



**CHRISTMAS ISLAND  
PHOSPHATES**

## **Supporting Documentation for Clearing Permit Application**

**Proposed Exploration Mining Lease MCI 70/10**



June 2015



Prepared for Phosphates Resources Limited

Name	Task	Version	Date
CPS 70-10 ver 0.1	Client Copy	0	30/6/2015

© EnviroBiz Pty Ltd 2015

The use of this report is solely for the Client for the purpose in which it was prepared. Range to Reef Environmental accepts no responsibility for use beyond this purpose.

All rights are reserved and no part of this report may be reproduced or copied in any form without the written permission of Range to Reef Environmental or the Client.

Range to Reef Environmental Unit 9, 18 Strang Street Beaconsfield, WA 6162

P: 08 9335 6223

F: 08 9335 6223

E: [admin@rangetoreef.com](mailto:admin@rangetoreef.com)

Prepared for Phosphate Resources Limited (trading as Christmas Island Phosphate)

## Executive Summary

Phosphate Resources Limited (PRL) trading as Christmas Island Phosphates, hold Mining Lease MCI 70/10 covering 109.7 ha.

PRL are applying to Department of Mines and Petroleum (DMP) for approval to undertake exploration in the mining lease for the purposes of assessing potential phosphate resources. This operation will involve a small amount of clearing (<1.2 ha) along historical drill lines to facilitate access by a 4WD mounted drill rig. PRL wish to apply for a clearing permit under the *Environmental Protection Act 1986 (WA) (CI)* for this purpose and this report provides supporting information for this process.

A flora survey was undertaken in May 2015 in support of the application. The survey did not encounter any Threatened flora species and it was considered unlikely that the clearing is at variance to the ten clearing principles under Section 5 of the *Environmental Protection Act 1986*.

The urgent consideration of this application is requested to facilitate exploration activities to be undertaken in 2015 before the wet season commences.

# Contents

<b>Executive Summary</b> .....	<b>3</b>
<b>1 Introduction</b> .....	<b>1</b>
1.1 Background and Purpose .....	1
1.2 Legislative Framework .....	1
1.3 History of Application .....	1
<b>2 Proposal</b> .....	<b>4</b>
2.1 Applicant .....	4
2.2 Clearing Area .....	4
2.3 Clearing Method .....	4
2.4 Required Permit Duration .....	5
<b>3 Existing Environment</b> .....	<b>5</b>
3.1 Location and Land Use .....	5
3.2 Climate .....	6
3.3 Geological and Physiographic Context of the Site .....	7
3.4 Environmentally Sensitive Areas .....	9
3.5 Vegetation .....	10
3.6 Flora .....	15
3.7 Fauna .....	21
<b>4 Survey Methodology</b> .....	<b>21</b>
4.1 Desktop assessment .....	21
4.2 Field Survey .....	22
<b>5 Results</b> .....	<b>26</b>
5.1 Photographs .....	28
<b>6 Discussion and Environmental Impact</b> .....	<b>32</b>
6.1 Conservation Significant Flora .....	32
6.2 Vegetation .....	33
6.3 Application of the Ten Clearing Principles .....	34
6.4 Planning Instruments .....	37
6.5 Other Relevant Matters .....	37
6.6 Environmental Protection Policies .....	39
<b>7 Conclusions and Recommendations</b> .....	<b>40</b>
7.1 Recommendations .....	40
<b>8 References</b> .....	<b>41</b>

## Figures

Figure 1. Laser surface model map of proposed exploration area, showing historical exploration lines. ....	2
Figure 2. Proposal area.....	3
Figure 3. Location of Christmas Island.....	5
Figure 4. Climate Averages (Airport Station 200790) (Bureau of Meteorology, 2015) .....	6
Figure 5. Topography of Christmas Island.....	8
Figure 6. Diagrammatic cross-section of Christmas Island, showing volcanic core, limestone capping, water flow lines (arrows) and typical cave development. Vertical scale is exaggerated x10. Source: Grimes (2001). ....	8
Figure 7. Vegetation of Christmas Island (Geoscience Australia, 2014).....	11
Figure 8. Vegetation mapping of proposed exploration lines, including height classes (Geoscience Australia, 2014).....	12
Figure 9. The seven major secondary (regrowth) structural types occurring on Christmas Island. ....	15
Figure 10. Christmas Island Spleenwort ( <i>Asplenium listeri</i> ). Photo by Khaliesha Amin .....	18
Figure 11. <i>Asplenium listeri</i> populations on Christmas Island.....	18
Figure 12. <i>Tectaria devexa</i> var. <i>minor</i> . Source: Butz (2004) .....	19
Figure 13. <i>Tectaria devexa</i> var. <i>minor</i> populations on Christmas Island.....	19
Figure 14. <i>Pneumatopteris truncata</i> . Source: <a href="http://www.phytoimages.siu.edu/">http://www.phytoimages.siu.edu/</a> .....	20
Figure 15. <i>Pneumatopteris truncata</i> populations on Christmas Island.....	20
Figure 16. Tall rainforest (left) is difficult to comprehensively survey from the ground. An entire community is present in the canopy (up to 50 m above) that can be overlooked in ground surveys. ....	27
Figure 17. The ferns <i>Davallia solida</i> , <i>Asplenium nidus</i> and <i>Pyrrhosia lanceolata</i> were all visible through binoculars in the top of the tree above (right) but other epiphytes such as orchids or <i>Hoya</i> may be present and less obvious.....	27
Figure 18. <i>Dendrocnide peltata</i> (stinging tree) seedling. ....	32
Figure 19. Proposed Town Planning Scheme 2 .....	38

## Tables

Table 1. Vegetation of Christmas Island.....	13
Table 2. Threatened Species under the EPBC Act (Department of the Environment, 2014). ....	16
Table 3. Vegetation condition rating scale.....	23
Table 4. Statement of botanical survey limitations.....	25
Table 5. Application of the Ten Clearing Principles .....	34

# 1 Introduction

## 1.1 Background and Purpose

Phosphate Resources Limited (PRL) have initiated an application with Department of Mines and Petroleum (DMP) for a Programme of Works to undertake exploration in Mining Lease MCI 70/10 for the purposes of assessing potential phosphate resources. This operation will comprise a small amount of clearing of three metre wide tracks, totalling approximately 1.2 ha, along historical drill lines.

The lease has previously been partially mined and, like most of the island, has been gridded out and drilled for phosphate by previous mining companies. Old drill lines are visible beneath the canopy in laser imaging of the island's surface (Figure 1). PRL proposes to undertake further exploration along historical drill lines to evaluate the resource remaining in MCI 70/10 and verify historic exploration data. These drill lines have been cleared up to 30 years previously and are now covered in regrowth vegetation.

Exploration is typically exempted from the clearing permit process under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* (WA), however exemptions do not apply in Environmentally Sensitive Areas (ESAs). ESAs are defined in the Western Australian Government Gazette and no sites on Christmas Island are included. However, Mining Lease MCI 70/10 overlaps some land included in the Register of the National Estate as "Christmas Island Natural Areas" (Figure 2). These areas could be considered as equivalent to an ESA as defined in the WA legislation (refer to Section 3.4), and therefore PRL wish to apply for a clearing permit under the *Environmental Protection Act 1986* (WA) (CI) to support the application for a Programme of Works. A flora survey was undertaken in May 2015 in support of the application and the results are outlined in this report. Urgent consideration of this application is requested to enable exploration activities to be undertaken during the dry season, to minimise any potential impacts on red crabs and erosion.

## 1.2 Legislative Framework

The legislative framework for Christmas Island is complex. The *Christmas Island Act 1958* outlines the governance arrangements for the island. Sections 8E and 8E of the Act make provision for the laws of Western Australia and the Commonwealth to apply in Christmas Island. The Minister lists selected Western Australian laws to be applied in the *Applied Laws (Implementation) Ordinance 1992*. The island is governed under Commonwealth legislation and administered by the Department of Infrastructure and Regional Development (DolaRD) (Formerly Department of Regional Australia, Local Government, Arts and Sport). Applied Western Australian laws are administered by the relevant Commonwealth Minister, by Commonwealth officers acting under ministerial delegations, or by State officers exercising delegated power and acting pursuant to inter-government service agreements under Section 8h of the act. The community is represented in the Federal Parliament by the Member for Lingiari in the House of Representatives and the two Senators for the Northern Territory in the Senate with local government (i.e. Shire of Christmas Island) utilising Western Australia legislation.

## 1.3 History of MCI 70/10

Mining Lease 70/10 was granted in September 2008. PRL applied for permission to mine a small area of Mining Lease MCI 70/10 proposed as an extension of the airport. Mining Lease 70/10 was applied for in 2002 and EPBC Act approval for the salvage, transport and processing of phosphate resources from the extended airport site on Christmas Island (EPBC 2003/1217) was granted in 2005. Mining on the site was completed and the EPBC approval expired in January 2015. Portions of the lease which are east of Phosphate Hill Road will be relinquished during the next wave of relinquishments. Mining Lease MCI 70/10 expires on 1 October 2029.

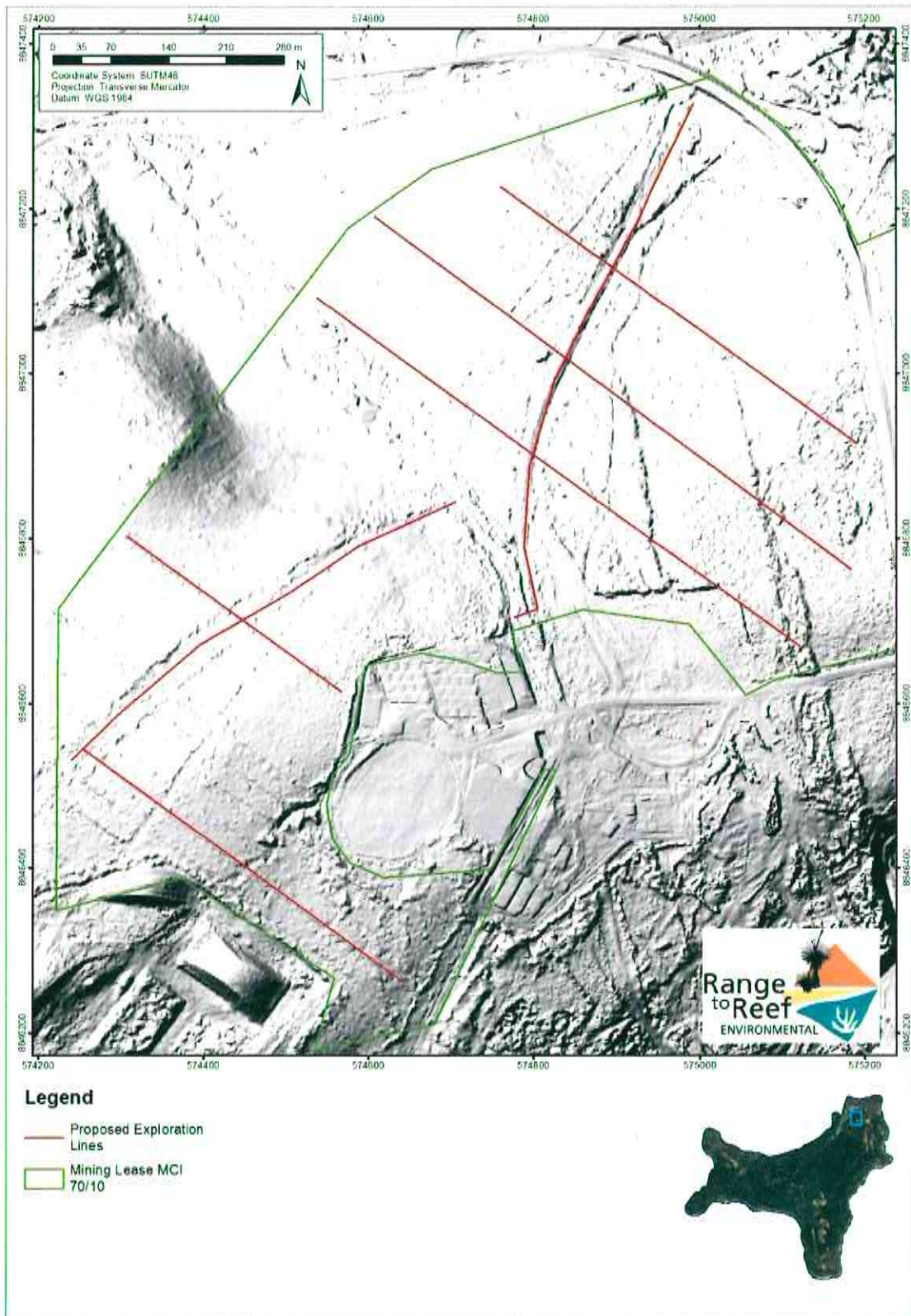


Figure 1. Laser surface model map of proposed exploration area, showing historical exploration lines.



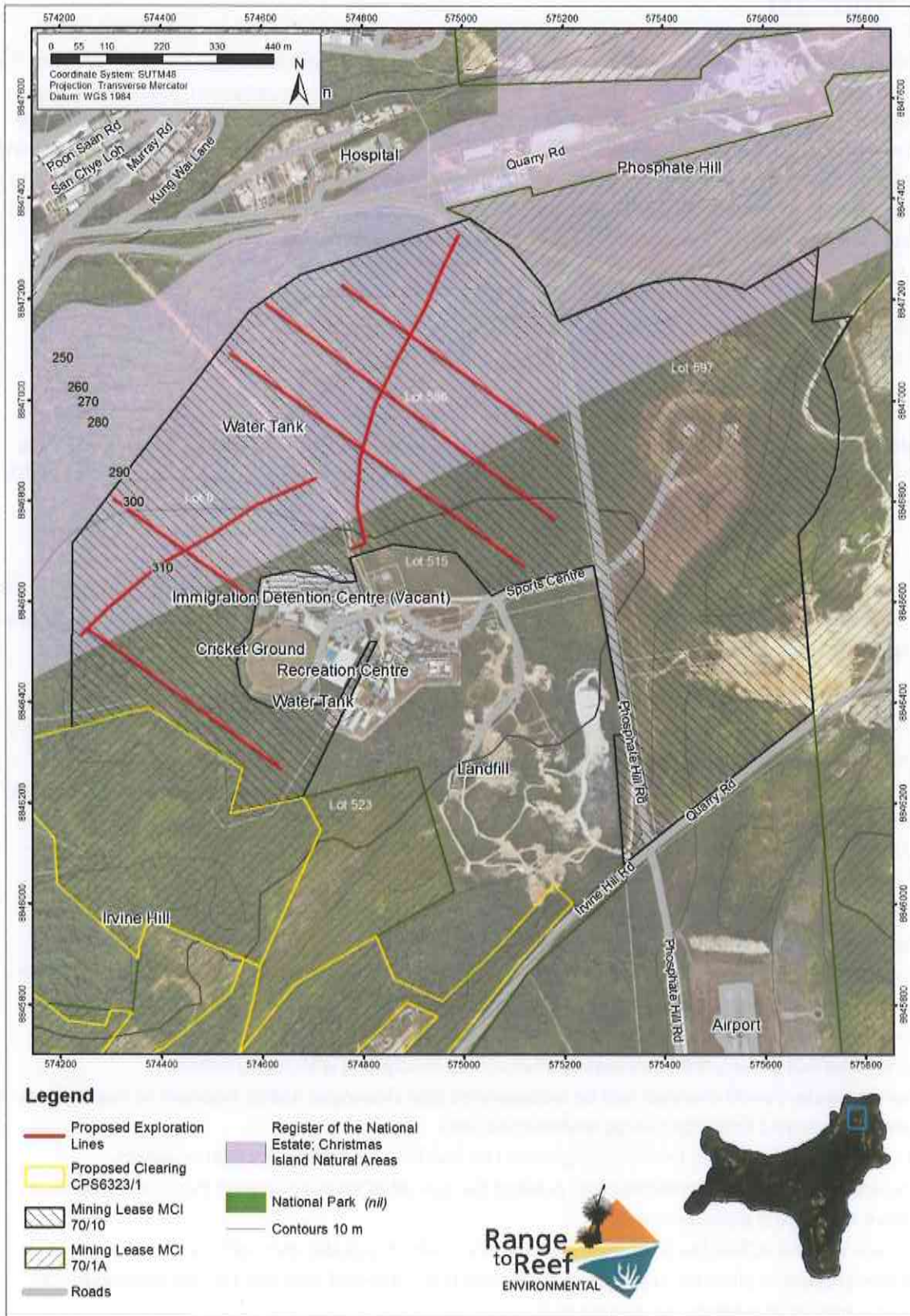


Figure 2. Proposal area

## 2 Proposal

Christmas Island Phosphates proposes a programme of aircore drilling in Mining Lease MCI 70/10 for the purposes of phosphate resource exploration. The proposal would explore previously uncleared areas in the west of the mining lease and previously cleared areas in the centre of the lease. However, clearing will be restricted to historical exploration lines (clearly visible on the surface model) containing regrowth vegetation. The clearing is solely for access of a WD vehicle and therefore the activity will be undertaken in such a way as to avoid large trees (see Section 2.3). The drilling would not require the construction of cut and fill pads or tracks, nor would it be likely to encounter groundwater.

### 2.1 Applicant

*Phosphate Resources Limited, trading as Christmas Island Phosphates*

Registered Address: 6 Thorogood Street, Burswood, WA 6100

### 2.2 Clearing Area

Christmas Island Phosphates proposes to clear a total of 1.2 ha for the purposes of exploration drilling (Figure 2). The proposed clearing will comprise seven drill lines totalling 4,100 m in length, with a width of approximately 3 m, within Mining Lease MCI 70/10.

### 2.3 Clearing Method

Clearing will be accomplished by mechanical removal using a loader. Clearing will be along previous drill lines (which contain smaller, regrowth vegetation) and will be diverted to avoid large trees. A number of management commitments are made to reduce the impact of the proposed clearing:

- Clearing will be along previous drill lines using a Cat 960 FEL.
- Clearing will be undertaken during the dry season to minimise impacts on red crabs (i.e. avoiding months when crabs are active or migrating), as well as minimising potential for erosion.
- Machinery will be supervised by Technical Services staff, with 2-way radio communication, flagging and GPS operators.
- Where possible the turning circle areas at the end of drill lines will be minimised and located to minimise clearing of trees.
- Existing tracks will be used where available.
- Significant vegetation e.g. large trees will be avoided by diverting equipment around them.
- Vegetation will be brushed to the side of the exploration track. Vegetation quickly breaks down in a tropical environment and is returned to the soil by red crabs.
- Exposed rocks i.e. limestone will be pushed to side of tracks.
- Drill holes will be secured immediately after survey by capping with rocks/debris.
- Surface water runoff channels will be incorporated into clearing at 150 m intervals in sloping areas to encourage water flow into nearby undisturbed area.
- Traffic will be minimised to limit compaction (1 x 960 FEL, 1 x drill rig, 2 x light vehicles).
- Vehicle hygiene will be maintained to prevent the spread of invasive species (machinery washed down before first pass clearing).
- Access by service/fuel truck during operating hours which includes own spill kit.
- A procedure is in place for any hydrocarbon spills (ENV-SOP-004 Fuel and Oil Spill Management).
- Daily removal of rubbish and sample bags.
- Access to tracks will be blocked to vehicles following clearing.
- Parks Australia North will have access to use cleared tracks during the annual island wide survey.

## 2.4 Required Permit Duration

The clearing will be undertaken in dry conditions within the period from June 2015 to December 2018.

# 3 Existing Environment

## 3.1 Location and Land Use

Christmas Island is located in the Indian Ocean, 10°30' South, 105°40' East, and approximately 2,600 km north-west of Perth, Western Australia. Christmas Island is 500 km south of the Indonesian capital Jakarta (Figure 3).



Figure 3. Location of Christmas Island

In the area immediately surrounding the application area, there are several land uses (Figure 2). To the north lies the townsite and to the south and central to the project area lie the Recreation Centre, Cricket Ground and the original Immigration Detention Centre. South-east of the Recreation Centre is the tip and further to the south-east is the Christmas Island Airport. The application area is bound by Phosphate Hill Road on the East, undeveloped Crown Land on the north and west, and Mining Lease MCI 70/1A to the south (currently under application as CPS 6323/1). A power line corridor runs through the centre of the application area with access to a water tank in Lot 558. An additional area of MCI 70/10 lies to the east of the road. Some portions of this have already been mined and the site (Lot 597) was at one point flagged for an airport extension associated with the now defunct APSC project.

Currently the application area is zoned as Unallocated Crown Land. Under the draft Town Planning Scheme 2, the application area is proposed to be zoned as Urban Development.

### 3.2 Climate

Christmas Island lies on the southern edge of the inter-tropical convergence zone and the climate is dominated by a low pressure trough that seasonally circles the equator. The Island has a tropical monsoonal climate with distinct wet and dry seasons and little seasonal variation in temperature. The dry season (May to November) is dominated by low and sporadic rainfall (see Figure 4) with consistent south-east trade winds. The wet season generally occurs from December to April with the island receiving most of its rainfall during this period. Christmas Island’s average annual rainfall since 1973 is 2,128 mm but may vary considerably from year to year with the island’s lowest recorded annual rainfall being 1,066.9 mm in 1987 (BOM, 2015). Temperatures remain relatively uniform throughout the year, with an average daily maximum of 28°C in March/April and average daily minimum of 22°C in August/September. The Island has high humidity (80-90%) throughout the year and frequent dews and heavy mists may occur during the wet season.

During the wet season, Christmas Island is subject to the influence of north-west monsoons, which typically cause high swells and high winds, with gusts of over 100 km/h. No cyclones have been recorded as passing directly over the island, but many have passed nearby, resulting in strong winds and heavy rainfall on the island. A cyclone in February 2014 came very close to the island and significant damage was recorded in rainforest communities, with trees blown over and foliage stripped from many areas.

The Island does have distinct microclimates due to the island’s geography, with rainfall measurements indicating that there are significant variations in rainfall (Falkland, 1999). Average rainfall at Rocky Point (Settlement), Jedda Cave and South Point (1,931, 2,375 & 1,907 mm respectively) for example shows the significant variation across the Island (Puhlovich et al., 2003). Daily evaporation exceeds rainfall between July and October.

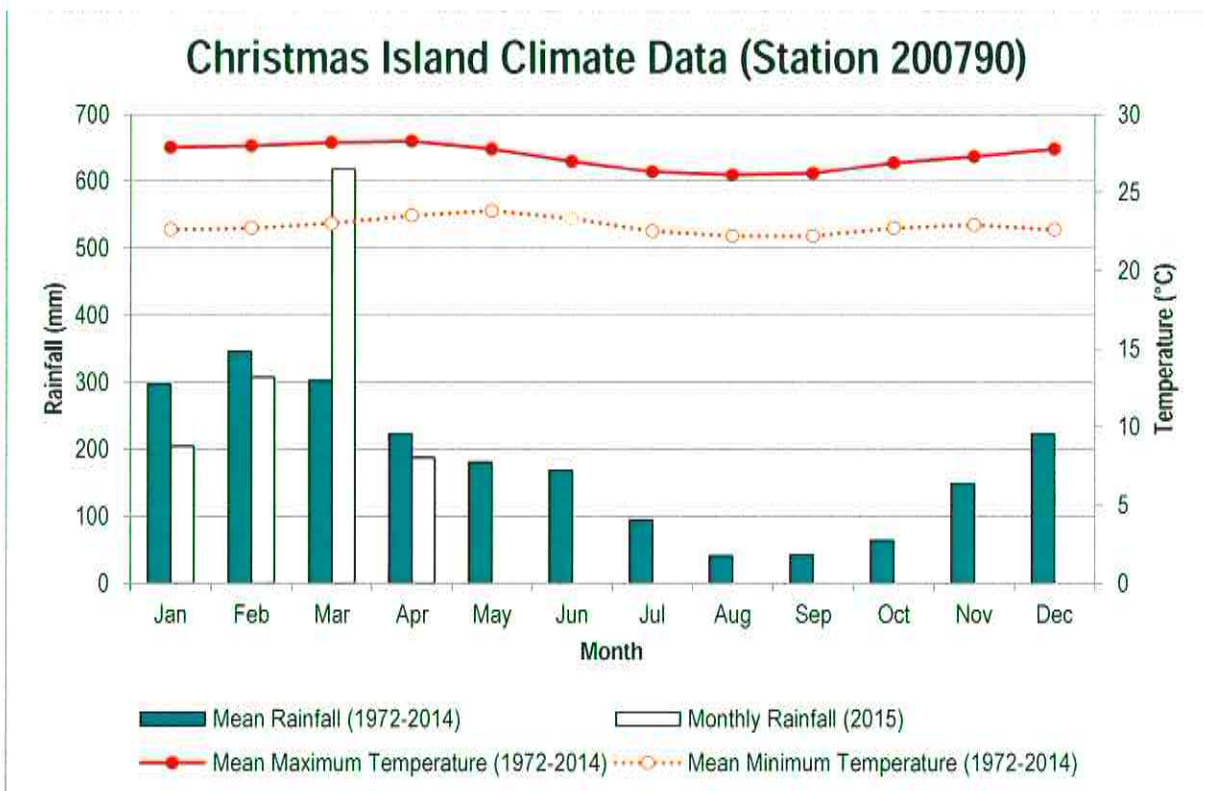


Figure 4. Climate Averages (Airport Station 200790) (Bureau of Meteorology, 2015)

### 3.3 Geological and Physiographic Context of the Site

#### 3.3.1 Geology and Soils

Christmas Island is one of a series of submarine seamounts that rise above the 5,500 m deep abyssal areas of the West Australian Basin (Jongsma, 1976). At the core of the island are volcanic rocks, mainly composed of basalt with a layer of limestone generally covering these volcanic rocks, with occasionally outcrops, particularly along the present coastline (Grimes, 2001).

A series of geological uplifts and successive layering of coral reefs over the basalt core of the island have led to the eruption of new cliffs and terraces from the ocean, forming stepped terraces and inland cliffs.

The oldest (Upper Eocene) limestones are found near present sea level and the youngest (Pliocene) near the island summit, 330 m above sea level. The limestone is mixed with dolomite sediments, basalts and tuffs. A layer of phosphate-rich soil material covers the limestone over about half of the island, with phosphatisation of the surface of the limestone.

The red crab (*Gecarcoidea natalis*) is the principle agent of organic matter turnover and incorporation into the soil. Crab activity is a key feature of water and nutrient availability in the subsoil, with burrows also providing a preferred pathway for water drainage into the soil (Hollingsworth, 2003).

Soils and geomorphology for the application area were investigated by Hollingsworth in 2003. An auger bore was sampled in the south western corner of the application area where the vegetation had been cleared but the soil had not been cultivated. They found shallow soils that were brown to grey phosphatic clay loams with small quantities of limestone gravel and neutral to very slightly alkaline pH.

The proposed exploration would provide further information regarding the depth and nature of soils through the remainder of the site, which are expected to be deeper as they support tall forest.

#### 3.3.2 Landforms and Topography

The island is characterised by sea cliffs that rise via a series of terraces to a central plateau (Figures 5 and 6). The shoreline is dominated by cliffs and extensive shore platforms with a few small beaches and Flying Fish Cove which has a relatively large beach and shallow platform being the only safe harbour for much of the year. The island's natural landscape is dominated by karstic surface landforms and cave systems (Grimes, 2001).

The application area is situated on the edge of the central plateau and falls away to the north with a moderate decline.

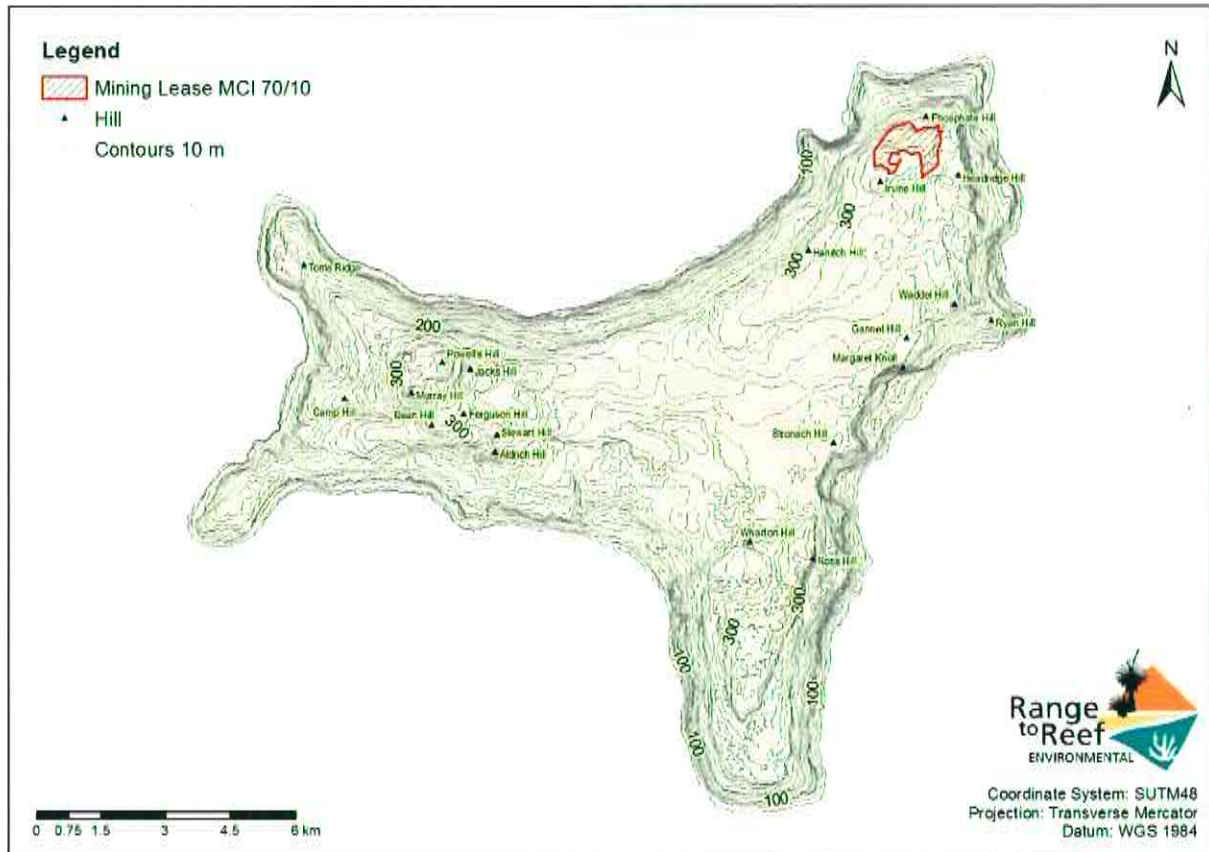


Figure 5. Topography of Christmas Island.

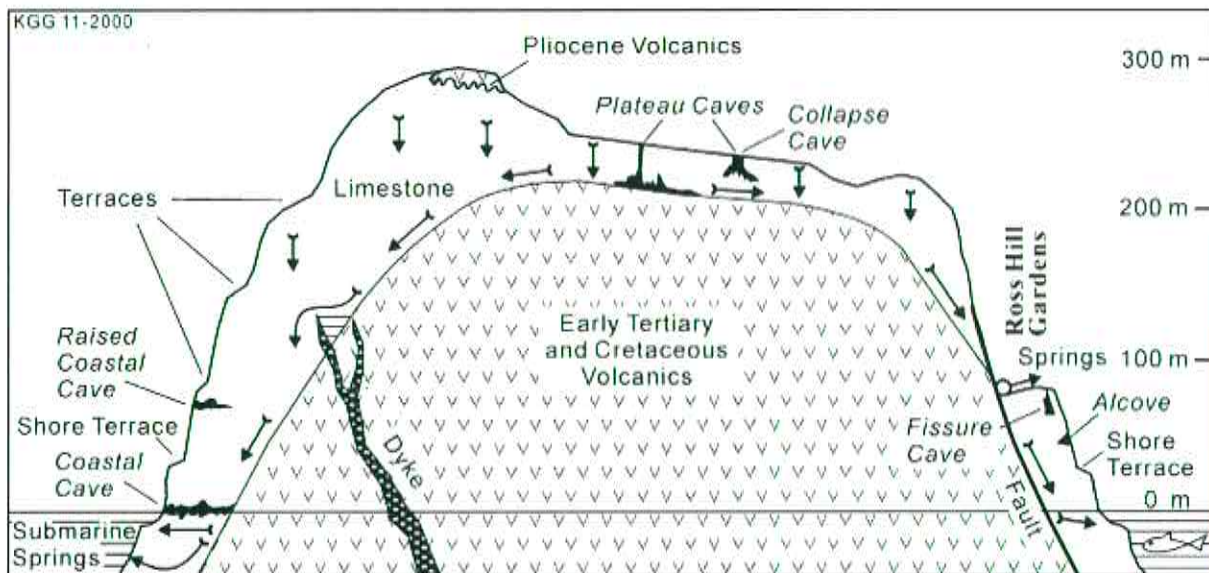


Figure 6. Diagrammatic cross-section of Christmas Island, showing volcanic core, limestone capping, water flow lines (arrows) and typical cave development. Vertical scale is exaggerated x10. Source: Grimes (2001).

### 3.3.3 Hydrogeology and Hydrology

A major feature of the Christmas Island geomorphology is the lack of surface drainage. Rainfall mostly infiltrates the land surface and is utilised by plants, contributes to soil water stores or recharges to groundwater. There is therefore no significant surface drainage network except down gradient of springs that arise at the interface between limestone and basalt formations.

Christmas Island's soils are generally highly permeable and there is consequently little runoff or erosion (Hollingsworth, 2003). In the Wet Season when the soils are saturated, runoff can during heavy rainfall providing some risk of erosion and sedimentation. However, given the high natural infiltration rates the risk of erosion and sedimentation is generally localised to compacted areas such as roads and stockpile pads. Infiltration tests by Puhlovich et al. (2003) indicate that soil infiltration rates are typically substantially higher than hourly rainfall intensities.

There are three key hydrogeological units on the island; shallow, residual soils, which overlie fractured, unconfined – semi-confined aquifers within the karstic limestone rocks, which in turn overlay relatively impermeable volcanic basement rocks (Puhlovich et al., 2003). Groundwater levels on the island are reflected by the location of the unconfined water table within the karst limestone aquifers. Limestone aquifers can be recharged when rainfall permeates through the soil zone into the underlying aquifers or by direct runoff of rainfall into karst features such as dolines and sinkholes that occur across the island (Puhlovich et al., 2003). Assessments suggest that approximately half of all incident rainfall passes through the soil zone and recharges the underlying limestone aquifers (Hollingsworth, 2003; Falkland, 1999). Groundwater discharge occurs at surface springs such as Hosnie's Spring and offshore springs such as those found at Flying Fish Cove (Puhlovich et al., 2003). The complex behaviour and extent of weathered/fractured rock aquifers on the island are not well understood.

Perennial (permanent) surface aquatic habitats (freshwater) on Christmas Island are limited to a number of spring-fed streams found along coastal or sloping areas of the island. Hosnie's Spring and The Dales are both listed as a Wetland of International Importance under the Convention on Wetlands of International Importance, Water Fowl Habitat 1971 (known as the 'Ramsar Convention') and are listed in the Directory of Important Wetlands in Australia.

### 3.3.4 Interim Biogeographical Regionalisation of Australia (IBRA)

Christmas Island is not included in the Interim Biogeographic Regionalisation of Australia (IBRA) (McKenzie et al., 2002).

## 3.4 Environmentally Sensitive Areas

An Environmentally Sensitive Area (ESA) means an area declared in Regulation 6 of the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* to be an Environmentally Sensitive Area. These areas are protected under the *Environmental Protection Act 1986* and are selected for their environmental values at a State or National level. As Christmas Island is a Commonwealth territory, there are no areas declared under this legislation as ESAs.

However, on Christmas Island there are areas which could be considered as equivalent to an ESA as defined in the WA legislation. These include:

- The National Heritage Listed "Christmas Island Natural Areas."
- The Ramsar listed, nationally important wetlands Hosnie's Spring and The Dales.

- The area covered by vegetation within 50 m of the threatened ferns §*Asplenium listeri*<sup>1</sup> (Christmas Island Splenwort), *Tectaria devexa* var. *minor* and *Pneumatopteris truncata*.

Most natural areas of the island, including previously cleared lease areas are included as “Christmas Island Natural Areas.” Hosnie’s Spring and The Dales are not near the proposed clearing areas. §*Asplenium listeri* (Christmas Island Splenwort), *Tectaria devexa* var. *minor* and *Pneumatopteris truncata* are unlikely to be found in the proposed clearing areas.

### 3.5 Vegetation

The Christmas Island National Park, which covers 63% of the island, is assigned to IUCN reserve category II, most of which is uncleared primary rainforest (Environment Australia, 2014). Some 25% of the island’s original vegetation has been cleared for mining and infrastructure (Environment Australia, 2014).

Three features of the ecology of the island’s native vegetation are notable (Environment Australia, 2014):

- The occurrence of many of the widespread Indo-Malesian species in habitats that would be considered extremely atypical elsewhere in their natural ranges, and associated with this, the exceptionally large stature of some of these species.
- The low diversity of canopy and sub-canopy species and the lack of structural complexity (e.g. relatively poor development of robust woody vines and rattans, the absence of aroids and of gingers in the understorey) in the Island’s rainforests.
- The very low diversity and lack of speciation amongst plant genera that elsewhere in the region is characteristic of early successional, and frequently disturbed, rainforest environments (e.g. *Macaranga*, *Claoxylon* and *Pipturus*).

The geology, geomorphology and climate on Christmas Island create the biophysical environment and constraints for the vegetation communities. These factors determine the soil nutrient status, the seasonal availability of moisture and the degree of exposure to wind, which in turn control the distribution, structure and functioning of the natural vegetation (Reddell and Zimmerman 2003).

Vegetation mapping of the island was initially undertaken by Mitchell (1985) for the Australian Nature Conservation Agency. This mapping had limited use due to its broad scale and spatial inaccuracy. Flora of Australia Volume 50 (Du Puy, 1993a) lists eight vegetation types for the island:

- Primary Rainforest,
- Marginal Rainforest,
- Areas with Surface Water,
- Open Forest, scrubby forest and vine forest,
- Inland cliffs,
- Coastal Fringe,
- Shore cliffs and spray zone, and
- Mined areas.

---

<sup>1</sup> § denotes endemic species



A vegetation mapping project was undertaken from 2011 to 2014 to attempt to map vegetation with better spatial accuracy, to determine height categories and to apply these consistently across the Island. Additional categories were added to include wetland vegetation and regrowth in cleared areas. The Christmas Island Vegetation and Clearing Map was developed through a collaborative project by Geoscience Australia, Christmas Island Phosphates, Christmas Island National Park and the Commonwealth Department of the Environment. The map classified the full extent of Christmas Island into vegetation and land cover classes (Figures 7, 8 and Table 1).

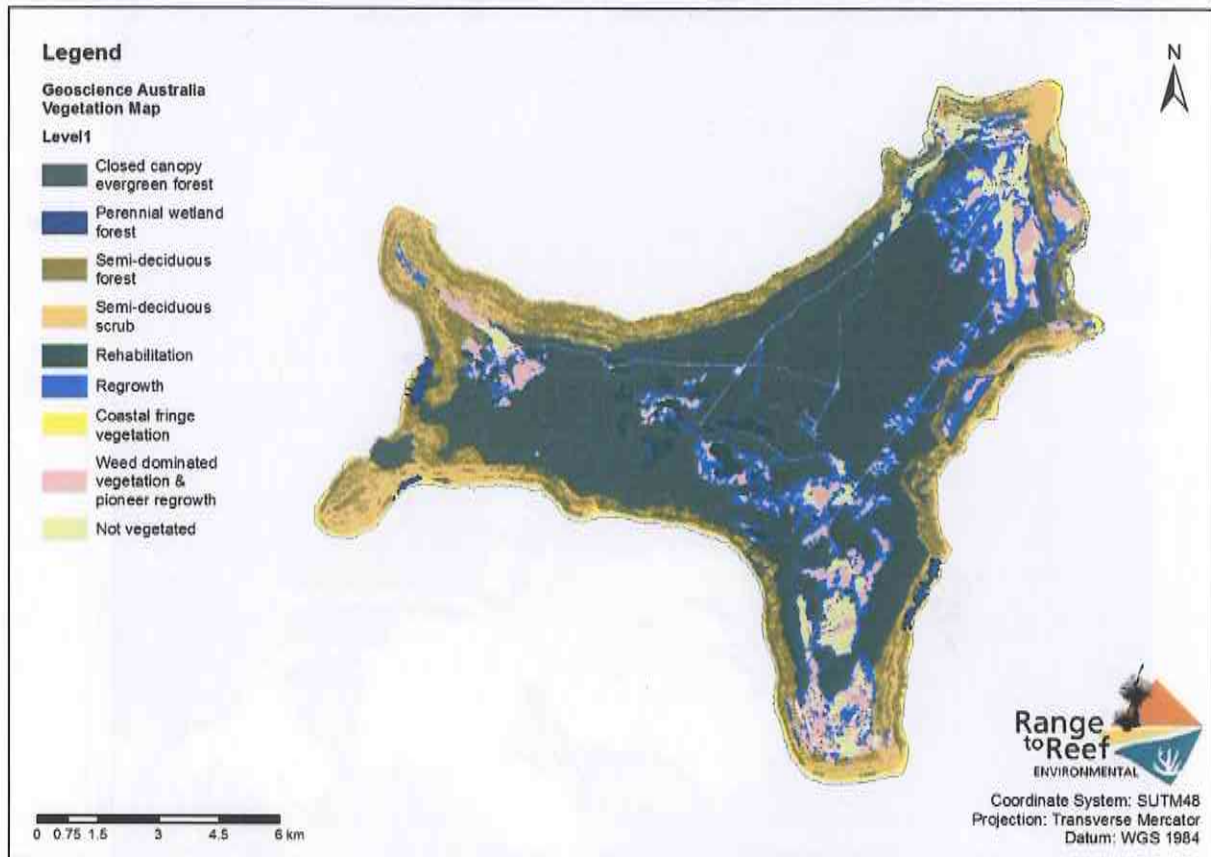


Figure 7. Vegetation of Christmas Island (Geoscience Australia, 2014)

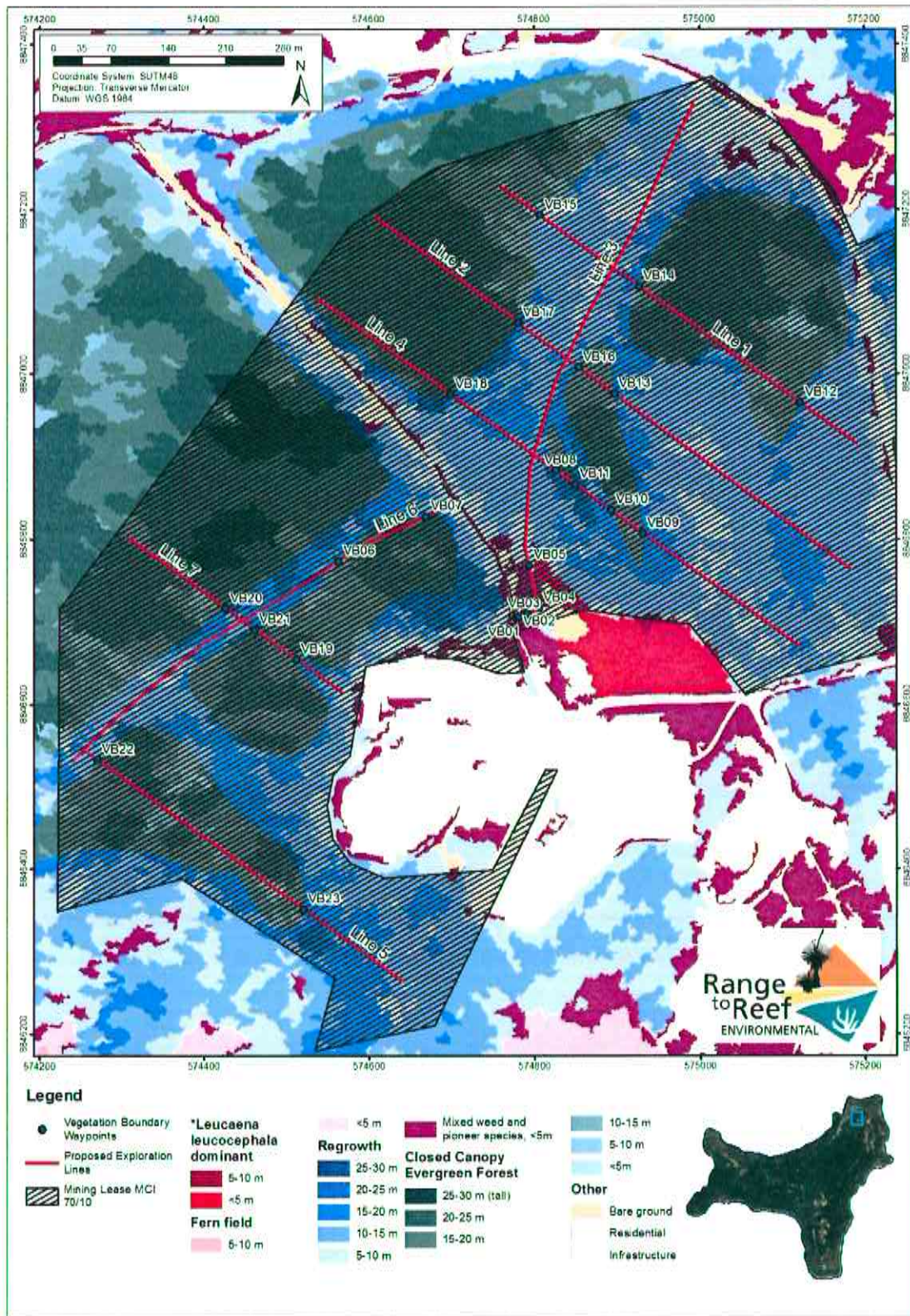


Figure 8. Vegetation mapping of proposed exploration lines, including height classes (Geoscience Australia, 2014)

Table 1. Vegetation of Christmas Island

Flora of Australia	Geoscience Australia			Indicator species
	Level 1	Level 2	Description	
Primary Rainforest	Closed canopy evergreen forest	Closed canopy evergreen forest (tall or moderate)	Generally found on the plateau and terraces, with a closed uneven canopy up to 40 m in height. Some trees emerge up to 10 m above the canopy. Often supports ferns and orchids, young palms and lilies in the understorey.	<i>Bolbitis heteroclita</i> , <i>Syzygium nervosum</i> , <i>Hernandia ovigera</i> , <i>Planchonella nitida</i> , <i>Pisonia umbellifera</i> , <i>Corymborkis veratrifolia</i> , <i>Ehretia javanica</i>
Marginal Rainforest	Semi-deciduous forest	Semi-deciduous forest	Generally found on the slopes and terraces down to the coast - and some plateau areas. Higher occurrence of semi-deciduous trees compared to Closed Canopy Evergreen, which lose a portion of leaves during the dry season. Tree height generally 10-25m	<i>Terminalia</i> , <i>Gyrocarpus</i> , <i>Erythrina variegata</i> , <i>Premna serratifolia</i> , <i>Pisonia grandis</i> , <i>Ochrosia ackeringae</i>
Inland Cliffs AND Open Forest, scrubby forest and vine forest	Semi-deciduous scrub	Semi-deciduous scrub	Found on the terraces, steep slopes and inland cliffs. Semi-deciduous canopy with vines and shrub understorey. Tree height generally <10m.	<i>Colubrina pedunculata</i> , <i>Canavalia cathartica</i> , <i>Carmona retusa</i> , Cycads
Areas with Surface Water	Perennial wetland forest	<i>Inocarpus fagifer</i> dominant	Areas of fresh water runoff on the lower terraces dominated by <i>Inocarpus fagifer</i> .	<i>Inocarpus fagifer</i>
		<i>Hibiscus tiliaceus</i> dominant	Areas of fresh water runoff on the shore terrace dominated by <i>Hibiscus tiliaceus</i> .	<i>Hibiscus tiliaceus</i>
Coastal Fringe OR Shore cliffs and spray zone, and	Coastal fringe vegetation	<i>Bruguiera</i> dominant	A single patch of vegetation dominated by <i>Bruguiera</i> at Hosnie's Spring. Occurring in an area of fresh water runoff on the shore terrace.	<i>Bruguiera gymnorhiza</i>
		Coastal herbland	Found between the coastal scrub and coastal cliffs in exposed areas. Class is dominated by low-lying herbs, sedges and grasses.	<i>Portulaca tuberosa</i> , <i>Ischaemum nativitatis</i> , <i>Opfismenus compositus</i> , <i>Sporobolus virginicus</i>
		Coastal shrubland	Dense salt-tolerant vegetation growing between the coastal herbland and the terrace cliffs.	<i>Pandanus christmatensis</i> , <i>Scaevola</i> , <i>Pemphis</i> , <i>Argusia argentea</i> , <i>Cordia cordata</i> , <i>Guetarda</i>

Continued over page...

Flora of Australia	Geoscience Australia		Indicator species		
	Level 1	Level 2		Description	
Mined Areas	Rehabilitation	Rehabilitation	Areas where forest rehabilitation has taken place. The standard of forest varies depending on the type of rehabilitation completed, species planted and management regime.	A mix of up to 30 native tree species when initially planted, dependent on characteristic of the site and year of rehabilitation. <i>Macaranga</i> , <i>Dysoxylum</i> , <i>Calophyllum</i> , <i>Tristropsis</i>	
	Regrowth	Regrowth			Generally well developed regrowth vegetation over 5 m mean tree height. May include some introduced or weed species.
	Weed dominated veg and pioneer regrowth		* <i>Leucaena leucocephala</i>	Monoculture of * <i>Leucaena leucocephala</i> . Often occurring as regrowth in previously cleared areas.	* <i>Leucaena leucocephala</i>
			Fern field	Expanse of low-lying ferns often growing on limestone pinnacles.	<i>Nephrolepis biserrata</i> , <i>Microsorium scolopendria</i> , <i>Psilotum nudum</i>
			Mixed weed and pioneer regrowth	Regrowth vegetation with a mean tree height of <5m. Can vary between native and introduced species depending on the location and time since clearing. Tends to have a higher occurrence of weed species compared to the 'Regrowth' category.	* <i>Muntingia calabura</i> , * <i>Psidium</i> sp. (Guava), * <i>Mimosa</i> , Passionfruit, <i>Macaranga</i>

(Source: Du Puy, 1993a and Geoscience Australia, 2014)

There are seven major structural types of secondary vegetation (i.e. vegetation that has established in areas that have been cleared of the original natural forest) on Christmas Island (Figure 9). The occurrence of these secondary vegetation types in specific disturbed areas on Christmas Island reflects the influence of four main factors:

- The areal extent and the severity/intensity of the original disturbance (especially whether the soil profile has been disrupted or removed);
- Proximity to the nearest forest boundaries and/or to weed-infested areas;
- The subsequent disturbance or management history of the area (especially the frequency and intensity of further disturbances including fire); and,
- The time since the last major disturbance occurred.

Whether or not the soil profile has been removed or disturbed, the proximity to forest and/or to weed infested areas and the occurrence of further disturbance are the major environmental determinants of secondary vegetation type and successional pathways. There are four main successional pathways:

- Arrested successions dominated by ferns;
- Stagnant successions dominated by thickets of exotic shrubs and vines;
- Reconstructive successions dominated by *Macaranga tanarius*; and
- Retrogressive successions leading to fernlands.

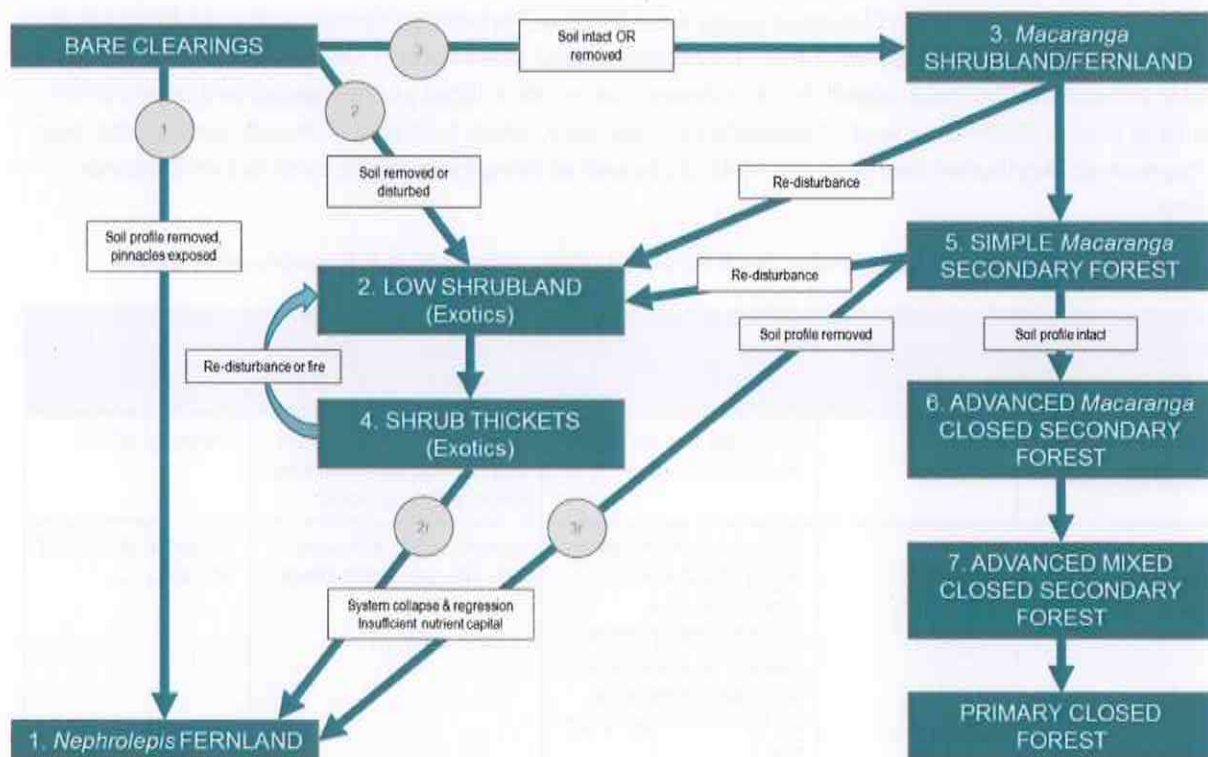


Figure 9. The seven major secondary (regrowth) structural types occurring on Christmas Island.

### 3.6 Flora

The flora of Christmas Island has very strong taxonomic relationships with those of the Indo-Malayan and Malesian regions. Some species (e.g. *Terminalia catappa*, *Inocarpus fagifer* and *Gyrocarpus americanus*) are elements of a more widely distributed, and largely unremarkable, tropical Indo-Pacific littoral flora

that extends as far east as the islands of Polynesia. Despite its isolated location, estimated 10-million year history above sea level, and diverse 'high-island' landscape, only around eighteen species are known to be endemic (denoted by §) to Christmas Island.

The general taxonomic status and affinities of the flora are relatively well known but detailed records of population distributions across the island (and its range of habitats) are limited for many species. Some additional species of ferns, herbs and shrubs continue to be added to the flora as a result of further collections, especially from poorly accessible terrace areas on the island.

Flora of Australia (1993a) lists 411 species of vascular plants, with 237 species indigenous to the island (including 16 endemics) and a further 174 species introduced since human occupation. Reddell and Zimmermann (2003) said that the flora comprises about 420 species of vascular plants with approximately 242 species indigenous to the island and a further 177 species introduced since human occupation. Claussen (2005) said that there are 213 species of native plants on Christmas Island, including 17 endemics. The Australian National Herbarium Specimen Information Register (ANHSIR, 2015) lists a number of additional species which are not included in Flora of Australia as having been collected on Christmas Island. The draft Christmas Island Biodiversity Conservation Plan (Director of National Parks, 2014) lists 17 endemic flora species for the island. The Christmas Island National Park Management Plan (Environment Australia, 2014) says the island is home to at least 20 endemic flora species.

### 3.6.1 EPBC Act Listed Flora

Three species which occur on Christmas Island were listed as Threatened Species under the EPBC Act at the time this report was prepared (Table 2). Christmas Island Spleenwort is listed as Critically Endangered and is endemic to Christmas Island. *Tectaria devexa* var. *minor* is listed as Endangered and occurs in Sri Lanka as well as Christmas Island. *Pneumatopteris truncata*, which is listed as Critically Endangered, has a fragmented distribution over Asia and Malaysia as well as being known from two sites on Christmas Island.

Table 2. Threatened Species under the EPBC Act (Department of the Environment, 2014).

Genus (& Family)	Conservation Status (EPBC Act)	Habitat	Description	Distribution
§ <i>Asplenium listeri</i> (Aspleniaceae)	Cr	Limestone rock crevices in dry, exposed areas.	A lithophytic fern with short erect fronds, 3.5–9 cm long, which grow in a crown.	Christmas Island.
<i>Tectaria devexa</i> var. <i>minor</i> (Dryopteridaceae)	En	Primary rainforest (tall and largely undisturbed), above 80 metres elevation; both in deeper soils and as a lithophyte (on mossy pinnacles at the base of a slope, a wet site).	A small, tufted, terrestrial fern with pale green fronds.	Christmas Island and Sri Lanka.
<i>Pneumatopteris truncata</i> (Thelypteridaceae)	Cr	Permanently moist sites in semi-deciduous closed forest.	A large terrestrial fern with an erect rhizome and fronds growing in a crown to 120 cm long. The fronds have aerophores (respiratory structures) at the base of the pinnae.	Fragmented distribution over Asia and Malaysia and two sites on Christmas Island.

### 3.6.2 Conservation Significant Flora

Holmes and Holmes (2002) made a number of recommendations relating to conservation significant flora including the nomination of the species §*Asplenium listeri*<sup>2</sup>, *Pneumatopteris truncata*<sup>2</sup>, §*Asystasia alba*<sup>2</sup>, §*Dicliptera maclearii*<sup>2</sup>, *Blumea lanceolaria*<sup>2,3</sup>, *Muellerargia timorensis*<sup>2</sup>, *Cycas rumphii*<sup>2</sup>, *Spondias cytherea*<sup>2</sup> and §*Dendrocnide peltata* var. *murrayana*<sup>2</sup> under the EPBC Act. The majority of these species occur in marginal rainforest (see footnotes) or are located within National Park. These locations are not generally under threat due to legislative protection (National Park), a lack of phosphate resources or difficult terrain.

The original EPBC Act approval for Mining Lease MCI 70/10 (2005) stipulated conditions for the then Threatened species *Carmona retusa*. In September 2005, the Threatened Species Scientific Committee judged the species to be not eligible for listing under the EPBC Act as the species was widespread elsewhere in the world and was not subject to any threatening processes in its Christmas Island distribution.

Parks Australia (2008) identified some 26 non-endemic vascular flora species as being potentially conservation significant in an issues paper prepared as part of the development of a draft regional recovery plan (which later became the Draft Christmas Island Biodiversity Conservation Plan).

The Draft Christmas Island Biodiversity Conservation Plan (Director of National Parks, 2014) identified four flora species as significant:

- §*Asplenium listeri* (Christmas Island spleenwort, a fern)
- *Pneumatopteris truncata* (a fern)
- *Tectaria devexa* var. *minor* (a fern)
- *Bruguiera gymnorhiza* and *B. sexangula* (mangroves)

The stand of the normally estuarine mangrove species *Bruguiera gymnorhiza* and *B. sexangula* occurs at Hosnie's Spring (listed as a Wetland of International Importance under the Ramsar Convention) about 50 metres above sea level (Parks Australia, 2008). This site is protected within National Park as well as a Ramsar listing.

In Western Australia, species that maybe Threatened or near Threatened but are data deficient or have not yet been adequately surveyed to be listed under the Schedules of the Wildlife Conservation (Rare Flora) Notice, are added to the Western Australian Priority Flora List under Priorities 1, 2 or 3. Under the State process for assessment of clearing permits (Department of Environment and Conservation, 2009), Priority listed flora are considered as contributing to biodiversity. Western Australian listings for Priority Flora species do not include Christmas Island's flora.

---

<sup>2</sup> Found in Marginal Rainforest (Holmes and Holmes, 2002)

<sup>3</sup> Found in Primary Rainforest (Holmes and Holmes, 2002) but prefers some light, usually found along disused drill lines (Du Puy, 1993b).

### *Asplenium listeri* (Christmas Island Spleenwort)

The Christmas Island Spleenwort grows colonially on limestone rocks and cliffs in marginal rainforest between 110 and 255 metres above sea level, growing mainly beneath or near *Ficus microcarpa* (Holmes and Holmes, 2002). Christmas Island Spleenwort is unlikely to be impacted by the proposed clearing which is in closed canopy evergreen forest, mostly above 250 metres above sea level (refer to **Error! Reference source not found.**) and away from known populations.



Figure 10. Christmas Island Spleenwort (*Asplenium listeri*). Photo by Khaliesha Amin

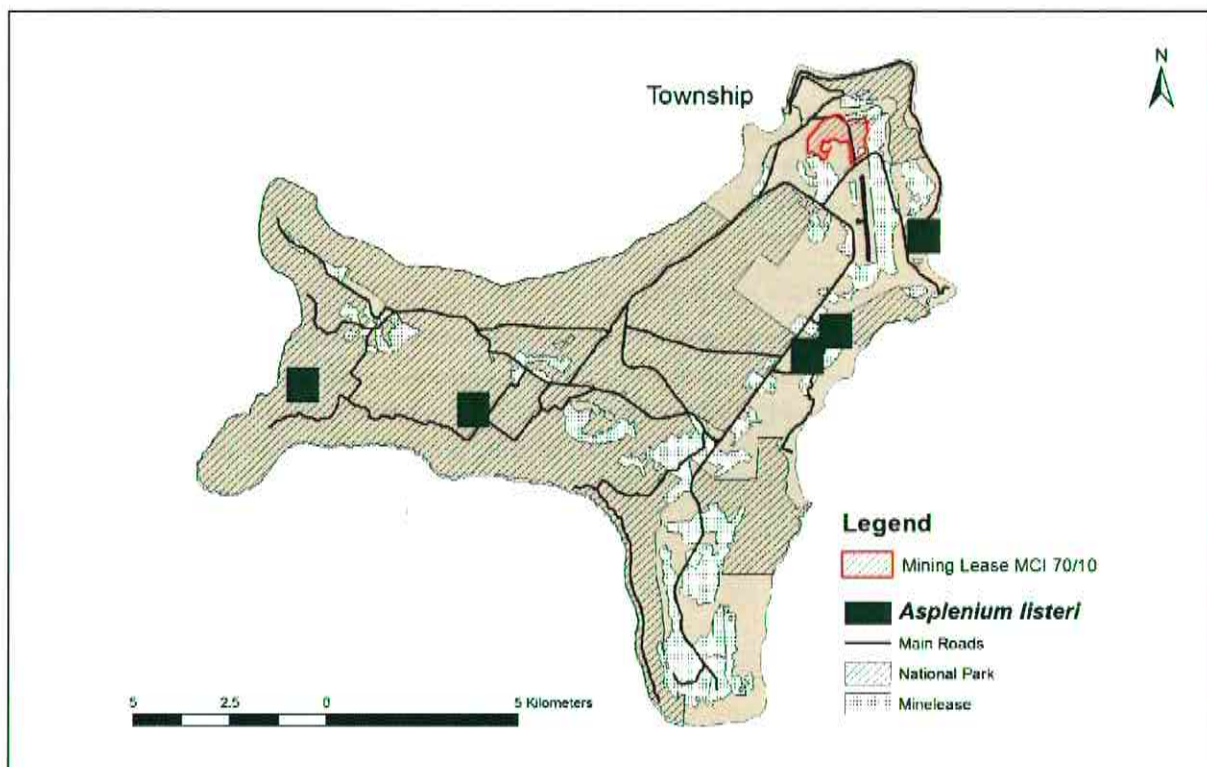


Figure 11. *Asplenium listeri* populations on Christmas Island



### *Tectaria devexa* var. *minor*

*Tectaria devexa* var. *minor* grows colonially, mainly on the plateau, in primary rainforest (tall and largely undisturbed), above 80 metres elevation; both in deeper soils and as a lithophyte (Holmes and Holmes, 2002). Ten populations of *Tectaria devexa* have been identified at Christmas Island, with the majority of these occurring in the National Park. No known populations of *Tectaria devexa* have been identified in the proposed clearing area. The species has a superficial similarity to the larger fern *Davallia solida* which is common on the island.



Figure 12. *Tectaria devexa* var. *minor*. Source: Butz (2004)

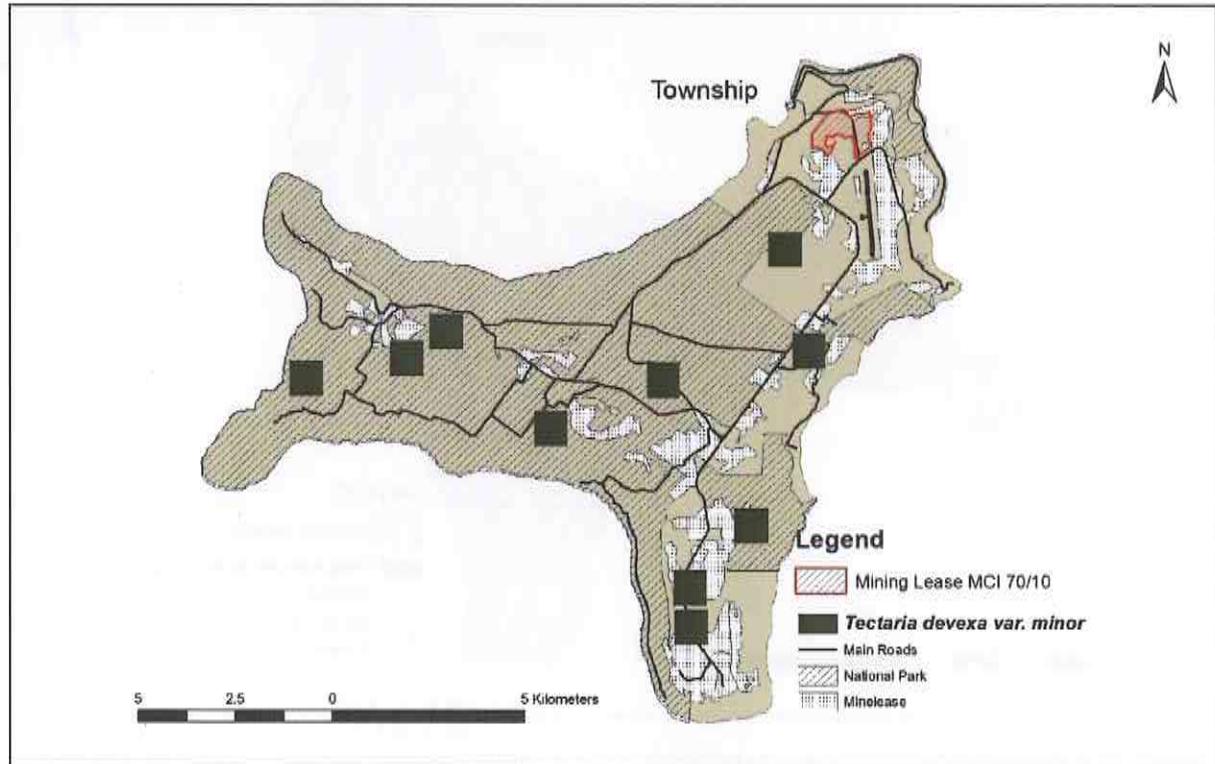


Figure 13. *Tectaria devexa* var. *minor* populations on Christmas Island

***Pneumatopteris truncata***

*Pneumatopteris truncata* grows colonially on permanently moist sites, in marginal rainforest (semi-deciduous closed forest) between 50 and 140 metres above sea level (Holmes and Holmes, 2002). It is known from two sites at Christmas Island. Both subpopulations of *Pneumatopteris truncata* occur within Christmas Island National Park. Neither location is within the proposed clearing area, which occurs within regrowth/closed canopy evergreen forest.



Figure 14. *Pneumatopteris truncata*. Source: <http://www.phytoimages.siu.edu/>

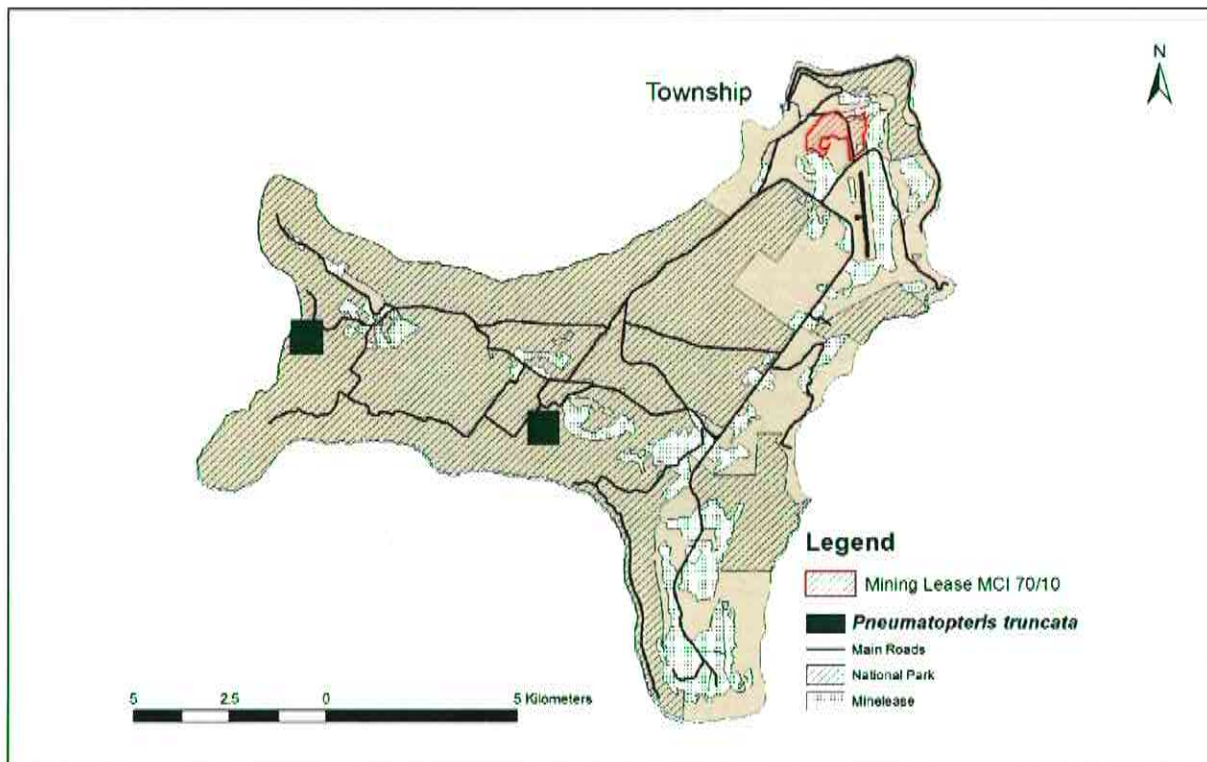


Figure 15. *Pneumatopteris truncata* populations on Christmas Island

### 3.7 Fauna

The Draft Christmas Island Biodiversity Conservation Plan (Director of National Parks, 2014) identified 22 terrestrial fauna species as significant. This included 3 seabirds, 7 forest birds, 3 mammals, 6 reptiles and 3 land crabs. Species considered to be extinct were not included. Of these, 2 mammals, 6 birds and 2 reptiles are listed as Threatened under the EPBC Act:

- Christmas Island frigatebird (*Fregata andrewsii*)
- Abbott's booby (*Papasula abbotti*)
- Christmas Island goshawk (*Accipiter hiogaster natalis*)
- Christmas Island emerald dove (*Chalcophaps indica natalis*)
- Christmas Island hawk-owl (*Ninox natalis*)
- Christmas Island thrush (*Turdus poliocephalus erythropleurus*)
- Christmas Island shrew (*Crocidura attenuata trichura*)
- Christmas Island pipistrelle bat (*Pipistrellus murrayi*)
- Christmas Island blind snake (*Ramphotyphlops exocoeti*)
- Lister's gecko (*Lepidodactylus listeri*)

Twelve broad fauna habitats have been identified on Christmas Island (Environment Australia, 2002). Within the proposed clearing area, there are two potential fauna habitats:

- Shallow soil rainforest on the higher terraces.  
Generally thin soils and exposed limestone pinnacles. Typical canopy species include *Celtis timorensis*, *Dysoxylum gaudichaudianum*, *Ficus microcarpa*, *Arenga listeri*, *Planchonella nitida* and *Tristiropsis acutangula*. Vegetation has a lower upper canopy and is floristically richer than the primary evergreen rainforest of the plateau. Pockets of deeper soil occur in this region, supporting primary evergreen rainforest.
- Deeper plateau and terrace soils evergreen rainforest.  
Typically a tall evergreen rainforest with emergent trees to 45 m. Typical emergent species are *Syzygium nervosum*, *Ficus microcarpa*, *Planchonella nitida* and *Hernandia ovigera*. The upper canopy is comprised of *Barringtonia racemosa*, *Inocarpus fagifer*, *Cryptocarya nitens*, *Dysoxylum gaudichaudianum* and *Tristiropsis acutangula*. The understorey is composed of *Arenga listeri*, *Pandanus elatus*, *Leea angulata*, *Ochrosia ackeringae*, *Pisonia umbellifera* and various shrubs and ferns.

Though karst habitat might also be possible within the clearing area, it is unlikely to be present, with Geoscience Australia's LIDAR imagery showing no significant holes or outcrops.

## 4 Survey Methodology

### 4.1 Desktop assessment

A desktop assessment of the proposed clearing areas was undertaken prior to the field survey. The desktop assessment consisted of a review of existing contextual data, reports or surveys undertaken in the vicinity of the proposed clearing areas. Past surveys conducted on Christmas Island include:

- A flora survey carried out by Sinclair Knight Merz and a fauna survey conducted by Bamford Consulting Ecologists (Sinclair Knight Merz, 1999) for the APSC project.
- Targeted Block 2 flora surveys undertaken by CIP environmental staff.
- Christmas Island Wide Survey (IWS) data conducted by Parks Australia (Parks) every 2 years.
- Holmes & Holmes 2002 report; Conservation Status of the Flora of Christmas Island, Indian Ocean.

- A range of studies undertaken from 2002-2005 for the EIS submission, including Reddell and Zimmermann's (2003) *Terrestrial Flora of the Proposed Phosphate Mine Leases on Christmas Island and an Assessment of Feasible Rehabilitation Options following Mining* which included Mining Lease MCI 70/10.
- A targeted fauna and flora survey undertaken by Range to Reef Environmental following submission of the South Point Referral in 2013 to provide additional information for the assessment process.
- A flora survey undertaken for CPS 6323/1 in 2014 by Range to Reef Environmental.
- Previous flora surveys of proposed clearing areas undertaken by Mark Bennett and prepared by CIP environmental staff.

#### 4.2 Field Survey

The field survey was undertaken from 18-21 May 2015 by Rachael A. Pratt, a botanist (B. Sci. Environmental Biology) with +15 years' experience, including previous survey experience from Christmas Island.

The survey was undertaken to confirm the Geoscience Australia (2014) vegetation mapping, describe vegetation condition along the proposed drill lines and to determine whether any conservation significant flora identified by the desktop study occurred or were likely to occur along the proposed drill lines.




The proposed drill lines were entered into ArcPad on a handheld Trimble Yuma. Each of the proposed drill lines was walked as closely as possible to identify and record any conservation significant flora species that might be present. Potential conservation significant flora were photographed and geographic coordinates were noted.

Vegetation geographic boundaries from Geoscience Australia (2014) were entered into the GPS as waypoints VB01 through VB23 along the proposed drill lines prior to the field survey. At these boundaries, the survey botanist made observations to confirm the transition between regrowth vegetation and Closed Canopy Evergreen Forest.




Common species that were well known to the survey botanist were identified in the field, while specimens of all other species were collected or photographed and identified on Christmas Island, using *Flora of Australia Volume 50 Oceanic Islands 2* (Du Puy, 1993) and *Native Plants of Christmas Island* (Claussen, 2005).

Vegetation condition assessment was based on the condition rating scale developed by Keighery (1994) and described in *Bush Forever* (Government of Western Australia, 2000) but adapted for use in the rainforest. The adapted scale examines regrowth development, retention of structural features present in undisturbed rainforest, weediness and landform disturbance. The vegetation condition rating scale is provided in Table 3.

Table 3. Vegetation condition rating scale

Condition Rating	Keighery (1994)	Adapted scale
P Pristine	Pristine or nearly so, no obvious signs of disturbance.	Mature, undisturbed rainforest or very advanced secondary regrowth. Disturbance is limited to cyclone damage occurring in February 2014. Climax species dominate and full structural complexity is present with epiphytic orchids and ferns, terrestrial orchids and ferns, § <i>Pandanus</i> , palms, buttressing and woody lianes. 
Ex Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	Little to no weed species and a largely intact landform with few signs of disturbance. The vegetation structure is beginning to develop the full complexity and diversity expected in rainforest, with climax species present and a range of features included such as buttressing, palms, ferns, epiphytes and orchids, but the canopy is likely to be more open than in undisturbed rainforest. 
VG Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.	Low diversity vegetation with few signs of disturbance or moderately diverse vegetation on a disturbed landform, a canopy dominated by pioneer species, though recruitment of climax species may be evident, an open canopy or poor structural complexity. Few weeds present or weeds are limited to less aggressive species. 

Continued over page...

Condition Rating	Keighery (1994)	Adapted scale
G Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.	Multiple signs of disturbance or with low diversity and no structural complexity. Typically displays little to no recruitment of climax tree species. Numerous weeds present or a dense understory dominated by one or two native fern species. 
D Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Vegetation at very early successional stages with a canopy of one to two species and an understory dominated by ferns or weeds, typically adjacent to completely degraded land. May have the potential to develop into better quality vegetation as the canopy develops if weeds are managed. 
CD Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often referred to as parkland cleared with the flora composing weed or crop species with isolated native trees or shrubs.	The structures of primary rainforest are no longer present and native species are limited to only a few species, for example, weed dominated shrubland with sparse emergent <i>Macaranga</i> or a near monoculture <i>Nephrolepis biserrata</i> fernland. The landscape may be highly disturbed, often with significantly reduced soil and pinnacles exposed. Predominantly lacking a native canopy and with little to no potential to develop one due to dense groundcover or shallow soil. 

#### 4.2.1 Botanical Survey Limitations

Possible survey limitations identified in the EPA Guidance for Assessment of Environmental Factors: *Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, No. 51* (EPA, 2004) have been addressed in Table 4.

Table 4. Statement of botanical survey limitations

Potential Limitation	Constraint (Yes/No); Significant, Moderate or No Constraint	Comment
Competency/experience of the consultant undertaking the survey	No constraint	The lead survey botanist has over 15 years' experience, with recent experience in the wet tropics.
Scope	No constraint	The scope of the flora and vegetation survey was met and fully adhered to during the site visit and the reporting component of the assessment.
Sources of information (historical/recent/new or anecdotal)	No constraint	Christmas Island has been the subject of numerous flora and vegetation surveys and has a dedicated volume of <i>Flora of Australia</i> (Volume 50).
Proportion of task achieved and further work that may need to be undertaken	No constraint	The three threatened fern species identified by the EPBC Act database searches would have been identifiable during the survey period, if present.
Timing/weather/season/cycle	No constraint	The survey was undertaken in late May after above average March rainfall. The weather was fine with occasional rain and mild in temperature during the site visit.
Disturbances which affected results of the survey	No constraint	The proposed clearing areas have previously been cleared for past exploration and contain regrowth vegetation.
Intensity of survey	No constraint	The intensity of the survey was adequate to meet the requirements of the scope of works and to assess the flora and vegetation values against the ten clearing principles within the <i>Environmental Protection Act 1986</i> .
Completeness	Yes; Moderate	Vegetation was mapped by Reddell and Zimmerman (2003) and Geoscience Australia (2014). For the purposes of this assessment, a threatened flora survey was completed but due to access problems (see below), there was a low likelihood (perhaps 30%) that threatened flora would be detected if they were present on proposed drill lines.
Resources	No constraint	Adequate resources were allocated to the survey.
Remoteness and/or access problems	No constraint	The proposed clearing areas are located on Christmas Island in dense tropical regrowth vegetation. The sites were easily accessible via existing tracks or roads but the density of vegetation prevented the survey botanist from walking directly along the proposed drill lines. The proposed clearing areas contained dense vegetation, fallen trees and it was difficult to get a satellite signal on the GPS beneath the canopy. Historic exploration lines were not readily discernible so it was not possible to walk the exact route of the proposed drill line. Another entire community of vegetation was present in the canopy that was easy to miss. This included a number of common fern species, orchids and <i>Hoya aldrichii</i> .
Availability of contextual information for the Project	No constraint	Contextual information for the site is readily available, and was utilised where necessary during the preparation of this report.

## 5 Results

Coordinates from the Trimble Yuma were recorded in a notebook to map photograph locations in the field. When these were mapped in ArcGIS, it became apparent that the Yuma had been providing very inaccurate coordinates, probably due to canopy cover, which explained the difficulty with navigating the drill lines in the field.

The historic drill lines were not recognisable, though the two proposed exploration lines (lines 3 and 6) along what was an old road were more easily identifiable due to a change in landform and the presence of weeds and increased numbers of terrestrial ferns. Regrowth vegetation had infilled the previous clearing along drill lines (lines 1, 2, 4, 5 and 7).

Vegetation mapping by Geoscience Australia (2014) was confirmed to be accurate to within a few metres, using waypoints uploaded to the Garmin GPS Map 62S, with transition from regrowth (containing dense understorey and few mature trees) to Primary Rainforest (mature forest with full structural complexity) being readily apparent. Vegetation in Primary Rainforest areas was in Excellent to Pristine condition. Vegetation in areas mapped as regrowth by Geoscience Australia was typically in Very Good to Excellent condition. Areas immediately adjacent to roads and tracks contained more weed species and were in Degraded condition.

No reptiles, mammals or seabirds were seen during the field survey. Five fauna species of conservation significance, including one listed threatened species, were identified in the survey area:

- Christmas Island imperial pigeon
- Christmas Island thrush (Listed as *Endangered* under the EPBC Act)
- Christmas Island white-eye
- Robber crab
- Red crab

Many parts of the survey area had few red crabs present and litter cover of 70-100%, indicative of yellow crazy ant presence.

No Threatened flora species were identified during the field survey. Seedlings of *Dendrocnide peltata*, identified by Holmes and Holmes (2002) as potentially conservation significant were found scattered through the survey area.









Figure 16. Tall rainforest (left) is difficult to comprehensively survey from the ground. An entire community is present in the canopy (up to 50 m above) that can be overlooked in ground surveys.



Figure 17. The ferns *Davallia solida*, *Asplenium nidus* and *Pyrrosia lanceolata* were all visible through binoculars in the top of the tree above (right) but other epiphytes such as orchids or *Hoya* may be present and less obvious.

## 5.1 Photographs

	<p><b>Photo 40, Line 1</b></p> <p>Taken just west of VB14 near Line 3. Regrowth vegetation with young trees and <i>Schefflera elliptica</i> vines. Few red crabs and 80-100% litter cover.</p> <p>Condition: Excellent</p>
	<p><b>Photo 44, Line 1</b></p> <p>Taken at the north-western end of Line 1. Closed Canopy Evergreen Forest. Few red crabs were present and there was 100% litter cover, possibly indicative of the presence of yellow crazy ants.</p> <p>Condition: Excellent-Pristine.</p>
	<p><b>Photo 55, Line 2</b></p> <p>Taken at the north-western end of Line 2. Tall Closed Canopy Evergreen Forest with limestone outcropping, medium densities of red crabs and two robber crabs. Litter cover was approximately 70%.</p> <p>Condition: Pristine</p>
	<p><b>Photo 59, Line 2</b></p> <p>Regrowth vegetation in the south-eastern section of Line 2. Lots of Christmas Island thrush and Christmas Island white-eye were seen at this location. Few red crabs and 90% litter cover.</p> <p>Condition: Excellent</p>



**Photo 65, Line 3**

Regrowth vegetation with young trees, saplings, *Schefflera elliptica* vines and lots of ferns (*Nephrolepis biserrata* and *Microsorium scolopendria*). No red crabs.

Condition: Good



**Photo 69, Line 3**

Mixed weeds and pioneer species. Lots of weeds, including *\*Leucaena leucocephala* and *\*Clausena excavata*. No rainforest structural features.

Condition: Degraded-Completely Degraded



**Photo 79, Line 4**

Taken at the edge of Tall Closed Canopy Evergreen Forest north-west of VB18. Few red crabs and litter cover near 100%.

Condition: Pristine



**Photo 81, Line 4**

Taken in Closed Canopy Evergreen Forest between VB09 and VB10. Christmas Island thrush was present. Lots of seedlings, few red crabs and litter cover at approximately 80%.

Condition: Excellent-Pristine



**Photo 96, Line 5**

Taken near the south-eastern end of Line 5. Regrowth forest with very high densities of *Pandanus elatus* and *Maclura cochinchinensis*. It wasn't possible to follow the proposed drill line in this location.

Condition: Very Good-Excellent



**Photo 99, Line 5**

Taken near the south-eastern end of Line 5. Regrowth forest with very high densities of *Pandanus elatus* and *Maclura cochinchinensis*. It wasn't possible to follow the proposed drill line in this location.

Condition: Very Good-Excellent



**Photo 107, Line 5**

Taken roughly midway along Line 5. Closed Canopy Evergreen Forest. Litter cover was at approximately 50%. Lots of ants were seen on the line. Christmas Island thrush and Christmas Island imperial pigeon were seen. Red crabs were at medium to low densities.

Condition: Excellent-Pristine



**Photo 118, Line 6**

Taken near VB06 on Line 6. Regrowth vegetation with young trees, ferns and *Schefflera elliptica*. Few to no red crabs.

Condition: Very Good



**Photo 120, Line 6**

Taken near VB06 on Line 6.  
Regrowth vegetation with young trees, ferns and *Schefflera elliptica*. Few to no red crabs.

Condition: Very Good



**Photo 112, Line 7**

Taken near the north-western end of Line 7.  
Closed Canopy Evergreen Forest. 80-90% litter cover with few red crabs. Christmas Island thrush and Christmas Island imperial pigeon were present.

Condition: Pristine



**Photo 113, Line 7**

Taken at VB19, facing south-east.  
Regrowth vegetation with no mature trees and dense *Pandanus elatus* on limestone rubble/outcropping. Few to no red crabs.

Condition: Very Good-Excellent

## 6 Discussion and Environmental Impact

### 6.1 EPBC Act Listed Flora

No EPBC Act Threatened flora species were found during the field survey. In many locations, the survey had a low likelihood of encountering threatened flora species, if any were present, due to the difficulty of navigating the proposed drill lines in the rainforest vegetation. This particularly applied to regrowth vegetation along Lines 5 and 7 which were so densely overgrown with *Pandanus elatus* and *Maclura cochinchinensis* (refer to photos 96 and 99) that no straight line could be taken through the forest. In other locations, lack of adequate satellite data and the need to go around clumps of vegetation also made traversing the proposed drill lines difficult.

It is unlikely that Threatened flora were present within the proposed drill lines, with the vegetation and landform only providing suitable habitat for *Tectaria devexa* var. *minor*. *Tectaria devexa* var. *minor* has previously been found in ten locations on the plateau. The nearest population was found approximately 2.5 km south of the proposed clearing area. Where *Tectaria devexa* var. *minor* has been found previously, it has been found growing in a colony, which increases the likelihood that it would be found. Given the presence of several colonies of *Tectaria devexa* var. *minor* in National Park, it is unlikely that the proposed exploration would have a significant impact on the species if present.

### 6.2 Other Conservation Significant Flora



Figure 18. *Dendrocnide peltata* (stinging tree) seedling.

*Dendrocnide peltata* (stinging tree) seedlings were found scattered through the survey area. The seedlings were most likely to be var. *peltata*, which grows on the plateau, with var. *murrayana* being found in marginal rainforest below 150 m a.s.l. (Holmes and Holmes, 2002).

Though Holmes and Holmes (2002) identified *Dendrocnide peltata* var. *murrayana* as having conservation significance, field observations indicate that this species may be uncommon on the island due to low light conditions, as *Dendrocnide peltata* seedlings have appeared in large numbers in canopy gaps since the 2012 cyclone. This corresponds with Holmes and Holmes (2002)

observation that “it is likely to respond well to disturbance of the canopy, as recruitment within the genus *Dendrocnide* is clearly favoured by increase in light intensity at ground level.”

The presence of the species in the area may present a health and safety risk during exploration and workers should be educated about the risks of touching any part of the plant which can inflict severe, painful stings.

No other potentially conservation significant flora were identified during the field survey.

### 6.3 Vegetation

Vegetation along the proposed drill lines consisted of regrowth and Closed Canopy Evergreen Forest (Geoscience Australia, 2014). The undisturbed forest surrounding the proposed drill lines was unremarkable, with no features that stood out from other plateau vegetation.

The condition of areas mapped as Closed Canopy Evergreen Forest along the proposed drill lines was Excellent to Pristine, despite historic exploration clearing. Much of this may be attributable to the ease with which large trees can be bypassed, resulting in minimal disturbance during exploration clearing.

Regrowth vegetation along the proposed drill lines was generally in Very Good to Excellent condition with few weeds and few landform disturbances. The vegetation had substantially reduced rainforest structural features such as epiphytic orchids and ferns, terrestrial orchids, buttressing and woody lianes. Trees present were young and climax species such as *Hernandia ovigera* were generally absent.

Lines 3 and 6 were more disturbed, with a built up road area altering the landform. Vegetation along these lines was all mapped as regrowth and numerous weeds were present. Vegetation condition ranged from Completely Degraded areas on Line 3 to Very Good condition. Line 6 was in generally in Good to Very Good condition.

There is 6536 hectares of Closed Canopy Evergreen Forest remaining on Christmas Island. Of this, 5124 hectares (74%) is protected within National Park (Geoscience Australia, 2014). The proposal would impact 0.44 hectares of Closed Canopy Evergreen Forest (<0.01% of the remaining Closed Canopy Evergreen Forest). Mining Lease MCI 70/10 contains 28 hectares of Closed Canopy Evergreen Forest (0.43% of the remaining Closed Canopy Evergreen Forest).

The National Objectives and Targets for Biodiversity Conservation 2001-2005 recognises that a retention of 30% or more of the pre-clearing extent of each ecological community is necessary if Australia's biological diversity is to be protected (ANZECC, 2000). It is recognised that biodiversity conservation presents greater challenges in an island environment, which is particularly susceptible to biodiversity losses. Approximately 75% of Christmas Island has never been cleared and 83% of this (63% of total island area) is protected within the Christmas Island National Park (IUCN reserve category II) (Geoscience Australia, 2014; Environment Australia, 2014). Based on the National Objectives and Targets for Biodiversity Conservation 2001-2005, the vegetation complex is adequately reserved (i.e. greater than 30% of pre-clearing extent) within the Shire of Christmas Island and at a regional, State and National level.

#### 6.4 Application of the Ten Clearing Principles

Ten clearing principles have been developed under Section 5 of the *Environmental Protection Act 1986* for the purposes of determining the impact of clearing. These are taken into account when a decision to grant or refuse a clearing permit is required. An assessment of the potential impacts of clearing, against the ten clearing principles, is outlined in Table 5 below.

Table 5. Application of the Ten Clearing Principles

Principle No.	Native Vegetation Should Not be Cleared if ...	Is the Proposed Project at Variance?	Comment
(a)	...it comprises a high level of biological diversity.	Proposal is <b>not likely to be at variance</b> to this Principle.	Christmas Island is home to approximately 420 species of vascular plants, including 177 introduced species and 242 species thought to be indigenous to the island. Approximately eighteen species are known to be endemic to Christmas Island, with the other flora being more widely distributed through the Indo-Malayan and Malaysian regions, or throughout the tropical Indo-Pacific. No Priority Flora species are listed for Christmas Island. Areas of the island which are previously uncleared and retain high biodiversity have been reserved as National Park, including the island's two Ramsar wetlands. Areas which have been previously cleared have been allocated to the Shire of Christmas Island for future development, or to Mining Lease for future mining. All areas proposed for clearing have been previously cleared, though some of these have regrowth vegetation that is up to 30 years old. Condition of regrowth varies, with some areas being very weedy. Given that all areas proposed for clearing have been previously cleared and that the clearing comprises only 1.2 ha of a vegetation type that is well represented on the island, the proposal is not likely to be at variance to this principle.
(b)	...it comprises the whole or part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	Proposal is <b>not likely to be at variance</b> to this Principle.	Christmas Island provides necessary habitat for several fauna indigenous to the island including fourteen native bird species and nine species of seabird which use the island for breeding. Three seabird taxa and nine land bird taxa are endemic to the island. A further 104 migratory or vagrant bird species have been recorded on the island. Six of the island's endemic birds are listed as threatened under the EPBC Act 1999. Five endemic native mammals have been recorded on Christmas Island with only one, the Christmas Island flying-fox, now known to remain. Christmas Island has six species of native terrestrial reptiles, five of them endemic. Mammal and reptile species indigenous to the island have undergone a catastrophic decline since human settlement, believed to be attributed to invasive fauna such as yellow crazy ant, giant centipedes, cats and rodents. As a consequence, it is considered unlikely that any mammal or reptile species of conservation significance rely upon habitat in areas proposed to be cleared. In addition clearing will be minimal and recovery rapid along the exploration lines. Crustaceans are the most conspicuous invertebrate fauna of Christmas Island, with the island supporting over 20 terrestrial and intertidal crab species of which 14 are regarded as true land crabs, depending on the ocean only for their larval development. Three land-crab species have been identified as conservation significant.



			<p>the Red Crab, Blue Crab and Robber Crab. Blue Crabs have a restricted distribution and do not occur within the areas proposed for clearing. Red crabs are common throughout the island but are a keystone species in the island's ecology. Robber crabs have a wide distribution across many Indian and Pacific oceanic islands but in most of their range they are now scarce due to human's hunting them for food. Although abundant on Christmas Island their exact conservation status is unknown. Few robber crabs were present in proposed clearing areas.</p> <p>Five conservation significant fauna species were observed in the proposed clearing areas. These were the Christmas Island thrush, Christmas Island white-eye, Christmas Island imperial pigeon, red crab and robber crab. All of these species are habitat generalists and can be found in many of the island's twelve known terrestrial fauna habitats, most of which are protected in the Christmas Island National Park. Only one fauna habitat was confirmed to occur within the proposed exploration lines.</p> <p>The proposed clearing is of previously cleared vegetation and is not near known Abbott's Booby nest sites. For these reasons, it is considered that the proposal is not likely to be at variance to this principle.</p>
(c)	...it includes, or is necessary for the continued existence, or rare flora.	<p>Proposal is not likely to be at variance to this Principle.</p>	<p>Three Christmas Island flora species are listed as Threatened under the EPBC Act. These are <i>Asplenium listeri</i> (Christmas Island Spleenwort), which is listed as Critically Endangered, <i>Tectaria devexa</i> var. <i>minor</i>, which is listed as Endangered and <i>Pneumatopteris truncata</i> which is listed as Critically Endangered.</p> <p>The Christmas Island Spleenwort occurs in limestone rock crevices in dry, exposed areas on Christmas Island and hence is not associated with proposed clearing sites.</p> <p><i>Tectaria devexa</i> grows colonially, mainly on the plateau, in primary rainforest (tall and largely undisturbed), above 80 metres elevation; both in deeper soils and as a lithophyte (on mossy pinnacles at the base of a slope, a wet site). Ten populations of <i>Tectaria devexa</i> have been identified at Christmas Island, with the majority of these occurring in the National Park. No known populations of <i>Tectaria devexa</i> have been identified at proposed clearing locations, though additional management measures may be proposed to mitigate against the possibility of <i>Tectaria devexa</i> being identified during the clearing process.</p> <p><i>Pneumatopteris truncata</i> is known from two sites at Christmas Island. Neither location is within the proposed clearing areas. <i>Pneumatopteris truncata</i> grows in permanently moist sites in semi-deciduous closed forest. The survey did not find any of these species and there are no known populations close to the proposed clearing site. For these reasons, it is considered that the proposal is not likely to be at variance to this principle.</p>
(d)	...it comprises the whole or a part of, or is necessary for the maintenance of, a threatened ecological community.	<p>Proposal is not at variance to this Principle.</p>	<p>There are no listed Threatened Ecological Communities on Christmas Island. Therefore the clearing as proposed is not at variance to this principle.</p>
(e)	...it is significant as a remnant of native vegetation in an area that has been extensively cleared.	<p>Proposal is not at variance to this Principle.</p>	<p>Approximately 75% of Christmas Island has never been cleared and 83% of this (63% of total island area) is protected within National Park (Geoscience Australia, 2014). The proposed clearing occurs on land that has previously been cleared for exploration and consists of regrowth vegetation with native species common on the island. The vegetation under application is not part of the island's original forests and the vegetation for some of the application areas is in a degraded condition and no longer representative of rainforest structural</p>

				values. The vegetation within the application area is not considered to be a significant remnant of vegetation as it is not located in an extensively cleared landscape and therefore is not at variance to this principle.
(f)	...it is growing in, or in association with, an environment associated with a watercourse or wetland.	Proposal is not at variance to this Principle.		The application area is not associated with or adjacent to a watercourse or wetland. Perennial surface water features on Christmas Island are limited to spring fed streams on coastal or sloping areas of the island. All of the area under application is situated on the plateau and not within wetland areas. This proposal is not at variance to this principle.
(g)	...the clearing of the vegetation is likely to cause appreciable land degradation.	Proposal is not at variance to this Principle.		The interior of the island is slightly undulating plateau, from about 160-360 m above sea level. The area under application is situated on the plateau with relatively little relief, and above the terraces. Due to the nature of exploration clearing, no top soil will be removed. The land is proposed to be zoned Urban Development under TPS2 so its land capability will not be impacted by clearing. No wind erosion, water erosion, salinity, eutrophication or waterlogging is expected as a result of the clearing so this proposal is not at variance to this principle.
(h)	...the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	Proposal is not at variance to this Principle.		There are four noteworthy conservation areas at Christmas Island. These are the Christmas Island National Park, the Ramsar wetlands Hosnie's Springs and The Dales, and the Commonwealth Heritage Site "Christmas Island Natural Areas". The proposed exploration is within the "Christmas Island Natural Areas," but is not near other conservation areas and it should be noted that the lands are zoned for future rural and urban uses. Undisturbed Christmas Island rainforest vegetation is naturally resistant to weed invasion (Green et al. 2004) and the proposal is for low-impact exploration drilling in a 3 m corridor, therefore this proposal is not likely to be at variance to this principle.
(i)	...the clearing of the vegetation is likely to cause deterioration on the quality of surface or underground water.	Proposal is not at variance to this Principle.		Due to the high natural rate of infiltration at Christmas Island, erosion and sedimentation is generally localised to compacted areas such as roads and stockpiles (Puhlovich et al., 2003). There is no potential for deterioration of underground water as a consequence of clearing. Due to the location of the application area, it is unlikely that the clearing of native vegetation for exploration will cause deterioration in the quality of surface water or groundwater within the local area. Therefore this proposal is not at variance to this principle.
(j)	...the clearing of the vegetation is likely to cause, or exacerbate, incidence or intensity of flooding.	Proposal is not likely to be at variance to this Principle.		Christmas Island's soils and karstic limestone rocks are generally highly permeable so clearing on the island does not cause or exacerbate flooding (Puhlovich et al., 2003). The exploration will be undertaken during the dry season and where necessary, erosion drains will be installed. This will minimise any potential for erosion or flooding. As the clearing as proposed is not likely to cause or exacerbate waterlogging or flooding and as the water features on Christmas Island are not close to the applied area, the clearing as proposed is not likely to be at variance to this principle.

## 6.5 Planning Instruments

### 6.5.1 Indian Ocean Territories Regional Plan

The Indian Ocean Territories (IOT) Regional Plan Summary (Regional Development Australia; 2012) was published in October 2012. Building the capacity of the community and business to transition from a mining based economy to a diverse and broad based economy is a focus of the Regional Plan. The sectors identified for growth are tourism, food production and education and research. The care and management of the natural environment is also critical because if the natural environment is not well managed and protected, it also puts a risk the possibility of establishing a new tourism based economy.

### 6.5.2 Town Planning Scheme

Town Planning Scheme No. 1 received approval in accordance with the requirements of the then *Town Planning and Development Act 1928* (WA) (CI) in June 2001. A review of the current scheme has been undertaken to incorporate a Local Planning Strategy and the Draft Town Planning Scheme No. 2 is currently under assessment by Planning Western Australia.

Under Draft Town Planning Scheme No. 2 (TPS 2), much of the land proposed for clearing is zoned Urban Development (Figure 19) (Shire of Christmas Island, 2012b), with the intention that the land be available for expansion of the townsite following mining. The land in question is located between the townsite and the Christmas Island Recreation Centre and Airport.

## 6.6 Other Relevant Matters

### 6.6.1 Land Use Impacts

The economy of Christmas Island has historically been almost solely dependent on phosphate mining. The historic reliance on a single economic driver has meant that the island's economic outlook lacked flexibility to change (Shire of Christmas Island, 2012a). Diversification of activities on the island increased with the construction of the Immigration Detention Centre, however, recent indications are that the use of the island for this purpose has and will continue to be significantly reduced. The economy is therefore still heavily reliant on phosphate mining.

### 6.6.2 Previous Decisions

1. EPBC Act referral for proposed phosphate mining in South Point, Christmas Island (Ref: 2012/6653)
2. Previous clearing permit decisions:

• CPS2090/1 (CIP)	refused
• CPS2132/2 (CIP)	exp. 11 November 2022
• CPS2373/1 (CIP Exploration Permit)	permit surrendered
• CPS2376/1 (CIP Exploration Permit)	permit surrendered
• CPS2870/1 (CIP)	exp. 2 February 2016
• CPS3290/2 (CIP)	exp. 31 August 2019
• CPS3472/4 (CIP)	exp. 11 January 2020
• CPS4506/1 (CIP)	exp. 16 March 2020
• CPS6124/1 (Parks Australia)	exp. 21 July 2019
• CPS6104/1 (Hidden Garden Sustainable Farms)	exp. 3 January 2017

1. Clearing permits currently under assessment:

• CPS6323/1 (CIP decision)	submitted October 2014 (awaiting decision)
----------------------------	--

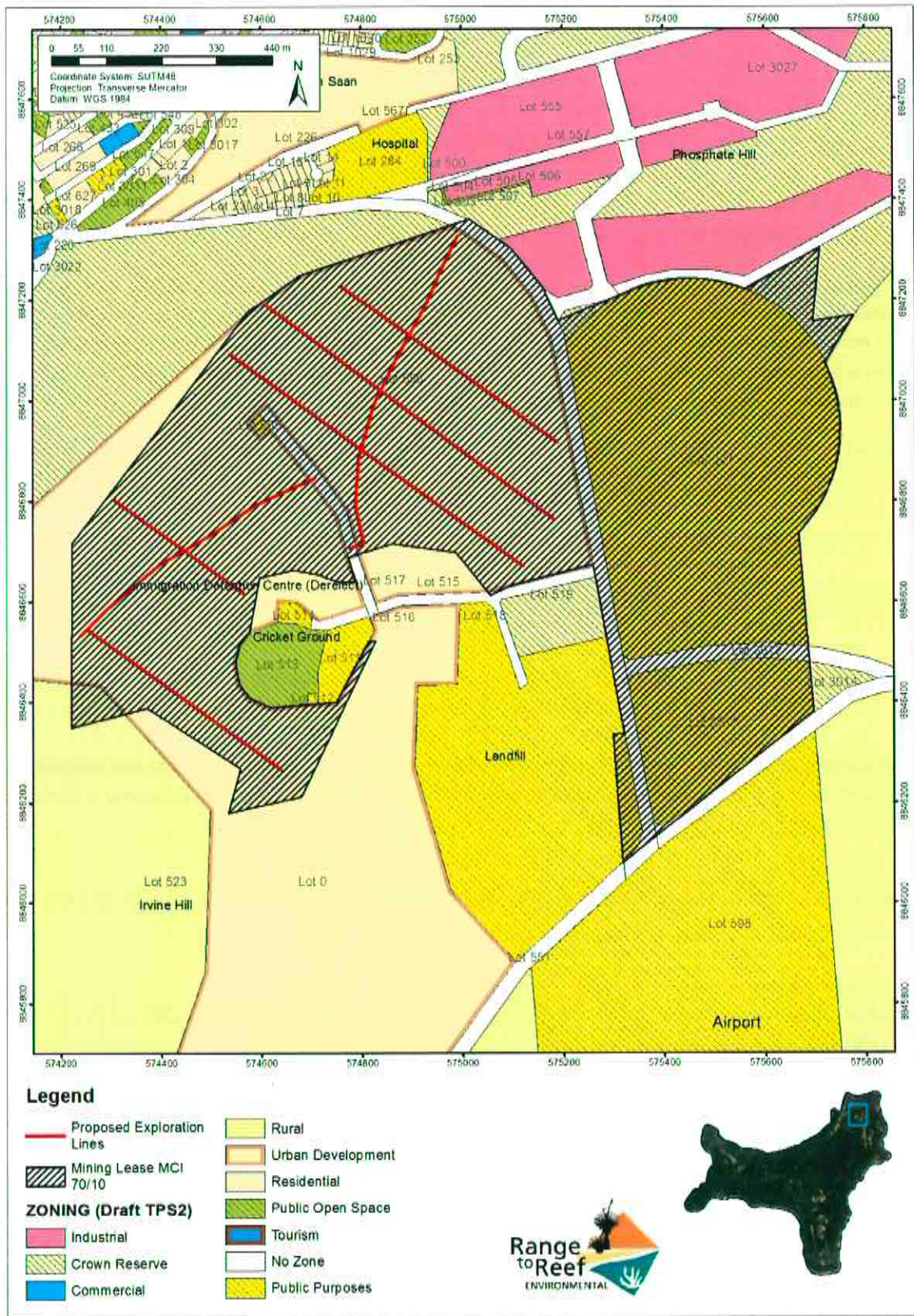


Figure 19. Proposed Town Planning Scheme 2

### 6.6.3 Legislative Requirements

Mining Lease MCI 70/10 was granted to CIP by the Commonwealth in 2008 under the *Mining Act 1978 (WA) (CI)* following approval under the EPBC Act for a small area of MCI 70/10. This approval has now expired.

There are no Aboriginal Sites of significance or Native Title Claims over the area.

The EPBC Act applies on Christmas Island. The Western Australian Environmental Protection Authority does not make decisions on Christmas Island.

The *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply to Christmas Island under the *Applied Laws (Implementation) Ordinance 1992* and are administered by the Department of Environment Regulation.

CIP have a Part V prescribed premises licence issued to them under the EP Act for the control and abatement of pollution from the loading and unloading activities and processing activities (beneficiation of metallic or non-metallic ore).

### 6.6.4 Necessity

Mining on Christmas Island is essential for ongoing employment and support of the island's economy. Mining leases on the island will continue to 2034, however, the number of years of mining remaining is subject to the availability of marketable phosphate product.

Further exploration in Mining Lease MCI 70/10 will allow PRL to determine the value of any resource present within the lease and make decisions about the future of the lease.

### 6.7 Environmental Protection Policies

There are no Environmental Protection Policies developed under Part III of the EP Act that apply to Christmas Island.

## 7 Conclusions and Recommendations

An assessment of the proposed clearing of 1.2 ha of regrowth native vegetation against each of the ten clearing principles outlined in Schedule 5 of the *Environmental Protection Act 1986* has identified that the proposal is unlikely to be at variance to the clearing principles. The proposed clearing is a very small area and will be in regrowth vegetation along previous drill lines, avoiding major trees. The land under consideration is close to the townsite and has been proposed to be a mix of future 'rural' and 'urban' uses.

Clearing is to allow for access only for low impact drilling operations and in the tropical environment vegetation recovery of these tracks is expected to be rapid. The proposal will have a temporary impact on less than 0.01% of the remaining Closed Canopy Evergreen Forest on Christmas Island. Though conservation significant native fauna utilise the area, the proposal will not impact on important habitats and these species noted are widespread across the island. No Threatened flora species have been found within the proposal area.

### 7.1 Recommendations

It is recommend that;

- A permit if approved for areas proposed for clearing in this application subject to the application of conditions relating to management commitments as set out in the CIP Environmental Management Plan 2012.
- Implementation of the approved CIP Weed Management Plan 2015 to this clearing operation.

## 8 References

- ANHSIR, 2015. ANHSIR: ANH Specimen Information Register. IBIS database, Australian National Herbarium, Australian Government, Canberra. URL: <http://www.cpbr.gov.au/cgi-bin/ahsir>.
- ANZECC 2000. Review of the National Strategy for the Conservation of Australia's Biological Diversity. Australian and New Zealand Environment and Conservation Council, Environment Australia, Canberra, Australian Capital Territory.
- Bureau of Meteorology. 2015. Climatic averages for Australian Sites, Publicly available data prepared by the Bureau of Meteorology, Commonwealth of Australia, URL: [http://www.bom.gov.au/climate/averages/tables/ca\\_wa\\_names.shtml](http://www.bom.gov.au/climate/averages/tables/ca_wa_names.shtml).
- Butz, M. 2004. National Recovery Plan for *Tectaria devexa*. Department of the Environment and Heritage, Canberra, Australia.
- Claussen, J. 2005. Native Plants of Christmas Island. Flora of Australia Supplementary Series Number 22. Department of the Environment and Heritage, Canberra.
- Commonwealth of Australia. 2013. Mining Lease No. MCI 70/1. Signed by the Honorable Catherine King MP, Minister for Regional Services, Local Communities and Territories on Behalf of the Commonwealth of Australia, 27 June 2013.
- Department of Environment and Conservation. 2009. A guide to the assessment of applications to clear native vegetation under Part V of the Environmental Protection Act 1986. Department of Environment and Conservation, Western Australia.
- Director of National Parks. 2014. DRAFT Christmas Island Biodiversity Conservation Plan. Department of the Environment, Canberra.
- Du Puy, D.J. 1993a. Christmas Island. In: *Flora of Australia* 50:1-30. Australian Government Publishing Service, Canberra.
- Du Puy, D.J. 1993b. Asteraceae. In: *Flora of Australia* 50:405-427. Australian Government Publishing Service, Canberra.
- Environment Australia. 2002. *Christmas Island National Park Management Plan*. Director of National Parks, Canberra.
- Environment Australia. 2014. *Christmas Island National Park Management Plan 2014-2024*. Director of National Parks, Canberra.
- EPA. 2004. Guidance for the Assessment of Terrestrial Factors: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia, Guidance Statement No. 51, June 2004. Environmental Protection Authority, Perth, Western Australia.
- EWL Sciences & Tallegalla Consultants Pty Ltd. 2003. Draft environmental impact statement for the proposed Christmas Island phosphate mines (9 sites) (EPBC 2001/487) Main report. Christmas Island Phosphates.
- Falkland, T. 1999. Christmas Island, Indian Ocean: Groundwater Investigations and Monitoring Report. Canberra: ACTEW Corporation Ltd.

- Geoscience Australia. 2014. Christmas Island Vegetation and Clearing Map. Compiled May 2014. Prepared by Geoscience Australia in collaboration with Christmas Island Phosphates and the Commonwealth Department of Environment, Canberra.
- Government of Western Australia. 2000. Bush Forever – Keeping the Bush in the City. Volume 2 – Directory of Bush Forever Sites, Perth, Western Australia.
- Green, P.T., Lake, P.S. and Dowd, D.J. 2004. Resistance of island rainforest to invasion by alien plants: influence of microhabitat and herbivory on seedling performance. *Biological Invasions* 6:1-9.
- Grimes, K. 2001. Karst features of Christmas Island (Indian Ocean). *Helictite* 37(2):41-58.
- Hollingsworth, I.D. 2003. Soils and geomorphology in relation to proposed new mining leases, Christmas Island, Indian Ocean. In Phosphate Resources Ltd 2005. *Draft Environmental Impact Statement for the Proposed Christmas Island Phosphate Mines*. Technical Appendices Vol 1. Phosphate Resources Ltd.
- Holmes, J. & Holmes, G. 2002. *Conservation status of the flora of Christmas Island, Indian Ocean*. Unpublished report to Parks Australia.
- Jongsma, D. 1976. *A review of the geology and geophysics of Christmas Island and the Christmas Rise*. Department of Minerals and Energy, Canberra.
- Keighery, B.J. 1994. Bushland Plant Survey: A Guide to Plant Community Survey for the Community. Wildflower Society of Western Australia (Inc.), Nedlands, Western Australia.
- Mitchell, B.A. 1985. A vegetation survey of Christmas Island. Report to Australian Nature Conservation Agency, Canberra.
- McKenzie, N. L., May, J. E. and McKenna, S. 2002. Bioregional Summary of the 2002 Biodiversity Audit for Western Australia. Department of Conservation and Land Management. Perth.
- Parks Australia 2008. *Conservation status and threats to the flora and fauna of the Christmas Island Region*. Issues Paper prepared by Parks Australia as part of the development of a draft Regional Recovery Plan for Christmas Island, Indian Ocean.
- Puhalovich, A., Jacobsen, N., and Overall, R.A. 2003. Surface water and groundwater hydrology in relation to proposed new mining leases, Christmas Island, Indian Ocean. In Phosphate Resources Ltd 2005. *Draft Environmental Impact Statement for the Proposed Christmas Island Phosphate Mines*. Technical Appendices Vol 1. Phosphate Resources Ltd.
- Reddell, P. & Zimmermann, A. 2003. Terrestrial Flora of the Proposed Phosphate Mine Leases on Christmas Island and an Assessment of Feasible Rehabilitation Options following Mining. In Phosphate Resources Ltd 2005. *Draft Environmental Impact Statement for the Proposed Christmas Island Phosphate Mines*. Technical Appendices Vol 1. Phosphate Resources Ltd.
- SKM. 1999. Christmas Island Satellite Launch Facility: Draft Environmental Impact Study. Sinclair Knight Merz, Brisbane.
- Regional Development Australia. 2012. Indian Ocean Territories Regional Plan 2012-2017. Regional Development Australia Midwest-Gascoyne, Geraldton.
- Shire of Christmas Island. 2012a. Draft Christmas Island Local Planning Strategy. Shire of Christmas Island.
- Shire of Christmas Island. 2012b. Draft Town Planning Scheme No. 2. Shire of Christmas Island.