • Workers transport. • School children involvement. • Time to project commencement.
11.4.03	Broome Growers Association (BGA)	Project Stage 2 Briefing Meeting	• Industry potential.
16.4.03	OMP	Project Stage 2 Briefing Meeting	• OMP assistance in agency liaison. • Marketing and promotion.
17.4.03	Kimberley Land Council (KLC)	Project Stage 2 Briefing Meeting	• Aboriginal employment. • Financial outcomes for Beagle Bay.
17.4.03	Star Radio	Project Stage 2 Briefing Meeting	• Public meeting announcements.
22.4.03	Burrdunk (Beagle Bay Company)	Project Stage 2 Briefing Meeting for Directors	
24.4.03	Beagle Bay Elders	Project Stage 2 Briefing Meeting	
24.4.03	KPIA, BCC, OMP, DEP, DIA, ALT, Broome Shire, Dampier Peninsula Communities, ABC, GWN, Broome Advertiser, KLC, Kimberley Regional Fire Management Project, FPC, Agriculture WA, Kimberley, CALM, WRC, DOIR, Office of Aboriginal Economic Development (OAED), ACC, Carol Martin, Tom Stephens, Kimberley College of TAFE.	Invitations to public meeting and copy of public consultation leaflet.	
28.4.03	ABC	Project Stage 2 Briefing Meeting	• Interview regarding Public Meeting.
1.5.03	General Public	Public Meeting.	
1.5.03	General Public	Pamphlet in local paper Reply paid comment submission opportunity	• Commendation on project concept. • Land clearing. • Traditional ownership. • Sustainability. • Plantation layout and fire hazard. • Economic sustainability. • Water use. • Plant susceptibility to disease. • Chemical application.

Date	Stakeholder Group	Consultation Format	Issues Raised
1.5.03	Australian Conservation Foundation, Environs Kimberley (EK)	Project Stage 2 Briefing Meeting	• Emphasis on environmental management plans.
1.5.03	Public Meeting - Broome Civic Centre		• Wide-ranging inputs.
1.5.03	Member for Mining and Pastoral Area	Project Stage 2 Briefing Meeting	• Economic benefits to region.
20.5.03	Minister for the Environment	Project Stage 2 Briefing Meeting	•
21.5.03	Minister for Regional Services and Local Govt.	Project Stage 2 Briefing Meeting	
25.5.03	Minister for Ag, Forestry & Fisheries		• Site visit • Introduction to elders. • Briefing.
26.5.03	ABC		• News item regarding the public response to public comment submissions.
28.5.03	Broome Advertiser		• EK press release article- concerns regarding pesticides / water usage. • Land clearing.
12.6.03	BB, Australian and Torres Strait Islander Services (ATSIS)	Project Update	
18.6.03	Rotary Club of Broome	Project Stage 2 Briefing Meeting	• Questions re investment opportunities. • BB involvement. • Export. • Potential spin-offs for Broome. • Employment opportunities.
29.6.03	Environs Kimberley		• Site visit • Briefing & discussions re pest/fertiliser management. • Water use. • Land clearing. • Host selection. • Effects on mound springs. • BB involvement.
3.7.03	BB, OAED		• Project up-date regarding the Scoping Document and Groundwater Investigation Program
23.7.03	Catholic Diocese of Broome		• Site visit. • Project briefing. • Discussion regarding employment & training opportunities for Beagle Bay people.
24.7.03	Member for Mining & Pastoral Area		• Site visit. • Briefing & discussions regarding pest/fertiliser management. • Water use. • Land clearing. • Beagle Bay involvement.
28.7.03	Deputy Commissioner for Soil & Land Conservation	Up-date Meeting	
6.8.03	OMP	Up-date Meeting	

Date	Stakeholder Group	Consultation Format	Issues Raised
6.8.03	Member for Mining and Pastoral Area	Up-date Meeting	• Up-date regarding Groundwater Investigation Program.
7.8.03	BB Peoples meeting	Community Meeting	
13.8.03	BB Staff, Council, community members, Ecologia, Rockwater, CALM Broome, ALT/DIA, Broome Shire, EK, OAED, KC TAFE, ATSIS, DET, Mowanjum Community CEO, KPIA, Talbot & Olivier, DPI Broome, DLG & R, KACC	Stakeholder Meeting	• Briefing on environmental management (Ecologia) and groundwater resources & investigations (Rockwater). • Wide-ranging discussions included: o methods of land clearing, o transport/frequency, o water resources, o flora & fauna surveys, o decommissioning processes, o pesticide/herbicide monitoring, o fertiliser application, o potential weediness of tree species, o project finance & structure of venture companies, o role of ALT/DIA, o local employment opportunities/ CDEP or wages, o numbers of jobs, o type of work/training, o mound springs/salt-water interface issues.
2.9.03	WRC, BBC, DIA	Briefing re groundwater investigations requirement.	• Inspection of some mound springs
18.9.03	Aboriginal Lands Trust Members, DIA staff	Up-date Meeting	• Project status and development proposals
19.9.03	CoS - Minister Agriculture, Forestry, etc	Up-date Meeting	• Project update
9.10.03	CALM	Plantation layout meeting	• Meeting to discuss plantation layout, wildlife corridors, etc
15.10.03	FPC	Up-date Meeting	• Inspection of trial crops
24.10.03	KDC - Kimberley Investment Tour, KDC Staff, National & international bankers & stockbrokers	Project overview presentation	
25.10.03	State Ministers for Tourism and the North West Federal Minister for Transport & Regional Services	Project briefing	
13.11.03	EK	Project up-date	•
24.11.03	OAED	Project update and site inspection	•
27.11.03	Beagle Bay Burrdunk (BBB)	Update meeting	• Current status of project, appointment of BBB Project Manager, general development plans.
5.12.03	President - Broome Chamber of Commerce	Project up-date	
11.12.03	BCC - AGM Members and executive	Project up-date	
30.12.03	OAED	Project update	• Appointment of BBB Project Manager
19.1.04	Broome Advertiser	News item in Broome Advertiser	• Current status of project
23.1.04	Goolarri Media TV Production Staff	Production of 5 minute TV segment to	

Date	Stakeholder Group	Consultation Format	Issues Raised
		go to air on GTV 35 daily for 3 months	
16.04.04	DoE, CALM, Rockwater, EPA, Ecologia	PER update meeting	• Validity of modelling used in Groundwater Investigations. • Lack of ecological investigations into wetland systems north of the plantation site. • Effects of drawdown from groundwater pumping on wetland systems.
21.05.04	DoE	Meeting	• Discussions on works required for the Environmental Water Requirements of the Wetland Systems north of the plantation site.
01.06.04	Minister for Industry and Resources	Project Update	
21.06.04	Australian Greenhouse Office	Discussion on Carbon Credits	
23.06.04	ONF Land Management	Project Briefing	
26.07.04	Department of Business, Industry and Resource Development – Northern Territory	Project Briefing	• Forestry
27.07.04	Department of Business, Industry and Resource Development – Northern Territory	Project Briefing	• Entomology
29.07.04	Greening Australia – Northern Territory	Project Briefing	
30.07.04	KPIA – Kununurra	Project Update	
12.08.04	Department of Indigenous Affairs - Broome	Project Update	
12.08.04	EK	Project Update	
16.08.04	BBB members	Project Update	
01.09.04	DoE	Meeting	• Monitoring of wetland areas
03.09.04	OAED	Meeting	• Project Update
21.09.04	OAED	Site Visit	• Review of trial plantation
06.10.04	BBC	Meeting	• Project update

4.2 Site Inspection

The proposed plantation site and trial plots have been inspected by the following individuals and by representatives from the following organisations:

- Aboriginal and Torres Strait Islander Commission;
- Aboriginal Lands Trust;
- Agriculture WA;
- Alan Carpenter, the then Minister for Indigenous Affairs;
- AusIndustry;
- Broome Botanical Society;
- Broome Growers Association;
- Broome Shire Council;
- Carol Martin, MLA;
- Clive Brown, Minister for State Development;
- Department of Conservation and Land Management;
- Department of Employment and Training;
- Department of Industry and Resources;
- Department of Planning and Infrastructure;
- Department of Tourism;
- Environs Kimberley;
- Forest Products Commission;
- GWN, ABC, Star Radio, Broome Advertiser, The Sunday Times, The West Australian, The Australian, Kimberley Business Bulletin;
- Indigenous Affairs Department;
- Indigenous Land Corporation/ Land Enterprise Australia;
- Kim Chance, Minister for Forestry;
- Kimberley ACCC;
- Kimberley College of TAFE;
- Kimberley Development Commission;
- Kimberley Primary Industry Association;
- Kimberley Regional Fire Management Project;
- Office of Aboriginal Economic Development;
- Robin Chapple MLC; and
- Waters and Rivers Commission.

4.3 Peer Review

The following individuals from the relevant fields have conducted peer reviews of specific aspects of the proposal:

Hydrogeology: Peter Thorpe
Thorpe Groundwater and Environmental Services
18 Carlisle Rd, Kalamunda
Ph: 9293 1288

Fauna: Tony Start
Department of Conservation and Land Management
Woodvale Research Centre
Wildlife Pl, Woodvale 6026
Ph: 9405 5100

Flora:	Kevin Kenneally Department of Conservation and Land Management 17 Dick Perry Ave, Kensington 6151 Ph: 9334 0561
EMS:	Keith Holmes-Browne INTRACO Management Consulting Pty Ltd 6/45 Central Walk, Joondalup 6027 Ph: 9301 4901
Tree Water Requirements	Don White CSIRO Forestry and Forest Products Private Bag 5 Wembley WA 6913 Ph: 9333 6693
GDE Flora	Kevin Kenneally Department of Conservation and Land Management 17 Dick Perry Ave, Kensington 6151 Ph: 9334 0561

Responses are included as Appendix B of this PER document.

5.0 EXISTING ENVIRONMENT

5.1 Climate

The Kimberley region has a tropical monsoon climate with two distinct seasons; a hot humid summer and a dry cool winter, separated by short transitional periods. The hot and humid summer constitutes the "wet season", extending from November to April. During this period, approximately 90 % of the annual rainfall is received, when low-pressure systems and unstable air patterns dominate the weather patterns. Extreme weather events are common in the Kimberleys, and the area is prone to tropical cyclones between December and April. Most cyclones cross the coast between Cape Leveque and Exmouth, however the effects of wind associated with these storms can be felt throughout the region. Furthermore, the area commonly experiences severe storms and large amounts of rainfall over short periods of time.

The Dampier Peninsula has a distinct tropical climate with a wet season from December to March during which almost all of the annual rainfall is received and humidity is high. Rainfall in the Dampier Peninsula ranges from 576 mm/yr at Broome to 768 mm/yr at Cape Leveque (Table 5.1). Beagle Bay lies midway between these two sites and receives approximately 736 mm of rainfall annually.

Daytime temperatures are high throughout the year, particularly during the months prior to the wet season when maxima greater than 40 ºC are common. The highest daily temperature recorded in Cape Leveque is 42.7 °C in November; the minimum temperature is 11.1 °C in July (Bureau of Meteorology, 2004).

TABLE 5.1: SUMMARY OF CLIMATIC DATA FOR BROOME AIRPORT AND CAPE LEVEQUE

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean Daily Maximum Temperature (° C)													
BME	33.3	32.9	33.9	34.2	31.5	29.1	28.8	30.3	31.8	32.9	33.5	33.8	32.2
CL	31.9	31.6	32.2	32.5	30.4	27.9	27.4	28.5	29.9	31.1	32.0	32.4	30.6
Mean Daily Minimum Temperature													
BME	26.2	25.9	25.4	22.5	18.2	15.3	13.6	15.0	18.4	22.3	25.0	26.4	21.2
CL	26.1	26.0	26.0	25.2	22.5	20.0	18.8	19.8	21.9	24.1	25.8	26.6	23.5
Mean Rainfall (mm)													
BME	176.1	176.4	98.0	27.9	30.0	19.3	5.0	1.6	1.5	1.4	8.4	50.8	596.3
CL	210.0	198.3	137.3	46.9	47.4	20.8	12.2	2.0	1.1	1.7	6.3	84.4	768.4
Mean no. rainy days													
BME	11.2	11.3	7.6	2.7	2.6	1.9	1.1	0.6	0.8	0.5	1.2	5.3	46.7
CL	11.9	10.7	8.2	3.0	2.1	1.5	0.8	0.4	0.3	0.4	1.0	4.7	44.9

(Source: Bureau of Meteorology, 2004)

5.2 Topography and Landforms

The Dampier Peninsula is typified by extensive, gently undulating sandplains (termed Pindan) which are dissected in two areas, inland of Cape Bertholet and at How Mar, inland of Roebuck Plains (Beard, 1979). Rocky outcrops, dunes, beaches and mudflats occur around the coastal margins.

An east-west section reveals the Dampier Peninsula is convex, with a maximum elevation of 247 m halfway between Beagle Bay and Broome, 60 km north-east of Broome. The Project area has an elevation of approximately 70 m above sea level with a uniformly flat landscape which rises gently southward.

5.3 Geology

The Dampier Peninsula is located within the Fitzroy Trough, a major subdivision of the Canning sedimentary Basin. It is underlain by about 8,000 m of Phanerozoic sedimentary mainly obscured by Quaternary sandplains except around the coast where some of the Phanerozoic formations are exposed in cliffs.

The oldest geological formation exposed on the Dampier Peninsula is the Jarlemai sandstone, but it outcrops only in the lower Fraser River area (Kenneally *et al*, 1996). It dates from the Upper Jurassic or Early Cretaceous (150-120 mya) and contains numerous fossil marine shells.

The Jarlemai siltstone is overlain by the Broome Sandstone consisting of strongly cross-bedded sandstone, with some siltstone and minor conglomerate, of marine origins. The Broome Sandstone is generally regarded as being of Early Cretaceous age and has been found to be up to 286 m thick in petroleum exploration wells drilled on the Dampier Peninsula.

Overlying the Broome Sandstone is the Melligo Sandstone, which consists of thin-bedded, well sorted sandstones. It forms the flat-topped, erosion-resistant hill cappings found in the Mount Jowlaenga area and along cliffs on the north-eastern coast of the Peninsula. This is overlain by the Emeriau Sandstone, which outcrops at Emeriau Point near Beagle Bay, and consists of interbedded sandstone and siltstone. It outcrops as the low hills with laterite cappings in the Carnot Peak-Kings Peak area.

The rocks are locally faulted by small scale and regional faults and folded into a broad east-west anticline (Baskerville Structure) and complimentary syncline near Bobby's Creek.

5.4 Soils

Most of the Dampier Peninsula is mantled by the reddish-grey Quaternary sandplains of mixed alluvial and Aeolian origin, termed Pindan, which developed during the Quaternary period on desert dune sandstone. They have deep uniform profiles of coherent clayish sands, and an earthy appearance apparently due to the coating and bridging of sand grains by clayish materials, including iron oxides. The Pindan soils form extensive undulating plains with little or no organised surface drainage. Seasonal runoff forms sheets of water behind the coastal dune systems. Around Broome, the Pindan is often overlain by a layer of more recent, coarser and unconsolidated sand, which assists in water penetration, plant establishment and growth. The term Pindan has been used to describe the most widespread plant community on the Peninsula, and is also applied to the soil type associated with this vegetation.

Soils grade into yellowish-grey sandplains towards the northern end of the Peninsula where rainfall is higher (Kenneally *et al*, 1996). Areas of red windblown sand manifest themselves as weak linear dunes which occur throughout the Peninsula. These are understood to be remnants from a previous era of widespread aridity, which featured strong easterly winds and the expansion of the Great Sandy Desert. A later return to a somewhat wetter climate has obliterated discernable dune structure over much of the Peninsula today. Beaches and sand dunes of quartzose shelly sand and saline mudflats, either supratidal or tidal (including mangroves), also occur coastally.

5.5 Groundwater

5.5.1 Regional Hydrogeology

Broome Aquifer

The main freshwater-bearing aquifer on the Dampier Peninsula is the Broome aquifer. This comprises the Broome, Melligo and Emeriau Sandstones which are in hydraulic continuity and form a single unconfined aquifer (Rockwater 2004a; See Appendix F). The aquifer is about 300 m thick and underlain by the Jarlemai Siltstone which forms an aquiclude isolating the Broome aquifer from underlying aquifers.

Aquifer Recharge

Groundwater in the Broome aquifer originates from rainfall infiltration. The average annual rainfall on the Dampier Peninsula shows a general pattern increasing from about 760 mm at Cape Leveque with an area of higher rainfall of about 895 mm on the central part of the peninsula near Country Downs Station. The area of higher rainfall occurs close to the highest part of the peninsula (~200 m above sea level) and may result from topographic effects. Interpretation from Bureau of Meteorology maps of monthly rainfall indicates that the average annual rainfall at the TTP plantation is about 860 mm. The actual rainfall, mainly originating from monsoonal conditions, may vary considerably.

The proportion of rainfall which provides groundwater recharge has been estimated from the ratio of chloride in rainwater to chloride in groundwater. This indicates recharge of 5 to 6 % at Broome (Laws 1991) and about 11 % at the TTP plantation site, possibly reflecting the higher rainfall and greater depth to water table.

Storage and Movement

The rainfall recharge infiltrates through the Pindan soils to a regional water table which lies close to the surface along Bobby's Creek to about 100 m below surface beneath the central highest part of the peninsula. Locally perched aquifers may occur above the regional water table. The seasonal variation in the water table is not known and is being monitored by TTP. From the known thickness and extent of the Broome aquifer extremely large volumes of groundwater are in storage within the aquifer.

The groundwater flows in regional groundwater flow systems from poorly defined groundwater mounds (e.g. Laws 1991) to the lower reaches of the major drainage lines and to the coast. The groundwater moves very slowly (<50 m/year) under low groundwater gradients.

The TTP plantation site is located toward the downstream end of a northward moving flow-system originating near the rest of the Baskerville Anticline (Rockwater 2004a). On topographic evidence and hydrogeological considerations, a similar flow system occurs to the north of Bobby's Creek. From this area, some groundwater flows southward and meets the northward flowing groundwater from the Baskerville Anticline along the lower reaches of Bobby's Creek.

Groundwater Discharge

Groundwater discharge occurs *via* seepage faces and springs along the coast and by evapotranspiration from hydrophytic vegetation along the lower reaches of Bobby's Creek. The water table approaches the surface along the lower reaches of Bobby's Creek. Superimposed over the water table is discharge from springs originating at depth in the Broome aquifer. The groundwater in the springs is under pressure and

stands slightly higher than the water table. The springs probably form low local groundwater mounds superimposed on the water table (Rockwater 2004c; See Appendix F).

Over twenty springs are known. They probably originate from both the northern and southern flow systems and occur where the flow systems meet. The location of the groundwater discharge from the Broome aquifer may be localised along faults and the various springs at the surface may result from piping through the overlying estuarine and alluvial sediments to various discharge points forming the present springs.

Saltwater Interface

A saltwater interface is known to occur at the base of the Broome aquifer around the coast in the Broome region, and is certain to extend around the coast and possibly beneath the entire northern end of the peninsula where it narrows near Cape Leveque.

It is uncertain whether a saltwater interface occurs beneath the lower reaches of Bobby's Creek. A bore drilled to 98 m and stopped, because of technical difficulties, did not reach the interface. From the Ghyben-Herzberg principal the interface is estimated to be 300 to 400 m below surface and may be present at the base of the aquifer at the BBC, however, from both calculations and drilling results is not present beneath the TTP plantation (Rockwater 2004a).

Groundwater Quality

According to Laws (1991) the groundwater salinity in the Broome aquifer varies from about 100 mg/L TDS to 7200 mg/L near the saltwater interface. The groundwater contains natural background levels of silica up to 50 mg/L and nitrate of 10 mg/L.

5.5.2 Project Area

In the project area, the Melligo and Emeriau Sandstones (Figure 5.1), which are of similar lithology are about 60 m thick and are underlain by about 250 m of Broome Sandstone. They are inferred to underlie the lease area, and are in hydraulic continuity with the Broome Sandstone (Rockwater, 2004a). For convenience the sandstone units are considered to be part of a single aquifer, here referred to as the Broome aquifer, and which extends upward from the top of the Jarlemai Siltstone to the regional water table (Rockwater, 2004a).

The Broome aquifer consists of lithified (silicified and ferruginised) to unconsolidated, fine to very coarse grained sandstone with interbeds of conglomerate, siltstone and shale. The beds of siltstone are generally 5 to 15 m thick but are locally up to 30 m (Rockwater, 2004a).

The configuration of the water table across the lease area is given in Figure 5.2. The contours show that the water table ranges from 15 metres AHD at the south-western corner to 12 metres AHD at the north-eastern corner of the lease. The direction of groundwater flow is north to north-east and the depth to the water table beneath the lease ranges from about 60 metres below surface in the south to 30 metres in the north (Rockwater, 2004a).

The regional throughflow in the groundwater flow system, supported by recharge estimates, is calculated to be 62 GL/a (Rockwater, 2004a).

It should be noted that the total throughflow of the system is greater than estimated because recharge downstream from the 15 m water table contour is not included, and is additional to the calculated throughflow.

Figure 5.1

HYDROGEOLOGICAL SETTING

I:/296.0/Projects/Surfer/Beagle Bay Hydro 250K.srf

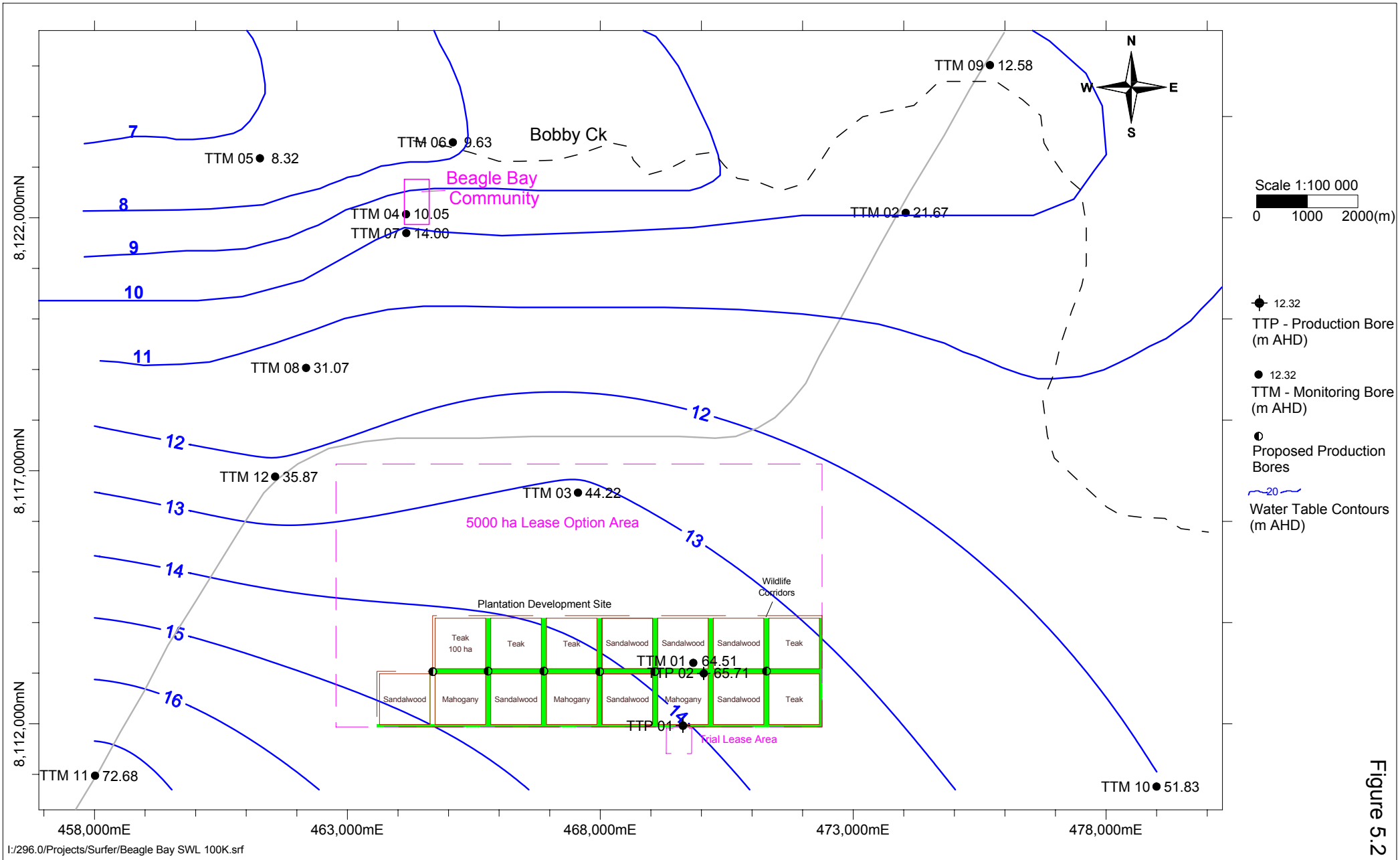
CLIENT: Tropical Timber Plantations

PROJECT: Beagle Bay Project

DATE: March 2004

Dwg. No: 296.0/04/5.1

Rockwater Pty Ltd



I:/296.0/Projects/Surfer/Beagle Bay SWL 100K.srf

Figure 5.2

CLIENT: Tropical Timber Plantations

PROJECT: Beagle Bay Project

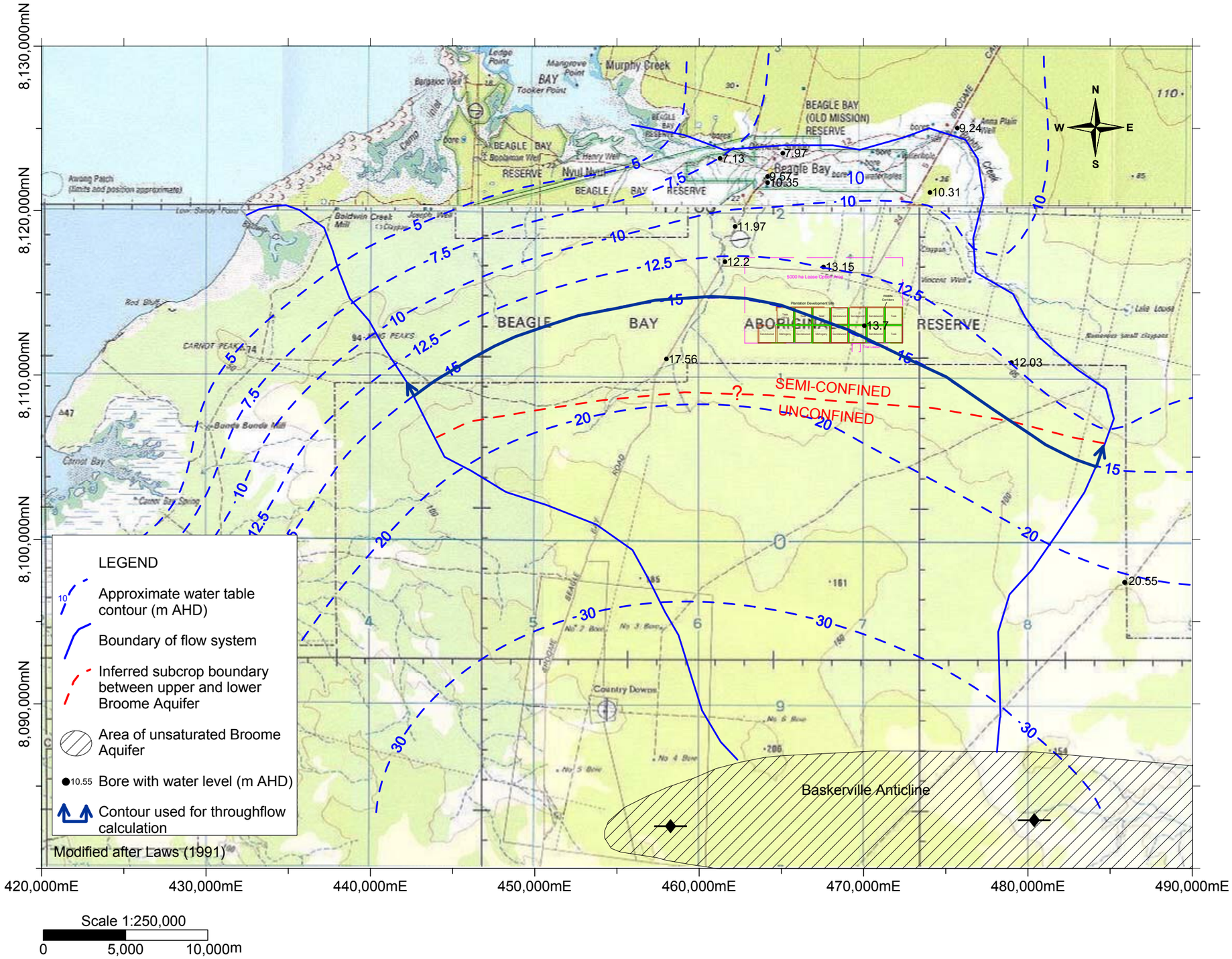
DATE: March 2004

Dwg. No: 296.0/04/5.2

WATER TABLE CONTOURS (JAN 2004) AND PROPOSED PRODUCTION BORES

Rockwater Pty Ltd

Figure 5.3



MODEL CALCULATED GROUNDWATER LEVELS AND MEASURED VALUES (m AHD)

I:/296.0/Projects/Surfer/calcsswls.srf

CLIENT: Tropical Timber Plantations

PROJECT: Beagle Bay Project

DATE: March 2004

Dwg. No: 296.0/04/5.3

Rockwater Pty Ltd

5.5.2.1 Aquifer Characteristics

Groundwater in the Broome aquifer originates from the infiltration of a proportion of the annual rainfall to the water table. The infiltration is presumed to occur over the entire Dampier Peninsula but it is likely that the percentage varies considerably depending on rainfall intensity, depth to water table, location of drainage lines and the nature of the subcropping Broome aquifer (Rockwater, 2004a).

The groundwater in the Broome aquifer is unconfined and a regional water table broadly following the form of the regional topography extends throughout the region. Locally and at depth in the aquifer, the groundwater may be confined beneath beds of siltstone and fine-grained sandstone (Rockwater, 2004a). However, there are no known significant vertical head differences in the aquifer (Laws, 1984). In some areas where interbedded siltstone occurs above the regional water table, there are local perched aquifers (Rockwater, 2004a). In the lease area semi-confined groundwater conditions with local perched aquifers are present (Rockwater, 2004a).

Groundwater in the aquifer moves in regional groundwater flow-systems controlled by the topography, and the location of recharge and discharge areas. The groundwater moves very slowly to be discharged into the sea, estuaries, claypans and local springs (Rockwater, 2004a). The discharge around the coast occurs over an underlying saltwater wedge which may extend inland for 10 to 15 km within the vicinity of Broome (Laws, 1991). The lease area is located within a local flow system which has an area of about 1,250 km^2 (Fig 5.1).

The groundwater in the Broome aquifer is generally very fresh (< 250 mg/L TDS) but may have a slightly higher salinity in the upper siltstone/sandstone sequence in the aquifer and above the saltwater interface between the saltwater wedge and the groundwater flow system (Rockwater, 2004a). High rainfall recharge, depth to the regional water table and the siliceous nature of the aquifer are factors contributing to the low salinity of the groundwater (Rockwater, 2004a).

Analyses of groundwater from the existing production bore on the plantation (TTP 01) and for the test production bore (TTP 02) are given in Table 5.2.

TABLE 5.2: MAJOR ION ANALYSES FOR TTP 01 AND TTP 02

Analyte	TTP 01 29 May 2003 (mg/L)	TTP 02 28 January 2004 (mg/L)
pH (pH units)	6.0	5.8
Electrical conductivity @ 25°C (micro siemens/cm)	120	130
Total Dissolved Solids (as NaC1)	80	85
Hardness (equivalent $CaCO_3$)	15	15
Iron (soluble)	<0.05	0.05
Sodium	16	20
Potassium	<0.05	0.6
Calcium	1.2	0.6
Magnesium	2.8	3.4
Chloride	32	34
Bicarbonate	10	15
Sulphate	<1	2
Nitrate	2.6	2.8
Silica	45	32
Total Phosphorus	<0.05	<0.05

The results of the analyses show that the groundwater is slightly acidic and has very low salinity. The principal constituents are silica, chloride and sodium. The groundwater has a natural nitrate level of 2.8 mg/L and a very low concentration of sulphate, and has been used successfully for the irrigation of the trial plots (Rockwater, 2004a).

5.5.2.2 Saltwater Interface

A saltwater wedge is inferred to underlie the area bordering Beagle Bay (Rockwater, 2004a). As part of the groundwater investigations a monitoring bore was drilled about 150 m from the BBC Water Supply bores to a depth of 98 m. It was drilled 25 m deeper than the community water supply bores and did not reach the saltwater wedge. Electrical conductivity measurements from the test hole showed that at the bottom the groundwater salinity was about 500 mg/L TDS and the interface had not been reached (Rockwater, 2004a).

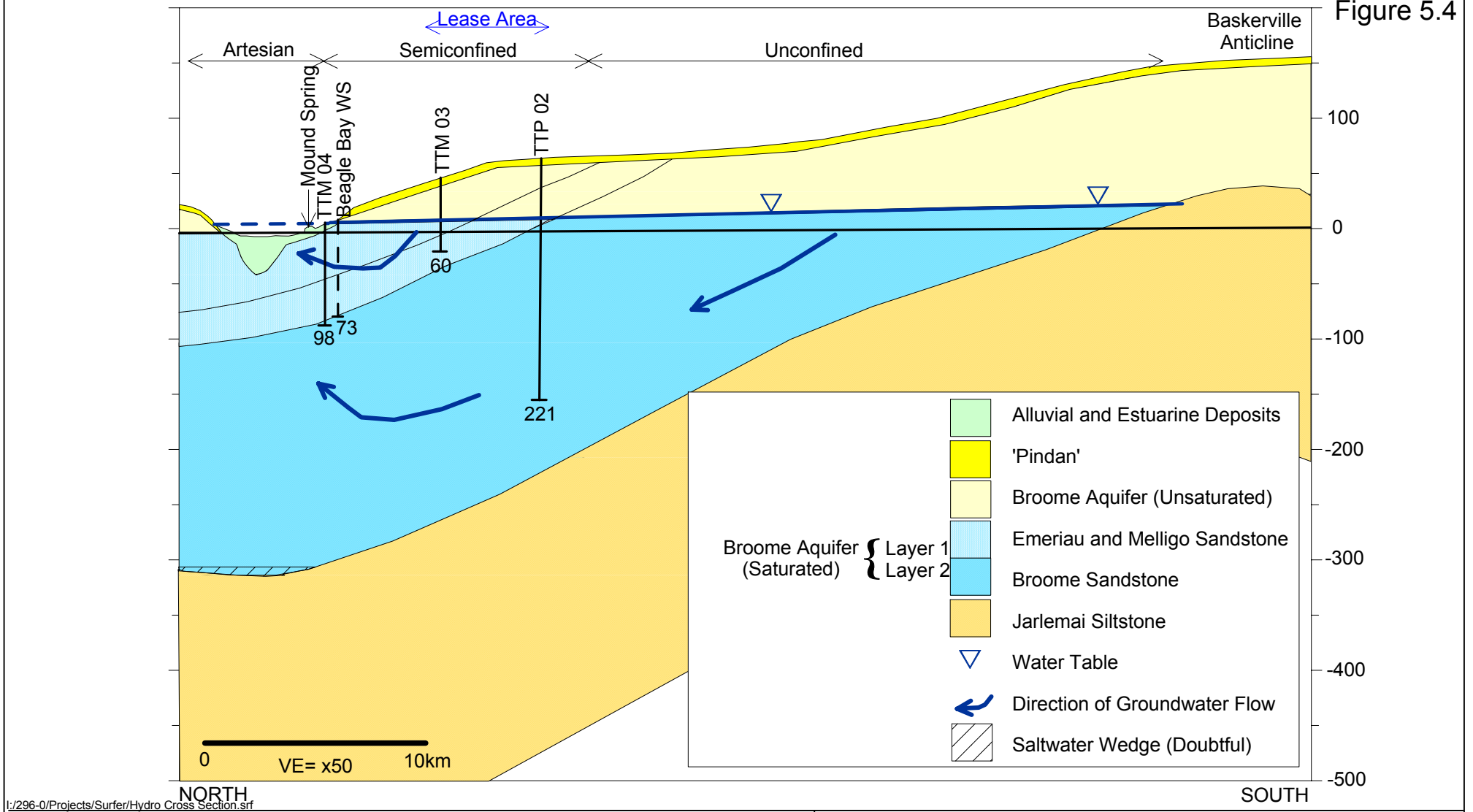
The water table beneath the BBC is at about 7.5 to 10 m AHD (Figure 5.2). Based on the Ghyben-Herzberg principal the interface with the saltwater wedge should be about 40 times the elevation of the water table and theoretically would be at an approximate depth of about 300 m below the water table and somewhat shallower in the discharge area, which is approximately 220 m below the production bores (Rockwater, 2004a). The base of the Broome aquifer is about –325 m AHD (Laws, 1991) and based on these considerations, it is uncertain whether the toe of the wedge underlies the BBC (Figure 5.4). Based on similar considerations, the saltwater wedge is not likely to be present beneath the lease area (Rockwater, 2004a).

5.5.2.3 Wetland Systems

During the course of the investigations undertaken by Rockwater (2004a) various spring discharge areas were identified and mapped along the lower reaches of Bobby's Creek and the approximate areas in which they occur are shown in Figures 5.5 (a), (b) and (c). They generally comprised near-circular areas of paperbarks with dense vegetation surrounded by claypans or low grasses. Areas of free-standing water or wet soils were located within these areas but no significant mounding was noted (Rockwater, 2004a). Overflow from the springs was not observed and presumably most of the discharging groundwater is lost by evapo-transpiration. During the wet season flows in February and March 2004 the mound springs were completely inundated by run-off from Bobby's Creek (Rockwater, 2004a).

The spring discharge areas are sites of groundwater discharge from the Broome aquifer. It is inferred that they are sites where groundwater is piped through the overlying alluvium to discharge at the surface (Rockwater, 2004a). More diffuse and widespread discharge presumably occurs through the overlying alluvium, possibly contributing to the formation of the claypans along Bobby's Creek (Rockwater 2004a).

Figure 5.4



I:/296-0/Projects/Surfer/Hydro Cross Section.srf

CLIENT:	Tropical Timber Plantations
PROJECT:	Beagle Bay Project
DATE:	March 2004
Dwg. No:	296.0/04/5.4

HYDROGEOLOGICAL CROSS-SECTION

Rockwater Pty Ltd

JOHN BRENNAN AND ASSOCIATES

REGIONAL SPRINGS
GENERAL LOCATIONS

A3

Client: **TROPICAL TIMBER PLANTATIONS PTY LTD**	Revision No. **5**
	Date: October 2004
Project: **BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION**	Scale: 1:500 000
	Figure No. **5.5a**
Author: J.Brennan — Drawn: S.Coleman	Plan No. **BB-016**

INDIAN OCEAN

KING SOUND

Cape Leveque

Thomas Bay

Lombadina

Spring Site

One Arm Point
Aboriginal Community

Cygnet Bay

Steel Star
(flowing spring)

Goonjarlan

Deep Water Point

Cunningham Point

Gudumul

Spring Site

Pender Bay

Middle Lagoon

Tappers Inlet

Weedong Well
and Lake

Spring Sites

Beagle Bay

Camp Inlet

See BB-017
for enlargment

Beagle Bay
Aboriginal Reserve
(350 000 ha)

Disaster Bay

Spring
Sites

Beagle Bay
Community

Bobby's Creek
ephemeral
drainage system

Spring Sites

5000 ha Lease
Option Area

Lake Louisa

Lake Paterson

Malaburra Spring

Woolnong Spring

Kallumbarrit Springs

Wahja Springs

Midgeguna Spring

Road

Country Downs Station

Carnot Bay

Bunda Bunda Spring

Jabir Jabir Spring
(flowing)

Cape Leveque

Jangan Spring

Country Downs Homestead

Fraser

River

Spring Sites

Bungarragut Ck

Derby

DERBY

HWY

Broome

Wonganut Springs

Fraser River South

To Broome 53 km

400000mE

450000mE

500000mE

550000mE

8150000mN

8100000mN

N

SCALE 1 : 500 000

0 25

Kilometres

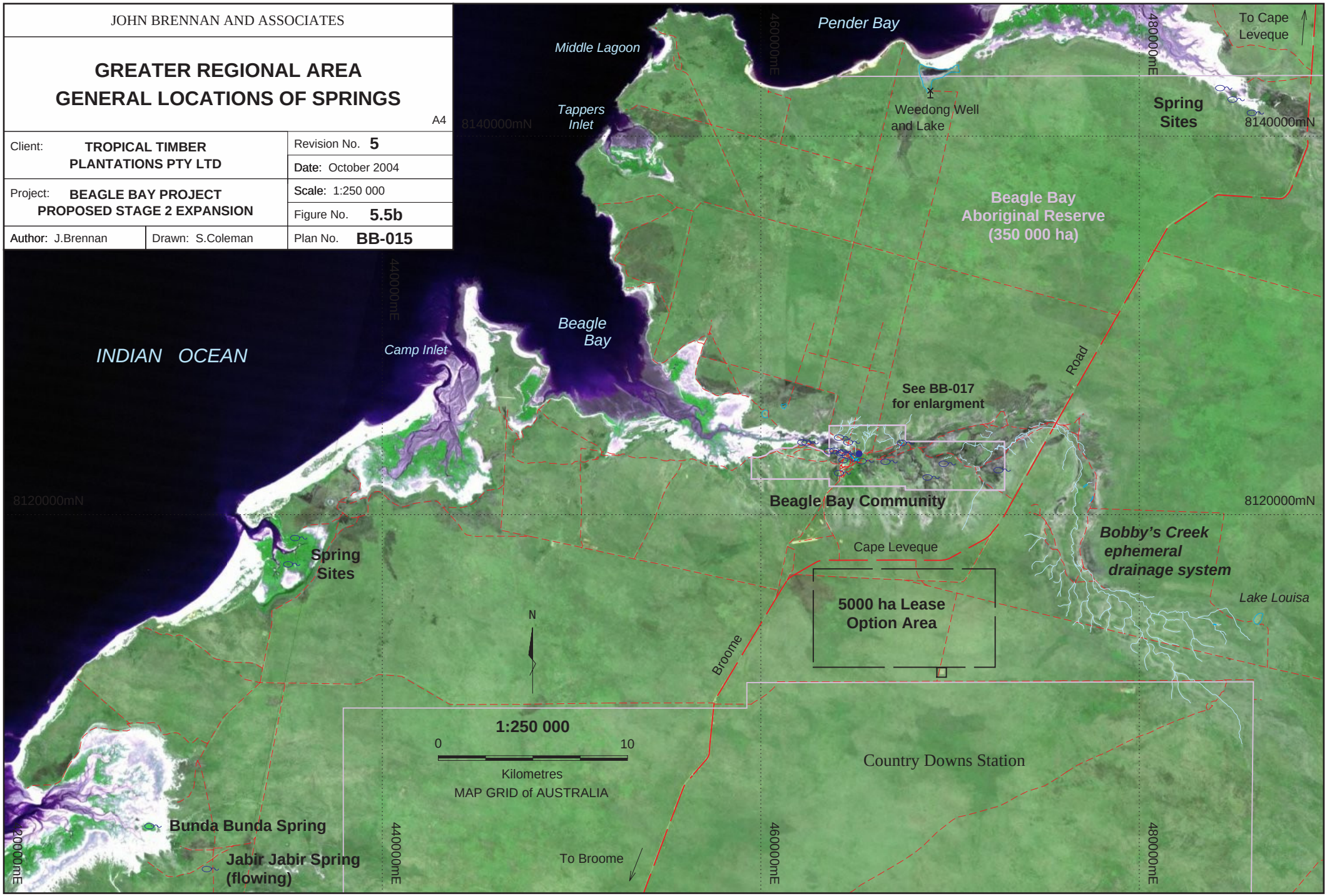
MAP GRID OF AUSTRALIA
GRID BASED ON
TRANSVERSE MERCATOR PROJECTION

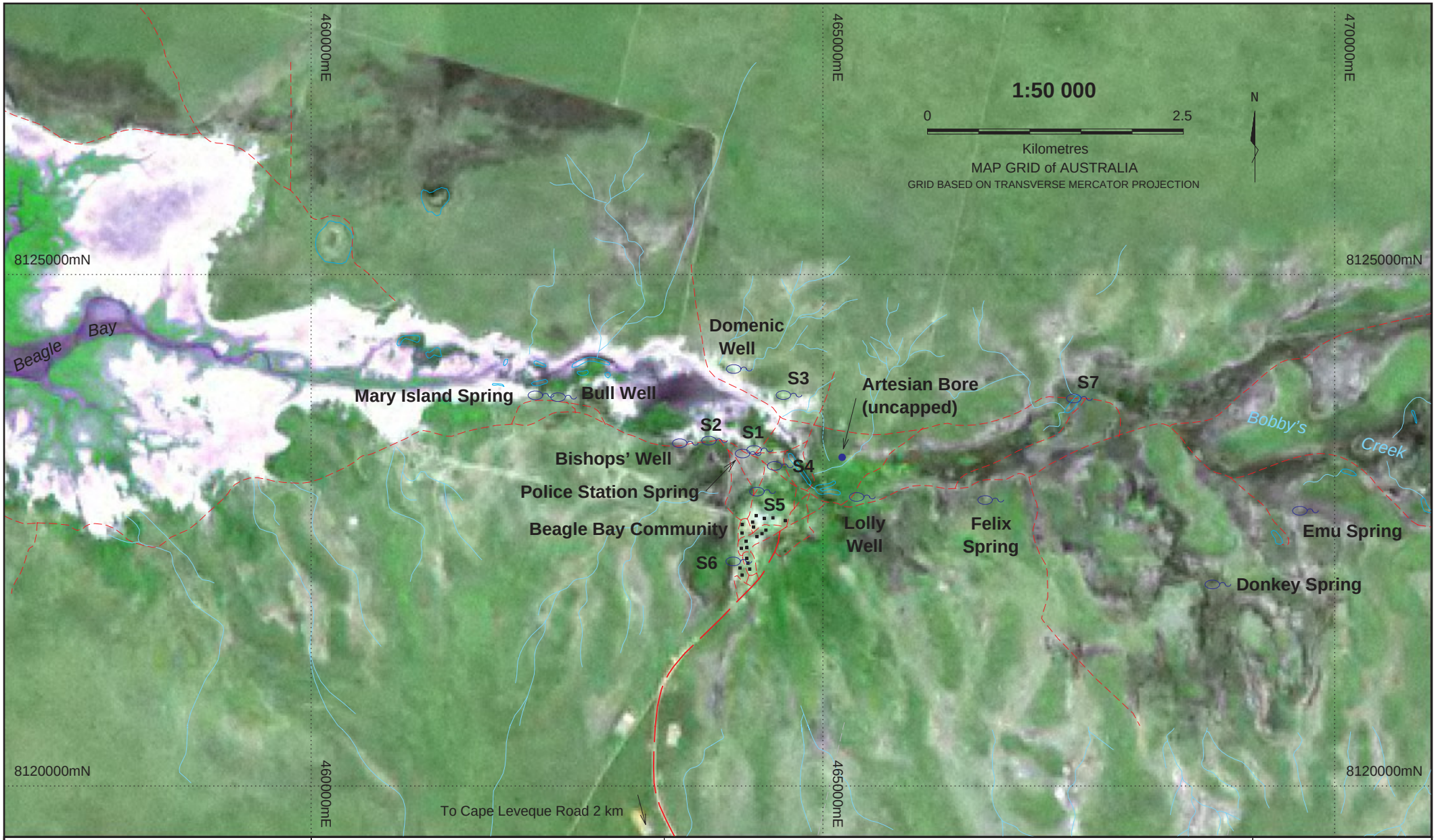
JOHN BRENNAN AND ASSOCIATES

GREATER REGIONAL AREA
GENERAL LOCATIONS OF SPRINGS

A4

Client: TROPICAL TIMBER PLANTATIONS PTY LTD	Revision No. 5
	Date: October 2004
Project: BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION	Scale: 1:250 000
	Figure No. 5.5b
Author: J.Brennan — Drawn: S.Coleman	Plan No. BB-015





JOHN BRENNAN AND ASSOCIATES Project Managers	Client: TROPICAL TIMBER PLANTATIONS PTY LTD	**GREATER BEAGLE BAY AREA GENERAL LOCATIONS OF SPRINGS**	Date: October 2004
			Scale: 1:50 000
	Project: BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION	A4	Figure No. **5.5c**
Author: J.B. / S.C. — Drawn: S.Coleman			Plan No. **BB-017**

5.5.2.3 Monitoring data

Rockwater have been monitoring 12 bores (TTM01-TTM12) within the plantation site and the vicinity of the project area for a period of 12 months (Figure 5.6). During this period groundwater levels ranged from 7 to 18 m above AHD, decreasing in a northerly direction. Most bores show a negligible nett change over the monitoring period, although most showed a broad fluctuation of 0.1 to 0.5 m. This is likely a result of tidal and barometric-pressure changes.

Bore TTM08 showed atypical results, as a peak of 5 m above the starting and finishing water level was recorded in May 2004. At this point it is not possible to determine if the data are accurate, or if the hydrogeological conditions at this bore are different to those elsewhere.

Eight bores were sampled for the last quarter of 2004 (TTM13 – TTM17A). In shallow monitoring bores TTM15 to TTM17, the water levels showed levels trends or rises of up to 0.2 m. The adjacent spring, in each case, showed negligible nett change. This suggests that the shallow groundwater levels are more affected by seasonal factors than the spring water levels.

5.6 Surface Water

5.6.1 Regional Hydrology

The topography of the Dampier Peninsula is gently convex, reaching a maximum elevation of 247 m above sea level approximately 60 km north east of Broome. The low gradient of the land, lack of defined drainage channels and heavy seasonal rainfall mean that sheet flooding dominates the surface water flow on the Peninsula (Kenneally *et al*, 1996).

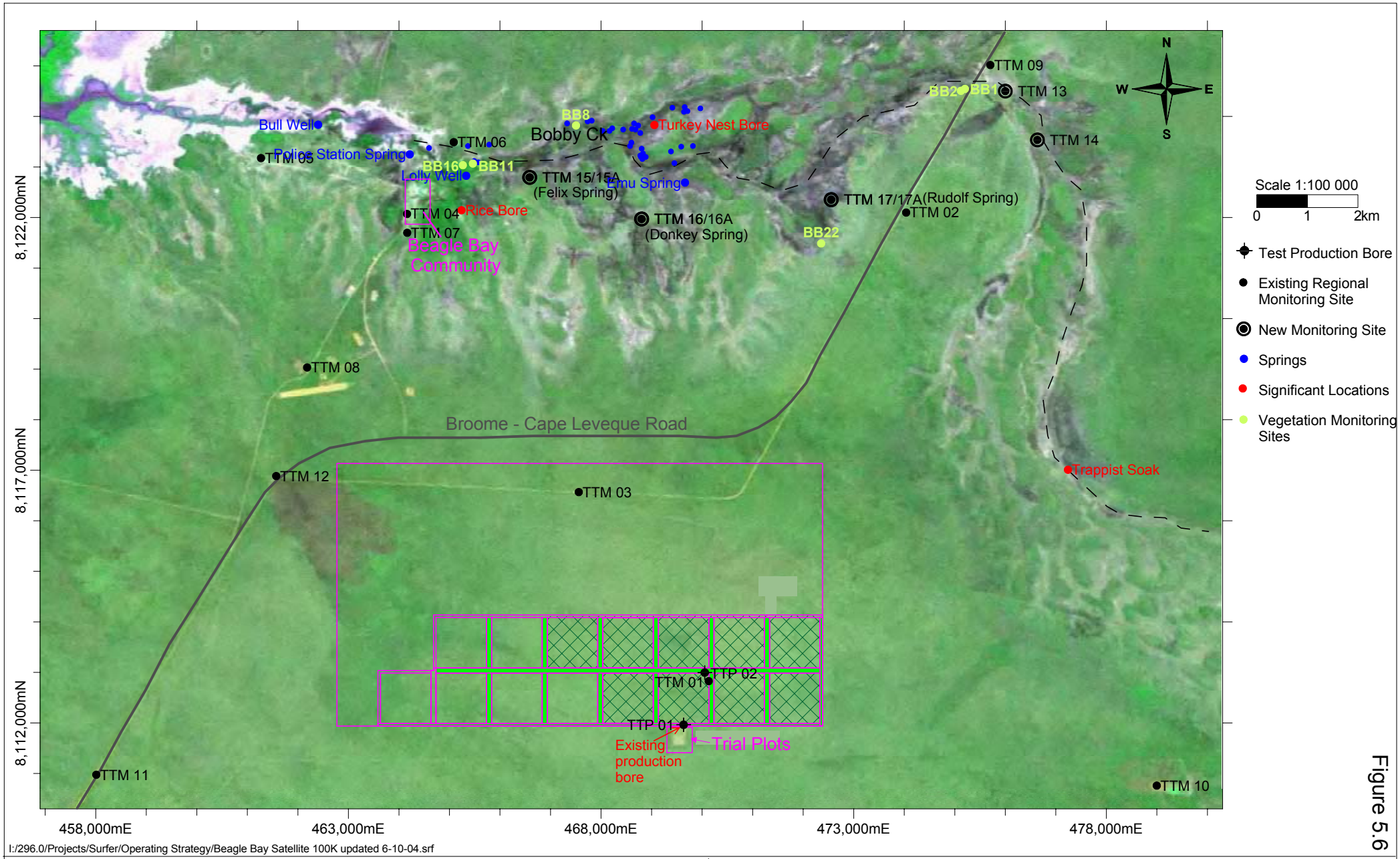
A peripheral, radial system of minor creeks exists in the southern half of the Peninsula, with the most well-developed channels located near the coast in the Coulomb Point Nature Reserve and east of Dampier Hill. The northern end of the Peninsula is low lying and features broad sub-coastal drainage valleys with seasonal swamps, particularly inland from Beagle and Pender Bays (Kenneally *et al*, 1996).

5.6.2 Project Area

There are no major surface hydrological features in the Beagle Bay project area. The land is flat and low lying (elevation of 70 m above sea level) with uniform Pindan vegetation across the whole project area. Surface water transport occurs only as sheet flow during, and directly following, seasonal heavy rains.

There is no permanent surface water within the project area.

The nearest hydrological feature of conservation importance is Lolly Well Springs, located approximately 1-2 km from the Beagle Bay township and approximately 12 km from the project area. Potential impacts to Lolly Well Springs are discussed in Section 6.2 Priority Ecological Communities.



I:/296.0/Projects/Surfer/Operating Strategy/Beagle Bay Satellite 100K updated 6-10-04.srf

Figure 5.6

CLIENT: Tropical Timber Plantations Pty Ltd

PROJECT: Beagle Bay *Big Tree Country* Project

DATE: January 2005

Dwg. No: 296.0/05/1-5.6

LOCATION OF MONITORING SITES

Rockwater Pty Ltd

5.7 Vegetation and Flora Overview

5.7.1 Regional Vegetation

The project area falls within the Dampier Botanical District, which is broadly characterised by Pindan formation on sandplains (Beard, 1979) (Figure 5.7). The Dampier Botanical District comprises eight sub-districts, of which the relevant sub-district is the Dampier Peninsula. Within the Dampier Peninsula, ten terrestrial plant communities are recognised (Kenneally *et al*, 1996), of which, the plantation site occurs within a single type: Pindan vegetation.

Beard (1979) describes the Pindan vegetation of the sandplains as an open layer of trees 12-15 metres in height over a dense layer of *Acacia* species and a sparse grass ground covering. The woodlands are generally co-dominated by scattered to open Darwin Box *Eucalyptus tectifica* and Ochre Bloodwood *Corymbia dampieri*, together forming a canopy about 8-12 m high. A sparse layer of small trees/tall shrubs typically occurs below with the species *Acacia tumida, A. platycarpa, Brachychiton diversifolius, Bauhinia* (previously *Lysiphyllum*) *cunninghamii, Dolichandrone heterophylla, Ehretia saligna, Erythrophleum chlorostachys*, *Ficus opposita, Hakea macrocarpa, H. arborescens, Grevillea pyramidalis* and *G. refracta, Terminalia* spp. and *Persoonia falcata* common elements. The understorey is dominated by grasses, such as *Triodia schinzii, Sorghum stipoideum, Chrysopogon pallidus* and *Heteropogon contortus,* and few shrubs, such as *Carissa lanceolata, Distichostemon hispidulus, Trichodesma zeylanica, Acacia adoxa* and *Solanum cunninghamii* (Kenneally *et al*, 1996).

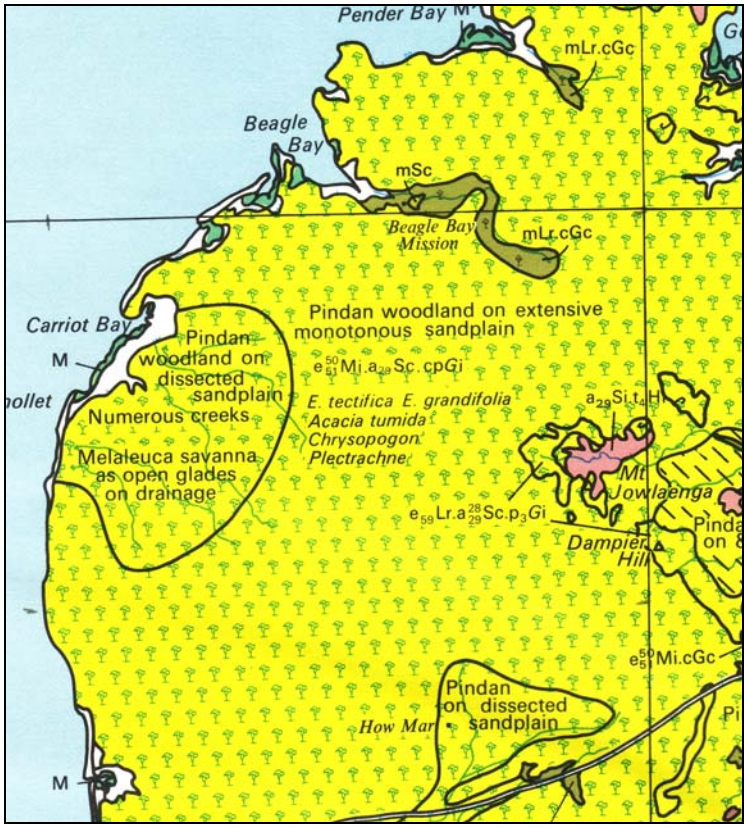


FIGURE 5.7 BEARD VEGETATION UNITS ON THE DAMPIER PENINSULA (Reproduced from Beard 1979)

Whilst the species composition within the site is relatively homogeneous, localised variations in the structure occur, almost certainly in response to the fire regime, with more frequently burnt areas impoverished in the shrub/low tree stratum.

5.7.2 Previous Floristic Surveys

There have been very few biological surveys carried out within the Dampier Peninsula. Beard (1979) and Kenneally *et al.* (1996) provide detailed accounts of the botanical surveys of the Kimberley region, which date back to the early 19th Century. Broadscale vegetation mapping of the Dampier Peninsula was conducted by Beard in 1979, with detailed floristic inventories of the region commencing in 1977.

In 1983, McKenzie and Kenneally published a listing of 311 plant species for the Peninsula. This information has been supplemented by field collections by the Broome Botanical Society. Petheram and Kok (1991) provide a description of most common Kimberley species in *Plants of the Kimberley Region of Western Australia*. Wheeler *et al.* (1992) published *The Flora of the Kimberley Region*, which describes 1,046 plant species within the Dampier Botanical District. Kenneally *et al* (1996) noted 717 species of vascular plants within the Dampier Peninsula, which occupies approximately 14,000 km^2 of the 84,400 km^2 Dampier Botanical District.

More recently, a survey of the Broome to Cape Leveque Road between Beagle Bay and Cape Leveque was conducted by *ecologia* (2002). The floristic survey concentrated on flora and vegetation along the proposed Broome to Cape Leveque main alignment and adjoining access roads. Five linear transects and thirty three unbounded quadrats of approximately 10,000m^2 were undertaken within the survey area. A total of 226 species of vascular plants were collected, from 56 families and 128 genera, 94 were each represented by a single taxon. An additional 31 species could not be identified beyond genus level due to the absence of reproductive parts (*ecologia*, 2002). Eight introduced species were recorded. Two Priority species were recorded and one species of Declared Rare Flora may have been located; however identification beyond species level was unachievable due to the absence of reproductive material.

The 'Botanical Survey for Proposed Tropical Timber Plantation, Beagle Bay, West Kimberley' (Willing and Dureau, 2000) describes the study of vegetation and flora within the Trial Plantation site. A total of 59 species of vascular flora, from 53 genera belonging to 36 families were identified. It is estimated that an additional 20 species would have been identified in a post wet season survey (Willing and Dureau, 2000). No Declared Rare or Priority Flora species were detected during the survey. No exotic or weed species were detected.

5.7.3 Survey Methodology

As part of the approvals process, flora and vegetation surveys were conducted from 9th – 15th April 2003 and from the 13th – 15th February, 2004 (*ecologia* 2004a; See Appendix F). Twenty-four sites were sampled using 50 by 50 metre quadrats (Figure 5.8). Sites were selected by visual assessment from access tracks; however as long grass impeded visibility in some locations aerial photography was also used to determine site location.

Quadrat size was determined using the Nested Quadrat Technique in the initial stage of the April 2003, survey. This technique is used to establish an optimal size for collecting the maximum amount of floristic data according to vegetation type. A quadrat size of 50 by 50 m was determined to be of sufficient size to adequately represent the vegetation assemblage in these vegetation types.

Opportunistic collections were restricted to records of additional species observed in transit between quadrats and on walks to remote quadrats from access roads.

Voucher specimens of taxa not identified in the field were collected for subsequent identification and comparison to specimens lodged at the State Herbarium.

5.7.3.1 Survey Limitations

The recurrence of fire throughout the region has reduced the shrub layer, decreased the diversity of herbs and grasses and removed reproductive debris which aid in identification. This may have contributed to a reduced floristic inventory within the project area. Fire swept through the region three months prior to the CALM survey (Willing and Dureau, 2000), and 12 months prior to the *ecologia* (2003) survey and was evident during the subsequent survey in 2004.

A significant effort was made during the work to ensure opportunistic collections were made from all local niches to capture as many taxa as possible. The timing of the survey was also opportune with rainfall resulting in the emergence of ephemeral herbs and annual grasses.

460000mE
465000mE
470000mE
475000mE
8120000mN
8115000mN
8110000mN

Beagle Bay 1 km

To Cape Leveque

Site 5

N

1:50 000

0 2.5

Kilometres

MAP GRID of AUSTRALIA

GRID BASED ON TRANSVERSE MERCATOR PROJECTION

Beagle Bay Access Road

Airstrip

Seismic Line

Site 13

Site 23

BROOME CAPE LEVEQUE ROAD

OLD CAPE LEVEQUE ROAD

Site 18

Site 12

Site 4

Site 3

5000 ha Lease Option Area

Site 19

Site 16

Site 17

P3 *Phyllanthus aridus*

Site 2

Vincent Well

ACCESS TRACK

Habitat Corridors

Site 22

Plantation Development Site

Nested Site

Site 1

Site 20

Site 24

Site 21

Teak 100 ha	Teak	Teak	Sandalwood	Sandalwood	Sandalwood	Teak
Sandalwood	Mahogany	Sandalwood	Mahogany	Sandalwood	Mahogany	Sandalwood	Teak

Nested Site

Site 11

Trial Lease Area

Fence Line

Site 15

Nested Site

Site 9

Site 10

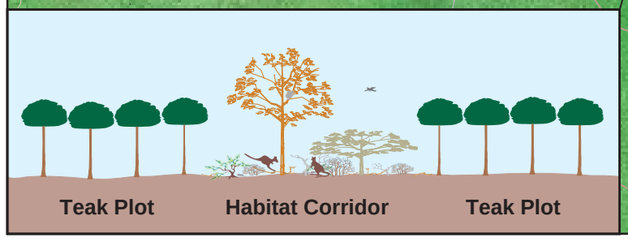
Site 8

Site 7

Site 6

Site 14

Country Downs Station



Legend

- Flora Survey Location Sites
- Greater Project Area

JOHN BRENNAN AND ASSOCIATES
Project Managers

Author: M.L. / S.C.

Drawn: S.Coleman

Client: TROPICAL TIMBER PLANTATIONS PTY LTD

Project: BEAGLE BAY PROJECT
PROPOSED STAGE 2 EXPANSION

BEAGLE BAY PLANTATION
FLORA SITE LOCATIONS

A3

Date: 19 January 2004

Scale: 1:50 000

Figure No. 5.8

Plan No. BB-004

5.8 Vegetation Communities

5.8.1 Regional Mapping

In a regional context, Kenneally *et al.* (1996) recognised ten terrestrial plant communities on or around the Dampier Peninsula:

- **Pindan –** open canopy of trees, predominantly eucalypts, dense mid storey dominated by wattles and a sparse grassy ground layer
- **Fitzroy sandplains** - savannah characterised by boabs *Adansonia gregorii* and dominated by *Eucalyptus tectifica* and *Bauhinia cunninghamii*
- **Rocky outcrops** - support coastal communities of *Acacia tumida, Gyrocarpus americanus* and *Ficus opposite*; woodlands of *Eucalyptus flavescens* and *Acacia* species and vine thicket species such as *Sarcostemma viminale* and *S. brevipedicellatum*
- **Creeks, wetlands and seepage areas** - sub-coastal drainage valleys and seasonally swampy areas support woodlands of *Eucalyptus polycarpa, E. bella* and *Melaleuca viridiflora*; estuaries support low closed forests of *Melaleuca alsophila*; mound springs support large fern populations of *Cyclosorus interruptus, Lygodium microphyllum* and *Acrostichum speciosum*
- **Vine thickets** - located behind the coastal dune systems, vine species include *Abrus precatorius, Gymnanthera oblonga, Jacquemontia paniculata, Caesalpinia major, Capparis lasiantha* and *Paramignya trimera.* Tree species include Mangarr *Pouteria sericea, Terminalia petiolaris* and *T. latipes*
- **Coastal dunes, beaches and limestone outcrops** - *Spinifex longifolius, Fimbristylis cymosa, F. sericea* and *Cyperus bulbosus* dominate the coastal foredunes; *Abutilon indicum, Clerodendrum tomentosum, Crotalaria cunninghammii, Hypoestes floribunda, Jasminum didymium, Mallotus nesophilus* and the grass *Whiteochloa airoides* characterise secondary dunes
- **Saltwater paperbark thickets -** *Melaleuca alsophila* inhabits the landward margin of saline grasslands
- **Samphire flats** - hypersaline environment limits vegetation occurrence, *Ceriops tagal* and *Excoecaria agallocha* inhabit the seaward edges and saltmarsh shrubs the landward margins
- **Saline grasslands** - dominated by salt water couch *Sporobolus virginicus*; shrubs such as *Flaveria australasica, Hibiscus panduriformis, Streptoglossa odora* and *Phyla nodiflora* inhabit landward edges
- **Mangroves** - *Avicennia marina* is often associated with *Sonneratia alba* and *Camptostemon schultzii* on the seaward margin and *Aegialitis annulata, Aegiceras cornicultum* and *Ceriops tagal* on the landward edge

5.8.2 Vegetation of the Project Area

The project area comprises savannah woodlands which, on the red sandy loams soils of the Dampier Peninsula, are also termed 'Pindan woodland' (Kenneally *et al*, 1996) (Figure 5.7).

To the east of the Lease Option Area is a prominent drainage line dominated by *Melaleuca viridis* woodlands over grey-white clay soils. These two vegetation types are described below:

Type 1: Savannah woodlands (Pindan); *Eucalyptus tectifica* / *Corymbia dampieri* dominated woodlands over open mixed tall shrubs over hummock and tussock grasslands.

This vegetation type is characterised by a particular assemblage of species, rather than characteristic species unique to this vegetation type. Although actual species composition changes slightly from site to site, the typical Pindan overstorey in the area consists of medium sized open woodlands of Dampier's Bloodwood *Corymbia dampieri,* and Darwin Box *Eucalyptus tectifica*. Both *Corymbia dampieri* and *Eucalyptus tectifica* form monospecific stands at a small number of sites (e.g. Sites 5 & 6 for *E. tectifica*), but in most sites are co dominant (e.g. Sites 9, 13 & 16) (Figure 5.8).

The tall shrub/small tree stratum is a characteristic and prominent component of the vegetation in the project area and is also represented by typical Pindan species. It forms an open to scattered assemblage beneath taller tree species and consists of characteristic species such as *Bauhinia cunninghamii*, Ironwood *Erythrophleum chlorostachys*, lemonwood *Dolichandrone heterophylla*, Northern Kurrajong *Brachychiton diversifolius*, Wild Pear *Persoonia falcata*, Caustic Tree *Grevillea pyramidalis* and an assemblage of *Acacia* species. The most conspicuous *Acacia* species within the study site is the Wongai or Spear Wattle *Acacia tumida*. There are very few species characteristic of the middle storey vegetation, such as *Distichostemon hispidulus, Terminalia latipes* and *Corchorus pumilio.* More commonly the mid-storey comprises juvenile and regenerative large shrubs and trees.

At ground level there is a moderately dense to open cover of small shrubs, creepers and herbs such as *Gossypium rotundifolium*, Woolly Glycine *Glycine tomentella*, *Hybanthus aurantiacus* and *Goodenia sepalosa*. The grass stratum is a conspicuous component of the Pindan woodlands in the study area and typically consists of mixed or uniform stands of *Triodia schinzii*, Annual Sorghum *Sorghum stipoideum*, Ribbongrass *Chrysopogon pallidus* and / or Northern Kerosene Grass *Aristida hygrometrica*.

Type 2: Creekline vegetation; moderately dense to open *Melaleuca viridiflora* woodlands over open mixed tall shrubs over mixed sedges, grasses and herbs.

This vegetation type is confined to comparatively small areas within the major low lying creek lines, wetlands and seepage areas of the Dampier Peninsula (*ecologia*, 2002) and was considered worthy of study as it is a distinct vegetation regime lacking any significant investigation. This vegetation type is located approximately 3 km outside of the eastern boundary of the proposed plantation. The creek line runs in a north to north-westerly direction toward Beagle Bay Inlet and delineates the border between the Pindan vegetation on red sandy loam soils to the west and the riverine vegetation on grey-white clays to the east. The plantation site itself is located near the eastern fringe of the transition zone between the two soil types. Further north and east of the creekline, the Pindan becomes more prominent again (*ecologia*, 2004a).

Whilst the coverage of the tree/shrub *Melaleuca viridiflora* varies locally from sparse to moderately dense, the shrub cover is generally sparse. Many familiar tree species from the Pindan also occur here, albeit in lower densities, and include *Brachychiton diversifolius*, *Acacia platycarpa*, and *Bauhinia cunninghamii*. At ground level there is a dense to moderately dense cover of *Triodia schinzii* and *Chrysopogon pallidus*, sedges and herbs. As might be expected, there are species which were only recorded within this habitat, including the herbs *Drosera derbyensis, Tephrosia remotiflora*, the sedge *Xyris complanata,* the grass *Thaumastochloa major* and the fern *Platyzoma microphyllum.*

Plate 5.1 Savannah woodlands (Pindan); *Eucalypt tectifica* / *Corymbia dampieri* dominated woodlands over open mixed tall shrubs over hummock and tussock grasslands.

Plate 5.2 Creekline vegetation; moderately dense to open *Melaleuca viridiflora* woodlands over open mixed tall shrubs over mixed sedges, grasses and herbs.

5.8.3 Significant Ecological Communities

The significance of the flora and vegetation of the project area has been assessed at three spatial scales; State, Regional and Local.

State Significance

State significance refers to those features of the environment that are recognised under State legislation as being of importance to the Western Australian community. It is based primarily on the presence of flora species protected under the WA *Wildlife Conservation Act* 1950. As no flora of Rare or Priority status was recorded within the plantation site, the conservation significance of the plantation at a State level is considered negligible.

There are no Threatened Ecological Communities (TECs) or other vegetation communities of conservation significance within the project area. There is a Priority Ecological Community located at Lolly Well Spring, approximately 12 km north of the plantation site. The significance of Lolly Well Spring is discussed in Section 6.2.

Regional Significance

Regional significance refers to the importance of a site at a biogeographic regional level. The plantation site is located within the Dampier Botanical District, which is broadly characterised by Pindan formation on sandplains (Beard, 1979). The reservation status of the bioregion is less than five percent which is comparatively low, with Pindan vegetation being particularly poorly represented. However, there is currently a proposal to create the Dampierland National Park, which would include the already existing Coloumb Point Nature Reserve, thereby significantly increasing the amount of Pindan vegetation reserved in the State's conservation estate (Tim Willing, CALM, pers. com.). Nevertheless, this

vegetation type is abundant throughout the Peninsula, and the magnitude of clearing associated with the project on a regional scale is considered to be small (See Table 5.3).

TABLE 5.3 REGIONAL PERCENTAGE OF VEGETATION LOSS AS A RESULT OF CLEARING FOR THE PROPOSED PLANTATION.

Region	Size	Percent loss
Beagle Bay Aboriginal Reserve	350 000 ha	0.26
Dampier Peninsula	14 000 km^2	<0.001
Dampier Botanical District	84 400 km^2	<0.001

Local Significance

Local significance refers to those species or vegetation associations that are poorly represented in the project area or hinterland, those with the capacity to support site-specific elements or those that are in better condition than other similar locations. As the development of the plantation has the potential to influence fire regimes, and given that fire is the controlling element affecting vegetation in the region, the control of fire will influence the local conservation value and significance of the area.

The vegetation of the plantation site is relatively undisturbed, with little evidence of cattle or feral animal grazing. With the exception of fire scars, there is also little sign of anthropogenic disturbances. Like much of the Dampier Peninsula, most areas surveyed have been exposed to fire within the last ten or more years. In the absence of fire, mature species of Pindan vegetation, such as *Acacia* spp. may be killed by overgrowth of mistletoe species, such as *Lysiana spathulata* and *Dendrophthoe alsophila* (Kenneally *et al*, 1996). However, when fires occur too frequently this can contribute to a decrease in species richness and diversity (McKenzie, 1983; Russell-Smith *et al*, 2003). Similarly, fires that are too intense (canopy scorching) also decrease diversity. Plate 5.3 shows the resultant effect of a late Dry season fire in 2001 near to the plantation site. It is pertinent to note the destruction of the middle level canopy and the inability of many mature trees to regenerate after such an intense fire.

Given the extent of habitat modification of the Dampierland biogeographic region, as a result of fire and other historic variables (natural and non-natural), there is little or no opportunity to create the pre-European landscape, the components of which are not even well documented (Start, 2003). Therefore, the present landscapes should be viewed as worthy of as much conservation as the traditional landscapes might have been. Conservation objectives should target the preservation of the biodiversity that is present, rather than aimed at the re-creation of historic vegetation assemblages (Start, 2003).

The fire-regeneration cycle in Pindan generally spans five to seven years, and if a low to moderate fire regime (4 – 7 years) is maintained in a tropical savannah, woody vegetation will remain structurally stable (Russell-Smith *et al*, 2003; Start, 2003; Williams *et al*, 2003). Opportunities for fire management exist for the plantation site and it is feasible to achieve the five to seven-year fire regeneration cycle, with localised fires occurring only during the Wet season to reduce intensity. When fire is retarded and the intensity is minimised, the vigour of vegetation structure at all strata levels best represents the pre-European landscape (Plate 5.4).

5.9 Flora

5.9.1 Flora of the Region

A total of 122 families, 361 genera and 717 species have been recorded within the Dampier Peninsula by Kenneally *et al.* (1996). The total number of taxa does not include the unknown taxa, which have only been identified to family level. The majority of these unknown taxa are short lived species which, depending on the seasonal conditions, pose difficulties in the identification phase.

Plate 5.3 Growth and structure of vegetation three years after an intense late Dry season fire.

Plate 5.4 Pindan vegetation 3 years after low intensity fire, illustrating the well developed and vigorous mid storey and ground storey vegetation.

Surveys have been conducted from Roebuck Station extending north of the Great Northern Highway throughout the Dampier Peninsula, inclusive of the project area. The best represented families within the Peninsula were Poaceae (84 species), Papilionaceae (50 taxa), Cyperaceae (36 taxa) and Euphorbiaceae (30 taxa). In the wider Kimberley Region, Wheeler (1992) identified Poaceae (259 taxa), Papilionaceae (164 taxa), Cyperaceae (156 taxa) and Mimosaceae (103 taxa) as the dominant families.

If a comparison is made of the respective locations of floristic surveys in the region it is apparent that the total number of taxa found at each locality increases as the total area surveyed increases (see Table 5.4). Direct comparisons cannot be applied rigorously because of the variation in survey intensity and seasonal timing.

TABLE 5.4 FLORA TAXA AND SURVEYS WITHIN THE REGION

Survey Area	Data Source	Area covered	No. of Taxa*
Lease Option Area & surrounds	*ecologia*	6000 ha	204
Trial plantation site	CALM	25 ha	53
Bobby's Creek wetlands	*ecologia*	~ 46 km^2	267
Beagle Bay to Cape Leveque Road	*ecologia* (2002)	~ 100 km^2	226
Dampier Peninsula	Kenneally *et al* (1996)	~ 14,000 km^2	717
Kimberley Region	Wheeler *et al.* (1992)	~ 300,000 km^2	1,046

* excluding unidentified taxa

5.9.2 Flora in the Project Area

A total of 203 taxa of vascular flora from 56 families and 117 genera were collected during the study of the Lease Option Area and surrounds (Appendix C). However ten of these taxa were recorded solely in the *Melaleuca* woodland external to the site, resulting in a total inventory for the plantation of 193 taxa. An additional five collections could not be identified beyond family level and 12 collections could not be identified beyond genus level due to the absence of reproductive parts.

The likelihood of any of these unidentified taxa being of rare or priority status is considered negligible, as there are proportionally few taxa of conservation significance within the Dampier Peninsula (see Table 5.5 below).

TABLE 5.5 PROPORTION OF SIGNIFICANT TAXA WITHIN THE DAMPIER PENINSULA FOR EACH UNIDENTIFIED COLLECTION.

Unidentified collection	Total taxa	Significant taxa	Weed taxa	Proportion of priority taxa
Ptilotus sp.	39	0	0	0
Heliotropium sp.	21	0	0	0
Bonamia sp.	5	0	0	0
Ipomoea sp.	17	0	5	0
Polymeria sp.	2	0	0	0
Phyllanthus sp.	8	1	0	0.125
Haemodorum sp.	1	0	0	0
Sida sp	10	0	0	0
Acacia sp.	71	0	0	0
Themeda sp.	2	0	1	0
Corchorus sp.	10	0	1	0

The most numerously represented families were Papilionaceae (20 species), Poaceae (19 species) and Convolvulaceae (9 species); whilst the most numerously represented genera were *Crotalaria*, *Tephrosia* and *Grevillea* (each with 5 species). Twenty-three families and 69 genera were represented by a single species.

5.9.3 Introduced Flora

Some high Priority weeds that are, or have the potential to become, pests to agriculture can be formally declared under the *Agriculture and Related Resources Protection Act, 1976* (ARRP Act). Weeds listed under the Act are listed with a coded definition of the requirements for control. There are five Priority groupings, and more than one Priority may be placed on a weed species. An explanation of the codes is included in Table 5.6.

No weed species have been recorded from within the proposed plantation site or from within the trial plantation site. Twelve weed species have been recorded from within the Bobby's Creek complex to the north of the plantation site (*ecologia* 2004b; See Appendix F). Two of these species are listed as Declared Weeds under the ARRP Act, and are discussed in further detail below. The locations of all weed species are included in Table 5.7 and Figure 5.9 a & b.

**Parkinsonia aculeata* (Caesalpiniaceae), commonly referred to as Parkinsonia, is a native of tropical America. It is a perennial shrub or small tree growing up to 8 metres high. It usually has only a single stem but it may form branches close to the base following mechanical damage. It produces bright yellow flowers predominantly during May and June. This species is listed as P1 and P4 for the municipal

districts of Broome, Derby-West Kimberley, Halls Creek and Wyndham-East Kimberley. This declaration prohibits the movement of plants or seeds and aims to prevent the infestation spreading from within the existing boundaries.

TABLE 5.6 EXPLANATION OF CODES FOR DECLARED WEEDS IN WESTERN AUSTRALIA.

Priority	Requirements
P1 Prohibits movement	The movement of plants or their seeds is prohibited within the State. This prohibits the movement of contaminated machinery and produce including livestock and fodder.
P2 Aim is to eradicate infestation	Treat all plants to destroy and prevent propagation each year until no plants remain. The infested area must be managed in such a way that prevents the spread of seed or plant parts on or in livestock, fodder, grain, vehicles and/or machinery.
P3 Aims to control infestation by reducing area and/or density of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set for all plants:- • Within 100 metres inside of the boundaries of the infestation. • within 50 metres of roads and high-water mark on waterways. • within 50 metres of sheds, stock yards and houses. • Treatment must be done prior to seed set each year. Of the remaining infested area:- • Where plant density is 1-10 per hectare treat 100% of infestation. • Where plant density is 11-100 per hectare treat 50% of infestation. • Where plant density is 101-1000 per hectare treat 10% of infestation. Properties with less than 2 hectares of infestation must treat the entire infestation. Additional areas may be ordered to be treated.
P4 Aims to prevent infestation spreading beyond existing boundaries of infestation	The infested area must be managed in such a way that prevents the spread of seed or plant parts within and from the property on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set all plants:- • within 100 metres inside of the boundaries of the infested property • within 50 metres of roads and high-water mark on waterways • within 50 metres of sheds, stock yards and houses • Treatment must be done prior to seed set each year. Properties with less than 2 hectares of infestation must treat the entire infestation. Additional areas may be ordered to be treated. Special considerations: In the case of P4 infestations where they continue across property boundaries there is no requirement to treat the relevant part of the property boundaries as long as the boundaries of the infestation as a whole are treated. There must be agreement between neighbours in relation to the treatment of these areas.
P5	Infestations on public lands must be controlled

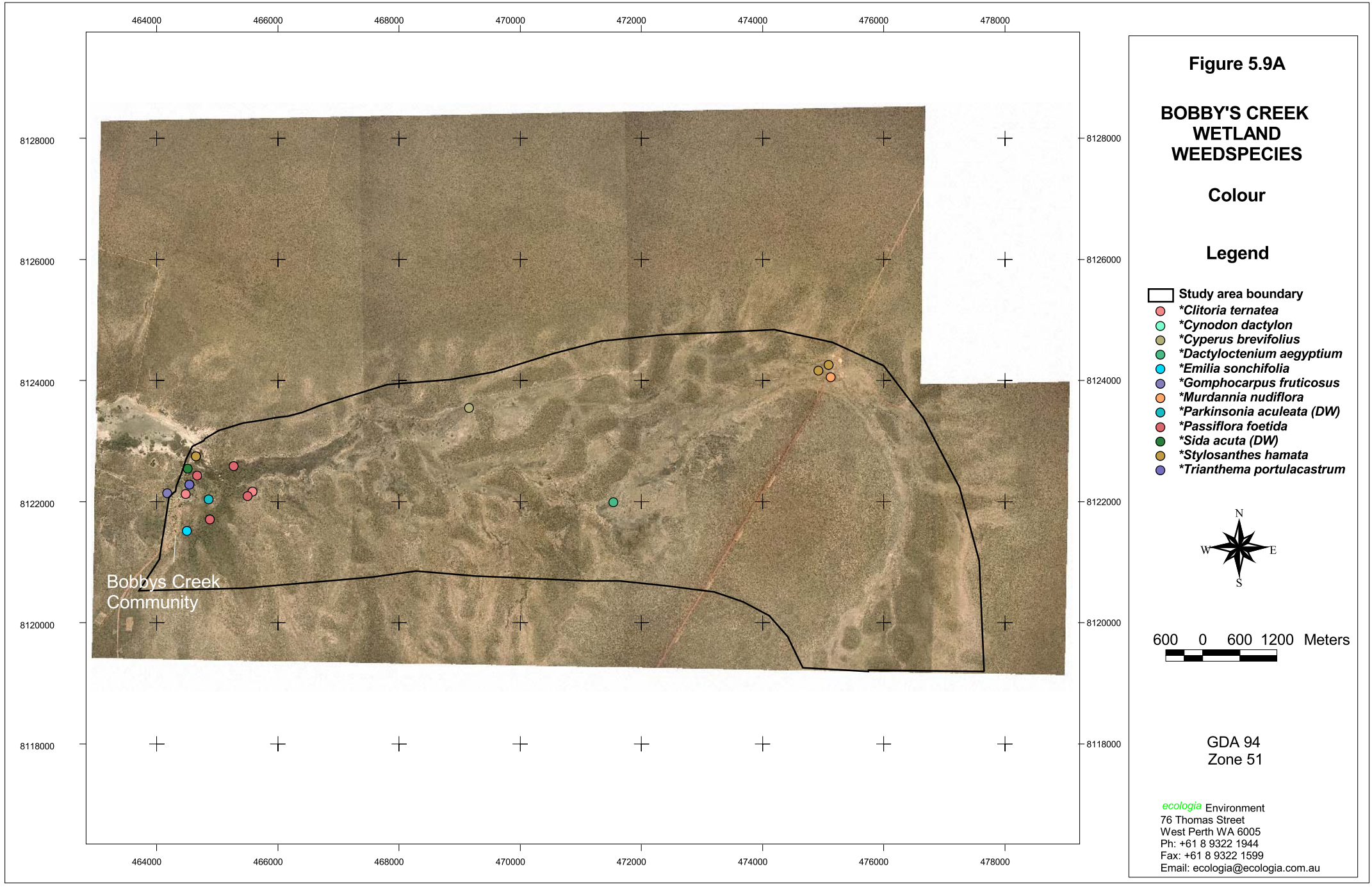


Figure 5.9A

BOBBY'S CREEK WETLAND WEEDSPECIES

Colour

Legend

- Study area boundary
- **Clitoria ternatea*
- **Cynodon dactylon*
- **Cyperus brevifolius*
- **Dactyloctenium aegyptium*
- **Emilia sonchifolia*
- **Gomphocarpus fruticosus*
- **Murdannia nudiflora*
- **Parkinsonia aculeata (DW)*
- **Passiflora foetida*
- **Sida acuta (DW)*
- **Stylosanthes hamata*
- **Trianthema portulacastrum*

N
W E
S

600 0 600 1200 Meters

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

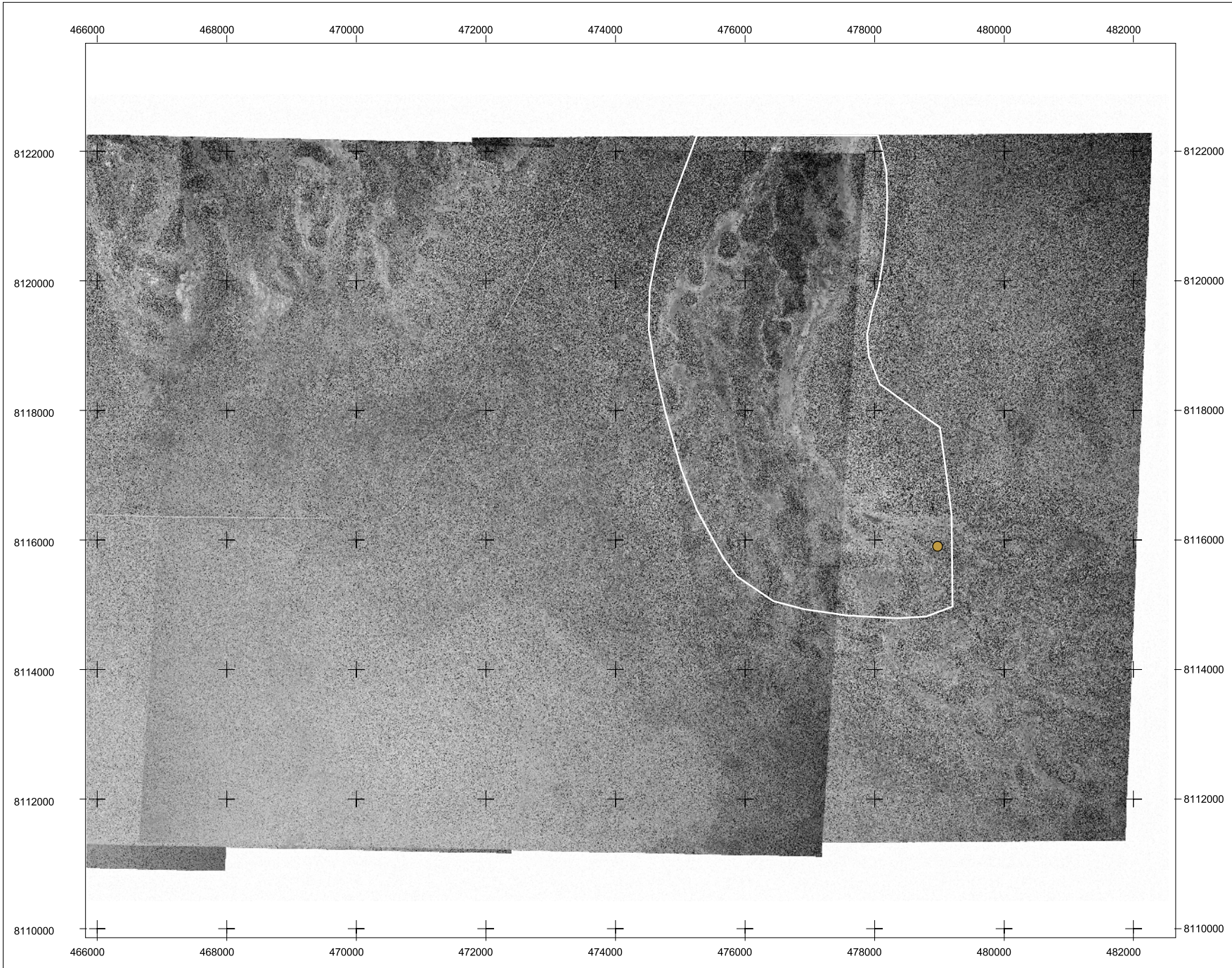


Figure 5.9B

BOBBY'S CREEK WETLAND WEED SPECIES

Black and White

Legend

- Study area boundary
- **Clitoria ternatea*
- **Cynodon dactylon*
- **Cyperus brevifolius*
- **Dactyloctenium aegyptium*
- **Emilia sonchifolia*
- **Gomphocarpus fruticosus*
- **Murdannia nudiflora*
- **Parkinsonia aculeata (DW)*
- **Passiflora foetida*
- **Sida acuta (DW)*
- **Stylosanthes hamata*
- **Trianthema portulacastrum*

N
W E
S

600 0 600 1200 Meters

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

**Sida acuta* (Malvaceae) is a sparsely branched annual shrub up to 1.5 metres tall with fibrous stems. It produces yellow inconspicuous flowers between February and April which are borne on short stalks (peduncles) in leaf axils. The fruit is dark brown; it splits into six to ten single seeds with two sharp awns at the top of each seed. This species is believed to have originated in America, but is now found throughout the warm regions of the world. This species is listed as P1 for all areas of Western Australia north of the 26th parallel. This declaration means that the movement of plants or their seeds is prohibited under the ARRP Act.

TABLE 5.7 WEED SPECIES RECORDED WITHIN THE VICINITY OF BEAGLE BAY

Species	Declared Weed (y/n)	No. populations
**Clitoria ternatea*	n	2
**Cynodon dactylon*	n	1
**Cyperus brevifolius*	n	2
**Dactyloctenium aegyptium*	n	1
**Emilia sonchifolia*	n	2
**Gomphocarpus fruticosus*	n	1
**Murdannia nudiflora*	n	1
**Parkinsonia aculeata*	y	1
**Passiflora foetida*	n	4
**Sida acuta*	y	2
**Stylosanthes hamata*	n	4
**Trianthema portulacastrum*	n	1

* Percent coverage of a 50 x 50 m quadrat

5.10 Rare & Priority Flora

5.10.1 Environment Protection and Biodiversity Conservation Act

At a National level, some flora are protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Act contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Extinct or Extinct in the Wild (Table 5.8).

TABLE 5.8 DEFINITION OF CATEGORIES DESCRIBED UNDER THE EPBC ACT.

Conservation Category	Description
Extinct	A species is extinct if there is no reasonable doubt that the last member of the species has died.
Extinct in the wild	A species is categorised as extinct in the wild if it is only known to survive in cultivation, in captivity or as a naturalised population well outside its past range; or if it has not been recorded in its known/expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
Critically Endangered	The species is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.
Conservation Dependent	The species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

5.10.2 WA Wildlife Conservation Act

Whilst all native flora are protected under the *Wildlife Conservation Act 1950-1979,* a subset of flora are also protected under the *Western Australian Wildlife Conservation (Rare Flora) Notice 2004* of the *Wildlife Conservation Act 1950*. The Notice lists protected flora taxa that are extant and considered likely to become extinct or rare. Priority species are maintained on a "Reserve List", which is reviewed on an annual basis, and assigned to one of four Priority categories (Atkins, 2004). Definitions of categories of Declared Rare Flora (DRF) and Priority Flora are provided in Table 5.9.

TABLE 5.9 DEFINITION OF DECLARED RARE AND PRIORITY FLORA CATEGORIES

Code:	**Definition**
DRF	Declared Rare Flora - Extant Taxa. Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection.
1: Priority One	Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat.
2: Priority Two	Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat.
3: Priority Three	Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under immediate threat.
4: Priority Four	Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.

(From Atkins, K.J., Declared Rare and Priority Flora List 2004, CALM)

5.10.2.1 Potential Rare and Priority Flora in a Regional Context

A search of CALM databases for Rare and Priority Flora potentially occurring within the Dampier Peninsula area was undertaken as part of the *ecologia* (2002) survey. One DRF species and 13 Priority taxa (Table 5.10) were identified. None of these species were recorded from within the project area during recent *ecologia* surveys (2004a).

TABLE 5.10: NUMBERS OF DECLARED RARE FLORA AND PRIORITY FLORA THAT POTENTIALLY OCCUR IN THE DAMPIER PENINSULA AND PROJECT AREA

Category	Dampier Peninsula			Project area* No. of taxa
	Code	No. of taxa (potential)	No. of taxa (recorded)#	
Declared Rare Flora	R	2	1	
Priority 1	P1	3	2	
Priority 2	P2	2	2	
Priority 3	P3	7	4	1 (not within the lease option area itself)
Priority 4	P4	1	-	
TOTAL PRIORITY FLORA		13	1	
TOTAL DRF and Priority Flora		15	2	

ecologia survey (2002);
*Project area is defined as the Lease Option Area and the immediate surrounds

5.10.2.2 Rare and Priority Flora in a Local Context

Twelve taxa of conservation significance have been recorded within the Dampier Peninsula, of which four taxa have been previously recorded in the vicinity of Beagle Bay. These species are listed in Table 5.11 below.

TABLE 5.11 PRIORITY TAXA PREVIOUSLY RECORDED IN THE VICINITY OF THE BEAGLE BAY COMMUNITY.

Species	Priority	Location	Flowering Period
Aphyllodium glossocarpum	P3	Beagle Bay	
Glycine Pindanica	P1	15 km NNE of Beagle Bay Community	Feb-Apr
Nymphoides beaglensis	P2	Bobby's Creek near Beagle Bay	Apr-Aug
Stylidium costulatum	P3	4 km E of Beagle Bay Community	

No DRF or Priority taxa as listed in the Department of Conservation and Land Management Wildlife Conservation (Rare Flora) Schedule 2004 were collected within the proposed plantation site. However a single specimen of the Priority 3 *Phyllanthus aridus* was recorded approximately 100 metres to the east of the plantation site (51K 0472573, UTM 8115197). Six Priority flora species have been recorded from within the vicinity of Bobby's Creek to the north of the plantation site (see Section 5.11.3 below).

Phyllanthus aridus is an erect, much-branched shrub growing to 0.25 m high with cream-green flower between May and June. It is commonly recorded on sandstone, gravel and red sand (FloraBase, 2004). It has previously been recorded at West Kimberley, Chichester Range, West Angelas, Pardoo, Shay Gap, Doongan Homestead and Durack River (Atkins, 2004), thus showing a broad distribution in the Kimberleys and a more sporadic occurrence in the Pilbara.

Although not recorded within the project area, the proximity of the collection to the eastern boundary means that its presence within the area cannot be unequivocally rejected.

5.10.3 Other species of Conservation Value

None of the vascular flora species recorded within the proposed plantation site have been recognised as being of significant conservation interest.

5.11 Priority Ecological Communities

To the north of the plantation lies the Bobby's Creek wetland system. The close proximity of these wetlands to the plantation combined with their dependence on the groundwater table indicates that these community types may be potentially impacted by drawdown of groundwater from abstraction for plantation requirements. Consequently, a flora and vegetation survey of this area was undertaken by *ecologia* in June 2004 (*ecologia* 2004b). Detailed below are the results of this survey.

5.11.1 Survey Methodology

The survey was conducted by one botanist between the 10th and 20th June 2004. The survey combined the following two basic methodological approaches:

(i) detailed site/association assessments; and
(ii) broad-scale vegetation mapping.

In addition, opportunistic collections and transects were carried out to confirm plant community boundaries and to search for additional species.

Six permanent quadrats were marked for future monitoring.

The survey area was centred around Bobby's Creek, north of the plantation lease area adjacent to the BBC. The western most point was the Beagle Bay causeway and the eastern most point was located approximately 11 km along Bobby's Creek on the east side of Bobby's Crossing. In total the survey area was approximately 23 km long and 2 - 4 km wide.

5.11.2 Flora

Two hundred and sixty eight taxa from 69 families and 170 genera were recorded during the survey (Appendix C). Seventeen taxa could not be identified beyond genus level due to the lack of reproductive material.

The most numerously represented families were Poaceae (47 taxa), Cyperaceae (39 taxa) and Papilionaceae (24 taxa), while the most common genera were *Fimbristylis* (14 taxa) and *Cyperus* (12 taxa). Thirty three families were represented by a single taxon. The number of sedges (Cyperaceae) is particularly high and is attributed to the specific habitat types surveyed (damplands).

5.11.3 Priority Flora

Four species of Priority status have previously been collected in the vicinity of the BBC (Table 5.11).

During the flora survey of the Bobby's Creek wetland system, three of the Priority taxa listed in Table 5.11 (above) were recorded. An additional three Priority species were recorded, all of which are discussed below. The locations of all Priority species recorded are included in Table 5.12 and Figure 5.10 a & b.

Aphyllodium parvifolium (Papilionaceae) – Priority 1, is a small spreading prostrate shrub growing to 10 cm in height (Paczkowska and Chapman 2000). This species has previously been collected from Barred Creek (approx. 30 km north of Broome), Broome and from the McLarty Hills in the Great Sandy Desert (Atkins 2004, Kenneally *et al.* 1996). It was recorded at one location (Table 5.12) within the survey area.

Gomphrena pusilla (Amaranthaceae) – Priority 2, is a small annual herb which is semi-prostrate or sprawling and grows up to 20 cm high. This species has previously been recorded from Cable Beach and Barred Creek on the Dampier Peninsula and Port Hedland (Atkins 2004, Kenneally *et al.* 1996). The type locality for this species is Foul Point in the Pilbara. It was recorded at one location (Table 5.12) within the survey area.

Nymphoides beaglensis (Menyanthaceae) – Priority 2, commonly called Beagle Bay Marshwort, is a floating aquatic plant that is commonly rooted in mud at the edge of pools (Kenneally *et al.* 1996). Current data suggest that this species is endemic to the Dampier Peninsula (Atkins 2004, Kenneally *et al.* 1996). This species was recorded from three locations during the current survey (Table 5.12) all of which were seasonal pools or wetlands on the flood plain on a dark brown to black clay based substrate.

Aphyllodium glossocarpum (Papilionaceae) – Priority 3, is an erect or spreading shrub which grows up to two metres. It occurs on sand in Pindan vegetation. This species is believed to be restricted to the Dampier Peninsula, with collections from Beagle Bay and Brunswick Bay (Atkins 2004, Kenneally *et al.* 1996). During the current survey this species was recorded on white sand in riparian vegetation on a broad creek flood bank (Table 5.12).

Triodia acutispicula (Poaceae) – Priority 3, is a tussock-forming resinous perennial grass that grows to heights of 0.5–1.5 m high. It is restricted to the Kimberley, but has a wide ranging distribution within this area having previously been recorded at Drysdale River, Cape Leveque, Derby, Prince Regent River, Beverley Springs Station and the Mitchell Plateau (Atkins 2004). It was recorded at three locations (Table 5.12) within the survey area.

Stylidium costulatum (Stylidiaceae) – Priority 3, is a slender reddish plant growing to 30 cm in height (Kenneally *et al.* 1996). This species is restricted to the Kimberley with records from Coulomb Point Nature Reserve, Wonganut Spring, Beagle Bay, Beverley Springs Station and Mt Barnett Station (Atkins 2004, Kenneally *et al.* 1996). Within the survey area it was recorded opportunistically from three locations (Table 5.12).

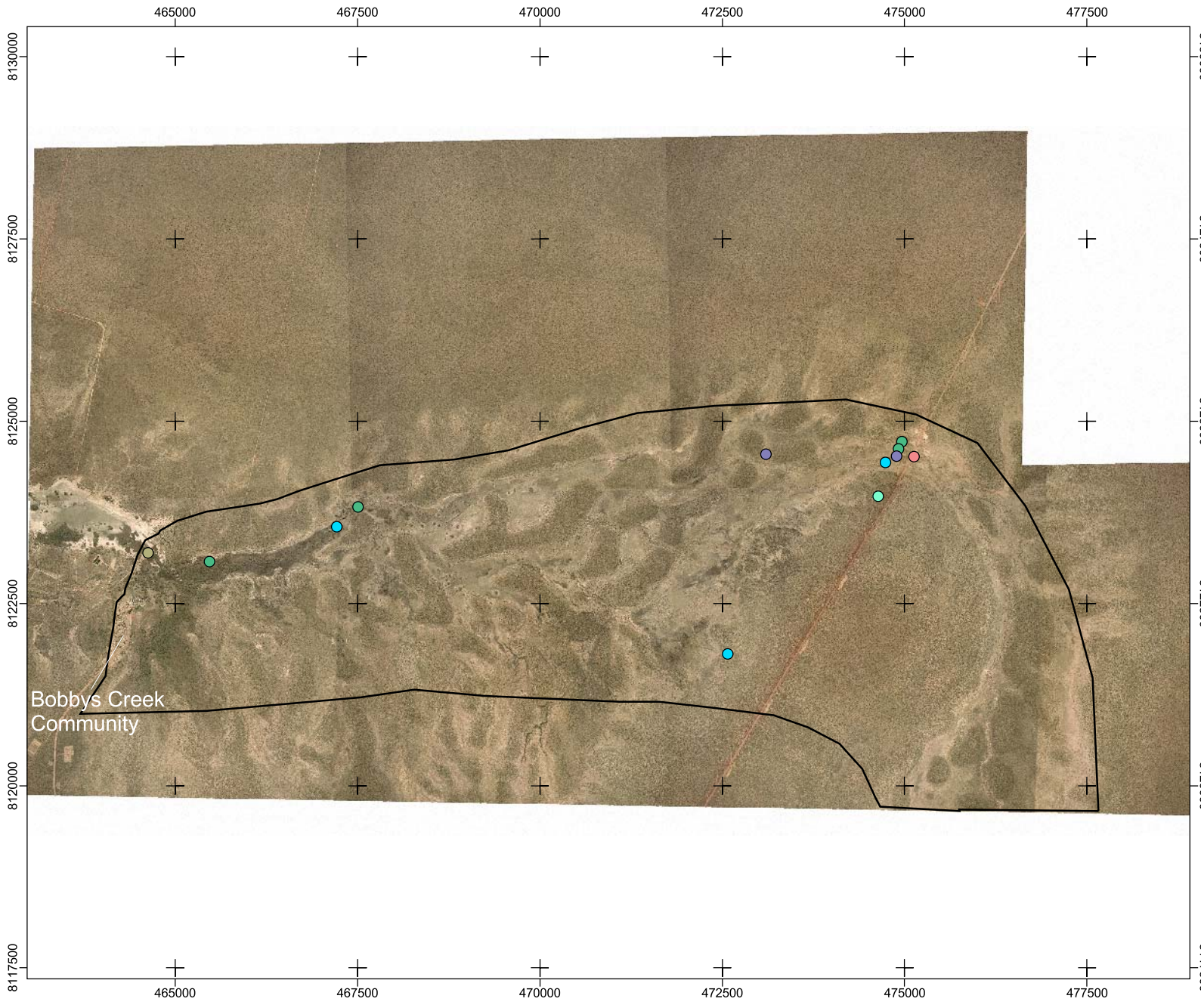


Figure 5.10A

BOBBY'S CREEK WETLAND PRIORITY SPECIES

Colour

Legend

- Study area boundary
- *Aphyllodium glossocarpum*
- *Aphyllodium parvifolium*
- *Gomphrena pusilla*
- *Nymphoides beaglensis*
- *Stylidium costulatum*
- *Triodia acutispicula*

N
W E
S

600 0 600 1200 Meters

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

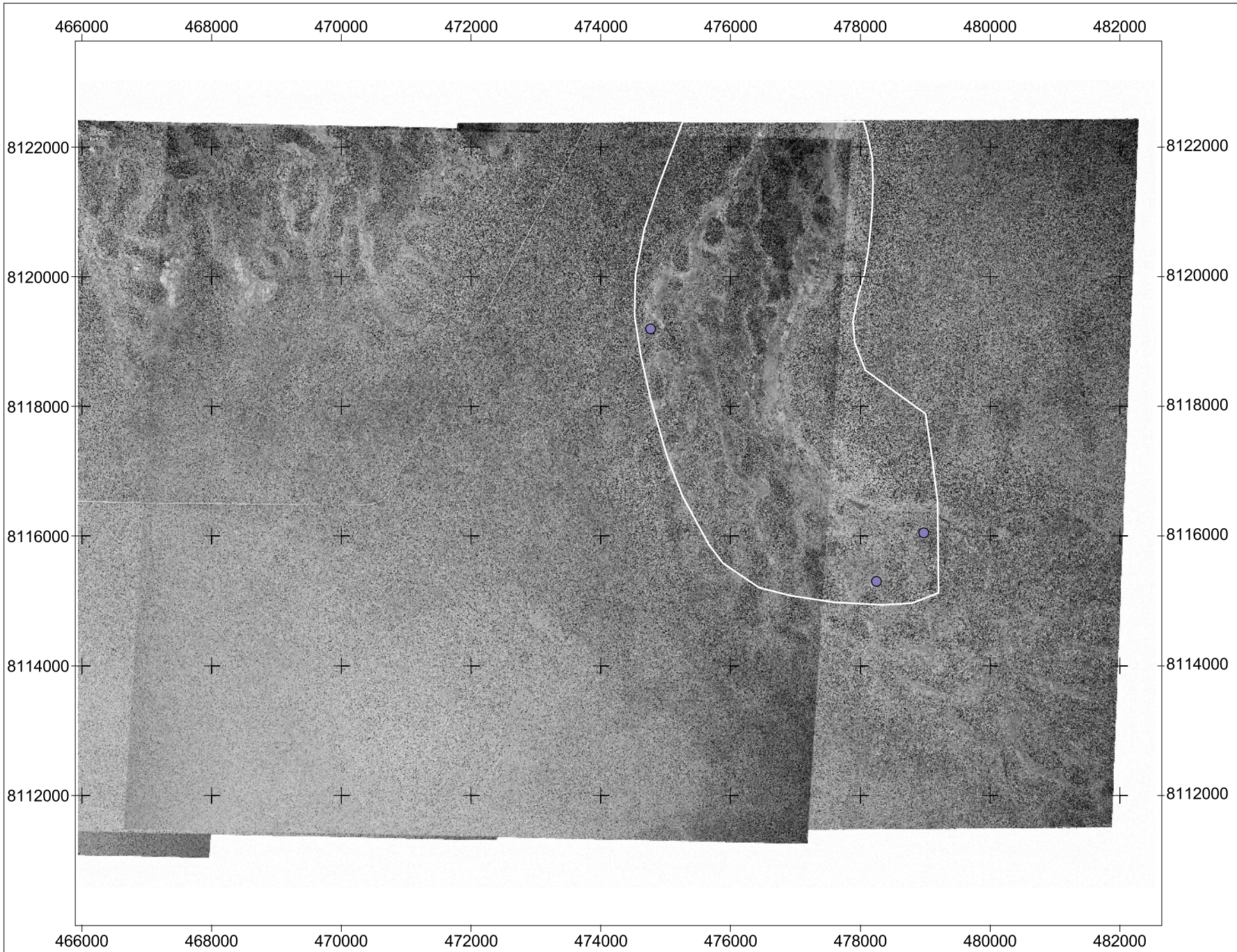


Figure 5.10B

BOBBY'S CREEK WETLAND PRIORITY SPECIES

Black and White

Legend

- Study area boundary
- *Aphyllodium glossocarpum*
- *Aphyllodium parvifolium*
- *Gomphrena pusilla*
- *Nymphoides beaglensis*
- *Stylidium costulatum*
- *Triodia acutispicula*

N
W E
S

1 0 1 2

Kilometers

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

TABLE 5.12 LOCATIONS OF PRIORITY FLORA

Species	Priority	Density*	Location (GDA 94)	
			Eastings	Northings
Aphyllodium parvifolium	1	<2 %	51K 4754643	8123963
Gomphrena pusilla	2	<10 %	51K 464621	8123191
Nymphoides beaglensis	2	<10 % <10 % <1 % <10 %	51K 474913 51K 467504 51K 465463 51K 474959	8124614 8123821 8123068 8124711
Aphyllodium glossocarpum	3	<2 %	51K 475122	8124506
Triodia acutispicula	3	10-30 % 2-10 % <2 % 10-30 %	51K 474881 51K 478311 51K 478969 51K 473093	8124514 8115790 8116043 8124543
Stylidium costulatum	3	<10 % <1 % <10 %	51K 474732 51K 467212 51K 472570	8124427 8123543 8121801

* Density is percent coverage of a 50 m x 50 m quadrat.

5.11.4 Vegetation Overview

Low-lying sandplains occur in the northern section of the Peninsula, which are associated with broad sub-coastal drainage valleys and seasonally swampy areas. The following dampland areas occur within the vicinity of Beagle Bay:

(i) **Low sandplains** – comprising dark alluvium over clay substrate supporting a grassplain of *Chrysopogon* spp. with scattered thickets of *Melaleuca alsophila* and sometimes *Verticordia verticillata*;

(ii) **Open pools of freshwater** – supports large groves of *Melaleuca cajuputi* and *M. viridiflora* and aquatic species such as *Nymphaea violacea, Nymphoides indica* and *N. beaglensis*; and

(iii) **Mound springs** – these may rise as much as two metres above the surrounding plains and typically support large fern colonies of *Cyclosorus interruptus* and *Lygodium microphyllum*, which occur within of vicinity Bunda Bunda (Kenneally *et al.* 1996).

5.11.5 Vegetation of the Survey Area

The aim of the survey was to assess the vegetation of the survey area with regard to likely dependency on groundwater. As such, the following vegetation descriptions are described as “wetland” (perennial groundwater dependence), “terrestrial” (seasonal groundwater dependence) or “Pindan” (minimal to no groundwater dependence).

Wetland vegetation typically included a *Melaleuca* (typically *Melaleuca cajuputi*) open to closed forest over sedges and grasses associated with a wet habitat or sedgelands and sedgeland/grasslands, including fringing vegetation around (probably) seasonal damplands. Wetland vegetation was classified as 'mound spring' vegetation for the purposes of this survey where the wetland vegetation type occurred in typically small areas, often only 10 to 20 metres in diameter, with a *Melaleuca* open forest over sedges and wetland grasses that typically grew around a central shallow pool of water. Sometimes a 'moat' was

evident where the central area was elevated due to vegetation deposition. Discrete 'mound spring' units became difficult to differentiate in areas where expansive areas of apparently spring fed closed to open *Melaleuca* forest over sedgeland and fernlands occurred (in the lower reaches of Bobby's Creek near Beagle Bay).

Vegetation in the area was classified as 'terrestrial' if it was likely to have at least seasonal dependency on ground water, indicated by the presence of Melaleuca scattered trees to woodlands over flood plains of grasses such as Chrysopogon sp.[1] and by the absence of sedgelands. Other related flood plain vegetation types were also included in this unit as was neighbouring vegetation on low sandy rises or sand plains where Melaleuca tree species were present.

Vegetation that occurred on the 'islands' of elevated low sandy rises on the Bobby's Creek flood plain and that did not have the likely ground water dependent species such as Melaleuca tree species and sedges, were classified as 'Pindan-related', although the actual ground water dependency status of this vegetation type in the survey area is not known.

Bobby's creek consists of a narrow creekline, sometimes cutting up to 2 metres in depth into the surrounding flood plain. The creek flows seasonally and was not flowing at the time of the survey in June 2004. The creek meanders across the floodplain and often does not have a distinctive vegetation unit associated with it. In places, seasonal dampland vegetation (see above) occurs in the creek bed.

5.11.6 Mapping Units

The vegetation of the survey area is mapped in Figures 5.11 a - h. Listed below are descriptions of the vegetation communities and sub-communities occurring within the survey area.

(1) WETLAND VEGETATION

Wetland vegetation units are classified as Mound Springs (MS) or wetland (W) units as described above.

(1A) Mound Springs

MS *Melaleuca cajuputi, Melaleuca viridiflora* moderately dense forest over *Timonius timon* sparse trees over *Pandanus spiralis* and *Acacia neurocarpa* scattered to sparse low trees over *Cyperus haspan, Fimbristylis nutans, Fimbristylis blakei* and *Fuirena ciliaris* closed sedgeland.

MSa *Melaleuca viridiflora* closed low woodland over *Chrysopogon* sp. sparse grasses and *Fimbristylis cymosa* scattered sedges, surrounded by a 3 metre wide strip of *Melaleuca graminea* low woodland.

(1B) Melaleuca open to closed forest over sedgelands (fernlands)

W1 *Melaleuca cajuputi* moderately dense forest over *Eleocharis sundaica* and *Cyperus haspan* closed sedgeland with *Merremia hederacea* scattered lianes.

W1a *Melaleuca cajuputi* moderately dense forest over *Eleocharis sundaica* closed sedgeland.

W1b *Melaleuca cajuputi* closed forest over *Timonius timon* scattered low trees over *Cyclosorus interruptus* closed fernland, *Eleocharis ?sundaica*, (*Fuirena umbellata*) moderately dense sedgeland and *Philydrum lanuginosum* scattered herbs.

[1] All collections of *Chrysopogon* sp. are the same species and are either *C. pallidus* or *C. fallax*; however at the time of survey all collections were sterile and therefore it was not possible to conclusively identify this species.

W1c *Melaleuca cajuputi* high closed forest over *Cyperus polystachyus*, *Fimbristylis ferruginea* moderately dense sedgelands with *Gymnanthera oblonga*, *Cynanchum carnosum* sparse lianes.

(1C) Sedgelands

W2 *Eleocharis* sedgelands.

W2a *Melaleuca graminea* sparse low trees over moderately dense sedgeland.

(1D) Grasslands/ Sedgelands

W3 Low lying areas dominated by grass and sedge species.

W3a *Melaleuca cajuputi* moderately dense forest over *Imperata cylindrica*, *Themeda* sp. closed grassland with small areas of *Eleocharis* sedgeland.

W3b *Melaleuca cajuputi* scattered trees over *Eriachne pauciflora* closed grassland and *Eleocharis sundaica* closed sedgeland.

W3c *Melaleuca alsophila* scattered low trees over *Eriachne glauca*, *Bothriochloa bladhii* subsp. *bladhii* closed grassland/sedgeland.

W3d *Melaleuca cajuputi* scattered trees to open forest over *Sesbania cannabina* scattered shrubs over *Cyperus* sp. closed sedgeland.

W3e *Melaleuca cajuputi* moderately dense forest over *Melastoma affine* scattered low trees over *Acacia neurocarpa* scattered tall shrubs over closed grassland with *Cyperus polystachyus* scattered sedges.

W3f *Melaleuca alsophila* moderately dense low forest over *Fuirena umbellata*, *Eleocharis ochrostachyus* and *Fimbristylis blakei* closed sedgeland.

(1E) Melaleuca scattered trees over sedgelands fringing ephemeral fresh water pools.

W4 *Melaleuca viridiflora*, *Melaleuca alsophila* scattered low trees over *Eleocharis sundaica*, *Cyperus bifax* closed sedgeland with *Nymphoides beaglensis*, *Rotala diandra* sparse herbs to open herbland and *Marsella hirsuta* sparse ferns.

W4a *Nymphaea violacea* sparse herbs and sedge *Schoenoplectus litoralis* moderately dense to closed sedgeland (near banks) fringed by *Melaleuca graminea* low open woodland over *Lumnitzera racemosa* moderately dense mangroves over *Fimbristylis ferruginea*, *Cyperus* sp. moderately dense sedgeland and *Xerochloa imberbis* sparse grasses.

(1F) Seasonal damplands

W5 *Chamaecrista mimosoides* scattered shrubs over *Eleocharis sundaica* sparse to open sedgeland over *Marsella hirsuta* sparse ferns to open fernland and *Rotala diandra*, *Nesaea stratiflora* and *Nymphoides beaglensis* low herbland and *Eriocaulon cinereum* and *Cyperus breviculmis* sparse sedges.

W5a *Melaleuca alsophila* sparse trees over *Xerochloa imberbis* moderately dense grassland.

(II) TERRESTRIAL VEGETATION

(2A) Scattered Melaleuca alsophila over Chrysopogon sp. grasslands.

T1 *Melaleuca alsophila* scattered low trees over *Chrysopogon* sp. moderately dense grassland with *Calandrinia quadrivalvis*, *Gomphrena canescens* subsp. *canescens*, *Synaptantha scleranthiodes* sparse herbs.

T1a *Melaleuca graminea* scattered low trees over *Xerochloa imberbis* and *Digitaria bicornis* closed grasslands.

(2B) Melaleuca viridiflora moderately dense low woodlands over grasslands

T2 *Melaleuca viridiflora* moderately dense woodland over *Chrysopogon* sp., *Aristida hygrometrica* and *Panicum seminudum* open grassland with *Gomphrena* canescens subsp. *canescens* open herbland.

(2C) Corymbia/ Eucalyptus scattered to sparse trees over grasslands

T3 *Corymbia polycarpa, Corymbia bella* sparse open woodland over *Chrysopogon* sp. moderately dense grassland.

T3a *Eucalyptus tectifica* sparse low woodland over *Bauhinia cunninghamii* scattered low trees over *Chrysopogon* sp., *Eragrostis cumingii* and *Xerochloa imberbis* closed grassland.

T3b *Corymbia polycarpa*, *Corymbia flavescens* low open woodland over *Acacia neurocarpa* scattered trees over grass *Heteropogon contortus* closed grassland.

T3c *Corymbia polycarpa*, *Corymbia flavescens* sparse woodland over *Acacia neurocarpa* moderately dense low woodland over *Heteropogon contortis* sparse grasses.

(2D) Melaleuca scattered trees to low open woodland on edge of sand plain adjacent to Bobby's Creek floodplain

T4 *Melaleuca viridiflora, Corymbia polycarpa* and *Corymbia flavescens* sparse low woodland over *Planchonia careya* scattered low trees over *Acacia tumida* var. *tumida* open high shrubland over *Waltheria indica* open shrubland over *Chrysopogon* sp. and *Eriachne obtusa* moderately dense grassland.

T5 *Eriachne glaucha*, *Xerochloa imberbis* grassland with *Polycarpaea breviflora* sparse herbs and *Fimbristylis blakei*, *Fimbristylis acicularis* sparse sedges.

T6 *Eriachne glaucha*, **Cynodon dactylon* closed grassland.

(2E) Pandanus spiralis sparse low trees on the edge of the floodplain

T7 *Corymbia flavescens* and *Acacia tumida* scattered low trees over *Melaleuca viridiflora* and *Verticordia verticillata* scattered low trees over *Pandanus spiralis* open high shrubland over *Chrysopogon* sp, *Triodia acutispicula* and *Schizachyrium fragile* grassland.

(2F) Creek bank vegetation

T8 *Melaleuca alsophila*, *Melaleuca viridiflora* and *Acacia tumida* moderately dense low forest over *Perotis rara* and *Eriachne salcata* moderately dense grassland and *Fuirena ciliaris* sparse sedges.

(III) PINDAN TYPE VEGETATION

P *Corymbia polycarpa, Corymbia flavescens* and *Acacia tumida* var. *tumida* open woodland over *Waltheria indica* sparse shrubs over *Chrysopogon* sp. moderately dense grassland with *Gomphrena canescens* subsp. *canescens, Spermacoce auriculata* and *Ptilotus lanatus* var. *lanatus* sparse to open herbland.

5.11.7 Conservation Significance

Six species listed as Priority under the WA *Wildlife Conservation Act 1950* were recorded within the survey area. Given the relatively small survey area (approximately 46 km^2), this area contains a very high concentration of Priority flora. This is attributed to the dominance of wetland vegetation, which is poorly represented in the region (in comparison to areas such as savannah woodland, which is widespread in the Kimberley). In addition, collections of flora from the Kimberley is relatively poor in comparison to other areas of the State (e.g. the Swan Coastal Plain) and hence a number of Kimberley flora are placed on the Priority listing because they are poorly collected rather than because they are genuinely uncommon (Tim Willing, CALM Broome, pers. comm.).

Current data suggests that four of the six species recorded are restricted to the Kimberley region, whilst two of these species are believed to be restricted to the Dampier Peninsula (*Nymphoides beaglensis* and *Aphyllodium glossocarpum*). Two species are restricted to wetland/ dampland areas (*N. beaglensis* and *Stylidium costulatum*).

The assemblages of the Lolly Well Springs wetland complex, which occur within the Bobby's Creek system, have been listed as Priority 4 on the CALM Priority Ecological Communities list, which functions as a reserve list for CALM recognised Threatened Ecological Communities.

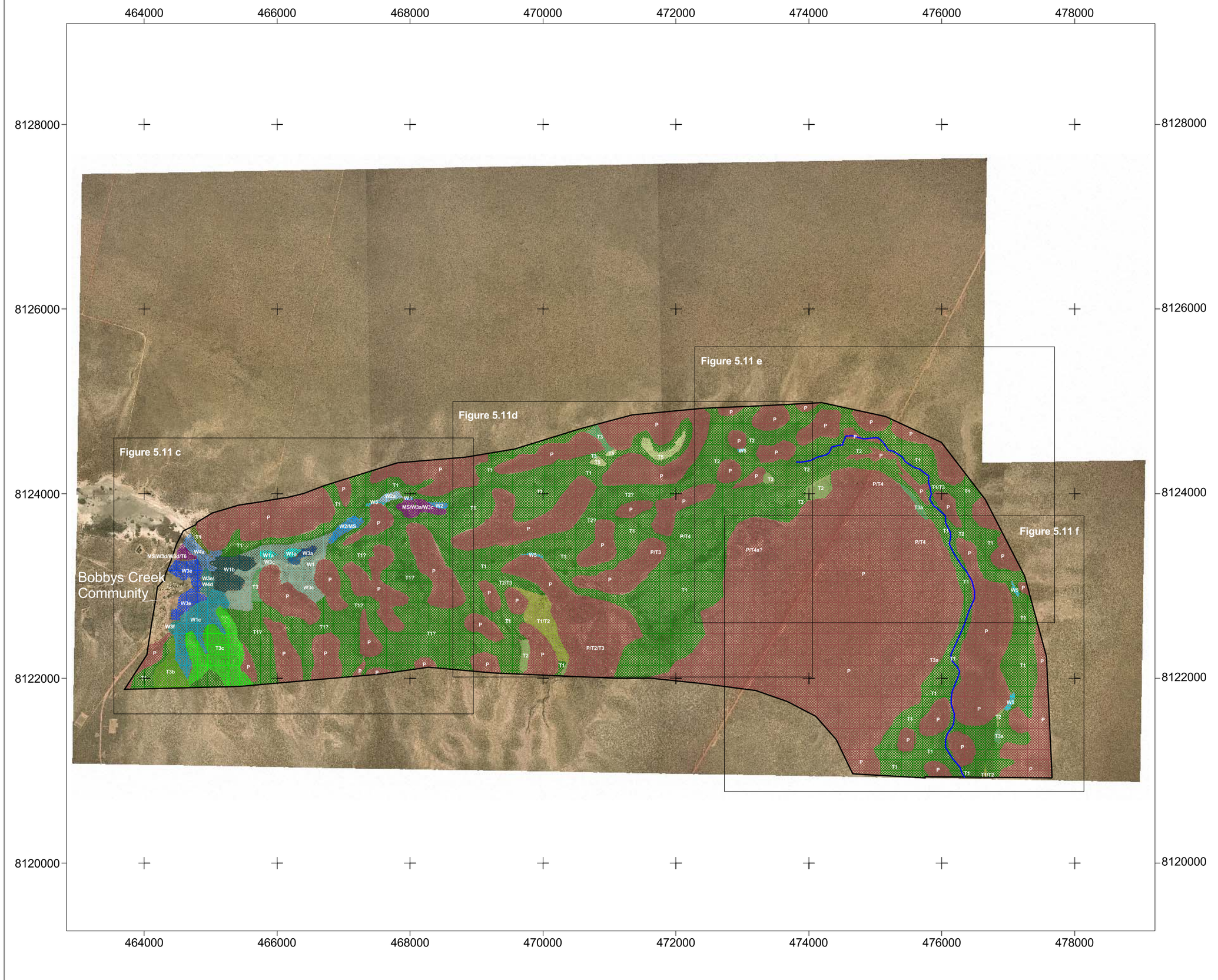
The wetland communities of Bobby's Creek have local significance, as they are one of the few areas of permanent freshwater on the Peninsula (Kenneally *et al*. 1996). In particular, this area is one of the few known locations of the locally endemic Priority 2 taxon *Nymphoides beaglensis*.

The vegetation of the survey area is generally in excellent to pristine condition. There is little evidence of cattle grazing or anthropogenic disturbances, and although there are a number of weed species present within the area, including two declared weed species, weed density is generally low and localised. The highly invasive Stinking Passion Flower (**Passiflora foetida*) was recorded at four locations and has the potential to spread throughout the area if conditions become suitable, i.e. there is degradation of the habitat. One quite dense (10 to 30 % cover) population of Parkinsonia (**Parkinsonia aculeata*) was recorded in a previously cleared area, and if possible, an eradication programme should be undertaken to remove all plants from the area.

Figure 5.11A

BOBBY'S CREEK WETLAND VEGETATION MAPPING

Colour



- Unconfirmed Mound Spring
- Confirmed Mound Spring
- Bobby's Creek
- Study Area Boundary
- P
- MS

Terrestrial Vegetation Units

- T1
- T1/T1a
- T1/T2
- T2
- T3
- T3b
- T3c
- T5

Wetland Vegetation Units

- W1a
- W1b
- W1c
- W2
- W2a
- W3a
- W3b
- W3c
- W3e
- W3e/W3d
- W3f
- W4a
- W5

N
W E
S

0.5 0 0.5 1 1.5 Kilometers

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

455000 460000 465000 470000 475000 480000

8125000 8120000 8115000 8110000 8105000

Map 5

Map 6

Figure 5.11B

BOBBY'S CREEK WETLAND VEGETATION MAPPING

Black and White

N
W E
S

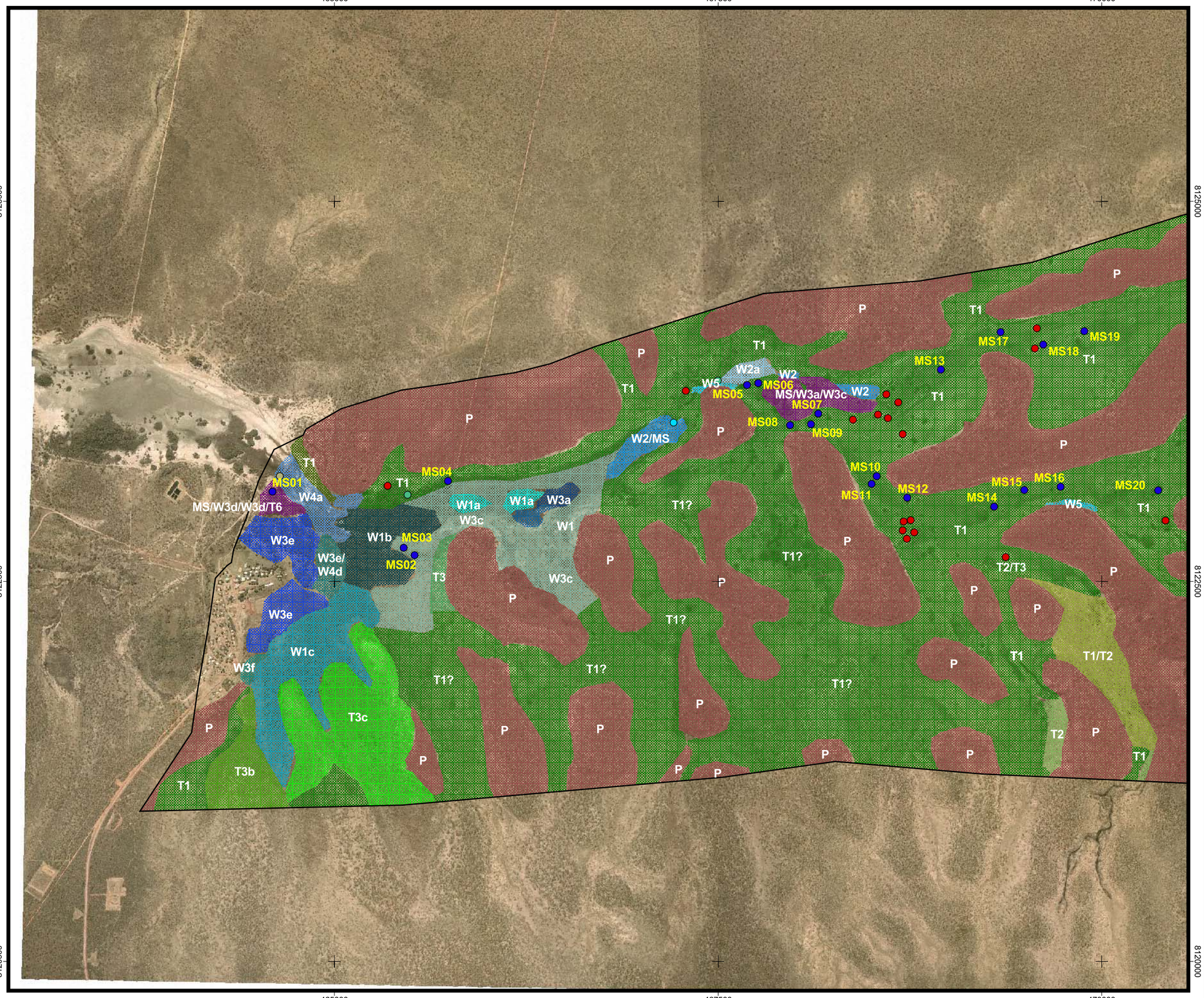
0.9 0 0.9 1.8 2.7 Kilometers

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

Figure 5.11C

BOBBY'S CREEK WETLAND VEGETATION MAPPING



Unconfirmed Mound Spring
Confirmed Mound Spring
Bobby's Creek
Study Area Boundary
P
MS

Terrestrial Vegetation Units
- T1
- T1/T1a
- T1/T2
- T2
- T3
- T3b
- T3c
- T5

Wetland Vegetation Units
- W1a
- W1b
- W1c
- W2
- W2a
- W3a
- W3b
- W3c
- W3e
- W3e/W3d
- W3f
- W4a
- W5

N
W E
S

0.2 0 0.2 0.4 0.6 Kilometers

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

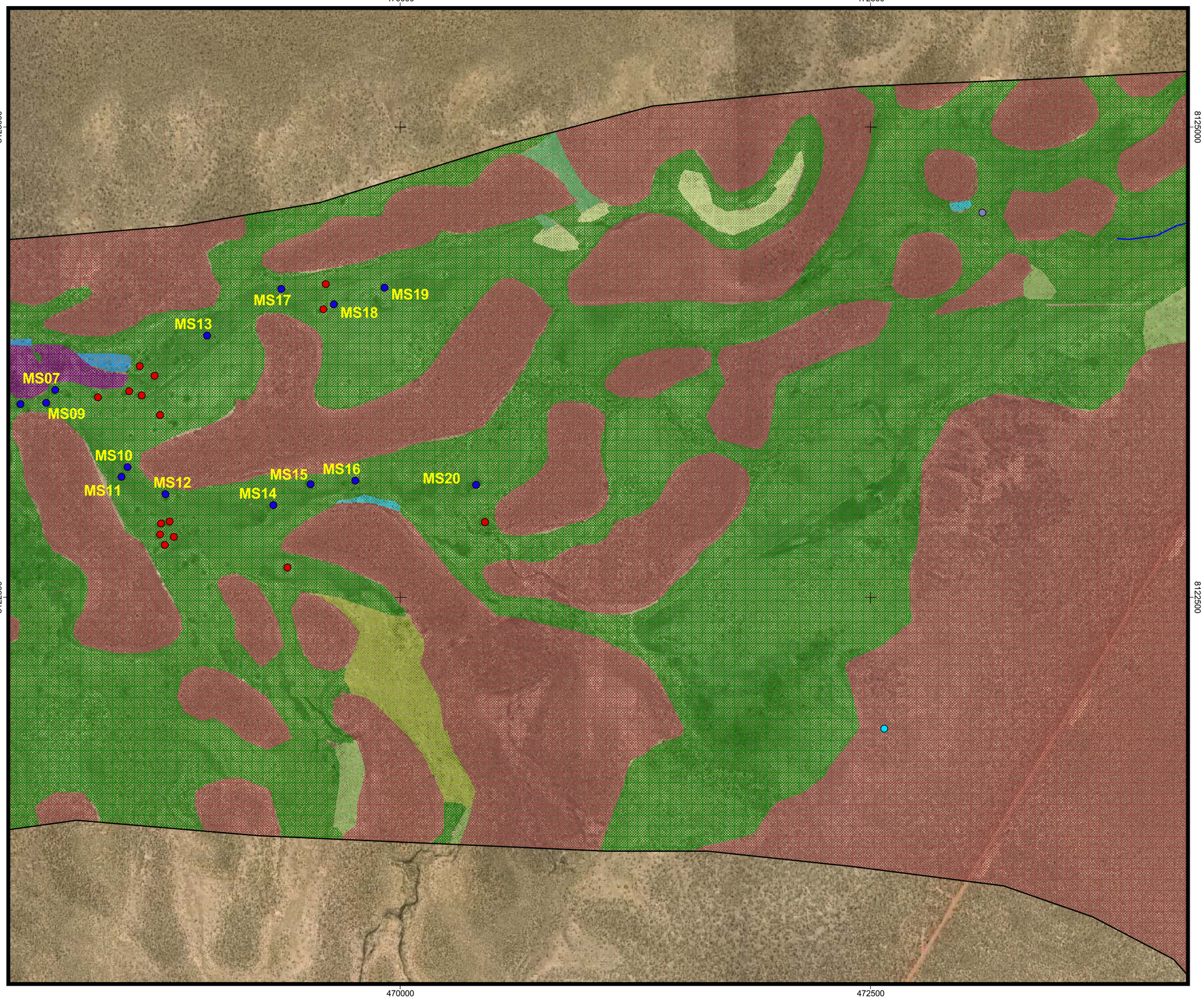


Figure 5.11D

BOBBY'S CREEK WETLAND VEGETATION MAPPING

- Unconfirmed Mound Spring
- Confirmed Mound Spring
- Bobby's Creek
- Study Area Boundary
- P
- MS

Terrestrial Vegetation Units

- T1
- T1/T1a
- T1/T2
- T2
- T3
- T3b
- T3c
- T5

Wetland Vegetation Units

- W1a
- W1b
- W1c
- W2
- W2a
- W3a
- W3b
- W3c
- W3e
- W3e/W3d
- W3f
- W4a
- W5

N
W E
S

0.2 0 0.2 0.4 0.6 Kilometers

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

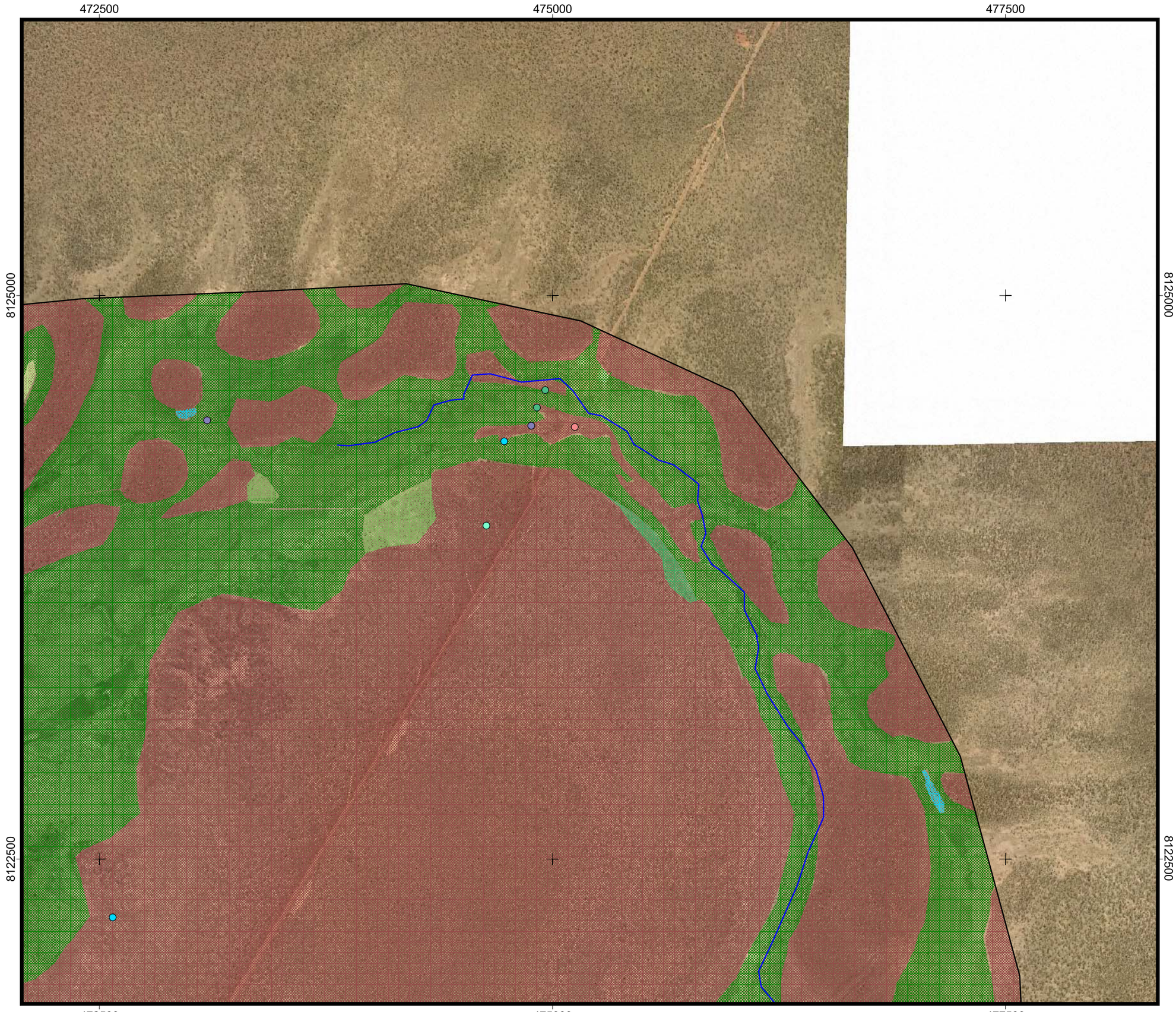


Figure 5.11E

BOBBY'S CREEK WETLAND VEGETATION MAPPING

- Unconfirmed Mound Spring
- Confirmed Mound Spring
- Bobby's Creek
- Study Area Boundary
- P
- MS

Terrestrial Vegetation Units

- T1
- T1/T1a
- T1/T2
- T2
- T3
- T3b
- T3c
- T5

Wetland Vegetation Units

- W1a
- W1b
- W1c
- W2
- W2a
- W3a
- W3b
- W3c
- W3e
- W3e/W3d
- W3f
- W4a
- W5

N
W E
S

300 0 300 600 Meters

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

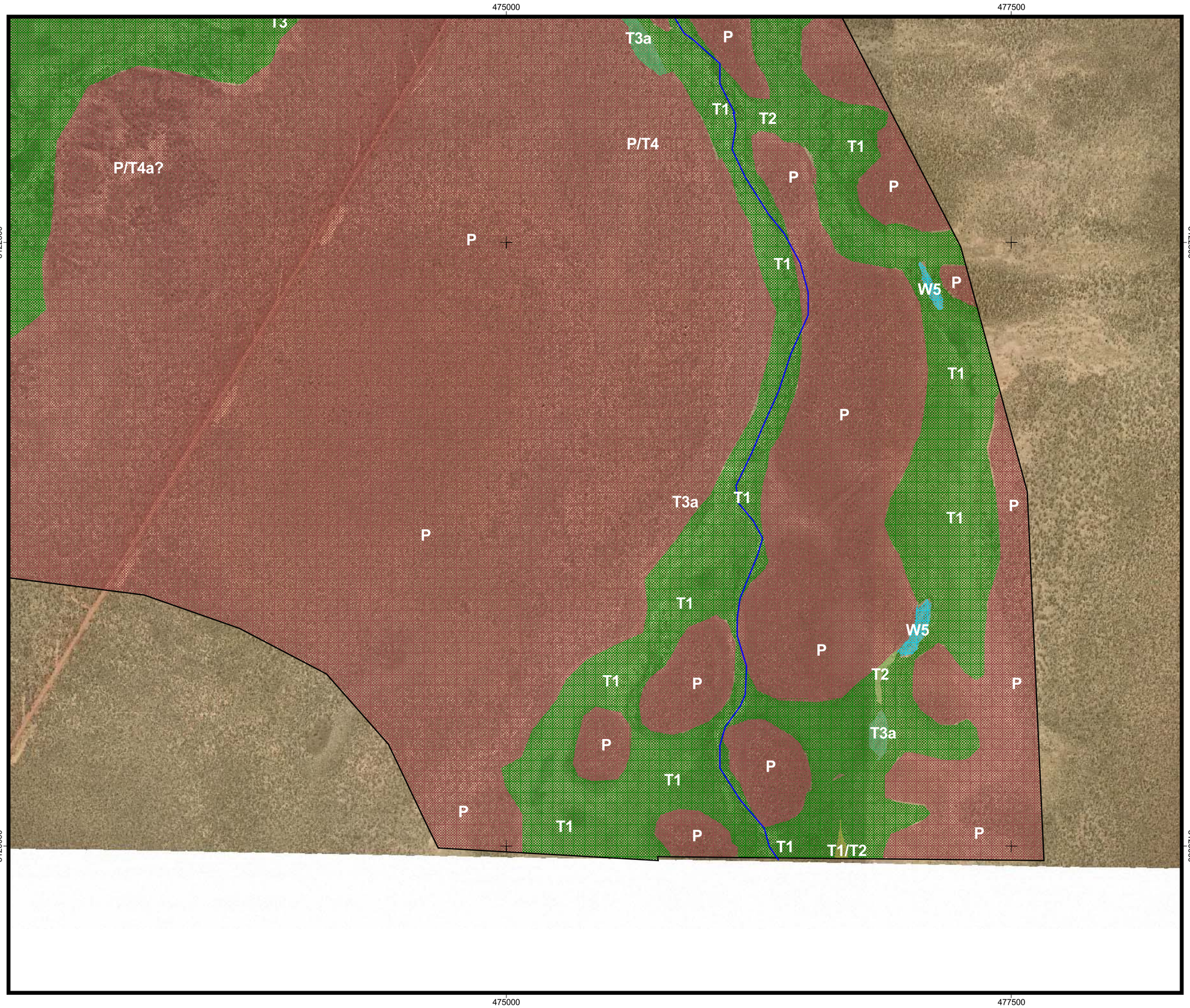


Figure 5.11F

BOBBY'S CREEK WETLAND VEGETATION MAPPING

- Unconfirmed Mound Spring
- Confirmed Mound Spring
- Bobby's Creek
- Study Area Boundary
- P
- MS

Terrestrial Vegetation Units

- T1
- T1/T1a
- T1/T2
- T2
- T3
- T3b
- T3c
- T5

Wetland Vegetation Units

- W1a
- W1b
- W1c
- W2
- W2a
- W3a
- W3b
- W3c
- W3e
- W3e/W3d
- W3f
- W4a
- W5

N
W E
S

300 0 300 600 Meters

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

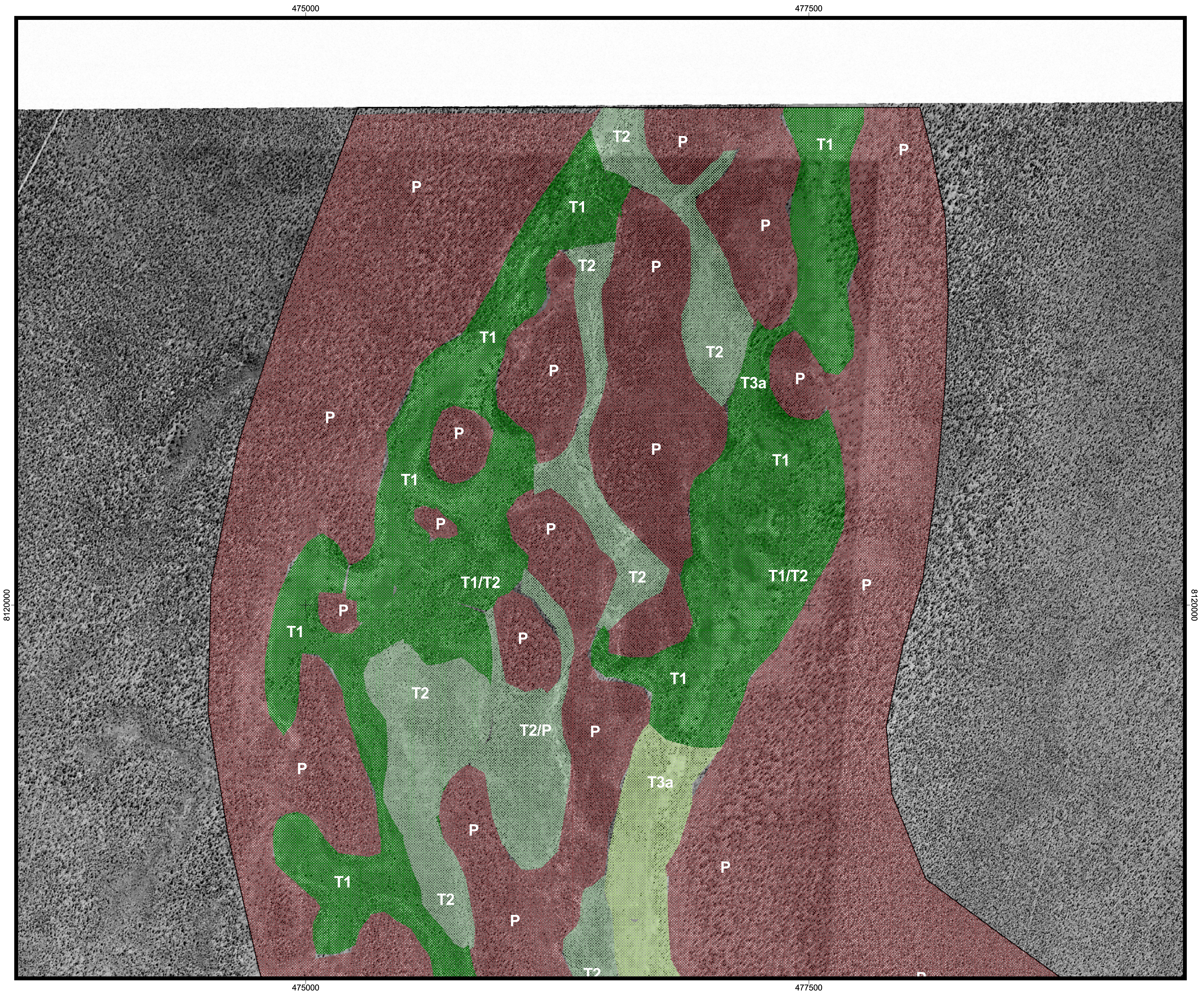


Figure 5.11G

BOBBY'S CREEK WETLAND VEGETATION MAPPING

Study Area Boundary

Terrestrial Vegetation Units

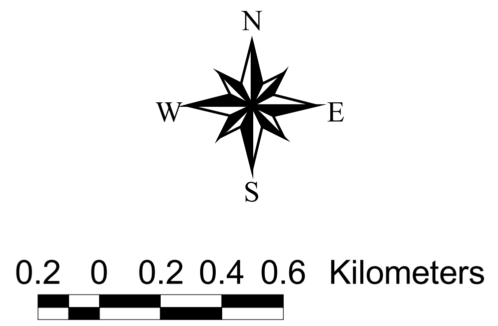
T1

T2

T3a

Pindan Vegetation Units

P



GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

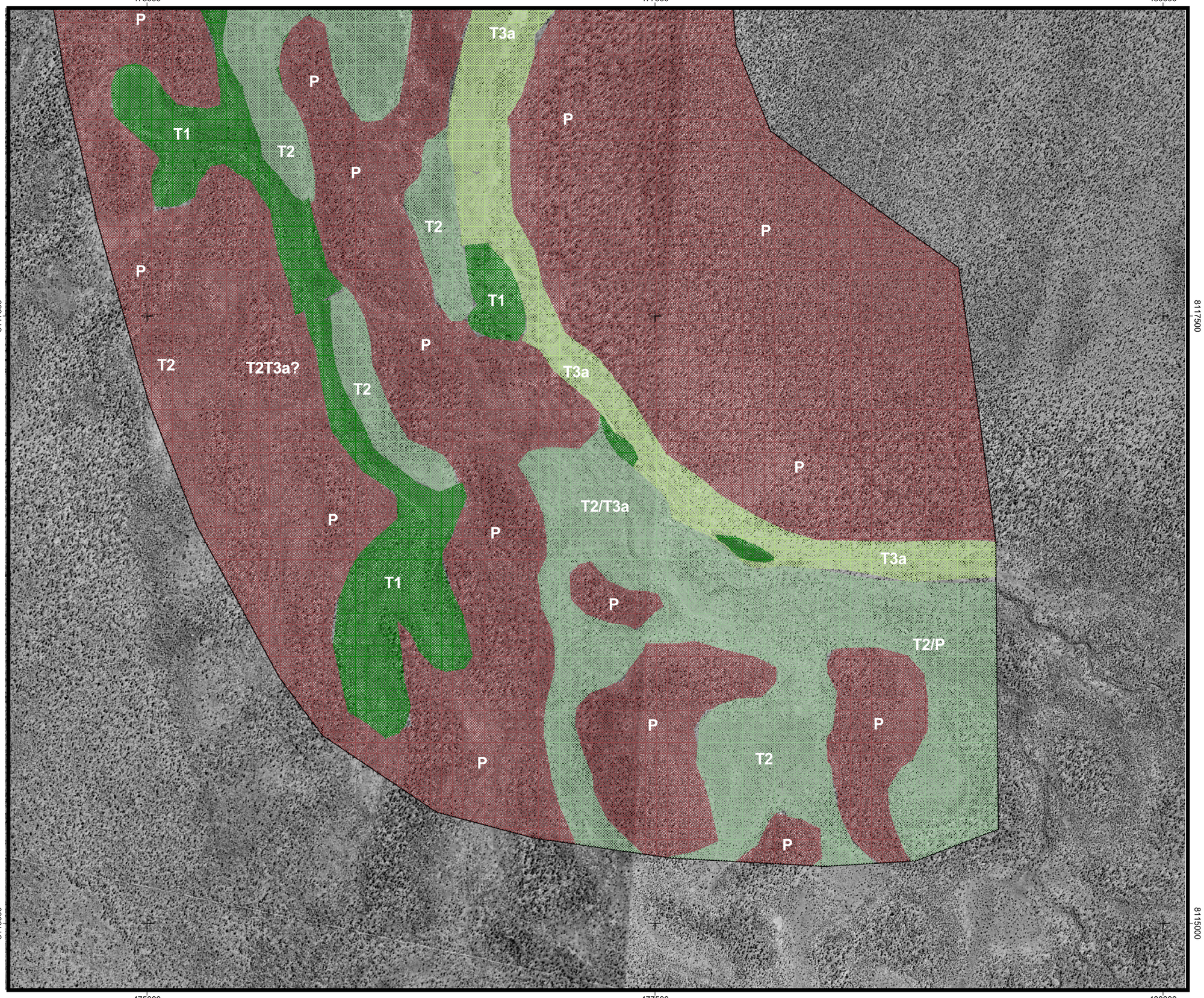


Figure 5.11H

BOBBY'S CREEK WETLAND VEGETATION MAPPING

Study Area Boundary

Terrestrial Vegetation Units

- T1
- T2
- T3a

Pindan Vegetation Units

- P

N

W E

S

300 0 300 600

Meters

GDA 94
Zone 51

ecologia Environment
76 Thomas Street
West Perth WA 6005
Ph: +61 8 9322 1944
Fax: +61 8 9322 1599
Email: ecologia@ecologia.com.au

5.12 Terrestrial Vertebrate Fauna

The fauna assessment provided within this PER has drawn upon a significant literature database, including both published and unpublished information, and a recent terrestrial vertebrate fauna survey of the project area (*ecologia*, 2004c).

The area lies within the subtropical Torresian zoogeographic region. Due to its location near the margin of the arid Eyrean zoogeographical sub-region, the area contains fauna having biogeographic affinities with this zone in addition to the more typical subtropical zone component and an array of cosmopolitan species. The Peninsula is part of a larger and topographically more diverse district known as the Phanerozoic South-West Kimberley, which corresponds approximately to the Dampier Botanical District of Beard (1979) (McKenzie, 1983).

5.12.1 Previous Fauna Studies

Previous fauna surveys on the Dampier Peninsula are few. Only two studies are relevant to this proposal area. A broad-scale survey by McKenzie (1983) examined the vegetation formations around Coulomb Point Nature Reserve, Borda Bay and Cygnet Bay for the then Department of Fisheries and Wildlife. A bird survey was conducted by Swann (2003) for TTP of the Trial Plantation area. The information from these surveys has been supplemented by opportunistic collecting by amateur herpetologists, much of which is lodged at the Western Australian Museum.

5.12.2 Survey Methodology

A vertebrate fauna assessment survey of the proposed plantation site was conducted by *ecologia* between the 19th – 26th March 2003 (*ecologia* 2004c; See Appendix F). This survey period was selected as the late wet season is an opportune time to record amphibians and a greater variety of birds.

Following a preliminary reconnaissance, detailed survey sites (Figure 5.12) were chosen as being either:

(i) Representative of vegetation associations;

(ii) Areas of conservation value or ecological sensitivity; and

(iii) Areas of environmental impact arising from the proposed development.

The methodology adopted for the current survey was formulated in context with the EPA's Draft Guidance Statement No. 56: Guidance Statement for Terrestrial Fauna Surveys for Environmental Impact Assessment.

The inventory of fauna was carried out using a variety of sampling techniques, including systematic and opportunistic sampling. Systematic sampling refers to data methodically collected over a fixed time period in a discrete vegetation community type, using an equal or standardised sampling effort. The resulting information can be analysed statistically facilitating comparisons within and among sites and between seasons. Opportunistic sampling includes data collected non-systematically within and outside fixed sampling sites.

Fauna trapping was undertaken using a standardised trapping format. The objective of this baseline survey was to enable the compilation of a fauna species inventory for the project area. As the vegetation and habitats of the project area are uniform, six sites were deemed sufficient.

At all systematic survey sites a combination of trapping, opportunistic searching and bird censusing was conducted, including Pit and Elliot trapping, microhabitat searching, spotlighting and set time avifauna transects. The six fauna survey sites resulted in a total of 360 pit trap and 720 Elliott trap nights. A total of 25.5 person hours were spent searching microhabitats within the 6 systematic sites and 30.5 hours was spent undertaking avifauna surveys. A total of 7.5 hours were spent mist-netting and acoustic readings for bat fauna.

5.12.3 Fauna Habitats

Different parts of the project area may support different fauna assemblages, which will influence species richness. However, on the basis of landform units and vegetation associations present, the habitat of the project area is characterised as uniform for the red sand plains of the Dampier Peninsula (Kenneally *et al*, 1996). It is possible to examine the similarity of the species assemblages across the six sites using cluster analysis, where sufficient data have been collected to perform the analysis.

5.12.4 The Fauna Community

Systematic sampling and opportunistic collecting within the proposed plantation area yielded 105 vertebrate species, including 65 birds, 28 reptiles, four amphibians and eight mammals (six native and two introduced) (Appendix D). The highest species richness within the study area was recorded from Site 3, with a total of 60 species, including five mammals, 41 birds and 14 herpetofauna species.

An estimated 193 vertebrate fauna species may potentially occur in the study area. This comprises 17 native and six introduced mammals, 110 birds, 52 reptiles and eight frog species. Of the species that may potentially occur in the project area, 54 % were recorded during the current survey.

Representative species of each of the major mammal groups were recorded in the project area, including marsupials, placental mammals, vespertilionid bats, rodents and introduced fauna. The deficit between species observed (eight species) during the recent survey (ecologia 2004c) and those previously recorded (23 species) is primarily due to the under representation of bats (eight potential species not recorded), introduced species (four species not recorded) and marsupials (two species not recorded). Moreover, there is a relative paucity of mammal species that may potentially occur within the area, due to the uniformity of habitat, the effects of changing fire regimes, and the predation pressure from feral animals.

All of these factors contribute to a decline in mammal diversity, particularly for species falling within the Critical Weight Range (CWR) or 35 – 5500 g, which are more susceptible to decline (Burbidge and McKenzie, 1989).

Mammals:

Three species of bat were recorded during the course of the survey. All of these individuals were captured by mist-netting, and no calls were recorded. Individuals of the Hoary Wattled Bat *Chalinolobus nigrogriseus*, Little Broad-nosed Bat *Scotorepens greyii* and Kimberley or Yellow-lipped Cave Bat *Vespadelus douglasorum* were recorded. By night, all species are likely to forage over a variety of habitat types. During the day the Hoary Wattled and Little Broad-nosed Bat frequently roost in dead hollow limbs of Eucalypts (Churchill, 1998). Conversely, the Kimberley or Yellow-lipped Cave Bat is a cave dweller, and a record of this species in the middle of the Dampier Peninsula is unusual. The individuals captured during the current survey must have either been transients, or they may have been roosting among the camp buildings. Alternatively, the species may not actually be cave-dependent, as described by Strahan (1995).

460000mE
465000mE
470000mE
475000mE
8120000mN
8115000mN
8110000mN

N

1:50 000
0 2.5
Kilometres
MAP GRID of AUSTRALIA
GRID BASED ON TRANSVERSE MERCATOR PROJECTION

Beagle Bay 1 km
To Cape Leveque
Beagle Bay Access Road
Airstrip
Seismic Line
Vincent Well

BROOME CAPE LEVEQUE ROAD
OLD CAPE LEVEQUE ROAD

Site 4

5000 ha Lease Option Area

ACCESS TRACK

Habitat Corridors

Plantation Development Site

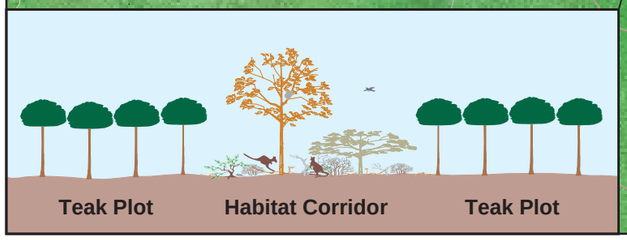
Teak 100 ha	Teak	Teak	Sandalwood	Sandalwood	Sandalwood	Teak
Sandalwood	Mahogany	Sandalwood	Mahogany	Sandalwood	Mahogany	Sandalwood	Teak

Site 1
Site 2
Site 3
Site 5
Site 6

Trial Lease Area

Fence Line

Country Downs Station



Legend
- Fauna Survey Location Sites
- Greater Project Area

JOHN BRENNAN AND ASSOCIATES Project Managers	Client: TROPICAL TIMBER PLANTATIONS PTY LTD	BEAGLE BAY PLANTATION FAUNA SITE LOCATIONS	Date: 19 January 2004
	Project: BEAGLE BAY PROJECT PROPOSED STAGE 2 EXPANSION		Scale: 1:50 000
Author: J.B. / S.C. Drawn: S.Coleman		A3	Figure No. 5.12
			Plan No. BB-003

The Northern Brushtail Possum *Trichosurus vulpecula arnhemensis* was another significant record for the project area. Although this species is not priority listed or scheduled by CALM, it has suffered declines across parts of its natural range, despite being common in urbanised areas (T. Start, CALM, pers. comm.). The declines are very likely due to altered fire regimes on the Peninsula, coupled with the influence of feral predation. The Northern Brushtail Possum forages across a variety of habitats, but depends upon the presence of mature Eucalypts with hollows for roosting, many of which are lost during intense dry season wildfires.

Only two species of native rodents were recorded during the current study. Four individuals of the Delicate Mouse *Pseudomys delicatulus* were recorded during this survey and was the most widespread mammal recorded within the study area. The Western Chestnut Mouse *Pseudomys nanus* is always observed in areas where there is a dense ground cover of tussock grasses, often beneath the low eucalypt woodland characteristic of much of northern Australia. Two individuals were recorded during this survey.

Avifauna:

Sixty-one bird species from 33 families were recorded throughout the project area. The highest species richness was recorded was from Site 3, with a total of 41 species; although all sites were relatively similar in overall species richness. Some of the most speciose families were the Meliphagidae (honeyeaters; eight species), Alcedinidae (pigeons and doves; four species), Cuculidae (parasitic cuckoos; four species) and Psittacidae (Lorikeets and Parrots; four species).

Species that were widespread in the project area included Varied Lorikeet *Trichoglossus versicolor*, Rainbow Lorikeet *Trichoglossus haematodus rubritorquis*, Red-winged Parrot *Aprosmictus erythropterus*, Red-backed Fairy-wren *Malurus melanocephalus*, Brown Honeyeater *Lichmera indistincta*, Rufous-throated Honeyeater *Conopophila rufogularis*, Black-chinned Honeyeater *Melithreptus gularis*, Jacky Winter *Microeca fascinans*, Rufous Whistler *Pachycephala rufiventris*, Black-faced Cuckoo-shrike *Coracina novaehollandiae,* Pied Butcherbird *Cracticus nigrolgularis*, Long-tailed Finch *Poephila acuticauda* and Grey-crowned Babbler *Pomatostomus temporalis*.

Four nocturnal species were recorded in the project area; Boobook Owl *Ninox novaeseelandiae,* Tawny Frogmouth *Podargus strigoides,* Australian Owlet-nightjar *Aegotheles cristatus* and the Bush-stone Curlew *Burhinus grallarius.*

Species of interest recorded during the survey include the Bush Stone-curlew *Burhinus grallarius* and Australian Bustard *Ardeotis australis.* These two species typically avoid the thick ground storey vegetation that is common in the project area, and the records were most likely of transients rather than individuals occupying the project area (G. Swann, pers. com.). The recording of the Little Bronze-cuckoo *Chrysococcyx minutillus* would normally be regarded as significant, as this species is associated with mangroves and vine thickets (Johnstone and Storr, 1998), however it has been sited throughout the Peninsula and inland Kimberley (G. Swann, pers. com.) and similar to *Vespadelus douglasorum*, this species may not be as habitat specific as is usually thought.

Herpetofauna:

A total of 32 herpetofauna species were recorded from the 6 sites within the project area. This included five geckos, one pygopod, nine skinks, three elapid snakes, five dragons, two varanids, one blind snake and two pythons. Four amphibians, *Cyclorana australis*, *Litoria caerulea*, *Litoria rubella* and *Uperoleia talpa* were also recorded from the project area. Some of the more widespread species included *Diporiphora pindan*, *Tiliqua scincoides intermedia* and *Lerista griffinii*. Bynoe's Gecko *Heteronotia bynoei*, *Diplodactylus stenodactylus* and *Gehyra pilbara* were the most abundant species recorded during the survey. Species recorded from a single specimen during the survey included *Carlia tricantha,*

Ctenotus inornatus, Diporiphora magna, Varanus gouldii, Varanus scalaris, Pygopus nigriceps, Aspidites melanocephalus, Liasis stimsoni and *Furina ornata*.

A total of seven species have not previously been vouchered from the area and lodged with WAM, indicating how poorly this area has been surveyed in the past. Of these seven records, two species (*Aspidites melanocephalus* and *Pygopus nigriceps*) were collected opportunistically as single records from the project area. Species of note collected during this survey include *Rhynchoedura ornata* which has not previously been vouchered from the Dampier Peninsula, *Morethia storri* which is restricted to Dampier Peninsula, and *Diporiphora magna, Uperoleia talpa* and *Varanus gouldii*, all of which are not commonly collected on the Dampier Peninsula.

Feral Fauna:

Two species of feral fauna were recorded in the project area during the course of the field survey: the Feral Cat *Felis catus* and Donkey *Equus asinus*. Two feral cats were sighted opportunistically in the project area. Donkeys were recorded at Sites 1 and 3.

5.13 Rare and Specially Protected Fauna

All vertebrate fauna species are protected by law under Commonwealth and State Legislation, though rare or threatened fauna are afforded greater protection under the same legislation. At the national level, fauna are protected under the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). Within Western Australia rare fauna are listed under the *Western Australian Wildlife Conservation Act* 1950. International Agreements include the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA) and cover migratory species of avifauna, particularly trans-equatorial waders. In addition, fauna are protected under the April 1991 Australian and New Zealand Environment and Conservation Council (ANZECC) convention.

During the fauna survey two species listed under international agreements, the Rainbow Bee-eater *Merops ornatus* and Fork-tailed Swift *Apus pacificus* and two priority fauna species, the Australian Bustard *Ardeotis australis* and Bush Stone-curlew *Burhinus grallarius* were recorded.

5.13.1 Species Protected by International Agreements

Three international agreements address components of the Australian fauna, with a focus on protecting migratory species. These three agreements are JAMBA, CAMBA and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). Of the species listed under these agreements, four may potentially occur in the project area and two of these were recorded (Table 5.13).

TABLE 5.13 SPECIES PROTECTED BY INTERNATIONAL AGREEMENTS

Common Name	Scientific Name	International Agreement
Recorded		
Rainbow Bee-eater	*Merops ornatus*	*JAMBA*
Fork-tailed Swift	*Apus pacificus*	*JAMBA/CAMBA*
Potentially Occur		
White-bellied Sea Eagle	*Haliaeetus leucogaster*	*CAMBA*
Yellow Wagtail	*Motacilla flava*	*JAMBA/CAMBA*
Oriental Cuckoo	*Cuculus saturatus*	*JAMBA/CAMBA*

5.13.2 Environmental Protection and Biodiversity Conservation Act

Schedule 1 of the EPBC ACT contains a list of species that are considered Critically Endangered, Endangered, Vulnerable, Extinct, Extinct in the Wild and Conservation Dependent.

Classification relevant to fauna that occur or potentially occur in the project area are defined in Table 5.14.

TABLE 5.14: EPBC ACT CATEGORIES

Category	Definition
Endangered	The species is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction.
Vulnerable	Within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.

Gouldian Finch *Erythrura gouldiae*

The Gouldian Finch *Erythrura gouldiae* is listed as Endangered under the EPBC Act. Gouldian Finches occupy two different regions of the landscape on an annual cycle; tropical north during the dry season, and the arid interior during the wet season. Generally the species occupies eucalypt woodlands with a grassy understorey, adjacent clearings and the edge of mangrove communities. Trees provide nesting sites while feed mainly comprises native grasses, including soft Spinifex, Cockatoo Grass and Golden Beard Grass (Lewis, 2001). Individuals are also usually closely associated with water (Blakers *et al,* 1984). The Gouldian Finch was not recorded during the current survey.

Given the propensity of this species to feed on, and occupy, grassy habitats, altered fire regimes such as is the case on the Dampier Peninsula may have contributed to reduced numbers of Gouldian Finches in this region, as has occurred with other congeners (Franklin, 1999). This is most likely due to the change in composition of grasses, from perennial to annual species (Start, 2003).

Red Goshawk *Erythrotriorchis radiatus*

The Red Goshawk *Erythrotriorchis radiatus* is listed as Vulnerable under the EPBC Act. A rare inhabitant of well-wooded country, this species nests in large trees and preys largely on birds but also reptiles and mammals. This species is unlikely to suffer any threatening processes associated with the plantation project. The Red Goshawk was not recorded during the current survey.

Bilby *Macrotis lagotis*

The Bilby *Macrotis lagotis* is listed as Vulnerable under the EPBC Act. Historically, it was distributed over 70 % of continental Australia. Now the species only occupies 20 % of its former range. Records indicate that the species may still occur in the southern Kimberley, and therefore habitats within the project area may support individuals, despite the fact that no individuals were located during the survey. Seven of the last 27 vouchers of this species, collected between 1950 and 1999, have been collected on the Dampier Peninsula. This is a CWR mammal, and declines would most certainly be associated with altered fire regimes, habitat modification since European settlement, and an increase in predation due to

the presence of feral mammals. The Bilby has not been sighted around the Beagle Bay area for many years (John Brennan, pers. comm.).

5.13.3 WA Wildlife Conservation Act

Classification of rare and endangered fauna under the Western Australian Wildlife Conservation (Specially Protected Fauna) Notice 2004 and the *Wildlife Conservation Act 1950* (WCA), recognises four distinct schedules for fauna that are 'in need of special protection' (Table 5.15).

TABLE 5.15: CLASSIFICATION OF SPECIES UNDER THE WA WILDLIFE CONSERVATION ACT

Classification	Definition
Schedule 1	Fauna that is rare or likely to become extinct.
Schedule 2	Fauna that is presumed to be extinct.
Schedule 3	Birds that are subject to an agreement between the governments of Australia and Japan relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	Other fauna that is need of special protection.

Scheduled species recorded or potentially occurring in the project area are detailed below.

Schedule 1

Bilby *Macrotis lagotis*

This species is described in detail in Section 5.13.2.

Red Goshawk *Erythrotriorchis radiatus*

This species is described in detail in Section 5.13.2.

Gouldian Finch *Erythrura gouldiae*

This species is described in detail in Section 5.13.2.

Schedule 3

Fork-tailed Swift *Apus pacificus*

This species is described in detail in Section 5.13.1.

Rainbow Bee-eater *Merops ornatus*

This species is described in detail in Section 5.13.1.

Schedule 4

Peregrine Falcon *Falco peregrinus*

The Peregrine Falcon is widely distributed throughout Australia. It is nomadic, sedentary or partly so, and prefers coastal or inland cliffs and gorges, timbered watercourses, plains and open woodlands. Its status is considered to be "generally uncommon, probably declining in settled regions; still well established in remote areas" (Pizzey, 1983). Blakers *et al.* (1984) consider that Australia is one of the strongholds of the species, since it has declined in many other parts of the world. The Peregrine Falcon was not recorded during the current survey.

5.13.4 CALM Priority Fauna

Species on the CALM Priority Fauna list include those removed from the scheduled fauna list and other species known from only a few populations or in need of monitoring. Four Priority Codes are recognised as defined in Table 5.16.

TABLE 5.16: CALM PRIORITY FAUNA CATEGORIES.

Category	Definition
P1	Taxa with few, poorly known populations on threatened lands.
P2	Taxa with few, poorly known populations on conservation lands.
P3	Taxa with several, poorly known populations, some on conservation lands.
P4	Taxa in need of monitoring.

The details of Priority Fauna that may be found or were recorded in the project area are:

Priority 1

Little North-western Mastiff Bat *Mormopterus loriae cobourgiana*

This species occurs along the northwest coast and is known to roost in mangroves. It has the potential to occur in the project area, but only as a transient possibly roosting in trees whilst moving across the peninsula. This species was not recorded during the current survey.

Priority 2

Simoselaps minimus (elapid snake)

This species has only been recorded on the Dampier Peninsula and little is known about its biology. *Simoselaps minimus* was not recorded during the current survey.

L*erista separanda* (skink)

Very few specimens of this skink have been collected and little is known about its biology. *Lerista* in general are one particular taxon that is under intense revision by the WA Museum. *Lerista separanda* was not recorded during the current survey.

Priority 4

Bush Stone-curlew *Burhinus grallarius*

Bush Stone-curlews generally inhabit open woodland areas with a leaf litter layer providing camouflage on which they rely for predator avoidance. Habitats within the project area are not ideal for this species, due to the density of ground cover. However, as it is a ground dwelling species, populations can be influenced by fire (Blakers *et al*, 1984). As a consequence individuals may utilise suboptimal habitats if favourable habitat is sparse. Two individuals were observed during the survey period.

Australian Bustard *Ardeotis australis*

This species is uncommon and may occur in open or lightly wooded grasslands. Similarly to the Bush Stone-curlew, the Bustard will occupy habitats with a denser ground storey either temporarily, or if better habitat is limited. One individual was observed during the survey period.

Priority 4 - Grey Falcon *Falco hypoleucos*

This species inhabits lightly timbered riverine plains. It may occur within the development site. The Grey Falcon was not recorded during the survey.

5.13.5 Conservation Significance

The significance of the biota of the project area has been assessed at four spatial scales; international/ national, state, regional and local. The project area comprises a small portion of ubiquitous Pindan habitat and does not contain any distinct landforms or fauna habitats.

International/ National Significance

Because of their migration patterns, the conservation of migratory fauna species is influenced by the action of other nations as well as those of Australia and is therefore of international significance. Such considerations are recognised by State and Federal legislation, and also International treaties. In addition, endangered animals are listed and their conservation status reviewed by the International Union for the Conservation of Nature (IUCN). National significance refers to those features of the environment which are recognised under legislation as being of importance to the Australian community. Species scheduled under the Commonwealth EPBC Act are regarded as nationally significant.

The Fork-tailed Swift *Apus pacificus* and, Rainbow Bee-eater *Merops ornatus,* which are listed under CAMBA and JAMBA, are species of international significance that occur in the project area (refer to Section 5.13.1). Both species are abundant and widespread and require no specific management in Australia. No species scheduled under the EPBC Act were recorded in the project area. The Gouldian Finch and Red Goshawk listed under the Act may potentially occur within the area; however the project is unlikely to significantly impact either of these species.

State Significance

State significance refers to those features of the environment that are recognised under State legislation as of importance to the Western Australian community; in particular, species scheduled under the *Wildlife Conservation Act* 1950. Fauna that are regarded as rare and/or endangered or habitats that are site or type specific and possess high ecological value are of State significance. Significant habitats will contain either specific habitat dependant fauna or high biodiversity and are poorly represented elsewhere. If a species or habitat is poorly represented in conservation reserves its conservation significance is increased.

Four species, potentially occurring within the area are of State significance; Bilby *Macrotis lagotis*, Red Goshawk *Erythrotriorchis radiatus,* Gouldian Finch *Erythrura gouldiae* and Peregrine Falcon *Falco peregrinus.* None of the species have been recorded from the project area or are likely to be impacted.

Regional Significance

Regional significance addresses the representation of species and habitats at a biogeographic regional level. Species or habitat types that are endemic to the Beagle Bay area and whose known distributions are limited or unknown are considered regionally significant. The project area encompasses habitats and vegetation associations which are widespread throughout the region. Some of the species listed in the CALM Priority list are considered regionally significant because of limited knowledge about their distribution, restricted distribution and/or poor representation within existing conservation reserves.

Fauna species of regional significance include Little North-western Mastiff Bat *Mormopterus loriae cobourgiana*, Bush Stone-curlew *Burhinus grallarius*, Australian Bustard *Ardeotis australis*, Grey Falcon *Falco hypoleucos*, *Simoselaps minimus* (elapid snake) and *Lerista separanda* (skink). Only two of these species were recorded in the project area.

The project will only result in the clearing of less than 0.001 % of the Dampier Peninsula and is unlikely to have any impact on these species. Given the limited habitat diversity and the widespread occurrence of the habitat type/ vegetation associations, there does not appear to be any features of regional significance within the project area.

Local Significance

Species are of local significance when their presence is confined to a specialised habitat type that is not common within the local area and whose disturbance or removal may lead to local extinction. *Diporiphora Pindan* is apparently restricted to Pindan habitat. Pindan woodland dominates the project area, but is widespread throughout the Dampier Peninsula. Therefore *Diporiphora Pindan* is unlikely to be significantly impacted by the project.

The Kimberley Cave Bat *Vespadelus douglasorum* currently has a distribution mapped in the west Kimberley district and has not previously been recorded as far west as the Beagle Bay Project Area. This species is a sandstone/limestone cave dweller, which has not been extensively studied. These bats have previously been caught within woodlands (Churchill, 1998), but records in the project area are quite disjunct from rocky landforms that may support cave formations. Disturbances associated with the plantation practices may reduce the species presence in the local area, if it inhabits woody roosts. However, as the individuals were all captured adjacent to the plantation site 'camp', it may be that they were roosting in buildings.

TABLE 5.17: CONSERVATION SIGNIFICANCE OF FAUNA WITHIN THE PROJECT AREA

Conservation Significance	**Relevant Legislation**	***Species Recorded*** **Species Potentially Occurring**
International/ National	CAMBA, JAMBA, EPBC Act, IUCN	Rainbow Bee-eater, Fork-tailed Swift, Red Goshawk, Gouldian Finch
State	WCA	Bilby, Red Goshawk, Gouldian Finch, Peregrine Falcon
Regional		Bush Stone-curlew, Australian Bustard Little North-western Mastiff Bat, Grey Falcon *Simoselaps minimus*, *Lerista separanda*
Local		*Diporiphora Pindan,* Kimberley Cave Bat

5.14 Invertebrate Fauna

Surveys on the invertebrate fauna on the Dampier Peninsula have been scarce. The broad-scale survey by McKenzie (1983) included an invertebrate fauna survey that recorded seven orders of insects, with Diptera and Lepidoptera the most common. During the time of the survey, when the fauna could be expected to be at its peak, diversity was low. The National Insect Collection at Canberra contains a total of 1380 species described from the Kimberley region. Most of the information on invertebrates relates to pests of the agricultural crops. Approximately 168 species of pests have been recorded within the Kimberley region (B. Thistleton, pers. com).

During a botanical survey of the proposed tropical timber plantation by Willing and Dureau (2000), the presence of two termite species, which are of interest to the proposed project were noted. Only two active colonies of the Spinifex Termite *Nasutitermes triodiae* were recorded during the survey.

Evidence of the Giant Northern Termite *Mastotermes darwiniensis* was noted within the proposed plantation site during the 2000 survey. *Mastotermes darwiniensis* is able to exploit the unstable habitat presented by recently cleared bushland, subsequently planted to a tree crop. This species attacks both living trees and structural timber and is the most serious pest of structural timber known in northern Australia. *M. darwiniensis* is widely distributed in the Australian Arid Tropics north of the Tropic of Capricorn. A colony of this species typically consists of a pair of primary reproductives, eggs, nymphal stages developing to primary reproductives, and larval stages developing into workers, which in turn can give rise to soldiers and secondary reproductives known as neotenics (Young *et al.,* 2001). It is a subterranean termite, only found in sandy soils and its nests can be found in the soil and inside trees. Colonies can extend at least 80 metres from the nest site and to a depth of 5 metres. *Mastotermes* activity is highest during the dry season and lowest during the wet season. During the wet season *M. darwiniensis* moves up towards the soil surface and into trees, stumps and fallen logs (Young *et al.,* 2001). In terms of damage to trees, activity seems to peak at the end of the wet season and again in August/ September. Two species of ants, *Iridomyrmex sanguineus* and *Solenopsis geminate,* are natural predators of the termite and have been recorded attacking healthy colonies of *Mastotermes* (Young *et al.,* 2001).

5.15 Biodiversity Overview

5.15.1 Introduction

Biodiversity conservation is a critical component of the environmental impact assessment process. There is an increasing community expectation that protection of the State's biological diversity of plants and animals be given greater importance through the EPA assessment process (EPA, 2000a).

With the adoption of the National Strategy for Ecologically Sustainable Development (NSESD), ESD principles are to be incorporated into government planning and initiatives at a national, state and regional level. The states have also reached agreement on the subsequent National Strategy for the Conservation of Australia's Biological Diversity. Western Australia has committed to an agreed framework, principles and objectives for the protection of biodiversity.

As a consequence of these actions, assessment of proposals must ensure that processes relating to the protection of biodiversity are undertaken to agreed National and Commonwealth standards and agreements. A greater level of detailed information is required to facilitate satisfactory assessment of factors that impinge on the biotic components of the environment.

5.15.2 Elements of Biodiversity

Biodiversity may be considered at two principal levels; its intrinsic value at the individual species, species assemblage and genetic level, and its functional value at the ecosystem level.

Environmental impact assessment in Western Australia principally considers biodiversity at the species and taxa levels. Flora has generally been considered at the species and species assemblage (vegetation community) level, while fauna has mainly been interpreted at the species level in relation to habitat, and, in terrestrial studies, invariably focuses on vertebrate fauna. Where possible or relevant, efforts are also made to identify subspecies or varieties, thereby enhancing taxonomic definition of the biota.

Diversity at the ecosystem level can be and usually is regarded in terms of species composition and abundance, but should also incorporate knowledge of functional relationships within an ecosystem. In the majority of situations the level of information available is insufficient to assess the nature of functional relationships and interactions.

Australia has adopted a bioregional approach (Thackway and Cresswell, 1995) in order to assess biodiversity conservation and representation at a national level, with 26 bioregions represented in Western Australia. The proposed project is situated entirely within the Dampierland Bioregion

5.15.3 Components of Biodiversity Associated with the Project

Australia has an international obligation to maintain biological diversity (biodiversity). The Commonwealth government has initiated the National Strategy for the Conservation of Biological Diversity, which incorporates elements of the NSESD. Biological diversity (biodiversity) relates to the richness of the biota at a local, regional, state, national or even global level, and includes all components of the environment, from bacteria to insects, plants, and vertebrate fauna. Biodiversity can be thought of as existing at several levels, including genetic, population and species (or taxon) diversity. This study examines biodiversity at the species and population level, and places it within a local, regional and national context.

A total of 105 vertebrate fauna species were recorded during the survey undertaken by *ecologia* (*ecologia* 2004c), comprising six native and two introduced mammals, 65 bird species, 28 reptiles and four amphibians. While this is not likely to be a comprehensive list of the vertebrate fauna species inhabiting the area, it suggests that a diverse array of fauna species utilise the area. Based on known species distributions and other information pertaining to the fauna of the area, additional species expected to occur in the project area would include several species of microchiropteran bats, marsupials, birds, several additional species of elapids, skinks and frogs.

One of the major issues from a biodiversity perspective is whether individual species would be restricted to the particular habitat of the project area. Pindan woodlands dominate the project area, but are widespread throughout the Dampier Peninsula. The original 900 ha plantation represents less than 0.01 % of the Dampier Botanical District (*ecologia* 2004c). Therefore, none of the species identified within the survey are likely to be significantly impacted by the project.

Part of the purpose of the biogeographic regionalisation of Australia (Thackway & Cresswell, 1995) was to examine the representation of ecosystems within conservation reserves at a bioregional level to ensure that the biodiversity of each bioregion was maintained. Within the Dampierland bioregion there are few areas managed for flora and fauna conservation at the present time. The level of reservation status of the Dampierland bioregion is 1-5 % and is described as low to moderate (Thackway & Cresswell, 1995). Accordingly, the EPA recommends the highest level of biological survey for projects likely to impact the

natural habitats within this region. Consequently a fauna survey was undertaken (*ecologia* 2004a) and the outcome has contributed to the knowledge of terrestrial vertebrate fauna in the area.

The Point Coulomb Nature Reserve is the nearest conservation area to the project area and protects a variety of habitats. The habitat type present in the project area is well represented in the reserve. Issues and processes that have been identified as important to conservation planning and management in the future include the extinction of CWR mammals, wildfire, grazing and feral animals.

The Beagle Bay *Big Tree Country* Plantation area is located entirely within the Dampier Botanical District and is characterised by a homogeneous Pindan association comprising an open layer of trees 12-15m high over a layer of *Acacia* species and a grass ground cover on red sands (Beard, 1979). There are no known DRF or Priority flora populations within the project area. There is a known Priority Ecological Community approximately 12 km north of the project area (Lolly Well), in addition to a number of mound springs associated with the wetland systems.

Fire is the controlling agent of Pindan, and the Beagle Bay vegetation is subject to an uncontrolled fire regime of burns approximately every 1-3 years. Pindan is fire-adapted, though too frequent occurrence of intense fires can result in alteration of species composition and structure within the community.

5.15.4 Conservation Significance

The relative importance of areas impacted by the proposed development, including landscape, vegetation and fauna is partially determined by the ecological integrity of the area and the role it plays as part of a regional environment.

The Beagle Bay Plantation Project area is not considered to be of significant conservation value in terms of rare or priority flora or significant vegetation and therefore impacts of the project on the flora and vegetation are likely to be minor at the local, regional and State level.

At a local scale the project is not expected to be of major significance to the biota of the Dampier Peninsula as a result of the loss or replacement of localised populations of plants or animals.

5.16 Regional Fire Regime

5.16.1 Historical

Fire is an integral part of the natural Australian environment and has played a significant part in the evolution of Australian flora and fauna (Attiwill *et al.,* 1994). By the time the Aboriginals arrived approximately 40 000 years ago, fairly high-frequency fires were common, with lightning starting fires when forests were sufficiently dry (Commonwealth of Australia, 1984). Aboriginal burning probably affected the distribution of species and the vegetation pattern locally. Relatively clear patches of eucalypt forests, woodland and grasslands were maintained by frequent Aboriginal burning. European settlement of Australia caused significant changes in the intensity, frequency and seasonality of fires (Attiwill *et al.,* 1994). Europeans altered the pattern of species distribution that had previously been maintained by Aboriginal burning regimes.

5.16.2 Recent

Fire regimes have been changing dramatically, with increased fire frequency and fires burning at higher temperatures. Figure 5.13 displays the fire frequency on the Dampier Peninsula for the period from 1993 to 2003. In 1995 approximately 27 % of the Kimberley was affected by fire, and this increased to 34 % in 2000 (Climate Action Network Australia, 2003). Extensive frequent fires are a feature of the savannahs of northern Australia with fire interval being as short as 1-3 years. The dominant vegetation type of the region is tropical savannah woodland or Pindan (discontinuous trees over grass), but also contains much smaller communities of open and closed forests. The wet and dry seasons are not predictable from year to year, therefore, fuel production cannot be tied to a consistency of seasons. Fire frequency in the Kimberley region can be high, generally occurring at least biennially across most of the region.

Shifts in fire frequency can lead to changes in shrub/tree/grass ratios. Frequent burning promotes grassy open woodlands, while reduced burning frequency results in increased woody vegetation cover. The middle stratum of the vegetation is most affected by fire. Frequent fire has been found to suppress recruitment in woody species and the larger tree species are lost to the dominance of annuals (Russell-Smith *et al.,* 2003). Conversely, if fire is inhibited completely, there is a general decrease in the diversity of both annuals and larger perennials that require fire to set seed (Russell-Smith *et al.,* 2003). Moreover, mature species, such as *Acacia* spp., can be overcome by parasitic mistletoes such as *Lysiana spathulata* and *Dendrophthoe alsophila* (Kenneally *et al,.* 1996). However, the increase in fuel loads over time which remain unburnt for several years may increase the risk of high intensity fires, whether unplanned or prescribed, resulting in substantial mortality of trees. In some areas of northern Australia, markedly reduced fire activity or fire exclusion is thought responsible for the conversion of savannah grasslands into woodlands over long time scales.

5.16.3 Project Area Fire History

The fire-regeneration cycle in Pindan generally spans five to seven years, and if a low to moderate fire regime of four to seven years is maintained in a tropical savannah, woody vegetation will remain structurally stable (Russell-Smith *et al.,* 2003; Williams *et al.*, 2003). During the first few years of this regeneration cycle, sub-shrubs, grasses, and ephemeral and perennial vines diversify and proliferate, and are then succeeded by trees greater than two metres tall that regenerate from burnt saplings (Williams *et al.*, 2003). When fire is retarded and the intensity minimised, the vigour of vegetation structure at all levels best represents the pre-European landscape.

Excessive fires however, lead to the mortality of trees and shrubs. As a result of this fire frequency and other factors such as intensity and time of year, the middle storey is removed and in many areas of the Peninsula is devoid. As the middle storey is removed, grasses become more dominant and the landscape shifts to open savannah woodland.

The project site along with much of the Dampier Peninsula is subject to this regime. In 2000 and 2003 the project area was ravaged by hot late-season fires (Sept/Oct) fanned by strong south-east winds. A less intense mid dry season fire also occurred in 2002. Consequently, much of the middle level of shrubs and smaller trees has been burnt out, including plants that might otherwise have regenerated in a less frequent and less intense regime.

In the 25 ha trial site, fire has been excluded since late 2000. Firebreaks of varying widths were established around the trial planting plots and the perimeter of the site. None of the fires penetrated the outer fire-breaks. With the exclusion of fire, the middle level vegetation is regenerating and there has been an overall improvement in the health and vigour of the plant community.

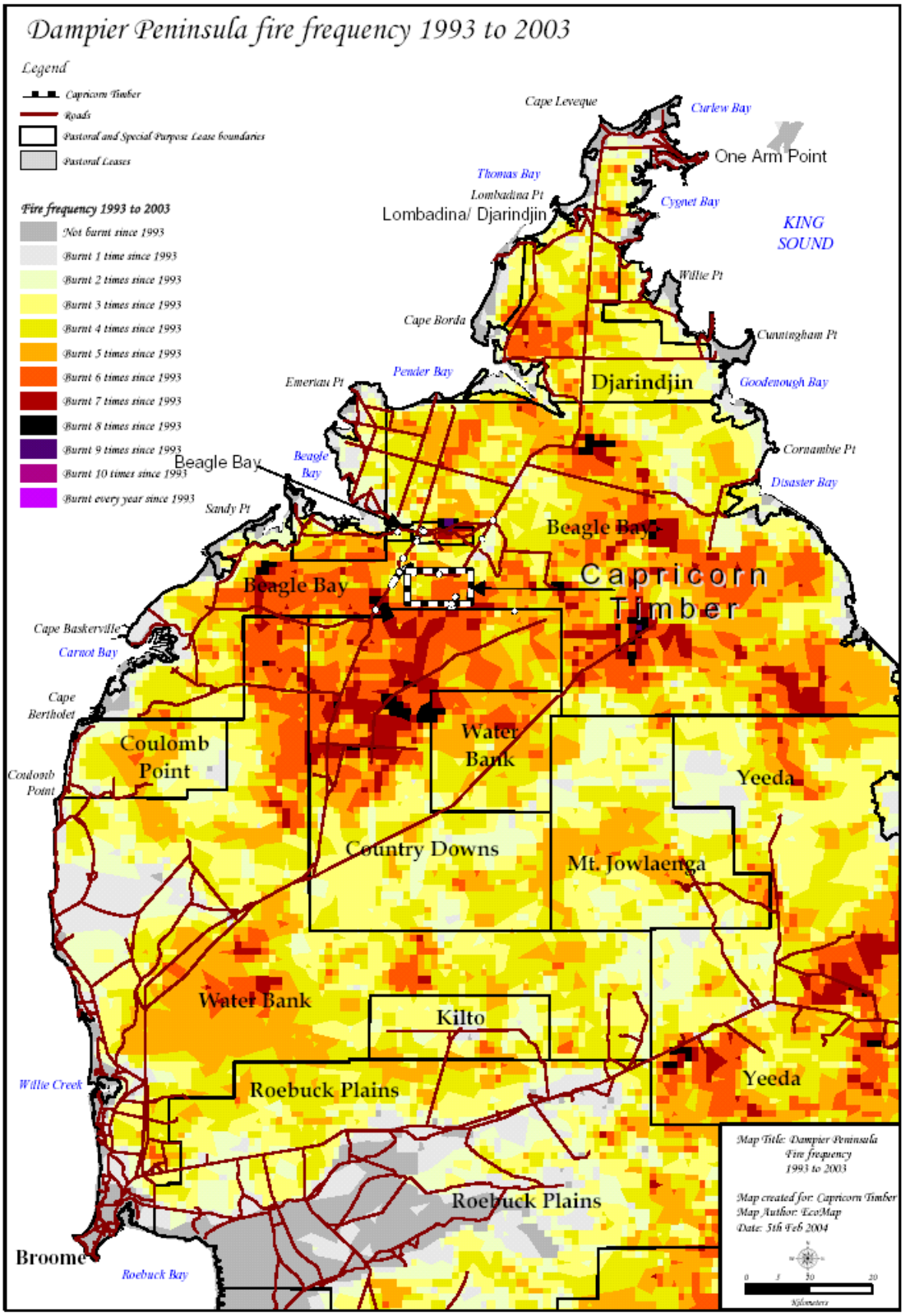


FIGURE 5.13: DAMPIER PENINSULA FIRE FREQUENCY 1993-2003.

5.17 Landuse & Tenure

5.17.1 Region

Human settlement dates back tens of thousands of years and is considered by some authorities to be at least 40,000 years. In the late 1900s the European colonisation of the Kimberley region began. The land was carved up into pastoral leases, mining leases and townsites were created. In the history of economic development of the Kimberley, there have been a number of substantial setbacks such as the failed cotton crop on the ORIA and sorghum crops at Camballin.

In more recent times there has been an upsurge in interest in the Kimberley. Major gas deposits have been discovered offshore, the horticulture industry is looking towards major expansion with projects such as the ORIA Stage 2 and aquaculture is seen as a potentially vibrant new industry. Tourism is also a significant and growing contributor to the regional economy.

5.17.2 Project Area

The land forms part of the 350,000 ha Aboriginal Reserve vested in the Aboriginal Lands Trust and leased by the BBC Inc. TTP has a sub-lease over a 25 ha trial site with the BBC Inc. The term of the sublease is a period of five (5) years, commencing from the 1st January 2001. Under the lease agreement document TTP has negotiated a 5000 ha/ 50 year lease option with BBC.

5.17.3 Conservation Estate

Nature Reserves are areas to be managed for nature conservation and scientific study. They have important nature conservation value, either as part of a conservation reserve system, as a remnant of native vegetation or because of the occurrence of particular species of flora and fauna. In Western Australia, Nature Reserves are vested in the Conservation Commission (CC) and managed by CALM.

Coulomb Point Nature Reserve

Coulomb Point Nature Reserve is located approximately 45 km South of Beagle Bay and has been declared a Class A Reserve for conservation of flora and fauna. The Coulomb Point Nature Reserve covers 28,676 hectares. Several plant communities are represented in the Coulomb Point Nature Reserve.

5.18 Social & Cultural Environment

5.18.1 Aboriginal Heritage

Dampierland

The actual dates of Aboriginal arrival on the Dampier Peninsula may never be known with certainty. However, excavation of a rock shelter at nearby Koolan Island revealed occupation in excess of 27,000 years (O'Connor, 1989). Until European settlement of the area, Aboriginal family groups camped at favourable sites on the coastal areas of the Peninsula on a semi nomadic basis. The abundance of shell middens, associated with anvil stones, suggests that they lived a coastal fishing, hunting and gathering lifestyle (Kenneally *et al,* 1996).

The first tangible reference to Australian Aborigines was made by William Dampier in 1688 when he encountered the Bardi people (Bindon, 1978). These people occupy the top end of the Peninsula south from Cape Leveque. There are 4 recognised tribal groups on the Peninsula. They include the Bardi, the Njulnjul, the Djabera Djabera and the Nimanburu. Traditionally, these groups lived on the marine resources of the region.

A number of these groups have re-located to Broome, Derby, and other settlements such as Beagle Bay. With the exception of the Bardi People, whose occupational history of tribal lands is virtually unbroken, there is currently little occupation of their traditional lands by tribal groups of the Peninsula.

Beagle Bay

The BBC, on the west coast of the Dampier Peninsula in Western Australia's remote north-west, is home to many Aboriginal people from the Kimberley region. Beagle Bay was named after the ship HMS Beagle by Commanders John Wickham and John Stokes, who explored the Peninsula in 1838. In 1899 the Catholic Church decided to create a 'mission for aborigines' at Beagle Bay that initially came under the control of Trappist Monks (Moncrief, 2001). In 1901 the Trappists left and the mission was placed in the care of the German Order of Pallottine Monks. With the introduction of the Aborigines Act of 1905, the government adopted a 'protection' and segregation policy toward indigenous people. Under this policy, children (now known as The Stolen Generation) were forcibly removed from their parents and their homelands and many Kimberley people were relocated to missions including Beagle Bay.

Beagle Bay has in the past few decades become well known for its Gothic-style church and more specifically its mother-of-pearl shell altar. The church was built entirely by hand by the monks and the local aboriginal people and took four years to complete (Moncrief, 2001).

Previous Surveys

The coast was the focus of aboriginal life in the region and the main camping areas were along its margins with concentrations of activity around the various natural springs. As well as a number of extensive archaeological sites along the coast, several significant ethnographic areas have been identified.

Locations away from the coast were used for short-term purposes such as hunting and gathering and quarrying. The archaeological evidence will, therefore, be in the form of small, low-density sites or areas of scattered artefacts with no discernable concentrations for such locations (Quartermaine, 2002).

There have been a number of archaeological sites recorded within the Dampier Peninsula as a result of previous surveys and independent research. These sites have been registered with the DIA. A search of the DIA sites database resulted in a listing of 21 sites, none of which are within the proposed project area.

The coastal areas of the Dampier Peninsula are typified by sandy plains (termed Pindan) with long, beaches, inlets and mud flats colonised by mangroves and rocky headlands with associated offshore reefs. Freshwater sources in the form of soaks are found all along the west and east coast of the Peninsula. Sometimes these occur in the intertidal zone and from prehistoric times, up to the present, provided both animals and man with essential water supplies (Bindon, 1978). The local people usually camped at some distance from a water source to create a minimal disturbance to animal exploitation patterns in the area. For this reason, the debris generated in a camping area near a water source tends to be widely scattered.

A survey for aboriginal sites in central Dampier Peninsula was performed for Esso Exploration in 1978 (Bindon, 1978) by the Museum of WA and encompassed the lease area of the current proposal. Throughout most of the survey area, there were few sites of aboriginal occupation. Many of the artefact scatters observed during the survey are situated within the coastal dunes and while not being more than 100m wide, extend laterally for a kilometre or more along the shoreline. Along the coast, there are almost invariably midden material and occupation sites.

Occasionally during the survey of the hinterland, flaked pieces of fine-grained siliceous rock were observed on deflated areas. The most likely explanation given for the occurrence of these utilised pieces

of stone is that they were lost or discarded by aboriginal groups travelling across the area (Bindon, 1978). Several informants told of how aboriginal groups would move from one coast, east or west, to the other to exploit different resources.

Several interesting tool types including shell knives, stone chisels, stone axes and blades used as knives or spearheads were also found during the survey of the coastal areas (Bindon, 1978). Some old bottle glass was discovered on sites which had been used within the five years previous to the 1978 survey. Aboriginal people from the Beagle Bay Mission were noted as going on camping trips to some of the sites recorded. At the Beagle Bay Mission, people over 70 years of age were interviewed and were able to supply information that indicated aboriginal visitation to many of the coastal sites extended virtually unbroken, back into pre-European times (Bindon, 1978).

The shell knives, made from an oval piece of baler shell mentioned in many ethnographic references and described in accounts by aborigines, indicate that these artefacts were used in the butchering of turtles and dugong. It is well known that baler shells and *Syrinx* were also used as water containers and broken fragments are readily available on most coastal sites (Bindon, 1978).

The midden scatters observed during the survey contain numerous shellfish species from rocky, sandy and estuarine environments; other faunal remnants on these sites include turtle carapace and bones from turtle and dugong.

An archaeological investigation and an ethnographic survey for Aboriginal heritage significance of the Cape Leveque road, north of Broome was commissioned by Main Roads Western Australia (Quartermaine, 2002). No registered sites were discovered within the designated survey area. No archaeological sites were discovered during the field inspection and none were expected, based on the completed work. The project area was characterised as flat and featureless with low archaeological site potential. Those areas of higher archaeological site potential such as lake margins, major creeklines and rock outcrops were not represented. Two ephemeral and largely unorganised drainage areas are associated with Bobby Creek and Kelp Creek. No archaeological material was discovered in the vicinity of either area.

One area of Aboriginal significance was recorded in the course of the survey within Bobby Creek (O'Connor, 2002). The current proposal does not impact on this area.

5.18.2 Native Title

The Djabera Djabera Native Title claim currently encompasses the project area.

5.18.3 Non-indigenous Heritage

A search has been conducted through the following sources in order to identify any sites of non-indigenous heritage that may be contained within the project area:

- Register of the National Estate Database – Australia's national inventory of natural and cultural heritage places compiled by the Australian Heritage Commission, the Commonwealth Government adviser on the National Estate.

- Register of Heritage Places - Heritage Council of Western Australia. This focuses on places, buildings and sites and is a list of places considered worth conserving. The *Heritage of Western Australia Act 1990* is official recognition by the community of its cultural heritage significance to Western Australia.

- Shire of Broome Municipal Inventory List – The Heritage Inventory process focuses on events and developments in Western Australian history since the arrival of European settlers. The inventory also includes buildings and sites associated with present day activities in the area.

The search yielded the following results:

- Register of the National Estate Database

Coulomb Point Nature Reserve. Coulomb Point Nature Reserve is located approximately 45 km South of Beagle Bay and has been declared a Class A Reserve for conservation of flora and fauna. The Coulomb Point Nature Reserve covers 28, 676 hectares. It is a known breeding area for endangered species, *e.g.* Bilby *Macrotis lagotis*, Nail-tailed Wallaby *Onychogalea unguifera* and for the rare Golden-backed Bandicoot *Isoodon auratus auratus*.

Point Coulomb Area, Broome Beagle Bay Rd, Broome. The point Coulomb area is part of the Dampier Peninsula and has aesthetic values for the local Dampier Peninsula community.

- Register of Heritage Places WA. One site was identified in the general vicinity but outside the immediate project area:

Beagle Bay Mission Church (Sacred Heart Church). The church has cultural heritage significance for the following reasons:

  - The place is closely associated with the work of missionaries and attempts to induct Aboriginal people into the Christian faith;
  - It is highly valued by the mission community for their considerable involvement in its establishment and contributes to their sense of place; and
  - The place illustrates the early European occupation of a previously isolated portion of the state.

- Shire of Broome Municipal Inventory List. This is not a statutory list. One site was identified within the vicinity of the project area:

Beagle Bay Mission Church (Sacred Heart Church).

None of these sites are within the project area or its immediate hinterland and will therefore not be impacted upon.

5.18.4 Demography

The Kimberley Region occupies an area of 421,451 square kilometres and is home to around 33,705 permanent residents (Regional Development Council of Western Australia, 2002). There are seven towns in the area accounting for the majority of the population, of which Broome is the largest with an estimated permanent population of 13,921 in June 2003 (ABS, 2004).

The project area lies within Aboriginal Reserve 1834.

Beagle Bay is located on the Dampier Peninsula within the Kimberley region of Western Australia, situated within the Shire of Broome. The population of Beagle Bay is approximately three hundred. Forty-six locals are employed in running the community, which includes a general store, medical centre,

powerhouse, offices and workshops. An additional one hundred people live in outstations located within the Beagle Bay reserve.

The major proportion of employees for the TTP project are to be sourced from the BBC.

PART THREE: ENVIRONMENTAL IMPACTS & MANAGEMENT

6.0 BIOPHYSICAL IMPACTS & MANAGEMENT

This Section identifies the environmental factors likely to be associated with the project and discusses each environmental factor as it applies to the project. Each factor includes reference to the EPA objective, the policy and technical framework which applies to that factor, predicted and potential environmental impacts and management of the proposal to achieve the EPA objective and concludes with a statement of the predicted outcome and TTP's Commitments to that objective.

An EMS will be the main operational tool through which effective and consistent management of environmental issues will be achieved. The Environmental Management System (EMS) is the principal supporting document for the PER and includes environmental management of all issues discussed in this PER document, which are addressed in Part 3 under the following headings:

BIOPHYSICAL
- Vegetation Communities
- Threatened Ecological Communities
- Rare and Priority Flora
- Terrestrial Vertebrate Fauna
- Specially Protected (Threatened) Fauna
- Invertebrate Fauna
- Fire Management
- Watercourses
- Groundwater
- Greenhouse Gas Emissions
- Landscape Values
- Decommissioning and Rehabilitation

POLLUTION MANAGEMENT
- Surface Water Quality
- Groundwater Quality
- Particulates and Dust
- Waste Materials
- Noise

SOCIAL SURROUNDINGS
- Aboriginal Culture and Heritage
- Non-indigenous Heritage

6.1 Vegetation Communities

6.1.1 EPA Objectives

- *Maintain the general abundance and diversity of species.*
- *Maintain the geographic distribution and productivity of vegetation communities.*

The State and Federal Government has endorsed the National Strategy for Conservation of Australia's Biological Diversity and the NSESD which require the protection and preservation of biological

diversity. In particular, one of the core ESD objectives is to "…protect biological diversity and maintain essential ecological processes and life support systems."

6.1.2 Potential Impacts

The project will require the clearing of land for replanting with exotic tropical timber and native species, the upgrade of existing infrastructure and construction of access roads and drainage. This clearing will result in the loss or replacement of natural vegetation with commercially viable tree crops and native species to be trialled in research programs. As a consequence, there is to be a corresponding loss of selected indigenous species and alteration of fauna habitat.

During the planting phase of the project, the direct impact on vegetation communities will be the removal of native flora and replacement with a commercially viable culture of trees.

Indirect impacts on vegetation may include the following:

- Risk of weed infestation or spread; and
- Dust generation.

6.1.3 Predicted Impacts

Impacts from Clearing
Initial clearing of the project area to allow for replanting with commercially viable timber species will result in the direct loss of natural vegetation. Clearing of 967 ha of natural vegetation is anticipated. The Pindan vegetation of the project area is widely occurring in the region and is not considered to be of particular conservation significance at the State, regional, or local level. The amount of clearing in a local and regional context is considered to be minimal. The impacts to vegetation through clearing will be minor.

TABLE 6.1: AREA OF NATIVE VEGETATION TO BE CLEARED FOR DEVELOPMENT OF PLANTATION.

Aspect	Required Clearing
Plantation Plots	900 ha
Firebreaks	30 ha
Access Roads	32 ha
Associated Infrastructure	5 ha

As discussed in Section 5.8, the project area does not contain any restricted or significant vegetation communities.

Impacts predicted include alteration to drainage resulting from the construction of access tracks which may influence sheet flow patterns.

Impacts from weeds

Weeds can be a significant cause of disturbance to native vegetation because they can compete with native species for space, nutrients and water, and can alter the composition and structure of vegetation communities. These problems may be particularly acute in the ground layer where introduced grasses and herbs invade and then preclude other species. In some cases weeds may carpet the ground, thereby minimising opportunities for seedlings to establish.

Within the project area weed invasion has not previously been significant, with no weed species recorded during the *ecologia* (2004a) survey. There is the opportunity for the introduction of weeds to the project area with nursery stock. The spreading of weeds can arise as a result of earthmoving activities and vehicle movements. TTP's proposed Weed Management procedures will include methods to reduce the invasion and spread of environmental weeds into the project area and will ensure that declared weeds are not introduced to the area. Impacts from weeds are therefore expected to be minimal.

Although two declared weed species have been recorded north of the plantation site within the Bobby's Creek wetland system, it is unlikely that either species will be spread into the project area. The weed species of greatest environmental concern is the highly invasive tropical weed **Passiflora foetida.* This species is spread by birds which feed on the fleshy fruit and will rapidly invade areas of disturbance once established.

Impacts from Dust

The main source of dust will be clearing and vehicle traffic on access roads. The generation of dust would pose a risk to nearby vegetation because it accumulates on the leaf surfaces of plants, thereby reducing the ability of the plant to photosynthesise. This is expected to be a limited localised impact that may affect vegetation along access roads, and the boundaries of cleared areas but only impinges on plants within a few metres of the road or cleared area (see Section 7.3).

Impacts from Groundwater Changes

There are no significant impacts expected from the potential lowering of the water table as a result of groundwater abstraction for the purposes of irrigating the timber plantation.

6.1.4 Management

Management and monitoring of vegetation impacts are addressed in detail in the project EMS. Strategies to be employed in the management of impacts associated with natural vegetation within the plantation area will include:

- Damage to native vegetation will be minimised by a 'minimum clearing' policy, with areas to be cleared only when required and necessary;
- Clearing boundaries to be well defined in the field;
- Retention of habitat corridors where practicable;
- Establishment of firebreaks;
- Personnel will be inducted into the importance of minimising disturbance to existing vegetation;
- Stripping and stockpiling of top soil, vegetation debris, logs and leaf litter for rehabilitation;
- Disturbed areas to be recovered with topsoil to a depth of 100 mm where practicable;
- Identification of environmental/ecologically sensitive areas or vegetation of conservation value;
- Implementation of weed management;
- Implementation of dust suppression when necessary;
- Fire prevention, reporting and procedures to follow in the event of a fire;
- Floodways and culverts to be used where necessary to minimise changes to natural surface drainage;
- Careful selection of access track layout so that alteration of drainage does not impact on vegetation and flora;
- Rehabilitation of site following completion of project;
- Local provenance seed material to be used for seeding during rehabilitation;
- Quantitative monitoring of vegetation regrowth in rehabilitated areas;
- Areas displaying inadequate regrowth will receive remedial work;

- Rehabilitation will occur upon decommission; and
- Topsoil and plant debris to be returned to the floor which will be contour ripped, where practicable, to promote vegetation regrowth;

6.1.5 Predicted Outcome

The predicted outcome of the project is:

- Loss of natural vegetation through clearing.

The predicted area to be cleared is approximately 967 ha. Establishment of the 900 ha plantation area will be carried out in 3 stages of 300 ha plantings per annum.

There are no restricted or significant vegetation communities within the project area. Following initial clearing and planting of crop trees, a proportion of the natural understorey will be allowed to regenerate within the plantation plots. Natural vegetation and habitat will be retained in all areas of the Lease that are not directly required for plantation plots, access tracks and other infrastructure or fire breaks. The retained natural vegetation/habitat will also be protected from fire.

COMMITMENT 1: TTP will develop and implement a weed management plan, including implementation of weed hygiene procedures.

COMMITMENT 2: TTP will develop and implement a dust management plan for construction and operation, which will include a dust monitoring program.

6.2 Priority Ecological Communities and Groundwater Dependent Ecosystems

6.2.1 EPA Objectives

- *Protect Threatened Ecological Communities, consistent with the objectives of the CALM Draft Policy Statement No. 9: Conserving Threatened Species and Ecological Communities.*

6.2.2 Potential Impacts

The assemblages of the Lolly Well Springs wetland system have been placed on the CALM Priority Ecological Communities list which functions as a reserve list for CALM recognised TECs. Priority TECs that do not meet the stringent survey criteria for the assessment of TECs are added to the Department's Priority Ecological Communities List. An explanation of Conservation Codes for Threatened and Priority Ecological Communities is included in Table 6.2 below. The Lolly Well Springs have been listed as Priority Four.

6.2.3 Predicted Impacts

The Lolly Well Springs are fed from the Broome Sandstone aquifer and are located approximately 1-2 km from the BBC township and approximately 12 km from the project site. The springs comprise wetland complexes and low organic mound springs. The vegetation communities of Lolly Well Springs are endemic to the area, with a total area of < 50 ha (CALM, 2003). Significant threats to the Lolly Well Springs have been identified by CALM as follows:

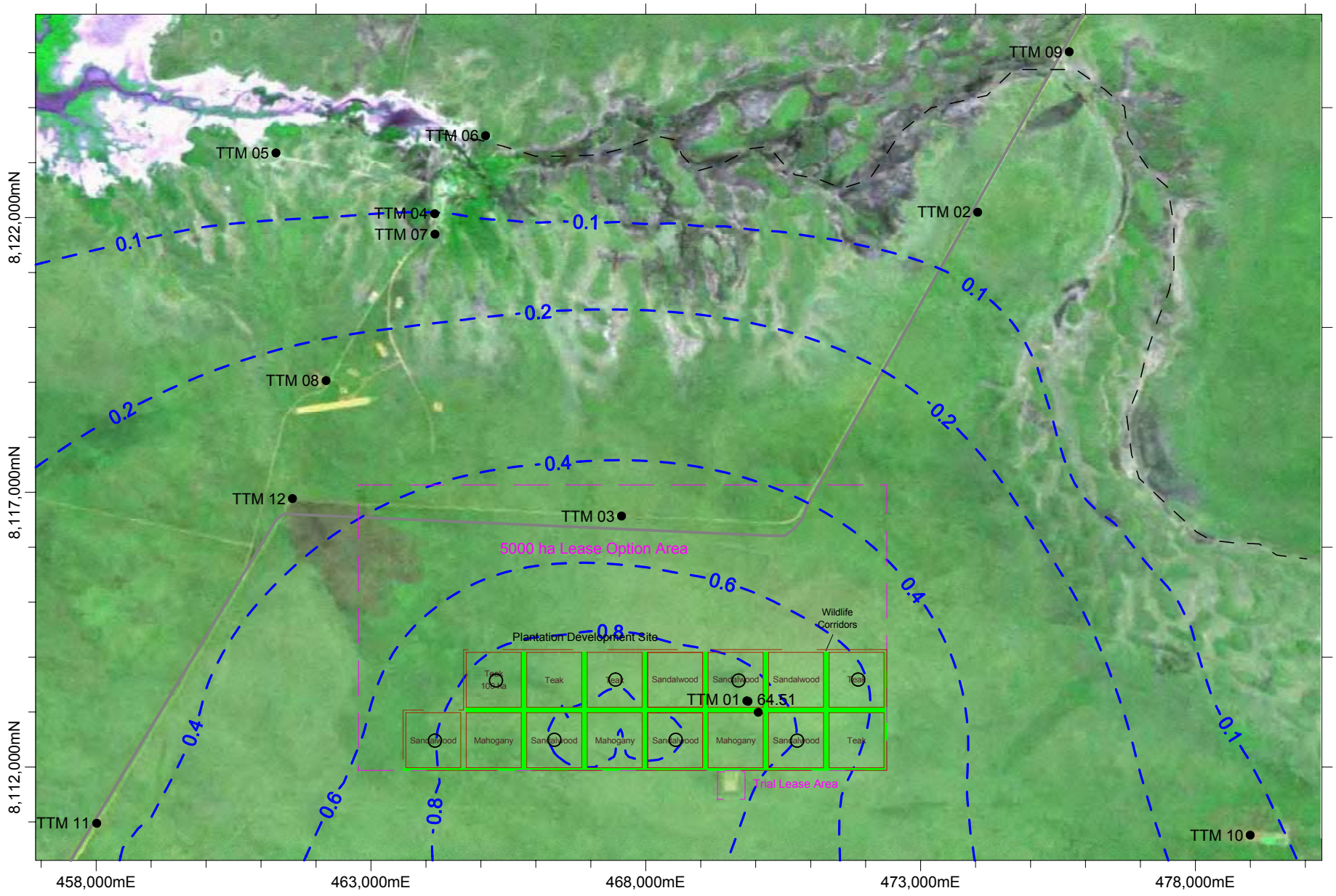
- Illegal rubbish dumping;
- Fire;
- Cattle grazing;
- Weed invasion; and
- Invasion by feral fish.

The potentiometric head in the aquifer in this area is about 7.5 to 10 m AHD (Figure 5.2) and in low-lying areas along Bobby's Creek the head is up to 3 m above ground level and artesian flows, maintaining the mound springs, occur where there are favourable geological conditions and the groundwater is piped to the surface (Rockwater, 2004a). Water levels in the mound springs will vary depending on seasonal, atmospheric and tidal conditions affecting loading on the aquifer. In addition, they will be directly affected by any nearby flowing artesian bores such as the bore maintaining the swimming hole north of the BBC.

TABLE 6.2: CONSERVATION CATEGORIES FOR THREATENED ECOLOGICAL COMMUNITIES

Code	Definition
Critically Endangered (CR)	Subject to major contraction in area OR was already of limited distribution, and is in danger of severe modification or destruction in the immediate future.
Endangered (EN)	Subject to major contraction in area OR was already of limited distribution, and is in danger of significant modification or destruction in the immediate future.
Vulnerable (VU)	Declining or declined in distribution and/or condition and whose ultimate security has not been secured OR still widespread but will become CR, EN or PD in the near future if threatening processes continue or begin to operate.
Presumed Destroyed (PD)	No examples left OR has been extensively modified that it is unlikely to recover in the foreseeable future.
Priority Ecological Communities	P 1 – Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation and for which current threats exist. P 2 – Communities that are known from few small occurrences, all or most of which are actively managed for conservation and not under imminent threat of destruction or degradation. P 3 – Poorly known ecological communities. P 4 - Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list. These communities require regular monitoring. P 5 - Conservation Dependent ecological communities.

The hydrogeological investigation and modelling studies (Rockwater 2004e) indicated that pumpage at 4.5 GL/a over a period of 20 years, may result in a slight lowering of the groundwater level by 19 mm at Bobby's Creek (Figure 6.1).



20y4-5dds.dat/.grd/.srf

Figure 6.1

CLIENT: Tropical Timber Plantations

PROJECT: Beagle Bay Project

DATE: December 2004

Dwg. No: 296.0/04/1-1

MODEL-CALCULATED GROUNDWATER LEVEL DRAWDOWNS (m) LAYER 1 AFTER 20 YEARS PUMPING AT 4.5 GL/yr

Rockwater Pty Ltd

6.2.4 Management

- Five environmental (shallow) monitoring bores have been placed adjacent to mound springs and upstream of the Cape Leveque Road – Bobby's Creek crossing (Plate 6.1 & 6.2; Figure 5.6). Water levels will be measured fortnightly, except during the wet season when they may become inaccessible;
- Twenty-five vegetation quadrats will be permanently marked and monitored annually;
- EWR criteria will be set to minimise potential impact to the wetlands from groundwater extraction;
- The Environmental Water Provision (EWP) criteria will be monitored and if the criteria are breached then abstraction will be shut down;
- During the construction phase aquatic fauna monitoring will be undertaken in the Bobby's Creek wetlands as per the Australian River Assessment System (AusRivAs) protocol (Davies 1994); and
- Investigations will be undertaken to determine the relationship between GDEs and selected tree species and the groundwater table within the Bobby's Creek wetlands.

These are to be updated following monitoring, analysis, assessment and further modelling projections based on actual pumpage.

6.2.5 Predicted Outcome

Currently, groundwater modelling indicates that the proposed abstraction of 4.5 GL/a over the lifespan of the project may result in lowering of the groundwater levels by 19 mm at Bobby's Creek. It is highly unlikely that this small change could be distinguished from changes in the groundwater level arising from seasonal and long-term variations in rainfall (Rockwater 2004d; See Appendix F).

TTP have committed to additional groundwater monitoring at both the plantation site and in the vicinity of Beagle Bay and Bobby's Creek. This will enable the groundwater model to be re-calibrated to provide a more accurate picture of the impacts of water abstraction on the groundwater levels.

Implementation of groundwater monitoring and management procedures detailed in the project EMS and Groundwater Licence Operating Strategy (GLOS) will ensure that groundwater contamination and excess drawdown risks are minimised.

COMMITMENT 3: TTP will monitor groundwater levels within the Bobby's Creek wetland system to the north of the project area.

COMMITMENT 4: TTP will monitor the Groundwater Dependent Ecosystems (GDEs) north of the project area.

COMMITMENT 5: TTP, in consultation with CALM and the DoE, will monitor flora and fauna aquatic indicator species of the Groundwater Dependent Ecosystems (GDEs) north of the project area.

PLATE 6.1 ENVIRONMENTAL MONITORING BORE LOCATED AT BOBBY'S CREEK SOUTH OF THE BROOME-CAPE LEVEQUE ROAD.

PLATE 6.2 ENVIRONMENTAL MONITORING BORE AT DONKEY SPRING.

6.3 Rare & Priority Flora

6.3.1 EPA Objectives

- *Protect Declared Rare and Priority Flora, consistent with the provisions of the Environmental Protection and Biodiversity Conservation Act 1999 and the Wildlife Conservation Act 1950.*
- *Protect other flora species of conservation significance.*

The policy framework is set by the WA *Wildlife Conservation Act* 1950 and the EPBC Act 1999. Declared Rare Flora (DRF) are protected under the Western Australian Wildlife Conservation (Rare Flora) Notice 2004 of the *Wildlife Conservation Act 1950*. The notice lists protected flora taxa that are extant and considered likely to become extinct or rare. The Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* lists Endangered, Vulnerable or Extinct Species.

The flora surveys commissioned by TTP have added significantly to the existing knowledge of the status of flora within the Dampier Peninsula.

6.3.2 Potential Impacts

The primary impacts to flora associated with the project will be the direct loss of individual plants through clearing.

6.3.3 Predicted Impacts

Recent surveys (*ecologia* 2003a) have indicated that no DRF or Priority Flora exist within the project area. However, one occurrence of the Priority 3 species *Phyllanthus aridus* was recorded approximately 100 m from the project area during the *ecologia* (2003a) survey. There is the potential for this species to also occur within the project area. Eight species of Priority flora are known to occur within the vicinity of the Beagle Bay Plantation site, six of which have been recorded from within the Bobby's Creek complex approximately 12 km north of the plantation (Table 6.3).

It is unlikely that *Nymphoides beaglensis* or *Stylidium costulatum* would occur in the project area due to the lack of permanent water bodies and the Pindan substrate is unlikely to support *Gomphrena pusilla* or

Aphyllodium parvifolium. However, the soil and vegetation of the Project Area is compatible for *Aphyllodium glossocarpum, Triodia acutispicula* or *Glycine Pindanica*.

Four species of Priority flora potentially occur within the plantation site (Table 6.3). Although likely to have been recorded during the two surveys conducted by *ecologia* (2003a) if present, the occurrence of these species within the plantation site cannot be excluded. Therefore, targeted DRF and Priority flora surveys of all areas to be cleared will be undertaken and if any Priority flora species are recorded, then a Priority Flora Management and Conservation Plan will be devised (see below).

Ongoing groundwater monitoring will be undertaken and staging of the project will ensure that any impacts can be identified and addressed at an early stage.

6.3.4 Management

TTP will comply with the Wildlife Conservation Act by undertaking the following:

- Measures to limit the extent of clearing of natural vegetation will be implemented;
- Existing procedures for vegetation management listed in Section 6.1 will be applied;
- Existing procedures for groundwater management listed in Section 6.9 will be applied;
- Due to the potential for four Priority species to occur within the plantation site, targeted Rare and Priority flora surveys will be undertaken prior to clearing to ensure that no potential species of conservation significance are inadvertently cleared; and
- TTP will implement a Priority Flora Management and Conservation Plan for the Project to address management of Priority Flora, should any be found within the Project Area. This plan will be formulated in close liaison with staff from CALM to ensure that it complies with CALM Policy and State and Federal legislature, and will incorporate measures to shift the plantation to avoid significant populations, translocation of smaller populations, and potential seed harvesting and propagation of Priority 1 species.

TABLE 6.3 PRIORITY FLORA SPECIES RECORDED WITHIN THE BEAGLE BAY AREA

Species	Priority	Species Description	Population Records
Aphyllodium parvifolium	P1	Small prostrate shrub growing to 10 cm. Flowers are mauve and produced in April. Favours sandy substrates in sand dunes.	Bobby's Creek (*ecologia* 2004b) – 10 plants. Three populations in the Great Sandy Desert.
Glycine Pindanica	P1	Prostrate or scrambling perennial, herb or climber. Flowers pink, blue, purple from Feb–Mar/Jun. Occurs on Pindan soils. **Potentially occurs.**	15 km NNE of Beagle Bay Community. Fourteen populations within the Dampier Peninsula.
Gomphrena pusilla	P2	Small semi-prostrate to sprawling annual herb growing to 20 cm high. Produces flower spikes between April and June. Favours fine sandy substrates.	Bobby's Creek (*ecologia* 2004b) – 10 to 20 plants. Five additional populations within the Dampier Peninsula and Pilbara.
Nymphoides beaglensis	P2	Aquatic annual, herb. Flowers white, pink, purple, from Mar–Jun. Grows in shallow freshwater, usually at edges of permanent waterholes or in seasonally inundated claypans & depressions.	Four populations recorded at Bobby's Creek near Beagle Bay (*ecologia* 2004b) – 10 to 20 plants per population. Nine additional populations in the Dampier Peninsula and North Kimberley.
Aphyllodium glossocarpum	P3	Spreading or erect shrub, to 1.2 m high. Flowers pink, purple from Apr–Oct. Occurs in sand and Pindan. **Potentially occurs.**	Bobby's Creek (*ecologia* 2004b) – 10 to 20 plants. Seven additional populations within the Dampier Peninsula and North Kimberley.

Species	Priority	Species Description	Population Records
Phyllanthus aridus	P3	Erect, much-branched shrub growing to 0.25 m with cream/green flowers between May and June. Prefers sandstone, gravel and red sand. **Potentially occurs.**	100 m east of plantation site (*ecologia* 2004a) – 10 to 20 plants. Twenty three additional populations in northern Australia.
Stylidium costulatum	P3	Erect, tufted annual, herb, to 0.1(–0.2) m high. Flowers yellow, orange, red, from Apr–Aug. Occurs on sandy or clayey soils, along creeks or seasonally wet areas.	Three populations recorded at Bobby's Creek (*ecologia* 2004b) – 10 to 20 plants per population. Ten additional populations in central and west Kimberley.
Triodia acutispicula	P3	Tussock-forming resinous perennial grass that grows to heights of 0.5–1.5 m. Cream to brown flowers are produced between January and April. Prefers sandy soils on river levees, Pindan plains, rocky hill slopes and outcrops. **Potentially occurs.**	Four populations recorded at Bobby's Creek (*ecologia* 2004b) – 10 to 30 plants per population. Eleven additional populations within the Dampier Peninsula and North Kimberley.

6.3.5 Predicted Outcome

No DRF or Priority Flora have been previously recorded within the TTP project area. However, the Priority 3 species *Phyllanthus aridus* was recorded approximately 100 m from the Project Area during the *ecologia* flora survey (2003a).

Eight Priority Flora species have been recorded within the vicinity of Beagle Bay. There is the potential for two of these species, *Glycine pindanica* (P1), *Phyllanthus aridus* (P3), *Aphyllodium glossocarpum* (P3) and *Triodia acutispicula* (P3) to occur within the project area. *Nymphoides beaglensis* (P2) or *Stylidium costulatum* (P3) are more likely to be associated with wetland systems, the impacts and management of which are discussed in Section 6.2. The remaining two species prefer substrates that do not occur within the plantation site.

COMMITMENT 6: *Undertake Rare and Priority flora surveys in areas to be cleared prior to disturbance.*

A Priority Flora Management Plan will be implemented if necessary.

6.4 Terrestrial Vertebrate Fauna

6.4.1 EPA Objectives

- *Maintain the general abundance and diversity of species.*
- *Maintain the general abundance, species diversity and geographical distribution of terrestrial fauna.*

The State and Federal Government endorsed, 'National Strategy for Conservation of Australia's Biological Diversity' and the NSESD require the protection and preservation of biological diversity. In particular one of the core ESD objectives is to "…protect biological diversity and maintain essential ecological processes and life support systems."

6.4.2 Potential Impacts

As a result of plantation establishment and operations, localised impacts to fauna are possible. These may result directly from clearing, construction of access tracks, use of chemicals and changes to land use. Indirect impacts may result from to the change in habitat type, human presence, introduction of exotic competitors or fragmentation / isolation of populations.

Direct impacts to Fauna:

- Introduced Species - Introduced flora may alter habitat. Introduced fauna may compete aggressively with native fauna for habitat and resources.
- Disturbance - Activity associated with the establishment and operation of the plantation may affect nearby fauna.
- Road deaths - An increase in road fauna deaths is likely where new access roads are constructed. Increased traffic on the existing Broome to Cape Leveque Road will result from workers commuting to and from the BBC and the provision of goods and services to site, this is also likely to increase the occurrence of road fauna death on the main road.

Indirect Impacts to Fauna:

- Loss of Habitat - Apart from the direct loss of fauna due to clearing, removal of fauna habitat reduces the availability of shelter and foraging areas, and causes displacement of local fauna populations. Loss of fauna may result in reduced species diversity in an area. Loss of species from animal communities may influence ecosystem functioning.
- Human presence and activity is often associated with a change in fire regimes, leading to degradation of natural ecosystems.

Summary of Potential Impacts to Fauna:

- Loss of fauna habitat, food and shelter resources;
- Death of non-mobile fauna;
- Reduced abundance of local fauna;
- Predation on native fauna by introduced fauna;
- Disturbance to fauna activity patterns;
- Disturbance to fauna movement patterns through barriers and habitat fragmentation;
- Death and injury to individual fauna;
- Changes to fauna populations;
- Changes to fire regime;
- Contamination of habitat; and
- Vegetation / habitat changes.

6.4.3 Predicted Impacts

Clearing: Loss of fauna and fauna habitat

The single most widespread environmental impact arising from the project will be the clearing of native vegetation and consequent loss of fauna and fauna habitat. Habitat loss will specifically affect those species dependent on the habitat. During the clearing for the project there will be an initial mortality of fauna. The greatest loss of animals will be the smaller, less mobile mammal species, reptiles and burrowing animals. Daytime tree hollow dwellers, such as bats and nocturnal birds may also be lost.

Plantation Practices: Indirect loss of fauna and fauna habitat

Introduced plant species successfully and rapidly invade areas cleared of native vegetation or otherwise disturbed by humans, thereby altering the nature of fauna habitats. This may include the area cleared for the plantation. Exposed areas of soil are rapidly colonised by exotic weed species, often at the expense of native plants. Introduced plant species may replace native species that provide shelter or foraging areas for native fauna. Major changes to the structure of the vegetation will alter the fauna habitat and consequently may influence fauna species composition.

To control possible weeds and regrowth (that may have a negative effect on the plantation species), knock-down herbicides will be used. Together with pesticides and fungicides there is a risk of contact with local fauna and damage to surrounding fauna habitat.

An increase in human activity is often associated with an increase in the abundance of introduced species such as the Feral Cat *Felis catus*. This may be due to the higher risk of introduction and decline in habitat health. The Cat is known to predate upon and compete against native species, severely disrupting the natural balance. In many situations in south-western Australia and Australia in general, loss of native species, particularly mammals, has been attributed in great part to the spread of feral predators, particularly the Cat (Kinnear, 1993). Cats are also known to take a variety of other prey, including birds and reptiles (Bamford, 1995). The Cat is likely to consume native species of reptiles, birds and small mammals in the area, hence it is important to ensure that populations of feral predators do not increase.

Invertebrate Pests (native termites): Influence on the dynamics of local populations

Evidence of the Giant Northern Termite *Mastotermes darwiniensis* has been noted within the proposed plantation site (Willing and Dureau, 2000). Willing and Dureau (2000) also noted two active colonies of the Spinifex Termite *Nasutitermes triodiae* during their survey. As many of the plantation trees are susceptible to termite attack, baiting for termites will be required. This has the potential to impact the dynamics of the local termite fauna population.

6.4.4 Management

The management of fauna issues are dealt with in the project EMS and are summarised below:

- *Clearing: Loss of fauna and fauna habitat*

To minimise the loss of fauna and fauna habitat, where possible the natural mid- to under-storey vegetation and fauna microhabitat will be maintained within the timber plantation. In addition, habitat corridors will be retained to facilitate the maintenance of local flora and fauna populations.

All clearing operations will be kept to a minimum. Clearing will be staged in order to allow mobile fauna species to relocate into surrounding habitats. Where practicable, clearing will be undertaken outside the main breeding season for birds and mammals.

- *Plantation Practices: Indirect loss of fauna and fauna habitat*

The use of knock-down herbicides to control weeds has the potential to further damage local fauna and fauna habitat. Where possible, the use of pesticides and fungicides will be applied directly to the root zone through the irrigation system thereby minimising any risk of contact with local fauna.

- *Invertebrate Pests (native termites): Influence on the dynamics of local populations*

To reduce the impacts from the baiting of the Giant Northern Termite *Mastotermes darwiniensis*, the planned method of control will be highly targeted and the pesticide application rates will be low.

6.4.5 Predicted Outcome

Based on the current plantation plans, there will be a limited loss of fauna habitat and associated direct impacts to fauna individuals and populations. Some loss of larger fauna is expected from road fauna deaths, but these impacts will be minimised by appropriate management.

The regional impact on fauna is expected to be negligible as representation of fauna habitats and their associated communities will be maintained in the project area and surrounds.

6.5 Specially Protected (Threatened) Fauna

6.5.1 EPA Objective

- *Protect Specially Protected (Threatened) Fauna consistent with the provisions of the Wildlife Conservation Act and the EBPC Act.*

The policy framework for this environmental factor is provided by the *WA Wildlife Conservation Act 1950* and *Environment Protection and Biodiversity Conservation Act 1999*.

6.5.2 Potential Impacts

None of the species of fauna recorded during the fauna survey are of significant conservation importance.

The Gouldian Finch *Erythrura gouldiae* and Red Goshawk *Erythrotriorchis radiatus* which are listed as Endangered and Vulnerable under the EPBC Act respectively have the potential to occur within the area, however the project is unlikely to significantly impact these species. Gouldian Finches occupy two different regions of the landscape on an annual cycle. In the dry season, and part of the late wet season between February and October, they nest within *Eucalypt* hills. The birds follow the heavy rains southward into lowland drainages and start breeding when they reach the southern half of their range. The Red Goshawk occurs at low densities and is infrequently encountered.

No TECs are known from the project area and no species of State significance are likely to be impacted by the development.

There is the potential for species of Regional Significance to occur in the project area, including the Little North-western Mastiff Bat *Mormopterus loriae cobourgiana*, Bush Stone-curlew *Burhinus grallarius*, Australian Bustard *Ardeotis australis*, Grey Falcon *Falco hypoleucos*, the elapid snake *Simoselaps minimus* and skink *Lerista separanda*. However, none of these species have been recorded from within the project prea and the project is unlikely to significantly impact any of them.

The project will only result in the clearing of less than 0.001 % of the Dampier Peninsula. Given the limited habitat diversity and the widespread occurrence of all the habitat types/vegetation associations, there do not appear to be any features of regional significance to fauna within the project area.

6.5.3 Predicted Impacts

No species of Specially Protected (Threatened) Fauna or habitat of conservation significance are known to occur within the project area. The project is unlikely to have an impact on any Specially Protected (Threatened) Fauna or significant habitat.

6.5.4 Management

The following management actions will be implemented to mitigate impacts on fauna species of conservation significance potentially occurring within the plantation site:

- All staff will be provided with information handouts describing fauna species of conservation significance that may potentially occur within the plantation site and will be alerted to the significance of these species; and
- Should any species of conservation significance be observed within the plantation site then a management plan will be implemented accordingly.

6.5.5 Predicted Outcome

Negligible impacts are expected in the vicinity of the proposed project area due to the absence of any fauna or habitat of particular conservation significance.

6.6 Invertebrate Fauna

6.6.1 EPA Objective

- *Maintain the general abundance and diversity of species*
- *Maintain the general abundance, species diversity and geographical distribution of terrestrial fauna*

The State and Federal Government endorsed, 'National Strategy for the Conservation of Australia's Biological Diversity' and the NSED require the protection and preservation of biological diversity. In particular, one of the core ESD objectives is to "...protect biological diversity and maintain essential ecological processes and life support systems."

6.6.2 Potential Impacts

As a result of the proposed project, there is likely to be limited localised impacts to the invertebrate fauna community. These may result from clearing of vegetation and plantation management practices.

Direct Impacts to Fauna

- Death of Fauna - Direct loss of invertebrate fauna is likely due to the clearing of natural vegetation.
- Introduced Species - An increase in human activity and disturbance to native vegetation is often associated with an increase in the abundance of introduced species and many agricultural pests. In particular, the native Northern Giant Termite *Mastotermes darwiniensis* is able to exploit the unstable habitat presented by recently cleared bushland and has been recorded within the project area. It has the potential to destroy both the living trees and harvested timber, posing a threat to

the plantation. Some ant species, such as *Iridomyrmex sanguineus* and *Solenopsis geminate* are natural predators of this termite.

Indirect Impacts to Fauna

- Loss of habitat - Apart from the direct loss of invertebrate fauna due to clearing, removal of habitat reduces the availability of shelter and foraging areas and may result in loss of species diversity.
- Introduction of non-native tree crops into the ecosystem - May cause a decrease in the diversity of native species present. Local species may be out-competed by r-strategists (typically pest species) that are more suited to a disturbed ecosystem, in this case a plantation of tree crops.

Summary of potential impacts to invertebrate fauna:

- Death of non-mobile invertebrate fauna;
- Localised loss of fauna habitat, food and shelter resources;
- Localised reduction of abundance and diversity of local fauna;
- Potential increase in abundance of agricultural pest species;
- Competition with and potential displacement of species unable to exploit the new conditions;
- Disturbance to fauna activity patterns;
- Changes to fauna populations; and
- Vegetation/ habitat changes due to fire.

6.6.3 Predicted Impacts

One of the impacts on invertebrate fauna arising from the development of the project will be the loss and degradation of fauna habitat through the clearing of native vegetation. Native vegetation will be cleared and replaced with various tree crops. The loss of habitat has the potential to result in the destruction of local populations, particularly soil-inhabiting invertebrates.

A principal impact is the introduction of agricultural pests through planting of exotic species and the potential increase in the Giant Northern Termite *Mastotermes darwiniensis* one of the most serious horticultural pests in the northern tropics of Australia with the potential to attack both the living trees and structural timber within the plantation.

6.6.4 Management

The management of invertebrate fauna will be handled in a similar manner to the management of vertebrate fauna (Section 6.4) and is dealt with in the project EMS. Key management strategies are summarised below:

Control of clearing activities:

- Vegetation clearance will be undertaken in a way that minimises the amount of native vegetation removed. The clearing for access tracks to the site will avoid large trees and shrubs as these accommodate a variety of ecosystem functions, including providing habitat for native fauna species; and

- Fragmentation of habitat will be minimised where possible and habitat corridors will be retained between the plantation plots. These corridors will accommodate the movement of fauna species within the plantation site.

Rehabilitation:

- Rehabilitation of any areas which do not need to remain cleared will be carried out immediately following the period of disturbance; and
- The vegetation and litter layer of all areas to be disturbed will be stockpiled and used as mulch for later rehabilitation programmes or, where clearing is permanent, to provide microhabitat for many invertebrate fauna. The height of stockpiles and the duration of storage should be minimised to retain microbial activity.

Agricultural Pest Control:

- Termite control will be achieved through a rigorous program of baiting during the early stages of the plantation when the trees are susceptible to termite attack. The planned method of control will be highly targeted and the insecticide application rates low;
- The most effective method to deliver the insecticide is by aggregating the termites in drums and feeding the chemical in a bait;
- Once the trees have become established, natural predators such as the ant species *Iridomyrmex sanguineus* and *Solenopsis geminate*, may help to control new populations of the termite;
- As the phenolic heartwood of Teak develops with age, the compounds anthroquinone and tectoquinone may provide natural resistance to termite attack (Tewari, 1992); and
- Frequent monitoring of termite populations will be carried out to detect any increases in abundance or any new potential pest species.

Fire

- A bushfire management strategy will be developed with the Broome office of CALM and the Kimberley Regional Fire Management Project (KRFMP) that covers the plantation area and is detailed in Section 6.7.

6.6.5 Predicted Outcome

Due to clearing of native vegetation for the plantation, there will be a localised loss of invertebrate fauna habitat and associated direct impacts to fauna populations. The most important outcome is the potential increase in agricultural pests, such as native termites. The invasion and abundance of these pest species will be reduced through careful management and baiting programs, as well as frequent monitoring of established populations and potential new species.

The impact on the invertebrate fauna is considered to be negligible as representation of fauna habitats and communities will be maintained in extensive surrounding areas.

6.7 Fire Management

6.7.1 EPA Objectives

- *To reduce the risk of fire to the tree plantation and protect the surrounding native vegetation*

- *Encourage tree plantation fire protection planning in accordance with the Bushfires Amendment Act 1987*

6.7.2 Potential Impacts

An outbreak of fire could be potentially devastating to the tree plantation and also to the surrounding native vegetation. A fire would result in a loss of trees and therefore revenue and could also have additional effects on the surrounding area, such as loss of vegetation, habitat, fauna and human life.

6.7.3 Predicted Impacts

Extensive frequent fires are a feature of the savannahs of the Kimberley region. Taking this into consideration, the likelihood of an outbreak of fire within or surrounding the plantation is high. This could have long-term consequences if it destroys part of the tree plantation and the significance of the consequences is high. The control of fire is extremely important in any plantation project.

As a fire management plan will be in place, the likelihood of a fire being started within the plantation is low, as there will be no burning of waste or cleared vegetation, and no refuelling of machinery will occur within the plantation area.

6.7.4 Management

Plantation layout options are discussed in Section 3.2

The chosen plantation layout is one in which the 100 ha plantation plots are adjacent to one another, with 80 m wildlife corridors and a 10 m wide access track between them (see Figure 3.1 and 3.3). Bordering the plantation development site, in addition to the wildlife corridor, is a 40 m bush corridor with adjacent 4m wide firebreaks. This dual firebreak surrounds the entire plantation, extending northwards to the Broome-Cape Leveque Road. This configuration allows for ease of access to each plot for fire-fighting vehicles and decreases the likelihood of losing the whole plantation to wild fire. This is the design preferred by Fire and Emergency Services Authority of Western Australia (FESA) (Chris Widmer, FESA, pers. comm.) and CALM (pers. comm. Tim Willing, CALM Broome).

The plantation layouts comply with FESA guidelines which recommend that the maximum size of plantation plots range between 30 to 100 ha (FESA, 2001).

Fire Management Procedures are an integral part of the plantation's EMS. The Fire Management Plan will detail the following strategies for fire prevention and control in the plantation:

General

- The use of fire to dispose of cleared vegetation, and for other uses, will be prohibited;
- The edge of plantings will not be established within 50 m of any existing habitable building and a further 50 m of plantation will be pruned and have ground fuels reduced so as to provide a minimum of a 100 m of low fuel area immediately surrounding the structure;
- Refuelling of machinery is prohibited within the plantation area;
- The size of plantation plots will comply with the *Guidelines for Plantation Fire Protection* (FESA, 2001) and will not exceed 100 ha;
- Personnel employed in tending and harvesting operations will be trained in fire control; and

- Fire detection systems will be in place to identify outbreaks of fire as soon as possible so that control measures can be implemented.

Firebreaks

- Firebreaks will comply with the *Guidelines for Plantation Fire Protection* (FESA, 2001);
- Firebreaks on boundaries and power lines will be four metres wide. Internal firebreaks between compartments will be a minimum of ten metres wide. In all cases a four-metre running surface will be maintained to allow access by firefighting equipment; and
- Firebreaks will be kept free of flammable material.

Roads and Tracks

- A road and track network (minimum four metres in width) is required to provide access by ground firefighting forces and will be maintained. Fire control access tracks will be incorporated into the plantation design, and maintained to permit vehicle movement for fire control.

Specific requirements

- Fire protection access which connects to perimeter firebreaks will be constructed at the time of plantation establishment;
- Access will have suitable surface condition and width to allow the safe movement of vehicles;
- Dead end access will be avoided where possible. Where this is not possible a turning circle will be provided;
- Encroaching vegetation will be cut back and overhanging branches cleared to a minimum height of 4 m from the road surface;
- Roads and tracks will be signposted to indicate road or track identification, or alternatively, be indicated on maps that are regularly updated.
- Since the plantation adjoins vegetation with a high fire frequency, controlled burning will be implemented as a means of protecting the plantations and the values of the native vegetation;
- Controlled burning will be implemented as determined by CALM and the KRFMP; and
- Fuel reduction burning will be carried out by competent persons, in accordance with the regulations.

Firefighting Equipment

- Water supply points (accessed from the irrigation system) will be located and/or constructed to enable quick and safe access for firefighting vehicles and pumps;
- Water points will be established such that the distance between any two is no greater than 2 km;
- Pump access will be no more than 3 m above or 2 m away from the water supply and be in an area large enough for firefighting vehicles to manoeuvre; and
- All water points will be maintained and sign posted, and supply indicated on regularly updated maps.

6.7.5 Predicted Outcome

It is predicted that implementation of the Fire Management Procedures will ensure that there is a low incidence of fire within the plantation project area, and that fire-related impacts on the project area will be minimal.

It is not possible to predict the frequency or incidence of fires in this environment (Start, 2001), but with comprehensive Fire Management Procedures in place the probability of a fire occurring within the

plantation is low. Fire outbreaks in surrounding native vegetation will be quickly identified and controlled. Fuel reduction burning will help prevent such bushfires and also promote a diverse and structurally stable ecosystem.

COMMITMENT 7: TTP will develop and implement a Bushfire Management Plan.

6.8 Watercourses

6.8.1 EPA Objective

- *Maintain the integrity, functions and environmental value of watercourses and sheetflow.*

The EPA's Guidance Statement No. 33: 'Guidelines for Environment and Planning' (EPA, 1997) and Draft Guidance Statement No. 26: 'Draft Guidelines for the Management of Surface Run-off from Industrial and Commercial Sites' (EPA, 1999) provide management advice for watercourses and rivers. The EPA's guidelines seek an assessment of the potential impacts on surface water flow rates, drainage patterns, sediment transport and wetlands that may be associated with planned projects and developments.

Under Section 17 of the *Rights in Water and Irrigation Act (1914)*, a Bed and Banks Permit is required if a proposed project is likely to obstruct, destroy or interfere with the waters, bed or banks of any watercourse flowing through or over, or wetland situated wholly or partly on, land that has not been granted or demised by the Crown. As there are no watercourses or rivers within the project area, a Bed and Banks Permit is not required for the project. Sediment transport and other potential pollution-related impacts are considered in Section 7.1 – Surface Water Quality.

6.8.2 Potential Impacts

Due to the absence of any sizeable watercourses or rivers in the vicinity of the plantation, impacts associated with drainage are not likely to be significant.

Potential impacts associated with establishment of access tracks and fire breaks may include the diversion or alteration of any surface sheet flow that exists following heavy rain. An increase in surface water runoff in cleared areas and areas near tracks may also be expected.

Potential impacts to surface water quality are discussed in Section 7.1 Surface Water Quality.

6.8.3 Predicted Impacts

Since the project area is uniformly flat and lacks any defined surface water drainage features, there will be no need for watercourses to be diverted or altered due to project activities. There is the potential for the surface water flow in small intermittent drainage channels and areas of sheet flow to be interrupted by construction of access tracks and other plantation infrastructure. Sheetflow generally occurs as a result of major rainfall events and will be maintained by installing multiple culverts and through the use of contour dispersion channels where required. This will ensure that run-off water is redistributed as sheet flow downstream of the plantation tracks and plots.

A Bed and Banks Permit 11/17/21A is not required.

No impacts associated with watercourses are expected.

6.8.4 Management

Environmental management of surface water flow in the project area will include:

- Structures and access tracks within the plantation will be located to minimise alterations to surface drainage;
- Drains and culverts will be incorporated in the plantation design in order to minimise interruptions to the existing patterns of surface water flow and maximise local infiltration; and
- The alignment of access tracks will avoid areas that have the potential for sheet flow where practicable.

Monitoring and mitigation of soil erosion during periods of heavy rainfall may be potentially required in cleared areas.

6.8.5 Predicted Outcome

Negligible impacts are expected in the vicinity of the proposed project area due to the absence of any defined watercourses or rivers.

The impact on surface flow as a result of the establishment and operation of the plantation is expected to be negligible due to the minimal relief and consequently poor development of drainage systems and the absence of susceptible vegetation types in the project area.

6.9 Groundwater

6.9.1 EPA Objective

- *Maintain (sufficient) quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.*

The Water and Rivers Commission (WRC) has responsibility for issuing groundwater extraction licences and ensuring that such licences take into account environmental impacts. Groundwater licences are issued as either exploration or production licences. The WRC must be satisfied that the groundwater resources are sufficient for the proposed abstraction. Saline groundwater resources are considered to be non-renewable.

6.9.2 Potential Impacts

TTP has applied for groundwater allocation of 4.5 GL/a for Stage 1 of the plantation operation.

This groundwater requirement comprises the following components:

- plant requirements;
- exceptional season requirements (including drought);
- system losses; and

- infrastructure requirements.

The plantation is proposed to be trickle irrigated. The plant requirements have been determined in the trial plots but will require further refinement as more experience is gained about the requirements of the plantation (John Brennan and Associates 2003). In addition to a base supply, additional water application may be needed in periods of drought and to meet seasonal conditions such as an extended dry season, abnormal easterly winds, or extended periods of high ambient temperatures (Rockwater, 2004). Allowances are required to meet losses from the irrigation system (Irrigation Industry Standard of system efficiency is 90 %) and a further 10 % more than plant requirements may be required. Water is also required for domestic purposes, gardening, fire-fighting, and dust suppression and will increase as the plantation is developed.

The approximate annual and monthly water requirements for the project as it is developed are given in Table 6.4 (Rockwater, 2004a). The annual volume of water required will gradually increase from 1.5 GL in Year 1 to 3 GL in Year 2 to 4.5 GL in Year 3. The groundwater pumpage and irrigation will be undertaken in the early morning to avoid evaporation losses.

Five new production bores will be placed approximately one kilometre apart and 300 m deep. Each bore will have a capacity of 35 L/s and will provide the 4.5 GL/a.

6.9.3 Predicted Impacts

Currently, modelling indicates a drawdown of up to 100 cm, concentrated within the lease area and, after 20 years of pumping at a rate of 4.5 GL/a, a potential drawdown of 19mm at Bobby's Creek. It is highly unlikely, however, that this small change could be distinguished from changes in the groundwater level arising from seasonal and long-term variations in rainfall (Rockwater 2004c). These small drawdowns are not considered likely to adversely affect the Beagle Bay water supply (Rockwater 2004a). A small rise in the depth of the salt/fresh water interface may result, but is not likely to affect any existing bores (Rockwater 2004a). Approval of a groundwater licence for the extraction of 4.5GL/a will not pose a significant impact to the environment.

In the lease area groundwater in the flow system is generally too deep (30 to 60 m) to be accessed by most vegetation except from any perched aquifer (Rockwater, 2004a). In the discharge area along Bobby's Creek, wetland vegetation occurs around the mound springs (Rockwater, 2004a).

The only other significant groundwater user is the BBC. Some small aboriginal outstations and Country Downs Station also pump from the aquifer but are too distant to be affected (Rockwater, 2004a). The BBC currently has a groundwater licence for 0.1 GL (100,000 kL/a). Annual pumpage is less than the licenced allocation and no major increase in annual pumpage is expected (Rockwater, 2004a).

Table 6.4 Estimated water requirements of plantation

YEAR No	YEAR (June to July)	NEW PLANTINGS/ ANNUM (ha)	TOTAL PLANTINGS (ha)	WATER REQUIRED FOR YEAR 1 PLANTINGS (GL/ANNUM)	WATER REQUIRED FOR YEAR 2 PLANTINGS (GL/ANNUM)	WATER REQUIRED FOR YEAR 3 PLANTINGS (GL/ANNUM)	ESTIMATED TOTAL WATER REQUIRED (GL/ANNUM)	AVERAGE DAILY PUMPING RATE/ANNUM (kL)	AVERAGE DAILY PUMPING RATE/ NINE MONTHS (kL)
1	2004-2005	300	300	1.5	0	0	1.5	4,110	5,474
2	2005-2006	300	600	1.5	1.5	0	3	8,219	10,949
3	2006-2007	300	900	1.5	1.5	1.5	4.5	12,329	16,423
4	2007-2008	0	900	1.3	1.5	1.5	4.5	12,329	16,423
5	2008-2009	0	900	1.3	1.3	1.5	4.5	12,329	16,423
6	2009-2010	0	900	1.3	1.3	1.3	4.5	12,329	16,423
7	2010-2011	0	900	1.3	1.3	1.3	4.5	12,329	16,423
8	2011-2012	0	900	1.3	1.3	1.3	4.5	12,329	16,423
9	2012-2013	0	900	1.3	1.3	1.3	4.5	12,329	16,423
10	2013-2014	0	900	1.3	1.3	1.3	4.5	12,329	16,423
11	2014-2015	0	900	1.3	1.3	1.3	4.5	12,329	16,423
12	2015-2016	0	900	1.3	1.3	1.3	4.5	12,329	16,423
13	2016-2017	0	900	1.3	1.3	1.3	4.5	12,329	16,423
14	2017-2018	0	900	1.3	1.3	1.3	4.5	12,329	16,423
15	2018-2019	0	900	1.3	1.3	1.3	4.5	12,329	16,423
16	2019-2020	0	900	1.3	1.3	1.3	4.5	12,329	16,423
17	2020-2021	0	900	1.3	1.3	1.3	4.5	12,329	16,423
18	2021-2022	0	900	1.3	1.3	1.3	4.5	12,329	16,423
19	2022-2023	0	900	1.3	1.3	1.3	4.5	12,329	16,423
20	2023-2024	0	900	1.3	1.3	1.3	4.5	12,329	16,423

Years 1 to 3 - 1.1 GL/annum/300ha plus 15% for drought (one in four year event) = 1.265; plus 10% inefficiency; plus 0.1 GL/annum contingency = 1.4915 (say 1.5 GL/annum)

6.9.4 Management

- The project is pioneering the establishment of tropical forestry in a semi-arid, monsoonal environment. A GLOS (Rockwater 2004b; See Appendix F) has been formulated following close liaison with the DoE. In addition, commitments to develop optimal irrigation strategies will be rigorously pursued. Twelve monitoring bores comprising four bores drilled during the groundwater investigation and eight decommissioned production bores will be used to monitor the regional water table;
- The interim EWP is to maintain the natural groundwater regime of the GDEs at Beagle Bay, i.e. zero drawdown due to irrigation abstraction at the GDEs. Trigger groundwater levels will be set by the DoE based on the first year of recorded hydrogeological and rainfall data. If trigger levels are breached, pumping is to cease until rectified;
- The irrigation system will be designed and monitored to ensure efficient usage of water, this will include the use of sensors to detect leaks and/or line failure and auto rain day shut-off; and
- CSIRO will be contracted to undertake studies into determining tree water demand through the use of soil moisture monitoring and sapflow metering and the use of other instrumentation such as a weather station.

6.9.5 Predicted Outcome

It is predicted that the drawdown associated with abstraction of 4.5 GL/a for Stage 1 of the project will not adversely impact on the wetland systems in the area (Figure 6.1) or other users of the Broome aquifer.

COMMITMENT 8: *TTP will undertake:*

- *A monitoring plan to ensure that groundwater levels are not significantly reduced; and*
- *Research to more accurately determine tree water demand of the plantation species.*

6.10 Greenhouse Gas Emissions

6.10.1 EPA Objective

- *Reduce greenhouse gas emissions to a level which is as low as is practicable.*

6.10.2 Potential Impacts

Emissions of greenhouse gases will arise from the following processes:

- Combustion of diesel fuel for vehicles and mobile equipment; and
- Decomposition of cleared vegetation.

However, the amount of greenhouse gas produced will be low on a relative scale due to the type of vegetation. The Pindan supports fairly low and sparse vegetation and therefore it has a lower level of carbon retention than areas of denser vegetation. It is expected that the amount of carbon produced through project activities will be well offset by the amount absorbed by the trees planted. The farmed trees will be planted at a higher density than the existing Pindan vegetation and the trees themselves are much larger and faster growing than the naturally dominant *Eucalyptus* and *Acacia* species and therefore have a higher capacity to store carbon.

At present there is insufficient data available to accurately estimate the carbon storage capacity of the plantation in comparison to the natural Pindan vegetation, but this will be established as part of the project's research and development.

The Australian Greenhouse Office (AGO) has developed a carbon sequestration model "CAMFor", which it recommends for use in calculating the carbon sequestration potential of tree plantations such as the Beagle Bay project. However, the model requires information regarding the mean annual increment in stem volume change for each tree species, details of debris generation, decomposition rates and methods and soil carbon data (amongst other parameters) to successfully produce output curves. At present, there is not enough biological information available to be able to generate a meaningful site-specific output from CAMFor for the Beagle Bay plantation. It would be possible to run CAMFor using the information that is currently available for Beagle Bay, together with information sourced from alternative tree species, other plantation studies, and industry estimates (in consultation with AGO), however any outputs are likely to incur an error margin of greater than 20 % (Robert Waterworth, AGO, pers. comm.).

The AGO is currently developing a superior model to CAMFor, named 'FullCAM' which is expected to be available for use within the next 12 months. It is likely that FullCAM will be able to generate a more accurate site-specific carbon sequestration curve for the Beagle Bay plantation with a reduced amount of input information required. FullCAM assessment is proposed to be undertaken when the model is finalised by the AGO.

In the interim, the broad-scale CAMFor carbon sequestration curves presented in Figure 6.2 suggest that the carbon sequestration potential of the project site may be significantly higher as a direct result of the proposed plantation. The existing Pindan has been broadly identified by the AGO as having medium-low sequestration potential (refer to Figure 6.3). The fact that the plantation trees will be fully irrigated automatically places them in the high sequestration potential category (AGO, 2001). Figure 6.2 shows that at 25 years of age, vegetation with med-low carbon sequestration potential will have sequestered approximately 228 tonnes of carbon dioxide per hectare where as trees with high sequestration potential will have sequestered approximately 482 tonnes of carbon dioxide per hectare (please see Figure 6.2 for notes on the degree of accuracy of the curves). While these figures indicate that the plantation may be capable of sequestering more than double the amount of carbon than that of the existing Pindan, the release of carbon through the initial clearing of vegetation will act to release carbon, and as such the net 'carbon sink' value of the plantation will be slightly lower than that indicated by the curves in Figure 6.2.

It is further expected that the fire management policies to be implemented in the area will reduce the amount of carbon produced during the annual Kimberley 'burn' (see Section 5.16).

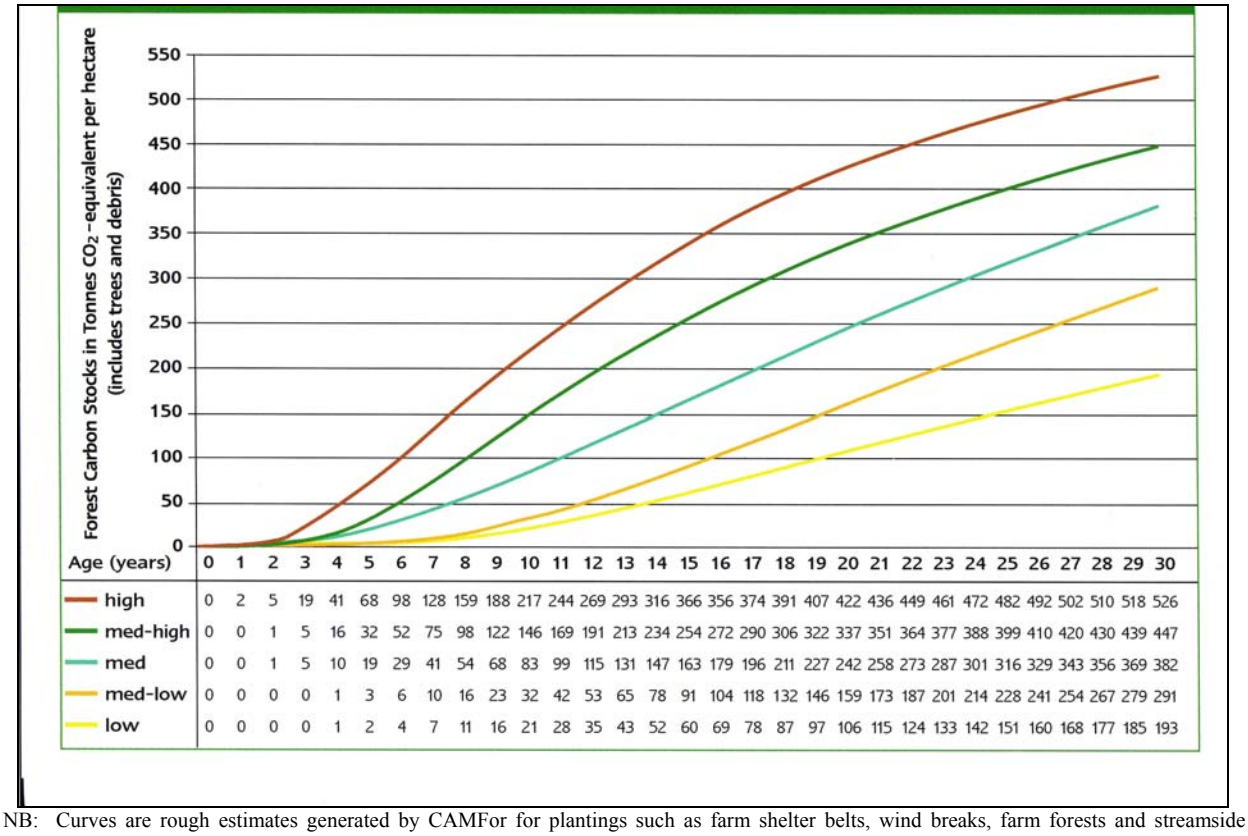
6.10.3 Predicted Impacts

The total greenhouse gas emissions predicted for the project cannot be accurately estimated at this stage. However, the AGO suggests that as an irrigated and healthy crop, the plantation trees will have a higher carbon sequestering potential than that of natural vegetation in the region. As such, the project will have positive impacts in terms of reducing atmospheric greenhouse gas.

6.10.4 Management

Management of emissions will be in compliance with the EPA Guidance Statement No. 12: Guidance Statement for Minimising Greenhouse Gas Emissions (EPA, 2002). To comply with the EPA Guidance, TTP will carry out the following:

- Greenhouse gas emission/sequestration totals will be estimated for the project in accordance with the National Greenhouse Gas Inventory Committee (NGGIC) methodology for calculation of greenhouse emissions and sinks once the models to do so become available form the AGO;
- A 'minimum clearing' policy will be adopted for the project; and
- Where possible, TTP will use the most fuel-efficient equipment and vehicles that are suitable and available.



Age (years)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
high	0	2	5	19	41	68	98	128	159	188	217	244	269	293	316	366	356	374	391	407	422	436	449	461	472	482	492	502	510	518	526
med-high	0	0	1	5	16	32	52	75	98	122	146	169	191	213	234	254	272	290	306	322	337	351	364	377	388	399	410	420	430	439	447
med	0	0	1	5	10	19	29	41	54	68	83	99	115	131	147	163	179	196	211	227	242	258	273	287	301	316	329	343	356	369	382
med-low	0	0	0	0	1	3	6	10	16	23	32	42	53	65	78	91	104	118	132	146	159	173	187	201	214	228	241	254	267	279	291
low	0	0	0	0	1	2	4	7	11	16	21	28	35	43	52	60	69	78	87	97	106	115	124	133	142	151	160	168	177	185	193

NB: Curves are rough estimates generated by CAMFor for plantings such as farm shelter belts, wind breaks, farm forests and streamside environmental plants. The curves are only applicable up to the point where wood is removed; based on broad-scale soil and climate information, and do not consider site-specific characteristics; for healthy, well-managed trees; based on tree carbon only and do not count soil carbon; and not thought to be accurate enough to form the basis of carbon sequestration claims.

FIGURE 6.2 CARBON SEQUESTRATION GRAPHS FOR FORESTS (FROM AGO, 2001)

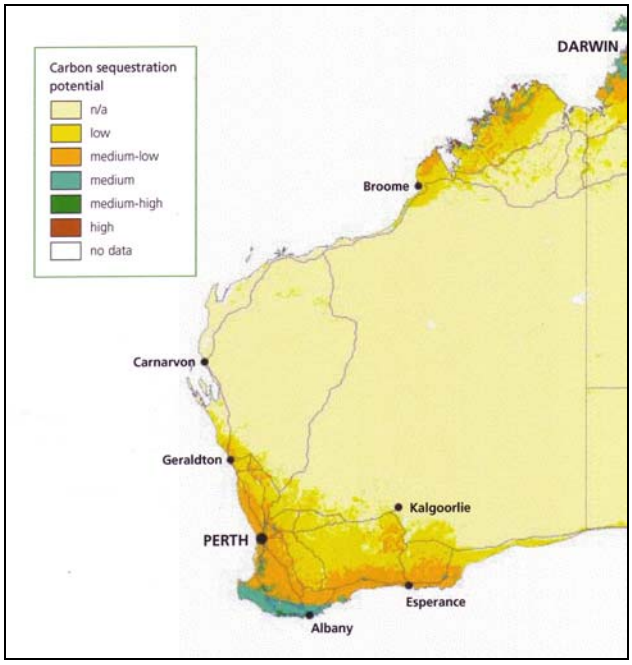
TTP has considered the use of renewable energy sources and will continue to do so where possible and will carry out regular maintenance checks on all equipment and vehicles to ensure that they are running efficiently. Solar water heating is used on site. The use of wind energy as an alternative power source has been investigated, however it was determined its use was not viable in this climatic regime.

6.10.5 Predicted Outcomes

The Plantation is expected to result in a carbon sequestration benefit; however there is currently insufficient information available to quantify this benefit. Initially, carbon will be released due to clearing of mature Pindan vegetation, which has reached a plateau in carbon sequestration. As the

plantation grows, carbon will be sequestered approximately in line with the high curve (Figure 6.2) until it equals the amount of carbon that was released. From there, sequestration will continue to a significantly higher value. Following harvesting, the carbon will remain locked within the timber. This is a benefit to the environment in terms of helping to reduce the concentration of carbon dioxide in the atmosphere and is directly in line with the principles of the State (in development) and National Greenhouse Strategy (AGO, 1998).

The low number of vehicle and plant equipment and the production of CO_2 from fuel burning will not be large enough to reduce the sequestration benefit.



NB – Figure 6.2 notes are also applicable to Figure 6.3

FIGURE 6.3 BROADSCALE ESTIMATED CARBON SEQUESTRATION POTENTIALS FOR AUSTRALIA (FROM AGO, 2001)

6.11 Landscape Values

6.11.1 EPA Objective

- *Manage and mitigate impacts to landscape values*

The landscape assessment is a combination of two distinct aspects – visual impacts in terms of the extent to which the development will be visible in the landscape, and the physical impact of the placement of the plantation within the structure of the landscape itself. The landscape assessment is therefore carried out at two levels – in relation to the impacts on the site's visual amenity; and in relation to the site's character.

There are currently no government agency guidelines or policies available that are strictly relevant to the assessment of landscape values for the project, however CALM, the Department of Planning and Infrastructure (DPI) and the EPA have advised that progress into developing general landscape value guidance statements/policies/recommendations are well underway with draft publications expected to be

issued by the EPA for public comment within the next 12 months. In the interim, the methodologies discussed in the following studies have been recommended by the above-mentioned agencies as providing a good interim guide to landscape assessment:

- Cleary, J., Cowan, L. & Koch, P., 1999, Shark Bay World Heritage Property Landscape Study, Draft Report, CALM;
- Institute of Environmental Assessment and Landscape Institute UK, 1995. Guidelines for Landscape and Visual Impact Assessment

In order to meet the EPA objective the following scope of works was proposed (in line with the above-mentioned guidelines):

- Assessment of potential impacts of the proposal on existing landforms/landscape values - including assessment of scale, character, condition and importance of the existing landscape to determine its sensitivity;
- Visual analysis; and
- Assessment of change or enhancement potential of the proposed measures to manage any impacts the project may have on the landscape.

6.11.2 Potential Impacts

Establishment of any kind of crop in an area that has previously supported natural vegetation will result in changes to the visual aspects and characteristics of the landscape.

The Plantation will require the removal of the natural savannah woodland and replacement with commercially viable tropical trees along with certain local native species to be cultivated for medicinal/food values/potential. The plantation will be managed to ensure that the water, nutrient and pest control requirements of the farmed trees are continuously met, to facilitate optimum growth and health. The plantation trees will be distinguishable from the surrounding vegetation in terms of size, species characteristics, geometric layout and homogeneity.

The upgrade of infrastructure and construction of access tracks and haulage roads will further impact on the landscape, by interrupting the continuous Pindan plains.

Landscape impacts associated with tree farming are generally greatest during the initial clearing and planting phase until the seedlings are established, and then again during the harvesting phase when the trees are logged. During these two phases, the visual amenity of the area will undergo rapid change as existing vegetation is removed and replaced. The area will appear to be more barren than its surroundings while the new, young vegetation grows to a point that it can provide similar visual amenity to surrounding native vegetation. The landscape will also be rapidly altered by the physical removal of existing vegetation, and establishment of access tracks, firebreaks and other infrastructure. In the interim period, while the trees are growing, it is expected that impacts on the visual amenity and character of the landscape will not be as discernable.

6.11.3 Predicted Impacts

The area to be affected by the project is remote and is relatively small in the context of the region and its homogeneous Pindan landscape characteristics. Environmental disturbance will be contained as far as possible during the project and adverse landscape impacts are expected to be minimal.

There is only one public road and no significant vantage points in the vicinity of the project area. It is proposed that a visual buffer of natural vegetation be retained between the Broome - Cape Leveque Road to minimise visual impacts for road users.

The project area is not in view of the nearest settlement, 12 kilometres to the north-west at Beagle Bay.

Changes to the landscape will include:

- Removal of natural vegetation;
- Establishment of access tracks, accommodation facilities and fire breaks;
- Construction of offices, workshops, and powerlines;
- Introduction of tropical tree species to the landscape; and
- Increase in water and nutrient supply to plantation landscape through irrigation systems.

6.11.4 Management

For 'well-represented' landscapes, such as the project site, general management objectives have been designed to cover a range of agency policy objectives (Cleary, 2002):

- The visual and physical integrity of a substantial, well-represented area (and its setting) should be maintained or restored; and
- Development should be of a temporary or minor nature and should be unrecognised from important travel routes and use areas for a substantial area of this significance (and its setting).

Minimising disturbance to landscape values will be important in the designation of land for plantation plots, access tracks and infrastructure. The project EMS will document measures that are to be implemented at each stage of the project in order to minimise landscape impacts. Mitigation will be achieved through the implementation of the following measures:

- A 'minimum clearing' policy and allowing regeneration of the natural understorey where practicable;
- Retention of a 'buffer zone' of natural vegetation to screen the project site from the Broome to Cape Leveque main road;
- Retention of natural vegetation corridors between plantation plots; and
- Use of appropriate colours for painting infrastructure so as to blend in with the surroundings.

6.11.5 Predicted Outcome

For the project duration there will be some impact on the landscape in terms of visual amenity and landscape character. The greatest impacts will be associated with clearing of vegetation for the initial planting of crop-trees and at the completion of the project when these trees are logged.

For the greater part of the project's 20 year lifespan, the plantation will contain tree crops, hence minimising the landscape impacts.

6.12 Decommissioning & Rehabilitation

6.12.1 EPA Objectives

- *Ensure that decommissioning and rehabilitation are carried out in a planned sequential manner;*
- *Ensure ecosystem function is maintained following plantation closure;*
- *Avoid State liability;* and
- *Ensure that the post-plantation landform is safe, stable, non-erodible, and is integrated into the surrounding environment.*

6.12.2 Policy and Technical Framework

Key requirements for the closure and rehabilitation of the project are as follows:

Stakeholder Involvement

- Identification of stakeholders and interested parties; and
- Effective consultation.

Planning

- Closure plans should be developed to reflect the status of the project; and
- The dynamic nature of closure planning requires regular review.

Financial provision

- A cost estimate for closure should be developed from the closure plan; and
- Cost estimates should be reviewed regularly to reflect changing circumstances.

Implementation

- Adequate resources must be provided to assure conformance with the Closure Plan; and
- The on-going management and monitoring requirements after closure should be assessed and adequately provided for.

Standards

- Stakeholders should develop standards that are both acceptable and achievable;
- Completion criteria are specific to the project and should reflect its unique set of environmental, social and economic circumstances; and
- An agreed set of indicators should be developed to demonstrate successful rehabilitation.

Relinquishment

The responsible authority should make the final decision on accepting closure; and
Once completion criteria have been met, the company may relinquish their interest.

6.12.3 Potential Impacts

Certain environmental values of the project area will be impacted as a result of the project and the development of associated infrastructure and access routes. The impacts are concentrated within Pindan woodland, which is broadly represented within the Region.

Decommissioning and rehabilitation of the entire project area will be carried out at the conclusion of the project. Should closure of the plantation be required before the end of the proposed 20 year period the site shall be fully rehabilitated and decommissioned as per the Closure Plan. In the event of a future Proponent taking over the plantation at the conclusion of the TTP lease, all areas not to be used in the future plantation will be rehabilitated.

6.12.4 Predicted Impacts

Plantation closure will address impacts to:

- The Lease Option Area;
- Access Tracks and Firebreaks; and
- Associated infrastructure.

There will be a variety of impacts on the environment during both the construction and operation phases of the proposed development.

6.12.5 Management

The objective of rehabilitation of the project area will be to minimise long-term environmental impacts, particularly in relation to landforms and vegetation, and to create self-sustaining natural ecosystems that closely resemble the pre-existing status of the area, in which ecosystem function will be maintained.

Rehabilitation will comprise an ongoing program to restore the physical, chemical and biological quality or potential of air, land and water regimes to a state that is acceptable to the regulators and post-plantation land users.

All disturbed areas will be rehabilitated on completion of the project following the removal of all structures and equipment.

The primary management strategy involved in rehabilitation efforts will be the project's EMS, Closure Plan and Rehabilitation Program. The Program will facilitate rehabilitation of disturbed areas to an array of vegetation types and fauna habitats that reflect the pre-disturbance state as closely as possible. The Program will address a wide variety of issues at various stages of project implementation. These issues are likely to include:

- Progressive / ongoing rehabilitation activities as impacted areas become available;
- Topsoil collection and stockpiling / stockpile management;
- Mulching and stockpiling of cleared vegetation;
- Consideration of deep ripping to loosen the compacted substratum to enable root penetration and increase microrelief to trap seeds and water;
- Respreading of topsoil/vegetation mulch as soon as practically possible to maximise the viability of seeds and soil microbiota;

- Seed/tissue sourcing from local vegetation, with particular attention to the rehabilitation and propagation of significant flora species;
- Seeds from a range of plants including herbs, grasses, shrubs and trees will be applied - while herbs and some grasses provide only an ephemeral cover, they are fast-growing and will assist in the initial stabilisation of soil surfaces, as well as increasing substrate microrelief and hence seed lodgement and water penetration;
- The application of fertiliser if necessary to offset the loss of nutrients and soil microbiota associated with topsoil storage;
- Monitoring with infill planting and weed control as necessary; and
- The development of suitable completion or "walk-away" criteria.

The natural regeneration of native vegetation of the plots will be encouraged following tree thinning, and rehabilitation will be undertaken following the harvesting of a plot. Local provenance seed and plants will be utilised in rehabilitation.

Plants will be established by:

- Propagules (seeds, lignotubers, corms, bulbs, rhizomes and roots) stored in the soil;
- Sowing seed;
- Spreading harvested plants with bradysporous (seed retained on the plant in persistent woody capsules) onto rehabilitation areas;
- Nursery-raised seedlings; and
- Invasion from surrounding areas through wildlife and wind.

Vegetation debris and logs will be returned to areas which have been disturbed as they assist in rehabilitation by providing microhabitats for recolonising fauna. The progression of rehabilitated areas will be monitored during routine inspections of the plantation.

6.12.6 Predicted Outcome

With proper and appropriate 'best practice' management, environmental impacts can be minimised. Development and implementation of the Closure Plan will ensure that the plantation is rehabilitated to its original environment as well as possible.

COMMITMENT 9: *TTP will develop a detailed Closure Plan for the plantation. The Closure Plan will address rehabilitation actions to be taken for the plantation and associated infrastructure and will provide the basis for and eventual 'walk away' strategy for the project. It will also accommodate potential project failure.*

7.0 POLLUTION IMPACTS & MANAGEMENT

7.1 Surface Water Quality

7.1.1 EPA Objective

- *Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the Australian and New Zealand Water Quality Guidelines (ANZECC, 2000)*

As part of the National Water Quality Management Strategy (NWQMS), the Australian and New Zealand Environment and Conservation Council (ANZECC), now the Natural Resource Management Ministerial Council, prepared a series of guidelines for Fresh and Marine Water Quality (ANZECC, 2000). Key issues underpinning the application of the guidelines are sustainable use of water resources and cooperative best management.

To implement the NWQMS at a local level it is necessary to identify the environmental values of waterbodies in the area and then apply the relevant water quality guidelines for measuring performance. The NWQMS includes guidelines for chemical and physical parameters in water and sediment, as well as biological indicators.

7.1.2 Potential Impacts

No permanent surface water is present in the project area and there are no well-defined streams or drainage channels. An irrigation system will be installed to provide pumped ground water to the trees, but this water will be delivered at a rate that is in equilibrium with plant uptake capabilities and therefore there will be no increase in surface runoff associated with the irrigation system.

The use of fertilisers and pesticides has the potential to adversely affect the quality of surface water. However, use of chemicals for the project will be carefully monitored and amounts required are anticipated to be low. Fertilisers and pesticides will be administered at rates that are proportional to plant uptake capabilities via the drip irrigation system and are not expected to have any significant impact on surface water quality in the area.

7.1.3 Predicted Impacts

Changes to surface water quality associated with the project may arise as a result of:

- Contaminants from materials used in operations such as waste oils or accidental spills;
- Contamination through overuse of fertilisers, herbicides, fungicides and/or insecticides; and
- Minor contamination in parking areas and along access roads due to general movement of vehicles.

7.1.4 Management

Proposed management measures to minimise impacts to water quality are further detailed in the project EMP and include:

- Fertilisers and pesticides will be stored in covered sheds with sealed flooring and fertiliser containers to be regularly inspected for leaks;
- Chemicals will be applied in accordance with the *Country Areas Water Supply Act 1947* and the Water & Rivers Commission (WRC) Statewide Policy no. 2 – Pesticide Use in Public Drinking Water Source Areas (WRC, 2000);
- The potential for point source pollution impacts in the project area will be minimised by the responsible disposal of wastewater and sewage and by appropriate storage of fuels and chemicals, including an impervious bunded area surrounding stores;
- Spill response kits will be maintained in all areas where a spill could potentially occur;
- Emergency procedures will be followed for fuel, oil or chemical spillages as will be outlined in the Emergency Preparedness and Response Procedure of the project EMS will be implemented;
- Employees will report spills via incident reports;
- Application of fertilisers and pesticides will be proportional to plant uptake capabilities;
- Slow release fertilisers will be used;
- Soil sampling and nutrient testing will be undertaken;
- Sampling of surface water run-off will be undertaken following serious rain events;
- Application of fertilisers and pesticides will be timed to minimise leaching and loss to the environment;
- Earthworks will be undertaken outside of the peak wet season;
- Vehicle maintenance will be undertaken in designated workshop areas thereby eliminating the potential for contamination of surface water by oil and other vehicle fluids;
- Water delivered by the irrigation system will be proportional to plant uptake capabilities; and
- Irrigation system will be checked regularly for leaks or faults.

7.1.5 Predicted Outcome

Impacts on sediment and nutrient loads in surface water are considered to be negligible.

Hydrocarbon or chemical spills are potential impacts; however, the implementation of chemical handling and emergency preparedness procedures contained in the project EMS will ensure that the risk is negligible.

7.2 Groundwater Quality

7.2.1 EPA Objective

- *Maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the Australian and New Zealand Water Quality Guidelines (ANZECC,2000).*

As part of the National Water Quality Management Strategy ANZECC has prepared a series of guidelines for Fresh and Marine Water Quality (ANZECC, 2000). The WA Guidelines for Fresh and Marine Waters (EPA, 1993) promote the concept of environmental values of groundwater.

7.2.2 Potential Impacts

The use of fertilisers and pesticides has very limited potential to adversely affect the quality of groundwater as the depth to groundwater in the project area is in excess of fifty metres. However, use of chemicals for the project will be carefully monitored and amounts required are anticipated to be low.

Fertilisers and pesticides will be administered at rates that are proportional to plant uptake capabilities and are not expected to have any impact on groundwater quality in the area.

Changes to groundwater quality at the plantation could potentially arise in the event that materials used in surface operations such as waste oils, or materials from accidental fuel spills reach the groundwater.

Water abstraction may cause the saltwater wedge which underlies the BBC may rise and result in the salinity levels of the community's water supply to increase.

7.2.3 Predicted Impacts

It is unlikely that infiltration of liquid pollutants into the groundwater will occur as a result of surface spills. Impacts and management of pollutants are dealt with in detail in relation to Surface Water Quality (Section 7.1).

The use of pesticides and herbicides has been minimal during the 3 years of the trial and this is expected to be the case in the staged expansion of the project. Herbicides are used to control regrowth, which competes for nutrients with the tree crops, and to maintain firebreaks. Pesticides have been used to control *Mastotermes* in baiting stations and along sentinel plantings. At present, no fungicides have been used.

Four chemicals have been used in the trial plantation; the fertilisers Agroblen and Peters Professional General Purpose Plant Food (which is to be applied via the irrigation system), the herbicide Roundup, to be applied as a spray, and the pesticide Termidor, which is to be used in baiting stations. The chemicals used in the project are highly degradable (for example Roundup has a field half life of 47 days) and given the depth to groundwater (50+ metres), factors such as dilution and dispersement in soils and water and adsorption due to soil type in the locality, it is highly unlikely that these chemicals could leach into the groundwater.

The proposed plantation site is not located in a Public Drinking Water Source Area, and therefore is not subject to the Water and Rivers Commission Statewide Policy No. 2 "Pesticide use in Public Drinking Water Source Areas." Nevertheless, glyphosate (the active ingredient of Roundup) is approved for use in water catchment areas (A. McTaggart, DoE, pers. comm.).

In the plantation area the depth to the water table is approximately 50 to 55 m below the surface and downward infiltration will be impeded by the clayey Pindan soils and siltsone in the unsaturated zone above the water table. In addition, when in production a cone of depression will be formed in the water table and this will capture and assist in recycling any infiltration from the plantation.

In addition to this, as part of the project's Risk Management Plan, the potential risks of chemicals reaching downstream wetland areas was evaluated. Modelling shows that should any infiltration leave the site it will be diffused (diluted) and take about 250 to 290 years to reach Bobby's Creek or the BBC water supply. As there are no wetland or drainage areas near to or within the site, there is no risk of superficial contamination of site soils having any downstream effects (by way of transportation). As the application of fertilisers is to be proportional to plant uptake capability, the potential for nutrient leaching to the groundwater is negligible.

The saltwater wedge is located approximately 220 m below the production bores at the BBC. It is highly unlikely that the wedge will rise this distance to impact on the community water supply.

7.2.4 Management

Environmental management of the groundwater will include:

- Application of fertilisers will be timed appropriately to maximise plant uptake and minimise leaching and loss to the environment;
- Fertilisers will not be applied when soils are saturated;
- Fertigation is the preferred method of application. The system design will ensure:
  - Back-flow of nutrients into the water resource cannot occur;
  - Accurate and uniform delivery; and
  - Minimal risk of spillage.
- Injection of pesticides and fertilisers will be conducted in an area where any potential spills can be completely contained;
- Potential groundwater contaminants such as hydrocarbons, will be stored on a concrete floor in a weatherproof corrugated iron-roofed shed as per Australian Standard (AS 1940.1993), and will be collected and disposed of as per DoE guidelines and in accordance with procedures in the project EMS;
- Baseline chemical screening of TTM01 (85 m deep water table 51 m below surface), located at the plantation site, and Beagle Bay water Supply bores 1/82 and 1/83 will be undertaken. Monitoring of groundwater contaminants will be undertaken every three years and compared with the baseline data;
- In the event of a significant hydrocarbon or contaminant spill monitoring of groundwater quality will be undertaken in bore locations near the spill to identify any changes to physical and chemical parameters;
- Annual monitoring of groundwater from each production bore will be undertaken to determine levels of major ions and nutrients;
- To meet BBC concerns, salinity profiles will be measured from 79 to 89 m at 3 monthly intervals in monitoring bore TTM04 to detect any movement of the saltwater wedge;
- A baseline soil survey will be undertaken prior to clearing and will involve characterisation of soil profile morphology, soil texture, soil structure, nutrient status, hydraulic conductivity, soil matric potential, nutrient and pesticide sorption characteristics and soil mineralogy; and
- Soil monitoring will be undertaken during the life of the project. Samples will be taken weekly during the initial stage of the plantation, and will then be reduced to fortnightly, then monthly and then six monthly. In addition, samples will be taken following large rainfall events.

7.2.5 Predicted Outcome

The impact on groundwater quality is likely to be negligible. As the plantation is not in a drinking water catchment or other sensitive area, the use of glyphosate and fipronil bait stations should not impact on the groundwater (M. Matisons, Health Department of WA, pers. comm.).

7.3 Particulates/Dust

7.3.1 EPA Objective

- *Use all reasonable and practical measures to minimise emissions*
- *Ensure that particulate / dust emissions, both individually and cumulatively, meet appropriate criteria and do not cause an environmental or human health problem*

The EPA Guidelines for dust are outlined in *Guidance Statement No. 18: 'Prevention of air impacts from land development sites.'*

With the formation of a National Environment Protection Measure for Ambient Air Quality (NEPM), there is a requirement for Western Australia to implement it. The means of implementation are not set down by the NEPM and Western Australia therefore has the flexibility to implement the most appropriate mechanisms for its own circumstances. The EPA is currently developing a draft Environmental Protection Policy (EPP) to provide the statutory framework for implementation of the NEPM and for the establishment and achievement of air quality objectives throughout the State.

The Environment Protection & Heritage Council (EPHC), (incorporating the National Environment Protection Council, (NEPC)) set uniform standards for ambient air quality in 1998 (varied in 2003). The standards contained in the NEPM for ambient air quality for particulates are PM^{10} values of 50 mg/m^3 over an averaging period of one day (NEPC, 1998).

7.3.2 Potential Impacts

The following have potential to generate dust / particles:

- General construction activities;
- Land clearance and disturbance of topsoil;
- Vehicular transport on unsealed roads and access tracks; and
- Earthworks.

Dust can potentially affect vegetation and fauna habitats, as well as posing a potential health risk. Dust accumulation on vegetation adjacent to haul roads diminishes light penetration to the foliage thereby potentially decreasing rates of photosynthesis and limiting plant growth.

7.3.3 Predicted Impacts

Dust generation is considered to be short-term, as once the trees are approx. 1-2 years old, dust is not considered to be an issue.

Clearing, construction works, planting, harvesting and vehicular use of unsealed roads are the greatest potential sources of dust. By controlling dust generation and dispersal within the project area, impacts on plantation personnel and the surrounding environment will be minimised.

Dust control is a necessary component of occupational health and safety and environmental management. The nearest human settlement is the BBC township, approximately 12 km north-west of the project area. It is highly unlikely that airborne dust particles from the project area could disperse over such a distance. No health or environmental impacts are expected at the township.

7.3.4 Management

Proposed measures to manage dust in the project area include:

- Site preparation will be in compliance with the *Soil and Land Conservation Act 1945*;
- Clearing will be minimised and prompt progressive rehabilitation of disturbed areas will be carried out;

- Unsealed, regularly trafficked roads such as access tracks, work areas and haul roads may require regular dampening using a water cart;
- Monitoring of soil stockpiles will be carried out to determine whether there is significant fugitive dust to require application of additional water; and
- Other measures for minimising site disturbance will include limiting vehicle speeds and restricted access to some areas.

7.3.5 Predicted Outcome

Clearing, construction of infrastructure, planting, harvesting and hauling activities will generate limited environmental dust. Procedures for dust monitoring and implementation of dust control measures, if required, will be outlined in the project EMS. This will ensure that the impacts of the project on ambient dust levels and the environment will be negligible.

7.4 Waste Materials

7.4.1 EPA Objective

- *Ensure that wastes are contained and isolated from ground and surface water surrounds and treatment or collection does not result in long term impacts on the natural environment.*

7.4.2 Potential Impacts

Construction and operation activities will generate waste materials, such as plastic, paper, wood, scrap metal, tyres, rubber, batteries and domestic solid wastes. If not adequately handled, stored or disposed of, this material can contaminate local soil, groundwater or surface waters. Contamination can arise from the escape of leachate containing elevated nutrients, biological oxygen demand or heavy metals. Other impacts from landfills may include vermin, feral fauna, fire and smoke, and spread of wind borne litter into the surrounding countryside.

7.4.3 Predicted Impacts

Organic waste is of low density, can take up double the volume of landfill as other waste and contributes to greenhouse gas emissions. With the proposed development of the project it is predicted that a significant amount of green waste will be produced from the project as a result of pruning. To minimise the volume of green waste generated, mulching and composting of organic waste will be employed in the early stages of plant growth, while waste timber will be chipped and recycled as mulch.

Currently, the majority of waste generated from the Trial Plantation is diverted to an existing landfill at the BBC, with vegetable waste buried onsite and recyclables and waste oil transported to Broome. With the full development of the project and the subsequent increase in the volume of waste produced, Beagle Bay Tip will receive putrescible and inert waste, disposal of hazardous waste will be achieved via Broome Landfill and Kimberley Waste will be utilised for recyclables. As a large proportion of the workforce is expected to be based at the BBC, the volume of domestic waste generated is expected to be small.

Sewage waste will be generated from accommodation facilities on site. This waste will be treated through the use of a standard septic system and leach drains licenced with the local shire under the Health Act.

7.4.4 Management

- Reduction - where possible waste reduction will be a priority;
- Recycling - where practical solid materials such as scrap metal will be recycled or reused;
- Recycling facilities will be provided for collection of different waste streams *e.g.* plastics, metals, glass, wood;
- Inert non-recyclables will be diverted to the Beagle Bay landfill;
- Organics and putrescibles will be mulched (green waste) and composted for use in soil conditioning;
- Treatment and disposal of sewage wastes will be in accordance with the Health Act and local authority requirements;
- Waste fuels and oils will be stored in above-ground tanks located within impervious bunded enclosures meeting AS (1940.1993) and recycled; and
- Processed water will be contained and prior to discharge, excessive turbidity and oils will be removed.

Procedures for the management of waste is dealt with in further detail in the project EMS.

7.4.5 Predicted Outcome

The management of waste is expected to result in negligible environmental impacts due to the low volumes produced and the removal of much of the inorganic waste from site.

Through composting, the recycled organic materials can be made available for soil amelioration. Previous studies suggest that although organic carbon incorporated into soils will be volatised over a number of years, it will initiate a cycle of carbon regeneration in soils to maintain stability and enhance productivity such that there would be a net reduction in greenhouse emissions as a result.

Applied recycled organic material can result in water savings in excess of 25 %, reduced chemical and fertiliser inputs, reduced runoff and consequent soil erosion and waterway pollution, and increased plant vitality.

7.5 Noise

7.5.1 EPA Objective

The EPA's environmental objective is to ensure that:

- *All potentially significant noise emissions are identified in the environmental review information submitted by the Proponent;* and

- *Compliance with the Environmental Protection (Noise) Regulations 1997 is demonstrated in a consistent manner which is acceptable to the EPA.*

Criteria for assessing noise are outlined in the *Guidance for the Assessment of Environmental Factors – Environmental Noise* to ensure that proposals comply with the *Environmental Protection (Noise) Regulations 1997.* Section 3 of the *Environmental Protection Act 1986* defines "noise" as "vibration of any frequency, whether transmitted through air or any other physical medium."

Regulation 7 of the *Environmental Protection (Noise) Regulations 1997* requires that noise emitted from any premise must comply with assigned noise levels when received at any other premise and be free of the intrusive characteristics of tonality, modulation and impulsiveness. Regulation 8 specifies the assigned levels of noise according to the type of premises receiving the noise, the time of day and the presence of commercial and industrial land zoning and major roads within a 450 metre radius of the receiver.

7.5.2 Potential Impacts

Noise will be generated during the development phase by movement of heavy clearing machinery and construction of plantation infrastructure. During the operational stage noise will be produced by harvesting of the timber crop, during processing/milling of timber products and during haulage of timber. Noise will also be produced by equipment such as vehicle engines and power generators.

7.5.3 Predicted Impacts

The distance of the plantation from the nearest community at Beagle Bay is approximately 12 km. Consequently, it is anticipated that any noise arising during the construction and operational stages of the plantation will have no impact on the community.

Noise and vibrations arising from the project may impact on local populations of native fauna, causing them to move away from the noise source. It is possible that native fauna will become accustomed to persistent noise and therefore be less affected by this type of noise than by variable noise.

7.5.4 Management

Measures to be implemented to manage noise include:

- Signs will be erected in areas subject to elevated noise levels and personnel working in these areas will be supplied with and instructed in the use of protective equipment.
- Machinery to be regularly serviced to ensure minimisation of noise generation.
    - Generators to be located in enclosed areas and at a sufficient distance from personnel areas to minimise sound disturbance.

7.5.5 Predicted Outcome

Noise arising from the plantation during both the development and operation phases will have no impact on the nearby BBC.

There will be negligible environmental impacts arising from noise.

8.0 SOCIAL SURROUNDINGS

8.1 Aboriginal Culture and Heritage

8.1.1 EPA Objective

- *Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972;*and
- *Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.*

The *Aboriginal Heritage Act 1972* states that no Aboriginal site can be disturbed without consent from the Minister for Aboriginal Affairs.

8.1.2 Potential Impacts

No Aboriginal sites as listed on the DIA database have been previously recorded within the project area.

8.1.3 Predicted Impacts

As there are no sites of archaeological or ethnographical significance recorded within the project area, there are no expected impacts on aboriginal heritage arising from the project.

8.1.4 Management

TTP is committed to consulting with the Aboriginal communities, elders and relevant DMAs as part of the planning process for any activities being considered in the area. Management measures will include:

- Ongoing consultation with the BBC;
- Representatives from the BBC are to examine the project area prior to clearing;
- Any new Aboriginal site identified during development and operation will be reported to the DIA for assessment; and
- If any Aboriginal site is required to be disturbed for the project, a written application (under Section 18 of the *Aboriginal Heritage Act 1972*) will be made to the Aboriginal Cultural Materials Committee for consent by the Minister for Aboriginal Affairs.

8.1.5 Predicted Outcome

Based on surveys undertaken to date the proposed expansion of the trial plantation area will not impact on Aboriginal Culture and Heritage.

COMMITMENT 10. *TTP will ensure that (an) Aboriginal custodian (s) of the Beagle Bay Community will examine the project area for anthropological/ethnographic and archaeological sites prior to clearing.*

If any new sites are discovered, clearing will cease and the DIA will be notified.

8.2 Non-indigenous Heritage

8.2.1 EPA Objective

- *Comply with statutory requirements in relation to areas of cultural or historical significance.*

The statutory policy and technical framework is provided by the *Federal Australian Heritage Commission Act,* the *Heritage Act of Western Australia 1990* and the *Town Planning and Development Act 1928* which together provide for registers of heritage places. Under these Acts local authorities are required to compile Municipal Heritage Inventories. In addition to this community groups such as the National Trust maintain registers of significant places.

8.2.2 Potential Impacts

As described in Section 5.15.3 (Non-indigenous Heritage), the project will not affect heritage-listed areas on the Peninsula as they lie outside the project area.

8.2.3 Predicted Impacts

There are no predicted impacts to Non-indigenous heritage sites.

8.2.4 Management

No specific management strategies are proposed.

8.2.5 Predicted Outcome

No impacts to Non-indigenous heritage are anticipated.

9.0 ENVIRONMENTAL MANAGEMENT STRATEGY

9.1 Introduction

The aim of this section is to document the environmental management strategies to be applied to the project and to outline TTP's Environmental Policy (Appendix E).

9.2 Environmental Policy

TTP recognise that managing environmental issues is an essential component of the proposed project. TTP will continually strive to achieve high standards in environmental management and has a stated Environmental Policy that involves:

- Environmental management, risk reduction and pollution prevention in all operations;
- Complying with legislation and other requirements;
- Setting and meeting targets and objectives to reduce and manage significant risks;
- Maintaining good internal and external communications;
- Supporting protection of heritage and cultural values;
- Community participation; and
- Continual improvement.

TTP will review and annually report on its environmental performance as a means of communicating its progress against risk reduction targets.

The full TTP Environmental Policy is detailed in Appendix B.

9.3 Environmental Management System

TTP has developed an EMS for its proposed Beagle Bay Plantation. TTP intends to maintain a 'continual improvement' strategy towards its EMS.

The aim of undertaking the EMS process is to align procedures and practices to the AS/NZS ISO 14001 standards. TTP intends to achieve their environmental objectives as stated in the Environmental Policy by developing and implementing the ISO 14001 based EMS.

The EMS will include the following elements:

- Environmental policy and commitment;
- Planning of activities for systematic reduction and management of risks;
- Implementation of plans;
- Measurement and evaluation of environmental performance; and
- Continual review and improvement of practices.

The EMS will be implemented at commissioning of the project.

COMMITMENT 11: TTP have developed and will implement a formal EMS for the Project that embraces the ISO 14001 standards and incorporates the following:

- Environmental policy and corporate commitment to the EMS;
- Mechanisms and processes to ensure:
  - Planning to meet environmental requirements,
  - Implementation and operation of actions to meet environmental requirements,
  - Measurement and evaluation of environmental performance,
  - Review and improvement of environmental outcomes;
- Monitoring of key environmental aspects;
- Management of environmental impacts from clearing, planting and operation;
- Rehabilitation and revegetation of the project area;
- An overview of timing for implementation of commitments; and

Reporting requirements.

9.4 Integration of EMS & Environmental Reporting

The reporting requirements from the PER process will be integrated within reporting frameworks addressed in the EMS.

TTP will prepare and submit Annual Environmental Reports (AERs) to Government Agencies and relevant stakeholders describing the performance of the project and compliance with legal and other commitments. Reporting will commence upon establishment of the plantation.

10.0 COMMITMENTS

Commitment/ Management Actions/ Policy	*Objective*	*Actions*	*Timing*	*Advice From*	*Compliance Criteria*
1. Weeds					
TTP will develop and implement a weed management plan, including implementation of weed hygiene procedures.	Ensure that weed species do not become established in the plantation site.	Prepare and implement a plan.	Prior to construction.	DoE, CALM.	Plan approved and implemented.
2. Dust					
TTP will develop and implement dust management plan for plantation construction and operation, which will include a dust monitoring program.	Ensure that particulate/dust emissions meet appropriate criteria and do not cause an environmental or human health problem.	Implementation of the dust management measures and monitoring program specified in the dust management plan.	Construction and ongoing	DoE.	Baseline and monitoring data obtained.
3. Wetland Groundwater Monitoring					
TTP will monitor ground water levels within the Bobby's Creek wetland system to the north of the project area.	Ensure the Environmental Water Provision (EWP) criteria aren't breached.	Monitor groundwater levels throughout the life of the project.	Ongoing.	DoE, CALM.	Completion and reporting of additional surveys.
4. Monitoring of Groundwater Dependent Ecosystems					
TTP will monitor the Groundwater Dependent Ecosystems (GDEs) north of the project area.	Ensure that groundwater extraction does not exacerbate natural	Monitor GDEs throughout the life of project.	Prior to construction and ongoing.	DoE, CALM.	Baseline and monitoring data obtained.

Commitment/ Management Actions/ Policy	*Objective*	*Actions*	*Timing*	*Advice From*	*Compliance Criteria*
	variations in the height of the water table, leading to adverse impacts on these GDEs.				
5. Aquatic Flora and Fauna Monitoring					
TTP, in consultation with CALM and the DoE, will monitor flora and fauna aquatic indicator species of the Groundwater Dependent Ecosystems (GDEs) north of the project area.	Ensure the protection of the aquatic flora and fauna of the GDEs.	Undertake monitoring of aquatic indicator species	Ongoing	DoE, CALM	Completion and reporting of additional surveys.
6. Rare and Priority Flora Surveys					
Undertake Rare and Priority flora surveys in areas to be cleared prior to disturbance. A Priority Flora Management Plan will be implemented if necessary.	Ensure the protection of Declared Rare and Priority Flora.	Undertake additional required botanical surveys.	Prior to construction.	DoE, CALM.	Completion and reporting of additional surveys.
7. Fire Management					
TTP will develop and implement a bushfire management plan.	To reduce the risk of fire to the tree plantation and protect the surrounding native vegetation.	Prepare and implement a plan.	Prior to construction.	DoE, CALM.	Plan approved and implemented.
8. Groundwater and Irrigation					
TTP will undertake: • A monitoring plan to ensure that groundwater levels are not significantly reduced; and • Research to more accurately determine tree water demand of the plantation species.	To maintain sufficient quantity of groundwater so that existing and potential uses, including ecosystem maintenance, are protected.	Undertake monitoring research.	Ongoing.	WRC, CSIRO.	Monitoring and tree water requirements data obtained.
9. Closure Plan					
TTP will develop a detailed closure plan for the plantation. The closure plan will address rehabilitation	Ensure ecosystem function is maintained	Develop plan.	Prior to commissioning	DoE.	Closure plan approved by the DoE.

Commitment/ Management Actions/ Policy	*Objective*	*Actions*	*Timing*	*Advice From*	*Compliance Criteria*
actions to be taken for the plantation and associated infrastructure and will provide the basis for and eventual 'walk away' strategy for the project. It will also accommodate potential project failure.	following plantation closure and ensure the post-plantation landform is safe, stable, non-erodible and is integrated into the surrounding environment.		and ongoing as the project develops.		
10. Aboriginal Site Survey					
TTP will ensure that (an) Aboriginal custodian (s) of the Beagle Bay Community will examine the project area for anthropological/ethnographic and archaeological sites prior to clearing. If any new sites are discovered, clearing will cease and the Department of Indigenous Affairs will be notified.	To ensure the protection of Aboriginal heritage sites within the project area.	Undertake surveys.	Prior to construction.	DIA.	Surveys conducted.
11. Environmental Management System					
TTP will develop and subsequently implement a formal Environmental Management System (EMS) for the project that embraces ISO 14001 standards and incorporates the following: • Mechanisms and processes to ensure: o Planning to meet environmental requirements; o Implementation and operation of actions to meet environmental requirements; o Measurement and evaluation of environmental performance; and o Review and improvement of environmental outcomes. • Monitoring of key environmental aspects; • Management of environmental impacts from clearing, planting and operation; • Rehabilitation and re-vegetation of the project	Manage environmental impacts of the construction and operation phases of the project.	Develop and implement EMS.	Prior to commissioning.	DoE.	EMS developed and implemented.

Commitment/ Management Actions/ Policy	*Objective*	*Actions*	*Timing*	*Advice From*	*Compliance Criteria*
area; • An overview of timing for implementation of commitments; and • Reporting requirements.					

11.0 IMPLICATIONS OF POTENTIAL FUTURE DEVELOPMENT TO STAGE 2

Following the first three years of the plantation (Stage 1), the Proponent anticipates expanding the plantation to encompass an area of 1500 ha (Table 11.1). This will result in a further two years of clearing at a rate of 300 ha per year. To accommodate the eventual expansion of the plantation, the Proponent anticipates a water requirement of 7.1 GL/a in Year 5, which will gradually reduce to 6.5 GL/a in Year 8 and for the remaining life of the plantation (Table 11.2). Consequently, the Proponent will apply to the EPA for approval of the expansion under part IV of the *Environmental Protection Act* 1986 and DoE for a Groundwater Well Licence of 7.1 GL/a at the conclusion of Stage 1 of the project.

The majority of environmental implications resulting from this expansion will be a proportional increase, i.e. clearing of vegetation or landscape impacts will increase by 67 percent (Table 11.3). The effect of the increase in water abstraction on the water table and on the GDEs to the north of the plantation is not as straight forward to predict. Preliminary modelling has been undertaken of the impacts of this increased water allocation and the information obtained thus far is provided below. These results are based on limited available data, and future monitoring over the three year period encompassing Stage 1 will enable a better understanding of the dynamics of the groundwater system and the relationship between the groundwater and the communities that depend on this resource.

11.1 Groundwater Modelling

Groundwater modelling indicates that after water abstraction at a rate 7.1 GL/a for 20 years, a shallow cone of depression, exceeding 600 mm concentrated beneath the lease area, will develop and that the drawdown decreases to 100 mm close to the Bobby's Creek GDEs (Figure 11.1) (Rockwater, 2004a). The results are believed to be conservative and effects are likely to be less than predicted (Rockwater, 2004a).

Following 20 years pumping, the drawdown at Beagle Bay is currently predicted to be up to 100 mm (Rockwater, 2004a). An additional 100 mm of drawdown caused by pumping from the plantations will not affect the yields from the production bores used for the BBC water Supply (Rockwater, 2004a).

The theoretical maximum rise in the saltwater interface below the Beagle Bay Water Supply bore based on a drawdown of 0.1 m from groundwater extraction of 7.1 GL/a for 20 years, is about 4 m and will remain well below the bores (Rockwater, 2004a). The wedge may move inland a short distance as a new dynamic equilibrium is established in response to the pumping. However, no adverse affects on existing water supply bores are likely to occur (Rockwater, 2004a). The saltwater wedge is not present beneath the lease area and the plantation production bores will not be affected (Rockwater, 2004a).

A further three years of groundwater monitoring at both the plantation site and in the vicinity of Beagle Bay and Bobby's Creek will enable the model to be re-calibrated thereby providing a more accurate assessment of the impacts of water abstraction on the groundwater levels. This information will be provided to the DoE prior to the application for an increased licence allocation.

Table 11.1 Key Characteristics Table for expansion to 1500ha plantation

Component	Key Aspect	Characteristic Description
Plantation Operations	Proposed Site Location	Dampier Peninsula 120 km north of Broome
	Estimated Area of Plantation	Approx. 1600 ha
	Planting Density	Mahogany 625 trees/ha Teak 1,000 trees/ha Sandalwood 315 trees/ha Sandalwood hosts 315 trees/ha
	Species to be Cultivated	Teak *Tectona grandis,* Indian Rosewood *Dalbergia latifolia,* Indian Sandalwood *Santalum album,* African Mahogany *Khaya senegalensis*, Australian Ebony *Diospyros ferrea* and Gubinge *Terminalia latipes*.
	Planting Rate	Expansion will be undertaken in 2 stages of 300 ha each.
	Total Estimated Production	95,500 m^3 Timber
	Project Life Span	20 years
	Anticipated Year of Project Closure	2025
	Water Supply Requirements	Up to 7.1 GL/a
Transport Requirements	Road Train Movements	2700 loads hauled to Broome
General	Workforce	25
	Workforce Accommodation	Accommodation Village for 25 people Area of disturbance 2 ha
	Infrastructure	Power source – Beagle Bay power station. Water source – Groundwater from site.
Plantation Facilities	Nursery Storage Shed Site Office etc.	Area of disturbance – 5 ha

Table 11.2 Estimated water requirements of 1500ha plantation

YEAR No	YEAR (June to July)	NEW PLANTINGS/ ANNUM (ha)	TOTAL PLANTINGS (ha)	WATER REQUIRED FOR YEAR 1 PLANTINGS (GL/ANNUM)	WATER REQUIRED FOR YEAR 2 PLANTINGS (GL/ANNUM)	WATER REQUIRED FOR YEAR 3 PLANTINGS (GL/ANNUM)	WATER REQUIRED FOR YEAR 4 PLANTINGS (GL/ANNUM)	WATER REQUIRED FOR YEAR 5 PLANTINGS (GL/ANNUM)	ESTIMATED TOTAL WATER REQUIRED (GL/ANNUM)	AVERAGE DAILY PUMPING RATE/ANNUM (kL)	AVERAGE DAILY PUMPING RATE/ NINE MONTHS (kL)
1	2004-2005	300	300	1.5	0	0	0	0	1.5	4,110	5,474
2	2005-2006	300	600	1.5	1.5	0	0	0	3	8,219	10,949
3	2006-2007	300	900	1.5	1.5	1.5	0	0	4.5	12,329	16,423
4	2007-2008	300	1200	1.3	1.5	1.5	1.5	0	5.8	15,890	21,168
5	2008-2009	300	1500	1.3	1.3	1.5	1.5	1.5	7.1	19,452	25,912
6	2009-2010	0	1500	1.3	1.3	1.3	1.5	1.5	6.9	18,904	25,182
7	2010-2011	0	1500	1.3	1.3	1.3	1.3	1.5	6.7	18,356	24,453
8	2011-2012	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
9	2012-2013	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
10	2013-2014	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
11	2014-2015	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
12	2015-2016	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
13	2016-2017	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
14	2017-2018	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
15	2018-2019	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
16	2019-2020	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
17	2020-2021	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
18	2021-2022	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
19	2022-2023	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723
20	2023-2024	0	1500	1.3	1.3	1.3	1.3	1.3	6.5	17,808	23,723

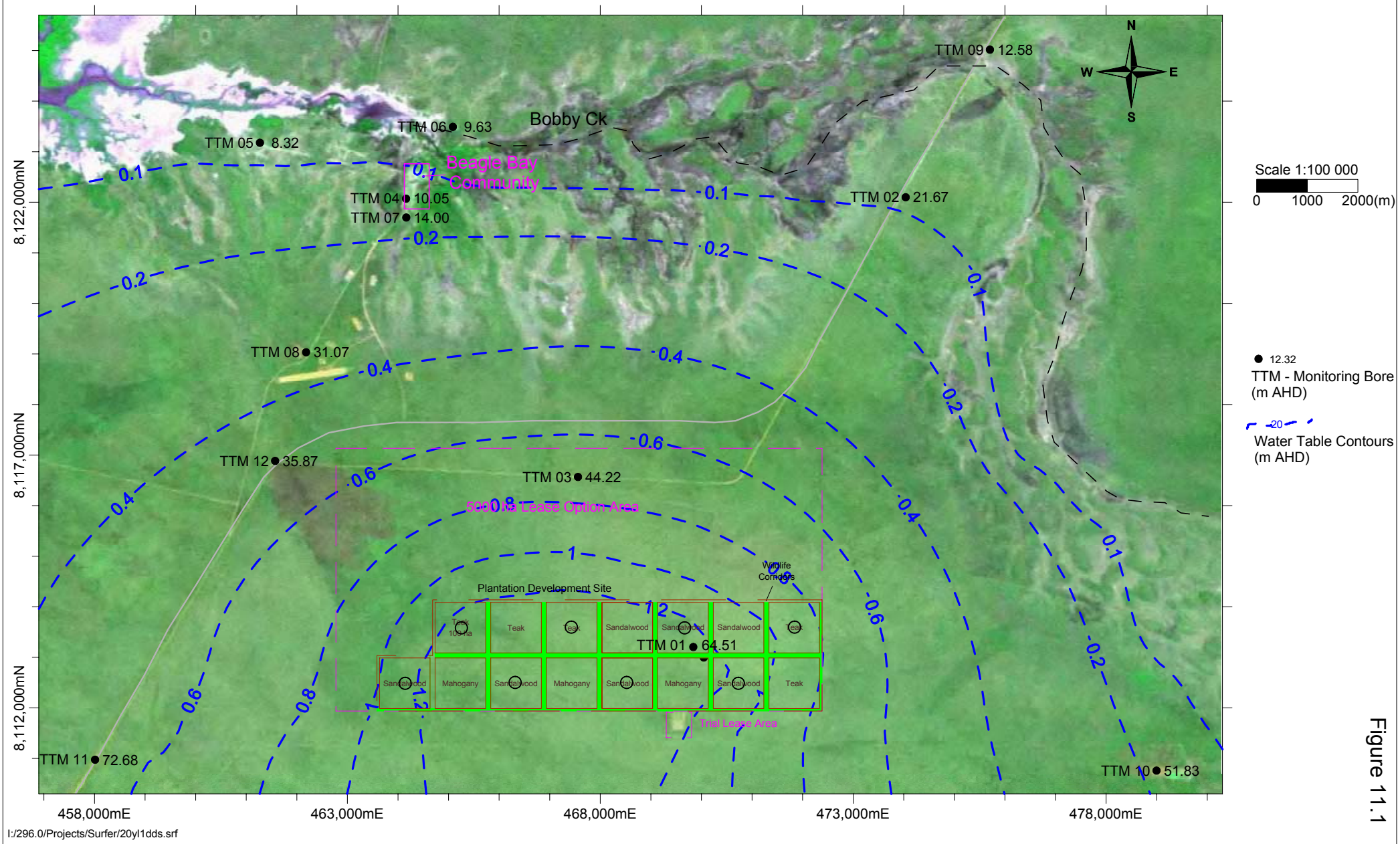
Years 1 to 3 - 1.1 GL/annum/300ha plus 15% for drought (one in four year event) = 1.265; plus 10% inefficiency; plus 0.1 GL/annum contingency = 1.4915 (say 1.5 GL/annum)

Years 4 to 20 - 0.96 GL/annum/300ha (i.e. trees older 4 years and older) plus 15% for drought (one in four year event) = 1.104; plus 10% inefficiency; plus 0.1 GL/annum contingency = 1.3144 (say 1.3 GL/annum)

Table 11.3 Potential impacts of expansion to Stage 2 of project.

SECTION	ISSUE	IMPACT OF STAGE 1	IMPACT OF STAGE 2
6.1	Vegetation communities	Loss of 967 ha of native pindan vegetation.	A 67 % increase in native vegetation clearing, with a total loss (Stage 1 and Stage 2) of approximately 1600 ha.
6.2	Priority Ecological Communities and Groundwater Dependent Ecosystems	Groundwater modelling indicates that the proposed pumpage of 4.5 GL/a over a period of three years will not extend to Bobby's Creek where the water table is near the surface (Figure 6.1). Therefore it is predicted that there will be no measurable impacts on groundwater levels at the GDEs and the 30 % flux criteria will be met.	See Section 11.1.
6.3	Rare & Priority Flora	No impact on DRF or Priority flora.	No impact on DRF or Priority flora.
6.4	Terrestrial Vertebrate Fauna	Limited loss of fauna habitat and associated direct impacts to fauna individuals and populations. Some loss of larger fauna is expected from road fauna deaths, but these impacts will be minimised by appropriate management.	There will be a 67 % increase in loss of fauna habitat, and proportional increase in fauna mortalities.
6.5	Specially Protected (Threatened) Fauna	Negligible impacts are expected in the vicinity of the proposed project area due to the absence of any fauna or habitat of particular conservation significance.	As per Stage 1.
6.6	Invertebrate Fauna	Localised loss of invertebrate fauna habitat and associated direct impacts to fauna populations; however the impact on the invertebrate fauna is considered to be negligible as representation of fauna habitats and communities will be maintained in extensive surrounding areas.	There will be a 67 % increase in loss of fauna habitat, and proportional increase in fauna mortalities.
6.7	Fire Management	Fire Management Procedures will ensure that there is a low incidence of fire within the plantation project area, and that fire-related impacts on the project area will be minimal.	As per Stage 1.
6.8	Watercourses	Negligible impacts are expected in the vicinity of the proposed project area due to the absence of any defined watercourses or rivers.	As per Stage 1.

SECTION	ISSUE	IMPACT OF STAGE 1	IMPACT OF STAGE 2
6.9	Groundwater	Modelling suggests that an allocation of 4.5GL/a for three years will not impact on the wetland systems in the area or other users of the Broome aquifer.	See Section 11.1.
6.10	Greenhouse Gas Emissions	Stage 1is expected to result in a carbon sequestration benefit; however there is currently insufficient information available to quantify this benefit	The sequestration benefit is likely to increase; however it is not possible to quantify the increase at this stage of development.
6.11	Landscape Values	Visual amenity and landscape character will be impacted due to the clearing of native vegetation.	67 % increase in land clearing will have a proportional impact on landscape values.
6.12	Decommissioning & Rehabilitation	Rehabilitation of 967 ha of plantation and infrastructure.	67 % increase in plantation area to be rehabilitated.
7.1	Surface Water Quality	Impacts on sediment and nutrient loads in surface water are considered to be negligible. Risk of hydrocarbon or chemical spills is negligible.	As per Stage 1.
7.2	Groundwater Quality	The impact on groundwater quality is likely to be negligible.	67 % increase in agrochemicals; however impact is likely to be as per Stage 1.
7.3	Particulates/Dust	Clearing, construction of infrastructure, planting, harvesting and hauling activities will generate limited environmental dust; however management implementations will ensure impact is negligible.	Two year increase in clearing and therefore dust production. 67 % increase in dust production during ongoing plantation practices; however impact is likely to be as per Stage 1.
7.4	Waste Materials	Negligible environmental impacts due to the low volumes of waste produced and the removal of much of the inorganic waste from site.	67 % increase in waste products, particularly organic waste; however impact is likely to be as per Stage 1.
7.5	Noise	Noise arising from the plantation during both the development and operation phases will have no impact on the nearby Beagle Bay Aboriginal Community. There will be negligible environmental impacts arising from noise.	As per Stage 1.
8.1	Aboriginal Culture and Heritage	Based on surveys undertaken to date the proposed expansion of the trial plantation area will not impact on Aboriginal Culture and Heritage.	As per Stage 1.
8.2	Non-indigenous Heritage	No impacts to Non-indigenous heritage are anticipated.	As per Stage 1.



I:/296.0/Projects/Surfer/20yl1dds.srf

Figure 11.1

CLIENT: Tropical Timber Plantations

PROJECT: Beagle Bay Project

DATE: March 2004

Dwg. No: 296.0/04/11.1a

MODEL-CALCULATED GROUNDWATER LEVEL DRAWDOWNS (m) AFTER 20 YEARS PUMPING, LAYER 1

Rockwater Pty Ltd

REFERENCES

Anonymous (2000). *Waterbank Structure Plan*. Department of Land Administration Perth.

Ashvini (2001). Khaya senegalensis. Tropical Attitudes Gardening. Internet Posting. www.raingardens.com

Atkins, K.J. (2004) *Declared Rare and Priority Flora List April 2003*, Department of Conservation and Land Management, Perth.

Attiwill, P.M., Florence, R.G., Hurditch, W.E. and Hurditch, W.J. (1994). The Burning Continent. Forest Ecosystems and Fire Management in Australia. Institute of Public Affairs, Perth.

Australian Bureau of Statistics (2003) Population by Age and Sex. (ABS cat. No. 3235.0-8.55.001)

Australian Bureau of Statistics (2003). Regional Population Growth, Australia and New Zealand, 2003-2003, (ABS cat. No. 3218.0)

Australian Greenhouse Office (2001). Growing Trees as Greenhouse Sinks – an overview for landowners. A Bush for Greenhouse Project, September 2001.

Australian Greenhouse Office (2000). Carbon Accounting Model for Forests (CAMFor) Users Manual, Version 3.35. National Carbon Accounting System Technical Report No. 26.

Australian Greenhouse Office (1998). National Greenhouse Strategy. (Commonwealth and State and Territory Governments, with input from the Australian Local Government Association, industry and the community).

Australia New Zealand Environmental and Conservation Council (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, ANZECC: http://www.deh.gov.au/water/quality/nwqms/index.html

Bamford, M.J. (1995). Predation by feral cats upon lizards. Western Australian Naturalist 20: 191-196.

Beard, J.S. (1979) *Vegetation Survey of Western Australia: Kimberley.* University of Western Australia Press, Perth.

Bindon, P. (1978). A Survey for Aboriginal Sites in Central Dampier Land for Esso Exploration.

Blakers, M., Davies, S. J. J. F. and Reilly, P. N. (1984). The Atlas of Australian Birds. RAOU. Melbourne University Press.

Burbidge, A. A and McKenzie, N. L. (1989). Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. Biological Conservation 50: 143-198.

Bureau of Meteorology. Accessed on 27 January 2004. www.bom.gov.au.

Centeno, J.C. (1997). The Management of Teak Plantations. Tropical Forest Update ITTO Newsletter V7 No2. Japan.

Churchill, S. (1998). Australian Bats. Reed New Holland, Sydney.

Cleary, J. (2002). Koolyanobbing Expansion Project, Landscape Supplementary Study. Unpublished report for Portman Limited, 2002.

Cleary, J., Cowan L. & Koch, P., (1999). Shark Bay World Heritage Property Landscape Study. Draft Report, CALM.

Climate Action Network Australia (2003). http://swiftek.modwest.com/cana/bush/rangelands.htm

Commonwealth of Australia. (1984). Bushfires and the Australian Environment. Report for the Standing Committee on Environment and Conservation.

Davies, P. (1994) *River Bioassessment Manual.* Land and Water Australia, Canberra, ACT.

Department of Agriculture (1998b), *TreeNote No.4 Pruning Trees for Sawlogs,* Department of Agriculture, Perth.

ecologia Environment (2002). Cape Leveque Road Beagle Bay to Cape Leveque Section – Environmental Assessment and Management Plan. Unpublished report for Main Roads WA, March 2002.

ecologia Environment (2003). Beagle Bay "Big Tree Country" – Scoping Document. Unpublished report for Tropical Timber Plantations Pty Ltd.

ecologia Environment (2004a). Beagle Bay "Big Tree Country" – Flora Assessment Survey. Unpublished report for Tropical Timber Plantations Pty Ltd.

ecologia Environment (2004b). Beagle Bay "Big Tree Country" Timber Plantation– Groundwater Dependent Ecosystems Flora Assessment. Unpublished report for Tropical Timber Plantations Pty Ltd.

ecologia Environment (2004c). Beagle Bay "Big Tree Country" Tropical Timber Plantation– Fauna Assessment Survey. Unpublished report for Tropical Timber Plantations Pty Ltd.

Environmental Protection Authority (1993). Western Australian Water Quality Guidelines for Fresh and Marine Waters. Bulletin Report No. 711 EPA, November 1993.

Environmental Protection Authority (2002). Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) - Guidance Statement for Minimising Greenhouse Gas Emissions. Guidance Statement No. 12, EPA, October 2002.

Environmental Protection Authority (2000a) General requirements for Terrestrial Biological Surveys' Preliminary Position Statement No. 3.

Environmental Protection Authority, (2000b). Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) – Prevention of air quality impacts from land development sites. Guidance Statement No. 18, March 2000.

Environmental Protection Authority (1999). Draft Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protections Act, 1986) – Management of Surface Run-off from Industrial and Commercial Sites, Draft Guidance No. 26, March 1999.

Environmental Protection Authority (1997). Policies, Guidance and Criteria for the Assessment for Environmental Impact Assessment – Guidelines for Environment and Planning. Preliminary Policy No. 33, August 1997.

Fire and Emergency Services Authority of Western Australia (2001). Guidelines for Plantation Fire Protection.

Franklin, D. C. (1999). Evidence of disarray amongst granivorous bird assemblages in the savannas of northern Australia, a region of sparse human settlement. *Biological Conservation* 90: 58-68.

Institute of Environmental Assessment and Landscape Institute (1995). Guidelines for Landscape and Visual Impact Assessment. Institute of Environmental Assessment and Landscape Institute, United Kingdom.

John Brennan and Associates (2003). Proposed Irrigation of Tree Crops. Unpublished Report.

Johnstone, R. E. and Storr, G. M. (1998). Handbook of Western Australian Birds; Volume 1 - Non-passerines. Western Australian Museum, Perth.

Kenneally, K.F., Edinger, D.C. and Willing, T. (1996) *Broome and Beyond, Plants and People of the Dampier Peninsula.* Department of Conservation and Land Management, Perth.

Kinnear, J. (1993). Masterly marauders; the cat and the fox. Landscope 8(2): 20-28.

Laws, A.T. (1991). *Explanatory notes on the Broome 1:250,000 hydrogeological sheet.* Western Australia Geological Survey hydrogeological map series.

Laws, A.T. (1984) Broome hydrogeological map preliminary report. West Australian Geological Survey Hydrogeology Report No. 2575. Unpublished Report.

Lewis, M. (2001). Threatened Species of the Northern Territory: Gouldian Finch *Eurythrura gouldiae.* Northern Territory Parks and Wildlife Commission.

Mckenzie, N.L. (ed) (1983) Wildlife of the Dampier Peninsula, South-West Kimberley, Western Australia. Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife, Perth, Western Australia.

McKenzie, N.L. and Kenneally, K.F. (1983) Background and Environment. In: N.L. Mckenzie (ed.), *Wildlife of the Dampier Peninsula, South-West Kimberley, Western Australia.* Department of Fisheries and Wildlife, Perth.

Moncrief, D. (2001). Bringing Them Home Goes to Beagle Bay, Bringing Them Home Oral History Project. URL (http://www.nla.gov.au). Last accessed 11/02/04.

National Environment Protection Council, (1998). National Environment Protection Measure for Ambient Air Quality, NEPC, June 1998.

O'Connor, R. (2002). Report on an ethnographic survey of proposed MRWA works on the Broome to Cape Leveque Road.

O'Connor, S. (1989). New radiocarbon dates from Koolan Island, West Kimberley, W.A. *Australian Archeology.* 28: 92-104.

Pazckowska, G. and Chapman, A. (2000).The Western Australian Flora: Descriptive Catalogue. Wildflower Society of Western Australia, Perth, Western Australia.

Petheram, R.J. and Kok, B. (1983). Plants of the Kimberley Region of Western Australia, University of W. A. Press, Perth, Western Australia

Phengklai, C., Smitinand, T., Kartasubrata, J., Laming, P.B., Lim, S.C. and Sosef, M.S.M. (1997) Tectona L.f. PROSEA Handbook. Internet posting.

Pizzey, G. (1983). A Field Guide to the Birds of Australia. Collins. Sydney.

Prasad, A.G. D. (1994). Dalbergia latifolia – the high-valued Indian rosewood. NFT Highlights. NFTA 94-04 FACT Net, Arkansas, USA.

Quartermaine, G.S. (2002). Report on an archaeological investigation of Aboriginal sites Beagle Bay and Cape Leveque sections Cape Leveque Road, North of Broome.

Rockwater Pty. Ltd. (2004a). Beagle Bay Big Tree Country Plantation Project: Groundwater assessment and modelling to support groundwater licence application. Report for Tropical Timber Plantations Pty. Ltd.

Rockwater Pty. Ltd. (2004b). Beagle Bay Big Tree Country Plantation Project: Groundwater Licence Operating Strategy. Report for Tropical Timber Plantations Pty. Ltd.

Rockwater Pty. Ltd. (2004c). Beagle Bay Big Tree Country Plantation Project: Installation of Environmental Monitoring Sites TTM 13 to 17. Unpublished Report for Tropical Timber Plantations Pty.Ltd.

Rockwater Pty. Ltd. (2004d). Beagle Bay Big Tree Country Plantation Project: Results of Additional Groundwater Modelling. Unpublished Report for Tropical Timber Plantations Pty.Ltd.

Russell-Smith, J., Whitehead, P.J., Cook, G.D. and Hoare, J.L. (2003). Response of Eucalyptus-dominated savanna to frequent fires: Lessons from Munmarley, 1973-1996. Ecological Monographs 73: 349-375.

Singh, U.V. (1995). Sandalwood – Scope for commercial propagation on community lands in India. Sandalwood Research Newsletter. Issue 4. DCLM. WA.

Start, A. (2003). Fire management and healthy country in the Kimberley Region, Western Australia. In: Kohen, J.L. (ed) Proceedings of the 2nd Biannual Kimberley Fire Forum. Kimberley Specialists.

Start, A. (2001). Fire Management and Healthy Country in the Kimberley Region, Western Australia. Forum paper for the 2nd Biannual Kimberley Fire Forum, May 2001.

Strahan, R. (Ed.) (1995). The Mammals of Australia. Reed Books, Sydney.

Swann, G. (2003) Ornithological Survey for Proposed Tropical Timber Plantation. Unpublished Report for John Brennan and Associates.

Tewari, P.N. (1992) *A monograph on Teak (Tectona grandis Linn. f.).* International Book Distributors. Dehra Dun, India.

Thackway, R. and Cresswell, I.D. (1995). 'An Interim Biogeographic Regionalisation for Australia'. Nature Conservation Agency, Canberra.

Water & Rivers Commission (2000) Pesticide Use in Public Drinking Water Source Areas, Environment Statewide Policy No. 2, Water & Rivers Commission October, 2000

Wheeler, J.R. (ed) (1992). *Flora of the Kimberley Region.* Department of Conservation and Land Management, Perth.

Williams, P.R., Congdon, R.A., Grice, A.C. and Clarke, P.J. (2003). Effect of fire regime on plant abundance in a tropical eucalypt savanna of north-eastern Australia. Austral Ecology 28: 327-338.

Willing, T. and Dureau, D. (2000). Botanical Survey for Proposed Tropical Timber Plantation, Beagle Bay, West Kimberley, WA. Conservation and Land Management, Broome, WA.

Young, G., Neal, M., Geyer, M ; and Cymbaline (2001) Biology and Control of the Giant Northern Termite, *Mastotermes darwiniensis* Froggatt (Isoptera: Mastotermitidae).

LIST OF ABBREVIATIONS

%	percent
<	less than
ABC	Australian Broadcasting Commission
ABS	Australian Bureau of Statistics
ACN	Australian Company Number
AER	Annual Environmental Review
AGO	Australian Greenhouse Office
AHD	Australian Height Datum
ALT	Aboriginal Land Trust
ANZECC	Australian and New Zealand Environment and Conservation Council
ARRP Act	Agriculture and Related Resources Protection Act
AS	Australian Standard
ATSIS	Australian and Torres Strait Islander Services
AusRivAs	Australian River Assessment System
BB	Beagle Bay
BBB	Beagle Bay Burrunk
BBC	Beagle Bay Community
BCC	Broome Chamber of Commerce
BGA	Broome Growers Association
CaCO3	Calcium Carbonate
CALM	Department of Conservation and Land Management
CAMBA	China-Australian Migratory Bird Agreement
CC	Conservation Commission
CDEP	Community Development Employment Projects
CEO	Chief Executive Officer
cm	centimetre
CO2	Carbon Dioxide
CSIRO	Commenwealth Scientific and Industrial Research Organisation
CWR	Critical Weight Range
DEP	Department of Environmental Protection
DIA	Department of Indigenous Affairs
DLG & R	Department of Local Government and Regional Development
DLI	Department of Land Information
DMA	Decision Making Authority
DoE	Department of Environment
DoIR	Department of Industry and Resources
DPI	Department for Planning and Infrastructure
DRF	Declared Rare Flora
DW	Declared Weed Species
e.g.	for example
EK	Environs Kimberley
EMS	Environmental Management System
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act
EPHC	Environment Protection & Heritage Council
EPP	Environmental Protection Policy

ERMP	Environmental Review and Management Plan
ESD	Ecologically Sustainable Development
EWP	Environmental Water Provisions
EWR	Environmental Water Requirements
FESA	Fire and Emergency Services Authority of Western Australia
FPC	Forest Products Commission
GDA	Geodetic Datum Australia
GDE	Groundwater Dependent Ecosystem
GL	Gigalitre
GL/a	Gigalitre per annum
GLOS	Groundwater Licence Operating Strategy
GWN	Golden West Network
ha	hectare
ISO	International Organisation for Standardisation
IUCN	International Union for the Conservation of Nature
JAMBA	Japan-Australia Migratory Bird Agreement
KACC	Kimberley Area Consultative Committee
KDC	Kimberley Development Commission
kL/a	kilolitre per annum
KLC	Kimberley Land Council
km	kilometre
km^2	square kilometre
KPIA	Kimberley Primary Industry Association
KRFMP	Kimberley Regional Fire Management Project
L	litre
m	metre
m^2	square metre
m^3	cubic metre
mg/L	milligram per litre
MLC	Member of the Legislative Council
mm	millimetre
mm/yr	millimetre per year
MS	Mound Springs
MSDS	Material Safety Data Sheet
mya	million years ago
NaC1	Sodium Chloride
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure for Ambient Air Quality
NGGIC	National Greenhouse Gas Inventory Committee
NNW	north north-west
NSESD	National Strategy for Ecologically Sustainable Development
NWQMS	National Water Quality Management Strategy
NZS	New Zealand Standard
OAED	Office of Aboriginal Economic Development
ºC	degrees Celsius
OMP	Office of Major Projects
ORIA	Ord River Irrigation Area
P	Priority
PER	Public Environmental Review

pers. com.	personal communication
pH	measure of acidity
PM10	airborn particulates less than 10 microns in diametre
sp	species
spp	species (plural)
subsp	subspecies
TAFE	Technical and Further Education
TDS	Total Dissolved Solids
TEC	Threatened Ecological Community
TTP	Tropical Timber Plantations Pty Ltd
var	variant
VHF	Very High Frequency
W	Wetland
WA	Western Australia
WAM	Western Austrlian Museum
WCA	Wildlife Conservation Act
WRC	Water and Rivers Commission

APPENDICES

APPENDIX A

EPA Response to Scoping Document

Environmental Protection Authority

Westralia Square, Level 8
141 St George's Terrace, Perth, Western Australia 6000
PO Box K822, Perth, Western Australia 6842
Telephone (08) 9222 7000 Facsimile (08) 9222 7155
www.epa.wa.gov.au

Mr Gary Connell
Ecologia Environmental Consultants
76 Thomas St
PERTH WA 6005

Dear Mr Connell

Scoping Document: Tropical Timber Plantations Pty Ltd: Proposed *Big Tree Country* Timber Plantation Beagle Bay

Thank you for your letter of 9 July 2003 with which you submitted a draft Scoping Document for the above proposal.

The Environmental Protection Authority (EPA) considered the level of assessment for the proposal and the draft Scoping Document at its meeting of 17 March 2003. At the meeting the EPA agreed in principle, to setting the level of assessment for the proposal at Public Environmental Review. However in order for the EPA to provide final endorsement of the Scoping Document for public release as the basis for the PER, the EPA requires that the Scoping Document address the following:

1. The PER is to include detailed substantiation of the scientific basis of the predicted water requirements of the proposal including:-
   - the water demand of the proposed tree crop plantation through all its growth stages; and
   - the water requirements for the whole project, including any possible future expansion.
2. The scope of investigations for the PER is to include an expanded hydrological study incorporating:-
   - modelling of the impact of water extraction on the springs and groundwater level;
   - assessment of the sustainable yield of the aquifer;
   - assessment of the ecological water requirements necessary to meet the objective of maintaining environmental values, taking into account drought; and
   - provision of water resource information from a regional perspective.
3. The PER is to include an assessment of the impacts of water extraction on the social and cultural values of users of the springs.

4. The PER is to provide information on the impact of water abstraction on any other licensees.

5. On the matter of biodiversity the Scoping Document should make reference to the intention to include strategies in the PER to:-

   - contain (during the life of the project) and then eradicate (at project completion) weeds and exotic plants; and
   - protect fauna populations in the area of the project.

6. The Scoping document should make reference to the intention to fully document, in the PER, the extent of community consultation and peer review involvement. This would include confirmation of the peer review panel.

Upon receipt of the final Scoping Document addressing the matters referred to above, it is the EPA's intention to determine the level of assessment for the proposal under Section 40 of the *Environmental Protection Act 1986* and to place this decision on the public record. Please make at least 12 copies of the final Scoping Document available to the EPA (via the EPA Service Unit) at that time.

Following the determination of any appeals on the level of assessment, the EPA will correspond with you in relation to a timeline for the assessment of the proposal.

Should you wish to further discuss any of the above matters, please contact Nicholas Woolfrey of the EPA Service Unit by telephone on (08) 92227002 in the first instance.

Yours sincerely

Walter Cox
CHAIRMAN

25 July 2003

APPENDIX B

Peer Review Responses

THORPE
GROUNDWATER & ENVIRONMENTAL SERVICES PTY LTD
18 Carlisle Road KALAMUNDA WA 6076
Ph: (08) 9293 1288 Mob: 0408 957 277 Fax: (08) 6293 1440 Email: pethorpe@iinet.net.au

Our Ref. T74/TGES 582

Dr A D Allen
Rockwater Pty Ltd
PO Box 201
Wembley
WA 6913

30 March 2004

Dear Tony,

Re. Peer review of Rockwater report for Tropical Timber Plantation Pty Ltd: Beagle Bay Big Tree Country Plantation Project. Groundwater Assessment and Modelling to support Groundwater Licence Application March 2004 (Ref. 296.0/04/1)

A complete copy of the above report was received at our office on 26 March 2004. The report clearly and comprehensively describes the results of a groundwater resource assessment investigation at the proposed plantation lease area in support of an application for a licence to take water.

Methodology

The methodology applied to the assessment was developed in consultation with Department of Environment (DoE). A relatively high level of assessment was set as the subject area occurs within the Kimberley-Canning Groundwater Management Area for which a groundwater management plan has not been developed by DoE. The methodology applied, in terms of the breadth and level of detail involved in the groundwater investigation, is considered to be adequate to protect the water resource and associated environmental values in the area.

Drilling and Testing programme

The drilling and testing programme involved the construction of one test production bore and four monitor bores. The production bore located within the proposed plantation area was drilled to intersect the main highly productive interval within the Broome aquifer referred to as the Broome Sandstone.

The geology and hydrogeology of the area is relatively simple and quite well documented by previous Government hydrogeological studies. It is therefore possible to make valid assumptions regarding the lateral extension of the Broome aquifer without the need to construct numerous test production and monitor bores.

Interpretation of findings

The report clearly describes and interprets the findings of the groundwater assessment. The orientation of the water table in the broader area surrounding the plantation lease area is well defined. The high permeability (and high yield capacity) of the Broome aquifer is clearly shown by the low gradient of the water table across the area.

The saltwater interface is predicted to occur at significant depth in the Broome aquifer about 5 km downgradient of the plantation lease area. This interface was not intersected by the exploratory drilling of monitor bore TTM 04 near the Beagle Bay Community to a depth of 98 m (-88 mAHD). The saltwater interface is inferred to occur at the base of the Broome aquifer at this location at a depth of at least 300 m below surface (-300 mAHD).

The interface is highly unlikely to extend beneath the plantation lease area 8 km to the south. Here the aquifer base occurs at a shallower depth (about -275 mAHD) and is further away from marine influence. Any slight movement in the saltwater interface at the Beagle Bay Community in response to abstraction will have impact only at great depth in the Broome aquifer. This movement in the saltwater interface is unlikely to have any impact whatsoever on the relatively shallow production bores at the Beagle Bay Community located at a maximum depth of about -95 mAHD within the upper part of the Broome aquifer. The assessment has adequately addressed changes in the saltwater interface in response to pumping at the plantation lease area. It follows that the 3-monthly conductivity profiling of monitor bore TTM 04 proposed in Table 11 page 26 to assess the presence of the saltwater interface may not be required.

The results of pumping tests confirm previous assessments of the hydrogeological properties of the Broome aquifer. The major part of the Broome aquifer, Broome Sandstone, has a high permeability throughout the region and can sustain high rates of abstraction. The pumping test were conducted at relatively low discharge rates considering the lithology of the aquifer and hence small drawdown responses were recorded during the step tests and 48 hour constant rate test. It is understood and should be accepted that higher rate pumping equipment was not readily available in this remote location during the wet season. The pumping test results gave calculated hydraulic parameters that are in line with existing data for the Broome aquifer and textbook (lithology-based) estimates of permeability for coarse sand and gravel.

Rockwater have proposed that additional production bores will be designed to produce significantly higher flow rates per bore than the existing test production bores. Fewer production bores are likely to be required to produce the water supply for the development. This comment is fully agreed with.

Groundwater Model

The groundwater model is considered to be adequate for the proposed development. The conceptual model is suitably conservative in its assumptions regarding aquifer parameters and is firmly based on existing hydrogeological data and the results of the site investigation. The calibration of the model is adequate as shown by the model generated watertable contour plan in Figure 11. The model results are acceptable and the critical modelled parameter of throughflow was verified by an independent method based upon estimated rainfall recharge in the flow system upgradient of the plantation lease area.

The model predicted effects on the Beagle Bay Community, saltwater interface and the mound springs are assessed to be reasonable. The assessment that the predicted drawdown in the Broome aquifer will have a negligible effect on any on these receptors is considered also to be realistic. The staging of the proposed development will provide a contingency in the event that impacts are greater than predicted and adjustments would then be made to development plan in terms of water use.

Monitoring Programme

The proposed monitoring programme is adequate. It may be appropriate to monitor for possible impact on the watertable of agro-chemicals via a series of dedicated shallow monitor bores with a short screen intervals set to span the watertable rather than using the deeper production bores (Table 11).

Conclusions

The conclusions provided are agreed with in full and are reasonable and appropriate.

Minor (non critical) comments

- Page 10, Table 5. A record of the approximate date of bore construction for monitor bores TTM-05 to -12 would be useful.
- Page 17 Section 4.2.8 first sentence should refer to Table 8 not 7.
- Figure 7. The height data attached to each bore location is the top of casing (datum). It would be helpful if the measured reduced water level were included here for purposes of comparison to the estimated water level contours.
- TTP02 bore completion data sheet. It would be useful to include the water salinity test result from Table 8.

Yours sincerely

Dr Peter Thorpe, Principal Hydrogeologist

Attached: CV for Dr Peter Thorpe
Issued on 30 March 2004 by post.

Department of Conservation and Land Management

Conserving the nature of WA

Your ref:
Our ref: 046435F2003V01
Enquiries: Daniel Coffey
Telephone: (08) 9334 0368
Fax: (08) 9367 9913
Email: danielco@calm.wa.gov.au

Environmental Protection Section
Locked Bag 104
BENTLEY DELIVERY CENTRE
WA 6983

Ecologia Environment
76 Thomas Street,
West Perth 6005

Attention: Belinda Barnett

BEAGLE BAY TROPICAL TIMBER PLANTATION PROJECT

I refer to your letter dated 20th December 2005, requesting a peer review of the fauna assessment survey of the above project by Tony Start. CALM provides the following comments by way of clarification of Ecologia's request.

From an earlier request of Ecologia, Tony Start reviewed an early draft of the Fauna Report. This review was specifically restricted to the methodology and technical aspects of the content and presentation of that report. Tony did not express any view on the on the acceptability or otherwise of likely environmental impacts, though his comment obviously covered technical matters that might affect the capacity of reviewers to assess environmental impacts. He also explained that CALM coordinated its response to environmental impact assessments through the department's Environmental Protection Section in collaboration with regional and science based staff.

Tony was highly critical of the first document and to the company's credit, Mitchell Ladyman of Ecologia took that criticism constructively (as was the intention) and discussed with Tony, at some length, the issues he'd raised. At Mitchell's request Tony read the subsequent, revised document. Mitchell was up-front with Tony in that some less critical issues had not been addressed because of time constraints. Despite that, Tony considered that the document had dealt with the critical issues satisfactorily, and Tony told him so.

Accordingly, Tony is comfortable with his name being included as a Peer reviewer of this document on the proviso that the document explicitly notes that his review was on the methodology and technical aspects of the Fauna report and not an assessment on the environmental impacts.

Regards,

for Keiran McNamara
EXECUTIVE DIRECTOR

9 February 2005

Department of Conservation and Land Management

Conserving the nature of WA

Your ref:

Our ref: 046435F2003V01

Enquires: Daniel Coffey

Phone: (08) 9334 0368

Fax: (08) 9367 9913

Email: danielco@calm.wa.gov.au

Ecologia
76 Thomas Street
West Perth 6005 WA

Attention: Shane Waldeck

RE: BEAGLE BAY TROPICAL TIMBER PLANTATION PROJECT – *Draft Flora and Vegetation Assessment Survey*

In response to your letter dated 1 April 2004 the Department of Conservation and Land Management (CALM) would like to provide the following comments on the above document:

Overall the survey appears to have been conducted in a professional manner to a high standard. However, the Department has concerns regarding the limited time frames in which the flora surveys were conducted (April and February). Many tropical species appear and/or commence flowering immediately following the onset of the 'wet season' in November. This suite of species may have been missed from those surveys.

Page iv - mentions that at the regional scale the impact of the plantation is considered low due to its location within Pindan vegetation which is well represented within the region. Although the Pindan vegetation is widespread it is important to note that the vegetation of the Peninsula represents a transition zone of significance between the deserts to the south and the sub-tropics to the north. Acknowledging the botanical studies done in the project area thus far, there is still a substantial knowledge gap with regard to floristics in this area.

Pages 7-8. The references to Bindon (1978), O'Connor (1989), Moncrief (2001) and Tindale (1974) do not appear in the bibliography on pages 27 and 28.

Page 15. Table 4.4. - Priority taxa previously recorded in the vicinity of the Beagle Bay community

- *Aphyllodium glossocarpum* and *Glycine pindanica* are both legumes with a pindan habitat, which could occur in the proposed plantation area.
- *Nymphoides beaglensis* is an aquatic marshwort and most unlikely to be present in the proposed plantation areas on a habitat basis.

- *Stylidium costulatum* is a trigger-plant, which invariably occurs in seepage areas, especially in damp yellowish sands on creeklines. Again, it is not likely to occur in the proposed plantation area, based on its habitat.

Page 21. Section 6.2 - Regional Significance

In reference to "Tim Willing, CALM, pers. comm.", Tim Willing makes the following clarification "DOLA's Waterbank Structure Plan (2000) proposed a "Reserve for Conservation & Aboriginal Heritage" (92 234 ha) immediately south and east from the Coulomb Point Nature Reserve. At the present time, tenure arrangements are the subject of high level negotiations between the State Government and the Kimberley Land Council. If implemented, this area would conserve: (a) significant coastal monsoon vine thickets between Barred Creek and James Price Point; (b) inland spring and riparian communities running approximately north east from Wonganut Spring; (c) large areas of pindan communities (mainly Wanganut Land System with some areas of Yeeda Land System)."

Page 34. Second species should read "*Corymbia polycarpa*" (typo).

Page 35. *Gardenia resinosa* subsp. *resinosa.* C.F. Puttock's revision of northern *Gardenia* (in Nuytsia 11(2) of 1997) indicates that this species does not occur on the Dampier Peninsula, so I would suspect that this is almost certainly a misidentification of *G. pyriformis* subsp. *keartlandii.*

for Keiran McNamara
EXECUTIVE DIRECTOR
29 April 2004

Cc: EPA Service Unit

25th October 2004

Tropical Timber Plantations Pty Ltd – Beagle Bay Tropical Timber Plantation Project
Environmental Management Systems Desktop Review

Introduction

The attached report details the findings of a desktop review performed on the Management System documentation for the Beagle Bay Tropical Timber Plantation Project.

The review was performed by Mr Keith Holmes-Brown of Intraco Management Consulting Pty Ltd. Keith is a certified Senior Environmental Auditor under the QSA Auditor Registration Scheme (Registration No. 005798). Keith has a number of years experience of implementing and auditing of Environmental and Safety Management Systems relating to the Plantation (Bluegum) Industry.

Intraco Management Consulting certify that Keith Holmes-Brown has been totally independent of the preparation and implementation of the system documentation and that the findings in the attached summary are free from any external influence.

The review and subsequent findings are based solely on material submitted to Intraco Management Consulting on behalf of Tropical Timber Plantations Pty Ltd by Ecologia as consultants to Tropical Timber Plantations Pty Ltd. Appendix 1 to the report lists the documents reviewed. Copies of such material can be made available for review by any interested party only with the express permission of Tropical Timber Plantations Pty Ltd.

Executive Summary

The Management system documentation provided for review would appear to provide an excellent model for effective implementation on site. The documentation is comprehensive, easy to access, understandable and fully addresses each and every requirement of ISO

Cont…

14001:1996 Environmental Management Systems, whilst at the same time appearing to address the specific requirements of the client and the site.

It is acknowledged that this system has not yet been implemented and therefore findings relating to implementation have not been raised as significant. The findings have been detailed as Discrepancies or Comments as applicable and numbered sequentially.

A total of two (2) discrepancies were raised, both of a relatively minor nature, however discrepancy number two may have warranted the raising of a Corrective Action Request at a certification audit. In addition twelve (12) comments were made relating to the requirements for subsequent implementation on-site or opportunities for improvement.

The Discrepancies identified are as follows;

Discrepancy 01 Clause 4.2 Environmental Policy
The system documentation fails to define how the policy will be made available to the public. The Communication Procedure P006 references external communication methods but does not specifically address the availability of the Policy.

Discrepancy 02 Clause 4.5.1 Environmental Monitoring
The system documentation (P010) fails to define requirements for calibration of environmental monitoring equipment.

The Observations or Opportunities for Improvement are as follows;

1. P001 Risk Assessment does not reference P002 Legal and Other Requirements as part of the Risk Assessment Process.
2. R001 Risk Register does not appear to include Fire Risk or Risks during Harvesting Operations.
3. P001 Risk Register does not reference Work Instructions which are listed in P008 as being control measures.
4. P009 Emergency Response details environmental emergencies. It may be worth adding Safety emergencies to this procedure as response measures are often required for both.
5. P009 References *Water Quality Protection Note – Chemical Spills Emergency response Planning* but does not state where this document is found, (there is no link to the Obligations Register).
6. P009 States compliance is assessed during Audits, this should include assessment via drills and post incident review.

7. P010 Monitoring Procedure appears to reference performance monitoring with little mention of environmental monitoring such as; application rates, water usage etc.
8. P013 Inspection and Audit Procedure refers to ISO 14012. This has now been superceded by ISO 19011.
9. P018 Irrigation Management Procedure does not refer to calibration of Flow Meters.
10. P024 Fire Management Procedure. Whilst this procedure covers basic issues there may be a need to develop a more comprehensive Fire Manual with maps, contacts and work instructions as the plantations become more established and the risk increases.
11. P027 Dog Baiting Procedure will require further detail if program is invoked.
12. WI003 Fertiliser Application. Steps in WI go from step 9 to step 12.

Signed……Date……..

Keith Holmes-Brown.
QSA Registered Senior Auditor Environment, Safety & Quality
Director – Intraco Management Consulting Pty Ltd

Standard: ISO 14001 - 1996	Date: 25th October 2004	Report No: KHB04-13

Organisation: Tropical Timber Plantations Pty Ltd – Beagle Bay Tropical Timber Plantation Project	
Contacts: **1. Valarie Ee - Ecologia**	**2.**

ISO14001 Element	Action		
	Observation	***Compliant***	***Discrepancy***
Environmental Policy			*Discrepancy 01*
Aspects and Impacts	*Comment 01, 02, 03*		
Legal and Other Requirements		*Compliant*	
Objectives & Targets		*Compliant*	
Environmental Management Programme		*Compliant*	
Structure and Responsibility		*Compliant*	
Training, Awareness and Competence		*Compliant*	
Communication			*Discrepancy 01*
Environmental Management System Documentation		*Compliant*	
Document Control		*Compliant*	
Operational Control	*Comment 11, 12*		
Emergency Preparedness and Response	*Comment 04, 05, 06, 10*		
Monitoring and Measurement	*Comment 07, 09*		*Discrepancy 02*
Non-conformance and Corrective and Preventive Action		*Compliant*	
Records		*Compliant*	
Environmental Management System Audit	*Comment 08*		
Management Review		*Compliant*	

Corrective Action Implementation:

Where a discrepancy has been raised, manuals, procedures and practices should be reviewed and revised prior to the next audit. Your corrective action in this respect will be followed up at the next audit, but should be implemented within a timeframe corresponding to the level of risk.

Status: Compliant , Discrepancy Number 01, 02 etc, Comment Number 01, 02 etc.

–

Auditor Name(S): K HOLMES-BROWN **Signature:** **Date:**

Cont…

4.2 ENVIRONMENTAL POLICY

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
4.2	Is the environmental policy defined and documented?	EMS Manual P.2	*Compliant*
4.2	If the environmental policy is part of a larger environmental policy, (e.g., a corporate policy), how is the connection made?	EMS Manual P.2	*Compliant*
4.2	Does the environmental policy address the following issues? a) Is the policy appropriate to the nature, scale and environmental impacts of all activities, products and services; b) includes a commitment to continual improvement and prevention of pollution; c) includes a commitment to comply with relevant legislation and regulations and with other requirements to which the organisation subscribes; d) provides a framework for the setting and reviewing of environmental objectives and targets; e) is documented, implemented and maintained and communicated to all employees; f) is available to the public	EMS Manual P.2	 *Compliant* *Compliant* *Compliant* *Compliant* *Compliant* *Discrepancy 01*

4.3 PLANNING

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
4.3.1	**Environmental aspects**		
4.3.1	Is there a procedure that details the methods for identification of environmental aspects.	P 001 Env Aspects Procedure	*Compliant*
4.3.1	Is there evidence to show that the identified aspects have been assessed to determine if they have significant impacts	WI 001 Risk Assessment R001 Risk Register	*Comment 01, Comment 02, Comment 03*
4.3.1	Are aspects that are shown to have significant impacts considered in the setting of environmental objectives	R003 Objectives and Targets	*Compliant*
4.3.1	Is there a mechanism for ensuring that this information is kept up to date	P 004 Change Mgt Procedure	*Compliant*
4.3.2	**Legal and other requirements**		
4.3.2	Is there a procedure to identify and ensure access to legal and other requirements directly applicable to the environmental aspects of the divisions activities.	P 002 Legal and Other Requirements Procedure	*Compliant*
4.3.2	Is there evidence to show that such requirements are known	As above	*Compliant*
4.3.3	**Objectives and targets**		
4.3.3	Are documented objectives and targets established and maintained at each relevant function and level within the division	P 003 Env Planning and Mgt	*Compliant*

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
		Programs, R003 Objectives & Targets	
4.3.3	Do the methods for the review and setting of objectives and targets include consideration of legal and other requirements, technical, financial, operational and business requirements and the views of interested parties.	P 003 Env Planning and Mgt Programs, R003 Objectives & Targets	*Compliant*
4.3.3	Are the objectives and targets consistent with the environmental policy, including the commitment to prevention of pollution.	P 003 Env Planning and Mgt Programs, R003 Objectives & Targets	*Compliant*
4.3.4	**Environmental management programmes**		
4.3.4	Has the Division established a program for achieving it's objectives and targets	P 003 Env Planning and Mgt Programs, R003 Objectives & Targets	*Compliant*
4.3.4	Does the program designate the responsibility for the achievement of objectives and targets at each relevant function and level within the organisation	P 003 Env Planning and Mgt Programs, R003 Objectives & Targets	*Compliant*
4.3.4	Does the program detail the means and timeframe by which objectives and targets are to be achieved.	P 003 Env Planning and Mgt Programs, R003 Objectives & Targets	*Compliant*
4.3.4	Is there provision within the plan for ensuring that environmental management system requirements are applied to new developments or modified activities	P 004 Change Mgt Procedure	*Compliant*

4.4 IMPLEMENTATION AND OPERATION

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
4.4.1	**Structure and responsibility**		
4.4.1	Are roles, responsibilities and authorities defined, documented and communicated.	EMS Manual Pages 5-6	*Compliant*
4.4.1	Have the necessary resources been allocated for the implementation and control of the EMS, including human, specialist skills, technology and financial resources	EMS Manual Pages 5-6	*Compliant*
4.4.1	Has a specific Management Representative been appointed	EMS Manual Pages 5-6	*Compliant*
4.4.1	Does the role description for the MR include responsibility for; a) Ensuring the effective implementation and maintenance of the EMS, and; b) Reporting on the performance of the EMS to top management for review and as a basis for continuous improvement.	EMS Manual Pages 5-6	*Compliant*
4.4.2	**Training, awareness and competence**		

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
4.4.2	Is there a documented method for the identification of training needs	P 005 Training Procedure	*Compliant*
4.4.2	Is there evidence to show that personnel whose work may create significant environmental impact have received appropriate training	R 004 Training Matrix	*Compliant*
4.4.2	Is there a procedure for ensuring that employees at each relevant function or level are made aware of; a) The importance of conformance with policy and procedures and the requirements of the EMS b) The significant environmental impacts of their work (actual or potential) and the benefits of improved environmental performance c) Their roles in achieving conformance with policy, procedures and EMS requirements including emergency preparedness and response c) The potential consequences of departure from specified procedures	P 005 Training Procedure	*Compliant*
4.4.2	Is there evidence to show that personnel performing specific assigned tasks that may cause significant environmental impacts are competent based on appropriate education, training and/or experience	R 004 Training Matrix	*Compliant*
4.4.3	**Communication**		
4.4.3	Are procedures maintained for; a) internal communications between the various levels and functions of the division and within the entire organisation b) Receiving, documenting and responding to communications from external interested parties, regarding its environmental aspects and EMS.	P 006 Communication Procedure	*Refer Discrepancy 01*
4.4.3	Has the organisation considered its position on external communication of its significant environmental aspects. Has this decision been recorded	P 006 Communication Procedure	*Compliant*
4.4.4	**Environmental management system documentation**		
4.4.4	Does the system contain in paper or electronic form, information to; a) Describe the core elements of the system and their interaction, and; b) Provide direction to related documentation	EMS Manual	*Compliant*
4.4.5	**Document control**		
4.4.5	Are there documented procedures for controlling all documents required by ISO 14001	P 007 Document Control	*Compliant*
4.4.5	Does the procedure ensure that; a) Documents can be located; b) They are periodically reviewed, revised as necessary and approved for adequacy by authorised personnel prior to issue for use; c) The current versions of relevant documents are available at all locations where operations essential to the effective functioning of the EMS are performed; d) Obsolete documents are promptly removed from all points of issue and use or are otherwise assured against unintended use;. e) Obsolete documents retained for legal and/or knowledge preservation purposes are suitably identified	P 007 Document Control R 007 Environmental Documents Register	*Compliant*
4.4.5	Is the documentation legible, dated (with dates of revision) and readily identifiable, maintained in an orderly manner and retained for a specified period	P 007 Document Control	*Compliant*

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
4.4.5	Do procedures exist to identify the responsibilities for the creation and modification of the various types of document	P 004 Change Management	*Compliant*
4.4.5	Are document control procedures suitably maintained	P 007 Document Control	*Compliant*
4.4.6	**Operational control**		
4.4.6	Have the operations and activities/processes associated with the identified significant environmental aspects in line with the policy, objectives and targets been identified	P 008 Operational Controls Procedure	*Comment 11, 12*
4.4.6	Are the activities identified planned to ensure they are carried out under specified conditions	P 008 Operational Controls Procedure	*Comment 11, 12*
4.4.6	Does planning take into account the following? a) documented procedures to cover situations where their absence could lead to deviations from the environmental policy and the objectives and targets; b) monitoring and control of relevant process characteristics and the stipulation of operating criteria c) documented procedures relating to the significant environmental aspects of goods and services used by the organisation and the communication of relevant procedures and requirements to suppliers and contractors;	P 008 Operational Controls Procedure JSEA Form F 001	*Comment 11, 12*
4.4.7	**Emergency preparedness and response**		
4.4.7	Do procedures exist for identifying potential for and response to accident and emergency situations , and for preventing and mitigating the environmental impacts that may be associated with them	P 009 Emergency Response Procedure	*Comment 04, 05, 06, 10*
4.4.7	Are there documented methods for the review and revision of such procedures particularly after the occurrence of accidents and emergency situations.	P 009 Emergency Response Procedure	*Comment 04, 05, 06, 10*
4.4.7	Is there a plan/evidence to show that such procedures are to be periodically tested to ensure their effectiveness, where practicable	P 009 Emergency Response Procedure	*Comment 04, 05, 06, 10*

4.5 CHECKING AND CORRECTIVE ACTION

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
4.5.1	**Monitoring and measurement**		
4.5.1	Are there established procedures for the monitoring and measurement of key characteristics of the Division's operations that can have a significant impact on the environment	P 010 Monitoring Procedure	*Compliant*
4.5.1	Do such procedures include the requirements for the recording of information to track performance, relevant operational controls and conformance with the Division's objectives and targets.	P 014 Management Review	*Comment 07*
4.5.1	Does a procedure exist for the calibration and maintenance of monitoring and measuring equipment	P 010 Monitoring Procedure	*Discrepancy 02, Comment 08*
4.5.1	Are calibration records maintained that identify equipment and current	P 010 Monitoring	*Discrepancy 02*

Clause No:	Requirement	Where covered Manual, Procedure or WI	Status Compliant or Disc/Obs No (Auditor use)
	calibration status / requirements	Procedure	
4.5.1	Is a procedure maintained to periodically evaluate compliance with relevant environmental legislation, regulation and procedures	P 013 Inspections and Audits, P 014 Management Review	*Compliant*
4.5.2	**Non-conformance and corrective and preventive action**		
4.5.2	Do procedures exist that define the responsibility and authority for; the handling and investigating of non-conformance's; taking action to mitigate any impacts caused, and; initiating and completing corrective and preventive action	P 011 Incident & Nonconformance Mgt Procedure	*Compliant*
4.5.2	Does the system ensure that corrective and preventive actions taken to eliminate the causes of actual or potential non-conformance's are appropriate to the magnitude of problems and commensurate with the environmental impact encountered	P 011 Incident & Nonconformance Mgt Procedure	*Compliant*
4.5.2	Does the system ensure that any changes to documentation resulting from corrective and preventive action are implemented and recorded	P 011 Incident & Nonconformance Mgt Procedure	*Compliant*
4.5.3	**Records**		
4.5.3	Is there a procedure for the identification , maintenance and disposition of environmental records.	P 012 Records Procedure	*Compliant*
4.5.3	Does the procedure ensure that training records and the results of audits and reviews are part of such records.	P 012 Records Procedure	*Compliant*
4.5.3	Does the procedure ensure that records are; legible and identifiable to the to the activity, product or service involved; stored in a manner to prevent damage, deterioration or loss; readily retrievable, and their retention times are established and recorded	P 012 Records Procedure	*Compliant*
4.5.3	Are the records maintained appropriate to the system and the organisation and do they demonstrate conformance to the requirements of ISO 14001.	P 012 Records Procedure	*Compliant*
4.5.4	**Environmental management system audits**		
4.5.4	Is a procedure and program maintained for ensuring that periodic EMS audits are carried out	P 013 Inspections and Audits Procedure	*Comment 08*
4.5.4	Does the program define the intervals for audits based on the environmental importance of the activity concerned and the results of previous audits	R 005 Inspection & Audit Schedule	*Compliant*
4.5.4	Does the audit procedure ensure that the EMS is evaluated on whether it; conforms to planned arrangements and the requirements of ISO 14001, and; has been properly implemented and maintained	P 013 Inspections and Audits Procedure	*Compliant*
4.5.4	Does the audit procedure provide a framework for the reporting of audit results to Senior Management	P 013 Inspections and Audits Procedure	*Compliant*
4.5.4	Does the audit procedure cover , the audit scope, frequency, and audit methodologies, in addition to the responsibilities for conducting audits and reporting results.	P 013 Inspections and Audits Procedure	*Compliant*

4.5 MANAGEMENT REVIEW

Clause No:	Requirement	Where covered Manual EMP, ECP or WI-E	Status OK or Discrepancy No (Auditor use)
4.5	Is there a system for carrying out management reviews of the suitability, adequacy and effectiveness of the environmental management system?	P 014 Management Review Procedure	*Compliant*
4.5	Is the frequency for management reviews documented	P 006 Communications Procedure	*Compliant*
4.5	Is the review process documented (minutes of review meetings)	P 014 Management Review Procedure	*Compliant*
4.5	Does the process ensure that suitable information is collected to allow management to carry out an evaluation	P 014 Management Review Procedure	*Compliant*
4.5	Does the process address the possible need for changes to policy, objectives and other elements of the EMS, in the light of EMS audit results, changing circumstances and the commitment to continual improvement	P 014 Management Review Procedure	*Compliant*

Appendix 1 – List of Documents Reviewed

EMS Manual
Environmental Policy
Overview of Environmental Management System
EMS Manual - Procedures
P 001 – Environmental Aspects Procedure
P 002 – Legal and Other Requirements Procedure
P 003 – Environmental Planning and Management Programs Procedure
P 004 – Change Management Procedure
P 005 – Training Procedure
P 006 – Communications Procedure
P 007 – Document Control Procedure
P 008 – Operational Control Procedure
P 009 – Emergency Preparedness & Response Procedure
P 010 – Monitoring Procedure
P 011 – Incident and Non-conformance Management Procedure
P 012 – Records Procedure
P 013 – Inspection and Audits Procedure
P 014 – Management Review Procedure
P 015 – Pesticide Management Procedure
P 016 – Fertiliser Management Procedure
P 017 – Land Clearing and Infrastructure Procedure
P 018 – Irrigation Management Procedure
P 019 – Planting and Tree Maintenance Procedure
P020 Harvesting Procedure
P021 Weed Management Procedure
P022 Flora and Fauna Procedure
P023 Rehabilitation Procedure
P024 Fire Management Procedure
P025 Waste and Hydrocarbon/Chemical
Management Procedure
P026 Hydrocarbon & Chemical Spills Procedure
P027 Dog Baiting Procedure
EMS Manual - Work Instructions
WI001 Risk Assessment Work Instruction
WI002 Pesticide Application Work Instruction
WI003 Fertiliser Application Work Instruction
WI004 Tree Planting & Maintenance Work Instruction
WI005 Tree Thinning & Harvesting Work Instruction
WI006 Nursery Operations Work Instruction
EMS Manual - Forms
F001 Job Safety and Environment Analysis Form
F002 Change Control Form
F003 Training Records Form
F004 Meeting Minutes Template
F005 Incident and Non-conformance Report Form
F006 Environmental Controlled Document Transmittal Slip
F007 Environmental Inspection Form
F008 Weed Hygiene Certificate
F009 Site Disturbance Permit
EMS Registers
R001 Risk Register
R002 Obligations Register
R003 Objectives, Targets and Management Programs Register
R004 Training Needs Matrix
R005 Inspections / Audit Schedule
R006 Environmental Records Register
R007 Environment Document Register
R008 Weed Register

Cont…

R009 Weed Hygiene Register
R010 Environmental Incidents and Nonconformance Register
R011 Rehabilitation Register Electronic / Server
R012 Groundwater & Soil Monitoring Register
R013 Pesticide Register
R014 Fertiliser Register
R015 Planting & Harvesting Register
R016 Significant Flora and Fauna Register
R017 Tree Development & Maintenance Register
R018 Nursery Register

APPENDIX C

Flora Species Lists

C1: Plantation Site
C2: Bobby's Creek System

C1 Flora Species List for the Plantation Site

Classification and nomenclature according to the Western Australian Herbarium and R.J. Hnatiuk (1990), Census of Australian Vascular Plants. Australian Government Publishing Service.

Key: * = introduced species
§ = taxa that could not be fully identified due to a lack of material
= Priority taxa.

FAMILY	SPECIES
ACANTHACEAE	*Dicliptera armata*
AIZOACEAE	*Trianthema pilosa*
AMARANTHACEAE	*Gomphrena canescens*
	Gomphrena flaccida
	Ptilotus calostachyus var. *calostachyus*
	Ptilotus corymbosus
	Ptilotus fusiformis
	Ptilotus sp.
ANTHERICACEAE	?*Tricoryne elatior*
APIACEAE	*Trachymene didiscoides*
APOCYNACEAE	*Carissa spinarum*
	Wrightia saligna
ASCLEPIADACEAE	*Cynanchum* ?*pedunculatum*
	Cynanchum carnosum
	Cynanchum floribundum
	Marsdenia angustata
ASTERACEAE	*Pterocaulon verbascifolium*
BIGNONIACEAE	*Dolichandrone heterophylla*
BORAGINACEAE	*Ehretia saligna*
	Heliotropium diversifolium
	Heliotropium foliatum
	Heliotropium leptaleum
	Heliotropium sp.
	Trichodesma zeylanicum
CAESALPINIACEAE	*Bauhinia cunninghamii*
	Chamaecrista symonii
	Erythrophleum chlorostachys
	Senna costata
	Senna oligoclada

FAMILY	SPECIES
CAPPARACEAE	*Cleome tetrandra* var. *tetrandra*
	Cleome viscosa
CARYOPHYLLACEAE	*Polycarpaea corymbosa*
	Polycarpaea longiflora
CELASTRACEAE	*Maytenus cunninghamii*
COMBRETACEAE	*Terminalia canescens*
	Terminalia hadleyana subsp. *carpentariae*
	Terminalia latipes
	Terminalia latipes subsp. *latipes*
COMMELINACEAE	*Cartonema parviflorum*
	Cartonema spicatum
	Murdannia graminea
CONVOLVULACEAE	*Bonamia linearis*
	Bonamia sp.
	Evolvulus alsinoides
	Ipomoea diamantinensis
	Ipomoea graminea
	Ipomoea polymorpha
	Ipomoea sp.
	Jacquemontia pannosa
	Polymeria ambigua
	Polymeria calycina
	Polymeria linearis
	Polymeria sp.
CUCURBITACEAE	*Mukia maderaspatana*
CYPERACEAE	*Bulbostylis barbata*
	Crosslandia setifolia
	Cyperus microcephalus subsp. *microcephalus*
	Cyperus viscidulus
	Fimbristylis cardiocarpa
	Fimbristylis denudata
	Fimbristylis macrantha
	Fimbristylis oxystachya
	Scleria brownii
DROSERACEAE	*Drosera derbyensis*
EUPHORBIACEAE	*Bridelia tomentosa*
	Euphorbia mitchelliana
	Flueggea virosa
	Phyllanthus aridus
	Phyllanthus maderaspatensis
	Phyllanthus sp.
	Phyllanthus virgatus

FAMILY	SPECIES
	Sebastiania chamaelea
GOODENIACEAE	*Goodenia sepalosa*
	Velleia panduriformis
GYROSTEMONACEAE	*Codonocarpus cotinifolius*
	Gyrostemon tepperi
HAEMODORACEAE	*Haemodorum gracile*
	Haemodorum sp.
HALORAGACEAE	*Gonocarpus leptothecus*
LAMIACEAE	*Anisomeles malabarica*
LAURACEAE	*Cassytha capillaris*
LECYTHIDACEAE	*Planchonia careya*
LOGANIACEAE	*Mitrasacme connata*
MALVACEAE	*Abutilon hannii*
	Gossypium populifolium
	Gossypium rotundifolium
	Sida hackettiana
	Sida rohlenae
	Sida rohlenae subsp. *occidentalis*
	Sida sp.
MENISPERMACEAE	*Tinospora smilacina*
MIMOSACEAE	*Acacia holosericea*
	Acacia platycarpa
	Acacia sp.
	Acacia tumida
MORACEAE	*Ficus opposita*
MYRTACEAE	*Corymbia dampieri*
	Corymbia polycaarpa
	Eucalyptus tectifica
	Melaleuca cajuputi
	Melaleuca viridiflora
NYCTAGINACEAE	*Boerhavia gardneri*
OLEACEAE	*Jasminum didymum*
	Jasminum molle
PAPILIONACEAE	*Alysicarpus rugosus*
	Cajanus marmoratus

FAMILY	SPECIES
	Crotalaria crispata
	Crotalaria cunninghamii
	Crotalaria medicaginea
	Crotalaria ramosissima
	Crotalaria retusa
	Cullen cuneatum
	Galactia tenuiflora
	Glycine tomentella
	Indigofera trita
	Tephrosia leptoclada
	Tephrosia remotiflora
	Tephrosia rosea var. *rosea*
	Tephrosia sp. B. Kimberley Flora
	Tephrosia stipuligera
	Uraria cylindracea
	Vigna vexillata var. *angustifolia*
	Zornia albiflora
	Zornia chaetophora
PLATYZOMATACEAE	*Platyzoma microphyllum*
POACEAE	?*Themeda* sp.
	Alloteropsis semialata
	Aristida holathera var. *holathera*
	Aristida hygrometrica
	Aristida latifolia
	Aristida pruinosa
	Chrysopogon fallax
	Chrysopogon pallidus
	Dicanthium fecundum
	Eriachne ciliata
	Eriachne obtusa
	Panicum compositum
	Panicum effusum
	Schizachyrium pachyarthron
	Sehima nervosum
	Sorghum stipoideum
	Thaumastochloa major
	Triodia schinzii
	Urochloa holosericea subsp. *velutina*
POLYGALACEAE	*Polygala longifolia*
	Polygala tepperi
PORTULACACEAE	*Calandrinia quadrivalvis*
	Calandrinia strophiolata
	Calandrinia uniflora
	Portulaca bicolor
	Portulaca oligosperma
	Portulaca pilosa

FAMILY	SPECIES
PROTEACEAE	*Grevillea heliosperma*
	Grevillea pyramidalis
	Grevillea refracta
	Grevillea refracta subsp. *refracta*
	Grevillea striata
	Hakea arborescens
	Hakea macrocarpa
	Persoonia falcata
RHAMNACEAE	*Ventilago viminalis*
RUBIACEAE	*Gardenia pyriformis*
	Gardenia pyriformis subsp. *keartlanii*
	Gardenia resinosa subsp. *resinosa*
	Gardenia sp. A Kimberley Flora
	Oldenlandia galioides
	Oldenlandia mitrasacmoides
	Spermacoce auriculata
	Spermacoce leptoloba
SANTALACEAE	*Santalum lanceolatum*
SAPINDACEAE	*Atalaya variifolia*
	Distichostemon hispidulus
	Distichostemon hispidulus var. *aridus*
SCROPHULARIACEAE	*Lindernia chrysoplectra*
	Stemodia lathraia
	Stemodia lythrifolia
	Stemodia viscosa
	Striga curviflora
SOLANACEAE	*Solanum cunninghamii*
	Solanum diocum
STACKHOUSIACEAE	*Stackhousia intermedia*
STERCULIACEAE	*Brachychiton diversifolius*
	Melhania oblongifolia
	Waltheria indica
TILIACEAE	*Corchorus* sp.
	Corchorus sidoides subsp. *vermicularis*
	Grewia brevifolia
	Grewia retusifolia
	Triumfetta ?breviaculeata
	Triumfetta simulans
	Triumfetta sp. D Flora of Kimberley Region

FAMILY	SPECIES
VERBENACEAE	*Clerodendrum floribundum*
	Clerodendrum floribundum var. *ovatum*
	Clerodendrum tomentosum var. *mollissima*
VIOLACEAE	*Hybanthus aurantiacus*
	Hybanthus enneaspermus
XYRIDACEAE	*Xyris complanata*
ZYGOPHYLLACEAE	*Tribulopis angustifolia*
	Tribulus occidentalis

C2 Flora Species List for the Bobby's Creek System

Classification and nomenclature according to the Western Australian Herbarium and R.J. Hnatiuk (1990), Census of Australian Vascular Plants. Australian Government Publishing Service.

Key: * = introduced species
§ = taxa that could not be fully identified due to a lack of material
⚑= Priority taxa.

FAMILY	SPECIES
ACANTHACEAE	*Nelsonia campestris*
AIZOACEAE	*Trianthema patellitecta* **Trianthema portulacastrum*
AMARANTHACEAE	*Achyranthes aspera* *Alternanthera angustifolia* *Gomphrena canescens* subsp. *canescens* ⚑*Gomphrena pusilla* – Priority 2 *Gomphrena tenella* *Ptilotus lanatus* var. *lanatus*
AMARYLLIDACEAE	*Crinum angustifolium*
ANTHERICACEAE	*Thysanotus chinensis*
APOCYNACEAE	*Wrightia saligna*
ASCLEPIADACEAE	*Cynanchum carnosum* **Gomphocarpus fruticosus* *Gymnanthera oblonga* *Tylophora cinerascens*
ASTERACEAE	*Blumea integrifolia* *Cyanthillium cinereum* **Emilia sonchifolia* *?Epaltes australis* *Pluchea rubelliflora* *Pluchea tetranthera* *Pterocaulon serrulatum?* *Pterocaulon* sp. A Kimberley Flora *Pterocaulon sphacelatum* *Thespidium basiflorum*
BIGNONIACEAE	*Dolichandrone heterophylla*
BORAGINACEAE	*Heliotropium cunninghamii* *Trichodesma zeylanicum* var. *latisepalum*

FAMILY	SPECIES
BYBLIDACEAE	*Byblis filifolia* *Byblis liniflora*
CAESALPINIACEAE	*Bauhinia cunninghamii* *Chamaecrista mimosoides* **Parkinsonia aculeata*
CAPPARACEAE	*Cleome tetrandra* *Cleome viscosa*
CARYOPHYLLACEAE	*Polycarpaea breviflora*
CENTROLEPIDACEAE	*Centrolepis banksii* *Centrolepis exserta*
CHENOPODIACEAE	*Halosarcia* sp.
COMBRETACEAE	*Lumnitzera racemosa*
COMMELINACEAE	*Cartonema parviflorum* *Cyanotis axillaris* *Murdannia graminea* **Murdannia nudiflora*
CONVOLVULACEAE	*Bonamia linearis* *Cressa australis* *Cressa cretica* *Ipomoea coptica* *Ipomoea polymorpha* **Merremia dissecta* *Merremia hederacea*
CYPERACEAE	*Abildgaardia schoenoides* *Bulbostylis barbata* *Cyperus* sp. *Cyperus aquatilis* *Cyperus bifax* *Cyperus breviculmis* **Cyperus brevifolius* *Cyperus castaneus* *Cyperus haspan* *Cyperus latzii* *Cyperus microcephalus* subsp. *microcephalus* *Cyperus nervulosus* *Cyperus polystachyos* *Cyperus pulchellus* *Eleocharis dulcis* *Eleocharis geniculata* *Eleocharis ochrostachys* *Eleocharis sundaica* *Fimbristylis* sp.

FAMILY	SPECIES
CYPERACEAE (cont)	*Fimbristylis acicularis* *Fimbristylis blakei* *Fimbristylis cymosa* *Fimbristylis dichotoma* *Fimbristylis ferruginea* *Fimbristylis miliacea* *Fimbristylis nutans* *Fimbristylis phaeoleuca* *Fimbristylis polytrichoides* *Fimbristylis rara* *Fimbristylis solidifolia* *Fimbristylis tetragona* *Fimbristylis trigastrocarya* *Fuirena ciliaris* *Fuirena umbellata* *Lipocarpha microcephala* *Rhynchospora affinis* *Schoenoplectus lateriflorus* *Schoenoplectus litoralis* *Schoenoplectus mucronatus*
DROSERACEAE	*Drosera broomensis* *Drosera indica* *Drosera indica* "Dampier Peninsular Form" *Drosera indica* sens. lat.
EBENACEAE	*Diospyros rugosula*
ERIOCAULACEAE	*Eriocaulon cinereum*
EUPHORBIACEAE	*Phyllanthus* sp. *Euphorbia myrtoides* *Euphorbia* sp. *Flueggea virosa* *Phyllanthus maderaspatensis* *Poranthera microphylla*
GLEICHENIACEAE	*Platyzoma microphyllum*
GOODENIACEAE	*Goodenia lamprosperma* *Goodenia sepalosa*
HALORAGACEAE	*Gonocarpus leptothecus*
JUNCAGINACEAE	*Triglochin dubia*
LAMIACEAE	*Premna acuminata*
LECYTHIDACEAE	*Planchonia careya*
LEMNACEAE	*Spirodela punctata*

FAMILY	SPECIES
LOGANIACEAE	*Mitrasacme ambigua* *Mitrasacme exserta* *Mitrasacme kenneallyi?* *Mitrasacme nummularia*
LYTHRACEAE	*Ammannia baccifera* *Ammannia multiflora* *Nesaea striatiflora* *Rotala diandra*
MALVACEAE	*Gossypium rotundifolium* **Sida acuta*
MARSILEACEAE	*Marsilea hirsuta* *Marsilea mutica*
MELASTOMATACEAE	*Melastoma affine*
MENISPERMACEAE	*Tinospora smilacina*
MENYANTHACEAE	*Nymphoides beaglensis* – Priority 2
MIMOSACEAE	*Acacia holosericea* *Acacia neurocarpa* *Acacia tumida* var. *tumida*
MORACEAE	*Ficus opposita* var. *indecora*
MYRTACEAE	*Calytrix exstipulata* *Corymbia bella* *Corymbia dampieri* *Corymbia flavescens* *Corymbia polycarpa* *Eucalyptus tectifica* *Melaleuca alsophila* *Melaleuca cajuputi* *Melaleuca nervosa* *Melaleuca nervosa* subsp. *crosslandiana* *Melaleuca viridiflora* *Verticordia verticillata*
NAJADACEAE	*Najas graminea*
NYMPHAEACEAE	*Nymphaea violacea* *Riccia ?duplex*
ONAGRACEAE	*Ludwigia octovalvis* *Ludwigia perennis*
ORCHIDACEAE	*Cymbidium canaliculatum*

FAMILY	SPECIES
PANDANACECE	*Pandanus spiralis*
PAPILIONACEAE	*Aeschynomene indica* *Alysicarpus* sp. *Alysicarpus muelleri* *Aphyllodium glossocarpum* – Priority 3 *Aphyllodium parvifolium* – Priority 1 *Cajanus marmoratus* **Clitoria ternatea* *Crotalaria sp* *Crotalaria brevis* *Crotalaria crispata* *Crotalaria cunninghamii* subsp. *cunninghamii* *Desmodium filiforme* *Desmodium* sp. *Desmodium trichostachyum* *Indigofera colutea* *Indigofera linifolia* *Sesbania cannabina* **Stylosanthes hamata* *Tephrosia crocea* *Tephrosia simplicifolia* *Vigna* sp. *Vigna lanceolata* var. *filiformis* *Vigna vexillata* var. *angustifolia* *Zornia muelleriana* subsp. *congesta*
PARKERIACEAE	*Ceratopteris thalictroides*
PASSIFLORACEAE	**Passiflora foetida*
PHILYDRACEAE	*Philydrum lanuginosum*
PLATYZOMATACEAE	*Platyzoma microphyllum*
POACEAE	*Alloteropsis semialata* *?Aristida holathera* *Aristida hygrometrica* *Arundinella nepalensis* *Bothriochloa bladhii* subsp. *bladhii* *Chloris lobata* *Chloris pumilio* *Chrysopogon ?pallidus* *Chrysopogon* sp. *Cymbopogon* sp *Cymbopogon bombycinus* **Cynodon dactylon* **Dactyloctenium aegyptium* *Digitaria bicornis* *Ectrosia agrostoides*

FAMILY	SPECIES
POACEAE (cont)	*Elionurus citreus*
	Elytrophorus spicatus
	Eragrostis cumingii
	Eragrostis fallax
	Eriachne ciliata
	Eriachne glauca
	Eriachne melicacea
	Eriachne obtusa
	Eriachne pauciflora
	Eriachne sulcata
	?Eriachne sp.
	Heteropogon contortus
	Imperata cylindrica
	Panicum sp.
	Panicum seminudum
	Perotis rara
	Phragmites karka
	Pseudoraphis spinescens
	Sacciolepis indica
	Schizachyrium crinizonatum
	Schizachyrium fragile
	Setaria apiculata
	Sorghum timorense
	Sporobolus australasicus
	Thaumastochloa pubescens
	Themeda triandra
	Themeda sp.
	/P*Triodia acutispicula* – Priority 3
	Triraphis mollis
	**Urochloa mutica*
	Xerochloa imberbis
POLYGACEAE	*Polygala tepperi*
POLYGONACEAE	*Persicaria attenuata*
PORTULACACEAE	*Calandrinia quadrivalvis*
	Calandrinia strophiolata
	Portulaca bicolor
PROTEACEAE	*Grevillea striata*
	Hakea arborescens
RUBIACEAE	*Gardenia pyriformis* subsp. *keartlandii*
	Oldenlandia galioides
	Oldenlandia mitrasacmoides subsp. *mitrasacmoides*
	Spermacoce auriculata
	Synaptantha scleranthoides
	Timonius timon

FAMILY	SPECIES
SAPINDACEAE	*Atalaya variifolia* *Distichostemon hispidulus*
SCROPHULARIACEAE	*Buchnera asperata* *Buchnera ramosissima* *Buchnera urticifolia* *Glossostigma drummondii* *Limnophila fragrans* *Lindernia aplectra* subsp. 'short-haired' *Lindernia chrysoplectra* *Lindernia clausa* *Lindernia tectanthera* *Microcarpaea minima* *Mimulus debilis* *Mimulus uvedaliae* *Stemodia lathraia* *Stemodia lythrifolia* *Striga curviflora*
SOLANACEAE	*Physalis minima* *Solanum* sp
STACKHOUSIACEAE	*Stackhousia intermedia*
STERCULIACEAE	*Brachychiton diversifolius* *Helicteres* sp. *Waltheria indica*
STYLIDIACEAE	*Stylidium costulatum* – Priority 3 *Stylidium schizanthum*
TACCACEAE	*Tacca leontopetaloides*
THELYPTERIDACEAE	*Cyclosorus interruptus*
THYMELAEACEAE	*Thecanthes punicea*
TILIACEAE	*Corchorus pumilio* *Triumfetta breviaculeata*
XYRIDACEAE	*Xyris complanata*
ZYGOPHYLLACEAE	*Tribulus angustifolius*

APPENDIX D

Fauna species observed or potentially occurring within the Plantation Site

D1 – Mammals
D2 - Avifauna
D3 - Herpetofauna

Key to Abbreviations

\+ : Species potentially occurring
X : Species recorded
* : Introduced / feral species

APPENDIX D1: MAMMALS

SPECIES	COMMON NAME	PRESENCE (observed)
MACROPODIDAE		
Macropus agilis	Agile Wallaby	+
Onychogalea unguifera	Northern Nailtail Wallaby	+
THYLACOMYIDAE		
Macrotis lagotis	Bilby	+
PHALANGERIDAE		
Trichosurus vulpecula arnhemensis	Northern Brushtail Possum	X
PTEROPODIAE		
Pteropus alecto	Black Flying-fox	+
Pteropus scapulatus	Little Red Flying-fox	+
EMBALLONURIDAE		
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	+
VESPERTILIONIDAE		
Chalinolobus gouldii	Gould's Wattled Bat	+
Chalinolobus nigrogriseus	Hoary Wattled Bat	X
Miniopterus schreibersii	Common Bentwing Bat	+
Nyctophilus arnhemensis	Arnhem Land Long-eared Bat	+
Nyctophilus bifax daedalus	North Queensland / Northwestern Long-eared Bat	+
Scotorepens greyii	Little Broad-nosed Bat	X
Vespadelus douglasorum	Kimberley Cave / Yellow-lipped Bat	X
MOLOSSIDAE		
Mormopterus loriae cobourgiana	Little Northern Freetail-bat	+
MURIDAE		
Mus domesticus	*House Mouse	+
Pseudomys delicatulus	Delicate Mouse	X
Pseudomys nanus	Western Chestnut Mouse	X
Rattus rattus	*Black Rat	+
CANIDAE		
Canis lupus	*Dingo	+
FELIDAE		
Felis catus	*Feral Cat	X
EQUIDAE		
Equus asinus	*Donkey	X
BOVIDAE		
Bos taurus	*European Cattle	+
Total species observed		**8**
Total species potential		**23**

APPENDIX D2: AVIFAUNA

FAMILY	SPECIES	COMMON NAME	PRESENCE (observed)
PHASIANIDAE	*Coturnix ypsilophora*	Brown Quail	+
RALLIDAE	*Gallirallus philipensis*	Buff-banded Rail	+
ACCIPITRIDAE	*Elanus caeruleus*	Black-shouldered Kite	+
	Hamirostra isura	Square-tailed Kite	+
	Hamirostra melanosternon	Black-breasted Buzzard	+
	Milvus migrans	Black Kite	X
	Haliastur sphenurus	Whistling Kite	+
	Accipiter fasciatus	Brown Goshawk	X
	Accipiter cirrhocephalus	Collared Sparrowhawk	X
	Erythrotriochis radiatus	Red Goshawk	+
	Aquila morphnoides	Little Eagle	+
	Aquila audax	Wedge-tailed eagle	+
	Circus assimilis	Spotted Harrier	+
FALCONIDAE	*Falco berigora*	Brown Falcon	X
	Falco cenchroides	Australian Kestrel	X
	Falco longipennis	Australian Hobby	+
	Falco hypoleucos	Grey Falcon	+
	Falco peregrinus	Peregrine Falcon	+
	Falco subniger	Black Falcon	+
GRUIDAE	*Grus rubicunda*	Brolga	+
OTIDIDAE	*Ardeotis australis*	Australian Bustard	X
TURNICIDAE	*Turnix maculosa*	Red-backed Buton Quail	+
	Turnix pyrrhothorax	Red-chested Button-quail	+
	Turnix velox	Little Button-quail	X
BURHINIDAE	*Burhinus gallinaceus*	Bush Stone-curlew	X
ALCEDINIDAE	*Alcedo azurea*	Azure Kingfisher	
COLUMBIDAE	*Ocyphaps lophotes*	Crested Pigeon	X
	Geopelia cuneata	Diamond Dove	X
	Geopelia striata	Peaceful Dove	X
	Geopelia humeralis	Bar-shouldered Dove	X
PSITTACIDAE	*Calyptorhynchus banksii*	Red-tailed Black Cockatoo	X
	Cacatua roseicapilla	Galah	X
	Cacatua sanguinea	Little Corella	+
	Nymphicus hollandicus	Cockatiel	+
	Trichoglossus haematodus	Rainbow Lorikeet	X
	Trichoglossus versicolor	Varied Lorikeet	X
	Aprosmictus erythropterus	Red-winged Parrot	X
	Melopsittacus undulatus	Budgerigar	+
CUCULIDAE	*Cuculus saturatus*	Oriental Cuckoo	+
	Cuculus pallidus	Pallid Cuckoo	X
	Cuculus variolosus	Brush Cuckoo	X
	Chrysococcyx basalis	Horsfield's Bronze Cuckoo	X

FAMILY	SPECIES	COMMON NAME	PRESENCE (observed)
	Chrysococcyx lucidus plagosus	Golden Bronze Cuckoo	+
	Chrysococcyx minutillus	Little Bronze-cuckoo	X
	Scythrops novaehollandiae	Channel-billed Cuckoo	+
CENTROPODIDAE	*Centropus phasianinus*	Pheasant Coucal	X
STRIGIDAE	*Ninox connivens*	Barking Owl	+
	Ninox novaeseelandiae	Boobook Owl	X
TYTONIDAE	*Tyto alba*	Barn Owl	+
PODARGIDAE	*Podargus strigoides*	Tawny Frogmouth	X
CAPRIMULGIDAE	*Eurostopodus argus*	Spotted Nightjar	+
AEGOTHELIDAE	*Aegotheles cristatus*	Australian Owlet-nightjar	X
APODIDAE	*Apus pacificus*	Fork-tailed Swift	X
HALCYONIDAE	*Dacelo leachii*	Blue-winged Kookaburra	X
	Todiramphus pyrrhopygia	Red-backed Kingfisher	+
	Todiramphus sanctus	Sacred Kingfisher	X
MEROPIDAE	*Merops ornatus*	Rainbow Bee-eater	X
CORACIIDAE	*Eurystomus orientalis*	Dollarbird	+
CLIMACTERIDAE	*Climacteris melanura*	Black-tailed Treecreeper	X
MALURIDAE	*Malarus lamberti assimilis*	Variegated Fairy-wren	+
	Malurus melanocephalus	Red-backed Fairy-wren	X
PARDALOTIDAE	*Gerygone olivacea*	White-throated Gerygone	X
	Smicrornis brevirostris	Weebill	X
	Pardalotus striatus	Striated Pardalote	X
MELIPHAGIDAE	*Lichmera indistincta*	Brown Honeyeater	X
	Lichenostomus virescens	Singing Honeyeater	XS
	Lichenostomus flavescens	Yellow-tinted Honeyeater	X
	Lichenostomus unicolour	White-gaped Honeyeater	+
	Melithreptus albogularis	White-throated Honeyeater	X
	Melithreptus gularis	Black-chinned Honeyeater	X
	Philemon citreogularis	Little Friarbird	X
	Certhionyx pectoralis	Banded Honeyeater	X
	Conopophila rufogularis	Rufous-throated Honeyeater	X
	Manorina flavigula	Yellow-throated Miner	+
PETROICIDAE	*Melanodryas cucullata*	Hooded Robin	X
	Microeca fascinans	Jacky Winter	X
POMATOSTOMATIDAE	*Pomatostomus temporalis*	Grey-crowned Babbler	X
NEOSITTIDAE	*Daphoenositta chrysoptera*	Varied Sittella	X
PACHYCEPHALIDAE	*Pachycephala rufiventris*	Rufous Whistler	X
	Colluricincla harmonica	Grey Shrike-Thrush	X

FAMILY	SPECIES	COMMON NAME	PRESENCE (observed)
DICRURIDAE	*Myiagra ruficollis mimakae*	Broad-billed Flycatcher	+
	Myiagra rubecula	Leaden Flycatcher	X
	Myiagra inquieta	Restless Flycatcher	X
	Rhipidura fuliginosa	Grey Fantail	+
	Rhipidura leucophrys	Willie Wagtail	X
	Rhipidura rufiventris	Northern Fantail	+
	Grallina cyanoleuca	Magpie-lark	X
CAMPEPHAGIDAE	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	X
	Lalage sueurii	White-winged Triller	X
ORIOLIDAE	*Oriolus sagittatus*	Olive-backed Oriole	X
ARTAMIDAE	*Artamus leucorynchus*	White-breasted Woodswallow	+
	Artamus personatus	Masked Woodswallow	X
	Artamus cinereus	Black-faced Woodswallow	X
	Artamus minor	Little Woodswallow	X
CRACTICIDAE	*Cracticus nigrolgularis*	Pied Butcherbird	X
CORVIDAE	*Corvus orru*	Torresian Crow	X
	Corvus bennetti	Little Crow	X
PTILONORHYNCHIDAE	*Ptilonorhynchus nuchalis*	Great Bowerbird	X
HIRUNDINIDAE	*Hirundo rustica*	Barn Swallow	+
	Hirundo nigricans	Tree Martin	X
	Hirundo ariel	Fairy Martin	+
SYLVIIDAE	*Cincloramphus mathewsi*	Rufous Songlark	+
	Cisticola exilis	Golden-headed Cisticola	+
ALAUDIDAE	*Mirafra javanica*	Singing Bushlark	+
DICAEIDAE	*Dicaeum hirundinaceum*	Mistletoebird	X
PASSERIDAE	*Taeniopygia guttata*	Zebra Finch	+
	Poephila bichenovii	Double-barred Finch	+
	Poephila acuticauda	Long-tailed Finch	X
	Erythrura gouldiae	Gouldian Finch	+
MOTACILLIDAE	*Anthus novaeseelandiae*	Richard's Pipit	+
	Motacilla flava	Yellow Wagtail	+
Total species observed			**65**
Total species potential			**110**

APPENDIX D3: HERPETOFAUNA

TAXONOMIC GROUP	SPECIES	PRESENCE (observed)
AMPHIBIANS		
HYLIDAE		
Pelodryadinae		
	Cyclorana australis	X
	Litoria caerulea	X
	Litoria nasuta	+
	Litoria rothii	+
	Litoria rubella	X
MYOBATRACHIDAE		
Limnodynastinae		
	Limnodynastes ornatus	+
	Notaden nichollsi	+
Myobatrachinae		
	Uperoleia talpa	X
REPTILES		
AGAMIDAE		
Amphibolurinae		
	Chelosania brunnea	+
	Chlamydosaurus kingii	X
	Ctenophorus nuchalis	+
	Diporiphora magna	X
	Diporiphora Pindan	X
	Diporiphora spp.	X
	Lophognathus gilberti gilberti	+
	Pogona minor mitchelli	X
GEKKONIDAE		
Diplodactylinae		
	Diplodactylus conspicillatus	+
	Diplodactylus stenodactylus	X
	Oedura rhombifera	+
	Rhynchoedura ornata	X
	Strophurus ciliaris aberrans	X
Gekkoninae		
	Gehyra pilbara	X
	Heteronotia binoei	X
PYGOPODIDAE		
	Delma tincta	+
	Lialis burtonis	+
	Pygopus nigriceps	X
SCINCIDAE		
Lygosominae		
	Carlia munda	X
	Carlia rufilatus	+
	Carlia triacantha	X
	Cryptoblepharus carnabyi	X
	Cryptoblepharus plagiocephalus	+

TAXONOMIC GROUP	SPECIES	PRESENCE (observed)
	Ctenotus colletti	+
	Ctenotus inornatus	X
	Ctenotus serventyi	X
	Glaphyromorphus isolepis	X
	Lerista apoda	+
	Lerista bipes	+
	Lerista griffini	X
	Lerista separanda	+
	Menetia maini	+
	Morethia storri	X
	Notoscincus ornatus wotjulum	+
	Tiliqua multifasciata	+
	Tiliqua scincoides intermedia	X
VARANIDAE		
	Varanus brevicauda	+
	Varanus gouldii	X
	Varanus scalaris	X
	Varanus tristis tristis	+
TYPHLOPIDAE		
	Ramphotyphlops diversus	X
BOIDAE		
Pythoninae		
	Antaresia stimsoni	X
	Aspidites melanocephelus	X
	Liasis olivaceus olivaceus	+
COLUBRIDAE		
Colubrinae		
	Dendrelaphis punctulata	+
ELAPIDAE		
Hydrophinae		
	Brachyurophis roperi	X
	Demansia olivacea	+
	Furina ornata	X
	Pseudechis australis	+
	Pseudonaja nuchalis	X
	Simoselaps minimus	+
	Suta punctata	+
Total amphibian species observed		**4**
Total reptile species observed		**28**
Total herpetofauna species potential		**60**

APPENDIX E

Tropical Timber Plantations Pty. Ltd.

Environmental Policy

Environmental Policy

Tropical Timber Plantations Pty Ltd embraces the international community's desire and objective to develop natural resources "in a way that meets the needs of the present, without compromising the ability of future generations to meet their own needs"[1]

Tropical Timber Plantations will continually strive to achieve excellence in implementing its policy by pursuing the highest standards in its environmental and social performance and through its business practices.

All Tropical Timber Plantations activities will be planned, implemented and monitored so that potentially adverse environmental impacts are prevented or minimised.

In order to achieve and maintain these standards, Tropical Timber Plantations will –

- Apply systematic management, environmental risk reduction and pollution prevention strategies as part of all operations in the short and long term
- Strive for continual improvement in our activities
- Comply with applicable legislation and other requirements

.

- Establish environmental objectives and targets, implement management plans, monitor the effects of all activities and take the appropriate action to address adverse effects.
- Openly communicate with employees, the Beagle Bay community, government and the wider community in relation to environmental performance
- Support the protection of special heritage sites and the cultural values of the peoples of the Dampier Peninsula
- Support and participate in community-based environmental projects and actively promote environmental awareness.

The Managing Director of Tropical Timber Plantations Pty Ltd is responsible to the Board of Directors of the company to effect the introduction and maintenance of this Policy which is to be reviewed annually.

Naresh Patel
Managing Director

1 September 2003

[1] UN Declaration on sustainability


Tropical Timber Plantations
Beagle Bay Project