ENVIRONMENTAL ASSESSMENT
LOT M1482 ALKIMOS
LOCAL STRUCTURE PLAN

Prepared for

Peet Limited

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Prepared by

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Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between Peet Limited ('the Client') and ENV.Australia Pty Ltd (ENV) ("scope of services"). In some circumstances the scope of services may have been limited by factors such as time, budget, access and/or site disturbance constraints.

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EXECUTIVE SUMMARY

Aklimos-Eglinton is an area of approximately 2660 ha of coastal land between Butler and Yanchep, 40 km north of Perth. The land is zoned as Urban under the Metropolitan Region Scheme.

After the rezoning of the land from Rural to Urban, Metropolitan Scheme Amendment 1029/33 was referred to the Environmental Protection Authority for assessment, and an Environmental Review was prepared in 2005. Following the Metropolitan Region Scheme Amendment, the areas of environmental significance identified by the Environmental Protection Authority were reserved for Parks and Recreation and Public Purposes.

A District Structure Plan was prepared for the area by the Department of Planning and Infrastructure in 2006.

The site, Lot M1482, is bounded to the west by the Indian Ocean, to the east by the proposed Mitchell Freeway extension, and to the north and south by other proposed residential developments. Lot M1482 is an area of 244 ha, or approximately 10% of the larger Alkimos-Eglinton District Structure Plan area.

This report is based on the work done for the site in the preparation of the District Structure Plan and on flora and fauna survey work carried out by ENV Australia Pty Ltd on Lot M1482. The report includes recommendations for environmental management of the site related to the proposed development.

The major environmental issues for the site are as follows:

- the geoheritage of the dune land form, and in particular the parabolic dunes. The parabolic dune land form that encircles the coastal village will be retained as a natural feature of the development. This includes the northern and southern faces of the northernmost parabolic dunes;

- significant flora, including several small occurrences of the Threatened Ecological Community 26a – *Melaleuca huegleii – Melaleuca systena* shrublands on limestone ridges, a possible Department of Environment and Conservation Priority species (Priority 3/4), and a Bush Forever site. The Bush Forever site lies within the Regional Open Space. The Threatened Ecological Community was found at eight locations in the Local Structure Plan area, including four locations in the Regional Open Space and four in other locations;

- Bush Forever site 397 is incorporated in the coastal reserve and Regional Open Space linkage in the south of the site. Bush Forever site 130 is east of the Mitchell Freeway Reserve, outside the District Structure Plan area, and is therefore not included in the Local Structure Plan; and

- *Banksia* woodland, which provides potential feeding habitat for Carnaby's Black Cockatoo, which is protected as Endangered under the Environment Protection and Biodiversity Conservation Act. Any proposal (including a planning proposal) which has the potential to impact significantly on a species protected by the Environment Protection and Biodiversity Conservation Act must be referred for assessment to the Department of Environment, Water, Heritage and the Arts.

The following recommendations are made for environmental management of the site:

- preserve as much of the dune structure as possible, retaining the broader structure of the landform of the parabolic dunes;

- retain areas that have been identified as Threatened Ecological Communities outside the Regional Open Space within Public Open Space, and protect them during the development phase and from public disturbance in the future through Environmental Management Plans;

- enhanced biodiversity should be sought through green linkages of Public Open Space augmented by native plantings in streetscaping;

- manage the significant vegetation in Regional Open Space and Public Open Space in accordance with Minister's Statement 722, including the development of site-specific Environmental Management Plans prior to subdivision in accordance with Department of Environment and Conservation and Local Government requirements;

- refer the Local Structure Plan for consideration of the project's significance for Carnaby's Black Cockatoos under the Environment Protection and Biodiversity Conservation Act; and

- install fauna crossing points (such as appropriately-designed culverts) under the coastal road to allow the movement of ground-dwelling species between the coastal and east-west Regional Open Space reserves.

1 INTRODUCTION

ENV Australia Pty Ltd ('ENV') was commissioned by Peet Limited to undertake an Environmental Assessment and Report to guide the preparation of the Local Structure Plan ('LSP') for Lot M1482, Alkimos, in the City of Wanneroo. This report, presented here, builds on the environmental assessments completed for the District Structure Plan ('DSP') for Alkimos-Eglinton by others, as well as work undertaken by ENV to inform the preparation of the LSP and the development of the site for residential purposes.

ENV has assessed and mapped the native vegetation, undertaken a fauna habitat assessment and groundwater hydrology at the site. This report provides an overview of geology and soils, hydrology, vegetation and fauna to inform the LSP design for the site. The report also discusses the environmental context of the site, its environmental conditions, and makes recommendations for environmental management of the site.

1.1 SITE DESCRIPTION

Lot M1482 ('the site') is approximately 40 km north-west of the Perth Central Business District, and is bound to the west by the Indian Ocean, to the east by the proposed Mitchell Freeway extension, and to the north and south by other proposed residential developments. Lot M1482 is an area of 244ha, or approximately 10% of the larger Alkimos-Eglinton District Structure Plan Area. This new urban area is expected to grow to approximately 500 homes in the next 10-25 years (RPS BBG 2006).

The site is currently zoned as Urban under the Metropolitan Region Scheme ('MRS'). Following MRS Amendment 1029/33 Alkimos/Eglinton (Figure 1), significant areas of land were reserved as Regional Open Space ('ROS'). This includes areas in the south of the site and the coastal foreshore area along the entire 5.7 km coastline, which is currently reserved for Parks and Recreation.

1.2 PROPOSED DEVELOPMENT

The proposed development is a residential and mixed-used coastal development, consisting predominantly of residential lots, with a district centre and commercial zone. The site includes development of the part of the coastal foreshore area which is currently reserved as ROS, with possible beach parking facilities, recreational facilities and beach access pathways to be included. The development also includes the construction of a north-south local road running through part of the Alkimos ROS corridor in the south-west of the site.

1.3 SCOPE OF WORKS

This report documents the environmental features of the site by reference to previous studies by ENV and others. These include soils and geology, hydrology, flora and vegetation, and fauna habitat, and management recommendations are provided to ensure the environmental impact of the proposed development is minimised.

This report describes the environmental context of the site, opportunities and constraints from an environmental perspective, and outlines how the environmental issues can be managed through the development of the Local Structure Plan.

Environmental Management Plans ('EMPs') are required to manage the potential impacts of urban development of infrastructure on the ROS areas and on vegetation retained in Public Open Space ('POS'). This report provides strategies and recommendations for management of these areas.

2 BACKGROUND

The site is currently zoned as Urban under the MRS. Subsequently, MRS Amendment 1029/33 Alkimos/Eglinton was referred to the Environmental Protection Authority ('EPA'), and an Environmental Review was prepared (Bulletin 1207) in 2005.

Following the gazettal of MRS Amendment 1029/33, the areas of environmental significance identified by the EPA were reserved for Parks and Recreation and Public Purposes in the Alkimos-Eglinton DSP. Part of the Public Purposes reserve associated with the development of a wastewater treatment plant buffer has been identified for conservation, landscape and complementary purposes.

The area reserved for conservation purposes in the MRS occupies approximately 500 ha, or 20% of the Alkimos-Eglinton area. The conservation areas consist of three linkages across the Alkimos-Eglinton area (two east-west linkages and one north-south linkage). The Minister for the Environment set environmental management conditions (Minister's Statement 722) (Appendix A), which must be met for these areas.

The City of Wanneroo Town Planning Scheme ('TPS') No. 2 map will be amended to comply with the MRS. As the TPS Amendment accords with the assessed MRS, it does not require formal assessment by the EPA (for the assessed environmental factors).

The Minister for the Environment's Statement 722 (Appendix A) sets out the following:

> *Prior to approving subdivision or development applications (whichever is sooner) for infrastructure proposals, the Western Australian Planning Commission or Local Government, as the case requires, may require an Environmental Management Plan to be prepared and implemented to achieve the objective of managing the potential impacts of the proposed subdivision development or infrastructure on the following:*
>
> 1. *Land reserved as Regional Open Space; and*
>
> 2. *bushland or land that may be part of an ecological linkage.*

A DSP was prepared for the area by the Department of Planning and Infrastructure ('DPI') in 2006. The DSP carried forward the conditions from Ministerial Statement 722 to the LSP stage.

EMPs for the ROS reserves in the LSP will be developed at subdivision stage in accordance with Department of Environment and Conservation and City of

Wanneroo requirements. (See section 7 for a more detailed discussion on EMPs).

3 GEOLOGY, SOILS AND LANDFORM

The Alkimos area is characterised by significant coastal dunes and coastal heath vegetation. Mapping by McArthur & Bartle (1980) shows that the site consists of two dune systems: Quindalup and Spearwood (See Figure 3). The Spearwood Dunes have a core of Tamala Limestone overlain by sand, and are partially overlaid by the newer Quindalup Dunes. In many places the surface soils have been removed by wind action, exposing the underlying limestone. The Spearwood Dunes are older, more weathered and have less undulation than the Quindalup Dunes. The soil profile of the Spearwood dunes is more developed, supporting *Banksia*, Tuart and Dryandra vegetation. The Quindalup Dunes were formed more recently, and exhibit more undulating and steeper landscape features (RPS BBG, 2006).

3.1 SOILS AND GEOMORPHOLOGY

The Quindalup Dune system is characterised by a series of parabolic dunes, as well as small beach ridges and blowouts. One major dune blowout is located on Lot M1482. The underlying Spearwood Dune System comprises ridges of limestone and quartz sand running parallel to the shore.

Tamala Limestone forms the dominant surface geology from 1-1.5 km inland from the coast to beyond the eastern boundaries of the property. The site comprises sands overlying limestone.

The soils of the site have been mapped by the Geological Survey of Western Australia ('GSWA') Figure 2. GSWA (1986) maps three main soils on the site. The dominant soil types associated with the Quindalup and Spearwood Dune system are as follows:

- (S_2) Calcareous Sand – white, fine- to medium-grained, sub-rounded quartz and shell debris, of eolian origin;
- (S_7) Sand-pale and olive yellow, medium- to coarse-grained, sub-angular quartz with traces of feldspar, moderately sorted, of residual origin; and
- (LS_1) Light yellowish-brown, fine- to coarse-grained, sub-angular to well-rounded, quartz, trace feldspar, shell debris, variable lithified, surface kankar of eolian origin.

  The eastern half of the site soil consists of a grey-brown surface which passes into bright yellow sand, and limestone usually occurs within 2 m of the surface.

The dominant landform/soil types associated with the Quindalup Dune system are as follows:

- Quindalup Oldest Dune Phase (Q1) – this unit occurs as a wall of sand with low relief, a smooth outline and a symmetrical cross-section. It can occur up to 6 km inland. The soil profile is calcareous throughout, has organic matter to at least 30 cm, and white sand below, which shows cementation at about a metre below the surface.

- Quindalup Second Dune Phase (Q2) – Similar to Q1 with slightly higher relief and slightly less organic matter.

- Quindalup Third Dune Phase (Q3) – this unit has steeper slopes and greater relief than Q1 and Q2, with an irregular outline. Organic matter to 10 cm, cementation minimal.

- Quindalup Youngest Dune Phase (Q4) – Generally, dunes are asymmetric with gentle inner slopes and steep outer faces. The outline is very jagged with many deep scallops and irregularities. The soils show very little humus content other than slight organic accumulation at the surface.

- Quindalup Deep Sand Flat Phase (Qp) – nearly flat or gently undulating plains enclosed in parabolic dunes. Soils are dark in colour, with organic matter accumulation to 50 cm, then pale sand, sometimes weakly-cemented, overlying older limestone. These soil types occur predominantly in the western half of the site (RPS BBG, 2006).

3.1.1 Acid Sulphate Soils

Acid Sulphate Soil ('ASS') risk mapping for the northern Perth region (WAPC 2003) indicates that the site is mapped as low to no risk of ASS at greater than 3 m depth. Therefore no ASS investigation is considered necessary for this development.

3.2 TOPOGRAPHY AND LANDFORM

The Alkimos-Eglinton area comprises a north-west to south-east trending undulating dune landscape overlaid by well-defined vegetated dunes. A one-kilometre wide belt of discontinuous dunes is located along the coastal frontage. These dunes have elevations of up to 20-25 m AHD. Further inland, the dunes are less concentrated. Approximately 2.5 km from the coast, there is a long ridge running generally parallel with the coast, with peak elevations of about 55 m AHD. This inland ridge is overlaid in places by further sand dunes extending from the coast in an easterly direction. In the southern portion of the site, a stabilised parabolic dune extends inland for a considerable distance, and forms a dominant landscape feature. In general terms, the younger dune systems

have slopes in the range of 15-25%, and older systems are flatter, with slopes of 0-15%. Central to the site is a large blowout which is denuded of vegetation and highly unstable due to the effects wind erosion.

3.2.1 Geoheritage

The Alkimos parabolic dune system is recognised as having geoheritage significance (RPS BBG, 2006). Most of the Q4 and some of the Q3 dunes are conserved in the foreshore reserve and the east-west ROS reserve. The DSP for the Alkimos-Eglinton area states that LSPs will examine retention of the natural landscape and form of the Q3 parabola dunes in order to preserve the geoheritage of the dunes (V&C Semeniuk Research Group 2004) (RPS BBG, 2006).

3.3 CONCLUSIONS AND RECOMMENDATIONS

The LSP for M1482 aims to preserve as much of the form of the dune structure as possible, whilst providing an appropriate development outcome. Some areas will be required to be cut and filled, however, the structure of the landform and dunes will be retained wherever possible.

The form of parabolic dune that encircles the coastal village will be retained as a natural feature of the development. This includes the northern and southern faces of the northernmost parabolic dunes.

4 HYDROLOGY

4.1 CLIMATE

The Alkimos-Eglinton area experiences a warm Mediterranean-type climate that produces hot, dry summers and mild, wet winters. The mean daily maximum temperatures are approximately 30°C in summer and 17°C in winter, and mean daily minimum temperatures of approximately 18°C in summer and 9°C in winter. Average annual rainfall is approximately 870 mm, of which most falls in June-September, and the average annual evaporation rate is more than 2000 mm (ATA Environmental 2003).

4.2 SURFACE WATER

There are no surface water bodies in the site. The nearest wetlands are Coogee Swamp (1.2 km to the north), Beonoddy Swamp (1 km to the north), Carrabooda Lake (1.1 km to the south-east) and Karli Springs (2.2 km to the south). There are no drainage lines in the site, because of the high infiltration capacity of the deep sands and the dense vegetation.

4.3 GROUNDWATER

There are three Department of Water ('DoW') groundwater monitoring wells within the site, and one monitoring well installed by ENV. The Perth Groundwater Atlas (Water & Rivers Commission 1997, Department of Environment 2004) indicates that groundwater flows from east to west (8 m AHD to less than 1 m AHD) (Figure 4). Groundwater fluctuates seasonally by approximately 1 m, according to the groundwater atlases.

4.3.1 Depth to Groundwater

The shallowest depth to groundwater from the natural surface is 24 m from the highest groundwater level. The base of the superficial formation is approximately -30 m AHD beneath the site. The superficial formation consists of sand over karstic tamala limestone across the site.

4.3.2 Groundwater Quality

Groundwater salinity increases towards the coast (3000-7000 mg/L total dissolved solids ('TDS')), and is lower in the east of the site (0-500 mg/L TDS).

4.4 CONCLUSIONS AND RECOMMENDATIONS

Development, including roads, roofs and other impermeable areas, will increase stormwater runoff on the site. Due to the nature of the soils, topography and the

lack of surface water of the site, disposal of stormwater from development is expected to be relatively uncomplicated. The following strategies are identified for the site:

- all stormwater runoff from the development should be locally infiltrated in road reserves, medians or multiple-use POS;
- drainage in the area should be based on a water-sensitive design approach to maintain the quantity and quality and the longer-term sustainability of the underlying groundwater resource;
- water-sensitive design should incorporate the maximisation of stormwater recharge through diversion of run-off into roadside swales, infiltration trenches and basins, and the maximisation of water quality through retention and planting of vegetation in recharge areas; and
- a local water management strategy ('LWMS') will detail water-related design objectives for the site, including water quality and conservation. Guidelines for the contents of the LWMS are provided by the *Report for Alkimos-Eglinton District Structure Plan: Sustainability Strategy* (GHD 2006).

5 VEGETATION AND FLORA

Vegetation and flora surveys were carried out over parts of the Alkimos-Eglinton site in 1990, 1996, 2002 and 2004. The results of the various surveys and information about the flora and vegetation in Lot 1482 are summarised below.

5.1 VEGETATION

5.1.1 Vegetation Complex

The patterning of plant and animal distributions on the Swan Coastal Plain is closely related to the geology, geomorphology and soils of the plain. The site is located partially on the Quindalup Dunes, which are characterised by vegetation of the Quindalup Complex (west portion of the site close to the coast) and the Spearwood Dunes, characterised by Cottesloe Complex-Central-South (east portion of the site) (Government of Western Australia 2000).

The Quindalup Vegetation Complex has 48% of its pre-clearing extent remaining on the Swan Coastal Plain (Government of Western Australia 2000), with 20% proposed for protection through Bush Forever. The Quindalup Complex is the dune complex consisting mainly of two alliances – the stand and foredune alliance, and the mobile and stable dune alliance. Local variations include the low closed forest of *Melaleuca lanceolata-Callitris preissii* and the closed scrub of *Acacia rostellifera*.

The Cottesloe Complex-Central-South has 36% of its pre-clearing extent remaining (Government of Western Australia 2000), with 18% proposed for protection through Bush Forever. This complex consists of mosaics of woodland of *Eucalyptus gomphocephala* and open forest of *Eucalyptus gomphocephala-Eucalyptus marginata-Corymbia calophylla*; closed heath on the limestone outcrops.

An extensive survey of the bushland on the site by ENV in 2004 identified 41 vegetation communities. Many of the vegetation communities are very similar, but they have different tree species combinations and different dominant understorey species.

5.1.2 Vegetation Communities

The 41 vegetation communities identified by ENV were compared against the Floristic Community Types ('FCTs'), described in Gibson *et al.* (1994) and Bush Forever (Government of Western Australia 2000), to determine what FCTs are in Lot M1482. These are listed below:

FCT 24 – northern Spearwood shrublands and woodlands;

FCT 26a – *Melaleuca huegelii – M. systena* shrublands of limestone ridges;

FCT 28 – spearwood *Banksia attenuata* or *Banksia attenuata – Eucalyptus* woodlands;

FCT 29a – coastal shrublands on shallow sands;

FCT 29b – *Acacia* shrublands on taller dunes;

FCT S13 – northern *Olearia axillaris – Scaevola crassifolia* shrublands; and

FCT S15 – weed group.

(Gibson *et al.* 1994, Government of Western Australia 2000).

5.1.3 Significant Vegetation

The database search undertaken before field work identified FCT 26a as occurring in the area. FCT 26a is listed as a Threatened Ecological Community ('TEC'). It is listed as:

Limestone ridges (SCP 26a) - *Melaleuca huegelii – Melaleuca systena* (formerly *acerosa*) shrublands on limestone ridges (Gibson *et al.* 1994 type 26a). The threat and criteria that FCT 26a is categorised under in Western Australia is **ENDANGERED (EN)**. SCP 26a is not a Commonwealth-listed TEC.

From the data collected during the 2004 vegetation survey, ENV inferred two vegetation communities as being that of FCT 26a (Department of Conservation and Land Management, 2004):

DsMs – 16 Shrubland of *Dryandra sessilis* var*. cygnorum, Xanthorrhoea preissii, Melaleuca systena, Grevillea preissii* subsp. *preissii, Melaleuca huegelii* subsp*. huegelii, Lomandra maritima, Kennedia prostrata, Desmocladus asper* and *Brachyscome iberidifolia* on limestone outcropping; and

StDsAt – 27 Dense Tall Scrub of *Dryandra sessilis* var*. cygnorum* that has been burnt and now consists of Low Open Shrubland of *Scaevola thesioides* subsp*. thesioides, Acacia truncata, Grevillea preissii* subsp*. preissii, Melaleuca systena, Melaleuca huegelii* subsp. *huegelii, Lomandra maritima, Poa porphyroclados, Leucopogon parviflorus, Xanthorrhoea preissii, Opercularia vaginata* and *Dryandra sessilis* var*. cygnorum* with limestone outcropping.

Figure 5 details the locations of the above vegetation community.

These communities are predominantly located in the south and west of the site, in the Quindalup vegetation community. However, one is further east, in the Cottesloe Central and South vegetation community (ENV Australia 2005).

The database search also identified FCTs 29a (Coastal Shrublands on Shallow sands) and 29b (Acacia Shrublands on taller dunes) as classified by Gibson *et al.* (1994) and English & Blyth (1997) as possibly occurring in the area. These two communities are not currently listed as TECs at the State or national level, but they are recommended for listing by the Department of Environment and Conservation ('DEC') and are currently known as Priority Ecological Communities ('PECs').

The 2004 field survey identified 17 vegetation communities that have been inferred as PECs 29a and 29b:

Table 1: Priority Ecological Communities

Vegetation Community	FCT	Vegetation Community	FCT
LmMs- 20	29b	LmPp(D) - 32	29a
LmMsAc- 21	29b	SaAl - 33	29a
XpLmMs- 22	29b	LmSa - 34	29a
LmApAs- 25	29b	OaSg - 36	29a
AlMs- 26	29b	AlSr- 28	29a
LmMsAl - 38	29b	LmMsSa- 39	29a
XpAl - 42	29b	AlLmPp- 29	29a/29b
AsMs - 37	29a/29b	AcRb- 30	24/29b
		AlLmMs- 31	29a/29b

5.1.4 Threatened Ecological Community Confirmation

In Spring 2008, ENV carried out a flora and vegetation survey to attempt to confirm the presence of the suspected Threatened Ecological Communities (TECs) identified in the 2004 survey using quadrats and data analysis. Four quadrats were established in the communities suspected of being TEC 26a across the site (see Appendix F for the data collected and photos taken at each quadrat locations).

The data collected from these quadrats was run through statistical data analysis (Primer) to confirm the Floristic Community Type (FCT). The result of the analysis was inconclusive with the four quadrats having a low (~13%) similarity to six Floristic Community Types. These are as follows (in no particular order):

- 27 – Species poor mallees and Shrublands on limestone
- 26b - Woodlands and mallees on limestone
- 26a – *Melaleuca huegelii – M. systena* Shrublands of limestone ridges
- 29b – Acacia Shrublands on taller dunes
- 24 – Northern Spearwood Shrublands and Woodlands

- 30b – Quindalup *Euclayptus gomphocephala* and/or *Agonis flexuosa* Woodlands

All but one quadrat have been affected by fire as recently as March 2008 with the majority of the species being burnt beyond recognition. At the time of the survey the three affected quadrats were dominated by annuals and the regrowth of previously existing shrubs. Due to the degraded condition of three of the sites, attributed to the fire, species diversity was lower than expected. This is likely to have had a major influence on the outcome of the data analysis.

It is very unlikely that the vegetation communities in question are that of FCTs 26b, 29b or 30b due to species and structural composition. This leaves the possibility of the communities being FCTs 27, 24 and 26a (which is the TEC in question).

Through liaison with the Department of Environment and Conservation (DEC), it has been established that SCP FCT 26a is unlikely to occur within the Quindalup dune system, however, it is possible. Three occurrences of SCP FCT 26a that occur on the Quindalup Dunes system have been identified north of Perth CBD from other surveys and have been entered onto the DEC's TEC database. Floristic Community Type 26a, however, is more likely to occur within the Cottesloe Complex which occurs on the eastern half of the site.

Due to every avenue being undertaken to confirm whether the TEC is on site through performing Primer analysis, comparing species, looking at distribution and liaison with the DEC and still not reaching a definitive answer as to whether there are occurrences of the TEC FCT 26a on site, the next step would be to request that as part of the LSP referral and assessment process a site visit be coordinated with the DEC Species and Communities Branch.

5.1.5 Vegetation Condition

In 2004 vegetation condition on the site was mapped as Pristine to Very Good on the eastern half of the site and as Very Good to Good on the western half. The exception is the large blow-out on the coast (west boundary), which is mapped as Completely Degraded, as there is no vegetation remaining because of severe wind erosion.

The main areas that are degraded because of weeds are the edges of tracks, which act as a medium for introducing weeds into the bushland. This has caused the edges to become dominated by weeds, which are gradually moving further into the bushland. There is a very degraded area, described as vegetation community LoAv- 41 (see Figure 5) that is nearly devoid of native species. The implications for management of the natural environment along the coastline and blow-out area are described later in this report. A large proportion of the vegetation of the site was subject to bushfire in summer 2008.

The condition of the vegetation has been severely impacted by the recent fire which has completely removed the former dense understorey of shrubs leaving only the larger Banksia and Eucalypt overstorey. While some of these trees may recover, it will take a substantial length of time for the site to recover fully. During this period the site will be subject to weed invasion, uncontrolled access and increased fire frequency.

The site is located in a coastal area and such locations are particularly vulnerable to degradation following fires. The typically sparse nature of coastal vegetation, negligible nutrient storage in the soil, the low moisture content of coastal sands and strong on-shore winds make plant establishment following fires difficult.

5.2 FLORA

Forty-four families, 112 genera and 169 taxa were recorded in the survey area. (See Appendix C).

5.2.1 Significant Flora

Previous surveys in the area (DEC, formerly CALM) have identified ten priority species that could occur in the Alkimos-Eglinton area. Of these, Armstrong (1996), Trudgen & Keighery (1990a) and ATA Environmental and Bennett (2004) recorded three priority species in the Alkimos area:

- *Conostylis pauciflora* subsp. ?*euryhipis/pauciflora* P3/P4
- *Stylidium maritimum* P3
- *Hibbertia spicata* subsp. *leptotheca* P3

Of these, only *Conostylis pauciflora* subsp. ?*euryhipis/pauciflora* was located in Lot M1482. There was difficulty in differentiating between several *Conostylis* species in the area, and the *Conostylis* specimens collected in the field were taken to the Western Australian Herbarium for identification. It was found that the specimens shared attributes of three *Conostylis* species: *Conostylis pauciflora* subsp. *euryhipis* (P3), *Conostylis pauciflora* subsp. *pauciflora* (P4) and *Conostylis candicans,* and therefore they could not be identified further. Because of this finding, it should be assumed that the Priority species *Conostylis pauciflora* subsp. *euryrhipis* and *Conostylis pauciflora* subsp. *pauciflora* occur in all of the vegetation communities from which the specimens were collected.

From the surveys undertaken, seven species that are considered significant were located in the site. Significant flora species are of particular interest, as they are rare, poorly known, restricted in distribution or have some other distinctive feature (Government of Western Australia 2000).

The following significant species found by the surveys in the site are listed in the table below, together with the reasons they are considered significant.

Table 2: Significant Species Found by Surveys in Lot M1482

Taxa	Comments
Conospermum triplinervium	Considered poorly reserved, as well as belonging to taxa containing significant populations (p and s taxa) (Government of Western Australia 2000).
Lechenaultia linarioides	Considered poorly reserved (p taxa) (Government of Western Australia 2000).
Melaleuca cardiophylla	(Status unknown). Representative of a species that contains significant populations at the northern or southern limit of its geographic range (r and s taxa) (Government of Western Australia 2000). According to DEC distribution mapping (www.florabase.com), however, this species extends from Perth to Karratha. The precise conservation status of this species is unknown.

p: considered to be poorly reserved

s: significant populations

r: populations at the northern or southern limit of their known geographic range

5.2.2 Introduced Species

Of the 169 species recorded at the site, 19 were introduced. The dominant weed families were Poaceae (5 taxa), Asteraceae (3 taxa) and Iridaceae (3 taxa).

One of the recorded species, *Moraea flaccida* (P1) is listed as a Declared Plant by the Department of Agriculture and Food WA.

Declared Plants ('DP') are listed with a code definition of the requirements for control (P1, P2, P3, P4 or P5). Details of the standard meaning of these codes are presented in Appendix E.

Moraea flaccida is listed as P1, which means the movement of these plants or their seeds is prohibited within the State, and this includes the movement of contaminated machinery and produce, including livestock and fodder. Landholders with declared plants on their property are obliged to control them.

5.3 BUSH FOREVER

Bush Forever is a State Government Policy which aims to identify, preserve and protect representative areas of native vegetation on the Swan Coastal Plain.

Bush Forever site 397 is incorporated in the coastal reserve and ROS corridor in the south of the site. Bush Forever site 130 lies east of the Mitchell Freeway Reserve, outside the DSP area, and therefore is not included in the LSP. Management of the Bush Forever site is discussed under ROS in Section 7.

5.4 LOCAL BIODIVERSITY STRATEGY

The City of Wanneroo Local Biodiversity Strategy was released for public comment in October 2008 sets targets for Biodiversity Conservation across planning precincts. The Target for retention of both Cottesloe Central and South and Quindalup vegetation complexes in the Alkimos Eglingon Precinct is 3% of the total development area. This is for POS for conservation/passive recreation outside of Regional Open Space reserves.

The City requires consideration of the targets in the configuration of POS in the LSP for flora and vegetation conservation and passive recreation, as opposed to being for active recreation such as playing fields. This is above the WAPC Liveable Neighbourhoods policy target of 2%. Conservation areas may be considered for passive recreational areas, given controlled access. This is discussed in more detail under Environmental Management in Section 7. The City has also expressed a desire to see biodiversity enhanced through non-contiguous green linkages between natural areas (Coleen Murphy, pers. comm.). This can be achieved through the location of POS and augmented by native plantings in streetscaping.

5.5 CONCLUSIONS AND RECOMMENDATIONS

The site supports significant flora, including several small occurrences of the TEC 26a – *Melaleuca huegleii – Melaleuca systena* shrublands on limestone ridges and one possible Priority species (P3/4), and a Bush Forever site. The Bush Forever site lies within the ROS. The TEC was found at four locations in the LSP area, and at four locations in the ROS (Figure 7). The area was subject to fire in March 2008, and some of the locations of the TEC may have been destroyed. The site was resurveyed in spring 2008 to ascertain the condition of the TECs and whether they are required to be retained. The conclusion of the survey and data analysis due to fire impacts are inconclusive requiring assessment by the Department of Environment and Conservation.

The following recommendations are made for significant flora at the site:

- areas identified as TECs outside of the ROS should be retained within POS and protected during the development phase, and from public disturbance in the future;
- the City of Draft Wanneroo Local Biodiversity Strategy targets of 3% of the total development for Cottesloe South and Central and Quindalup vegetation complexes are able to be achieved through incorporation of privately owned ROS and Bush Forever.
- biodiversity should be enhanced through green linkages of POS, augmented by native plantings in streetscaping; and
- the protection of the TECs will be discussed in more detail with the Department of Environment and Conservation
- Environmental Management Plans to be developed for the significant vegetation in ROS and POS on the site before subdivision.

6 FAUNA

The fauna habitats in the Alkimos-Eglinton Project Area can be broadly separated into three major types that dominate the area. These are based primarily on the broad vegetation units that strongly reflect the underlying soil types and geomorphic features.

The main fauna habitat types comprise:

- Quindalup Heath;
- Limestone Heath; and
- *Banksia* Woodland

Other habitats constituting a minor portion of the area include heath on the younger Quindalup Dunes, Tuart Woodland, and cleared grassland or pasture.

A vertebrate fauna survey of the Alkimos-Eglinton Project Area was undertaken in October 1996 (ATA Environmental 1996). This survey included a trapping program using Elliott, pitfall and cage traps, as well as bird transect surveys, active searching and opportunistic recordings (RPS Bowman Bishaw Gorham 2006).

The survey recorded one amphibian species, 18 species of reptiles, 49 bird species, and three native and three introduced mammal species. From known distribution and habitat usage, more species may be present in the Alkimos-Eglinton Project Area. The Alkimos-Eglinton area is expected to support relatively high species diversity because of its extent, its range of habitats and the general quality of the habitats, combined with the connectivity of the area to other extensive vegetated areas to the north, south and east.

The list of recorded and expected species includes 35 species identified as having special conservation significance, as they are listed under provisions of the Commonwealth Environment Protection and Biodiversity Act 1999 and the Wildlife Conservation Act 1950, on the DEC's Priority Fauna list or identified as Significant Bird Species in Bush Forever. Species of special significance are summarised in Table 3.

ATA (1998) lists five species of conservation significance at State or Commonwealth level.

Table 3: Species of Special Significance

Species	Wildlife Conservation Act	EPBC Act	DEC Priority List	Preferred Habitat	Observed on site?
Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)	Schedule 1	Endangered		Banksia Woodland	Yes
Peregrine Falcon (*Falco peregrinus*)	Schedule 4			Tuart Woodland	Yes
Southern Carpet Python (*Morelia spilota*)	Schedule 4		Priority 4	Limestone Heath Banksia and Tuart Woodland areas	No
Southern Brown Bandicoot or Quenda (*Isoodon obesulus*)			Priority 4	Favour low (<1 m) dense vegetation	No
Western Brush Wallaby (*Macropus irma*)			Priority 4	Woodland habitats	No

See Appendix G for Fauna conservation Code definitions (Source RPS BBG 2006)

6.1 CARNABY'S BLACK COCKATOO

There is a significant area of Carnaby's Black Cockatoo foraging habitat on the Alkimos-Eglinton DSP area (approximately 40% of the site, some 1000 ha).

The potential for development of the whole Alkimos-Eglinton site to have an impact on the amount of foraging habitat available for Carnaby's Black Cockatoo was considered by the EPA in its assessment of MRS Amendment 1029/33. This was a contributing factor to the EPA's recommendation that the area zoned for conservation purposes in the MRS be increased from 146 ha to 523 ha (Environmental Protection Authority 2005).

Approximately 42 % of the site (103 ha) is Cottesloe South and Central vegetation complex which is potential cockatoo foraging habitat (Figure 6).

ENV was commissioned by Peet Limited to undertake a habitat survey and assessment of the significance of the site for Carnaby's Cockatoo. The fauna habitat survey found no evidence of nesting or roosting on the site. Nesting is unlikely to occur on the site due to a low number of suitable trees and the presence of many much more suitable locations north of the site (in Yanchep National Park), and the fact that the few trees present are isolated and exposed.

Foraging evidence in the form of bitten off Eucalypt flowers, Banksia fruit or new growth, was found, however, the bird species responsible for the foraging could not be identified. Other parrots observed in the area such as Galahs and Ring-Necked Parrots would cause such damage to vegetation and were possibly responsible for the foraging evidence observed at the study site.

Carnaby's Black Cockatoos are listed as Threatened under the State Wildlife Protection Act and as Endangered under the Federal Environmental Protection and Biodiversity Conservation Act 1999 ('EPBC Act'). The EPBC Act is administered by the Commonwealth Department of Environment, Water, Heritage and the Arts ('DEWHA'). It provides a framework under which matters of national environmental significance are protected.

Matters of national environmental significance include threatened species such as Carnaby's Black Cockatoo.

Any group or individual proposing an action which may have a significant impact on a matter of national environmental significance must have that proposed action referred to DEWHA for assessment (Department of Environment Water Heritage & the Arts 2008).

The impact of development on the species is expected to be minimal given the following:

- The narrowness and configuration of the site. Carnaby's Black Cockatoo foraging habitat is limited to the eastern portion of the site which is narrow and runs east-west;
- No opportunity for breeding on site due to absence of suitable trees;
- Fragmentation of the Carnaby's Black Cockatoo foraging habitat due to three north–south transport infrastructure corridors that cross the site effectively creating three fragmented areas of vegetation ranging from 20-30 ha;
- Impacts of fire, weeds and uncontrolled access on the vegetation

Significantly large intact areas of potential foraging habitat are within a 10 – 20 km radius of Yanchep including substantial areas secured in national parks and reserves.

6.2 CONCLUSIONS AND RECOMMENDATIONS

North-south and east-west fauna corridors of ROS are provided for by the DSP, and therefore none are incorporated into the design of the LSP. Biodiversity will be encouraged through non-contiguous green linkages between natural areas, achieved through the placement of POS and native species landscaping. There will be opportunities for ground-dwelling fauna to move between the coastal reserve and the east-west ROS linkage via appropriately-designed underpasses.

The retention of TECs in POS and some vegetation following the alignment of the parabolic dune (Vigo Trail) will also provide fauna habitat on the site.

The site supports *Banksia* woodland, which provides potential feeding habitat for Carnaby's Black Cockatoo. Under the EPBC Act any proposal (including a planning proposal) which has potential to have a significant impact on a protected species must be referred to the DEWHA for consideration and possible assessment.

The LSP seeks to maintain the integrity of the Coastal Foreshore reserve outside the blowout area and the southern east-west ROS corridor on the site.

- Fauna crossing points (such as appropriately-designed culverts) under the coastal road will be provided to allow the movement of ground-dwelling species between the coastal and east-west ROS reserves.
- Detailed management measures for the protection and maintenance of ecological function will be provided in site-specific EMPs for the ROS corridors and POS.
- Biodiversity will be enhanced through green linkages of POS, augmented by native plantings in streetscaping.
- Referral of the LSP for consideration of the project's impact on Carnaby's Black Cockatoos under the EPBC Act.

7 ENVIRONMENTAL MANAGEMENT

7.1 FLORA AND VEGETATION MANAGEMENT

The Minister for the Environment's Statement 722 (Appendix A) for the MRS amendment, which created the configuration of ROS in the Alkimos-Eglinton DSP area, sets out the following:

> *Prior to approving subdivision or development applications (whichever is sooner) for infrastructure proposals, the Western Australian Planning Commission or Local Government, as the case requires, may require an Environmental Management Plan to be prepared and implemented to achieve the objective of managing the potential impacts of the proposed subdivision development or infrastructure on the following:*

1. *Land reserved as Regional Open Space; and*

2. *Bushland or land that may be part of an ecological linkage.*

The environmental management plans shall include;

1. *A description of existing environmental values, and the identification of the environmental outcome to be achieved through the implementation of the EMP;*

2. *Clear delineation of boundaries or significant areas to be protected;*

3. *Management of construction, access and rehabilitation;*

4. *Vegetation mitigation strategies;*

5. *Allocation of responsibilities and identification of timing and duration of implementation;*

6. *Provision for routine monitoring and environmental values; and*

7. *Provision of details of contingency plans in the event that the monitoring surveys indicate that the development is having or has had an adverse impact on environmental values.*

(Minister's Statement 722, 2006).

EMPs of the ROS reserves in the LSP will be developed at subdivision stage, in accordance with Department of Environment and Conservation and City of Wanneroo requirements.

7.1.1 Regional Open Space

The site includes a section of the Regional Open Space in the south-west corner. This is part of the southernmost major east-west corridor thorough the southern Alkimos-Eglinton DSP area.

The following broad principles have been established by the DSP to guide the management of the Alkimos-Eglinton ROS:

- provide adequate and appropriate public access to ROS for sustainable passive recreation and protect the values of the ROS from uncontrolled pedestrian access by providing shared pathways that connect to the shared pathway network in the adjacent areas;
- erect appropriate fencing to discourage uncontrolled access;
- provide beach access paths to guide and facilitate pedestrian transit and prevent dune degradation from uncontrolled access;
- create a clear boundary between the ROS and private land to minimise disturbance to the ecological values;
- the interface of the urban development and the ROS is to be physically separated by a road, by a shared path or by POS; and
- protect the linkage values and biodiversity values of the ROS.

7.1.2 The Coastal Road

The north-south coastal road passes through the ROS corridor on Lot 1482. The location of significant vegetation and topography has been taken into consideration in determining the alignment of this road in the DSP. A specific EMP will be required to be developed for this aspect. Issues to be addressed in the EMP for the coastal road include:

- Revegetation using only endemic plant species.
- fauna crossing points (such as appropriately-designed culverts) under the coastal road will be provided to allow the movement of ground-dwelling species between the coastal and east-west corridor ROS.

7.1.3 Coastal Foreshore Reserve

Lot M1482 (the site) includes 5.75 km of coastline which is reserved as Regional Open Space for Parks and Recreation in the MRS.

The purpose of the foreshore reserve is to provide a setback for physical coastal processes, protection of ecological values, landscape, visual amenity, indigenous

and cultural heritage, and public access, recreation and safety (Western Australian Planning Commission 2003; RPS Bowman Bishaw Gorham 2006). The foreshore reserve area is 150–250 m wide along the western edge of the site. A specific EMP will be developed for the foreshore reserve.

7.2 CONCLUSIONS AND RECOMMENDATIONS

The site includes significant areas of vegetation which have been reserved in the coastal reserve and the east-west ROS corridor, and potential areas of significant native vegetation retained in POS.

The following recommendations are provided as a general guide for vegetation management in the LSP area. Site-specific Environmental Management Plan's will be developed for significant vegetation retained in ROS including the foreshore reserve and the east west corridor and for any significant vegetation retained in POS before subdivision:

- Clearing should be undertaken systematically, so that only the vegetation necessary for the establishment of service corridors, roads, fences, buildings and infrastructure is cleared.
- Tracks in ROS areas not required for access should be closed and rehabilitated to prevent their continued use.
- To prevent informal access (particularly during the construction phase), paths should be positioned to avoid areas of vegetation.
- Positioned pathways through areas where erosion risk is minimal and, where possible, through already degraded areas, to minimise disturbance of vegetation in good condition.
- Revegetate degraded areas in POS and in conservation areas with locally endemic species to restore soil stability and reduce the risk of erosion and ensure site-specific ecosystem values and functions are maintained.
- Revegetate areas following weed removal to prevent weed re-establishment.
- Weed control should be implemented to stem the spread and introduction of weeds in conservation areas during site works, and should be continued in the long term.
- Provide buffer separation to vegetation retained in ROS from urban development in the LSP design such as POS, roads, shared pathways or grade separation.

- Install fencing to control access to environmentally-sensitive areas.
- Install interpretative signage communicating the importance of protecting remnant vegetation and the need to stay on designated pathways.
- Fire management to minimise the risk of fire to the bushland and adjacent property.

8 REFERENCES

Armstrong, P (1996). Vegetation Condition and Conservation Values for Lots 8 and 11 Eglinton, City of Wanneroo. Unpublished report for Landcorp and Alan Tingay and Associates.

ATA Environmental (2003). Alkimos-Eglinton Coastal Planning Strategy.

ATA Environmental and Bennett (2004). Metropolitan Regional Scheme Amendment 1029/33 Alkimos-Eglinton Flora, Vegetation and Fauna Baseline Information. Report No. 2004/253.

City of Wanneroo (2002). Local Environmental Plan, City of Wanneroo ,Perth, Western Australia

Department of Conservation and land Management (2004), Florabase Perth. Online: http://florabase.calm.wa.gov.au/.

Department of Agriculture (2004). Declared Weeds. Online: www.agric.wa.gov.au.html

Department of Environment, Water, Heritage & the Arts (2008). Online: www.environment.gov.au/epbc/about/index.html

Department of Environment (2003) Perth Groundwater Atlas 2nd Edition, Perth Western Australia.

English, V & Blyth, J (1997) Identifying and Conserving Threatened Ecological Communities (TECs) in the South West Botanical Province. Department of Conservation and Land Management.

ENV Australia (2005). Flora and Vegetation Survey of the Proposed Parks and Recreation Area within Lot M1482, Alkimos.

Environmental Protection Authority (2005), Alkimos –Eglinton Metropolitan Region Sceheme Amendment No. 1029/33. Report and Recommendations of the Environmental Protection Authority, Bulletin 1207.

GHD (2006). Alkimos-Eglinton District Structure Plan Appendix 1 Sustainability Strategy.

Gibson , N.,Keighery,B.J,Keighery, G.J, Burbidge, A.H., and Lyons, M.N.(1994) A Floristic survey of the southern Swan Coastal Plain. Unpublished report for the Australian Heritage Commission prepared by the Department of Conservation and Land management and the Conservation and Environment, WA.(1994)

Government of Western Australia (2000), Bush Forever Volume 2: Directory of Bush Forever Sites. Department of Environmental Protection , Perth, Western Australia

McArthur W.M and Bartle G.A (1980) Landforms and Soils as an Aid to Urban Planning in the Perth Metropolitan Northwest Corridor, Western Australia. Land Resource Management Series No 5. CSIRO.

RPS Bowman Bishaw Gorham (2006). Alkimos-Eglinton District Structure Plan Appendix 2 Environmental Report.

RPS BBG (2006). Alkimos-Eglinton District Structure Plan Appendix 3 Coastal Strategy.

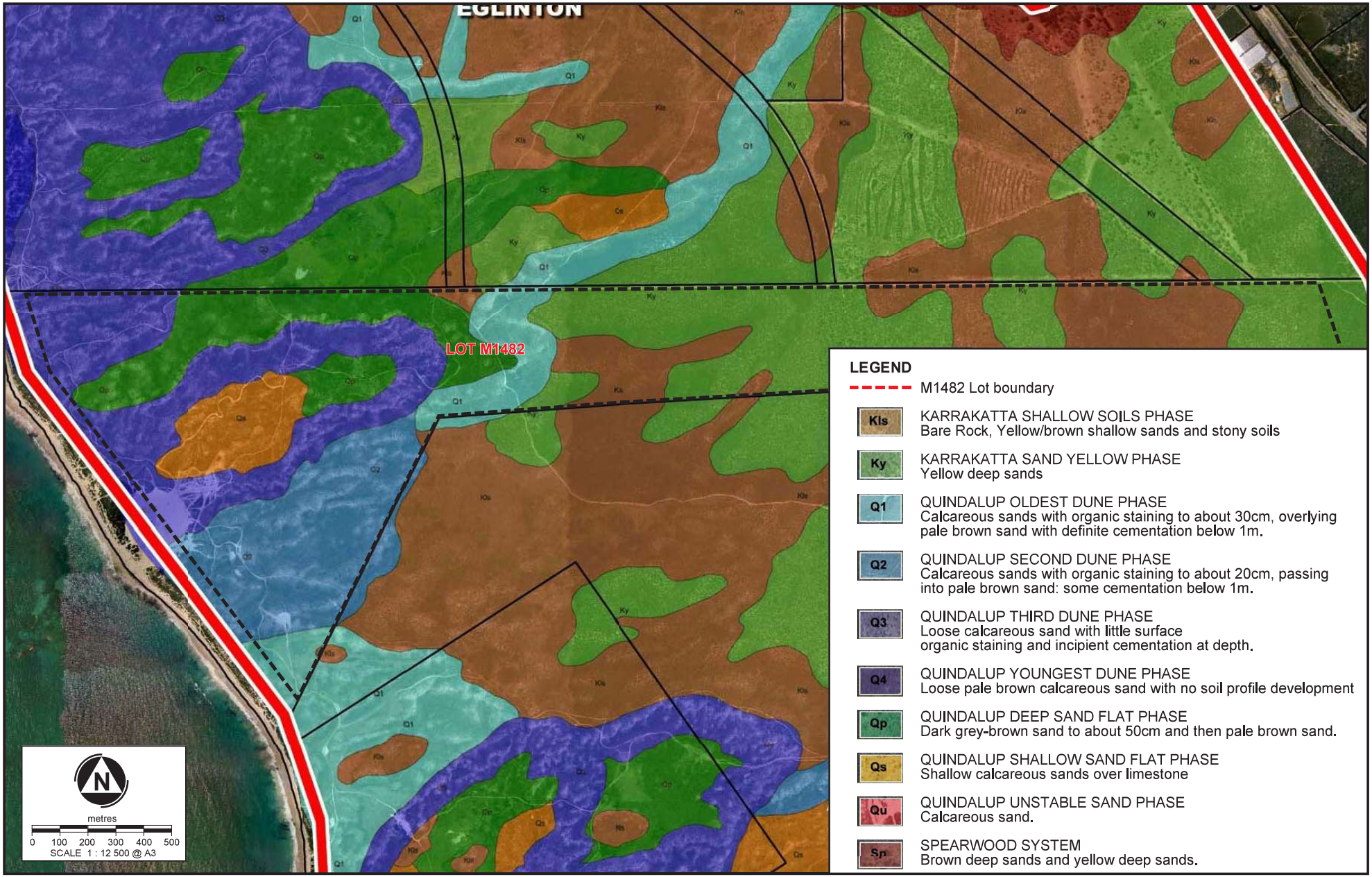
Trudgen, M, & Keighery, BJ (1990). A report on the Flora and Vegetation of the Alkimos Area and Conservation Issues Affecting it. Unpublished report for Landcorp.

Western Australian Planning Commission (2003) State Coastal Planning Policy, Government of Western Australia.

Water & Rivers Commission (1997), Perth Groundwater Atlas 1st Edition, Perth Western Australia.

FIGURES

PRINTED: Tue 16 Dec 08



LEGEND

- M1482 Lot boundary
- **Kls** KARRAKATTA SHALLOW SOILS PHASE
  Bare Rock, Yellow/brown shallow sands and stony soils
- **Ky** KARRAKATTA SAND YELLOW PHASE
  Yellow deep sands
- **Q1** QUINDALUP OLDEST DUNE PHASE
  Calcareous sands with organic staining to about 30cm, overlying pale brown sand with definite cementation below 1m.
- **Q2** QUINDALUP SECOND DUNE PHASE
  Calcareous sands with organic staining to about 20cm, passing into pale brown sand: some cementation below 1m.
- **Q3** QUINDALUP THIRD DUNE PHASE
  Loose calcareous sand with little surface organic staining and incipient cementation at depth.
- **Q4** QUINDALUP YOUNGEST DUNE PHASE
  Loose pale brown calcareous sand with no soil profile development
- **Qp** QUINDALUP DEEP SAND FLAT PHASE
  Dark grey-brown sand to about 50cm and then pale brown sand.
- **Qs** QUINDALUP SHALLOW SAND FLAT PHASE
  Shallow calcareous sands over limestone
- **Qu** QUINDALUP UNSTABLE SAND PHASE
  Calcareous sand.
- **Sp** SPEARWOOD SYSTEM
  Brown deep sands and yellow deep sands.

08-137-1-F2.dgn
DATUM: MGA50
DRAWN: TE 16-09-08
AUTHOR: GR 16-09-08
SOURCE: McArthur and Bartle(1980) Landforms as an aid to Urban Planning in the Perth Metropolitian Norhtwest Corriror, WA
From RPS Bowman Bishaw Gorham, Landform and Soils Figure 3

Peet Limited
LOT M 1482 ALKIMOS LOCAL STRUCTURE PLAN
ENVIRONMENTAL ASSESSMENT
PARABOLIC DUNE
FIGURE 3

env Australia

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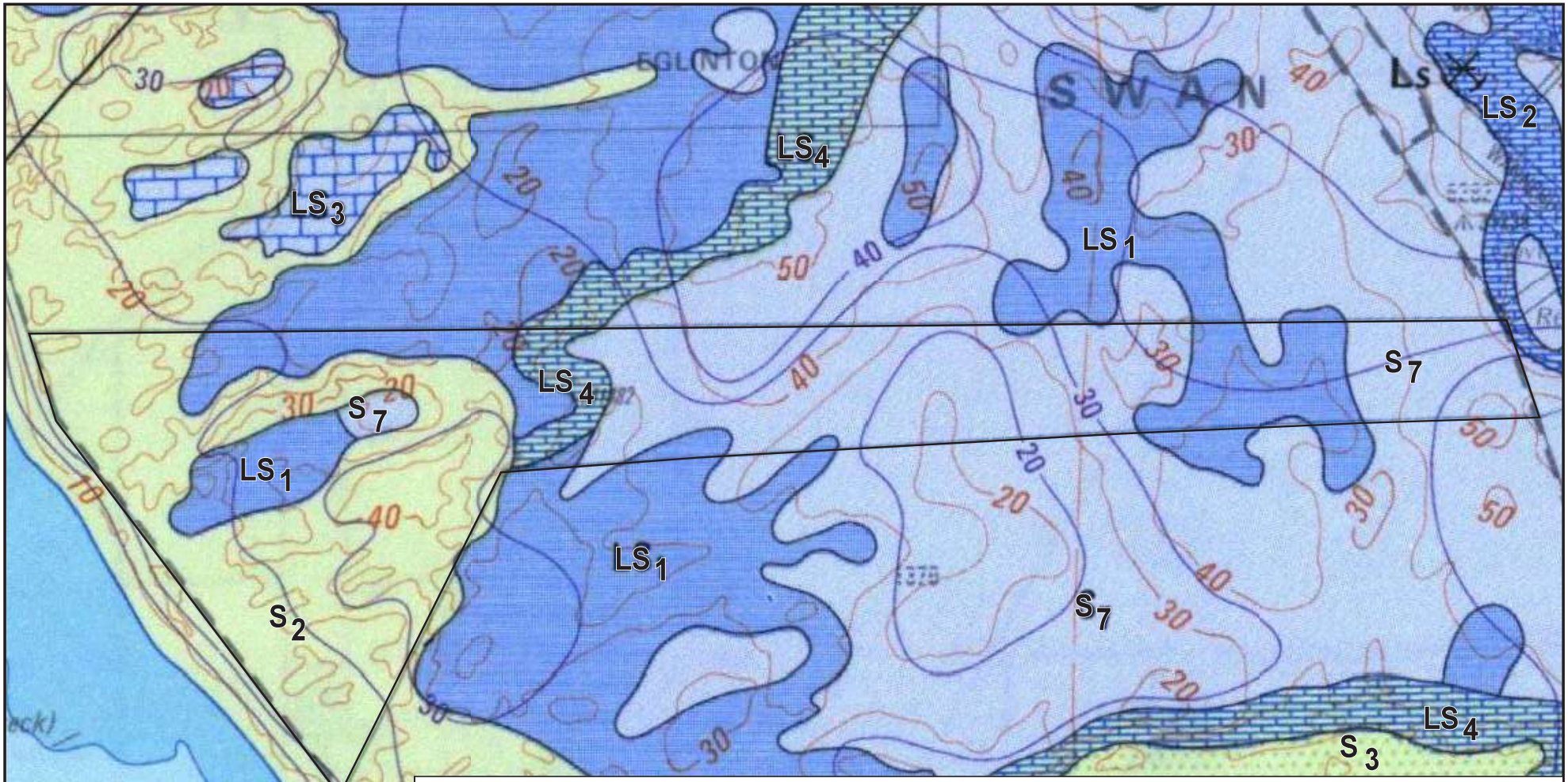

LEGEND

S 2	CALCAREOUS SAND - white, fine to medium grained, sub-rounded quartz and shell debris, of eolian origin.
S 3	CALCAREOUS SAND - as S 1 occurs as relatively thick covering over LS 1
LS 4	LIMESTONE - pale yellowish brown weakly cemented, friable, medium-grained, sub-rounded, quartz and shell debris, of eolian origin.
S 7	SAND - pale and olive yellow, medium to coarse-grained, sub-angular quartz with trace of feldspar, moderately sorted, of residual origin.
LS 1	LIMESTONE - light yellowish brown, fine to coarse-grained, sub-angular to well rounded, quartz, trace feldspar, shell debris, variable lithified, surface kankar, of eolian origin.
LS 2	LIMESTONE - as LS 1 abundant karstic phenomena including caves, dolines, swallows.
LS 3	LIMESTONE - as LS 1, generally with a thin (<0.5m) covering of S 3calareous sand.

08-137-1-F1.dgn
DATUM: MGA50
DRAWN: TE 16-09-08
AUTHOR: GR 16-09-08
Geology Source: Geological Survey of Western Australia, 1:50 000 Environmental Geology Series

Peet Limited
LOT M 1482 ALKIMOS LOCAL STRUCTURE PLAN
ENVIRONMENTAL ASSESSMENT
SOILS AND GEOLOGY
FIGURE 2

env Australia

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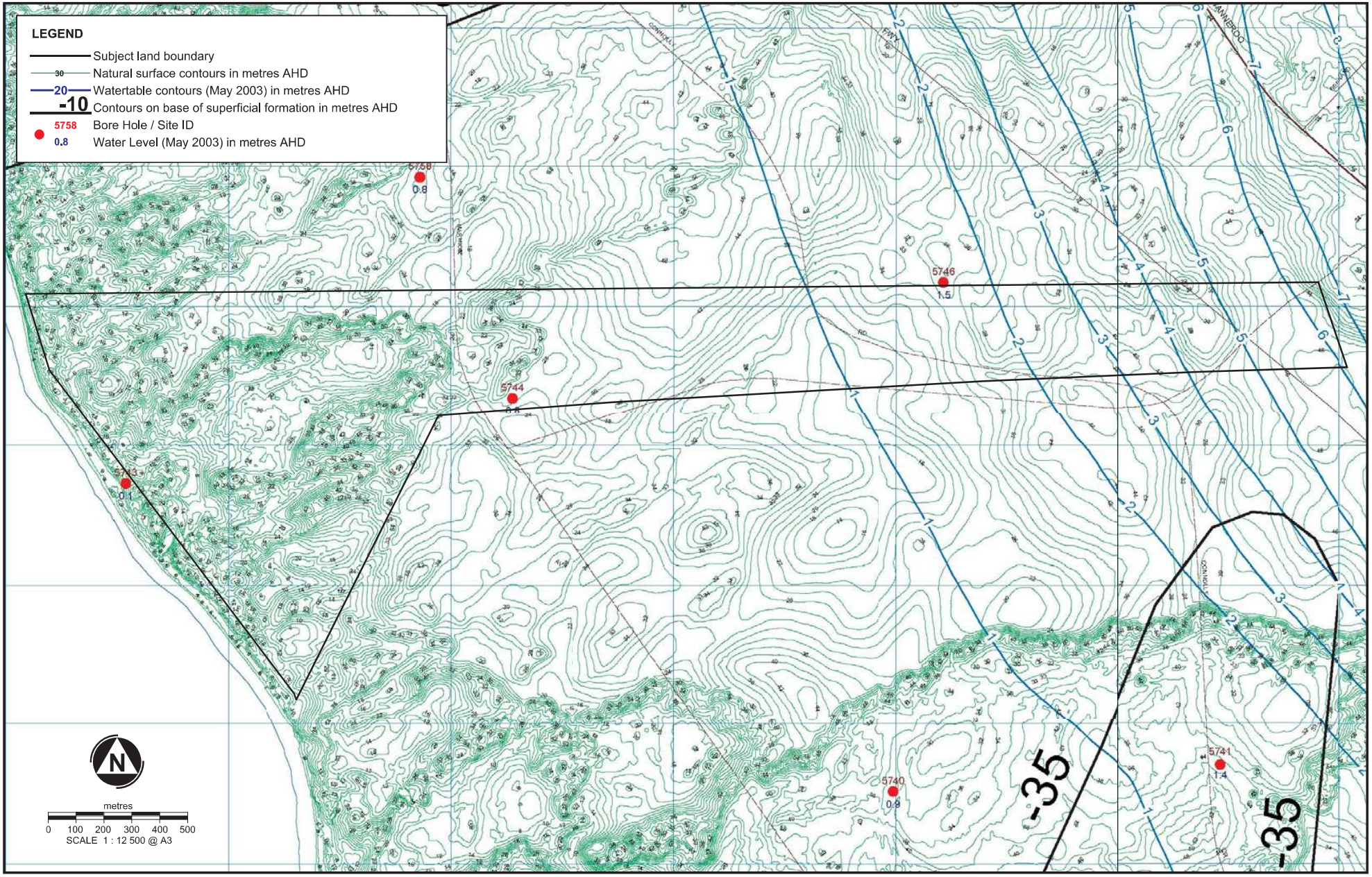

08-137-1-F3.dgn
DATUM: MGA50
DRAWN: TE 16-09-08
AUTHOR: GR 16-09-08
SOURCE: DOE Groundwater Atlas, 2004

Peet Limited
LOT M 1482 ALKIMOS LOCAL STRUCTURE PLAN
ENVIRONMENTAL ASSESSMENT
GROUNDWATER
FIGURE 4

env Australia

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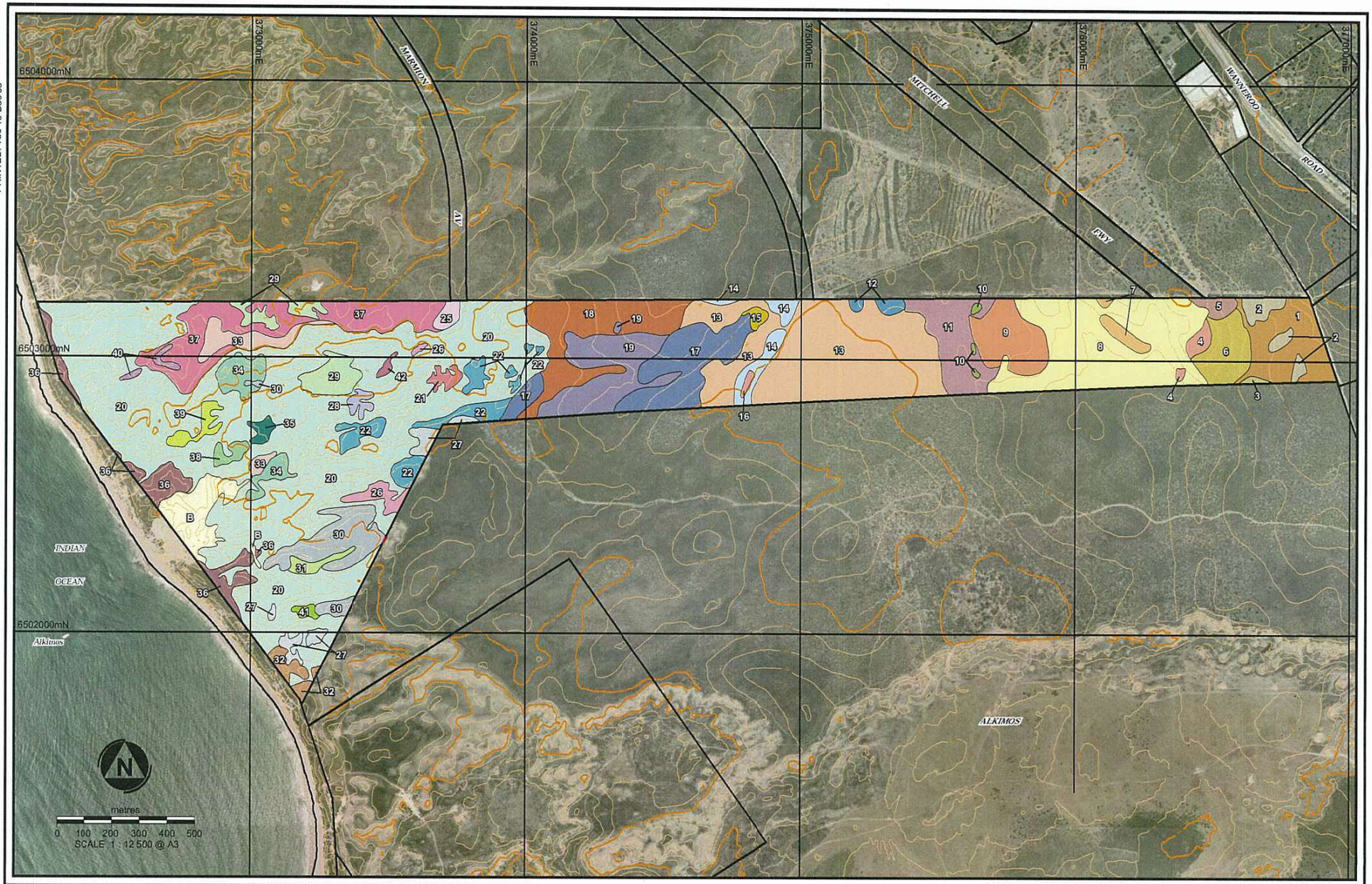

08-137-1-F4.dgn
DATUM: MGA50
DRAWN: TE 16-09-08
AUTHOR: GR 16-09-08
SOURCE: Cadastre and Topography: McMullen Nolan and Partners Surveyers Pty Ltd, 6-10-04

Peet Limited
LOT M 1482 ALKIMOS LOCAL STRUCTURE PLAN
ENVIRONMENTAL ASSESSMENT
VEGETATION AND FLORA
FIGURE 5

env Australia

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COMMUNITY DESCRIPTIONS

BaBmAf - 1
Low Woodland of *Banksia attenuata Banksia menziesii - Allocasuarina fraseriana* over dense understorey of *Xanthorrhoea preissii, Hibbertia hypericoides, Jacksonia stembergiana, Hakea trifurcata, Dryandra sessilis* var. *cygnorum, Allocasuarina humilis, Mesomelaena pseudostygia, Hakea costata* and *Leucopogon polymorphus*.

BaBmEt - 2
Low Open Woodland of *Banksia attenuata Banksia menziesii Eucalyptus todtiana - Nuytsia floribunda* over low dense understorey of *Allocasuarina humilis, Hakea costata, Hibbertia hypericoides, Xanthorrhoea preissii, Leucopogon polymorphus, Hakea ruscifolia* and *Mesomelaena pseudostygia.*

BaBmEtEd - 3
Low Open Woodland of *Banksia attenuata Banksia menziesii Eucalyptus todtiana Eucalyptus decipiens Nuytsia floribunda* over low dense understorey of *Allocasuarina humilis, Hakea costata, Hibbertia hypericoides, Xanthorrhoea preissii, Leucopogon polymorphus, Hakea ruscifolia* and *Mesomelaena pseudostygia.*

AfBaBmEd - 4
Low Woodland of *Allocasuarina fraseriana Banksia attenuata Banksia menziesii Eucalytpus decipiens over Dryandra sessilis* var. *cygnorum, Hibbertia hypericoides, Xanthorrhoea preissii* and *Mesomelaena pseudostygia.*

AfBaBmEtEd - 5
Low Woodland of *Allocasuarina fraseriana Banksia attenuata Banksia menziesii Eucalyptus todtiana Eucalyptus decipiens* over *Hibbertia hypericoides, Mesomelaena pseudostygia, Dryandra sessilis* var. *cygnorum, Jacksonia stembergiana, Acacia pulchella, Bossiaea eriocarpa* and *Synaphea spinulosa* subsp. *spinulosa*.

AfBaBmEt - 6
Low Open Woodland of *Allocasuarina fraseriana Banksia attenuata Banksia menziesii Eucalyptus todtiana* over *Hibbertia hypericoides, Xanthorrhoea preissii, Mesomelaena pseudostygia, Macrozamia riedlei, Stirlingia latifolia, Jacksonia sternbergiana,*, and *Hakea ruscifolia.*

BaBmAfDs - 7
Low Woodland of *Banksia attenuata Banksia menziesii - Allocasuarina fraseriana* over tall dense understorey of *Dryandra sessilis* var. *cygnorum, Hakea trifurcata, Xanthorrhoea preissii, Hibbertia hypericoides, Conospermum triplinervium, Calothamnus quadrifidus* and *Jacksonia sternbergiana.*

DsHt - 8
Closed Tall Scrub of *Dryandra sessilis* var. *cygnorum, Hakea trifurcata, Xanthorrhoea preissii, Hibbertia hypericoides, Mesomelaena pseudostygia* with scattered *Eucalyptus todtiana* and various introduced species.

BaBmEtAr - 9
Low Woodland of *Banksia attenuata Banksia menziesii Eucalyptus todtiana Acacia rostellifera* over *Hibbertia hypericoides, Xanthorrhoea preissii, Dryandra sessilis* var. *cygnorum, Mesomelaena pseudostygia, Lepidosperma* sp., *Hakea prostrata, Macrozamia riedlei, Calytrix flavescens* and *Hakea trifurcata.*

BaBmAr - 10
Low Open Woodland of *Banksia attenuata Banksia menziesii Acacia rostellifera* over *Hibbertia hypericoides, Mesomelaena pseudostygia, Dryandra sessilis* var. *cygnorum, Jacksonia calcicola, Hakea trifurcata, Dryandra lindleyana* subsp. *lindleyana* and *Macrozamia riedlei.*

BaBmEg - 11
Low Woodland of *Banksia attenuata Banksia menziesii Eucalyptus gomphocephala* over *Hibbertia hypericoides Xanthorrhoea preissii, Hakea trifurcata, Petrophile macrostachya, Hakea ruscifolia, Macrozamia riedlei, Daviesia divaricata, Acacia cyclops* and *Acacia rostellifera.*

CqDs - 12
Closed Heath of *Calothamnus quadrifidus, Dryandra sessilis* var. *cygnorum, Xanthorrhoea preissii, Hibbertia hypericoides, Petrophile serruriae, Hakea prostrata* and *Jacksonia calcicola.*

EtEgBaBm - 13
Low Woodland of *Eucalyptus todtiana Banksia attenuata Banksia menziesii Eucalyptus gomphocephala* over *Hibbertia hypericoides, Xanthorrhoea preissii, Jacksonia stembergiana, Hakea prostrata, Mesomelaena pseudostygia, Hakea ruscifolia, Xanthorrhoea gracillis, Allocasaurina humilis* and *Macrozamia riedlei.*

DsHtCq - 14
Open Heath of *Dryandra sessilis* var. *cygnorum, Hakea trifurcata, Xanthorrhoea preissii, Calothamnus quadrifidus, Hibbertia hypericoides, Mesomelaena pseudostygia, Waitzia suaveolens* and *Acacia pulchella.*

BaBmEgAh - 15
Low Open Woodland of *Eucalyptus gomphocephala Banksia attenuata Banksia menziesii* over *Hibbertia hypericoides, Allocasuarina humilis, Mesomelaena pseudostygia, Conostephium pendulum, Calothamnus quadrifidus, Hakea trifurcata, Dryandra sessilis* var. *cygnorum* and *Hakea lissocarpha.*

DsMs - 16
Shrubland of *Dryandra sessilis* var. *cygnorum, Xanthorrhoea preissii, Melaleuca systena, Grevillea preissii subsp. preissii, Melaleuca huegelii* subsp. *huegelii, Lomandra maritima, Kennedia prostrata, Desmocladus asper* and *Brachyscome iberidifolia* on limestone outcropping.

DsHtCqCt - 17
Closed Heath of *Dryandra sessilis* var. *cygnorum, Hakea trifurcata, Calothamnus quadrifidus, Hakea prostrata, Xanthorrhoea preissii, Hibbertia hypericoides, Leucopogon polymorphus Jacksonia calcicola Conospermum triplinervum.*
and *Xanthorrhoea gracillis.*

BaBmAh - 18
Low Woodland of *Banksia attenuata Banksia menziesii* over *Allocasuarina humilis, Hibbertia hypericoides, Xanthorrhoea preissii, Lysinema ciliatum, Mesomelaena pseudostygia, Conostephium pendulum, Hakea costata* and *Xanthorrhoea gracillis.*

DsAhHc - 19
Closed Tall Shrub of *Dryandra sessilis* var. *cygnorum, Hibbertia hypericoides Hakea costata, Xanthorrhoea preissii, Allocasuarina humilis, Mesomelaena psuedostygia,* , *Calothamnus quadrifidus* and *Hakea trifurcata*

LmMs20
Low Open Shrubland of *Lomandra maritima, Melaleuca systena, Conostylis pauciflora* subsp. *euryrhipis*/subsp. *pauciflora/candicans, Acanthocarpus preissii, Acacia cochlearis, Desmocladus asper, Leucopogon parviflorus, Hemiandra pungens* and *Acacia lasiocarpa* var. *lasiocarpa.*

LmMsAc - 21
Low Shrubland of *Melaleuca systena, Lomandra maritima, Acacia cochlearis Desmocladus asper, Conostylis pauciflora* subsp. *euryrhipis* /subsp. *pauciflora/ candicans, Leucopogon parviflorus, Acanthocarpus preissii, Hemiandra pungens, Acacia cochlearis* and *Acacia lasiocarpa* var. *lasiocarpa.*

XpLmMs - 22
Open Low Heath of *Xanthorrhoea preissii, Melaleuca systena, Lomandra maritima, Desmocladus asper, Conostylis pauciflora* subsp. *euryrhipis* /subsp. *pauciflora/ candicans, Leucopogon parviflorus, Acanthocarpus preissii, Acacia cochlearis, Hemiandra pungens* and *Acacia lasiocarpa var. lasiocarpa.*

COMMUNITY DESCRIPTIONS

LmApAs - 25
Open shrubland of *Lomandra maritima, Acacia pulchella, Acacia saligna, Melaleuca systena, Hakea prostrata, Lomandra maritima, Xanthorrhoea preissii, Poa porphyroclados, Dryandra lindleyana* var. *lindleyana* and *Desmocladus asper.*

AlMs - 26
Open Shrubland of *Anthocercis littorea, Melaleuca systena, Lomandra maritima, Desmocladus asper, Conostylis pauciflora* subsp. *euryrhipis/* subsp. *pauciflora/ candicans, Leucopogon parviflorus, Acanthocarpus preissii, Acacia cochlearis, Hemiandra pungens* and *Acacia lasiocarpa* var. *lasiocarpa*

StDsAt - 27
Dense Tall Scrub of *Dryandra sessilis* var. *cygnorum* that has been burnt and now consists of Low Open Shrubland of *Scaevola thesioides* subsp. *thesioides, Acacia truncata, Grevillea preissii* subsp. *preissii, Melaleuca systena, Melaleuca huegelii subsp. huegelii, Lomandra maritima, Poa porphyroclados, Leucopogon parviflorus, Xanthorrhoea preissii, Opercularia vaginata* and *Dryandra sessilis* var. *cygnorum* with limestone outcropping.

AlSr - 28
Open Shrubland of *Anthocercis littorea,* , *Scaevola repens* var. *repens, Melaleuca systena, Poa porphyroclados, Rhagodia baccata* subsp. *baccata, Acacia saligna, Desmocladus asper, Conostylis pauciflora* subsp. *euryrhipis/* subsp. *pauciflora/ candicans* and *Acanthocarpus preissii.*

AlLmPp - 29
Low Open Shrubland of *Anthocercis littorea, Lomandra maritima, Poa porphyroclados, Scaevola repens* var. *repens, Melaleuca systena, Acacia cochlearis, Opercularia vaginata, Xanthorrhoea preissii, Rhagodia baccata* subsp. *baccata* and *Tricoryne elatior.*

AcRb - 30
Dense Tall Scrub of *Dryandra sessilis* var. *cygnorum* that has been burnt and now consists of Shrubland of *Acacia cochlearis, Rhagodia baccata* subsp. *baccata, Poa porphyroclados, Dryandra sessilis* var. *cygnum, Hardenbergia comptoniana* and *Senecio pinnatifolius.*

AlLmMs - 31
Low Open Shrubland of *Anthocercis littorea, Lomandra maritima, Melaleuca systena, Scaevola thesioides* subsp. *thesioides, Poa porphyroclados, Acanthocarpus preissii, Hibbertia racemosa* and *Tricoryne elatior.*

LmPp(D) - 32
Degraded Herbland of *Lomandra maritima, Poa porphyroclados, Conostylis pauciflora* subsp. *euryrhipis/* subsp. *pauciflora/ candicans, Lepidosperma* aff. *squamatum, Acanthocarpus preissii, Melaleuca systena, Podotheca gnaphaloides, Hibbertia racemosa* and *Tricoryne elatior.*

SaAl - 33
Shrubland of *Santalum acuminatum, Anthocercis littorea, Melaleuca systena, Poa porphyroclados, Acanthocarpus preissii, Podotheca gnaphaloides, Lepidosperma* aff. *squamatum, Hemiandra pungens, Lomandra maritima* and *Conostylis pauciflora* subsp. *euryrhipis/* subsp. *pauciflora/ candicans.*

LmSa - 34
Low Open Shrubland of *Lomandra maritima, Santalum acuminatum, Melaleuca systena, Poa porphyroclados, Hardenbergia comptoniana* and *Hibbertia racemosa.*

McSn - 35
Closed Heath of *Melaleuca cardiophylla, Scaevola nitida, Melaleuca huegelii* subsp. *huegelii, Acacia truncata, Lepidosperma* aff. *squamatum, Rhagodia baccata* subsp. *baccata* and *Leptomeria gladiatum.*

OaSg - 36
Shrubland of *Olearia axillaris, Lomandra maritima, Spyridium globulosum, Santalum acuminatum, Lepidosperma gladiatum, Poa porphyroclados, Desmocladus asper* and *Vulpia bromoides.*

AsMs - 37
Low Shrubland of *Acacia saligna, Melaleuca systena, Lomandra maritima, Conostylis pauciflora* subsp. *euryrhipis* / subsp. *pauciflora/ candicans, Podotheca gnaphalioides, Opercularia vaginata, Leucopogon parviflorus* and *Hardenbergia comptoniana.*

LmMsAl - 38
Low Open Shrubland of *Melaleuca systena, Lomandra maritima, Desmocladus asper, Conostylis pauciflora* subsp. *euryrhipis/* subsp. *pauciflora/ candicans, Leucopogon parviflorus, Acanthocarpus preissii, Acacia cochlearis, Hemiandra pungens, Anthocercis littorea* and *Acacia lasiocarpa* var. *lasiocarpa.*

LmMsSa - 39
Low Open Shrubland of *Lomandra maritima, Melaleuca systena, Santalum acuminatum, Acanthocarpas preissii, Poa porphyroclados, Scaevola repens* var. *repens, Senecio pinnatifolius* and *Lepidosperma* aff. *squamatum.*

XpAs - 40
Shrubland of *Xanthorrhoea preissii, Acacia saligna, Lomadra maritima, Melaleuca systena, Kennedia prostrata, Hybanthas calycinus, Opercularis vaginata and Conostylis pauciflora* subsp. *euryrhipis* / subsp. *pauciflora/ candicans*

LoAv - 41
Grassland of introduced species *Avena barbata, Lagurus ovatus, Trachyandra divaricata,* and *Euphorbia terracina.*

XpAl - 42
Shrubland of *Xanthorrhoea preissii, Anthocercis littorea, Melaleuca systena, Lomandra maritima, Desmocladus asper, Conostylis pauciflora* subsp. *euryrhipis/* subsp. *pauciflora/ candicans, Leucopogon parviflorus, Acanthocarpus preissii, Acacia cochlearis, Hemiandra pungens* and *Acacia lasiocarpa* var. *lasiocarpa*

B
Blowout

08-137-1-F5.dgn
DATUM: MGA50
DRAWN: TE 16-09-08
AUTHOR: GR 16-09-08
SOURCE: McMullen Nolan and Partners Surveyers Pty Ltd, 6-10-04

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LOT M 1482 ALKIMOS LOCAL STRUCTURE PLAN
ENVIRONMENTAL ASSESSMENT
VEGETATION LEGEND
FIGURE 6

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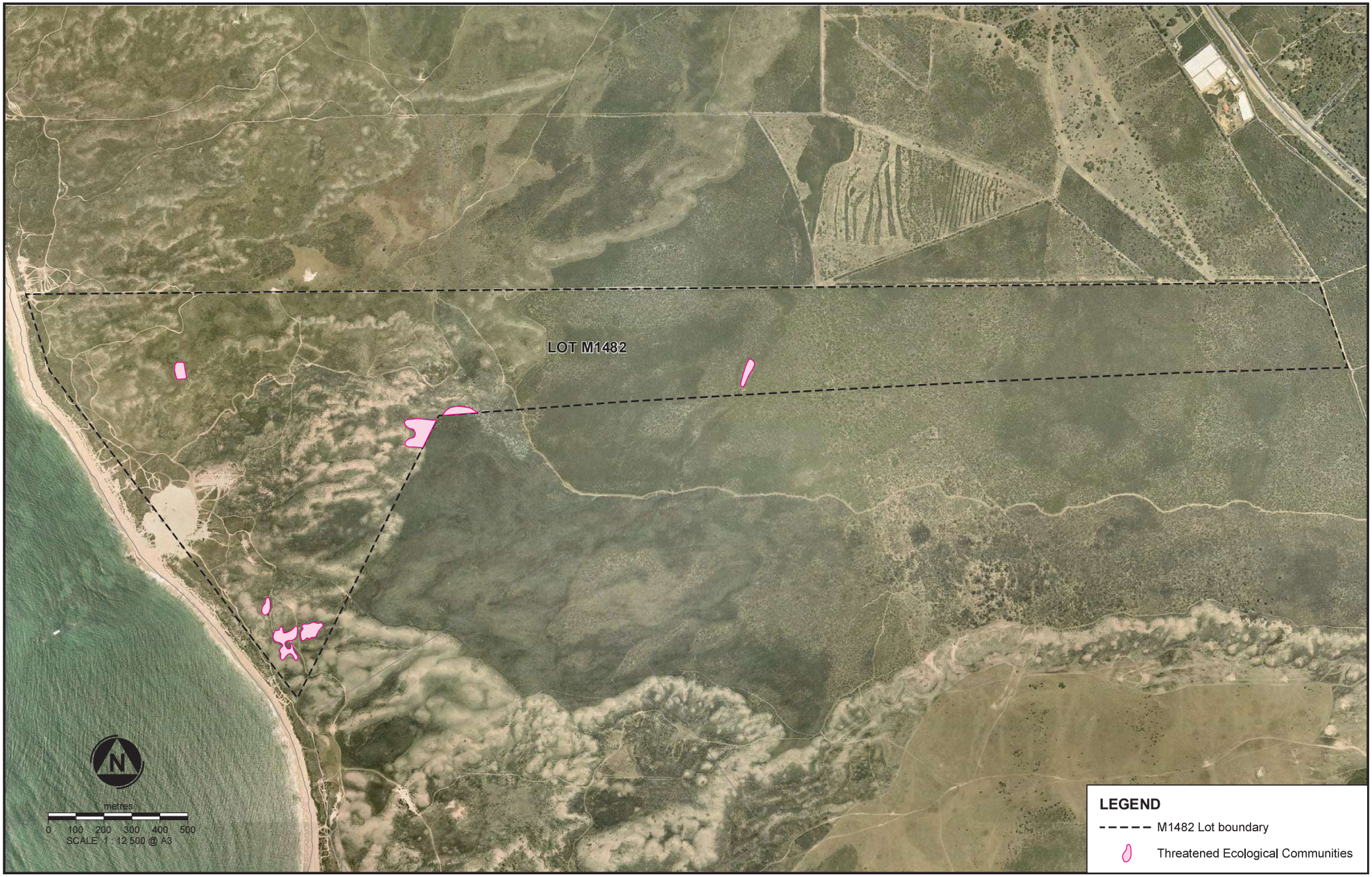

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AUTHOR: GR 16-09-08
SOURCE: Cadastre and Topography: McMullen Nolan and Partners Surveyers Pty Ltd, 6-10-04

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LOT M 1482 ALKIMOS LOCAL STRUCTURE PLAN
ENVIRONMENTAL ASSESSMENT
THREATENED ECOLOGICAL COMMUNITIES
FIGURE 7

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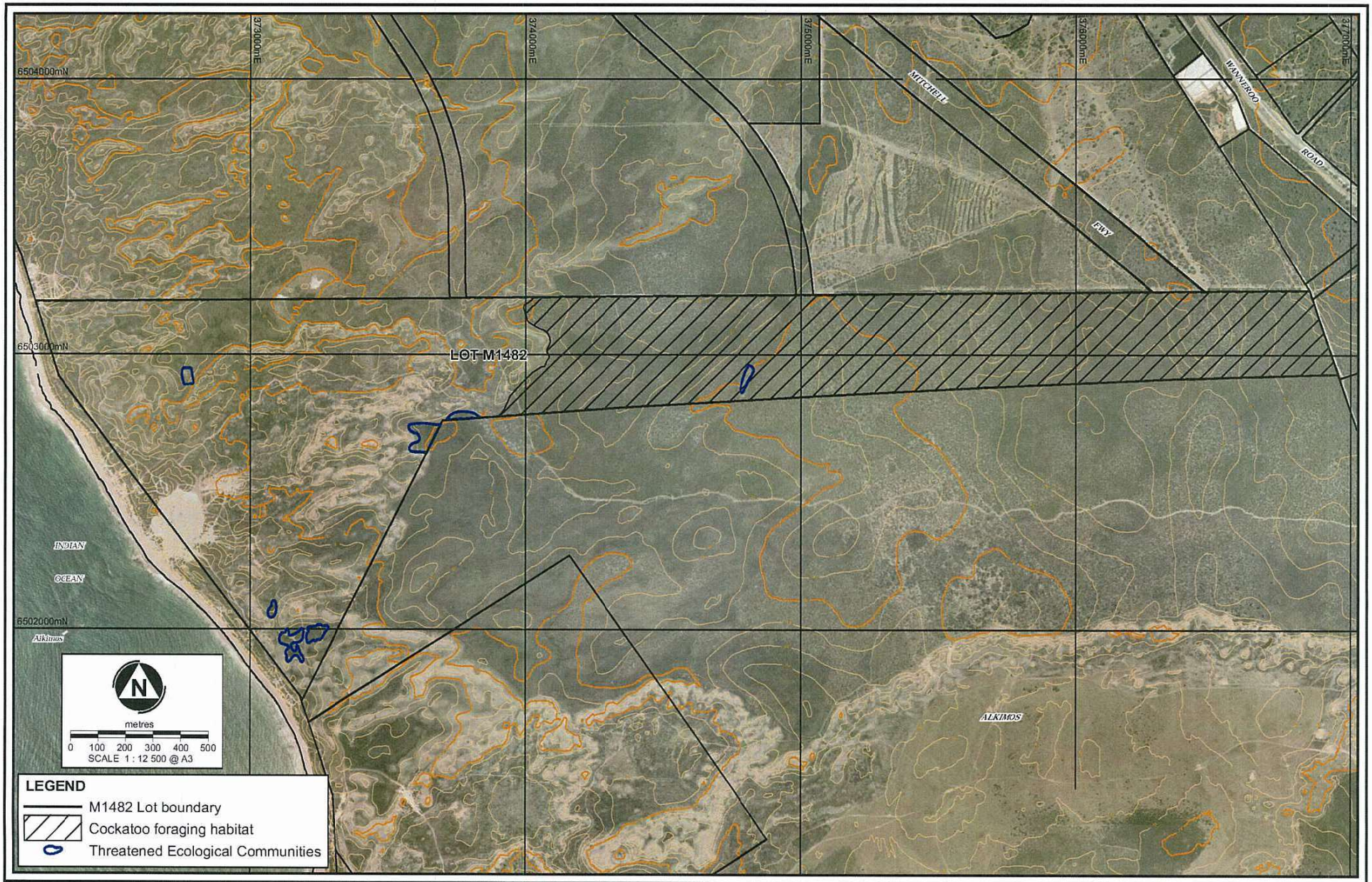

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AUTHOR: GR 16-09-08
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LOT M 1482 ALKIMOS LOCAL STRUCTURE PLAN
ENVIRONMENTAL ASSESSMENT
COCKATOO FORAGING HABITAT
FIGURE 8

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