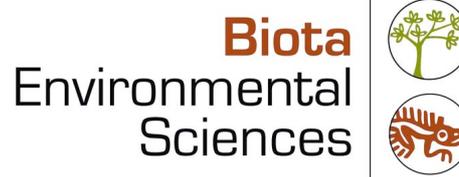




Cape Lambert Port B Development: Flora and Vegetation Survey





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1.0 Summary

1.1 Background

Biota Environmental Sciences was commissioned in 2007 to undertake a flora and vegetation survey of the proposed Cape Lambert Port B Development area, adjacent to the current Cape Lambert port facility operations. This report outlines the outcome of botanical survey work undertaken in October 2007, followed by a seasonal survey undertaken in March 2008.

The two field surveys were undertaken over an area of approximately 602 ha. Approximately 342 ha of vegetation will be cleared within the Cape Lambert Port B Development area. This includes some existing infrastructure and other areas which have been classified as 'Previously Disturbed'. A total area of 42.1 ha is classified as 'Previously Disturbed'.

1.2 Methodology

The first field survey was carried out between 3rd and 11th of October 2007 while the seasonal survey was carried out from 5th to 11th March 2008.

Thirty-two (32) standard 50 m x 50 m floristic survey quadrats were assessed, with 28 of these established during the October 2007 survey, and a further four established during the March 2008 survey. The original 28 survey quadrats from 2007 were assessed on both surveys, whereas the extra four quadrats were only assessed during the March 2008 field survey.

1.3 Vegetation

Nine vegetation types were identified from eight habitat types within the area:

CP Landform – Coastal plains.

Open shrubland dominated by *Acacia stellaticeps* and/or *Acacia bivenosa* over *Scaevola spinescens* and *Rhagodia eremaea* scattered low shrubs over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock grassland.

PDU Landform – Primary dunes.

Tall shrubland of *Acacia coriacea* subsp. *coriacea* over open shrubland of *Crotalaria cunninghamii*, *Santalum lanceolatum*, *Scaevola cunninghamii* and *Rhagodia preissii* subsp. *obovata* over tussock to open tussock grassland of *Spinifex longifolius*, *Whiteochloa airoides* and **Cenchrus ciliaris*.

SDu Landform – Secondary dunes.

Tall shrubland of *Acacia coriacea* subsp. *coriacea* over *Crotalaria cunninghamii*, *Rhagodia eremaea*, *Scaevola sericophylla* and *Scaevola spinescens* low open shrubland over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock to open tussock grassland.

BO Landform – Dune blowouts.

Acacia coriacea subsp. *coriacea* and *Acacia bivenosa* open shrubland or scattered shrubs over *Rhagodia eremaea* low open shrubland or scattered shrubs over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* open tussock grassland.

RH Landform – Rocky hills.

Triodia epactia hummock grassland and **Cenchrus ciliaris* scattered tussock grasses in the area of quadrat CLE05.

Triodia wiseana and/or *Triodia epactia* hummock grassland. Scattered shrubs of *Acacia inaequilatera* were present at quadrat CLE12, and a small amount of **Cenchrus ciliaris* was present at quadrat CLE15.

SD Landform – Low-lying saline drainage areas.

Halosarcia halocnemoides subsp. *tenuis* and *Halosarcia indica* subsp. *leiostachya* low samphire shrubland or open heath with *Frankenia ambita* and *Muellerolimon salicorniaceum* low open shrubland.

SIZ Landform – Saline interzone areas between low-lying saline drainage areas and flat coastal plains.

Acacia ampliceps tall shrubland, with *Sesbania cannabina* tall open herbland over *Sporobolus virginicus* tussock to closed tussock grassland'. Additionally, *Triodia angusta* hummock grassland was present at quadrat CLE22 and *Hemichroa diandra* low open shrubland was present at quadrat CLE28.

DB Landform – Drainage basin.

Acacia ampliceps and *A. bivenosa* tall closed scrub over *A. coriacea* subsp. *coriacea* tall open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* open tussock grassland'.

The mapping of these vegetation types is presented in Appendix 1.

The vegetation was generally considered to be in good to poor condition due to large parts of the survey area being infested with **Cenchrus ciliaris* (Buffel Grass).

None of the vegetation types within the study area are listed as Threatened Ecological Communities (TECs) by the Department of Environment and Conservation (DEC).

In addition to listed TECs, the DEC also maintains a list of Priority Ecological Communities (PECs) for Western Australia, which are considered 'other ecosystems at risk'. None of the vegetation types within the study area are listed PECs from the Chichester subregion.

The overall total area of vegetation that will be cleared for the Cape Lambert Port B Development is approximately 342 ha.

1.4 Flora

A total of 190 taxa of vascular flora from 101 genera belonging to 45 families were recorded from the survey area. This total includes seven taxa of introduced flora/weed species (from seven genera and six families). These introduced species are **Aerva javanica* (Kapok Bush), **Cenchrus ciliaris* (Buffel Grass), **Chloris barbata* (Purpletop Chloris), **Phoenix dactylifera* (Date Palm), **Portulaca oleracea* (Pigweed/Purslane), **Tamarix aphylla* (Athel Tree/Tamarisk) and **Vitex trifolia* var. *subtrisecta* (Three Leaved Chaste Tree).

**Tamarix aphylla* is the only introduced species that is listed as a Declared Plant species under the *Agriculture and Related Resources Protection Act 1976*.

There were no Declared Rare Flora (DRF) or Priority Flora recorded from the Cape Lambert Port B Development study area.

2.0 Introduction

2.1 Project Background and Location of the Study area

The existing Cape Lambert Port Operation is located within the Shire of Roebourne, 10 km north of the town of Wickham, on the coast of Western Australia.

Pilbara Iron Pty Limited currently operates the port facility at Cape Lambert and proposes to expand the existing operations through the development of its Cape Lambert Port B Development. The proposed Cape Lambert Port B Development lies adjacent to the existing Cape Lambert operation and is mostly focussed in the area to the west of the existing railway. The primary study area comprises approximately 602 ha, with approximately 342 ha of this area to be impacted by the Port B Development. The Cape Lambert Port B Development area, with proposed infrastructure layout, is shown in Figure 2.1. Included in the broader study area of 602 ha are areas adjacent to the survey area, such as adjoining beaches, and reference areas (to establish the wider distribution of any rare species).

In order to assess potential flora and vegetation issues associated with the Cape Lambert Port B Development, Biota Environmental Sciences (Biota) was commissioned to conduct flora and vegetation surveys in the development area. This report summarises the findings of the baseline (October 2007) and seasonal (March 2008) surveys, and identifies flora and/or vegetation issues associated with the proposed development.

2.2 Scope and Objectives of the Study

The flora and vegetation surveys were planned and implemented as far as practicable according to the Environmental Protection Authority (EPA) Position Statement No. 3 "Terrestrial Biological Surveys as an Element of Biodiversity Protection" (EPA 2002) and Guidance Statement No. 51 "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia" (EPA 2004).

The scope of the botanical surveys was to:

- describe and map the vegetation types occurring within the study area;
- identify any vegetation types of conservation significance within the study area;
- document the suite of flora species occurring within the study area;
- identify seasonal changes in floristic composition; and
- locate any flora of conservation significance (including Declared Rare Flora (DRF), Priority Flora and other flora of interest) within the study area.

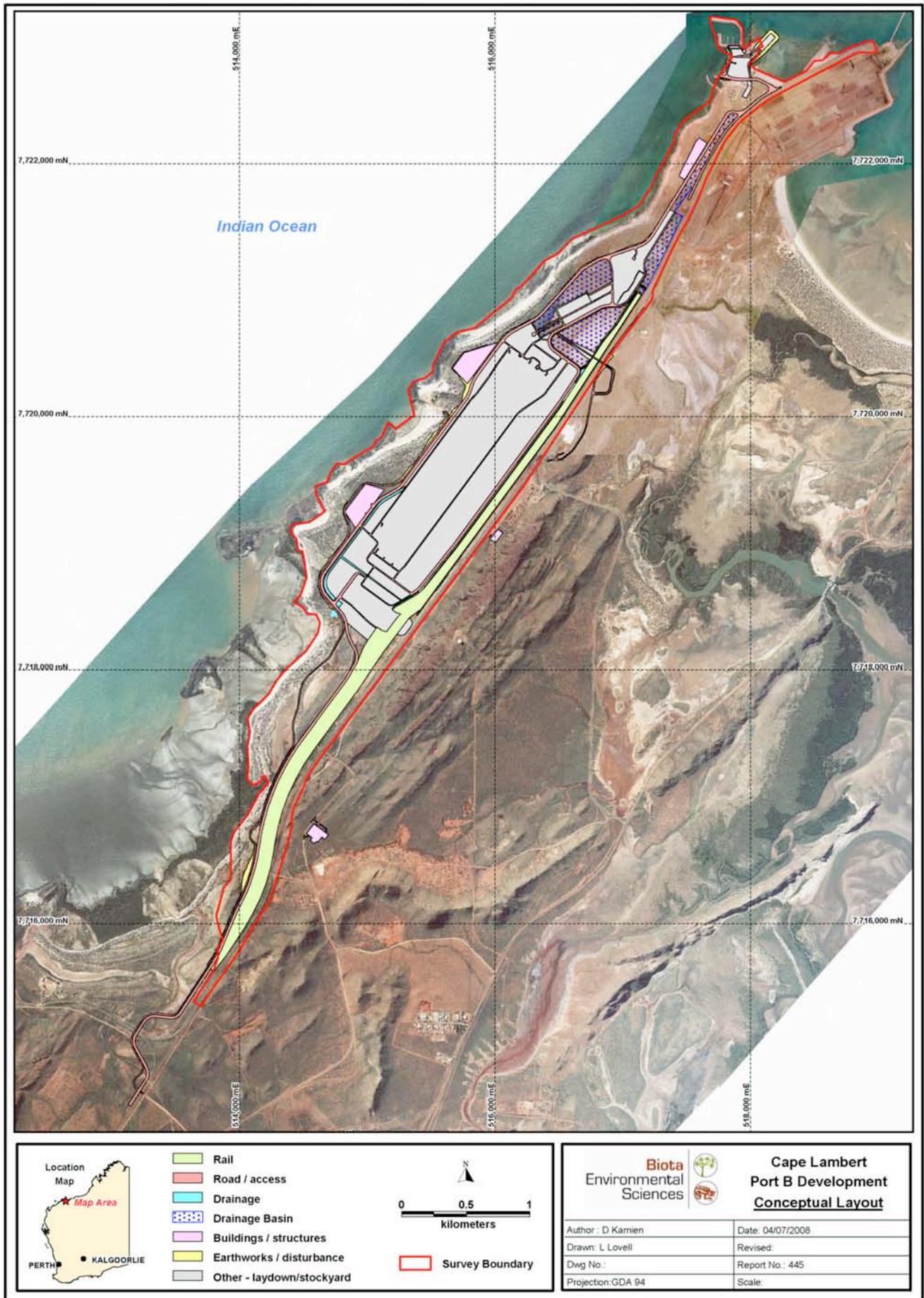


Figure 2.1: Cape Lambert Port B Development Study Area with Conceptual Infrastructure Layout

2.3 Regional Context of the Project Area

2.3.1 IBRA Bioregion

The interim Bioregional Regionalisation of Australia (IBRA) is a classification method applied over the Australian continent by the Department of Environment, Water, Heritage and the Arts. There are 85 bioregions in Australia, with 404 sub-regions. It is recommended that IBRA sub-regions are viewed at a scale of 1:250,000 for rangelands and pastoral regions such as those found in the Pilbara (Environment Australia 2000).

As a whole, the Pilbara bioregion is now recognised as a significant centre of biodiversity within Western Australia. A combination of altitude, geology, climate and geographical location has ensured a high rate of speciation over many millions of years (see van Leeuwen and Bromilow 2002 for more information). In addition, the Pilbara is located in a transitional zone between the Eyrean (Central Desert) and Torresian (tropical) zones, hence the flora of this bioregion often contains elements of both regions. In recognition of this, the Pilbara has been nominated as one of 15 National biodiversity hotspots by the Minister for the Environment, Heritage and the Arts (go to www.environment.gov.au/biodiversity/hotspots/national-hotspots.html#14).

The Pilbara bioregion contains four sub-regions: the Roebourne, Chichester, Fortescue Plains and Hamersley subregions (May and McKenzie 2003).

- Roebourne – Quaternary alluvial plains with a grass savannah of mixed bunch and hummock grasses, and dwarf shrub steppe of *Acacia stellaticeps/translucens* (*A. stellaticeps* in the Pilbara and *A. translucens* in the Kimberley) over *Triodia pungens* (*T. epactia*). Samphire, *Sporobolus* and mangal occur on marine alluvial flats. Arid tropical with summer rain.
- Chichester – Archaean granite and basalt plains supporting shrub steppe characterised by *Acacia pyrifolia* over *Triodia pungens* hummock grasses. Snappy Gum (*Eucalyptus leucophloia*) tree steppes occur on ranges.
- Fortescue Plains – Alluvial plains and river frontages. Salt marsh, Mulga-bunch grass and short grass communities on alluvial plains. River Gum woodlands fringe the drainage lines. This is the northern limit of Mulga (*Acacia aneura*).
- Hamersley – Mountainous area of Proterozoic sedimentary ranges and plateaux with Mulga low woodland over bunch grasses on fine textured soils and Snappy Gum over *Triodia brizoides* on skeletal sandy soils of the ranges.

2.3.2 Pilbara Subregion 1 - Chichester

Kendrick and McKenzie (2001) place the Cape Lambert Port B Development area in the Chichester (PIL 1) biological subregion within the Pilbara bioregion. The PIL1 subregion is 9,044,560 ha in size and is described as:

“The Chichester subregion (PIL 1) comprises the northern section of the Pilbara Craton. Undulating Archaean granite and basalt plains include significant areas of basaltic ranges. Plains support a shrub steppe characterised by *Acacia inaequilatera* over *Triodia wiseana* (formerly *Triodia pungens*) hummock grasslands, while *Eucalyptus leucophloia* tree steppes occur on ranges. The climate is Semi-desert tropical and receives 300mm of rainfall annually. Drainage occurs to the north via numerous rivers (e.g. De Grey, Oakover, Nullagine, Shaw, Yule, Sherlock).”

2.3.3 Geology, Topography and Soils

The Cape Lambert Port B Development study area comprised five major geological types based on the Geological Survey of Western Australia 1:500,000 scale map sheet (Thorne and Trendall 2001). These geological types are:

- **Afr** (Mount Roe Basalt): amygdaloidal basaltic flows and breccia; basaltic volcanistic sandstone; massive, vesicular and glomeroporphyritic basalt; metamorphosed;
- **Qhms**: Coastal, shelly sand in beach deposits and dunes; chiefly marine sand reworked by wind, but includes some reworked alluvium near deltas;
- **Qhm**: Marine mud and silt on supratidal to intertidal flats; includes intertidal deposits with mangroves;
- **Qs**: Eolian sand – red-yellow, wind-blown sand; local ridges;
- **Qc**: Colluvium – sand, silt and gravel in outwash fans; scree and talus; proximal mass-wasting deposits.

There are four main topographical features present in the Cape Lambert Port B Development study area:

- drainage areas; low-lying saline drainages in the coastal plains;
- coastal plains; typically vegetated with scattered shrubs and spinifex, with high infestations of *Cenchrus ciliaris*;
- primary and secondary dune formations, typically vegetated with mixed shrubland and hummock grassland on sand, also with high infestations of *Cenchrus ciliaris*; and
- rocky hills and outcrops; typically vegetated with spinifex hummock grasslands.

The main soil types associated with these topographical features are:

- red-brown or grey-brown clay or skeletal clay on the drainage areas;
- red, alluvial, fine-grained clayey loam on the coastal plains;
- white to pale brown, fine and large-grained sand on the primary dunes;
- brown, finer grained sand on the secondary dunes; and
- silty fine-grained red-brown clay or clay-loam on the rocky hills.

2.3.4 Beard's Vegetation Mapping

Beard (1975) mapped the vegetation of the Pilbara at a broad scale of 1:1,000,000. The Cape Lambert Port B Development study area lies entirely within the Fortescue Botanical District of the Eremaean Botanical Province. The Cape Lambert area is located within the Abydos Plain physiographic unit extending from Cape Preston east to Pardoo Creek, and south to the Chichester Range, including alluvial plains, low stony hills and granite outcrops, comprising largely granitic soils, with alluvial sands on the coastal portion.

Abydos Plain in the Fortescue Botanical District

This part of the Pilbara coast has a semi-desert tropical climate with summer rain, with an annual precipitation of approximately 300 mm. The geology of this area is Quaternary alluvium near the coast, with Archaean granite further inland. The coastal fringe of this plain consists of salt flats, tidal swamps and coastal sand dunes, the main soils being saline loams with shelly sands. Small areas of calcareous earths and shallow loams are associated with soils consisting of clay and lime. The greater part of the plain is on granite, with the granite plain including alluvial plains, pediplains, low stony hills and dissected pediments, with low granite outcrops and tors. The main soils are hard alkaline red soils, with the extensive alluvial plains along the coast being for the most part sandy. The predominant soils of these coastal alluvial plains are red earthy sands with extensive areas of red earths, and hard red

soils along creek lines. In the vicinity of residuals of basic and ultrabasic rocks, which occur mainly in the western section of the Abydos plain, the major soils are deep-cracking clays.

On the seaward fringe of the plain lies a zone of hyper-saline bare mud which may extend to 10 km in width (mostly 2-5 km). This is fringed by a narrow mangrove zone of *Avicennia marina*, or rarely by sandhills, sparsely vegetated, predominantly with *Triodia epactia/pungens* (soft spinifex). Inland of the mangrove zone are samphire communities with a number of characteristic halophytic species present such as *Halosarcia halocnemoides*, *Neobassia astrocarpa*, *Frankenia ambita/pauciflora*, *Hemichroa diandra* and *Sporobolus virginicus*.

Vegetation on the coastal plain is somewhat irregular, owing to rapid (localised) changes in the soil, with several of the vegetation units mapped as mosaics. On the hard alkaline red soils, the vegetation consists of shrub steppe, with *Acacia inaequilatera* and *Hakea lorea* as characteristic large, scattered shrubs over a medium to dense cover of *Triodia epactia/pungens*. Areas of calcrete and coarse textured alluvium along creeks, overlying hard alkaline red soil have *Triodia longiceps* as the dominant species of hard spinifex. Small trees of *Corymbia hamersleyana* may be present on drainage lines. The sandy patches have a higher density of shrub species present, with scattered trees of *Corymbia* ? *aspera* over shrubs (to 2 m tall) of *Acacia inaequilatera*, *A. ancistrocarpa*, *A. sclerosperma* and *A. tetragonophylla* over *Triodia epactia/pungens*. The introduced grass species **Cenchrus ciliaris* (Buffel Grass) is also commonly present in the understorey stratum of red sandy coastal areas which have been previously disturbed.

On the seaward margin of the granite plain, the alluvia are mainly sandy. There are extensive sandplains characterised by dwarf-shrub steppe covered by the hummock grass *Triodia epactia/pungens* and interspersed by numerous low spreading shrubs of *Acacia stellaticeps*. These sandplains are mostly devoid of taller shrubs or trees, but there may sometimes be scattered tall shrubs of *Acacia inaequilatera*, *A. pachycarpa*, *A. colei* var. *colei*, *A. tumida* and *Hakea lorea/chordophylla*. The granite plain is broken by numerous stony rises, low hills, basic dykes, large granite outcrops, and small ranges of hard, resistant Archaean rock. Stony rises and low hills are mainly characterised by the replacement of *Triodia epactia/pungens* with *Triodia wiseana*, *T. longiceps* or *T. angusta*.

Where finer-grained alluvia have been deposited, particularly those derived from the weathering of basic rock, open plains of grass or mixed grass and spinifex are prevalent. Close to the coast, clay plains, which are saline below 60 cm, supporting tussock grasslands occur, dominated by *Eragrostis xerophila* with individuals of *Streptoglossa odora*. Other grass species recorded on the clay plains include *Astrebla pectinata*, *Brachyachne convergens*, *Chrysopogon fallax* and *Eriachne benthamii/flaccida*. There are also patches of *Triodia epactia/pungens* hummock grassland that occur mixed with patches of tussock grass savannah on the clay plains.

Given the broad scale of Beard's mapping, these mapping units show only a broad correspondence with the vegetation types identified by the current study (see Section 4.0).

2.3.5 Land Systems

Land Systems (Rangelands) mapping for the Pilbara bioregion has been prepared by the Western Australian Department of Agriculture (Van Vreeswyk et al. 2004) and covers the study area (shown in Figure 2.2). Land Systems are comprised of repeating patterns of topography, soils, and vegetation (Christian and Stewart 1953) (i.e. a series of "land units" that occur on characteristic physiographic types within the Land System).

A total of 107 Land Systems occur in the Pilbara bioregion. This information was obtained by merging the Land System mapping for the Pilbara (Van Vreeswyk et al. 2004) and intersecting this with the Pilbara bioregion (Environment Australia 2000) in ArcView 3.2. Four of these land systems occur in the Cape Lambert Port B Development area: Littoral, Rocklea, Ruth and Uaroo (see Table 2.1 and Table 2.2). The Littoral land system exists in the northern, central and coastal portion of the study area. The Rocklea land system exists on the central eastern side of the study area and the Ruth land system covers the majority of the study area and exists in the northern and central parts. The Uaroo land system exists in a minor area of the southern tip of the study area.

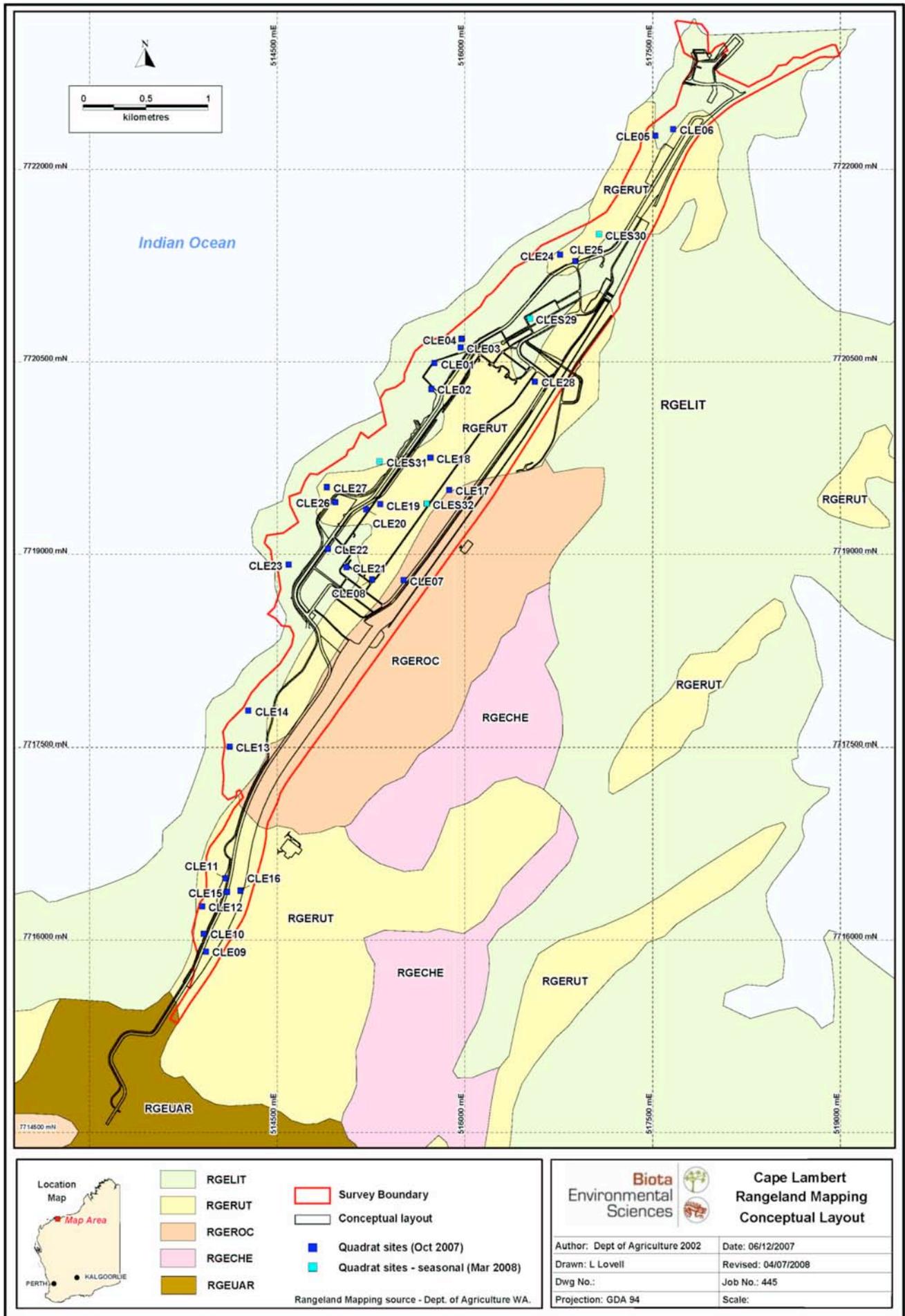


Figure 2.2: Land Systems (Rangelands) of the Cape Lambert Port B Development Area

Table 2.1: Land Systems within the Cape Lambert Port B Development area and the total area of each land system within the Chichester subregion (descriptions from Van Vreeswyk et al. 2004).

| Land System | Extent in Chichester subregion (ha.) | Description |
|-------------|--------------------------------------|--|
| Littoral | 3,304 | Tidal mudflats; mangroves and samphire; little pastoral value. Coastal dunes when cleared of vegetation are highly susceptible to wind erosion. |
| Rocklea | 2,129,000 | Basalt hills, plateaux, lower slopes and minor stony plains supporting hard spinifex (and occasionally soft Spinifex). Very low erosion potential. |
| Ruth | 137,600 | Hills and ridges of volcanic and other rocks supporting hard spinifex (and occasionally soft spinifex) grasslands. Not susceptible to erosion. |
| Uaroo | 490,000 | Broad sandy plains supporting shrubby hard and soft spinifex grasslands. Generally not susceptible to erosion. |

Table 2.2: Distribution of Land Systems within the Cape Lambert Port B Development area and wider Pilbara region (data from Van Vreeswyk et al. 2004).

| Land System | Total Area in the Pilbara Bioregion (Rank†) | General Distribution through the Pilbara Bioregion | Area within Cape Lambert Port B Development Area | |
|--------------|---|---|--|---------------------------------|
| | | | Hectares | % of total in Pilbara bioregion |
| Littoral | 210,733 ha (90 th) | Common in coastal areas throughout the Pilbara. | 230.5 | 0.11% |
| Rocklea | 2,881,200 ha (107 th) | Widespread through both the Hamersley and Chichester subregions, with numerous occurrences. | 86.4 | <0.01% |
| Ruth | 169,300 ha (84 th) | Restricted to the northwest in the Pilbara, uncommon. | 282.6 | 0.17% |
| Uaroo | 987,066 ha (104 th) | Very common in the north and far west of the Pilbara. | 0.46 | <0.01% |
| Total | 4,248,299 ha | | 599.96 ha | |

† Ranking of Land System in terms of area out of the 107 Land Systems in the Pilbara bioregion; ranked from least abundant in terms of area (1) to most abundant (107).

An additional area of approximately three (3) ha is occupied by areas for infrastructure located over ocean, rather than terrestrial areas.

A more detailed description of these land systems is provided below and is based on Van Vreeswyk et al. (2004).

Littoral Land System

1. Beaches (<1% of this land system): Shelly beaches flanked either by mangroves or foredunes.
2. Coastal dunes (3%): Vegetation of dunes is hummock grasslands of *Triodia pungens* or *T. epactia* and scattered shrubs of *Acacia coriacea*, *Scaevola sericophylla*, **Aerva javanica* and *Threlkeldia diffusa*.
3. Limestone ridges (<1%): Grasslands mixed with *Triodia pungens*, **Cenchrus ciliaris* and isolated shrubs.
4. Tidal flats (70%) and samphire flats (10%): Bare mudflats with occasional patches of scattered low shrublands of *Halosarcia halocnemoides* and *H. auriculata* (and/or *H. indica*), and *Sporobolus virginicus*.
5. Mangrove outer margins (5%) and tidal channels (4%): Closed mangrove woodlands of *Avicennia marina*.
6. Alluvial plains (2%): Tussock grasslands of **Cenchrus ciliaris* or mixed perennial grasses such as *Chrysopogon fallax*, *Eragrostis xerophila* and *Sporobolus virginicus*.
7. Sandy plains and islands (5%): Hummock grassland of *Triodia epactia/pungens* with isolated shrubs.

Rocklea Land System

1. Hills, ridges, plateaux and upper slopes (65% of this land system): Typically supporting hummock grasslands of *Triodia wiseana*, and less frequently *T. pungens* with scattered shrubs of *Acacia inaequilatera* and *Senna/Cassia* spp.
2. Lower slopes (15%): Typically supporting vegetation similar to unit 1.
3. Stony plains and interfluves (10%): Typically supporting hummock grasslands of *Triodia wiseana*, and less frequently *T. pungens* with scattered shrubs of *Acacia inaequilatera* and occasionally grassy shrublands with *Acacia*, *Senna/Cassia* and *Eremophila* spp.
4. Gilgai plains (1%): Tussock grasslands with *Astrebla pectinata*, *Eragrostis xerophila* (Roebourne Plains grass) and other perennial grasses.
5. Upper Drainage lines (4%): Supporting hummock grasslands of *Triodia wiseana* or *T. pungens* with scattered *Acacia* shrubs and occasionally *Corymbia hamersleyana* trees.
6. Drainage floors and channels (5%): Scattered shrublands or woodlands of *Acacia* and *Eucalyptus* spp. with numerous low shrubs and hummock or tussock grass understoreys.

Ruth Land System

1. Hills, ridges and upper slopes (75% of this land system): Hummock grasslands of *Triodia wiseana* or *T. pungens* with isolated shrubs such as *Acacia inaequilatera*, *A. pyrifolia* or *A. orthocarpa*.
2. Lower slopes and stony plains (15%): Typically supporting vegetation similar to unit 1.
3. Narrow drainage floors, creek lines and channels (5%): Typically supporting vegetation similar to unit 1.
4. Sand plains (5%): Hummock grasslands of *Triodia* spp. with isolated to scattered *Acacia* shrubs.

Uaroo Land System

1. Low hills (<1% of this land system): Hummock grasslands of *Triodia wiseana* and *Triodia* spp. with isolated to very scattered shrubs.
2. Low rises (3%): Typically supporting vegetation similar to unit 1.
3. Pebbly plains (8%): Hummock grasslands of *Triodia lanigera*, *T. plurinervata*, *T. wiseana* (less frequently with *T. pungens*) with isolated to scattered shrubs such as *Acacia inaequilatera* and *A. ancistrocarpa*.
4. Sandy/loamy plains (82%): Hummock grasslands or shrubby hummock grasslands of *Triodia pungens*, *T. epactia*, *T. schinzii* or *T. lanigera* with scattered shrubs of *Acacia stellaticeps*, *A. inaequilatera*, *A. tumida* and occasionally eucalypts.
5. Calcrete plains (1%): Typically supporting vegetation similar to unit 1.
6. Tracts receiving sheet flow (6%): Typically supporting vegetation similar to unit 1 with scattered tall shrublands or woodlands.

3.0 Methodology

3.1 Botanical Survey Team and Field Survey Timing

The first field survey was carried out between 3rd and 11th of October 2007 by four botanists (Raimond Orifici, Britta Mathews, Hanouska Marmarac and Justin Fairhead from Biota). The second seasonal survey took place between 5th and 11th of March 2008, and was again completed by four botanists (Raimond Orifici, Britta Mathews, Justin Fairhead and Paul Hoffman from Biota).

Figure 3.1 shows rainfall and temperature patterns for the Roebourne area, based on long-term climate data averages for a 99 year period from 1901 to 2000. The initial October 2007 survey took place in the later part of the dry season when little rain had fallen in the six months prior to the field survey (Figure 3.2). Many annual and ephemeral species were absent and many species dry and unrecognisable. Although a seasonal survey was conducted in March 2008, many ephemeral species were still absent, despite significant rainfall in February and March 2008 (see Figure 3.2). These conditions were still considered appropriate for the completion of the field surveys.

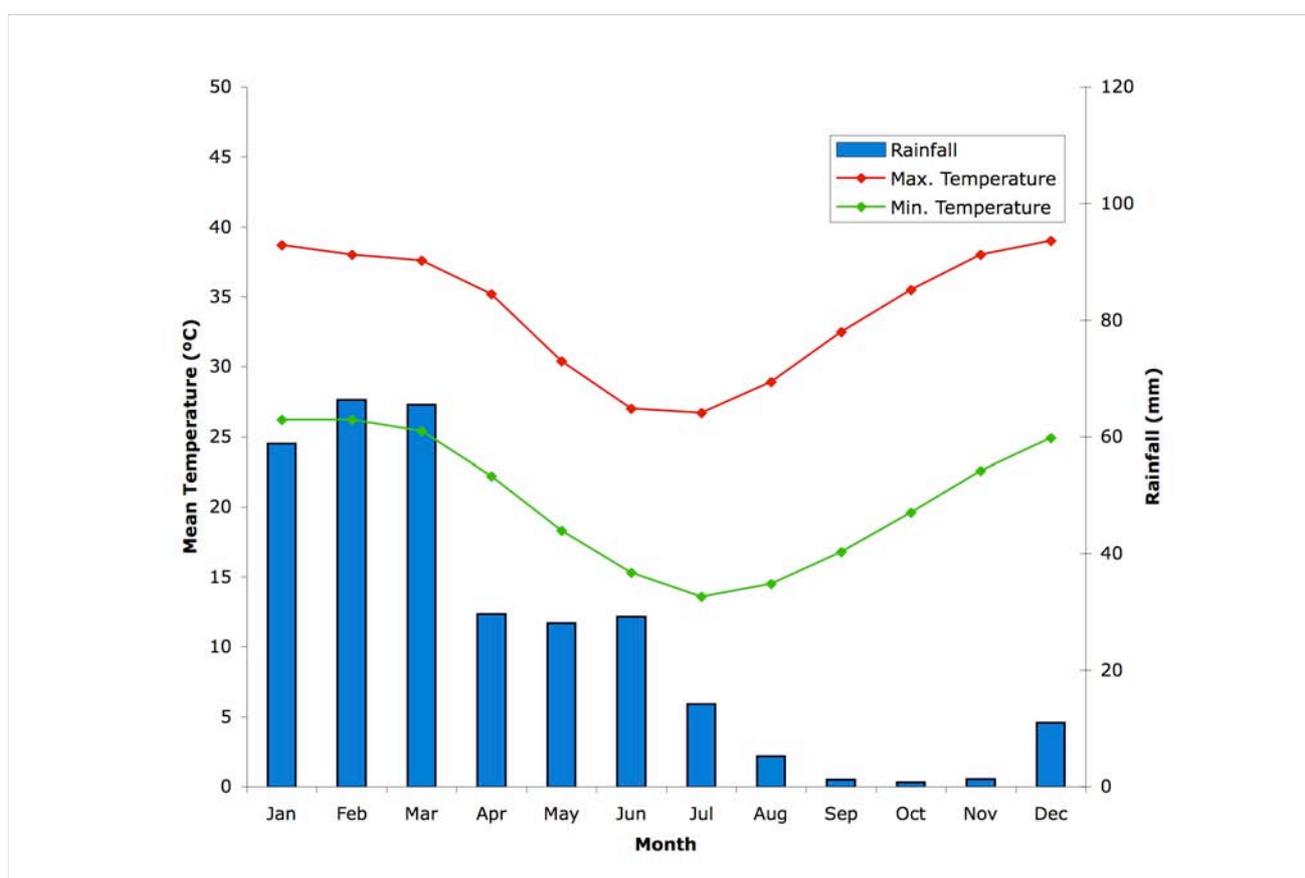


Figure 3.1: Long term average climate data for the Roebourne weather station from 1901 to 2000 (data supplied by Bureau of Meteorology).

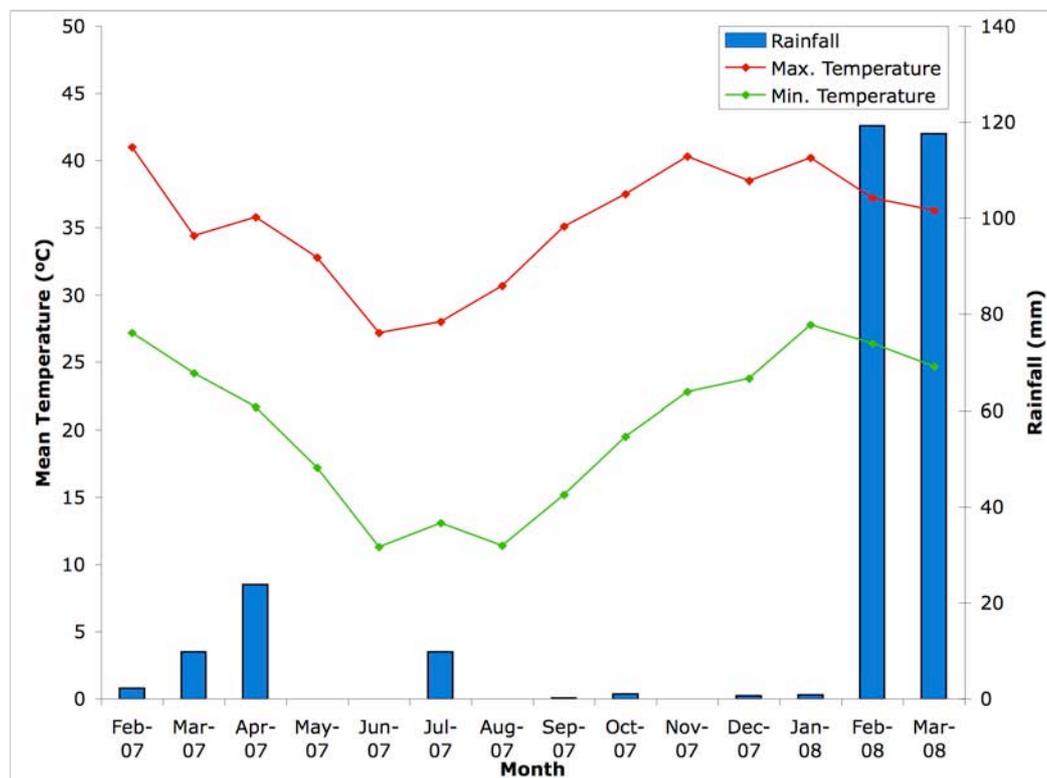


Figure 3.2: Seasonal climate data for the Roebourne area from February 2007 to March 2008 (data supplied by Bureau of Meteorology).

3.2 Vegetation Description and Mapping

In the current study, vegetation descriptions were based on the height and estimated cover of dominant species using Aplin's (1979) modification of the vegetation classification of Specht (1970) to include a hummock grassland category (see Appendix 2). Descriptions were made at each of the 32 floristic survey quadrats (see Section 5.0).

The vegetation descriptions were then grouped using Excel spreadsheets to develop vegetation units that were defined on the basis of a shared suite of perennial species with a similar range of cover values. These have been listed under the main landform/habitat types in which they were found to occur.

To gather spatial information, the quadrat vegetation descriptions were used together with mapping notes gathered in the field to prepare a draft map of vegetation, using rectified 1:20,000 scale colour digital photography as the background.

The vegetation boundaries were subsequently digitised on-screen using MapInfo Professional v7.0. The resulting shapefiles were "tagged" to provide each polygon with the vegetation unit code. Other point source datasets, such as locations of quadrats and weed species, were generated into spatial data using MapInfo. These datasets were subsequently saved as separate MapInfo files.

These datasets, in conjunction with other data supplied from other organisations, were used in the production of the vegetation maps contained in this report. All maps were produced using MapInfo.

3.3 Assessment of Floristic Quadrats

The locations of the 32 detailed flora-recording quadrats were chosen to represent the range of terrestrial vegetation types occurring within the survey area. The quadrats were uniquely numbered from CLE01 to CLE28 in the October 2007 survey, and from CLES29 to CLES32 in the March 2008 survey.

Quadrats were typically 50 m x 50 m, as this size gives a good sample of flora presence in the Pilbara (see Section 5.1.1). It also gives a good indication of the shrub and grass strata determining vegetation structure for most vegetation types in the Pilbara that occur in 'uniform' habitats (e.g. plains and hillslopes, where vegetation stands are typically greater than this quadrat size). Quadrat shape and/or size were adjusted as necessary to fit smaller or oddly shaped habitats (e.g. drainage areas).

Each quadrat was temporarily marked using coloured surveyor's tape at each of the quadrat corners. An optical square and measuring tapes were used to ensure that the quadrat sides were correctly positioned, in order to achieve a total area of 2500 m².

The following parameters were recorded for each quadrat:

1. **Location:** Location coordinates recorded in WGS84 datum (within 1-2 m of GDA94) using a hand-held Global Positioning System (GPS), to an accuracy usually within 5 m. Readings were taken for all four corners of the quadrat;
2. **Vegetation Description:** Broad description based on the height and estimated cover of dominant species after Aplin's (1979) modification of the vegetation classification system of Specht (1970) (see Appendix 2);
3. **Habitat:** Description of topographical features/landform and habitat;
4. **Soil and Rock Type:** Broad description of soil type and its surface, and a simple definition of the rock type present (if visible) in the quadrat;
5. **Disturbance Details and Vegetation Condition:** Evidence of grazing, mining exploration activities, weed invasion, frequent fires etc. Note that fire effects are only considered as a negative impact if they are caused by repeated burning (such as that done for pastoral purposes). Fire is a natural and frequent process in the Pilbara to which the vegetation has adapted, and to class areas as being in poor condition simply because they have been recently burnt is misleading; and
6. **Percentage Foliar Cover:** Cover was estimated visually for each species within the quadrat (thus also generating a complete species list for the quadrat at this particular point in time). Estimates were made to the nearest percent where possible, or a range (eg. 5-10%) was used. The symbol '+' was used where only occasional individuals were present, with a cover of less than 1%.

Colour photographs of the vegetation at each site were taken using a digital camera.

3.4 Specimen Identification, Nomenclature and Data Entry

Common species that were well known to the survey botanists were identified in the field. Voucher specimens of all other species were collected and assigned a unique number to facilitate tracking of data. These were pressed in the field and dried.

These vouchers were then identified by keying out, reference to appropriate publications, use of reference collections and comparison to the collections held at the Western Australian Herbarium. Most specimens were identified by Raimond Orifici, Britta Mathews, and Michi Maier of Biota, with assistance from Malcolm Trudgen of M.E. Trudgen and Associates for some taxa. Additional specialist taxonomists were consulted as required for assistance with difficult taxa, including Malcolm Trudgen for *Sida* and *Triodia* species identification.

Specimens will be lodged with the Western Australian Herbarium for all taxa for which suitable material is available. Nomenclature was checked against the current listing of scientific names recognised by the Western Australian Herbarium and updated as necessary.

The main outdated nomenclature retained was that relating to *Cassia*. This genus is currently recognised as *Senna* (see Randell 1989), however the older *Cassia* classification (Symon 1966) was perceived to be a more realistic level of separation of the taxa (e.g. with taxa such as '*glutinosa*' and '*pruinosa*' recognised at specific rather than subspecific level). A more detailed discussion is contained in Trudgen and Casson (1998), while a comparison of the nomenclature under the two classifications is presented in Appendix 3.

3.5 Limitations of this Study

A number of limitations of the field surveys and subsequent conservation assessments are discussed in the following section. These are factors that must be considered when reviewing and applying the results of this study. Despite these limitations, the field surveys and the subsequent analyses are believed to provide a good representation of the flora and vegetation values of the Cape Lambert Port B Development area.

The main limitations of this study are as follows:

- fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not specifically sampled during the field surveys, although some opportunistic records were made.
- the 28 flora quadrats set up in the October 2007 field survey were sampled twice (October 2007 and March 2008), although ephemeral flora species were not apparent in the area due to a lack of significant rainfall. The four additional flora quadrats, which were set up in the second field survey in March 2008 were only sampled once. The vascular flora species list should therefore be taken as indicative/representative rather than exhaustive.
- the vegetation units for this study were defined based on interpretation of rectified aerial photography signatures combined with the site data and field mapping notes recorded during the field surveys. As it was not possible to map areas outside the study area in this way, the distribution of these units outside the study area can only be inferred by their correlation with the Land Systems mapping prepared by the Department of Agriculture. This means that there is a level of uncertainty regarding the assessment of distribution of these vegetation types outside the current study area.
- this study is intended to present baseline information on the botanical values of the Cape Lambert Port B Development area. It discusses the impacts of the development on the vegetation types present, based on current design details.
- a floristic analysis of the data collected during the two field surveys was not completed for this study. However, a regional comparison of vegetation types recorded on similar surveys in Pilbara coastal locations has instead been made.

Despite these limitations, the field studies and subsequent analyses are believed to give a good representation of the flora and vegetation values of the Cape Lambert Port B Development area.

4.0 Vegetation

4.1 Description of Vegetation Types

The vegetation types occurring in the Cape Lambert Port B Development area have been interpreted on the basis of:

- ground truthing during the October 2007 and March 2008 flora and vegetation field surveys;
- digital photographs of the proposed clearing areas taken during the field surveys (Plates 4.1 to 4.12);
- digital aerial photography with the clearing areas spatially overlaid in a Geographical Information System (GIS); and
- spatial overlay of the proposed clearing areas with land system mapping units using GIS (Van Vreeswyk et al. 2004).

A number of areas within the Cape Lambert Port B Development area had been previously cleared of native vegetation or were in such a disturbed condition that only introduced (weed) species were present. An area of approximately 111.2 ha within the Cape Lambert Port B Development area has been classified as 'Disturbed'. Additionally, there are rocky, coastal (tidal influenced) areas, which are bare of vegetation, that occupy an area of approximately 30.7 ha within the area.

The remainder of the study area was delineated into eight broad habitat types supporting nine vegetation types (Table 4.1).

Table 4.1: Summary of habitats, vegetation types and areas in the Cape Lambert Port B Development area.

| Habitat | Broad Vegetation Type | Condition | Size (ha) | Potential Impact Area (ha) | Quadrat Numbers |
|---|--|-----------------------|-----------|----------------------------|--|
| Flat Coastal Plain (CP) | Scattered shrubs over hummock grassland. | Good - Poor | 158.5 | 132.7 ha | CLE01, CLE16, CLE19, CLE25. |
| Primary Dunes (PDU) | Scattered shrubs over open mixed tussock grassland. | Good-Poor | 55.6 | 1.0 ha | CLE04, CLE13, CLE14, CLE23, CLE30. |
| Secondary Dune (SDu) | Shrubland over hummock grassland. | Good-Poor | 91.6 | 45.2 ha | CLE02, CLE18, CLE24, CLE27, CLE31. |
| Dune Blowouts (BO) | Scattered shrubs over scattered hummock grasses | Poor | 1.1 | 0.94 ha | CLE03. |
| Rocky hills and outcrops in flat coastal plain (RH) | Spinifex hummock grassland, sometimes with scattered low shrubs. | Good-Very Good | 49.9 | 36.6 ha | CLE05, CLE07, CLE11, CLE12, CLE15, CLE17, CLE20, CLE26, CLE32. |
| Low lying saline drainage (SD) | Open samphire heath | Excellent | 52.9 | 40.4 ha | CLE08, CLE21, CLE29. |
| Saline Interzone (SIZ) | Tall shrubland | Very Good - Excellent | 42.3 | 35.4 ha | CLE09, CLE10, CLE22, CLE28. |
| Drainage Basin (DB) | Tall scrub | Good | 1.0 | 0 ha | CLE06. |

More detailed accounts of each of the vegetation types recorded in the surveys follow.

Flat Coastal Plain (CP)

These areas were widespread in the study area and were represented by a flat, broad plain with scattered shrubs in a *Triodia epactia* hummock grassland and/or **Cenchrus ciliaris* (Buffel Grass) tussock grassland. There was a high level of disturbance present in these plain areas as a result of infestation with **Cenchrus ciliaris*, with the vegetation condition at most of the quadrats assessed in this habitat type recorded as 'Good to Poor' using the modified classification system of Trudgen (1988).

The vegetation of this habitat type was described as 'Open shrubland dominated by *Acacia stellaticeps* or *Acacia bivenosa* over *Scaevola spinescens* and *Rhagodia eremaea* scattered low shrubs over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock grassland' (Plates 4.1 and 4.2). Site numbers CLE01, CLE16, CLE19 and CLE25 were located in this habitat.

The total area covered by this vegetation type in the flat coastal plain areas is approximately 158.5 ha. Based on the current designs, an area of approximately 132.7 ha. of this vegetation type will be impacted by the Cape Lambert Port B Development.

Primary Dunes (PDu)

These areas mainly consisted of marine deposited, large-grained, white sand adjacent to the ocean or to rocky coastal areas exposed at low tide, and sparsely vegetated with scattered shrubs in an open tussock grassland of mixed species. There was a high level of disturbance present in these primary dune areas as a result of infestation with **Cenchrus ciliaris*, with the vegetation condition at all of the quadrats assessed in this habitat type recorded as 'Good to Poor'.

The vegetation of this habitat type was described as 'Shrubland to tall shrubland of *Acacia coriacea* subsp. *coriacea* over open shrubland of *Crotalaria cunninghamii*, *Santalum lanceolatum*, *Scaevola cunninghamii* and *Rhagodia preissii* subsp. *obovata* over tussock to open tussock grassland of *Spinifex longifolius*, *Whiteochloa airoides* and **Cenchrus ciliaris*' (Plates 4.3 and 4.4). Site numbers CLE04, CLE13, CLE14, CLE23 and CLE30 were located in this habitat.

The total area covered by this vegetation type in the primary dune areas is approximately 55.6 ha. Based on the current designs, an area of approximately 1.0 ha. of this vegetation type will be impacted by the Cape Lambert Port B Development.

Secondary Dunes (SDu)

The secondary dunes (located behind the primary dunes) were made of fine-grained, pale brown sand, which is deposited through aeolian processes. These dunes had a higher level of vegetative cover than the primary dunes, and were typically vegetated with shrubland of mixed species over spinifex (*Triodia epactia*) hummock grassland and/or Buffel (**Cenchrus ciliaris*) tussock grassland. There is a high level of disturbance present in the secondary dune areas as a result of infestation with **Cenchrus ciliaris*, with the vegetation condition at all of the quadrats assessed in this habitat type recorded as mostly 'Poor' or 'Good to Poor'.

The vegetation of this habitat type was described as 'Tall shrubland of *Acacia coriacea* subsp. *coriacea* over *Crotalaria cunninghamii*, *Rhagodia eremaea*, *Scaevola sericophylla* and *Scaevola spinescens* low open shrubland over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock to open tussock grassland' (Plate 4.5). Site numbers CLE02, CLE18, CLE24, CLE27 and CLE31 were located in this habitat.

The total area covered by this vegetation type in the secondary dune areas is approximately 91.6 ha. Based on the current designs, an area of approximately 45.2 ha. of this vegetation type will be impacted by the Cape Lambert Port B Development.

Dune Blowouts (BO)

These areas were either mostly devoid of vegetation or had a low level of vegetative cover. They were typically located between the primary dune and secondary dune areas, and were made of coarse, white or pale-brown sand, which is likely to be deposited through both marine and aeolian processes. Wind blowing onto the dunes from the ocean, eddies over the top of the primary dune crests and has created blowouts on the leeward side of the dunes, thereby constantly moving the sand in these areas and making it difficult for significant amounts of vegetation to become established. The blowout areas were typically vegetated with scattered shrubs over scattered hummock grasses and open tussock grassland of **Cenchrus ciliaris*. The high level of infestation by Buffel Grass in the dune blowout areas means the vegetation in this habitat type is in 'Poor' condition.

The vegetation of this habitat type was described as '*Acacia coriacea* subsp. *coriacea* and *Acacia bivenosa* open shrubland or scattered shrubs over *Rhagodia eremaea* low open shrubland or scattered shrubs over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* open tussock grassland' (Plate 4.6). Site number CLE03 was located in this habitat.

The total area covered by this vegetation type in the dune blowout areas is approximately 1.1 ha. Based on the current designs, an area of approximately 0.9 ha. of this vegetation type will be impacted by the Cape Lambert Port B Development.

Rocky Hills and Outcrops in flat coastal plain (RH)

These were rocky hills or outcropping areas, located on the coastal fringe of the study area or inland from the coast in the coastal plain areas. They were typically vegetated with spinifex hummock grassland (*Triodia epactia* and/or *T. wiseana*), with only a small amount (scattered) of low shrub species present. There was a low level of disturbance present in these rocky hill and outcrop areas, as they are not highly susceptible to invasion by **Cenchrus ciliaris*. The vegetation condition at all of the quadrats assessed in this habitat type was recorded as 'Good to Very Good'. One quadrat (CLE05) was located on a rocky coastal area, near a cliff, and was vegetated with '*Triodia epactia* hummock grassland and **Cenchrus ciliaris* scattered tussock grasses'. The vegetation condition at this site was 'Very Good', due to the very small amount of **Cenchrus ciliaris* present.

Eight quadrats were located on rocky hillcrests and upper slope habitats inland from the coast in coastal plain areas. These were quadrats CLE07, CLE11, CLE12, CLE15, CLE17, CLE20, CLE26 and CLE32. The vegetation on these inland rocky hills and outcrops was principally '*Triodia wiseana* and/or *Triodia epactia* hummock grassland'. Scattered shrubs of *Acacia inaequilatera* were present at quadrat CLE12, a small amount of **Cenchrus ciliaris* was present at quadrat CLE15 and a significant amount of **Cenchrus ciliaris* was present at quadrat CLE32 (see Plates 4.7 to 4.9).

The total area covered by this vegetation type in the rocky hills and outcrop areas in the coastal plain is approximately 49.9 ha. Based on the current designs, an area of approximately 36.6 ha. of this vegetation type will be impacted by the Cape Lambert Port B Development.

Low-lying, Saline Drainage Areas (on silty clay or clay loam soils) (SD)

These sluggish drainage areas, which were located at or just above sea level, were mostly bare or sparsely vegetated with halophytic species. A number of these areas were vegetated with low shrubland or open heath of samphire species (*Halosarcia* spp.). The soil in these drainage areas was either silty, fine-grained clay or clay-loam, with a visible saline crust on the soil surface in most instances. The level of disturbance in this habitat type was very low to negligible, as it is not susceptible to invasion by **Cenchrus ciliaris*. The only disturbance recorded in this habitat type during the field survey was fragmentation due to vehicle access tracks, but this did not result in any invasion by introduced flora species. The vegetation condition allocated to the quadrats located in this habitat type was 'Excellent'.

The vegetation of this habitat type was described as '*Halosarcia halocnemoides* subsp. *tenuis* and *Halosarcia indica* subsp. *leiostachya* low samphire shrubland or open heath with *Frankenia ambita* and *Muellerolimon salicorniaceum* low open shrubland' (Plate 4.10). Site numbers CLE08, CLE21 and CLE29 were located in this habitat.

The total area covered by this vegetation type in the low-lying, saline drainage areas is approximately 52.9 ha. Based on the current designs, an area of approximately 40.4 ha. of this vegetation type will be impacted by the Cape Lambert Port B Development.

Saline Interzone Areas between low-lying, saline drainage areas and flat coastal plain (SIZ)

Between the low-lying saline drainage areas and the flat coastal plain areas, were interzone areas, which are likely to be subject to seasonal and/or tidal inundation. These areas were higher in the landscape than the low-lying saline drainage areas, and vegetated with species that are tolerant of mildly saline soils. The level of disturbance in this habitat type is low, as it is not very susceptible to invasion by **Cenchrus ciliaris* (which does not appear to grow well in saline or mildly saline habitats).

The vegetation condition allocated to the quadrats located in this habitat type was 'Very Good to Excellent'.

The vegetation typically recorded in this habitat type was '*Acacia ampliceps* tall shrubland, with *Sesbania cannabina* tall open herbland over *Sporobolus virginicus* tussock to closed tussock grassland' (Plate 4.11). Additionally, *Triodia angusta* hummock grassland was present at quadrat CLE22 and *Hemichroa diandra* low open shrubland was present at quadrat CLE28. Site numbers CLE09, CLE10, CLE22 and CLE28 were located in this habitat.

The total area covered by this vegetation type in the saline interzone areas is 42.3 ha. Based on the current designs, an area of approximately 35.4 ha. of this vegetation type will be impacted by the Cape Lambert Port B Development.

Drainage Basin in flat coastal plain (at base of a rocky outcrop area) (DB)

A low-lying/drainage basin feature at the base of a rocky hill/outcrop area was recorded as a separate habitat and vegetation type during the field surveys. Only one example of this habitat type was found during the surveys. It is a natural rather than an artificially excavated feature. The level of disturbance in this habitat type was high in the understorey stratum due to infestation with **Cenchrus ciliaris*, but negligible in the overstorey stratum. The overall vegetation condition in this habitat was 'Good', due to the level of **Cenchrus ciliaris* infestation.

The vegetation in this habitat type was described as 'Tall closed scrub of *Acacia ampliceps* and *A. bivenosa* over tall open shrubland of *A. coriacea* subsp. *coriacea* over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* open tussock grassland' (Plate 4.12). Site number CLE06 was located in this habitat.

The total area covered by this vegetation type in the drainage basin in the flat coastal plain is 1 ha. Based on the current designs, this vegetation type will not be impacted (0 ha.) by the Cape Lambert Port B Development.

Additionally, some very small areas of *Avicennia marina* dominated mangrove vegetation are located within the boundary of the Cape Lambert Port B Development area, but these will not be impacted in any way. An area of approximately 1 ha is covered by these mangrove communities.

Vegetation maps showing the described vegetation types within the Cape Lambert Port B Development area are provided in Appendix 1.

Areas outside of survey boundary which have been interpreted from aerial photography

A few small areas, located outside of the survey boundary, have vegetation types inferred from aerial photography interpretation. These areas are shown in the vegetation maps provided in Appendix 1. The total area of disturbance in these additional areas is 9.1 ha, composed of 2.7 ha in the flat coastal plain areas, 1.6 ha in the rocky hill areas, and 1 ha each in the low-lying saline drainage areas, the secondary dune areas and the saline interzone areas. An existing disturbed area of 1.5 ha is present in the small areas outside of the survey boundary, and a very small amount (0.2 ha) of 'drainage line vegetation' is present in the areas based on aerial photo interpretation. The vegetation of these drainage line features has not been described, as they were not identified within the boundary of the Cape Lambert Port B Development area during the two field surveys.

Plates 4.1 to 4.12 show the vegetation types in the various habitats identified during the field survey.



Plate 4.1: Flat coastal plain area with *Acacia bivenosa* open shrubland over *Scaevola spinescens* scattered low shrubs over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* tussock grassland. Site CLE01.



Plate 4.2: Flat coastal plain area with *Acacia stellaticeps* open heath over *Triodia epactia* and *T. schinzii* open hummock grassland. Site CLE16.



Plate 4.3: Coastal primary dune area with *Spinifex longifolius* open hummock grassland with open tussock grassland of *Eulalia aurea*, *Whiteochloa airoides* and **Cenchrus ciliaris*. Site CLE04.



Plate 4.4: Coastal primary dune area with *Crotalaria cunninghamii* and *Acacia coriacea* subsp. *coriacea* open shrubland over *Santalum lanceolatum* and **Aerva javanica* low open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* and *Whiteochloa airoides* open tussock grassland. Site CLE23.



Plate 4.5: Coastal secondary sand dune area with *Acacia coriacea* subsp. *coriacea* tall open shrubland over *Tephrosia rosea* var. *venulosa* ms. low open shrubland over mostly **Cenchrus ciliaris* open tussock grassland. Site CLE18.



Plate 4.6: Dune blowout area with *Acacia bivenosa* and *A. coriacea* subsp. *coriacea* shrubland over *Rhagodia eremaea* low open shrubland over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* open tussock grassland. Site CLE03.



Plate 4.7: Rocky hill and outcrop areas. Rocky coastal area near a cliff with *Triodia epactia* hummock grassland and **Cenchrus ciliaris* scattered tussock grasses. Site CLE05.



Plate 4.8: Rocky hill and outcrop areas. Rocky ridge and upper slopes with *Acacia inaequilatera* open shrubland over *Triodia epactia* and *T. wiseana* hummock grassland. Site CLE12.



Plate 4.9: Rocky hill and outcrop areas. Rocky hillcrest with *Triodia wiseana* and *T. epactia* hummock grassland. Site CLE26.



Plate 4.10: Saline drainage area with *Halosarcia halocnemoides* subsp. *tenuis* and *H. indica* subsp. *leiostachya* low open samphire heath over *Muellerolimon salicorniaceum* low shrubland. Site CLE21.



Plate 4.11: Saline interzone area with *Acacia ampliceps* tall shrubland over *Sporobolus virginicus* closed tussock grassland. Site CLE09.



Plate 4.12: Drainage basin in flat coastal plain area with *Acacia ampliceps* and *A. bivenosa* tall closed scrub over *A. coriacea* subsp. *coriacea* tall open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* open tussock grassland. Site CLE06.

4.2 Vegetation Condition

The vegetation types within the Cape Lambert Port B Development area generally varied in their condition depending on their habitat type (see Appendix 2). The condition varied from Good to Very Good at half of the sites assessed (16 out of 32), with Poor to Good condition vegetation recorded from four of the sites assessed, and Very Poor to Poor condition vegetation recorded from seven of the sites assessed. There were five sites which had an Excellent vegetation condition rating (CLE08, CLE10, CLE21, CLE28 and CLE29). This variation in vegetation condition was mostly dependent upon the level of cover of the weed species **Cenchrus ciliaris*, and to a lesser extent on the level of disturbance present (e.g. vegetation clearing or vehicle tracks). The quadrats with the vegetation condition rating of Very Poor to Poor had the highest level of **Cenchrus ciliaris* infestation, and were typically located on the sandier areas such as the primary and secondary dunes, dune blowouts and flat coastal plain areas.

Samphire low shrubland or heath sites were in Excellent condition with no infestation by **Cenchrus ciliaris*, however a number of these areas were disturbed/dissected by roads and wheel tracks. Sites on rocky hillslopes were in Good to Very Good condition and were mostly free of weeds.

Nearly all of the sites assessed in the Cape Lambert Port B Development area were found to have **Cenchrus ciliaris* present in varying quantities. Only two sites (CLE08 and CLE21) assessed during the field surveys did not have any **Cenchrus ciliaris* present. Additionally, sites CLE10, CLE28 and CLE29, had minimal amounts of **Cenchrus ciliaris* present, and were all assigned an Excellent vegetation condition status. Due to its highly invasive nature, **Cenchrus ciliaris* can be considered a 'sleeper' weed species within the Cape Lambert Port B Development area. It is currently mostly at medium levels through the majority of the study area, with high percentage cover levels of some localised areas within the dune habitats and the flat coastal plain areas. Processes such as vegetation clearing, soil disturbances, or repeated fire events are likely to cause this environmental weed species to proliferate.

4.3 Vegetation Conservation Significance Assessment

It is difficult to conclusively determine the conservation significance of vegetation in a region if there is a lack of contextual information. The lack of data is due to a scarcity of resources available for detailed regional botanical surveys across the large areas that remain poorly researched across much of Western Australia. Comparisons with vegetation types recorded from other biological surveys in Pilbara coastal areas are presented below. The discussion of vegetation conservation significance

mainly utilises information from the Bioregional Summary of the Biodiversity Audit of Western Australia's 53 Biogeographical Subregions in 2002 (May and McKenzie 2003).

4.3.1 Representation of the Vegetation Types in the Conservation Estate

The survey area is situated within the Chichester subregion of the Pilbara bioregion (see Sections 2.3.1 and 2.3.2). This subregion comprises only a small coastal section of the Pilbara IBRA bioregion, located at Cape Lambert, with the remainder of the subregion located just inland from the Pilbara coast (south of the Roebourne subregion). The Chichester subregion has 6.56% of its area reserved under some form of conservation tenure (Kendrick and McKenzie 2001).

Kendrick and McKenzie (2001) identified ecosystems within the Chichester subregion that had low, medium or high priority for reservation. Some of these ecosystems occur within the Cape Lambert Port B Development area as detailed in Table 4.2. Accurate matching of the vegetation types identified from the survey area with these reservation priority ecosystems was somewhat limited due to the lack of detail provided in Kendrick and McKenzie (2001).

The 'High' or 'Medium' reservation priority of these ecosystems is not due to their listing as habitats for flora species of conservation significance or because they represent Threatened Ecological Communities (TECs), but rather as a result of being poorly represented in the conservation estate in Western Australia.

Table 4.2: Reservation Priority Ecosystems within the Chichester subregion (after Kendrick and McKenzie 2001) which appear relevant to the Cape Lambert Port B Development Area

| Ecosystem Type (Kendrick and McKenzie 2001) | Reservation Priority | Equivalent Vegetation Type in the Study Area | Likely Impacts |
|--|----------------------|--|--|
| Hummock grasslands, shrub steppe; kanji (<i>Acacia inaequilatera</i>) over soft spinifex (<i>Triodia epactia</i>). | Low | <i>Acacia inaequilatera</i> open shrubland over <i>Triodia epactia</i> and <i>T. wiseana</i> hummock grassland. At site CLE12, in rocky hills and outcrop areas. | Disturbance due to vegetation removal and/or weed invasion (especially by * <i>Cenchrus ciliaris</i>). |
| Hummock grasslands, grass steppe; soft spinifex (<i>Triodia epactia</i>). | Medium | <i>Triodia epactia</i> hummock grassland with * <i>Cenchrus ciliaris</i> scattered tussock grasses at site CLE05 in rocky hills and outcrop areas. Open shrubland or open low shrubland of mixed species over <i>Triodia epactia</i> hummock grassland and * <i>Cenchrus ciliaris</i> tussock grassland on flat coastal plain areas. | Disturbance due to vegetation removal and/or weed invasion by * <i>Cenchrus ciliaris</i> . Flat coastal plain areas already show a significant level of infestation with * <i>C. ciliaris</i> . |
| Bare areas; mudflats | High | Low-lying saline drainage areas on silty clay or clay-loam soils. Typically mostly bare of vegetation or sparsely with halophytic (Samphire (<i>Halosarcia</i>)) species. | Impacts due to excavation or fill-in work |
| Hummock grasslands, shrub steppe; mixed shrubs over soft spinifex | Medium/Low | Open shrubland/open low shrubland of mixed species (<i>Acacia bivenosa</i> or <i>A. stellaticeps</i> over <i>Scaevola spinescens</i> , <i>Rhagodia eremaea</i> scattered low shrubs over <i>Triodia epactia</i> hummock grassland and * <i>Cenchrus ciliaris</i> tussock grassland on flat coastal plain/dune areas. | Disturbance due to vegetation removal and/or weed invasion by * <i>Cenchrus ciliaris</i> . Flat coastal plain areas already show a significant level of infestation with * <i>C. ciliaris</i> . |
| On coastal areas of the Roebourne subregion (PIL4), 'Succulent steppe; samphire' is a listed reservation priority ecosystem. | High | Low-lying saline drainage areas on silty clay or clay-loam soils. Typically mostly bare of vegetation or sparsely vegetated with halophytic (Samphire (<i>Halosarcia</i>)) species. <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> and <i>H. indica</i> subsp. <i>leiostachya</i> low samphire shrubland or open heath with <i>Frankenia ambita</i> and <i>Muellerolimon salicorniaceum</i> low open shrubland' | This ecosystem, while not common in the Chichester subregion, is found on the coastal tip of this subregion located at Cape Lambert, as well as frequently in the adjacent Roebourne subregion. Impacts due to excavation or fill-in work. |

- Soft spinifex usually refers to *Triodia pungens*, which is actually more likely to be *T. epactia*, as this was the only species of soft spinifex recorded in the Cape Lambert Port B Development Area. The two species are often misidentified.

4.3.2 Potential for Ecosystems at Risk to Occur in the Study Area

None of the vegetation types within the Cape Lambert Port B Development area are Threatened Ecological Communities (TECs) as listed by DEC. There are currently no TECs listed within the Chichester subregion of the Pilbara bioregion.

In addition to listed TECs, the DEC also maintains a list of Priority Ecological Communities (PECs) for Western Australia, which are considered 'other ecosystems at risk'. Three of these PECs are associated with the Chichester subregion:

1. cracking clay communities of the Chichester Range and Mungaroona Range;
2. invertebrate assemblages (Errawallana Spring type) Coolawanya Station; and
3. stygofaunal communities of the Millstream freshwater aquifer.

Only the first listed PEC, 'Cracking clay communities of the Chichester Range and Mungaroona Range' relates to vegetation, whereas the second and third listed PECs relate to invertebrate communities.

The cracking clay communities of the Chichester Range and Mungaroona Range are listed as Priority One ecosystems¹, which are:

"Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (eg. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well-defined, and appear to be under immediate threat from known threatening processes across their range" (DEC 2008).

None of the vegetation types recorded from within the Cape Lambert Port B Development area are Priority Ecological Communities (PECs).

4.3.3 Distribution of the Vegetation Types in Other Coastal Areas of the Pilbara

There are little data available to determine the uniqueness of the vegetation associated with the succulent steppe (Samphire) or bare areas - mudflats, as very few detailed botanical surveys have been published for the Chichester subregion. The 1:1,000,000 series vegetation mapping for the Pilbara by Beard (1975) shows that there is a negligible area (< 10 ha) of 'tidal mud flats' along the coastal areas of the Chichester subregion of the Pilbara bioregion. This subregion has a high proportion of areas mapped by Beard as 'grass steppe on rocky hills', as only a small proportion of the subregion is located in the coastal section of the Pilbara. A much larger area (~ 108,241 ha) of the 'tidal mud flats' vegetation type is present in the coastal areas of the Roebourne subregion of the Pilbara bioregion (adjacent to the Chichester subregion). This subregion is principally located along the Pilbara coastline, and roughly corresponds to the Abydos Plain area in Beards mapping.

All of the vegetation types recorded in the Cape Lambert Port B Development area are relatively typical of coastal habitats in the Pilbara region. Comparisons of vegetation types occurring in similar habitats in other studies in the locality are provided in Table 4.3 below.

¹ Possible threatened ecological communities, which do not meet survey criteria or are not adequately defined, are given a PEC rating of Priority 1 to Priority 3. These rankings are in order of priority for survey and/or definition of the community, and evaluation of conservation status, so that consideration can be given to their declaration as Threatened Ecological Communities. Priority 4 Ecological Communities are rare but not threatened, while Priority 5 Ecological Communities are conservation dependent.

Table 4.3: Comparison of similar vegetation types at different project areas located in various Pilbara coastal locations.

| Cape Lambert Port B Development (this study) | Dampier Salt Saltfield Expansion Area (Biota 2008) | Austeel Project at Cape Preston (HGM et al. 2001) | FMG Stage A Rail Corridor (Biota 2004) | Three Sections of the Port Hedland Saltworks (Trudgen 2005) | Port Hedland Solar Saltfield Expansion (Biota 2006a) | Onslow BHP-Billiton Pilbara LNG Facility (Biota 2005) |
|--|--|---|--|---|---|--|
| Flat coastal plain areas: <i>Acacia bivenosa</i> &/or <i>A. stellaticeps</i> open shrubland over <i>Scaevola spinescens</i> & <i>Rhagodia eremaea</i> scattered low shrubs over <i>Triodia epactia</i> hummock grassland & * <i>Cenchrus ciliaris</i> tussock grassland | <i>Acacia stellaticeps</i> open heath over <i>Triodia epactia</i> hummock grassland on alluvial clay plains (vegetation type ACP.3). <i>Acacia stellaticeps</i> low open shrubland to shrubland over <i>Triodia longiceps</i> (<i>T. wiseana</i>) hummock grassland and * <i>Cenchrus ciliaris</i> , <i>Sorghum plumosum</i> very open tussock grassland (vegetation type CCLP.1) | | <i>Acacia stellaticeps</i> scattered shrubs to low shrubland over <i>Triodia epactia</i> dense hummock grassland (code Apt10) on loamy plains and sandy areas of Abydos Plain. | <i>Acacia stellaticeps</i> low shrubland to open heath over <i>Triodia epactia</i> hummock grassland on loamy plains. | <i>Acacia stellaticeps</i> low shrubland over <i>Triodia epactia</i> hummock grassland and <i>Eriachne obtusa</i> open tussock grassland on gently undulating loamy plains/ low dune rises (code LP:As) | <i>Acacia bivenosa</i> shrubland over <i>Scaevola spinescens</i> low open shrubland over <i>Triodia epactia</i> hummock grassland and <i>Eulalia aurea</i> , * <i>Cenchrus ciliaris</i> open tussock grassland in dune swale/coastal plain areas (code Ds.6). |
| Primary sand dune areas: <i>Acacia coriacea</i> subsp. <i>coriacea</i> tall shrubland over <i>Santalum lanceolatum</i> , <i>Crotalaria cunninghamii</i> , <i>Scaevola cunninghamii</i> & <i>Rhagodia preissii</i> subsp. <i>obovata</i> open shrubland over <i>Spinifex longifolius</i> , <i>Whiteochloa airoides</i> & * <i>Cenchrus ciliaris</i> tussock - open tussock grassland | | <i>Acacia bivenosa</i> low open shrubland with <i>A. coriacea</i> subsp. <i>coriacea</i> scattered shrubs over <i>Spinifex longifolius</i> grassland (code Ld1). Associated species are <i>Rhagodia preissii</i> subsp. <i>obovata</i> and * <i>Cenchrus ciliaris</i> . | | | | <i>Acacia coriacea</i> subsp. <i>coriacea</i> tall open shrubland over <i>Crotalaria cunninghamii</i> open shrubland over <i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i> low open heath to open shrubland with <i>Spinifex longifolius</i> , <i>Sporobolus virginicus</i> & * <i>Cenchrus ciliaris</i> tussock grassland (code Cf.1) |
| Secondary sand dune areas: <i>Acacia coriacea</i> subsp. <i>coriacea</i> scattered low trees over <i>A. bivenosa</i> tall shrubland over <i>Rhagodia eremaea</i> , <i>Crotalaria cunninghamii</i> , <i>Scaevola sericophylla</i> & <i>S. spinescens</i> low open shrubland over <i>Triodia epactia</i> hummock grassland & * <i>Cenchrus ciliaris</i> tussock - open tussock grassland | <i>Acacia coriacea</i> subsp. <i>coriacea</i> scattered low trees over <i>A. bivenosa</i> shrubland, with <i>A. inaequilatera</i> scattered individual shrubs, over <i>Triodia epactia</i> , <i>T. wiseana</i> hummock grassland on alluvial clay plains (vegetation type ACP.1). | <i>Acacia coriacea</i> subsp. <i>coriacea</i> , <i>A. bivenosa</i> tall open shrubland over <i>Triodia epactia</i> curly spinifex grassland (code Ld3). Associated species are <i>Adriana tomentosa</i> , <i>Santalum lanceolatum</i> and occasional * <i>Cenchrus ciliaris</i> . | | | <i>Acacia coleii</i> var. <i>coleii</i> scattered shrubs over low shrubland of mixed species (<i>Corchorus incanus</i> , * <i>Aerva javanica</i> & <i>Tricoryne corynothecoides</i>) over <i>Triodia epactia</i> hummock grassland and <i>Eriachne obtusa</i> , <i>Whiteochloa cymbiformis</i> and * <i>Cenchrus ciliaris</i> tussock grassland (code SD) | <i>Acacia stellaticeps</i> and <i>Scaevola sericophylla</i> shrubland over <i>Triodia epactia</i> hummock grassland and * <i>Cenchrus ciliaris</i> open tussock grassland (code Ld.1) |

Table 4.3: Comparison of similar vegetation types at different project areas located in various Pilbara coastal locations.

| Cape Lambert Port B Development (this study) | Dampier Salt Saltfield Expansion Area (Biota 2008) | Austeel Project at Cape Preston (HGM et al. 2001) | FMG Stage A Rail Corridor (Biota 2004) | Three Sections of the Port Hedland Saltworks (Trudgen 2005) | Port Hedland Solar Saltfield Expansion (Biota 2006a) | Onslow BHP-Billiton Pilbara LNG Facility (Biota 2005) |
|---|---|---|---|---|---|--|
| Dune blowout areas: <i>Acacia coriacea</i> subsp. <i>coriacea</i> & <i>A. bivenosa</i> scattered shrubs or open shrubland over <i>Rhagodia eremaea</i> scattered shrubs or low open shrubland over <i>Triodia epactia</i> scattered hummock grasses & * <i>Cenchrus ciliaris</i> open tussock grassland | <i>Acacia coriacea</i> subsp. <i>coriacea</i> scattered low trees over <i>A. bivenosa</i> shrubland, with <i>A. inaequilatera</i> scattered individual shrubs, over <i>Triodia epactia</i> , <i>T. wiseana</i> hummock grassland on alluvial clay plains (vegetation type ACP.1). | <i>Acacia coriacea</i> subsp. <i>coriacea</i> , <i>A. bivenosa</i> tall open shrubland over <i>Triodia epactia</i> curly spinifex grassland (code Ld3). Associated species are <i>Adriana tomentosa</i> , <i>Santalum lanceolatum</i> and occasional * <i>Cenchrus ciliaris</i> . | | | | <i>Scaevola sericophylla</i> and <i>Pityrodia loxocarpa</i> low open shrubland with <i>Indigofera monophylla</i> , <i>Tephrosia rosea</i> var. <i>clementii</i> & <i>Trichodesma zeylanicum</i> var. <i>grandiflorum</i> low shrubland over <i>Triodia epactia</i> open hummock grassland & * <i>Cenchrus ciliaris</i> open to very open tussock grassland (code Df.1) |
| Rocky hill & outcrop areas: <i>Triodia epactia</i> hummock grassland & * <i>Cenchrus ciliaris</i> scattered tussock grasses on rocky coastal areas | <i>Triodia epactia</i> hummock grassland in understory stratum of different vegetation types (vegetation types ACP.1, ACP.3 & CCLP.4) | | <i>Triodia epactia</i> hummock grassland on sandy soils (code Apt3). | <i>Triodia epactia</i> hummock grasslands on loamy plains. | <i>Triodia epactia</i> hummock grassland to closed hummock grassland on loamy plain areas (code LP:Te) | <i>Cullen pogonocarpum</i> low open shrubland over <i>Triodia epactia</i> hummock grassland with open tussock grassland of <i>Eriachne helmsii</i> and open herbland of <i>Swainsona pterostylis</i> (code Ds.1) |
| Rocky hill & outcrop areas: <i>Triodia wiseana</i> &/or <i>T. epactia</i> hummock grassland on rocky hillcrests & upper hillslopes | <i>Triodia wiseana</i> hummock grassland on low clay rises/hills in the alluvial clay plains (vegetation type ACP.2). | <i>Triodia wiseana</i> hummock grassland (codes Nh1 and ROh1a) | <i>Acacia inaequilatera</i> scattered tall shrubs over <i>Triodia wiseana</i> hummock grassland (code Ah1). | | | |
| Low-lying saline drainage areas: <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> & <i>H. indica</i> subsp. <i>leiostachya</i> low samphire shrubland or open heath with <i>Frankenia ambita</i> & <i>Muellerolimon salicorniaceum</i> low open shrubland | Samphire shrublands on low-lying saline drainage areas (vegetation types SD.1, SD.2 & SD.3). Dominated by <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> , <i>H. indica</i> subsp. <i>leiostachya</i> &/or <i>H. pergranulata</i> | <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> low open shrubland to low open heath on saline mudflats (code Ls2). | Samphire shrublands on saline mudflats (code As) | <i>Halosarcia indica</i> , <i>H. pruinosa</i> &/or <i>H. halocnemoides</i> subsp. ? <i>halocnemoides</i> low shrubland to low open heath on saline mudflats | <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> , <i>H. indica</i> subsp. <i>leiostachya</i> or <i>H. pergranulata</i> subsp. <i>elongata</i> low open shrubland to low open heath, with scattered patches of <i>Eragrostis falcata</i> forming an open to very open tussock grassland on saline loam flats (code SAM) | Samphire low shrubland on saline flats with scattered low shrubs of <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> & <i>H. pterygosperma</i> subsp. <i>denticulata</i> over <i>Sporobolus virginicus</i> & <i>Eragrostis falcata</i> open tussock grassland (codes Sf.1 and Sf.2) |

Table 4.3: Comparison of similar vegetation types at different project areas located in various Pilbara coastal locations.

| Cape Lambert Port B Development (this study) | Dampier Salt Saltfield Expansion Area (Biota 2008) | Austeel Project at Cape Preston (HGM et al. 2001) | FMG Stage A Rail Corridor (Biota 2004) | Three Sections of the Port Hedland Saltworks (Trudgen 2005) | Port Hedland Solar Saltfield Expansion (Biota 2006a) | Onslow BHP-Billiton Pilbara LNG Facility (Biota 2005) |
|---|--|---|--|---|--|---|
| Saline interzone areas between low-lying saline drainage areas and flat coastal plain areas: <i>Acacia ampliceps</i> tall shrubland, with <i>Sesbania cannabina</i> tall open hermland over <i>Sporobolus virginicus</i> tussock to closed tussock grassland | | <i>Acacia ampliceps</i> high shrubland over <i>Sesbania cannabina</i> & <i>Acacia coriacea</i> subsp. <i>pendens</i> over <i>Triodia angusta</i> scattered hummocks & variable cover of <i>Sporobolus virginicus</i> & * <i>Cenchrus ciliaris</i> (code ROC5) | | | Saline interzone area with scattered individuals of <i>Sesbania cannabina</i> over <i>Sporobolus virginicus</i> tussock grassland (code IZ) | |
| Drainage basin in flat coastal plain areas: <i>Acacia ampliceps</i> & <i>A. bivenosa</i> tall closed scrub over <i>A. coriacea</i> subsp. <i>coriacea</i> tall open shrubland over <i>Triodia epactia</i> very open hummock grassland & * <i>Cenchrus ciliaris</i> open tussock grassland | <i>Acacia ampliceps</i> , <i>A. bivenosa</i> , <i>A. stellaticeps</i> & <i>A. xiphophylla</i> open shrubland over <i>Ptilotus murrayi</i> open hermland & * <i>Cenchrus ciliaris</i> open tussock grassland (vegetation type BLDA.1) | <i>Acacia coriacea</i> subsp. <i>pendens</i> , <i>A. bivenosa</i> high shrubland over <i>A. ampliceps</i> , <i>Rhagodia eremaea</i> tall shrubs over <i>Triodia wiseana</i> variable cover and * <i>Cenchrus ciliaris</i> variable cover (code ROC4) | | | Floodplain areas beside freshwater drainage channels with <i>Melaleuca argentea</i> , <i>Eucalyptus victrix</i> scattered trees over <i>Acacia ampliceps</i> , <i>A. trachycarpa</i> tall open shrubland over <i>Crotalaria cunninghamii</i> , <i>Corchorus incanus</i> low open shrubland over * <i>Cenchrus ciliaris</i> and * <i>C. setiger</i> tussock grassland (code FP) | |

Dampier Salt Saltfield Expansion Area (Biota 2008)

The survey of the proposed Dampier Salt Saltfield Expansion area, located between Dampier and Karratha (Biota 2008), identified seven vegetation types in similar habitats to those occurring in the Cape Lambert Port B Development area. These are presented in Table 4.3.

Of these vegetation types, four were considered to be of Moderate to High conservation significance. These were the saline drainage areas vegetation units (SD.1, SD.2 and SD.3) and the hummock grassland, dwarf shrub-steppe (*Acacia stellaticeps/translucens* over soft spinifex) vegetation unit (ACP.3 = *Acacia stellaticeps* open heath over *Triodia epactia* hummock grassland on alluvial clay plains). The Moderate to High conservation significance status allocated to these vegetation types was based on their listing as 'High reservation priority ecosystems in the Roebourne subregion' in Kendrick and Stanley (2001). The ecosystems are considered to be significant due to their possible low level of occurrence on the coastal areas of northern Western Australia and their low level of representation and reservation within the conservation estate in Western Australia.

The saline drainage areas vegetation units of the Dampier Salt Saltfield Expansion area are similar in dominant species to the low-lying saline drainage areas vegetation community recorded within the Cape Lambert Port B Development area.

The areas of *Acacia stellaticeps* open heath over *Triodia epactia* hummock grassland on alluvial clay plains in the Dampier Salt Saltfield Expansion area are similar in species composition to the vegetation type associated with the flat coastal plain areas in the Cape Lambert Port B Development area. This vegetation type is *Acacia bivenosa* and/or *A. stellaticeps* open shrubland over *Scaevola spinescens* and *Rhagodia eremaea* scattered low shrubs over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock grassland. It is given 'medium' reservation priority status in the Chichester subregion (see Table 4.2). The difference between the two study areas is that the vegetation is found on alluvial clay plain areas in the Dampier Salt Saltfield Expansion area and on sandy loam coastal plain areas in the Cape Lambert Port B Development area.

Cape Preston (HGM et al. 2001)

The survey of the Austeel project area at Cape Preston, on the coast 80 km southwest of Karratha (HGM et al. 2001), identified seven vegetation types in similar habitats to those occurring in the Cape Lambert Port B Development area. These are presented in Table 4.3.

Of these vegetation types, the sand dune (Ld3 and Ld4) vegetation units were considered to be of High conservation significance for a number of reasons, including:

- coastal sand dune habitat is relatively widespread but has a limited area; and
- sand dunes are susceptible to invasion by Buffel Grass (**Cenchrus ciliaris*) and erosion processes following physical disturbance.

The sand dune vegetation of the Austeel study area is similar in dominant species to the vegetation community recorded at the Cape Lambert Port B Development area as '*Acacia coriacea* subsp. *coriacea* tall shrubland over *Rhagodia eremaea*, *Crotalaria cunninghamii*, *Scaevola sericophylla* & *S. spinescens* low open shrubland over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* tussock to open tussock grassland'.

FMG Stage A Rail Corridor (Biota 2004)

The survey of the northern end of the FMG rail corridor at Port Hedland (Biota 2004) recorded four vegetation types in similar habitats to those occurring in the Cape Lambert Port B Development area. These are presented in Table 4.3.

Of these, only one ('succulent steppe; samphire) was considered to be of High conservation significance, due to its 'high reservation priority' listing by the DEC. This vegetation type is typically associated with, or adjacent to, bare areas/saline mudflats, which are also listed as 'high reservation priority'.

The three vegetation types which were recorded from the Cape Lambert Port B development area and are similar to the types recorded in the FMG Stage A rail corridor are: *Acacia stellaticeps* scattered shrubs to low shrubland over *Triodia epactia* dense hummock grassland on loamy plains and sandy areas of Abydos Plain; *Triodia epactia* hummock grassland on sandy soils and *Acacia inaequilatera* scattered tall shrubs over *Triodia wiseana* hummock grassland. These vegetation types are all listed as Low to Medium reservation priority ecosystems, and therefore are considered to be of low conservation significance.

Three Sections of the Port Hedland Saltworks (Trudgen 2005)

Trudgen (2005) surveyed three small sections of the Port Hedland Saltworks area, and identified three vegetation types similar to those occurring in the Cape Lambert Port B Development area. These are presented in Table 4.3.

Of these, only one (*Halosarcia indica*, *H. pruinosa* &/or *H. halocnemoides* subsp. ? *halocnemoides* (samphire) low shrubland to low open heath on saline mudflats) was considered to be of High conservation significance, due to its 'high reservation priority' listing by the DEC. This vegetation type is typically associated with, or adjacent to, bare areas/saline mudflats, which are also listed as 'high reservation priority'.

The other two vegetation types are; *Acacia stellaticeps* low shrubland to open heath over *Triodia epactia* hummock grassland on loamy plains and *Triodia epactia* hummock grasslands on loamy plains. These vegetation types are both listed as Low to Medium reservation priority ecosystems, and therefore are considered to be of low conservation significance.

Port Hedland Solar Saltfield Expansion (Biota 2006)

The survey of the proposed Port Hedland Solar Saltfield Expansion recorded six vegetation types in similar habitats to those occurring in the Cape Lambert Port B Development area. These are presented in Table 4.3.

Of these, three are not listed as reservation priority ecosystems in the Chichester subregion by the DEC. One vegetation type (*Halosarcia halocnemoides* subsp. *tenuis*, *H. indica* subsp. *leiostachya* or *H. pergranulata* subsp. *elongata* (samphire) low open shrubland to low open heath, with scattered patches of *Eragrostis falcata* forming an open to very open tussock grassland on saline loam flats) was considered to be of High conservation significance, due to its 'high reservation priority' listing by the DEC. This vegetation type is typically associated with, or adjacent to, bare areas/saline mudflats, which are also listed as 'high reservation priority'.

The other two vegetation types are; *Acacia stellaticeps* low shrubland over *Triodia epactia* hummock grassland and *Eriachne obtusa* open tussock grassland on loamy plains and *Triodia epactia* hummock grassland to closed hummock grassland on loamy plain areas. These vegetation types are both listed as Low to Medium reservation priority ecosystems, and therefore are considered to be of low conservation significance.

Onslow BHP Billiton Pilbara LNG Facility (Biota 2005)

The flora and vegetation survey of the proposed BHP Billiton Pilbara LNG processing facility at Onslow recorded six vegetation types in similar habitats to those occurring in the Cape Lambert Port B Development area. These are presented in Table 4.3.

Of these, two are not listed as reservation priority ecosystems in the Chichester subregion by the DEC. One vegetation type (samphire low shrubland on saline flats) was considered to be of High conservation significance, due to its 'high reservation priority' listing by the DEC. This vegetation type is typically associated with, or adjacent to, bare areas/saline mudflats, which are also listed as 'high reservation priority'.

One of the vegetation types recorded at the Onslow BHP Billiton Pilbara LNG facility was *Acacia stellaticeps*, *Scaevola sericophylla* shrubland over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* open tussock grassland on sand (secondary) dunes. This vegetation type is considered to be of Medium conservation significance due to its location on sand dunes.

The remaining two vegetation types are; *Acacia bivenosa* shrubland over *Scaevola spinescens* low open shrubland over *Triodia epactia* hummock grassland and *Eulalia aurea*, **Cenchrus ciliaris* open tussock grassland in dune swales/coastal plain areas and *Triodia epactia* hummock grassland with *Eriachne helmsii* open tussock grassland and *Swainsona pterostylis* open herbland. These vegetation types are both listed as Low to Medium reservation priority ecosystems, and therefore considered to be of low conservation significance.

4.3.4 Summary of State Significance

There are no ecosystems of State significance found in the Cape Lambert Port B Development area, as there are no listed TECs located in the study area (see Section 4.3.2). In addition, there are no significant conservation reserves in the vicinity of the study area.

4.3.5 Summary of Regional Significance

The landforms found within the study area are repeated outside of the future impact areas (flat coastal plain, primary and secondary sand dunes and associated dune blowouts, low-lying saline drainage areas, rocky hills and outcrops, saline interzone areas and drainage basin(s) in flat coastal plain). The vegetation types associated with one of these landforms, low-lying saline drainage areas, may be considered regionally significant due to its 'High reservation priority' listing by DEC. The remainder of the vegetation types associated with the other landforms in the study area are not considered regionally significant.

The low-lying saline drainage areas vegetation type (*Halosarcia halocnemoides* subsp. *tenuis* & *H. indica* subsp. *leiostrachya* low samphire shrubland or open heath with *Frankenia ambita* and *Muellerolimon salicorniaceum* low open shrubland) is poorly reserved in the Pilbara bioregion.

The Cape Lambert Port B Development area contained a representation of vegetation types that:

- a number of which were in Poor to Good condition (dependent on their location), as are a number of ecosystems in the Chichester subregion of the Pilbara. These ecosystems are under threat (known to be at risk) from threatening processes such as grazing pressure from pastoral activity (cattle), presence of feral animals and invasion by introduced/weed species;
- one of which is poorly reserved: samphire shrublands/heath (dominated by halophytic species) on low-lying saline flats/drainage areas;
- some of which are poorly known floristically as only limited survey work has been undertaken;
- may be restricted to the Chichester subregion of the Pilbara bioregion, but within this subregion they are not necessarily restricted to the project area;
- have identifiable threatening processes – such as weed invasion, feral animals (goats, rabbits, foxes), pastoral activity (cattle grazing) and/or development across their distribution; or
- their extent of representation outside the survey area is not known, with some likely to be relatively well represented (such as those found on flat coastal plain areas) and others not very well represented (such as samphire shrublands on the low-lying saline drainage areas).

There were no species of Declared Rare or Priority Flora recorded from the Cape Lambert Port B Development area (see Section 5).

4.3.6 Local Significance

None of the landforms or vegetation types within the Cape Lambert Port B Development area are considered to be locally significant.

5.0 Flora

5.1 Overview of the Flora of the Cape Lambert Port B Development Area

A total of 190 taxa of vascular flora from 101 genera belonging to 45 families were recorded from the survey area (see Appendix 3). This total includes seven taxa of introduced flora/weed species (from seven genera and six families). These introduced species were **Aerva javanica* (Kapok Bush), **Cenchrus ciliaris* (Buffel Grass), **Chloris barbata* (Purpletop Chloris), **Phoenix dactylifera* (Date Palm), **Portulaca oleracea* (Pigweed/Purslane), **Tamarix aphylla* (Athel Tree/Tamarisk) and **Vitex trifolia* var. *subtrisecta* (Three Leaved Chaste Tree).

The total number of vascular flora species present was considered relatively low for the study area, as very few ephemeral flora species were recorded during the surveys due to a lack of significant rainfall in the six to seven months prior to the survey. The families and genera within the study area with the greatest number of taxa are indicative of the plant groups which typically dominate survey areas in the coastal Pilbara locality.

The families and genera with the greatest number of taxa are shown in Table 5.1 and Table 5.2. These families and genera are those that are typically predominant in the vegetation of the coastal areas of the Pilbara Bioregion. They usually have the most representatives on flora lists in surveys of this region, due to their prominence in the flora of the Eremaean Botanical Province. Some of these families (e.g. the Amaranthaceae, Malvaceae and Poaceae) are more species rich in the Northern Botanical Province and poorer in the flora of the Southwest Botanical Province, while others (e.g. the Chenopodiaceae, Mimosaceae and Papilionaceae) are abundant in all three botanical provinces.

Table 5.1: Most species rich families within the Cape Lambert Port B Development area.

| Family | Number of Native Species (Weed Species) |
|--|--|
| Poaceae (Grass family) | 26 (2) |
| Papilionaceae (Pea family) | 23 (0) |
| Mimosaceae (Wattle family) | 18 (0) |
| Malvaceae (Hibiscus family) | 14 (0) |
| Amaranthaceae (Amaranth family) | 9 (1) |
| Chenopodiaceae (Saltbush, Bluebush family) | 9 (0) |
| Asteraceae (Daisy family) | 8 (0) |
| Euphorbiaceae (Spurge family) | 8 (0) |
| Goodeniaceae (Fanflower family) | 7 (0) |

Table 5.2: Most species rich genera within the Cape Lambert Port B Development area.

| Genus | Number of Native Species |
|---------------------------------|--------------------------|
| <i>Acacia</i> (Wattles) | 17 |
| <i>Tephrosia</i> | 6 |
| <i>Euphorbia</i> (Spurges) | 6 |
| <i>Eragrostis</i> (Lovegrasses) | 6 |
| <i>Indigofera</i> (Indigos) | 5 |
| <i>Ptilotus</i> (Mulla-mullas) | 5 |
| <i>Scaevola</i> (Fanflowers) | 5 |
| <i>Sida</i> (Sidas) | 5 |
| <i>Cassia</i> (Cassias/Sennas) | 5 |

5.2 Species Richness

Recorded species richness in the Pilbara shows a positive relationship with various factors, including the size of the study area. Species accumulation curves correlate the number of species recorded as a function of sampling effort (Magurran 2004). In this case the 50 x 50 m quadrat size is the optimal effort required for an optimal sampling rate in the Pilbara bioregion.

The diversity of habitats present and the amount of rainfall received by the locality is also related to species richness. Coastal areas in the Pilbara bioregion typically do not have a high level of species richness. This reflects two factors:

- the general paucity of the flora of the coastal environments in the wider Roebourne and Chichester subregions of the Pilbara bioregion; and
- the fact that many habitats comprise harsh environments for plant growth (e.g. saline claypan or clay-loam areas dominated by halophytic species; windblown, broad clay plains).

The Cape Lambert area has a species richness value within the range expected for its size when compared with six other study areas surveyed on the Pilbara Coast (see Table 5.3).

Table 5.3: Species richness and percentage of ephemeral flora species for various study areas in the region, including the Cape Lambert Port B Development.

| Study Area | Size | Number of Vascular Flora Species | Total % of Flora which are Ephemeral |
|--|-----------|----------------------------------|--------------------------------------|
| Cape Lambert Port B Development Area | 602 ha | 190 | 27% |
| Cape Preston study area (HGM et al. 2001) | 20,880 ha | 426 | Not stated |
| Dampier Salt Saltfield Expansion area (Biota 2008) | 4,200 ha | 309 | 47% |
| Port Hedland study area (Biota 2006a) | 1,550 ha | 201 | 39% |
| Pilbara LNG Additional Infrastructure Areas in Onslow (Biota 2007) | 1,305 ha | 242 | 35% |
| Onslow BHPB Pilbara LNG study area (Biota 2005) | 727 ha | 165 | 44% |
| Onslow Strategic Industrial Area (Biota 2006b) | 500 ha | 158 | 39% |

Species richness for the quadrats did not vary extensively between the initial (2007) and the seasonal survey (2008) (see Table 5.4). Most of the quadrats showed only a minor increase in species richness when compared with the initial October 2007 survey. Only two quadrats set up in the 2007 field survey (CLE11 and CLE26) had an increase in species numbers of ten or more individuals, with the remainder of the quadrats from this survey having between zero and nine additional species recorded during the seasonal (2008) survey. An average of approximately 22 species was recorded for the four quadrats set up in the March 2008 survey, which is similar to the average number (21 species) recorded for the 28 quadrats set up in the October 2007 survey.

Table 5.4: Number of flora species for each quadrat in 2007 and 2008, and over both survey phases combined.

| Quadrat | Number of Species Recorded (October, 2007) | Number of Additional Species (March, 2008) | Total Number of Species Recorded in Quadrat |
|---------|--|--|---|
| CLE01 | 13 | 3 | 16 |
| CLE02 | 13 | 1 | 14 |
| CLE03 | 18 | 5 | 23 |
| CLE04 | 17 | 1 | 18 |
| CLE05 | 27 | 3 | 30 |
| CLE06 | 43 | 5 | 48 |
| CLE07 | 29 | 4 | 33 |
| CLE08 | 9 | 0 | 9 |
| CLE09 | 16 | 1 | 17 |
| CLE10 | 17 | 4 | 21 |
| CLE11 | 20 | 13 | 33 |
| CLE12 | 29 | 5 | 34 |
| CLE13 | 21 | 2 | 23 |
| CLE14 | 16 | 2 | 18 |
| CLE15 | 27 | 9 | 36 |
| CLE16 | 28 | 6 | 34 |
| CLE17 | 25 | 8 | 33 |
| CLE18 | 17 | 4 | 21 |
| CLE19 | 17 | 5 | 22 |
| CLE20 | 26 | 4 | 30 |
| CLE21 | 9 | 1 | 10 |
| CLE22 | 11 | 1 | 12 |
| CLE23 | 21 | 2 | 23 |
| CLE24 | 30 | 3 | 33 |
| CLE25 | 23 | 2 | 25 |
| CLE26 | 27 | 10 | 37 |
| CLE27 | 19 | 3 | 22 |
| CLE28 | 16 | 4 | 20 |
| CLES29 | - | 19 | 19 |
| CLES30 | - | 28 | 28 |
| CLES31 | - | 15 | 15 |
| CLES32 | - | 27 | 27 |

5.3 Flora of Conservation Significance

5.3.1 Legislative and Administrative Levels of Flora Protection

While all native flora are protected under the *Western Australian Wildlife Conservation Act 1950-1979*, a number of plant species are assigned an additional level of conservation significance based on the limited number of known populations and the perceived threats to these populations (Table 5.5). Species of the highest conservation significance are designated Declared Rare Flora (DRF), either extant or presumed extinct. Species that appear to be rare or threatened, but for which there is insufficient information to properly evaluate their conservation significance, are assigned to one of four Priority flora categories by DEC. This is an administrative (rather than legislated) level of protection.

In addition, the presence of some flora species means that it may be necessary to refer proposals to the Federal Minister for the Environment under the *Federal Environment Protection and Biodiversity Conservation Act 1999*. In the Pilbara, only the two Declared Rare Flora species (*Lepidium catapycnon* and *Thryptomene wittweri*) are currently listed under the *EPBC Act 1999*.

Table 5.5: Categories of conservation significance for flora species (Atkins 2006).

| |
|--|
| <p>Declared Rare Flora - Extant Taxa. Taxa that 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.</p> <p>Declared Rare Flora - Presumed Extinct. Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently.</p> <p>Priority 1 - Poorly Known Taxa. Taxa which are known from one or a few (generally <5) populations which are under threat.</p> <p>Priority 2 - 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 threat.</p> <p>Priority 3 - Poorly Known Taxa. Taxa which are known from several populations, at least some of which are not believed to be under threat.</p> <p>Priority 4 - Rare Taxa. Taxa which are considered to have been adequately surveyed and which whilst being rare, are not currently threatened by any identifiable factors.</p> |
|--|

5.3.2 Listed Species under the *EPBC Act 1999* Known from the Pilbara Bioregion

Only two plant species from the Pilbara are currently listed under the *Environment Protection and Biodiversity Conservation Act 1999*. These species are both listed as Declared Rare Flora (DRF) in Western Australia:

- Hamersley *Lepidium* (*Lepidium catapycnon*) is now known from a number of locations in the Hamersley Range, extending broadly from Tom Price across to Newman. This species has been recorded from several locations around Tom Price, but has not been found in stony hill habitats in coastal areas. Given the absence of suitable habitat within the study area, this species would not be expected to occur.
- Mountain *Thryptomene* (*Thryptomene wittweri*) is only known from high-altitude mountaintops in the Pilbara, its distribution extending south into the Gascoyne and Great Victoria Desert bioregions. Given the absence of suitable habitat within the study area, this species would not be expected to occur.

Neither of these species were recorded from the Cape Lambert Port B Development area.

5.3.3 Flora of Conservation Significance Previously Recorded in the Vicinity of Cape Lambert

A search of the DEC Threatened Flora database was carried out for the proposed clearing areas, buffered by a distance of 50 km. The search co-ordinates used were 20° 21' – 21°04' S and 116° 34' – 117° 38' E (GDA94). The rectangular search area extended approximately 45 kilometres inland from the southern boundary, 55 kilometres east and west of the survey boundary and encompassed the Burrup Peninsula and islands (Appendix 4).

There were no known records of Threatened Flora from within the study area. One record of Declared Rare Flora was returned from within the wider searched area (i.e. within 50 km of the surveyed areas). The record of this species, *Drummondita ericoides* (R), is believed to be erroneous, arising from coordinates being assigned to the location of White Peak on the Burrup Peninsula rather than White Peak near Geraldton. The Western Australian Herbarium has been informed of this error to allow its correction.

While no Priority Flora are known to occur within the surveyed areas, 10 Priority listed species occur within the extended 50 km database search area (see Appendix 4). These were: *Helichrysum oligochaetum* (P1), *Stackhousia clementii* (P1), *Gomphrena pusilla* (P2), *Acacia glaucocaesia* (P3), *Goodenia pascua* (P3), *Gymnanthera cunninghamii* (P3), *Hibiscus brachysiphonius* (P3), *Rhynchosia bungarensis* (P3), *Themeda* sp. Hamersley Station (ME Trudgen 11431) (P3), and *Terminalia supranitifolia* (P3).

An additional four taxa from the Kimberley bioregion were listed in the database search results, due to their location on the Dampier Peninsula, rather than in the vicinity of Dampier town. These four taxa are not included in the listed species presented in Appendix 4.

5.3.4 Priority Flora Occurring in the Cape Lambert Study Area

None of the Priority Flora species listed by DEC in the database search were recorded during the first field survey in 2007 or in the seasonal survey March 2008.

5.4 Flora Species at the Geographical Boundaries of their Distribution

The geographical distribution of each of the flora species recorded in the field surveys was checked on the Western Australian Herbarium 'FloraBase' database. A number of the flora species present are at the northern, western or eastern extremities of their State distribution. The flora species present in the Cape Lambert-Wickham area are mostly from the Northern and Eremaean Botanical Provinces, which are species influenced by cyclonic summer rainfall patterns.

The surveys recorded two species at the northern limit of their known geographical distribution in Western Australia; *Rhagodia preissii* subsp. *obovata* and *Scaevola sericophylla*.

Eleven of the species recorded during the surveys were at the western limit of their known geographical distribution in Western Australia. These species were *Acacia melleodora*, **Chloris barbata*, *Cullen stipulaceum*, *Euphorbia careyi*, *Hakea chordophylla*, *Marsilea exarata*, *Polymeria calycina*, *Ptilotus polystachyus* var. *arthrotrichus*, *Tephrosia rosea* var. *venulosa* ms, *Tephrosia ? simplicifolia* and *Themeda* sp. Mt Barricade (M.E. Trudgen 2471).

Three of the species recorded during the surveys were at the eastern limit of their known geographical distribution in Western Australia. These species were *Acacia gregorii*, *Euphorbia careyi* and *Scaevola cunninghamii*.

A total of 16 species (8% of the recorded flora) were recorded in the field surveys, which were known from the limits of their geographical distribution in Western Australia.

5.5 Introduced Flora (Weeds)

In total, seven introduced flora species were recorded from the Cape Lambert Port B Development area. Of the introduced species recorded, **Aerva javanica* and **Cenchrus ciliaris* are common and widespread weed species in the Pilbara bioregion, while the remaining species are less frequent to uncommon. The species of *Portulaca* recorded during the surveys (**Portulaca oleracea*), has only recently been assigned 'introduced species' status. It was previously considered a native species in the northern part of Western Australia, but is now listed as an alien/weed species on 'FloraBase'. A brief discussion of each species follows:

- **Aerva javanica* (Kapok Bush) is a short-lived perennial which is found amongst tall trees, medium trees (*Eucalyptus* woodland), low trees, low (sclerophyll) shrubland, grassland and spinifex grassland. Its habitat preferences include outcrops, coastal areas, in rocky or stony soil, gravelly soil, sand, loam, clay; occupying sand-dunes; floodplains; river-banks; creeklines; drainage-lines; and growing in disturbed native vegetation (FloraBase).
- **Cenchrus ciliaris* (Buffel Grass) was introduced by pastoralists as a fodder species. It has demonstrated allelopathic capacities, whereby it releases chemicals that inhibit the growth of other plants, and it is an aggressive and effective competitor with native flora species. This perennial grass forms dense tussock grasslands, particularly along creeklines, floodplains and in sandy coastal areas. Infestations of this species are common throughout the Hamersley

Range, particularly in major creeklines, and in sandy coastal areas of the Pilbara. **Cenchrus ciliaris* was recorded throughout the Cape Lambert Port B Development area, particularly on the flat coastal plain, primary dune, secondary dune and dune blowout areas.

- **Chloris barbata* (Purpletop Chloris) is an annual or short-lived perennial grass species, which is widespread on levee banks, road verges, disturbed sites and creeklines (Hussey et al 1997).
- **Phoenix dactylifera* (Date Palm) is a palm/tree species, that has been planted in settlements in the arid zone. The species forms dense thickets by suckering and reproducing from seed. It has become a serious environmental weed in Millstream National Park, impeding water flow and displacing native species (Hussey et al 1997).
- **Portulaca oleracea* (Purslane/Pigweed) is a prostrate, succulent, annual herbaceous species that grows to a height of up to 20cm. It is often found at sites that have been previously disturbed, and prefers sandy or clay-loam soils. This species occurs commonly in the Pilbara, and during the field surveys was recorded at only one of the 32 quadrats. 'FloraBase' has only recently changed the classification of this species from 'native to WA' to an introduced/alien status.
- **Tamarix aphylla* (Athel Tree/Tamarisk) is a dense tree, often growing to a height of 10m. It has a suckering habit, which allows it to create dense thickets. Originally planted in the Pilbara as a shade tree, the species has the potential to become a serious arid zone weed particularly along river systems, as it can alter flow rates of creeks and rivers, as well as causing the salinisation of groundwater deposits. For these reasons, the species is a Declared Plant under the *Agriculture and Related Resources Protection Act 1976*, where it is listed as P1 (see Section 5.4.1). A group of five juvenile individuals were recorded opportunistically from a saline drainage area on a roadside (see Table 5.6 for location coordinates). Although **Tamarix aphylla* are unlikely to generate dense infestations in the habitats of the study area, removal of the five juvenile individuals of this species would be warranted.
- **Vitex trifolia* var. *subtrisecta* (Three Leaved Chaste Tree) is a medium to large shrub species, typically found amongst closed tussock grassland in sand, clay and in disturbed vegetation (FloraBase).

The locations of six of the seven weed species recorded within the study area are presented in Table 5.6. Records for **Cenchrus ciliaris* are not included in the table as this species was widespread throughout the Cape Lambert Port B Development area and found at all but two of the 32 survey quadrats. The species is widespread in disturbed, coastal sand-loam areas of the Pilbara.

5.5.1 Declared Plant Species

Different levels of priority are applied to a number of weed species which are "Declared" under the *Western Australian Agriculture and Related Resources Protection Act 1976*. Declared weeds are particularly invasive species that may pose a threat to agricultural and pastoral activities within a region. The different priority levels are outlined below:

- **P1:** Prohibits movement of plants and their seeds within the State. This prohibits the movement of contaminated machinery and produce, including livestock and fodder.
- **P2:** Eradicate infestation to destroy and prevent propagation each year, until no plants remain. The infested area must be managed in such a way as to prevent the spread of seeds or plants on, or in livestock, fodder, grain, vehicles or machinery.
- **P3:** Control the infestation in such a way as to prevent the spread of seed or plant parts, within and from the property, on or in livestock, fodder, grain, vehicles or machinery. Treat to destroy and prevent seed set on all plants.
- **P4:** Prevent the spread of infestation from the property, on or in livestock, fodder, grain, vehicles and/or machinery. Treat to destroy and prevent seed set on all plants.
- **P5:** Infestations on public lands must be controlled.

One of the species recorded during the field surveys, **Tamarix aphylla* (Tamarisk/Athel Tree), is listed as a "Declared Plant" species, and has a P1 status (Department of Agriculture and Food 2007).

Table 5.6: Locations of weed species within the Cape Lambert Port B Development area.

| Species | Location | Number of Individuals Recorded |
|--|---|--------------------------------|
| <i>*Aerva javanica</i> | CLE01: 51 5754E, 7720492N | 2 |
| | CLE02: 51 5731E, 7720290N | 8 |
| | CLE03: 51 5964E, 7720615N | 2 |
| | CLE04: 51 5972E, 7720681N | 15 |
| | CLE06: 51 7663E, 7722316N | 3 |
| | CLE07: 51 5508E, 7718801N | 2 |
| | CLE09: 51 3929E, 7715910N | 2 |
| | CLE10: 51 3913E, 7716049N | 2 |
| | CLE12: 51 3900E, 7716262N | 2 |
| | CLE14: 51 4267E, 7717787N | 2 |
| | CLE17: 51 5872E, 77719503N | 2 |
| | CLE18: 51 5723E, 7719756N | 8 |
| | CLE19: 51 5323E, 7719393N | 2 |
| | CLE20: 51 5209E, 7719353N | 5 |
| | CLE23: 51 4591E, 7718922N | 14 |
| | CLE24: 51 6758E, 7721337N | 5 |
| CLE25: 51 6882E, 7721287N | 8 | |
| CLE27: 51 4895E, 7719525N | 2 | |
| | Opportunistic observation (outside of quadrats) within the study area | 2-3 |
| <i>*Chloris barbata</i> | Adjacent to site CLE06 (on roadside): 51 7663E, 7722316N | 2 |
| | Opportunistic collection at 51 6875E, 7720943N | 2-3 |
| <i>*Tamarix aphylla</i> | Opportunistic collection at 51 6648E, 7720673N. Adjacent to roadside and a low-lying saline drainage area | 5 juvenile individuals |
| <i>*Portulaca oleracea</i> | CLE15: 51 4099E, 7716374N | 2-3 |
| <i>*Phoenix dactylifera</i> | Opportunistic observation at 51 7011E, 7721433N | 2 |
| <i>*Vitex trifolia</i> var. <i>subtrisecta</i> | Opportunistic observation at 51 7011E, 7721433N | 2 |

5.6 Flora Conservation Significance Assessment

No Declared Rare Flora have been recorded from the Cape Lambert Port B Development area, or are likely to occur, hence there are no flora listed under the *EPBC Act 1999* within the study area. Additionally, there were no Priority Flora species recorded from the study area, despite the fact that some suitable habitat may be present in the area for some of the Priority Flora species known to occur in the vicinity of Cape Lambert.

The remaining flora species recorded from the Cape Lambert Port B Development area are largely widespread and typical of coastal areas of the Pilbara bioregion. Some of these species may be at the geographical boundaries of their known distributions.

The Cape Lambert Port B Development area is considered to have a low to moderate conservation value for overall flora. The area supports a species richness within the expected range (for an area of this size located in coastal habitats in the Pilbara bioregion), and the majority of these species are either widespread in this region or at least typical of the coastal Cape Lambert locality.

A number of the habitats assessed showed a high level of infestation with **Cenchrus ciliaris*, with the low-lying saline drainage areas habitat type being the most resistant to invasion by this species

('Excellent' vegetation condition). The saline interzone habitat (typically located between low-lying saline drainage areas and flat coastal plain) was also seen to be resistant to invasion by **Cenchrus ciliaris*, and was typically found to have a vegetation condition of 'Very Good to Excellent'. The other habitats present in the area are susceptible to invasion by **Cenchrus ciliaris*, especially the sandier habitats associated with coastal primary and secondary dunes, dune blowouts and the flat coastal plain areas. These habitats are likely to show increased levels of infestation by this weed species in the future, due to disturbance, fires and wind dispersal of seed in the sandier areas.

6.0 Conclusions

6.1 Summary of Features of Conservation Significance

6.1.1 Vegetation

There are no listed Threatened Ecological Communities (TECs) in the Cape Lambert Port B Development area, and therefore no listed TECs under the Federal *EPBC Act 1999*. Additionally, there are no listed Priority Ecological Communities (PECs) as listed by the DEC (2008).

Of the nine vegetation types identified in the study area during the two field surveys (see Section 4.1), only one of these was considered to be of moderate to high conservation significance:

- **Low-lying, Saline Drainage Areas (on silty clay or clay loam soils) (SD).**

Sluggish drainage areas, located at or just above sea level, which were sometimes bare or typically only sparsely vegetated with halophytic species. Most of these areas were vegetated with low shrubland or open heath of *Halosarcia* species (samphire). The vegetation of this habitat type was described as '*Halosarcia halocnemoides* subsp. *tenuis* and *Halosarcia indica* subsp. *leiostachya* low samphire shrubland or open heath with *Frankenia ambita* and *Muellerolimon salicorniaceum* low open shrubland'.

A total area of approximately 40.4 ha of the low-lying saline drainage areas vegetation type will be cleared for the Cape Lambert Port B Development. The overall total area of vegetation that will be cleared for the Cape Lambert Port B Development is approximately 342 ha.

The remainder of the vegetation types are considered to be of low to moderate conservation significance, representing units that are likely to be widely distributed and relatively well represented in coastal areas of the Pilbara bioregion.

6.1.2 Flora

No Declared Rare Flora (DRF) were recorded, are known to occur or likely to occur in the Cape Lambert Port B Development area, and there are therefore no known populations of species listed under the Federal *EPBC Act 1999*.

There were no species of Priority Flora recorded during the two field surveys in the Cape Lambert Port B Development area.

A total of 16 species were recorded during the field surveys, which were known from the limits of their geographical distribution in Western Australia (see Section 5.4).

6.2 Potential Impacts of the Project

6.2.1 Clearing of Vegetation

The main impact of the proposed development will be from clearing of vegetation in the Cape Lambert Port B Development area. A total area of approximately 342 ha of vegetation will be cleared for the project. The proportion of the vegetation types that may be cleared is relatively minor, compared to their representation in the local area. Nonetheless, every effort should be made to minimise the area requiring clearing for the project, particularly with respect to the vegetation types identified as being of moderate to high conservation significance:

- low-lying saline drainage areas (succulent steppe; samphire) with *Halosarcia halocnemoides* subsp. *tenuis* and *H. indica* subsp. *leiostachya* low samphire shrubland or open heath with *Frankenia ambita* and *Muellerolimon salicorniaceum* low open shrubland.

6.2.2 Introduction/Spread of Weed Species

Seven species of introduced flora were recorded from the Cape Lambert Port B Development area (see Section 5.5). One of these species, *Tamarix aphylla* (Athel Tree/Tamarisk) is listed as a Declared Plant species for the Pilbara bioregion under the *Agriculture and Related Resources Protection Act 1976*. In addition, two of the other introduced species recorded in the project area are considered to be serious environmental weeds; *Cenchrus ciliaris* (Buffel Grass) and *Aerva javanica* (Kapok Bush).

The proposed Cape Lambert Port B Development has the potential to introduce additional weed species and/or spread existing populations within the study area, particularly where works occur in areas with existing dense weed infestations.

6.2.3 Dust and Erosion

Dust will be generated during construction, and during operation of unsealed roads, particularly through areas of clayey substrate.

Erosion could likewise arise following disturbance of the soil profile. Areas within the primary and secondary dune systems (sandier soils) and those areas with clay substrates would be particularly susceptible to erosion events, particularly after significant rainfall events.

These are considered to represent minor issues provided that standard management measures are implemented as part of normal project operation (e.g. standard dust suppression measures, use of erosion control matting as necessary, etc).

7.0 References

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8.0 Acknowledgements

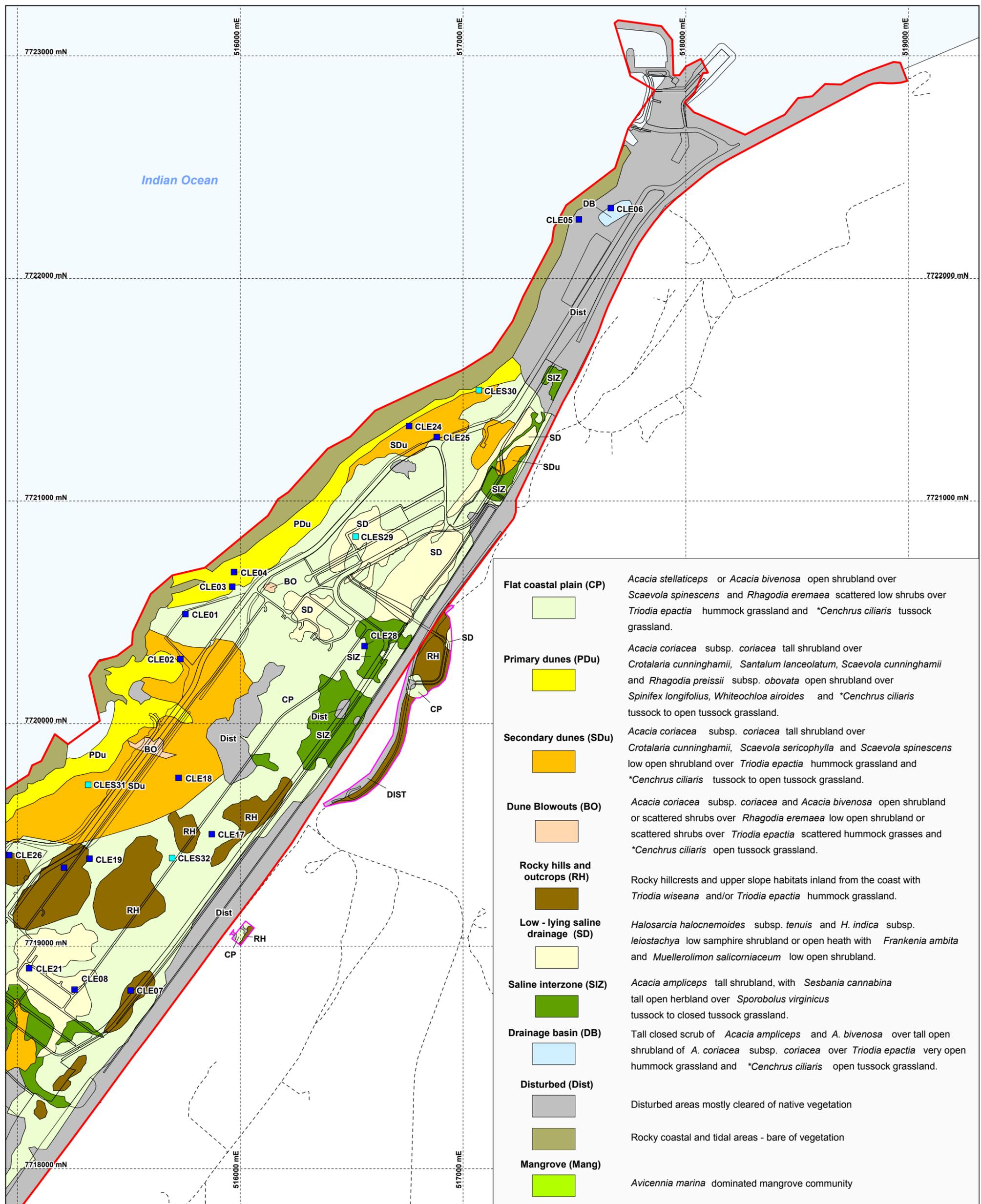
The following persons are gratefully acknowledged for their assistance with this study:

- Ms Bridgitte Long of DEC Rare Flora Section conducted the WA Herbarium and DEC rare flora database search.
- Mr Malcolm Trudgen of ME Trudgen & Associates assisted with identification of various problematic plant groups.
- Mr Paul Sawers and Mr Luke Lovell (Biota) prepared the vegetation mapping presented in this report.

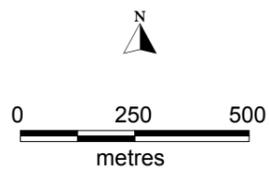
Appendix 1

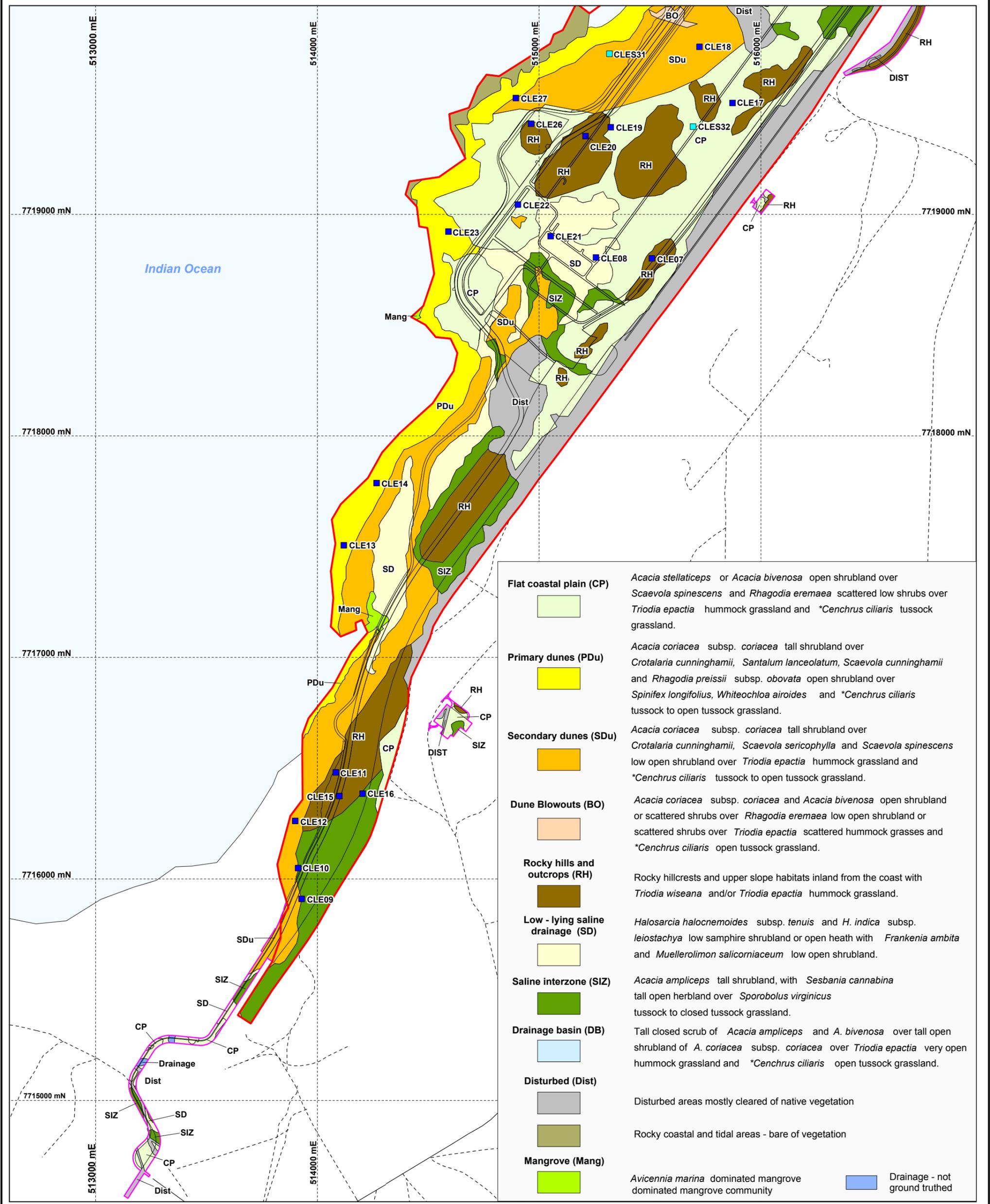
Vegetation Map for the Cape Lambert Port B Development Study Area



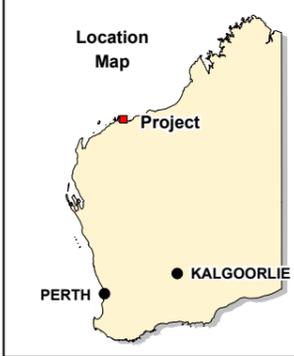


- Field survey boundary
- Vegetation mapping interpreted from photography
- Quadrat sites (Oct 2007)
- Quadrat sites - seasonal (Mar 2008)

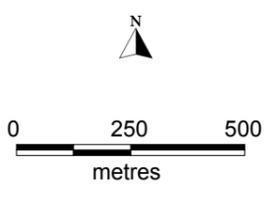




| | |
|---|--|
| Flat coastal plain (CP) | <i>Acacia stellaticeps</i> or <i>Acacia bivenosa</i> open shrubland over <i>Scaevola spinescens</i> and <i>Rhagodia eremaea</i> scattered low shrubs over <i>Triodia epactia</i> hummock grassland and * <i>Cenchrus ciliaris</i> tussock grassland. |
| Primary dunes (PDU) | <i>Acacia coriacea</i> subsp. <i>coriacea</i> tall shrubland over <i>Crotalaria cunninghamii</i> , <i>Santalum lanceolatum</i> , <i>Scaevola cunninghamii</i> and <i>Rhagodia preissii</i> subsp. <i>obovata</i> open shrubland over <i>Spinifex longifolius</i> , <i>Whiteochloa airoides</i> and * <i>Cenchrus ciliaris</i> tussock to open tussock grassland. |
| Secondary dunes (SDU) | <i>Acacia coriacea</i> subsp. <i>coriacea</i> tall shrubland over <i>Crotalaria cunninghamii</i> , <i>Scaevola sericophylla</i> and <i>Scaevola spinescens</i> low open shrubland over <i>Triodia epactia</i> hummock grassland and * <i>Cenchrus ciliaris</i> tussock to open tussock grassland. |
| Dune Blowouts (BO) | <i>Acacia coriacea</i> subsp. <i>coriacea</i> and <i>Acacia bivenosa</i> open shrubland or scattered shrubs over <i>Rhagodia eremaea</i> low open shrubland or scattered shrubs over <i>Triodia epactia</i> scattered hummock grasses and * <i>Cenchrus ciliaris</i> open tussock grassland. |
| Rocky hills and outcrops (RH) | Rocky hillcrests and upper slope habitats inland from the coast with <i>Triodia wiseana</i> and/or <i>Triodia epactia</i> hummock grassland. |
| Low - lying saline drainage (SD) | <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> and <i>H. indica</i> subsp. <i>leiostachya</i> low samphire shrubland or open heath with <i>Frankenia ambita</i> and <i>Muellerolimon salicorniaceum</i> low open shrubland. |
| Saline interzone (SIZ) | <i>Acacia ampliceps</i> tall shrubland, with <i>Sesbania cannabina</i> tall open herbland over <i>Sporobolus virginicus</i> tussock to closed tussock grassland. |
| Drainage basin (DB) | Tall closed scrub of <i>Acacia ampliceps</i> and <i>A. bivenosa</i> over tall open shrubland of <i>A. coriacea</i> subsp. <i>coriacea</i> over <i>Triodia epactia</i> very open hummock grassland and * <i>Cenchrus ciliaris</i> open tussock grassland. |
| Disturbed (Dist) | Disturbed areas mostly cleared of native vegetation |
| | Rocky coastal and tidal areas - bare of vegetation |
| Mangrove (Mang) | <i>Avicennia marina</i> dominated mangrove dominated mangrove community |
| | Drainage - not ground truthed |



- Field survey boundary
- Vegetation mapping interpreted from photography
- Quadrat sites (Oct 2007)
- Quadrat sites - seasonal (Mar 2008)



Cape Lambert Vegetation Mapping Southern Section

| | |
|-------------------|---------------------|
| Author: R Orifici | Date: 04/12/2007 |
| Drawn: L Lovell | Revised: 06/07/2008 |
| Dwg No.: | Job No.:445 |
| Projection GDA 94 | Scale:15 000 |

Appendix 2

Raw Data from Quadrats Assessed in the Cape Lambert Port B Development Study Area



Vegetation Structural Classification and Condition Scale used for the current survey

Vegetation Structural Classes*

| Stratum | 70-100% cover | 30-70% cover | 10-30% cover | 2-10% cover | <2% cover |
|------------------------|---|--|---|--|--|
| Trees over 30 m | Tall closed forest | Tall open forest | Tall woodland | Tall open woodland | Scattered tall trees |
| Trees 10-30 m | Closed forest | Open forest | Woodland | Open woodland | Scattered trees |
| Trees under 10 m | Low closed forest | Low open forest | Low woodland | Low open woodland | Scattered low trees |
| Shrubs over 2 m | Tall closed scrub | Tall open scrub | Tall shrubland | Tall open shrubland | Scattered tall shrubs |
| Shrubs 1-2 m | Closed heath | Open heath | Shrubland | Open shrubland | Scattered shrubs |
| Shrubs under 1 m | Low closed heath | Low open heath | Low shrubland | Low open shrubland | Scattered low shrubs |
| Hummock grasses | Closed hummock grassland | Hummock grassland | Open hummock grassland | Very open hummock grassland | Scattered hummock grasses |
| Grasses, Sedges, Herbs | Closed tussock grassland / sedgeland / herbland | Tussock grassland / sedgeland / herbland | Open tussock grassland / sedgeland / herbland | Very open tussock grassland / sedgeland / herbland | Scattered tussock grasses / sedges / herbs |

* Based on Aplin's (1979) modification of the vegetation classification system of Specht (1970):
 Aplin T.E.H. (1979). The Flora. Chapter 3 In O'Brien, B.J. (ed.) (1979). Environment and Science. University of Western Australia Press; Specht R.L. (1970). Vegetation. In The Australian Environment. 4th edn (Ed. G.W. Leeper). Melbourne.

Vegetation Condition Scale*

| |
|---|
| E = Excellent (=Pristine of BushForever) Pristine or nearly so; no obvious signs of damage caused by the activities of European man. |
| VG = Very Good (= Excellent of BushForever) Some relatively slight signs of damage caused by the activities of European man. For example, some signs of damage to tree trunks caused by repeated fire, the presence of some relatively non-aggressive weeds such as <i>Ursinia anthemoides</i> or <i>Briza</i> spp., or occasional vehicle tracks. |
| G = Good (= Very Good of BushForever) More obvious signs of damage caused by the activities of European man, including some obvious impact on the vegetation structure such as that caused by low levels of grazing or by selective logging. Weeds as above, possibly plus some more aggressive ones such as <i>Ehrharta</i> spp. |
| P = Poor (= Good of BushForever) Still retains basic vegetation structure or ability to regenerate to it after very obvious impacts of activities of European man, such as grazing, partial clearing (chaining) or frequent fires. Weeds as above, probably plus some more aggressive ones such as <i>Ehrharta</i> spp. |
| VP = Very Poor (= Degraded of BushForever) Severely impacted by grazing, very frequent fires, clearing or a combination of these activities. Scope for some regeneration but not to a state approaching good condition without intensive management. Usually with a number of weed species including very aggressive species. |
| D = Completely Degraded (= Completely Degraded of BushForever) Areas that are completely or almost completely without native species in the structure of their vegetation; ie. areas that are cleared or 'parkland cleared' with their flora comprising weed or crop species with isolated native trees or shrubs. |

* Based on Trudgen M.E. (1988). A Report on the Flora and Vegetation of the Port Kennedy Area. Unpublished report prepared for Bowman Bishaw and Associates, West Perth.

Cape Lambert Site CLE01

Described B. Mathews, J. Fairhead **Date** 5/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 515754 **mE** 7720492 **mN**
Habitat Flat coastal plain.
Soil Fine to coarse sand.
Vegetation *Acacia bivenosa* open shrubland over *Scaevola spinescens* scattered low shrubs over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* tussock grassland.
Vegetation Condition Poor- extensive **Cenchrus* infestation.
Fire > 5 years since fire.

Cape Lambert Site CLE02

Described R. Orifici, H. Marmarac **Date** 5/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 515731 **mE** 7720290 **mN**
Habitat Coastal dune ridge of secondary dune.
Soil Fine dune sand, pale brown orange.
Rock Type no visible outcropping.
Vegetation *Acacia coriacea* ssp *coriacea* tall shrubland over *Crotalaria cunninghamii* open shrubland over *Tephrosia rosea* var. *venulosa* ms. low open shrubland over **Cenchrus ciliaris* tussock grassland and *Whiteochloa airoides* very open tussock grassland.
Vegetation Condition Poor to good- overstory good, understory poor.
Fire > 5-7 years since fire.

Cape Lambert Site CLE03

Described B. Mathews, J. Fairhead **Date** 5/10/2007 **Type** Quadrat: 30m x 85m
MGA Zone 50 515964 **mE** 7720615 **mN**
Habitat Dune blowout.
Soil Coarse sand.
Vegetation *Acacia bivenosa* and *A. coriacea* subsp. *coriacea* shrubland over *Rhagodia eremaea* low open shrubland over *Triodia epactia* scattered hummock grasses and **Cenchrus ciliaris* open tussock grassland.
Vegetation Condition Poor
Fire > 5 years since fire.

Cape Lambert Site CLE04

Described R. Orifici, H. Marmarac **Date** 5/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 515972 **mE** 7720681 **mN**
Habitat Primary dune.
Soil Fine dune sand mixed with silica (aeolian).
Vegetation *Spinifex longifolius* open hummock grassland with an open tussock grassland of mixed species; *Whiteochloa airoides*, *Eulalia aurea* and **Cenchrus ciliaris*.
Vegetation Condition Good.
Fire Unburnt

Cape Lambert Site CLE05

Described B. Mathews, J. Fairhead **Date** 6/10/2007 **Type** Quadrat: 25m x 100m
MGA Zone 50 517520 **mE** 7722265 **mN**
Habitat Above a cliff on a gentle coastal exposed slope.
Soil Red brown clay loam.
Rock Type Ironstone.
Vegetation *Triodia epactia* hummock grassland and **Cenchrus ciliaris* scattered tussock grasses.
Vegetation Condition Very good, some *Cenchrus*, a lot dead.
Fire > 5 years since fire.

Cape Lambert Site CLE06

Described R. Orifici, H. Marmarac **Date** 6/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 517663 **mE** 7722316 **mN**
Habitat Low lying area/basin at base of rocky hill/ outcrop (natural, rather than an excavated feature).
Soil Fine to medium grained sand with small amount of loam. Medium brown colour, shallow soil layer over hard packed calcrete.
Rock Type ? Calcrete
Vegetation *Acacia ampliceps* and *A. bivenosa* tall closed scrub over *A. coriacea* subsp. *coriacea* tall open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* open tussock grassland.
Vegetation Condition Good- understorey is highly infested with **Cenchrus ciliaris*.
Fire Unburnt
Notes GPS accuracy to 5m

Cape Lambert Site CLE07

Described B. Mathews, J. Fairhead **Date** 6/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 515508 **mE** 7718801 **mN**
Habitat Exposed rocky hillcrest and slopes.
Soil Red brown clay loam.
Rock Type Iron stone.
Vegetation *Triodia wiseana* hummock grassland.
Vegetation Condition Good to Very Good
Fire Unburnt in last 5 years

Cape Lambert Site CLE08

Described R. Orifici, H. Marmarac **Date** 6/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 515256 **mE** 7718805 **mN**
Habitat Low lying clay saline area.
Soil Shallow surface of silt with underlying deep clay.
Rock Type Basalt
Vegetation *Halosarcia halocnemoides* subsp. *tenuis* and *H. indica* subsp. *leiostachya* low samphire shrubland with *Frankenia ambita* and *Muellerolimon salicorniaceum* low open shrubland.
Vegetation Condition Excellent
Fire Unburnt
Notes GPS accuracy = 7-8m. Elevation = 0m ASL

Cape Lambert Site CLE09

Described B. Mathews, H. Marmarac **Date:** 6/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 513929 **mE** 7715910 **mN**
Habitat Coastal flood plain.
Soil Dark brown clay loam.
Vegetation *Acacia ampliceps* tall shrubland over *Sporobolous virginicus* closed tussock grassland.
Vegetation Condition Very good.
Fire Unburnt

Cape Lambert Site CLE10

Described R. Orifici, H. Marmarac **Date** 6/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 513913 **mE** 7716049 **mN**
Habitat Low lying, saline drainage area just above sea level. Flat area surrounded by gentle slopes.
Vegetation *Sesbania cannabina* tall open herbland over *Sporobolous virginicus* closed tussock grassland.
Vegetation Condition Excellent
Fire Unburnt

Cape Lambert Site CLE11

Described J. Fairhead, H. Marmarac **Date** 7/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514083 **mE** 7716481 **mN**
Habitat Rocky hillcrest.
Soil Red brown clay.
Rock Type Iron stone.
Vegetation *Triodia epactia* and *T. wiseana* hummock grassland with *Themeda triandra* very open tussock grassland.
Vegetation Condition Good
Fire > 5 years since fire

Cape Lambert Site CLE12

Described R. Orifici **Date** 7/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 513900 **mE** 7716262 **mN**
Habitat Low rocky ridge and its upper slopes. Adjacent to lower lying saline drainage areas at or just above sea level.
Soil Skeletal, red loamy clay.
Rock Type ? Granite/ ironstone
Vegetation *Acacia inaequilatera* open shrubland over *Triodia epactia* and *T. wiseana* hummock grassland.
Vegetation Condition Very Good- **Cenchrus* present on lowest part of slope of western boundaries as vegetation grades into *Triodia* plain.
Fire Unburnt
Notes GPS accuracy = 5m. Altitude at NE corner of quadrat = 8m. ASL

Cape Lambert Site CLE13

Described R. Orifici, H. Marmarac **Date** 8/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514119 **mE** 7717506 **mN**
Habitat Coastal, aeolian, white sandy primary dune adjacent to tidal mangrove zone.
Soil White, coastal, large grained quartz, aeolian sand.
Vegetation *Acacia coriacea* subsp. *coriacea* tall shrubland over **Cenchrus ciliaris* open tussock grassland.
Vegetation Condition Poor
Fire Unburnt
Notes GPS accuracy to 1m. Elevation at NW corner = 1-2m. Vehicle track cuts through NE corner of quadrat.

Cape Lambert Site CLE14

Described B. Mathews, J. Fairhead **Date** 8/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514267 **mE** 7717787 **mN**
Habitat Low, coastal, primary sand dune adjacent to mangrove community and incoming tides.
Soil White sand.
Vegetation *Acacia ampliceps* and *A. coriacea* subsp. *coriacea* tall shrubland over *Rhagodia preissii* subsp. *obovata* and *Scaevola cunninghamii* low open shrubland over **Cenchrus ciliaris* very open tussock grassland.
Vegetation Condition Good
Fire >5 years since fire.

Cape Lambert Site CLE15

Described J. Fairhead, H. Marmarac **Date** 8/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514099 **mE** 7716374 **mN**
Habitat Rocky hillslope.
Soil Red brown sandy clay.
Rock Type Iron stone.
Vegetation *Triodia epactia* and *T. wiseana* hummock grassland with **Cenchrus ciliaris* very open tussock grassland.
Vegetation Condition Very good.

Fire >5 years since fire

Cape Lambert Site CLE16

Described B. Mathews, R. Orifici **Date** 8/10/2007 **Type** Quadrat: 50m x 50m

MGA Zone 50 514204 **mE** 7716385 **mN**

Habitat Flat, piedmont zone at base of hill, between rail line and hillslope.

Soil Red, alluvial, fine grained clayey loam.

Rock Type Ironstone.

Vegetation *Acacia stellaticeps* open heath over *Triodia epactia* and *T. schinzii* open hummock grassland.

Vegetation Condition Very Good

Fire > 5-7 years since fire.

Cape Lambert Site CLE17

Described J. Fairhead, H. Marmarac **Date** 8/10/2007 **Type** Quadrat: 50m x 50m

MGA Zone 50 515872**mE** 7719503**mN**

Habitat Gentle stoney slope.

Soil Red brown stoney clay.

Vegetation *Triodia epactia* and *T. wiseana* hummock grassland with **Cenchrus ciliaris* very open tussock grassland.

Vegetation Condition Very good.

Fire > 5-7 years since fire.

Cape Lambert Site CLE18

Described B. Mathews, R. Orifici **Date** 9/10/2007 **Type** Quadrat: 50m x 50m

MGA Zone 50 515723**mE** 7719756**mN**

Habitat West facing, secondary coastal sand dune.

Soil Pale brown, fine grained dune sand.

Vegetation *Acacia coriacea* subsp. *coriacea* tall open shrubland over *Tephrosia rosea* var. *venulosa* ms. low open shrubland over mostly **Cenchrus ciliaris* open tussock grassland.

Vegetation Condition Poor

Fire > 5-7 years since fire.

Notes *Swainsona formosa* recorded on roadside near site. Photo of quadrat taken from the SW corner. Vehicle wheel tracks seen in W boundary area of quadrat.

Cape Lambert Site CLE19

Described B. Mathews, J. Fairhead **Date** 9/10/2007 **Type** Quadrat: 50m x 50m

MGA Zone 50 515323 **mE** 7719393 **mN**

Habitat Minor plain below low hills.

Soil Pale brown sandy loam.

Vegetation *Acacia bivenosa* open shrubland over *Triodia angusta* and *T. epactia* open hummock grassland and **Cenchrus ciliaris* open tussock grassland.

Vegetation Condition Poor, lots of **Cenchrus*.

Fire > 5-7 years since fire.

Cape Lambert Site CLE20

Described R. Orifici, J. Fairhead **Date** 9/10/2007 **Type** Quadrat: 50m x 50m

MGA Zone 50 515209 **mE** 7719353 **mN**

Habitat Rocky hillslope, upper slope and crest.

Soil Shallow, skeletal red brown clay over outcropping ironstone.

Vegetation *Triodia wiseana* hummock grassland with **Cenchrus ciliaris* very open tussock grassland.

Vegetation Condition Good.

Fire Unburnt in 5-7 years

Cape Lambert Site CLE21

Described B. Mathews, J. Fairhead **Date** 9/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 515052 **mE** 7718901 **mN**
Habitat Broad saltmarsh plain.
Soil Saline sandy clay
Vegetation *Halosarcia halocnemoides* subsp. *tenuis* and *H. indica* subsp. *leiostachya* low open samphire heath over *Muellerolimon salicorniaceum* low shrubland.
Vegetation Condition Excellent
Fire Unburnt

Cape Lambert Site CLE22

Described R. Orifici, H. Marmarac **Date** 9/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514904 **mE** 7719044 **mN**
Habitat Interzone saline area between secondary coastal sand dunes, low lying samphire saline flat and rocky hillslope area.
Soil Silty, pale brown clayey loam.
Vegetation *Triodia angusta* hummock grassland with *Sporobolus virginicus* tussock grassland.
Vegetation Condition Good to very good- some **Cenchrus ciliaris*.
Fire Unburnt in the last 7+ years

Cape Lambert Site CLE23

Described B. Mathews, J. Fairhead **Date** 10/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514591 **mE** 7718922 **mN**
Habitat Low dune.
Soil Fine, white- brown sand.
Vegetation *Crotalaria cunninghamii* and *Acacia coriacea* subsp. *coriacea* open shrubland over *Santalum lanceolatum* and **Aerva javanica* low open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* and *Whiteochloa airoides* open tussock grassland.
Vegetation Condition Good- lots **Cenchrus*, however quite diverse.
Fire > 5 years since fire

Cape Lambert Site CLE24

Described R. Orifici, J. Fairhead **Date** 10/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 516758 **mE** 7721337 **mN**
Habitat Secondary coastal sand dune.
Soil Pale grey brown, aeolian dune sand.
Rock Type Limestone and accreted dune sand.
Vegetation *Acacia coriacea* subsp. *coriacea* and *A. bivenosa* shrubland over *Scaevola sericophylla* and *S. spinescens* low open shrubland over *Triodia epactia* open hummock grassland and **Cenchrus ciliaris* open tussock grassland.
Vegetation Condition Poor
Fire Unburnt in last 7 years

Cape Lambert Site CLE25

Described B. Mathews, H. Marmarac **Date** 10/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514963 **mE** 7719409 **mN**
Habitat Narrow plain between low coastal dune community and low spinifex hill complex.
Soil Unconsolidated limestone sediment, pale to medium brown, shells on surface.
Vegetation *Acacia coriacea* subsp. *coriacea* tall shrubland over *Rhagodia eremea*, *Aerva javanica*, *Sida rohlenae* scattered shrubs over *Trianthema turgidifolia* low shrubland over **Cenchrus ciliaris* open tussock grassland.
Vegetation Condition Good- weeds present
Fire Unburnt in last 5 years

Cape Lambert Site CLE26

Described B. Mathews, H. Marmarac **Date** 11/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514963 **mE** 7719409 **mN**
Habitat Small rocky hillcrest.
Rock Type Ironstone.
Vegetation *Triodia wiseana* and *T. epactia* hummock grassland.
Vegetation Condition
Fire > 5 years since fire.

Cape Lambert Site CLE27

Described B. Mathews, R. Orifici **Date** 11/10/2007 **Type** Quadrat: 50m x 50m
MGA Zone 50 514895 **mE** 7719525 **mN**
Habitat Secondary coastal sand dune.
Soil Aeolian, pale brown beach dune with fine shell grits on surface.
Vegetation *Acacia coriacea* subsp. *coriacea* tall shrubland over *Santalum lanceolatum* low open shrubland over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* very open tussock grassland.
Vegetation Condition
Fire Unburnt in last 7 years

Cape Lambert Site CLE28

Described R. Orifici, J. Fairhead **Date** 11/10/2007 **Type** Quadrat: 25m x 100m
MGA Zone 50 516558 **mE** 7720348 **mN**
Habitat Saline interzone gently sloping to saline drainage area at sea level with samphires.
Soil Pale brown silty clay.
Vegetation *Sporobolus virginicus* closed tussock grassland with *Hemichroa diandra* low open shrubland.
Vegetation Condition Excellent
Fire Unburnt

Cape Lambert Site CLE29

Described R. Orifici, P. Hoffman **Date** 10/03/2008 **Type** Quadrat: 50m x 50m
MGA Zone 50 516518 **mE** 7720840 **mN**
Habitat Low-lying semi saline drainage area.
Soil Fine brown, silt-clay.
Vegetation *Pluchea rubelliflora* low shrubland over *Sporobolus virginicus* open tussock grassland, *Triodia angusta* very open hummock grassland and *Trianthema triquetra* very open herbland.
Vegetation Condition Excellent
Fire Unburnt in the last 5 years.
Notes Algal matting covering site.

Cape Lambert Site CLE30

Described R. Orifici, J. Fairhead **Date** 10/03/2008 **Type** Quadrat: 50m x 50m
MGA Zone 50 517071 **mE** 7721498 **mN**
Habitat Primary dune upper slope and leeward side sloping down into swale. Mostly swale; NW corner in primary dune.
Soil Fine grained, red-brown secondary dune sand over hard packed red-brown loam.
Vegetation *Acacia bivenosa* tall open shrubland over *Acacia stellaticeps* low open shrubland over *Triodia epactia* very open hummock grassland and **Cenchrus ciliaris* tussock grassland.
Vegetation Condition Poor to Very Poor due to high level of **Cenchrus ciliaris* cover.
Fire > 7 years since fire.

Cape Lambert Site CLES31

Described B. Mathews, P. Hoffman **Date** 11/03/2008 **Type** Quadrat: 50m x 50m
MGA Zone 50 515317 **mE** 7719725 **mN**
Habitat Interzone between two north facing secondary dune systems.
Soil Pale brown sand.
Vegetation *Acacia coriacea* subsp. *coriacea* tall open shrubland over **Cenchrus ciliaris* open tussock grassland and *Triodia epactia* very open hummock grassland.
Vegetation Condition Poor to Good
Fire 7-10 years since fire

Cape Lambert Site CLES32

Described R. Orifici, J. Fairhead **Date** 11/03/2008 **Type** Quadrat: 50m x 50m
MGA Zone 50 515694 **mE** 7719396 **mN**
Habitat Hill swale area between low rocky rises on leeward side of secondary sand dunes.
Soil Fine grained, dark red-brown clayey loam.
Rock Type Ironstone on rocky low hills surrounding quadrat.
Vegetation *Acacia bivenosa* scattered shrubs over *Triodia epactia* hummock grassland and **Cenchrus ciliaris* very open tussock grassland.
Vegetation Condition Poor to Good
Fire > 5 years since fire

Appendix 3

Vascular Flora Species Recorded from the Cape Lambert Port B Development Flora and Vegetation Survey



Cape Lambert Port B Development

* denotes introduced species (weeds)

Correspondence of *Cassia* / *Senna* nomenclature

Cassia glutinosa – *Senna glutinosa* subsp. *glutinosa*
Cassia helmsii – *Senna artemisioides* subsp. *helmsii*
Cassia notabilis – *Senna notabilis*
Cassia oligophylla – *Senna artemisioides* subsp. *oligophylla*
Cassia pruinosa – *Senna glutinosa* subsp. *pruinosa*

| | | | |
|------|---|--|--|
| 110 | <u>Aizoaceae</u> | | <u>Cleome viscosa</u> |
| | <i>Trianthema triquetra</i> | | 113 |
| | <i>Trianthema turgidifolia</i> | | <u>Caryophyllaceae</u> |
| 106 | <u>Amaranthaceae</u> | | <i>Polycarpaea longiflora</i> |
| | * <i>Aerva javanica</i> | | 105 |
| | <i>Amaranthus undulatus</i> | | <u>Chenopodiaceae</u> |
| | <i>Gomphrena affinis</i> subsp. <i>pilbarensis</i> | | <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> |
| | <i>Gomphrena cunninghamii</i> | | <i>Halosarcia auriculata</i> |
| | <i>Hemichroa diandra</i> | | <i>Halosarcia halocnemoides</i> subsp. <i>tenuis</i> |
| | <i>Ptilotus astrolasius</i> var. <i>astrolasius</i> | | <i>Halosarcia indica</i> subsp. <i>leiostachya</i> |
| | <i>Ptilotus axillaris</i> | | <i>Neobassia astrocarpa</i> |
| | <i>Ptilotus exaltatus</i> var. <i>exaltatus</i> | | <i>Rhagodia eremaea</i> |
| | <i>Ptilotus polystachyus</i> var. <i>arthrotrichus</i> | | <i>Rhagodia preissii</i> subsp. <i>obovata</i> |
| | <i>Ptilotus villosiflorus</i> | | <i>Salsola tragus</i> |
| 054F | <u>Anthericaceae</u> | | <i>Threlkeldia diffusa</i> |
| | <i>Corynotheca pungens</i> | | 307 |
| 281 | <u>Apiaceae</u> | | <u>Convolvulaceae</u> |
| | <i>Trachymene oleracea</i> subsp. <i>oleracea</i> | | <i>Bonamia linearis</i> |
| 033 | <u>Arecaceae</u> | | <i>Bonamia media</i> var. <i>villosa</i> |
| | * <i>Phoenix dactylifera</i> | | <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> |
| 345 | <u>Asteraceae</u> | | <i>Ipomoea muelleri</i> |
| | <i>Flaveria australasica</i> | | <i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i> |
| | <i>Pentalepis trichodesmoides</i> | | <i>Ipomoea polymorpha</i> |
| | <i>Pluchea ferdinandi-muelleri</i> | | <i>Polymeria calycina</i> |
| | <i>Pluchea rubelliflora</i> | | 337 |
| | <i>Pluchea</i> sp. B Kimberley Flora | | <u>Cucurbitaceae</u> |
| | <i>Pterocaulon sphacelatum</i> | | <i>Cucumis maderaspatanus</i> |
| | <i>Pterocaulon sphaeranthoides</i> | | 032 |
| | <i>Streptoglossa decurrens</i> | | <u>Cyperaceae</u> |
| 310 | <u>Boraginaceae</u> | | <i>Cyperus blakeanus</i> |
| | <i>Heliotropium pachyphyllum</i> | | <i>Cyperus bulbosus</i> |
| | <i>Trichodesma zeylanicum</i> var. <i>grandiflorum</i> | | <i>Fimbristylis dichotoma</i> |
| 138 | <u>Brassicaceae</u> | | <i>Fimbristylis microcarya</i> |
| | <i>Lepidium pedicellosum</i> | | 185 |
| 164 | <u>Caesalpiniaceae</u> | | <u>Euphorbiaceae</u> |
| | <i>Cassia glutinosa</i> | | <i>Adriana urticoides</i> var. <i>urticoides</i> |
| | <i>Cassia notabilis</i> | | <i>Euphorbia biconvexa</i> |
| | <i>Cassia</i> aff. <i>oligophylla</i> (thinly sericeous) x <i>glutinosa</i> | | <i>Euphorbia careyi</i> |
| | <i>Cassia oligophylla</i> x <i>helmsii</i> | | <i>Euphorbia coghlanii</i> |
| | <i>Cassia pruinosa</i> | | <i>Euphorbia</i> aff. <i>myrtoides</i> |
| 137A | <u>Capparaceae</u> | | <i>Euphorbia</i> sp. (D105-1) |
| | <i>Capparis spinosa</i> var. <i>nummularia</i> | | <i>Euphorbia tannensis</i> subsp. <i>eremophila</i> |
| | | | <i>Phyllanthus maderaspatensis</i> |
| | | | 236 |
| | | | <u>Frankeniaceae</u> |
| | | | <i>Frankenia ambita</i> |
| | | | 341 |
| | | | <u>Goodeniaceae</u> |
| | | | <i>Goodenia microptera</i> |
| | | | <i>Goodenia stobbsiana</i> |
| | | | <i>Scaevola amblyanthera</i> var. <i>centralis</i> |
| | | | <i>Scaevola crassifolia</i> |

- Scaevola cunninghamii*
Scaevola sericophylla
Scaevola spinescens
313 Lamiaceae
 **Vitex trifolia* var. *subtrisecta*
131 Lauraceae
Cassytha capillaris
265 Lythraceae
Ammannia baccifera
221 Malvaceae
Abutilon dioicum
Abutilon lepidum
Abutilon aff. *lepidum* (3) (MET 16,120)
Abutilon otocarpum
Gossypium australe (Burrup Peninsula form)
Hibiscus aff. *coatesii* (site 664)
Hibiscus leptocladus
Hibiscus sturtii var. *campylochlamys*
Lawrenzia viridigrisea
Sida aff. *fibulifera* (HD148-13)
Sida aff. *fibulifera* (MET 16,494)
Sida aff. *fibulifera* (oblong; MET 15,220)
Sida pilbarensis (ferruginous form)
Sida rohlenae subsp. *rohlenae*
- 013 Marsileaceae
Marsilea exarata
Marsilea hirsuta
122 Menispermaceae
Tinospora smilacina
163 Mimosaceae
Acacia ampliceps
Acacia arida
Acacia bivenosa
Acacia bivenosa x *ampliceps*
Acacia colei var. *colei*
Acacia coriacea subsp. *coriacea*
Acacia elachantha
Acacia gregorii
Acacia inaequilatera
Acacia melleodora
Acacia pyrifolia
Acacia sabulosa
Acacia sclerosperma subsp. *sclerosperma*
Acacia stellaticeps
Acacia synchronicia
Acacia trachycarpa
Acacia tumida var. *pilbarensis*
Dichrostachys spicata
110A Molluginaceae
Mollugo molluginea
087 Moraceae
Ficus aculeata var. *indecora*
Ficus brachypoda
326 Myoporaceae
Myoporum montanum
- 273 Myrtaceae
Corymbia hamersleyana
Eucalyptus camaldulensis var. *obtusa*
107 Nyctaginaceae
Boerhavia burbridgeana
Boerhavia gardneri
Commicarpus australis
301 Oleaceae
Jasminum didymum subsp. *lineare*
165 Papilionaceae
Canavalia rosea
Crotalaria cunninghamii
Crotalaria novae-hollandiae subsp. *novae-hollandiae*
Crotalaria ramosissima
Cullen leucochaites
Cullen stipulaceum
Indigofera colutea
Indigofera linifolia
Indigofera linnaei
Indigofera monophylla (Burrup form)
Indigofera trita
Lotus cruentus
Rhynchosia minima
Sesbania cannabina
Swainsona formosa
Swainsona pterostylis
Tephrosia aff. *densa*
Tephrosia aff. *supina* (HD 133-20)
Tephrosia aff. *supina* (OGBP 45-006)
Tephrosia rosea var. *clementii*
Tephrosia rosea var. *venulosa* ms
Tephrosia ? *simplicifolia*
Vigna lanceolata
294 Plumbaginaceae
Muellerolimon salicorniaceum
031 Poaceae
Aristida holathera var. *holathera*
 **Cenchrus ciliaris*
 **Chloris barbata*
Chrysopogon fallax
Cymbopogon ambiguus
Enneapogon caeruleus
Eragrostis dielsii
Eragrostis eriopoda
Eragrostis aff. *eriopoda*
Eragrostis falcata
Eragrostis pergracilis
Eragrostis xerophila
Eriachne gardneri
Eriachne helmsii
Eriachne obtusa
Eulalia aurea
Iseilema dolichotrichum
Panicum decompositum
Spinifex longifolius
Sporobolus virginicus
Themeda triandra

Themeda ? sp. Mt. Barricade (M.E.
Trudgen 2471)
Triodia angusta
Triodia epactia
Triodia schinzii
Triodia wiseana
Triraphis mollis
Whiteochloa airoides
111 Portulacaceae
**Portulaca oleracea*
090 Proteaceae
Grevillea pyramidalis subsp.
leucadendron
Hakea chordophylla
Hakea lorea subsp. *lorea*
092 Santalaceae
Santalum lanceolatum
207 Sapindaceae
Diplopeltis eriocarpa
315 Solanaceae
Solanum diversiflorum
Solanum ellipticum
Solanum horridum
202 Stackhousiaceae
Stackhousia intermedia

223 Sterculiaceae
Waltheria indica
237 Tamaricaceae
**Tamarix aphylla*
220 Tiliaceae
Corchorus aff. *lasiocarpus* subsp. *parvus*
Corchorus parviflorus
Corchorus aff. *parviflorus* (1)(GLDSRH67-
5)
Corchorus aff. *walcotti*
Triumfetta clementii
243 Violaceae
Hybanthus aurantiacus
173 Zygophyllaceae
Tribulus occidentalis

Appendix 4

Priority Flora Recorded from the DEC Threatened Flora Database Search



| GENUS | SPECIES | CONS CODE | SITE | VEGETATION | LOCALITY |
|--------------------|------------------------|-----------|---|--|---|
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | | | Beside road next to Dampier Salt. |
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | | | Dampier Salt Lease. |
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | | | Munda – Karratha. |
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | | | Karratha-Port Headland area |
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | Stony brown loam | | 4km N of NW coastal HWY on rd to Cleaverville beach. |
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | | | ~15km due E of Karratha on rd to Cleaverville bch |
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | Brown, dry clay soil. | | Harding Dam rd, 1.5km from Roebourne. |
| <i>Acacia</i> | <i>glaucochaesia</i> | P3 | Clayey, loam on creek bank. | | 4km N of NW coastal HWY on rd to Cleaverville beach. |
| <i>Gomphrena</i> | <i>pusilla</i> | P2 | Fine beach sand, behind foredune on limestone | | Dampier Peninsula, Port Hedland |
| <i>Goodenia</i> | <i>pascua</i> | P3 | Bunch grass plain. | | 11 miles from Roebourne, Port Hedland Rd. |
| <i>Gymnanthera</i> | <i>cunninghamii</i> | P3 | | | West Lewis Is. Dampier Archipelago. |
| <i>Helichrysum</i> | <i>oligochaetum</i> | P1 | | | Port Walcott, ~10km N of Roebourne. |
| <i>Helichrysum</i> | <i>oligochaetum</i> | P1 | | | Port Walcott, ~10km N of Roebourne. |
| <i>Hibiscus</i> | <i>brachysiphonius</i> | P3 | Creekline | | Karratha beside creekline also at Cleaverville turnoff. |
| <i>Rhynchosia</i> | <i>bungarensis</i> | P3 | Crevices in rock piles. | | Near quadrant on cutting along rd to Con. Camp Burrup Peninsula. |
| <i>Rhynchosia</i> | <i>bungarensis</i> | P3 | Rocky outcrop atop rocky slopes. | | One Shack Bay, East Lewis Island. |
| <i>Stackhousia</i> | <i>clementii</i> | P1 | Edge of estuarine area | | Water Corp service corridor, near Karratha. |
| <i>Stackhousia</i> | <i>clementii</i> | P1 | | | King Bay-Hearson Cove tidal inlet, Burrup Peninsula. |
| <i>Terminalia</i> | <i>supranitifolia</i> | P3 | Rocky slope over a river bed. | | Above Munni Munni creek, ~5 km due S of Cherrata Homestead. |
| <i>Terminalia</i> | <i>supranitifolia</i> | P3 | White sand. | | Base hills right hand side Dampier Island, near Dampier Salt lease. |
| <i>Terminalia</i> | <i>supranitifolia</i> | P3 | Base of basalt ridge. | | 1.8 miles from Dampier rd to Hearson Cove, Nickol Bay. |
| <i>Terminalia</i> | <i>supranitifolia</i> | P3 | Rock pile. | | Near Dampier. |
| <i>Terminalia</i> | <i>supranitifolia</i> | P3 | Rock piles. | | King Bay- Withnell Bay rd, peninsula bw Dampier and Dolphin Bay Island. |
| <i>Terminalia</i> | <i>supranitifolia</i> | P3 | | | Various locations on the Burrup Peninsula x 30 sites |
| <i>Themeda</i> | sp. Hamersley Station | P3 | Cracking clay plain. | <i>Eragrostis xerophila</i> grassland. | 10km W of Karratha on rd to Dampier. |

Appendix 5

Species by Site Matrix for the Cape Lambert Port B Development Area



| NAME | CLE 01 | CLE 02 | CLE 03 | CLE 04 | CLE 05 | CLE 06 | CLE 07 | CLE 08 | CLE 09 | CLE 10 | CLE 11 | CLE 12 | CLE 13 | CLE 14 | CLE 15 | CLE 16 | CLE 17 | CLE 18 | CLE 19 | CLE 20 | CLE 21 | CLE 22 | CLE 23 | CLE 24 | CLE 25 | CLE 26 | CLE 27 | CLE 28 | CLE OPP | CLES 29 | CLES 30 | CLES 31 | CLES 32 | |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|--|
| <i>Cleome viscosa</i> | | + | + | | | | + | | | + | + | | + | + | + | | | + | + | + | | | + | + | | + | | | + | + | + | + | | |
| <i>Commicarpus australis</i> | | | + | + | | | | | | | | | | + | + | | | | | | | | + | | | | | | | | | | | |
| <i>Corchorus</i> aff. <i>lasiocarpus</i> subsp. <i>parvus</i> | | | | | | | | | | | | | | | | | | | | | | | | | | nc | | | | | | | | |
| <i>Corchorus parviflorus</i> | | | | | + | + | | | | | | 1% | | | | | | | | | | | | | + | | | | nc | | | | | |
| <i>Corchorus</i> aff. <i>parviflorus</i> (1)(GLD SRH67-5) | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Corchorus</i> aff. <i>walcottii</i> | + | | + | | | | | | | | | | | | | | 1% | + | + | + | | | | + | + | + | | nc | | + | | + | | |
| <i>Corymbia hamersleyana</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | nc | | | | | | |
| <i>Corynotheca pungens</i> | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | | | | | |
| <i>Crotalaria cunninghamii</i> | | | 3% | | | | | | | | | | | | | | | 1-2% | | | | | 2% | | | | + | | | | | + | | |
| <i>Crotalaria novae-hollandiae</i> subsp. <i>novae-hollandiae</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Crotalaria ramosissima</i> | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | nc | | | | | |
| <i>Cucumis maderaspatanus</i> | | | | | + | + | + | | | | + | | | | + | | | | | | + | | | | + | + | | | | | | | | |
| <i>Cullen leucochaites</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | nc | | | | | |
| <i>Cullen stipulaceum</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | nc | | | | | |
| <i>Cymbopogon ambiguus</i> | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Cyperus blakeanus</i> | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | |
| <i>Cyperus bulbosus</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | + | <1% | | 1% | | | | |
| <i>Dichrostachys spicata</i> | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | nc | | | | <1% | |
| <i>Diplopeltis eriocarpa</i> | | | | | | | | | | | | <1% | | | | | | | | | | | | | | + | | | | | | | | |
| <i>Enchylaena tomentosa</i> var. <i>tomentosa</i> | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | |
| <i>Enneapogon caerulescens</i> | | | | | | | + | | | | | | | | | | | | | | | | | | | + | | | | | | | | |
| <i>Eragrostis dielsii</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | nc | | | | | |
| <i>Eragrostis eriopoda</i> | | | + | | | | | | | nc | | <1% | | | + | + | | + | | | | | | + | | + | | | nc | | | | + | |
| <i>Eragrostis aff. eriopoda</i> | | | | | | | | | | 1% | | | | | | | | | | | | | | | | | | | nc | | | | | |
| <i>Eragrostis falcata</i> | | | | | | | | 1-2% | | | | | | | | | | | | | | + | | | | | | + | | | | | | |
| <i>Eragrostis pergracilis</i> | | | | | | | | | | <1% | | | | | | | | | | | | | | | | | | + | | | | | | |
| <i>Eragrostis xerophila</i> | | | | | | | | | | <1% | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Eriachne gardneri</i> | | | | + | | | | | | | | | | | | | | | | | | | | | | nc | | | | | | | | |
| <i>Eriachne helmsii</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | 1% | | | | | | | |
| <i>Eriachne obtusa</i> | | | | | | | | + | | | | | | | | 1% | | | | | | | | | | | | | | | | | | |
| <i>Eucalyptus camaldulensis</i> var. <i>obtusa</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | |
| <i>Eulalia aurea</i> | | | | 2-3% | | | | | | | | + | + | | | | | | | | | | <1% | | | + | | | | | | | | |
| <i>Euphorbia biconvexa</i> | | | | | | + | + | | | | | + | | | | | + | | | | | | | | | + | | | | | | | | |
| <i>Euphorbia careyi</i> | | | | | | + | | | | | 1% | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Euphorbia coghlanii</i> | | + | + | 1-2% | | | | | | | | | | + | + | | | | | | | | | | | | + | | nc | | | | + | |
| <i>Euphorbia aff. myrtoides</i> | | | | + | | | | | | | | | nc | + | | | | | | | | | | + | | | | | | | | | | |
| <i>Euphorbia tannensis</i> subsp. <i>eremophila</i> | | | | | | | | | | | | | + | | | | | | | | | | | + | + | | | + | | | | | | |
| <i>Euphorbia</i> sp. (D105-1) | | | | | | | | | | | | | | | | | + | | | | | | | | | | | | nc | | | | | |
| <i>Evolvulus alsinoides</i> var. <i>villosicalyx</i> | | | | | | | + | | | | + | | | | + | + | | | | | | | | + | | + | | | | | | | | |
| <i>Ficus aculeata</i> var. <i>indecora</i> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Ficus brachypoda</i> | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | nc | | | | | |
| <i>Fimbristylis dichotoma</i> | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | |
| <i>Fimbristylis microcarya</i> | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | |
| <i>Flaveria australasica</i> | | | | | + | nc | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <i>Frankenia ambita</i> | | | | | | | | 2-3% | | | | | | | | | | | | | | 1% | 2% | | | | | 1% | + | | | | | |

