Keysbrook Mineral Sand Project

Environmental Scoping Document
Public Environmental Review
(Assessment Number 1580)

DRAFT

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Olympia Resources Limited

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KEYSBROOK MINERAL SAND PROJECT

ENVIRONMENTAL SCOPING DOCUMENT PUBLIC ENVIRONMENTAL REVIEW (ASSESSMENT NUMBER 1580)

PREPARED FOR

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1. PURPOSE OF DOCUMENT

On 25 July 2005 the Environmental Protection Agency (EPA) set the level of assessment for the proposed Keysbrook Heavy Mineral Sand Project in the south west of Western Australia at the level of Public Environmental Review (PER) with an eight week public review period. There was a 14 day appeal period on this decision, during which any person may lodge an appeal with the Minister requesting that the Minister direct the EPA to increase the level of assessment or the length of the public review period. This appeal period closed on 8 August 2005. No appeals were lodged.

The level of assessment of PER is typically applied to proposals "of local or regional significance that raise a number of environmental factors, some of which are considered to be complex and require detailed assessment to determine whether, and if so how, they can be managed" (Government of Western Australia, 2002).

On 7 July 2005 the Commonwealth Department of the Environment and Heritage (DEH) declared that the proposed Keysbrook Heavy Mineral Sand Project is a Controlled Action under the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act 1999*). The *EPBC Act 1999* controlling provisions were determined to be Part 3, Division 1, Sections 16, 17B, 18 and 18A. In accordance with the Bilateral Agreement (16 August 2002) between the Commonwealth and the State, formal assessment of the proposal by DEH under Part 8 of the *EPBC Act 1999* is not required. Schedule 1 of the Bilateral Agreement provides accreditation of the State assessment procedure, at the level of PER, by the Commonwealth.

The purpose of this document is to provide a basis of understanding between the proponent (Olympia Resources Limited), the EPA and DEH regarding the assessment of the proposed Keysbrook Heavy Mineral Sand Project. It establishes the environmental issues and factors raised by the proposal, sets out the Scope of Works for the preparation of the PER, and gives indicative timelines for the assessment.

2. IDENTIFICATION OF THE PROPONENT

2.1 PROPONENT DETAILS

Olympia Resources Limited was incorporated in 1997 to carry out exploration and develop mineral deposits within Australia into profitable mining operations.

Olympia Resources Limited (Olympia) is the owner of the Keysbrook Heavy Mineral Sand Project. Olympia applied for an exploration licence over the Keysbrook project area on 29 November 2000 and was granted this licence on 6 September 2001. Keysbrook is planned to be Olympia's first heavy mineral sand mine commencing production in late 2006.

Contact details for Olympia are provided below.

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2.2 ENVIRONMENTAL CONSULTANT DETAILS

Olympia has appointed MBS Environmental as environmental consultants to assist them gain environmental approvals for the Keysbrook project.

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3. APPLICABLE LEGISLATION

3.1 WESTERN AUSTRALIAN LEGISLATION

In Western Australia the *Environmental Protection Act 1986* (the Act) is the principal instrument for environmental protection and governs the environmental approvals process. All proposed projects and schemes that may have an impact on the environment are required to be assessed under Part V of the Act. There are also provisions in the *Wildlife Conservation Act 1950* and the *Conservation and Land Management Act 1984* that are relevant to the protection of the environment and are applicable to the proposal.

Aside from environmental legislation, there are a number of other statutes that impact upon the proposal, or parts of the proposal, both directly and indirectly. A full list of applicable State legislation is given below:

- *Environmental Protection Act 1986.*
- *Bush Fires Act 1954.*
- *Conservation and Land Management Act 1984.*
- *Contaminated Sites Act 2003.*
- *Dangerous Goods (Transport) Act 1998.*
- *Explosives and Dangerous Goods Act 1961.*
- *Heritage Act 1990.*
- *Land Administration Act 1997.*
- *Rights in Water and Irrigation Act 1914.*
- *Town Planning & Development Act 1928.*
- *Wildlife Conservation Act 1950.*
- *Mining Act 1978.*
- *Mines Safety and Inspection Act 1994.*
- *Mining on Private Property Act 1898.*

3.2 OTHER WESTERN AUSTRALIAN PLANNING DOCUMENTS AND POLICIES

Other State planning documents, policies and guidelines relevant to the proposal include:

- *Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations 2004.*
- Environmental Protection Authority Position Statement "Environmental Protection of Native Vegetation in Western Australia": No 2 (December 2000).

- Environmental Protection Authority Position Statement "Terrestrial Biological Surveys as an Element of Biodiversity Protection": No 3 (March 2002).
- Environmental Protection Authority Position Statement "Environmental Protection of Wetlands": No 4 (November 2004).
- Environmental Protection Authority Position Statement "Towards Sustainability": No 6 (August 2004).
- Environmental Protection Authority Position Statement "Principles of Environmental Protection" No 7 (August 2004).
- Environmental Protection Authority Position Statement "Environmental Protection in Natural Resource Management (Preliminary)" No 8 (June 2004).
- Guidance for the Assessment of Environmental Factors "Level of Assessment for Proposals Affecting Natural Areas within the System 6 region and Swan Coastal Plain Portion of the System 1 Region": No 10 (January 2003).
- Guidance for the Assessment of Environmental Factors "Guidance Statement for Minimising Greenhouse Gas Emissions": No12 (October 2002).
- Guidance for the Assessment of Environmental Factors "Assessment of Aboriginal Heritage": No 41 (April 2004).
- Guidance for the Assessment of Environmental Factors "Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia": No 51 (June 2004).
- Guidance for the Assessment of Environmental Factors "Implementing Best Practice in Proposals Submitted to the Environmental Impact Assessment Process": No 55 (December 2003).
- Guidance for the Assessment of Environmental Factors "Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia": No 56 (June 2004).
- Guidelines for Mining and Mineral Processing: Mine site Water Quality Monitoring. Water Protection Guideline No 5. June 2002.
- Guidelines for Mining and Mineral Processing: Mine site Stormwater. Water Protection Guideline No 6. January 2000.
- Guidelines for Mining and Mineral Processing: Above-ground Fuel and Chemical Storage. Water Protection Guideline No 10. January 2000.
- Guidelines for Mining and Mineral Processing: Mine Dewatering. Water Protection Guideline No 11. January 2000.
- Department of Conservation and Land Management (CALM) Draft Policy Statement No 9. Conserving Threatened Species and Ecological Communities. (In Development).
- CALM Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan 2002 – 2012. April 2003.
- CALM Policy Statement No 3 "Threat abatement for *Phytophthera cinnamomi*. Draft for Public Comment. March 2004.
- Western Australian Planning Commission. Planning Bulletin No. 64. Acid Sulfate Soils. November 2003.

3.3 COMMONWEALTH LEGISLATION

On 7 July 2005 the Commonwealth DEH declared the proposed Keysbrook Heavy Mineral Sands Project to be a Controlled Action. Therefore the proposed development is required to be assessed in accordance with the Commonwealth *EPBC Act 1999*. In order to minimise the duplication of assessment of proposals, the Commonwealth has a Bilateral Agreement with the State. The agreement provides for the accreditation of the Western Australian environmental impact assessment process such that projects assessed by the State at the PER or Environmental Review and Management Plan level do not require further assessment by the Commonwealth.

Commonwealth legislation and other documents of relevance to the Project include the following:

- *EPBC Act 1999.*
- *Australian Heritage Council Act 2003.*
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) November 1983.
- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA) February 1974.
- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA) October 1986.

4. SUMMARY DESCRIPTION OF THE PROPOSAL

4.1 LOCATION

The project area is located within exploration lease 70/2407, located approximately 70 kilometres south of Perth and four kilometres west of the small township of Keysbrook (Figure 1). The following coordinates denote the north-east and south-west corners of the project area, respectively:

North-east corner of project area	-32.424°S, 115.915°E
South-west corner of project area	-32.518°S, 115.975°E

The project area is 3,500 hectares with about 1,800 hectares comprising the mineral sand deposit. The land use within this area is agriculture, specifically grazing of dairy cattle with a small area of intensive horticulture.

Of this, 582.6 hectares is vegetated in some way with about 498.5 hectares being 'parkland cleared'. There is a total area of 84.2 hectares of remnant vegetation, ranging in condition from good to excellent.

The project area is situated approximately 50 percent in the Shire of Serpentine Jarrahdale and 50 percent in the Shire of Murray. Both shires are dominated by rural landscapes with small to medium sized towns. The Shire of Murray has had a long association with the mining industry. Alcoa has a number of Bauxite mines located within the Shire, together with the Alumina refinery located at Pinjarra. The Shire of Serpentine – Jarrahdale historically has an association with the mining industry through the old Alcoa mine site at Jarrahdale. The Shire has also had a long association with extractive industries such as sand mining and hard rock quarrying. The Shire of Serpentine - Jarrahdale is focused on establishing an industry base centred on light industry, agriculture, horticulture and tourism.

4.2 PROPOSAL

Mineral sand mining and processing operations are straightforward and well proven. Olympia Resources intends to carry out its mineral sand mining and processing operations in a manner similar to current practices used by mining companies in the south-west of Western Australia. The proposed action is to extract mineral sands from a series of locations across the Keysbrook project area. This will require development of shallow pits to access the ore body and construction of a small screening and concentration plant. Ore will be accessed using free digging methods (removed without the aid of blasting) before being screened and the heavy mineral sand component concentrated to remove uneconomic fractions. The heavy mineral concentrate will be transported off site for further processing where gravity, magnetic and electrostatic separation are undertaken to produce separate mineral products for sale. The offsite separation plant does not form part of this proposal.

A more detailed explanation of the sequential mining process is described below:

1. *Land Clearance:* The proponent will undertake periodic clearing of remnant native vegetation to the width of the mine path. Removal of all vegetation will be strictly controlled. Wherever practically possible, trees will be retained and infrastructure will be located between scattered trees.

2. *Topsoil Stripping:* All topsoil will be stripped progressively from the mine path using scrapers or other efficient earth moving machinery. During early stages of mining, topsoil will be stockpiled until the pit has been suitably back-filled for topsoil respreading. Once the mining face has advanced sufficiently it is likely that stripping and respreading of topsoil in a single operation will be possible.

3. *Remove and Stockpile Overburden:* Overburden is the uneconomic subsoil material overlying the resource (ore). The Keysbrook deposit contains little or no overburden, however when it is present this material will be stripped and placed in designated stockpile areas for future rehabilitation unless it can be used immediately to construct internal pit bunds or refill pits.

4. *Mining:* Dry mining methods will be utilised in the extraction of ore from the area. Front end loaders or scrapers will extract the ore and deliver it to a screening and feed preparation plant located near the mining area.

   Mining will occur to a maximum depth of about five metres, with the average depth being two metres. Mining is likely to occur for a period of about eight years at a production rate of five million tonnes per annum.

5. *Screening and Feed Preparation:* The dry screening and feed preparation plant removes waste streams of plus two millimetres oversize and fines (clay and silt particles) from quartz and heavy mineral sand. The oversize and fines will be used to fill mine voids as part of the reclamation process. The sand is pumped into the wet concentration plant.

6. *Wet Concentration:* The Wet Concentration Plant separates the heavy mineral sand from uneconomic quartz sand by gravity separation on conventional spiral concentrators. The quartz sand is mixed with the fines from the feed preparation plant and pumped to backfill the mine voids as part of the reclamation process. The heavy mineral concentrate (HMC) is pumped onto a stockpile to drain of water prior to being transported offsite.

7. *Transport Offsite:* Heavy mineral concentrate will be transported offsite to a mineral separation plant. Heavy mineral concentrate will most likely be transported to Picton via existing roads.

5. ALTERNATIVE OPTIONS CONSIDERED AND BASIS FOR JUSTIFYING PROPOSAL AND SELECTING PREFERRED OPTION

The majority of the Keysbrook project area represents a heavy mineral sand resource. The area to be mined is determined by the mineral content of the orebody, the location of the orebody and access agreements made with the landowners.

The alternatives considered were:

- Do not mine the resource. This would not satisfy Olympia's objective to produce mineral sand products.
- Fully mine the resource. The extent of the economic resource is well defined. The amount potentially available for mining will be governed by the amount of land access and compensation agreements that can be entered into with the private landowners. To secure full rights, Olympia could choose to purchase all freehold land containing heavy minerals outright. This is unlikely to be desirable for all current landowners and would have a detrimental effect on the economics of the project. Time delays likely to acquire all land would also make this alternative undesirable.
- Partially mine the resource. The extent of the economic resource is well defined. The amount potentially available for mining will be governed by the amount of land access and compensation agreements that can be entered into with the private landowners. In reality, it is considered highly likely that agreements will not be entered into with all 20 landowners. Where agreements cannot be made, these areas will be excluded from mining operations.
- Mine the resource using dredging (wet mining) methods. This would require additional water to be extracted for use in the dredging operation. The shallow nature of the ore body and lack of overburden would make this economically and practically undesirable.
- Mine the resource using dry mining techniques. This will, at times, require dewatering of the resource zone. The shallow nature of the ore body and lack of overburden means that conventional dry mining techniques will be the most effective and efficient in terms of production, cost and environmental management.
- Do not mine the section of orebody located underneath the TEC. This is still being considered. The TEC is located on private freehold land. Access to the mineral sand resource in this area is subject to entering into land access and compensation agreements with the private landowner. Negotiations with the landowner will need to be undertaken before any decision regarding mining or long-term protection can be made.
- Undertake primary and secondary treatment on site. Due to the location of other potential ore bodies on tenements, costs and practicalities associated with provision of necessary infrastructure (primarily power and water), a decision has been made to only undertake primary treatment on site. The resultant heavy mineral concentrate will be transported off site for secondary treatment.
- Method of transport to offsite secondary treatment plant. Given the proximity of the railway line, the option of using rail to transport HMC to the secondary treatment plant

was considered. The cost of establishing rolling stock capable f transporting HMC, cost of upgrades to the lines necessary to allow transport of HMC, costs required to establish sidings to allow loading and unloading of trains were not able to be sustained for the project given the estimated eight year project life.

- A number of alternative transport routes for HMC are available. Olympia is working through the various options with both shire councils, Main Roads, the Keysbrook community and other stakeholders. A final route will be selected based on the outcomes of these discussions.

6. REGIONAL SETTING OF THE PROPOSAL

6.1 BIOPHYSICAL CONTEXT

6.1.1 Location

The Keysbrook Heavy Mineral Sand Project is located on Exploration Licence 70/2407. The project is situated along the eastern edge of the Swan Coastal Plain approximately 70 kilometres south of Perth and four kilometres west of the small township of Keysbrook. The project area for mining is 3,500 hectares located within the exploration licence area.

A large portion of the project area has been cleared for predominantly grazing activities, however patches of remnant vegetation remain. The remnant vegetation ranges from stands of trees over pasture grass with little to no understorey to areas of trees with a portion of degraded understorey.

Figure 2 shows the regional location of the project in relation to the Swan Coastal Plain. Figure 3 is an aerial photograph of the project area.

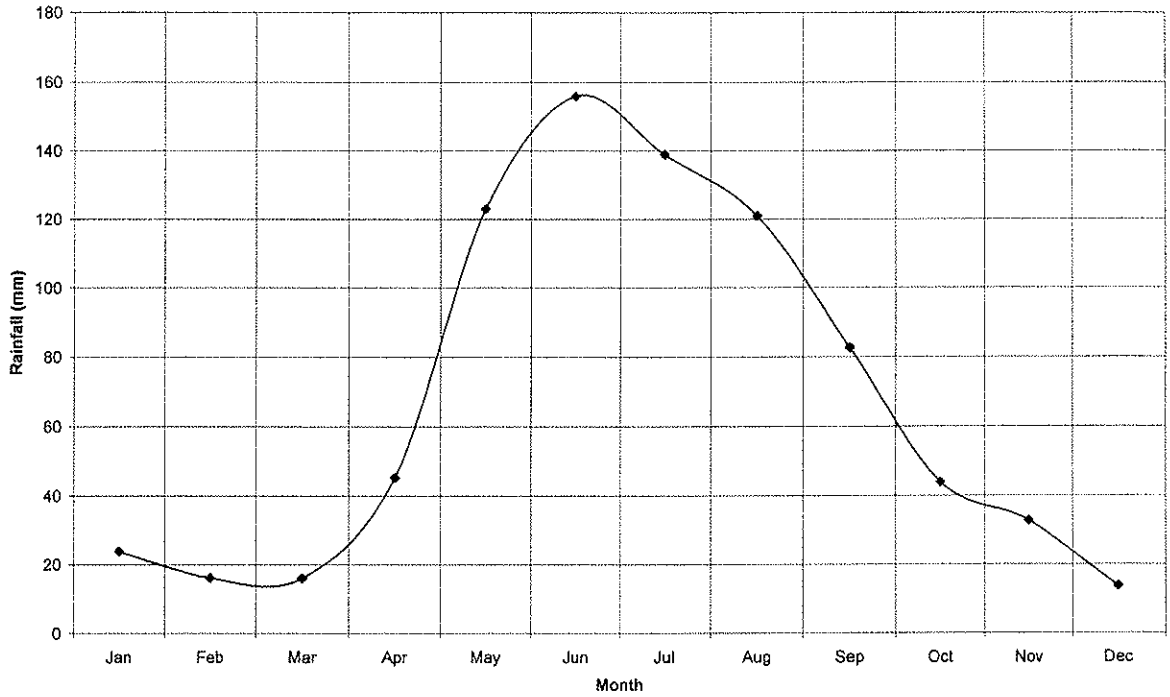
6.1.2 Climate

The area experiences a seasonal Mediterranean climate characterised by cool wet winters and warm to hot dry summers. The project area lies between the 1,000 and 1,100 millimetres rainfall isohyets (Heddle *et al.*, 1980). The Pinjarra South monitoring station, approximately 15 kilometres to the south of the project area, has a mean annual rainfall of 803 millimetres. Chart 1 shows the mean monthly rainfall recorded at the Pinjarra South Monitoring Station.

The nearest meteorological monitoring station is located at Karnet, approximately nine kilometres to the east. This weather station however, is located in the Darling Scarp and as such experiences a slightly different climate to the project area. The nearest meteorological monitoring station on the Swan Coastal Plain is located at the Medina Research Centre, approximately 28 kilometres to the north west of the project area. Karnet experiences mean maximum temperature ranges of 15.2 to 30.7 degrees Celsius and mean minimum temperature ranges of 6.1 to 15.7 degrees Celsius. Medina Research Station experiences mean maximum temperature ranges of 18.1 to 31.3 degrees Celsius and mean minimum temperature ranges of 8.0 to 17.2 degrees Celsius.

Winds are mainly easterly, but varied in the warmer months by reliable afternoon sea breezes and in the cooler months by the westerlies that are associated with approaching cold fronts and the bulk of the annual rainfall. Wind speeds range between eight and 20 kilometres per hour, though higher speeds and squalls are often associated with the passage of could fronts in winter. The winter months, aside from the winds associated with storms and cold fronts, tend to have lighter winds than the summer months.

Chart 1: Pinjarra South – Mean Monthly Rainfall



6.1.3 Topography, Landforms and Soils

The topography of the project area is gently undulating plain. The lowest elevations are in the south-west of the project area at approximately 22 metres AHD. This gradually slopes up to approximately 48 metres AHD in the north-east.

The project area encompasses three major landform and soil types as defined by Churchward and McArthur (1980). These are the Bassendean unit, the Guildford unit and the Southern River unit (Figure 4).

The central portion of the project area is characterised by the Bassendean unit, which consists of sand plains with low dunes and occasional swamps. Soils of the Bassendean complex consist of iron or humus podzols. In the southern and north-eastern portions, the landscape is characterised by the Guildford unit of flat plains with medium textured deposits and yellow duplex soils. The western portion is characterised by the Southern River unit, consisting of sand plain with low dunes and many intervening swamps. The soils of the Southern River unit are similar to those of the Bassendean unit, except that they overlay alluvial soils and so consist of iron and humus podzols, peats and clays.

Based on the Department of Environment (DoE) priority mapping for acid sulphate soils (Planning Bulletin No 64), the Keysbrook project area has a moderate to low risk of actual acid sulphate soils (AASS) and potential acid sulphate soils (PASS). These soils generally occur at depths of greater than three meters. There are some small areas in the southern half of the project area, mostly around low lying areas and wetlands, that have a high risk of AASS and PASS less than three metres from the surface.

6.1.4 Wetlands

The project area is located within the catchment of the Peel-Yalgorup System, the Becher Point Wetlands and Thompsons Lake. These wetlands are all Ramsar sites and are listed in "*A Directory of Important Wetlands in Australia*" (Environment Australia, 2001). Though the project area is located within these catchments, the actual wetlands are more than 15 kilometres distant (Table 1).

Table 1: Distance of the Project Area from Listed Ramsar Sites

Ramsar Wetland	Approximate Distance from Project Area (km)
Peel-Yalgorup System	20
Becher Point Wetlands	20
Thompsons Lake	37

The Biodiversity Audit of Western Australia (Mitchell *et al.*, 2002) lists eutrophication, changed hydrology, urban development and modification of the tidal flats as threatening processes for the Peel-Yalgorup System. Exotic weeds have been listed as a threatening process for both the Becher Point Wetlands and Thompsons Lake, which is also threatened by feral animals, eutrophication and changed hydrology (Mitchell *et al.*, 2002).

There are wetlands present on the project area that have been listed in the *Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy and Regulations 2004*. The initial assessment of the Swan Coastal Plain for wetlands of conservation value was undertaken on the basis of aerial photograph interpretation. The majority of these wetlands have not been ground-truthed and initial investigations by MBS Environmental have indicated that some of them may have been mistakenly listed. Figure 5 shows the locations of these wetlands.

Typically, wetlands of the project area are located in local topographical lows. These wetlands are seasonal, becoming inundated in winter and drying out during the summer months. Much of the project area has been cleared for pasture and cattle grazing and many of the original wetlands are in a severely degraded state. All fringing and other native vegetation has been removed from many of these wetlands, while those that have retained some vegetation have become degraded through grazing, erosion and changed nutrient regimes.

6.1.5 Surface Water

The project area is located within the Proposed Karnup – Dandalup Water Reserve. This area has been allocated a policy use of P2. P2 source protection areas are defined to ensure that there is no increase in risk of pollution to the water source. They are declared over land where low intensity development (such as rural) already exists. P2 areas are managed in accordance with the principle of risk minimisation and so some development is allowed under specific guidelines (DoE, 2005).

The low relief and high infiltration rates associated with predominantly sandy soils preclude the development of significant creek lines. The gentle undulating slopes do support occasional agricultural dams, ditches and small, isolated ephemeral wetland areas.

While there are no major drainage lines located within the project area approximately 80 percent of the area is situated within the Nambeelup Brook catchment. Nambeelup Brook discharges into Black lake which then flows into Goegrup Lake before ultimately flowing into the Peel-Yalgorup System. The northern section of the project area is located within the Dirk Brook catchment, while the southernmost section is located within the catchment of the North Dandalup River. Both of these systems also ultimately flow into the Peel-Yalgorup System.

6.1.6 Groundwater

The project area is located within the Proposed Karnup – Dandalup Underground Water Pollution Control Area. This area has been assigned a policy use of P2. As outlined in the previous section, P2 areas are declared over land where low intensity development already exists and are declared to ensure there is no increased pollution risk to the water source.

Two aquifers of the Perth Basin are relevant to the project. Firstly, the shallow Superficial formations, of which the upper four to eight metres (approximately) – Bassendean Sand – comprises moderately permeable material. In the project area the water table in this aquifer ranges from zero to 10 metres below ground surface. There is zero to about two metres saturation above the base of the Bassendean Sand, depending on the season and the local aquifer geometry. This aquifer will be affected by the mining operations as it contains the mineral-sand deposit.

Mining operations will result in the groundwater levels in the Bassendean Sand being temporarily lowered to the base of the unit, in and around individual mining cells. Water levels will commence recovering as mining moves to new cells, excavated cells are backfilled, and rainfall recharges the reconstituted aquifer.

The second relevant aquifer is the Leederville Formation extending to about 80 metres depth. It will be utilised as a water source for the mining operation.

Pumping of groundwater from the Leederville Formation to supply the anticipated 32 litres per second process-water supply is calculated to have an insignificant effect on water levels in this aquifer, less than one metre of drawdown at distances exceeding 600 metres from the pumped bore.

Water salinities in the Superficial aquifer range from 200 to 1000 milligrams per litre TDS, while in the Leederville Formation they are generally less than 1000 milligrams per litre TDS.

6.1.7 Flora and Vegetation Communities

The project area is located on the Pinjarra Plain subunit of the Swan Coastal Plain (Beard, 1980). Beard describes the vegetation of the project area as being Marri (*Corymbia calophylla*) woodland. Heddle *et al* undertook vegetation mapping of the Darling System on a finer scale than Beard. They identified four distinct vegetation complexes that occur on the

project area. These were the Forrestfield Complex, the Guildford Complex, the Bassendean Complex (South and Central) and the Southern River Complex (Figure 6).

Much of the project area has been cleared for the grazing of dairy cattle and a small area of intensive agriculture. There are some areas of native vegetation remaining, though much of this is in a degraded condition. In total there is approximately 582.6 hectares of native vegetation remaining. Of this about 498.5 hectares has been parkland cleared and 84.2 hectares can be classified as remnant vegetation. The native vegetation ranges from stands of trees over pasture grass with little to no understorey to areas of trees with a portion of degraded understorey. Figure 7 shows the distribution and condition of native vegetation over the project area.

The largest area of remnant native vegetation is located in the north of the project area and comprises *Banksia attenuata* woodland patches interspersed with Marri/Jarrah woodland. A seasonal wetland with very dense *Regelia* and *Melaleuca* species and sedges is located to the east of the *Banksia attenuata* woodland outside of the project area.

The woodland, along with much of the project area, has been surveyed by Dr Eleanor Bennett. From her observations it was inferred that this woodland was Floristic Community Type 20b, following Gibson *et al.*, 1994 (Bennett Environmental Consulting, 2004). Floristic Community 20b, *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern Swan Coastal Plain, has been declared by CALM as being a Threatened Ecological Community (TEC). This listing has been endorsed by the Minister of the Environment. This area has not previously been recorded in the CALM TEC database.

The vegetation in the south of the project area is dominated by vegetation consisting of Marri and Sheoak woodland with Banksia uplands that have been fragmented into a series of moderate to small degraded patches with parkland cleared understorey.

A total of 13 rare, endangered or otherwise specially protected flora may occur in the project area. Of these, none were recorded during recent flora surveys of the site. Table 2 lists these species and gives an indication of their likelihood of occurring in the project area. In addition to these native species, a total of 34 weeds have been recorded from the project area (Bennett Environmental Consulting, 2004).

Table 2: Rare, Threatened or Otherwise Specially Protected Flora that may Occur in the Project Area

Species	Status	Habitat and Comments	Likelihood of Occurrence on Project Area
Acacia oncinophylla subsp. *patulifolia*	P2	Shrub, 0.5–2.5(–3) m high, 'mini-ritchi' bark, phyllodes 4–9 cm long, 3–6 mm wide. Fl. yellow, Aug–Dec. Granitic soils, occasionally on laterite.	Low. Unsuitable soil type
Anthocercis gracilis (Slender Tailflower)	Vulnerable	Erect, spindly shrub, to 0.6(–1) m high. Fl. yellow, green, Sep–Oct. Sandy or loamy soils. Granite outcrops.	Low, soil type unsuitable.
Anthotium junciforme	P4	Open, erect to prostrate perennial, herb, 0.05–0.4 m high, leaves linear to terete, 0.5–1 mm wide; flowering stems 12–40 cm long. Fl. blue, violet, purple, Nov–Mar. Sandy clay, clay. Winter-wet depressions, drainage lines.	Moderate. Vague possibility in damp areas
Aponogeton hexatepalus	P4	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green, white, Jul–Oct. Mud. Freshwater: ponds, rivers, claypans	Moderate. If there is a wetland that contains standing water there is a possibility of being present.
Boronia tenuis	P4	Procumbent or erect & slender shrub, 0.1–0.5 m high. Fl. blue, pink, white, Aug–Nov. Laterite, stony soils, granite.	Low. Unlikely as unsuitable soil type
Caladenia sp. Jarrah forest	Vulnerable		
Calothamnus graniticus	P4	Shrub, 1–2.5 m high. Fl. red, May–Aug. Skeletal sandy soils, clay, laterite. Granite outcrops, hillsides.	High. subsp *leptophyllus* has been recorded from private property at Keysbrook.
Drakea elastica (Glossy leaved Hammer-orchid)	Endangered	Tuberous, perennial, herb, 0.12–0.3 m high. Fl. red, green, yellow, Oct–Nov. White or grey sand. Low-lying situations adjoining winter-wet swamps.	Moderate. May occur in damp areas at the site.
Drakea micrantha	Vulnerable	Tuberous, perennial, herb, 0.15–0.3 m high. Fl. red, yellow, Sep–Oct. White-grey sand.	Low. Recorded from Pinjarra in Banksia woodland so may occur at the site. Most records are from further south.

Species	Status	Habitat and Comments	Likelihood of Occurrence on Project Area
Lambertia multiflora var. *darlingensis*	P3	Many-stemmed shrub, to 2 m high. Fl. yellow, Jun–Nov. Deep white-yellow sands or loamy, clayey or gravelly soils, laterite, granite. Flats, gorges, base of scarp, rocky hills, plateaus, roadsides.	Low. Occurs at the base of the Darling Scarp and therefore unlikely to occur in area.
Lasiopetalum pterocarpum	Endangered	Open shrub 0.2-1.2 m high x ca 0.2-0.5 m wide, growing through other plants. Riverbank. Brown clay-sand over granite.	Low. Unlikely to occur in area.
Synaphea sp. Pinjarra	DRF	Compact shrub, to 0.4 m high, to 0.5 m wide. Fl. yellow, Sep. Grey clayey sand. Swamp. Recorded from Dandalup and Pinjarra.	Low. Unlikely to occur in the area.
Tetraria australiensis	DRF	Rhizomatous, tufted perennial, grass-like or herb (sedge), to 1 m high. Fl. brown, Nov–Dec.	Low. Unlikely to occur at site.

Source: CALM (2005a). DEH (2005). Likelihood of occurrence on project area provided by Dr Eleanor Bennett.

6.1.8 Fauna

The majority of the project area (over 90 percent) has been cleared for agricultural purposes. As such the amount of habitat available has been severely reduced. The primary issue for fauna in fragmented agricultural landscapes is connectivity of remnant vegetation. Any reduction in the number of remnants may lead to the reduction in value of the remaining remnants, as the movement of fauna will be impeded. Relatively few species use cleared areas, and those that do usually require areas of native vegetation to supply at least some of their needs. The vegetation of the project area is currently highly fragmented. The remnant vegetation in the north of the project area has the potential to provide habitat for a range of species, though it is not well connected with other similar patches.

There are ten species of amphibians, 45 species of reptiles (five of conservation significance), 94 species of birds (40 of conservation significance and six introduced), and 30 species of mammals (six of conservation significance and five introduced) that are expected to occur within the project area. A complete list of the species expected to occur within the project area and their conservation status is given in Appendix 1. Table 3 lists those species that are protected under State or Commonwealth Acts.

Table 3: Fauna Species that are Listed under State or Commonwealth Acts and are Expected to Occur in the Project Area

Species	Common Name	Conservation Category
Apus pacificus	Fork-tailed Swift	Migratory/Listed - overfly marine area
Ardea alba	Great Egret	Listed - overfly marine area
Ardea ibis	Cattle Egret	Listed - overfly marine area
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Lower risk (Near Threatened)
Calyptorhynchus baudinii	Long-billed (Baudin's) Black-Cockatoo	Vulnerable
Calyptorhynchus latirostris	Short-billed (Carnaby's) Black-Cockatoo	Endangered
Dasyurus geoffroii	Chuditch	Vulnerable
Falco peregrinus	Peregrine Falcon	Other Specially Protected Species
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory / Listed - overfly marine area
Isoodon obesulus fusciventer	Quenda	Priority 4
Merops ornatus	Rainbow Bee-eater	Migratory
Phascogale calura	Red-tailed Phascogale	Endangered
Phascogale tapoatafa	Brush-tailed Phascogale	Lower risk (Near Threatened)
Setonix brachyurus	Quokka	Vulnerable

Of particular interest is the potential presence of the Short-billed (Carnaby's) Black Cockatoo (*Calyptorrhynchus latirostris*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*). The Short-billed (Carnaby's) Black-Cockatoo is likely to utilise the remnants for feeding. Given the paucity of remnant vegetation in the area, these remnants are probably important for this species. Loss of feeding habitat for Carnaby's Cockatoo is identified as a key threatening process under the Commonwealth *EPBC Act 1999*. The Forest Red-tailed Black-Cockatoo may similarly utilise remnants in the area for feeding, but additionally this species may breed in suitable nest hollows in the region.

6.2 SOCIAL CONTEXT

The project area is situated approximately 50 percent within the Shire of Murray and 50 percent within the Shire of Serpentine – Jarrahdale.

The mining area is located approximately 2.2 kilometres west of the township of Keysbrook and 2.1 kilometres northwest of the town of North Dandalup. Data from the Australian Bureau of Statistics (2001) indicates that the population of North Dandalup in 2001 was 254, while the population for the Keysbrook postal district (postcode 6126) was 407 in 2001. The

data for North Dandalup refers only to the townsite and does not take into account farmers and other residents living outside of the town.

The project area and surrounding land is currently used for agricultural purposes. The majority of the land is held in pre-1898 title. The northern section of the project area is dominated by a few large landholdings while the southern portion consists of many smaller landholdings. The dominant industry of the area is dairy farming, though there is a small area of intensive horticulture and horse keeping, rearing and agistment is common.

7. COMMUNITY AND OTHER STAKEHOLDER CONSULTATION PROGRAM

7.1 OBJECTIVES

The objectives of the Community Consultation Program for the Keysbrook project are to:

- Identify key stakeholders.
- Ensure that appropriate information regarding the proposed project is communicated to all stakeholders.
- Determine the key concerns of stakeholders regarding the proposed project.
- Involve interested stakeholders in project design and planning.

By undertaking community consultation, Olympia aim to create an understanding with the stakeholders of the sincerity and capability of Olympia to address environmental issues.

7.2 STAKEHOLDERS

The stakeholders for the Keysbrook project are identified in Table 4 below.

Table 4: Keysbrook Project Stakeholders

Community	Statutory	Corporate	Employees
Private landowners within the project area	Department of the Environment and Heritage	Olympia Resources	Staff
Adjacent landowners	EPA	ASX	Contractors
WA Conservation Council	Department of Environment	Companies Analysts	Consultants
The Wildflower Society of Western Australia	Department of Conservation and Land Management	Customers	
Keysbrook and North Dandalup local businesses	Main Roads	Future Shareholders	
Media	Western Power	Banks	
Politicians	Water Corporation		
Mining industry peers	Shire of Serpentine-Jarrahdale		
Bunbury Port	Shire of Murray		
Keysbrook Community Group			
Keysbrook Ratepayers Association			
Landcare Groups			

7.3 CONSULTATION UNDERTAKEN TO DATE

Preliminary consultation has commenced. Consultation conducted to date includes:

- Initial contact has been made with the Shire of Serpentine Jarrahdale. Olympia made a presentation on 16 August 2005 outlining the project, approval methodology and likely environmental impacts. Questions raised by the councillors were addressed.
- Initial contact has been made with technical staff at the Shire of Serpentine Jarrahdale and Shire of Murray to discuss the proposed project. Meetings were held with each group on 18 August 2005. Discussions focused on assessment methodology and likely issues of technical concern.
- The majority of landowners within the project area have been contacted by Olympia as part of exploration and land access agreements. This has involved one on one meetings and provision of written material. Small landowners who are not residing on the property are still being contacted.
- Meetings have been held with representatives of DoE to discuss the proposed project prior to submission of the *EPBC Act 1999* and EPA referral and to answer questions raised by the EPA referral.

Preliminary discussions have been held with a large number of Stakeholders to identify their potential interest in the project.

7.4 FUTURE CONSULTATION

A more detailed consultation program is being developed and will be implemented once the scope of the project has been finalised. This program is based on proactive communication methods and aims to involve interested stakeholders in design of the project.

8. ENVIRONMENTAL ISSUES, FACTORS, SCOPE OF WORKS AND POTENTIAL MANAGEMENT

The environmental factors considered relevant to the proposed mining activities within the Keysbrook project area are detailed within Table 5.

Of the 18 environmental factors listed within Table 5, the factors considered to be of greatest significance are:

- Vegetation, including TECs.
- Fauna, including significant species.
- Wetlands.
- Groundwater.

In particular, the most significant potential environmental impacts of the project are considered by Olympia Resources Limited to be:

- Destruction of priority flora species and areas of floristic community 20b.
- Loss of habitat for specially protected fauna species.
- Extraction of up to two gigalitres of groundwater per annum for use in processing. Careful management will be required to ensure adverse localised impacts do not occur.

Additional surveys and investigations will be conducted to:

- Ground truth conservation category wetland boundaries and verify wetland categorisations are correct.
- Collect additional information about the Short-billed Black Cockatoo and the Forest Red-tailed Black Cockatoo within the project area.
- Collect information about and model the hydrology and hydrogeology of the project area and the Keysbrook region.
- Noise modelling.
- Soil characteristics.
- Groundwater modelling.

Whilst the other environmental factors listed within Table 5 are also important, these are considered to be less significant for this proposal as experience gained from similar mining operations indicate that effective management and mitigation measures can practically be implemented to ensure adverse environmental impacts are prevented or minimised and the stated EPA environmental objectives met.

Table 6 details the relevance of the Principles of Environmental Protection to the Keysbrook Heavy Mineral Sands project.

Table 5: Environmental Factors Relevant to the Keysbrook Heavy Mineral Sands Project

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Applicable Standards, Guidance & Policies
Biophysical						
Vegetation Communities	Keysbrook project area and surrounds.	To maintain the abundance, diversity, geographic distribution and productivity of vegetation communities through the avoidance or management of adverse impacts and improvement of knowledge.	About 84.2 hectares of remnant vegetation and 498.5 hectares of parkland cleared vegetation is present within the project area. About 305 ha (61.2%) of parkland cleared and 51.3 ha (60.9%) of remnant vegetation is likely to be needed to be cleared during the project life.	Investigate potential offsets in regard to remnant vegetation clearing.	The amount of vegetation to be cleared will be minimised as far as practicable. Mining areas will be rehabilitated upon completion using retained topsoil. Vegetation management plans will be developed.	EPA Position Statement No2 EPA Position Statement No 3 EPA Guidance Statement No 51 CALM Policy Statement No 9
Flora	Keysbrook project area.	To maintain the abundance, diversity, geographic distribution and productivity of flora at species ecosystem levels through the avoidance or management of adverse impacts and improvement of knowledge.	There is potential for flora of conservation significance to occur in the project area. Mining activities may result in the removal of these species.	Review results from previously conducted surveys. Conduct targeted surveys for species of conservation significance.	Vegetation management plans will be developed. Each new area will be inspected for the presence of significant flora prior to the start of mining.	EPA Position Statement No 2 EPA Position Statement No 3 EPA Guidance Statement No 51 CALM Policy Statement No 9
Fauna	Keysbrook project area.	To maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Progressive clearing of about 356.3 hectares has the potential to reduce the available habitat of fauna species. Reduction in habitat may reduce the local populations of fauna species of conservation significance.	Targeted surveys for Forest Red-tailed Black Cockatoos and Carnaby's Cockatoo. Investigate methods to increase habitat in other areas (eg nest boxes) and return of habitat post mining.	The amount of vegetation to be cleared will be minimised as far as practicable.	EPA Position Statement No 3 EPA Guidance Statement No 56
Wetlands	Keysbrook project area.	To maintain the integrity, ecological functions and environmental values of wetlands.	There are listed EPP wetlands on the project area. In the progressive mining of the area these may be removed.	Survey and analysis of the wetland areas to determine their status as wetlands and their value for conservation.	Wetlands on the edge of orebodies will be avoided and retained. Wetlands confirmed to have conservation value will be retained.	EPA Position Statement No 4 Revised Draft Environmental Protection (Swan Coastal Plain Wetlands) Policy
Surface Water	Keysbrook project area and surrounding catchments.	To maintain the quantity of surface water so that existing and potential environmental values, including ecosystem maintenance, are protected	Changes in the local surface runoff regime resulting in contamination of surface water runoff with sediment.	Investigations into and modelling of the surface water and hydrological regime of the project area.	Waters from potentially contaminated catchments will be captured and treated prior to release to natural catchments where necessary.	Water Protection Guideline No 6.
Groundwater	Keysbrook project area and area of hydrological influence.	To maintain the quantity of groundwater so that existing and potential environmental values, including ecosystem maintenance, are protected.	Extraction of up to 2 GL of water per annum.	Investigations into the hydrology and hydrogeology of the project area	Groundwater licence conditions will be complied with. Abstraction volumes and water quality monitoring requirements will continue to be met and be reported to regulatory authorities. Where possible, water will be recycled to minimise abstraction volumes.	Water Protection Guideline No 11.

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Applicable Standards, Guidance & Policies
Soil	Keysbrook project area.	To maintain the integrity, ecological functions and environmental values of the soil.	Alteration of the soil profile in mined areas. Loss of soil fertility viability due to stockpiling. Spread of *Phytophthera cinnamomi* in native vegetation areas. Disturbance of PASS and possible increase in soil acidity.	Review of current soil management practices in the mining and mineral sands industries. Map the current extent of dieback with the project area and surrounds. Determine the acid forming potential of the soils in the project area.	Topsoil will be stripped, re-used or stockpiled for later re-use in rehabilitation. Waste sand material from the plant will be returned to areas where mining has been completed. All plant and machinery will be cleaned down prior to entering into disease-free areas. Develop a Management Plan and procedures for *Phytophthera cinnamomi*. AASS/PASS will be addressed in the EMP.	CALM Policy Statement No 3 WA Planning Bulletin No. 64.
Landform	Keysbrook project area.	To maintain the integrity, ecological functions and environmental values of landforms.	Alteration of the local topography and landforms due to mining activities.	Review of current landform restoration practices.	Rehabilitation and landform design plans will be developed. Erosion control measures will be implemented during mining and maintained until rehabilitation is successful. As far as practicable, the post-mining landscape and landforms shall be returned to a state as close as possible to the pre-mining landscape.	
Conservation Areas	Keysbrook site.	To protect the environmental values of areas identified as having significant environmental attributes.	A portion of the TEC (floristic community 20b) may need to be cleared during the life of the mine.	Determine the distribution of Floristic community 20b in the vicinity of the project area.		EPA Position Statement No2 EPA Position Statement No 3 EPA Guidance Statement No 51 CALM Policy Statement No 9

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Applicable Standards, Guidance & Policies
Pollution Management						
Air Quality	Keysbrook project area and immediate rural surrounds.	To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements.	Mining activities will result in airborne dust particles. Minor release of greenhouse gases from mining equipment.	Calculation of likely project greenhouse gas emissions.	Dust suppression procedures applied in line with good industry practice. All practicable measures will be taken to reduce energy consumption. Completed areas will be rehabilitated and revegetated as soon as practicable.	EPA Guidance Statement No 12
Surface water quality	Surface waters at the Keysbrook project area and others within the zone of hydrological influence.	To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements.	Degradation of quality of surface runoff by sediments and hydrocarbon spillages.	Investigations into and modelling of the surface water and hydrological regime of the project area.	A hydrocarbon management plan will be prepared. Waters from potentially contaminated catchments will be captured and treated prior to release to natural catchments where necessary.	Water Protection Guideline No 5.
Groundwater quality	Groundwater within the zone of hydrological influence.	To ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements.	Contamination of groundwater by hydrocarbon spillages.	Investigations into the hydrology and hydrogeology of the project area	A hydrocarbon management plan will be prepared.	Water Protection Guideline No 5.
Soil quality	Keysbrook project area.	To ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.		Consultation with landowners to determine land use/s after mining is completed. Review of current rehabilitation techniques within the mineral sands industry.	Removal of and careful management of topsoil for use in rehabilitation. Development of a rehabilitation management plan.	
Noise	Keysbrook project area and immediate rural surrounds.	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal be ensuring the noise levels meet statutory requirements and acceptable standards.	Noticeable increase in noise levels for nearby residents.	Noise emissions and impact modelling.	Location of noise generating equipment within enclosed structures. Placement of topsoil stockpiles to buffer emissions.	
Noise – Road Transport	Route to be taken from the Keysbrook project area to the secondary processing plant at Picton.	Ensure that noise and vibration levels meet acceptable standards and that an adequate level of service, safety and public amenity is maintained.	Increases in noise, vibration and hazard along the haulage route.	Investigations into truck noise emissions.	All trucks will be well maintained and be operated by appropriately licensed operators. Roads will be maintained in a manner agreed with the local councils.	
Light	Keysbrook project area and immediate rural surrounds.	To avoid or manage potential impacts from light overspill and comply with acceptable standards.	Light overspill visible from nearby residences. Light overspill may result in avoidance of the area by fauna.		Orientate lights to minimise impacts on residences.	

Environmental Factor	Relevant Area	Environmental Objective	Potential Impacts	Additional Investigations	Potential Management	Applicable Standards, Guidance & Policies
Social Surrounds						
Heritage	Keysbrook project area.	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.	There are no known heritage sites located on the Keysbrook site.	Ethnographic/archaeological survey.		EPA Guidance Statement No 41
Visual amenity	Keysbrook project area and immediate surrounds.	To ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape as low as possible.	Mining areas may be visible from secondary roads at the edges of the project area and nearby residences.	Visual amenity study.	Buffer areas, bunds and visual screening will be used to reduce the impact on visual amenity.	

Table 6: Relevance of the Principles of Environmental Protection to the Keysbrook Heavy Mineral Sands Project

Principle	Relevant Y/N	If yes, consideration
1. The Precautionary Principle Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradations. In application of this precautionary principle, decisions should be guided by – (a) Careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and (b) An assessment of the risk – weighted consequences of various options.	Yes	Investigations required to provide sufficient information to address potential environmental impacts.
2. The Principle of Intergenerational Equity The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.	Yes	See 3. Information on long-term greenhouse gas emissions with respect to Guidance Statement No. 12.
3. The Principle of the Conservation of Biological Diversity and Ecological Integrity Conservation of biological diversity and ecological integrity should be a fundamental consideration.	Yes	Flora and fauna surveys undertaken. DRF, TEC presence and distribution to be checked, locally and regionally. Quantity of vegetation/habitat loss.
4. Principles relating to Improved Valuation, Pricing and Incentive Mechanisms (1) Environmental factors should be included in the valuation of assets and services. (2) The polluter pays principle – those who generate pollution and waste should bear the cost of containment, avoidance and abatement. (3) The users of goods and services should pay prices based on the full lifecycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste. (4) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and minimise costs to develop their own solutions and responses to environmental problems.	No	
5. The Principle of Waste Minimisation All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.	Yes	To be addressed in the EMP

9. STUDY TEAM

MBS Environmental has been appointed by Olympia Resources Limited to co-ordinate and manage the environmental approvals process for the proposed extension. As part of this responsibility, MBS Environmental has co-ordinated a number of technical specialists who have or are scheduled to conduct specific studies identified as being a necessary component of gaining environmental approval. Descriptions of the study team members are detailed in Table 7.

Table 7: Study Team Members

Team Member	Organisation	Expertise
Ms Kristy Sell	MBS Environmental Director – Environmental Science	Project Manager Environmental management planning, air quality, noise, rehabilitation.
Mr Raul Rokich	MBS Environmental Senior Environmental Scientist	Community consultation, environmental management planning, rehabilitation.
Mr Mike Dufty	MBS Environmental Senior Environmental Scientist	Water management, visual assessment
Ms Kate George	MBS Environmental Environmental Scientist	Flora, fauna, vegetation and habitat surveys and assessment.
Dr Eleanor Bennett	Bennett Environmental Consulting Pty Ltd	Vegetation, flora and wetland surveys.
Mr Robert Davis and Ms Jennifer Wilcox	Western Wildlife	Fauna and habitat survey and assessment.
Roger Passmore	Rockwater	Groundwater data collection and impact assessment.
Mr Peter Gazzard	Olympia Resources Managing Director	Mine and project management.
Mr John Baxter	Olympia Resources Technical Director	Mine planning, operations, geology.

10. PROJECT AND ASSESSMENT SCHEDULE

The following is an estimated schedule for the PER:

Referral of proposal to EPA	**4 July 2005**
Setting of level of assessment by EPA	**21 July 2005**
Advertisement of level of assessment by EPA	**25 July 2005**
Closing date for two week appeal period	**8 August 2005**
No appeals - Submission of draft Environmental Scoping Document (ESD) to EPASU	**14 September 2005**
Comments from EPASU on draft ESD	**1 October 2005**
Submission of Final ESD to EPASU	**Mid October 2005**
Scoping Document presented to EPA for endorsement	**20 October 2005**
Hydrogeological investigations	**August – September 2005**
Targeted cockatoo survey	**September – October 2005**
Other environmental studies and consultations	**September – November 2005**
Preparation of Draft PER document	**September – December 2005**
Review of draft by agencies	**Early February 2006**
Finalise PER and submit formally to EPA	**Late February 2006**
Release of PER document for eight week review	**March -April 2006**
Summary and response to issues raised in review	**May 2006**
EPA report to the Minister	**June 2006**
Two week appeal period *(If appeals lodged add at least two months to the process)*	**June 2006**
If no appeals - issuing of approval and conditions	**July 2006**

Note: This time sequence is an estimate only.

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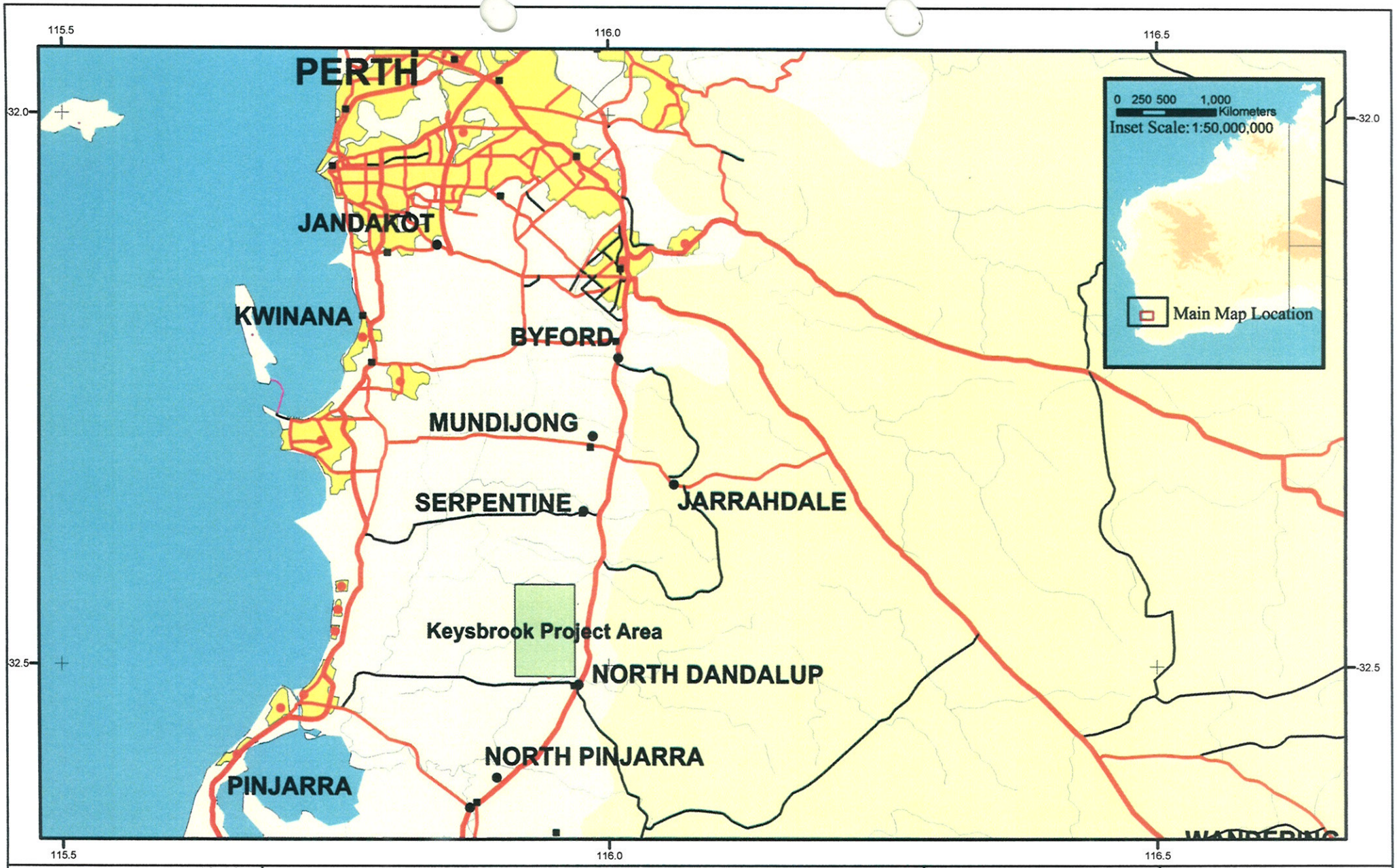
FIGURES



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Olympia Resources
Keysbrook Project

Location Plan

Figure 1

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Original Size: A4
Air Photo Date 2002
Drawn By Lisa Boulden

Olympia Resources Limited

Keysbrook
Heavy Mineral Sand Project

Regional Location in Relation to the Swan Coastal Plain

Figure 2

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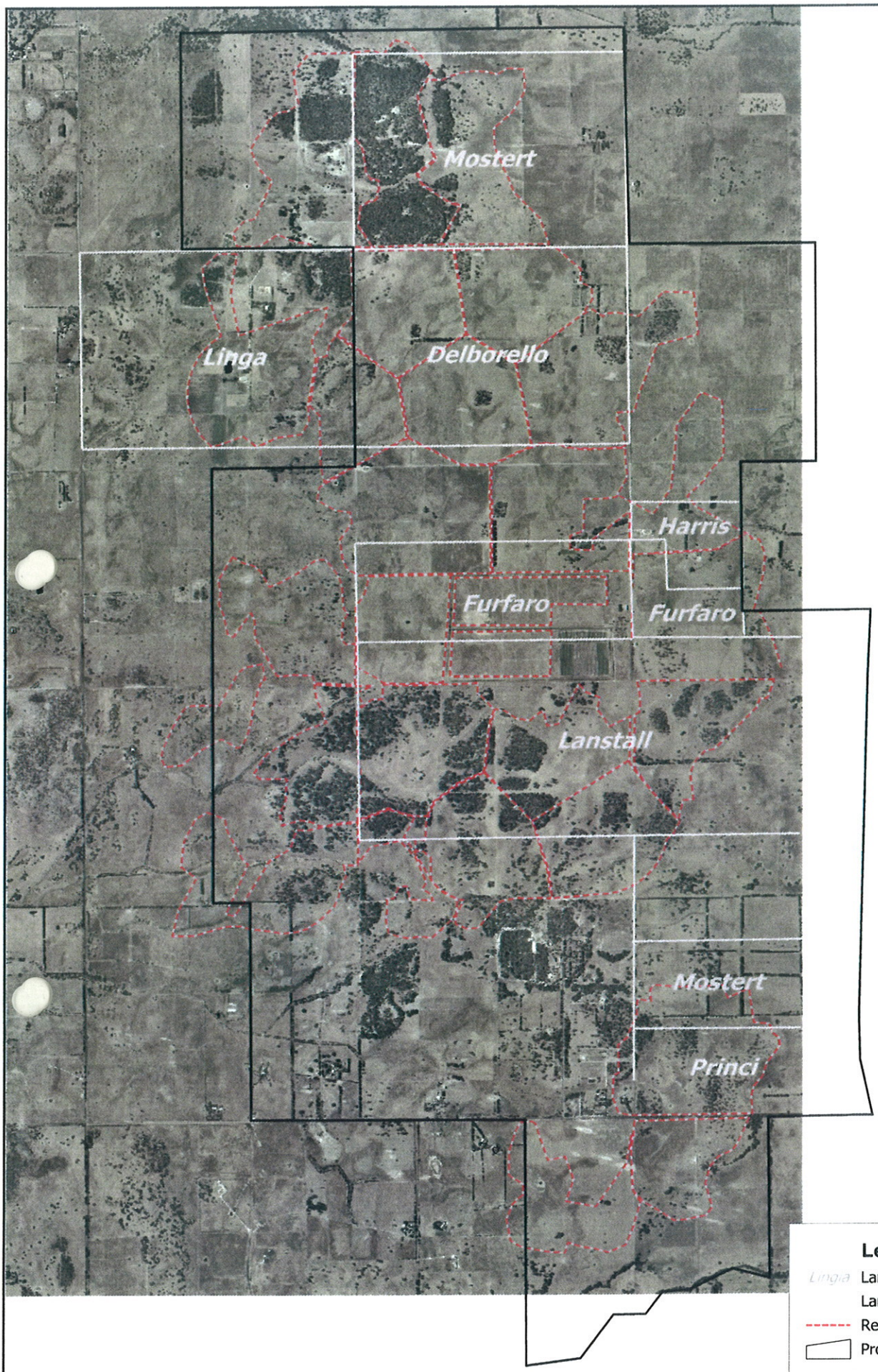

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Scale 1:40000
Original Size: A4
Projection: Australia MGA94 (50)
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Olympia Resources Limited

Keysbrook
Heavy Mineral Sand Project

Aerial Photograph

Figure 3

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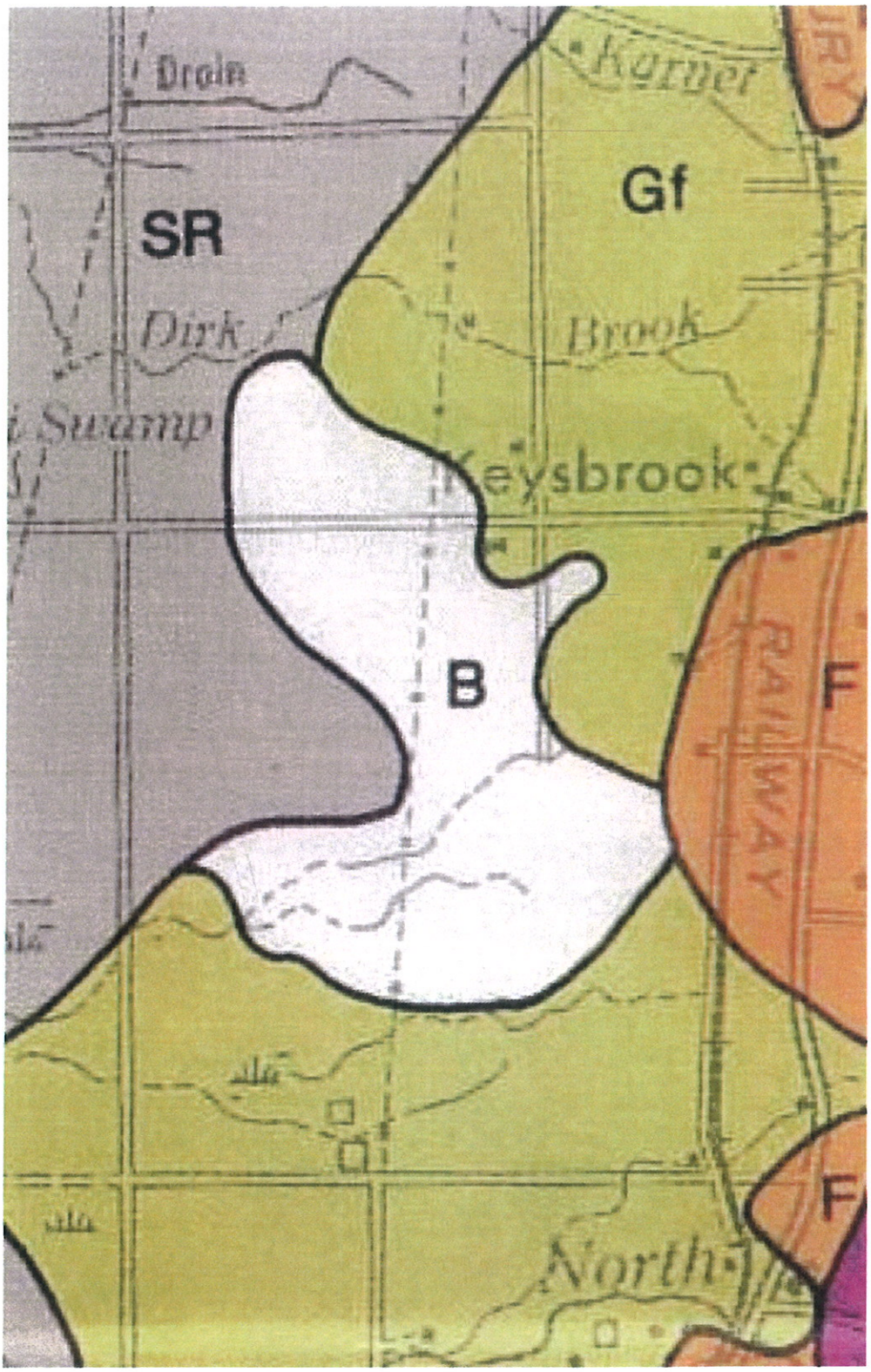

Source: Churchward and McArthur (1980)

B = Bassendean Unit

F = Forrestfield Unit

Gf = Guildford Unit

SR = Southern River Unit

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Landforms and Soils of the Keysbrook Area

Figure 4

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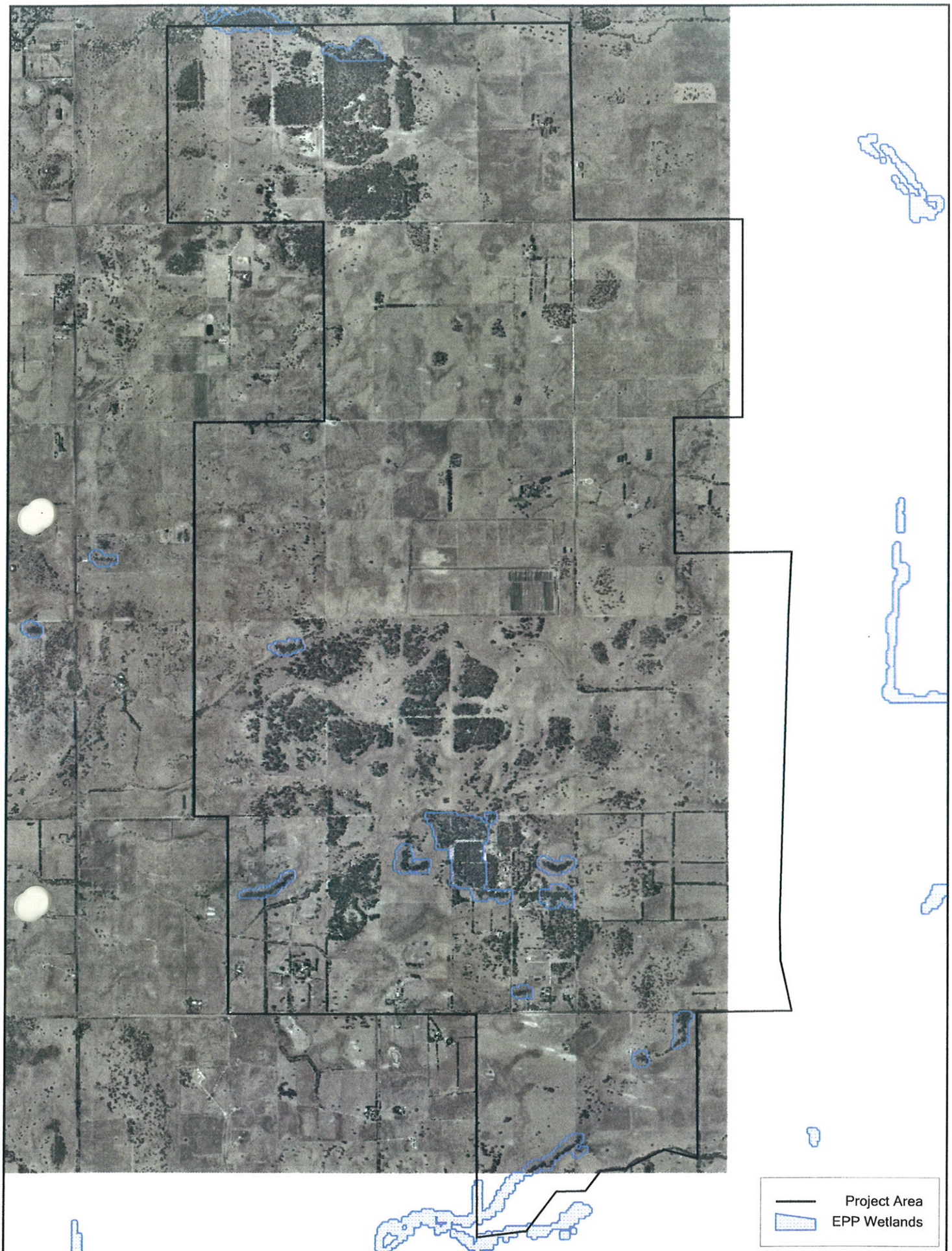

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Keysbrook
Heavy Mineral Sand Project

EPP Wetlands

Figure 5

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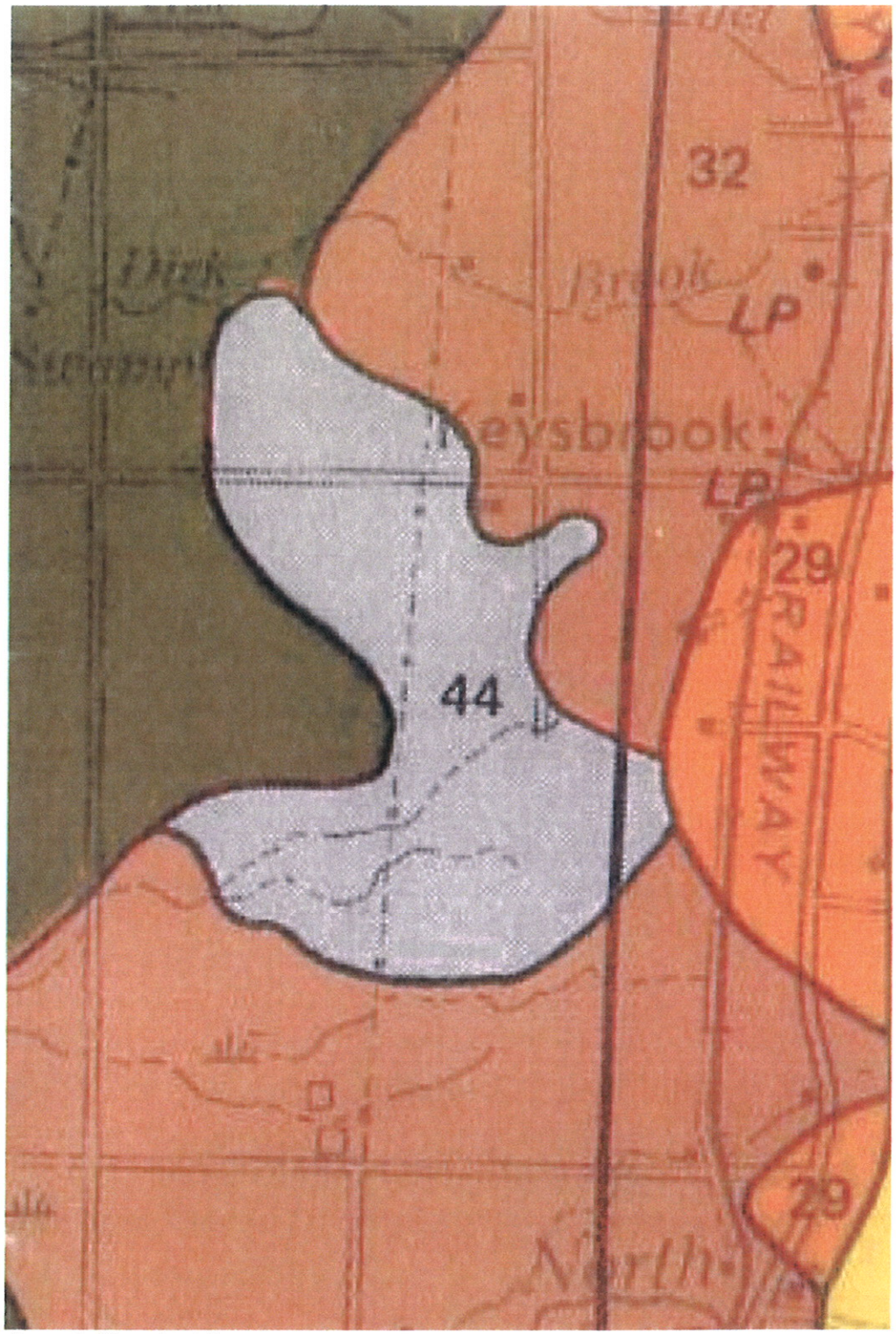

Source: Heddle *et al* (1980)

29 = Forrestfield Complex

32 = Guildford Complex

42 = Southern River Complex

44 = Bassendean Complex – Central and South

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Vegetation Complexes of the Keysbrook Area

Figure 6

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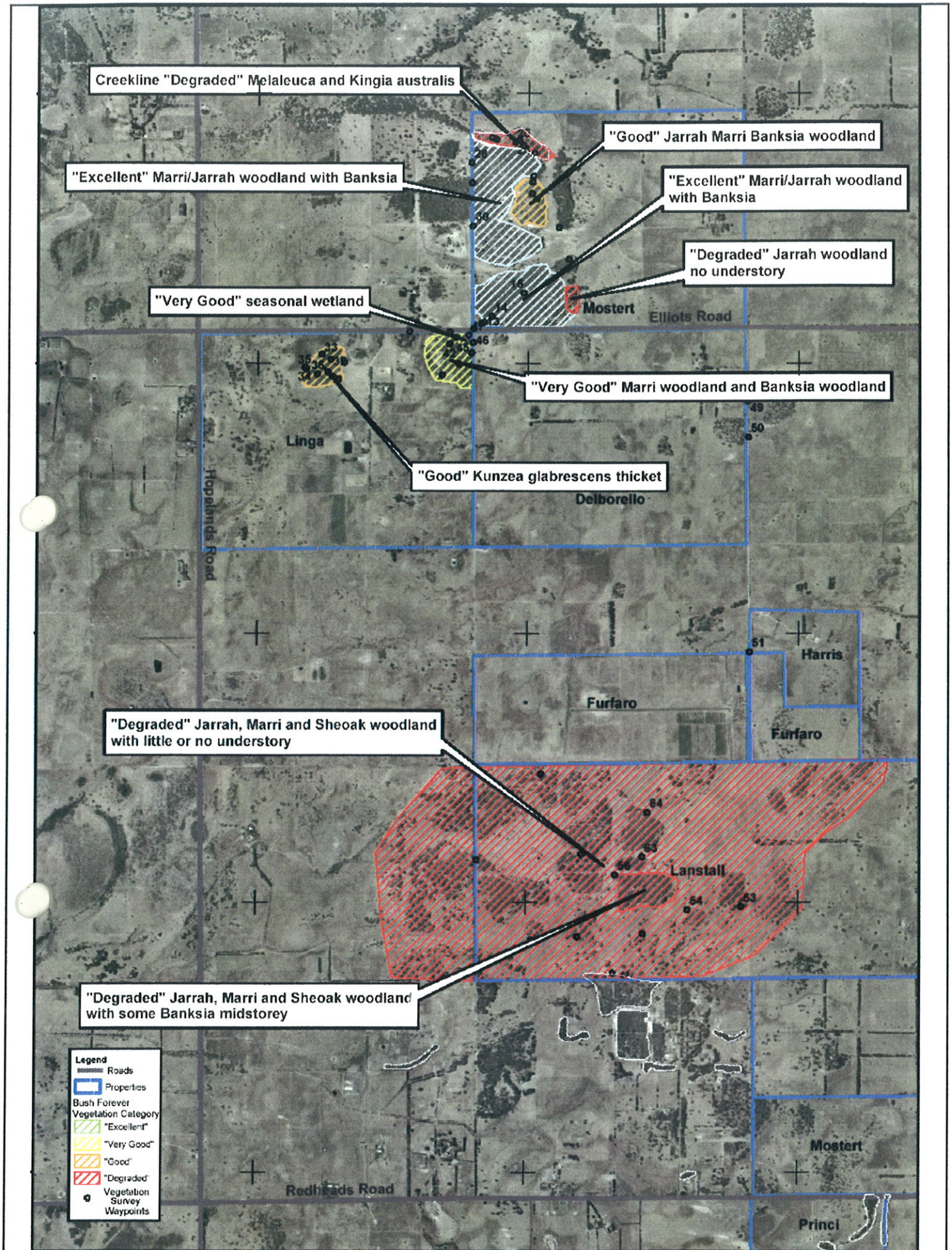

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Projection: Australia MGA94 (50)
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Native Vegetation Distribution and Condition

Figure 7

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APPENDICES

APPENDIX 1

Complete List of Vertebrate Fauna Species Recorded (+) or Expected to Occur Within the Keysbrook Project Area

Species	Common Name	Status	Observed or Recorded	
Amphibians				
Myobatrachidae (burrowing frogs)				
Crinia georgiana	Quacking Frog			WAM
Crinia glauerti	Glauert's Frog			
Crinia insignifera	Sandplain Froglet		+	
Crinia pseudinsignifera	Granite Froglet		+	WAM
Heleioporus eyrei	Moaning Frog		+	
Heleioporus psammophilus	Marbled Burrowing Frog			
Limnodynastes dorsalis	Pobblebonk Frog			
Myobatrachus gouldii	Turtle Frog			
Pseudophryne guentheri	Guenther's Toadlet		+	WAM
Hylidae (tree-frogs)				
Litoria adelaidensis	Slender Tree Frog			
Litoria moorei	Motorbike Frog			
Reptiles				
Gekkonidae (geckoes)				
Christinus marmoratus	Marbled Gecko			WAM
Strophurus spinigerus	Southern Spiny-tailed Gecko			
Underwoodisaurus milli	Barking Gecko			WAM
Pygopodidae (legless-lizards)				
Aprasia repens	Sand-Plain Worm-Lizard			
Delma fraseri	Fraser's Legless Lizard			
Delma grayii	Gray's Legless Lizard			
Lialis burtonis	Burton's Legless Lizard			WAM
Pygopus lepidopodus	Common Scaleyfoot			
Agamidae (dragon lizards)				
Pogona minor	Western Bearded Dragon			
Varanidae (monitors or goannas)				
Varanus gouldii	Gould's Sand Goanna			WAM
Varanus rosenbergi	Rosenberg's Goanna			WAM
Scincidae (skink lizards)				
Acritoscincus trilineatum	South-West Cool Skink			WAM
Cryptoblepharus plagiocephalus	Fence Skink		+	WAM
Ctenotus fallens	West Coast Ctenotus			
Ctenotus impar	Southwest Odd-striped Ctenotus			
Ctenotus labillardieri	Red-legged Ctenotus			WAM

Species	Common Name	Status	Observed or Recorded
Egernia kingii	King's Skink		WAM
Egernia luctuosa	Glossy Swamp Egernia		
Egernia napoleonis	Salmon-bellied Skink		WAM
Hemiergis quadrilineata	Two-toed Earless Skink		
Lerista elegans	West Coast Four-toed Lerista		
Lerista lineata	Perth Lined Lerista	CS2	
Menetia greyii	Dwarf Skink		WAM
Morethia lineoocellata	West Coast Morethia		
Morethia obscura	Dusky Morethia		WAM
Tiliqua rugosa	Bobtail		WAM
Boidae (pythons)			
Morelia spilota imbricata	South West Carpet Python		WAM
Typhlopidae (blind-snakes)			
Ramphotyphlops australis	Southern Blind Snake		WAM
Elapidae (front-fanged snakes)			
Brachyurophis fasciolata	Narrow-banded Shovel-nosed Snake		
Brachyurophis semifasciata	Southern Shovel-nosed Snake		WAM
Elapognathus coronatus	Crowned Snake		WAM
Echiopsis curta	Bardick		
Neelaps bimaculatus	Black-naped Snake		
Neelaps calonotos	Black-striped Snake	CS2	
Notechis scutatus	Western Tiger Snake		WAM
Parasuta gouldii	Gould's Snake		WAM
Parasuta nigriceps	Black-backed Snake		WAM
Pseudonaja affinis	Dugite		WAM
Simoselaps bertholdi	Jan's Bandy-Bandy		WAM
Simoselaps semifasciatus	Half-ringed Snake		
Chelidae (side-neck tortoises)			
Chelodina oblonga	South-West Long-necked Tortoise		
Birds			
Phasianidae (pheasants and quails)			
Coturnix pectoralis	Stubble Quail		
Anatidae (ducks and swans)			
Anas superciliosa	Pacific Black Duck		
Chenonetta jubata	Australian Wood Duck		
Tadorna tadornoides	Australian Shelduck		+

Species	Common Name	Status	Observed or Recorded	
Accipitridae (kites, hawks and eagles)				
Elanus axillaris	Black-shouldered Kite			
Haliastur sphenurus	Whistling Kite	CS3		
Circus approximans	Swamp Harrier			
Accipiter fasciatus	Brown Goshawk	CS3		
Accipiter cirrhocephalus	Collared Sparrowhawk	CS3		
Aquila audax	Wedge-tailed Eagle	CS3		WAM
Hieraaetus morphnoides	Little Eagle	CS3		
Hamirostra isura	Square-tailed Kite	CS3		
Haliaeetus leucogaster	White-bellied Sea-Eagle	CS1		
Falconidae (falcons)				
Falco peregrinus	Peregrine Falcon	CS1		
Falco longipennis	Australian Hobby			
Falco berigora	Brown Falcon	CS3		
Falco cenchroides	Nankeen Kestrel		+	
Turnicidae (button-quails)				
Turnix varia	Painted Button-quail	CS3		
Charadriidae (lapwings and plovers)				
Vanellus tricolor	Banded Lapwing			
Columbidae (pigeons and doves)				
Columba livia	Rock Dove (Domestic Pigeon)	Int.		
Streptopelia chinensis	Spotted Turtle-Dove	Int.		
Streptopelia senegalensis	Laughing Turtle-Dove	Int.		
Phaps chalcoptera	Common Bronzewing	CS3	+	
Ocyphaps lophotes	Crested Pigeon		+	
Cacatuidae (cockatoos)				
Calyptorhynchus banksii	Red-tailed Black-Cockatoo	CS2	+	WAM
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	CS1		WAM
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	CS1		WAM
Cacatua roseicapilla	Galah			
Cacatua pastinator	Western Long-billed Corella			
Cacatua sanguinea	Little Corella	Int		
Cacatua leadbeateri	Sulphur-crested Cockatoo	Int		
Psittacidae (lorikeets and parrots)				
Glossopsitta porphyrocephala	Purple-crowned Lorikeet		+	
Purpureicephalus spurius	Red-capped Parrot		+	WAM
Polytelis anthopeplus	Regent Parrot		+	WAM
Platycercus icterotis	Western Rosella			WAM

Species	Common Name	Status	Observed or Recorded
Barnardius zonarius	Australian Ringneck		+ WAM
Neophema elegans	Elegant Parrot		+
Cuculidae (cuckoos)			
Cuculus pallidus	Pallid Cuckoo		
Cacomantis flabelliformis	Fan-tailed Cuckoo		
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo		WAM
Chrysococcyx lucidus	Shining Bronze-Cuckoo		
Strigidae (hawk-owls)			
Ninox novaeseelandiae	Southern Boobook Owl		WAM
Ninox connivens	Barking Owl	CS2	
Tytonidae (barn owls)			
Tyto alba	Barn Owl		
Tyto novaehollandiae novaehollandiae	Masked Owl	CS2	
Podargidae (frogmouths)			
Podargus strigoides	Tawny Frogmouth		
Caprimulgidae (nightjars)			
Eurostopodus argus	Spotted Nightjar		
Aegothelidae (owlet-nightjars)			
Aegotheles cristatus	Australian Owlet-nightjar		
Apodidae (swifts)			
Apus pacificus	Fork-tailed Swift	CS1	
Halcyonidae (forest kingfishers)			
Dacelo novaeguineae	Laughing Kookaburra	Int.	+ WAM
Todiramphus sanctus	Sacred Kingfisher		
Meropidae (bee-eaters)			
Merops ornatus	Rainbow Bee-eater	CS1	
Climacteridae (treecreepers)			
Climacteris rufa	Rufous Treecreeper	CS3	WAM
Maluridae (fairy-wrens)			
Malurus splendens	Splendid Fairy-wren	CS3	+
Stipiturus malachurus	Southern Emu-wren	CS3	WAM
Pardalotidae (pardalotes and thornbills)			
Pardalotus punctatus	Spotted Pardalote	CS3	
Pardalotus striatus	Striated Pardalote		+ WAM
Sericornis frontalis	White-browed Scrubwren	CS3	+ WAM
Smicrornis brevirostris	Weebill	CS3	+
Gerygone fusca	Western Gerygone		+

Species	Common Name	Status	Observed or Recorded
Acanthiza apicalis	Inland Thornbill	CS3	+
Acanthiza inornata	Western Thornbill	CS3	
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	CS3	+
Meliphagidae (honeyeaters and chats)			
Anthochaera carunculata	Red Wattlebird		+
Anthochaera lunulata	Western Wattlebird	CS3	+
Lichenostomus virescens	Singing Honeyeater		+
Manorina flavigula	Yellow-throated Miner		+
Melithreptus brevirostris	Brown-headed Honeyeater		
Melithreptus lunatus	White-naped Honeyeater	CS3	+
Lichmera indistincta	Brown Honeyeater		+
Phylidonyris novaehollandiae	New Holland Honeyeater	CS3	+
Phylidonyris nigra	White-cheeked Honeyeater	CS3	
Phylidonyris melanops	Tawny-crowned Honeyeater	CS3	
Acanthorhynchus superciliosus	Western Spinebill		+
Epthianura albifrons	White-fronted Chat		+
Petroicidae (Australian robins)			
Eopsaltria griseogularis	Western Yellow Robin	CS3	
Petroica multicolor	Scarlet Robin	CS3	+
Neosittidae (sittellas)			
Daphoenositta chrysoptera	Varied Sittella	CS3	+
Pachycephalidae (whistlers)			
Pachycephala rufiventris	Rufous Whistler		+
Pachycephala pectoralis	Golden Whistler	CS3	+
Colluricincla harmonica	Grey Shrike-thrush	CS3	+
Dicruridae (flycatchers)			
Myiagra inquieta	Restless Flycatcher	CS3	
Grallina cyanoleuca	Magpie-lark		+
Rhipidura fuliginosa	Grey Fantail		+
Rhipidura leucophrys	Willie Wagtail		+
Campephagidae (cuckoo-shrikes)			
Coracina novaehollandiae	Black-faced Cuckoo-shrike		+
Lalage sueurii	White-winged Triller		
Artamidae (woodswallows)			
Artamus cinereus	Black-faced Woodswallow	CS3	+
Artamus cyanopterus	Dusky Woodswallow	CS3	
Cracticus torquatus	Grey Butcherbird		+
Gymnorhina tibicen	Australian Magpie		+ WAM

Species	Common Name	Status	Observed or Recorded
Corvidae (ravens and crows)			
Strepera versicolor	Grey Currawong	CS3	+
Corvus coronoides	Australian Raven		+
Motacillidae (pipits and true wagtails)			
Anthus novaeseelandiae	Richard's Pipit		
Mammals			
Tachyglossidae (echidnas)			
Tachyglossus aculeatus	Echidna		
Dasyuridae (dasyurids)			
Dasyurus geoffroii	Chuditch	CS1	WAM
Phascogale tapoatafa	Brush-tailed Phascogale	CS2	WAM
Peramelidae (bandicoots)			
Isoodon obesulus	Quenda or Southern Brown Bandicoot	CS2	+ WAM
Phalangeridae (possums)			
Trichosurus vulpecula	Brush-tailed Possum		WAM
Burramyidae (pygmy possums)			
Cercartetus concinus	Western Pygmy Possum		
Tarsipedidae (honey possum)			
Tarsipes rostratus	Honey Possum		WAM
Macropodidae (kangaroos and wallabies)			
Macropus fuliginosus	Western Grey Kangaroo		
Macropus irma	Brush or Black-gloved Wallaby	CS2	
Mollosidae (mastiff bats)			
Tadarida australis	White-striped Bat		
Mormopterus planiceps	Western Freetail Bat		
Vespertilionidae (vesper bats)			
Chalinolobus gouldii	Gould's Wattled Bat		
Chalinolobus morio	Chocolate Wattled Bat		
Falsistrellus mackenziei	Western False Pipistrelle	CS2	WAM
Vespadelus regulus	Southern Forest Bat		
Nyctophilus geoffroyi	Lesser Long-eared Bat		
Nyctophilus gouldii	Gould's Long-eared Bat		
Nyctophilus timoriensis	Greater Long-eared Bat		
Muridae (rats and mice)			
Hydromys chrysogaster	Rakali or Water Rat	CS2	
Mus musculus	House Mouse	Int.	
Rattus rattus	Black Rat	Int.	

Species	Common Name	Status	Observed or Recorded
Leporidae (rabbits and hares) *Oryctolagus cuniculus*	Rabbit	Int.	WAM
Canidae (foxes and dogs) *Vulpes vulpes*	European Red Fox	Int.	
Felidae (cats) *Felis catus*	Feral Cat	Int.	

Source: CALM (2005a), WAM (2005)

MBS Environmental Report Distribution Record

Report Title: **Keysbrook Mineral Sand Project: Environmental Scoping Document, Public Environmental Review (Assessment Number 1580)**

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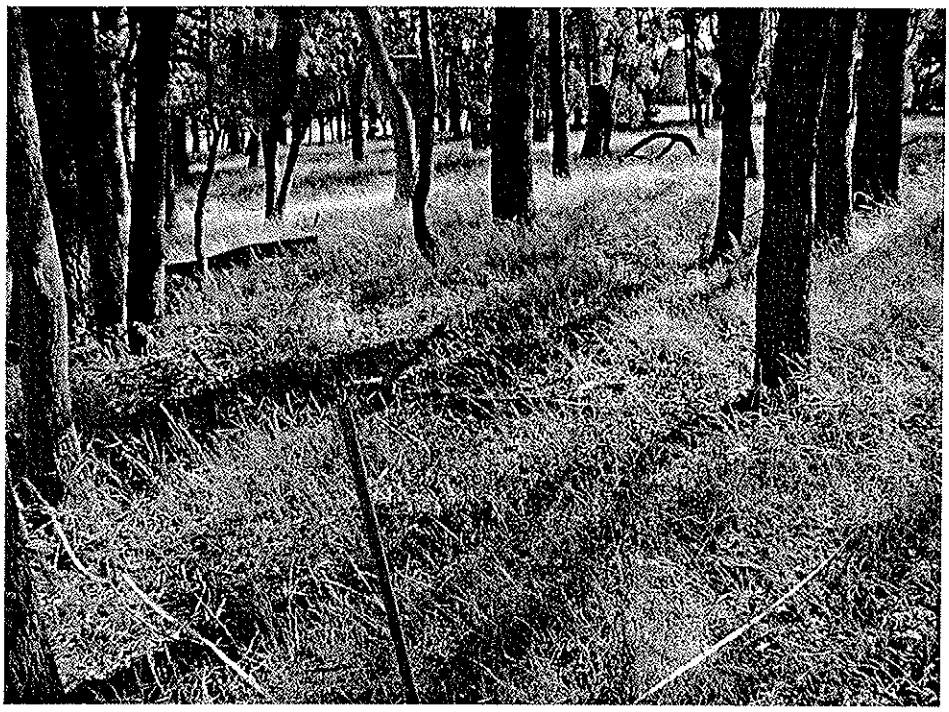
VEGETATION AND FLORA
OF
EXPLORATION LICENCE 70/2407
KEYSBROOK
WESTERN AUSTRALIA



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1. INTRODUCTION

1.1 Background

Bennett Environmental Consulting Pty Ltd was contracted by Martinick Bosch and Sell to undertake an overview of the flora and vegetation units of Exploration licence 70/2407 where it is proposed to undertake sand mining and processing operations (See Appendix E). The lease is situated along the eastern edge of the Swan Coastal Plain about 70 kilometers south of Perth and 4 kilometers west of the small township of Keysbrook.

1.2 Vegetation

Keysbrook is included in the Swan Coastal Plain subregion of the Southwest Botanical Province (Beard, 1990). This subdistrict is mainly *Banksia* Low Woodland on leached sands, with *Melaleuca* swamps where ill-drained; Woodland of Tuart (*Eucalyptus gomphocephala*), Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) on less leached soils.

Heddle *et al.*, (1980) mapped the vegetation complexes of the Darling System. Keysbrook and to the west falls within 3 vegetation complexes:

1. **Forrestfield Complex** – Vegetation ranges from Open Forest of *Corymbia calophylla – Eucalyptus marginata – Eucalyptus wandoo* to Open Forest of *Eucalyptus marginata – Corymbia calophylla – Allocasuarina fraseriana – Banksia* species. Fringing Woodland of *Eucalyptus rudis* in the gullies that dissect this landform. 29 in Figure 1.
2. **Guildford Complex** – A mixture of Open Forest to Tall Open Forest of *Corymbia calophylla – Eucalyptus wandoo – Eucalyptus marginata* and Woodland of *Eucalyptus wandoo*. Minor components include *Eucalyptus rudis – Melaleuca cuticularis*. 32 in Figure 1
3. **Bassendean Complex – Central and South** – Vegetation ranges from Woodland of *Eucalyptus marginata – Allocasuarina fraseriana – Banksia* species to Low Woodland of *Melaleuca* species and sedgelands on moister sites. This complex includes the transition *of Eucalyptus marginata* to *Eucalyptus todtiana* in the vicinity of Perth. 44 in Figure 1.
4. **Southern River Complex** – Open Woodland of *Corymbia calophylla – Eucalyptus marginata – Banksia* species with fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along creek beds. 42 in Figure 1.

Figure 1. Heddle *et al.* (1980) Vegetation Complexes recorded for area

1.3 Wetlands

Wetlands are areas that are permanently, seasonally or intermittently waterlogged or inundated with water that may be fresh, saline, flowing or static (Water and Rivers Commission, 2004). In Western Australia, the term 'wetlands' is commonly used to refer to those water bodies that are in basin or flat form, with the term 'waterways' commonly used to describe those water bodies occurring in channel form. At least 80% of all of the wetlands that were once present on the Swan Coastal Plain prior to European settlement have either been cleared, filled or developed. An estimated 15% have retained high ecological values (ie conservation category wetlands).

Wetlands within the Keysbrook area are the Keysbrook Suite. These occur as alluvial fans along the foothills of the Darling Scarp and typically are clay overlying lateritic clay and sand.

1.4 Soils

The Swan Coastal Plain is of low relief and composed of Quaternary continental sediments. Its eastern boundary is marked by scarps and associated features, which in the vicinity of Keysbrook are the sandy and gravelly spurs of the Forrestfield unit. The alluvial terrain along the eastern edge of the Plain comprises material of different ages. The older layers, characterised by duplex soils is the Guildford unit. Of the Aeolian deposits the Bassendean Dunes are the oldest and furthest inland. The Bassendean unit has peaty podzols in the swamps and is separated from the Southern River unit where sand appears to have been blown over the alluvial soils, resulting in the swamps having a clay base.

1.5 Previous Survey

K. George of MBS recorded the vegetation unit and dominant species at several waypoints within the total lease. It was obvious from these results that the remnant vegetation on the lease was located on two properties, Mostert and Linga. The remainder of the lease was pasture with scattered or occasional clumps of native trees. The current survey was to record the vegetation units in the lease area so it was concentrated on the Mostert and Linga properties. The aerial photograph provided indicated the condition of most of the lease area but there were some small properties in the south west corner where areas of remnant bushland remained. These land owner had not agreed to access.

1.6 Scope of Works

There were two requirements with this contract.

i. Map the vegetation and list the flora of the lease.
ii. Locate and record the presence of any Declared Rare and Priority Flora

2. METHODS

The field assessment was undertaken on 27th and 28th October 2004. A large portion of the exploration licence has been cleared for agricultural use, with only small patches of remnant bushland remaining. Transects were walked through all remnant vegetation and a combination of 10m x 10m quadrats and relevees were used to describe the vegetation units at the site.

During the survey any Declared Rare or Priority Flora located were recorded with a GPS reading in WGS84, a photograph and an estimate of their number. Prior to undertaking the field work all listed Declared Rare and Priority Flora had been checked against specimens housed at the Western Australian Herbarium

Where plants were unknown in the field they were collected, pressed and later identified using appropriate keys and by comparison with collections housed at the Western Australian Herbarium.

A pressed collection of each species of Declared Rare and Priority Flora was submitted to the Western Australian Herbarium for incorporation in their collection and all data was forwarded to the Rare Flora Section of the Department of Conservation and Land Management.

3. RESULTS

The vegetation units recorded during the survey were described using the vegetation layers as given in Table 1.

Table 1. Vegetation layers. Adapted from: Bush Forever (Department of Environmental Protection, 2000)

Life Form/ Height Class	Canopy Cover			
	100-70%	70-30%	30-10%	10-2%
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Tree mallee (8m tall)	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub mallee (under 8m tall)	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs over 2m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

3.1 Vegetation Units

All the information for the quadrats and relevees is provided in Appendix B. A total of 21 quadrats and 3 relevees were surveyed but these represent 9 different vegetation units. The vegetation units and the variation within each are described below and the mapping units provided after the description. The vegetation units and vegetation condition are mapped in Appendix C. The Floristic Community Type (Gibson *et al.*, 1994) is inferred for each vegetation unit but as most of the vegetation was altered the typical and common species listed for each Floristic Community Type were often not recorded during the survey.

3.1.1 Forests

Tall Closed Forest of *Corymbia calophylla* or occasionally *Eucalyptus patens* over Tall Shrubland of *Xanthorrhoea preissii* over weeds and bare ground (CcXp)
This was represented by quadrats 7 and 8 on Mostert property. This vegetation unit merged into remnant areas of the Low Open Woodland of *Corymbia calophylla* over Tall Shrubland of *Pericalymma ellipticum* over a Low Shrubland of *Hypocalymma angustifolium*.
This is inferred to be Floristic Community Type 3c.

Closed Forest of *Corymbia calophylla* over a Closed Grassland/Herbland of weeds (Cc)
This was represented by quadrat 20 and relevee C and was the vegetated remnant over pasture in many areas of the lease.
Too degraded to infer a Floristic Community Type.

Open Forest of *Corymbia calophylla* over Tall Open Shrubland of *Kingia australis* over Closed Grassland of weeds (CcKa)

This was represented by quadrat 11, only from Lanstal property.
This is inferred to be Floristic Community Type 3a.

Closed to Low Open Forest of *Banksia ilicifolia* and *Kunzea glabrescens* over Open Grassland (BiKg)
This was represented by quadrats 18 and 19 on Linga property.
This is inferred to be Floristic Community Type 21c.

Low Closed Forest of *Banksia attenuata* with scattered *Banksia menziesii* and *Eucalyptus marginata* subsp. *marginata* over Shrubland of *Xanthorrhoea brunonis* over Open Low Heath dominated by *Hibbertia hypericoides* (BaBm)
This was represented by quadrats 1, 2, 9, 10, 12 and 16.
This vegetation unit was recorded from the low sandy dunes in Mostert, Linga and Lanstal properties. This same vegetation unit in the remainder of the study area was completely degraded with remnant, scattered trees over pasture species.
This is inferred to be Floristic Community Type 20b.

Low Open Forest of *Melaleuca preissiana* over Sedgeland (Mp)
This was represented by quadrats 4, 17 and 21 and relevees A and B
The drains through the lease included several of the understorey species.
This is inferred to be Floristic Community Type 4.

3.1.2 Woodland

Low Open Woodland of *Corymbia calophylla* over Tall Shrubland of *Pericalymma ellipticum* over a Low Shrubland of *Hypocalymma angustifolium* (CcPe)
This was represented by quadrats 3 and 6.
The remnants of this vegetation unit were small as most of the lower lying areas are paddocks.
This is inferred to be Floristic Community Type 5.

3.1.3 Scrub

Closed Tall Scrub of *Regelia ciliata, Kunzea micrantha* subsp. *micrantha* and *Pericalymma ellipticum* (Rc)
This was represented by quadrats 13 and 15. This vegetation unit was only recorded from Linga property and consisted of vegetated areas with open areas between.
This is inferred to be Floristic Community Type 5.

3.1.4 Heath

Open Heath of *Astartea affinis* over Open Sedgeland/Grassland (Aa)
This was represented by quadrats 5 and 14.
Small remnants only of this vegetation unit remain, most has been developed as pasture.
This is inferred to be Floristic Community Type 5.

3.2 Vegetation Condition

The vegetation condition recorded for each of the quadrats is included in Appendix B and mapped in Appendix D.

Table 2 Explanation of Vegetation Condition Rating (Department of Environmental Protection, 2000)

Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

Cattle, horses and kangaroos graze the whole lease area. All the remnants had cattle in them at the time of the survey or not long previously. Kangaroos were dominant in the remnant bushland and had caused damage to several plants. In particular, the drains crossing the paddocks still contained water and were heavily used by cattle. When the survey was undertaken many cattle had congregated in these areas.

Table 3 provides a summary of the vegetation condition recorded using the vegetation rating provided in Table 2. Some degraded areas had a good tree canopy but the understorey was completely or nearly completely replaced by weeds.

Table 3. Vegetation Condition recorded during the survey

Rating	Description	Quadrats (Q), Releves (R)
2-3	Very good to excellent	Q13
3	Very good	Q1
3-4	Good to very good	Q2, Q5, Q14, Q17
3-5	Good to degraded	Q15
4	Good	Q3
4-5	Good to degraded	Q4, Q6, Q7, Q8, Q12
5	Degraded	Q18, Q19
5-6	Degraded to completely degraded	Q9. Q16. RC
6	Completely degraded	Q10, Q11, Q20, Q21, RA, RB

Most of the survey area was completely degraded varying to good with two quadrats recording very good to excellent vegetation condition.

3.3 Wetlands

Wetlands on the Swan Coastal Plain are described using the classification system developed by Seminuik (1987) an overview of which is provided in Table 6.

Table 4. Wetland types within the Swan Coastal Plain

Wetland Type	General Description
Basin Wetlands	Dampland - seasonally waterlogged basin. Sumpland - seasonally inundated basin. Lake - permanently inundated basin. Artificial basins (e.g. dams, reservoirs).
Flat Wetlands	Floodplain = seasonally inundated flat. Palusplain = seasonally waterlogged flat.

Within the study area the wetland types identified were flat wetlands namely floodplain and palusplain. Semeniuk (1996) described the natural wetland (cosanguineous) suites for the Swan Coastal Plain. The lease area is included in the Keysbrook Suite.

No significant wetland was recorded by Water and Rivers Commission (2004) for the study area. The wetland identified at the site consists of a mosaic of several of the vegetation units described in section 3.1. The variation within the wetland, the lower lying areas, varied from a forest unit to an open heath unit and include:

Floodplain

- Low Open Forest of *Melaleuca preissiana* over Sedgeland

Palusplain

- Low Open Woodland of *Corymbia calophylla* over Tall Shrubland of *Pericalymma ellipticum* over a Low Shrubland of *Hypocalymma angustifolium*
- Closed Tall Scrub of *Regelia ciliata, Kunzea micrantha* subsp. *micrantha* and *Pericalymma ellipticum*
- Open Heath of *Astartea affinis* over Open Sedgeland/Grassland

However the interzone between these lower vegetation unit and the higher ground vegetation units are also considered part of the wetland complex as these are very important as a buffer to ensure the wetland structure is maintained. This vegetation unit is:

- Closed to Low Open Forest of *Banksia ilicifolia* and *Kunzea glabrescens* over Open Grassland

This was the vegetation unit that surrounded the wetlands identified at the site.

3.4 Threatened Ecological Communities

Ecological communities are defined as naturally occurring biological assemblages that occur in a particular type of habitat (Department of Environmental Protection, 2000). English and Blythe (1997) have developed a procedure for identifying assigning TEC's to one of four categories depending upon the threat to the community (Table 5).

Table 5. Conservation categories for TEC recognised by CALM (English and Blythe, 1997)

CODE	DEFINITION
Presumed Totally Destroyed	An ecological community, which has been adequately searched for but for which no representative occurrences have been located. The community has been found to be totally destroyed or so extensively modified throughout its range that no occurrences of it is likely to recover its species composition and/or structure in the foreseeable future.
Critically Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or that was originally of limited distribution and is facing severe modification or destruction throughout its range but capable of being substantially restored or rehabilitated.
Endangered	An ecological community that has been adequately surveyed and found to have been subject to a major contraction in area and/or was originally of limited distribution and is in danger of significant modification throughout its range or severe modification or destruction over most of its range in the near future.
Vulnerable	An ecological community that has been adequately surveyed and is found to be declining and/or has declined in distribution and/or condition and whose ultimate security has not yet been assured and/or a community that is still widespread but is believed likely to move into a category of higher threat in the near future if threatening processes continue or begin operating throughout its range.

Commonwealth legislation also protects vegetation communities with the Environmental Protection and Biodiversity Conservation (EPBC) Act, 1999. Under this Act a person must not take any action that is likely to have a significant impact on a listed threatened ecological community without approval from the Minister for the Environment and Heritage. The definitions of these categories of TEC are listed in Table 6.

Table 6. Conservation Categories for Threatened Ecological Communities under the EPBC Act, 1999

CODE	DEFINITION
Critically Endangered	A community can be included in the Critically Endangered category if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
Endangered	A community can be included in the Endangered category if, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
Vulnerable	A community can be included in the Vulnerable category if, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

Floristic Community Type 20b is recorded as Endangered CALM (English, 2004)
Floristic Community Type 3a is recorded as Critical CALM (English, 2004) and Endangered (EPBC Act, 1999)
Floristic Community Type 3c is recorded as Critical CALM (English, 2004) and Endangered (EPBC Act, 1999)

The quadrats where FCT3a or FCT3c was inferred were degraded to completely degraded so should not be considered worthy of conservation. Some quadrats where FCT20b was inferred were in good bordering onto very good condition and could be considered for conservation, but the area of good quality vegetation is not extensive and surrounded by paddocks or degraded bush land.

3.5 Flora

A total of 40 vascular plant families, 119 genera and 169 taxa (species, subspecies and varieties) were recorded from this survey (Appendix A). The dominant plant families were: Poaceae with 21 taxa of which 15 are weeds; Myrtaceae with 13 taxa of which 1 is a weed; Asteraceae with 12 taxa of which 4 are weeds and Cyperaceae and Papilionaceae with 11 taxa of which 1 and 4 respectively are weeds. These 5 families represent 43% of the total number of taxa recorded during the survey.

3.6 Significant Flora

Species of flora are defined as rare or priority conservation status where their populations are restricted geographically or threatened by local processes. The Department of Conservation and Land Management recognises these threats of extinction and consequently has applied regulations towards population and species protection. Rare Flora are gazetted under subsection 2 of section 23F of the Wildlife Conservation Act (1950) and therefore it is an offence to "take" or damage rare flora without approval from the Mininster for the Environment.

Table 7 presents the definitions of Declared Rare and the four Priority Flora ratings under the Wildlife Conservation Act (1950) as extracted from Department of Conservation and Land Management (2003). Table 8 presents the definitions of the threatened species under the Commonwealth Environmental Protection and Diversity Conservation Act, 1999 (Environment Australia, 2001).

Table 7. Code and description of Rare and Priority Flora categories (Wildlife Conservation Act (1950)

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

Table 8. Categories of Threatened Flora Species (Environmental Protection and Biodiversity Conservation Act, 1999)

Code	Code Declared Rare and Priority Flora Categories
Ex	Extinct Taxa which at a particular time if, at that time, there is no reasonable doubt that the last member of this species has died.
ExW	Extinct in the Wild Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	Critically Endangered Taxa which at any particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	Endangered Taxa, which is not critically endangered, and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	Vulnerable Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	Conservation Dependent Taxa which at a particular time if, at that time, the species is the focus of a specific conservation program, the cessation of which would result in the species becoming vulnerable, endangered or critically endangered within a period of 5 years.

The list of significant flora provided by the Department of Conservation and Land Management for the survey area to MBS Environmental is set out below in Table 9.

Table 9. List of significant flora provided by the Department of Conservation and Land Management

Species	Status	Habitat and Comments
Anthocercis gracilis (Slender Tailflower)	Vulnerable - EPBC	Erect, spindly shrub, to 0.6(–1) m high. Fl. yellow, green, Sep–Oct. Sandy or loamy soils. Granite outcrops.
Caladenia sp. Jarrah forest **NOW** *Caladenia arrecta* Priority 4 species (Western Australian Herbarium 2004a)	Vulnerable - EPBC	Tuberous, perennial, herb, 0.12–0.35 m high. Fl. yellow, red, Aug–Oct. Loam, gravel, laterite. Moist situations.
Drakea elastica (Glossy leaved Hammer-orchid)	Endangered-EPBC	Tuberous, perennial, herb, 0.12–0.3 m high. Fl. red, green, yellow, Oct–Nov. White or grey sand. Low-lying situations adjoining winter-wet swamps.
Drakea micrantha	Vulnerable-EPBC	Tuberous, perennial, herb, 0.15–0.3 m high. Fl. red, yellow, Sep–Oct. White-grey sand.
Lasiopetalum pterocarpum	Endangered-EPBC	Open shrub 0.2-1.2 m high x ca 0.2-0.5 m wide, growing through other plants. Riverbank. Brown clay-sand over granite.
Synaphea sp. Pinjarra	DRF- WA Wildlife Act 1950	Compact shrub, to 0.4 m high, to 0.5 m wide. Fl. yellow, Sep. Grey clayey sand. Swamp. Recorded from Dandalup and Pinjarra.
Tetraria australiensis	DRF- WA Wildlife Act 1950	Rhizomatous, tufted perennial, grass-like or herb (sedge), to 1 m high. Fl. brown, Nov–Dec.
Acacia oncinophylla subsp. *patulifolia*	P2- WA Wildlife Act 1950	Shrub, 0.5–2.5(–3) m high, 'minni-ritchi' bark, phyllodes 4–9 cm long, 3–6 mm wide. Fl. yellow, Aug–Dec. Granitic soils, occasionally on laterite.
Anthotium junciforme	P4- WA Wildlife Act 1950	Open, erect to prostrate perennial, herb, 0.05–0.4 m high, leaves linear to terete, 0.5–1 mm wide; flowering stems 12–40 cm long. Fl. blue, violet, purple, Nov–Mar. Sandy clay, clay. Winter-wet depressions, drainage lines.
Aponogeton hexatepalus	P4- WA Wildlife Act 1950	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green, white, Jul–Oct. Mud. Freshwater: ponds, rivers, claypans
Boronia tenuis	P4- WA Wildlife Act 1950	Procumbent or erect & slender shrub, 0.1–0.5 m high. Fl. blue, pink, white, Aug–Nov. Laterite, stony soils, granite.
Calothamnus graniticus	P4- WA Wildlife Act 1950	Shrub, 1–2.5 m high. Fl. red, May–Aug. Skeletal sandy soils, clay, laterite. Granite outcrops, hillsides.

No significant flora were located during the survey.

3.7 Introduced Species

A total of 34 weeds were recorded from the site all of which have all been determined as weeds by the Department of Conservation and Land Management (1999). The rating allocated to each weed by CALM is based on three criteria:

Invasiveness – ability to invade natural bushland in good to excellent condition or ability to invade waterways.

Distribution – wide current or potential distribution including consideration of known history of wide spread distribution elsewhere in the world.

Environmental impacts – Ability to change the structure, composition and function of ecosystems. In particular an ability to form a monoculture in a vegetation community.

Ratings indicate the following.

High indicates this weed is prioritised for control and/or research ie prioritising funding to it.

Moderate indicates control or research effort should be directed to it if funds are available, however it should be monitored (possibly a reasonably high level of monitoring).

Mild indicates monitoring of the weed and control where appropriate.

Low indicates that this species would require a low level of monitoring.

Table 10. Weeds recorded during the survey classified according to Department of Conservation and Land Management (1999)

SCIENTIFIC NAME	COMMON NAME	CALM RATING	INVASIVENESS	IMPACTS
**Bromus diandrus*	Great brome	High	✓	✓
**Ehrharta calycina*	Perennial veldt grass	High	✓	✓
**Leptospermum laevigatum*	Victorian teatree	High	✓	✓
**Romulea rosea*	Guildford grass	High	✓	✓
**Aira caryophyllea*	Silvery hairgrass	Moderate	✓	
**Aira cupaniana*	Hairgrass	Moderate	✓	
**Arctotheca calendula*	Cape weed	Moderate	✓	
**Avena barbata*	Bearded oat	Moderate	✓	
**Briza maxima*	Blowfly grass	Moderate	✓	
**Briza minor*	Shivery grass	Moderate	✓	
**Callitriche stagnalis*	Common starwort	Moderate	✓	
**Carduus pycnocephalus*	Slender thistle	Moderate	✓	
**Cynodon dactylon*	Couch grass	Moderate	✓	
**Cyperus tenellus*	Tiny flat sedge	Moderate	✓	
**Disa bracteata*	South African orchid	Moderate	✓	
**Ehrharta longiflora*	Annual veldt grass	Moderate	✓	
**Hordeum leporinum*	Barley grass	Moderate	✓	
**Hypochaeris glabra*	Flat weed	Moderate	✓	
**Juncus bufonius*	Toad rush	Moderate	✓	
**Juncus capitatus*		Moderate	✓	
**Lolium rigidum*	Annual ryegrass	Moderate	✓	
**Orobanche minor*	Lesser broom rape	Moderate	✓	
**Parentucellia latifolia*	Red Bartsia	Moderate	✓	
**Solanum nigrum*	Black berry nightshade	Moderate	✓	
**Trifolium campestre*	Hop clover	Moderate	✓	
**Ursinia anthemoides*	Ursinia	Moderate	✓	
**Vulpia bromoides*	Squirrels tail fescue	Moderate	✓	
**Vulpia myuros*	Silvery grass	Moderate	✓	
**Rumex crispus*	Curled dock	Mild		
**Aira praecox*	Early hairgrass	Low		
**Bromus hordeaceus*	Soft brome	Low		
**Lotus suaveolens*	Hairy birdsfoot trefoil	Low		

**Ornithopus pinnatus*	Slender seradella	Low		
**Trifolium hirtum*	Rose clover	Low		

Only weeds recorded in the quadrats and relevees are recorded above and this list does not include all the pasture species. A total of 5 weeds were rated as high indicating these are the ones that should be targeted for removal, as these will have the greatest impact on the remnant bushland. One weed was rated as mild and 5 as low all the remainder were rated as having a moderate impact on the remnant bushland.

4. DISCUSSION

All remnant bushland identified from the supplied aerial photograph and by MBS Environmental (2004) were surveyed but most of the lease area is under pasture. The major areas of remnant vegetation were on Mostert and Linga properties where cattle wander through all the remnant vegetation. Generally it was observed that the cattle were less likely to wander through dense understorey vegetation. Cattle, horses and kangaroos have contributed to the degradation of the bushland with one quadrat recording a very good to excellent vegetation condition, another good to very good and the remainder varying from good to completely degraded.

MBS Environmental (2004) recorded the vegetation from several waypoints (Appendix E) and this information is correlated in Table 11 with the vegetation units of the quadrats/relevees data collected during this current survey. From Table 11 it is apparent that the current survey identified additional variations in the vegetation but the MBS survey recorded 54 waypoints, many more than the current survey.

Table 11. Vegetation locations, comparison between current survey and MBS survey

VEGETATION UNIT (See Section 3.1)	CURRENT SURVEY – QUADRATS AND RELEVEES	MBS ENVIRONMENTAL WAYPOINTS
CcXp	Q7, Q8	
Cc	Q20, RC	24, 40, 43, 44, 45, 60, 61, 63, 64
CcKa	Q11	25
BiKg	Q18, Q19	31-39
BaBm	Q1, Q2, Q9, Q10, Q12, Q16	11-15, 16, 18-22, 42, 45, 53-59
Mp	Q4, Q17, Q21, RA, RB	
CcPe	Q3, Q6	
Rc	Q13, Q15	41
Aa	Q5, Q14	46, 48

There were only a few vegetated remnants remaining on Mostert and Linga properties. Although there were groups of trees left on these and other properties these were very degraded. Except for the vegetated remnants the remainder of the lease recorded a vegetation condition of 6.

Table 12. Vegetation condition (see Table 2) comparison between current survey and MBS survey

VEGETATION UNIT (See Section 3.1)	CURRENT SURVEY – QUADRATS AND RELEVEES	MBS ENVIRONMENTAL WAYPOINTS
CcXp	4-5	
Cc	5-6, 6	3, 4, 5, 6
CcKa	6	5
BiKg	5	4
BaBm	3, 3-4, 4-5, 5-6, 6	2, 3, 5, 6
Mp	3-4, 4-5, 6	
CcPe	4, 4-5	
Rc	2-3, 3-5	4
Aa	3-4	3

Generally the vegetation condition allocated by MBS was rated higher than during the current survey (Table 12). The MBS survey was undertaken on 19th-20th May 2004 prior to the winter rains and germination of weeds. K. George (pers. comm.) stated there was a lot of bare ground in the survey area, indicating that all edible grasses had been eaten by the stock and kangaroos.

No declared rare or priority flora were located during the survey. Three of the vegetation units located during the survey were inferred to be potential threatened ecological communities. These were:

- Floristic Community Type 20b is recorded as Endangered CALM (English, 2004). This was Low Closed Forest of *Banksia attenuata* with scattered *Banksia menziesii* and *Eucalyptus marginata* subsp. *marginata* over Shrubland of *Xanthorrhoea brunonis* over Open Low Heath dominated by *Hibbertia hypericoides*.
- Floristic Community Type 3a is recorded as Critical CALM (English, 2004) and Endangered (EPBC Act, 1999). This was Open Forest of *Corymbia calophylla* over Tall Open Shrubland of *Kingia australis* over Closed Grassland of weeds.
- Floristic Community Type 3c is recorded as Critical CALM (English, 2004) and Endangered (EPBC Act, 1999). This was Tall Closed Forest of *Corymbia calophylla* over Tall Shrubland of *Xanthorrhoea preissii*.

Using Guidance Statement 51 prepared by the Environmental Protection Authority (EPA), 2003 the environmental potential of the area was assessed

- The site is in the vegetation complexes, Guildford, Forrestfield, Bassendean Central and South and Southern River of which 6%, 9%, 24% and 17% respectively are recorded as remaining as bushland in the Perth Metropolitan Area and is therefore above the 10% requirement (Department of Environmental Protection, 2000).
- The remnant vegetation is inferred to include Floristic Community Types 3a, 3c which are listed as Critical by Department of Conservation and Land Management and Endangered by the EPBC Act 1999. Floristic Community Type 20b is listed as an Endangered Vegetation Community as determined by the Department of Conservation and Land Management (English, 2004).
- The vegetation condition of Floristic Community Types 3a and 3c, quadrats 11, 7 and 8 was recorded as mainly degraded to completely degraded and they are not considered worthy of conservation.
- Floristic Community Type 20b, quadrats 1, 2, 9, 10, 12, and 16 varied in vegetation ondition from very good to completely degraded. Where the vegetation was recorded as very good the area was small and surrounded by degraded vegetation or pasture. The good to very good covers of this Floristic Community Type covered an area of under 2ha, less than the Urban Bushland Strategy's lowest preferred area limit of 20ha (EPA, 2003).
- There were no Declared Rare or Priority Flora recorded from the site.
- A total of 40 vascular plant families, 119 genera and 169 species were recorded from all remnant bushland surveyed.
- Nine different vegetation units, representing six Floristic Community Types (Gibson *et al.*, 1994) were recorded from the lease area.
- The tree canopy of the remnant bushland typically was still intact. Deaths of Banksia trees were recorded where they persisted in the pasture.
- The remnant vegetation in good or better condition, quadrats 1, 2, 3, 5, 13, 14 and 17. occurred as small remnants within the larger degraded to completely degraded bushland and they were of an irregular shape. Elongate and irregular remnants are stated by the EPA (2003) to have value as connecting links, but the more extended are the remnants, the greater their susceptibility to weed invasion and disturbance.
- There is linkage with an adjoining property to the west of Mostert property but this when viewed from the Mostert boundary fence had the understorey severely disturbed.

From the above it would appear that the remnant bushland of the Exploration Licence 70/2407, Keysbrook, although having some elements worthy of conservation, is too small an area and too dissected for it to be considered worthy of conservation.

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APPENDIX A

Species listed according to vegetation areas

ABBREVIATION	EXPLANATION
subsp.	subspecies
var.	variety
sp.	species. Used where the genus but not the species is known
*	weed
Aa	Open Heath of *Astartea affinis* over Open Sedgeland/Grassland
BaBm	Low Closed Forest of *Banksia attenuata* with scattered *Banksia menziesii* and *Eucalyptus marginata* subsp. *marginata* over Shrubland of *Xanthorrhoea brunonis* over Open Low Heath dominated by *Hibbertia hypericoides*
BiKg	Closed to Low Open Forest of *Banksia ilicifolia* and *Kunzea glabrescens* over Open Grassland
Ce	Closed Forest of *Corymbia calophylla* over a Closed Grassland/Herbland of weeds
CeKa	Open Forest of *Corymbia calophylla* over Tall Open Shrubland of *Kingia australis* over Closed Grassland of weeds
CePe	Low Open Woodland of *Corymbia calophylla* over Tall Shrubland of *Pericalymma ellipticum* over a Low Shrubland of *Hypocalymma angustifolium*
CeXp	Tall Closed Forest of *Corymbia calophylla* or occasionally *Eucalyptus patens* over Tall Shrubland of *Xanthorrhoea preissii* over weeds
Mp	Low Open Forest of *Melaleuca preissiana* over Sedgeland
Rc	Closed Tall Scrub of *Regelia ciliata, Kunzea micrantha* subsp. *micrantha* and *Pericalymma ellipticum*

FAMILY	SPECIES	VEGETATION UNIT								
		Aa	BaBm	BiKg	Cc	CcKa	CcPe	CcXp	Mp	Rc
ANTHERICACEAE	*Agrostocrinum scabrum*		+							+
	Caesia micrantha		+							
	Chamaescilla corymbosa		+				+			
	Sowerbaea laxiflora								+	
	Thysanotus patersonii			+						
	Thysanotus thyrsoideus		+							+
	Tricoryne elatior		+							+
CENTROLEPIDACEAE	*Aphelia brizoides*				+		+			+
	Aphelia cyperoides				+					
	Centrolepis aristatus									+
	Centrolepis drummondii							+		+
COLCHICACEAE	*Burchardia umbellata*		+	+						
CYPERACEAE	*Cyathochaeta avenacea*		+							+
	**Cyperus tenellus*	+			+		+		+	+
	Lepidosperma drummondii								+	
	Lepidosperma longitudinale								+	
	Lepidosperma temue		+							
	Mesomelaena tetragona		+							+
	Schoenus plumosus	+								
	Schoenus asperocarpus						+			
	Schoenus curvifolius									+
	Schoenus efoliatus									+
	Tetraria octandra		+							
DASYPOGONACEAE	*Dasypogon bromeliifolius*		+				+			+
	Kingia australis					+	+			+
	Lomandra hermaphrodita		+	+						
	Lomandra micrantha									+
	Lomandra microcephala		+							
	Lomandra preissii		+							
HAEMODORACEAE	*Conostylis aculeata* subsp. *aculeata*						+			+
	Conostylis juncea									+
	Conostylis serrulata		+							
	Conostylis setigera		+							
	Conostylis setosa									+
	Haemodorum laxum		+							
	Phlebocarya ciliata									+
IRIDACEAE	*Patersonia occidentalis*		+							+
	**Romulea rosea*						+		+	
JUNCACEAE	**Juncus bufonius*							+	+	
	**Juncus capitatus*				+					
	Juncus pallidus	+	+		+				+	+
	Juncus pauciflorus				+					
JUNCAGINACEAE	*Triglochin calcitrapa*	+							+	
	Triglochin procera								+	

FAMILY	SPECIES	VEGETATION UNIT								
		Aa	BaBm	BiKg	Cc	CcKa	CcPe	CcXp	Mp	Rc
ORCHIDACEAE	*Caladenia flava*		+	+				+		
	**Disa bracteata*		+	+				+		
	Elythranthera emarginatum		+				+			
	Microtis media subsp. *media*			+			+		+	+
	Prasophyllum drummondii						+			
	Prasophyllum giganteum								+	
	Pterostylis recurva		+							
	Pyrorchis nigricans							+		+
	Thelymitra canaliculata		+							
	Thelymitra cornicina			+					+	+
	Thelymitra pauciflora						+			
POACEAE	**Aira caryophyllea*	+	+	+	+		+			
	**Aira cupaniana*	+			+				+	
	**Aira praecox*								+	
	Amphibromus nervosus	+	+							
	Austrostipa compressa		+							
	Austrostipa mollis						+			
	**Avena barbata*		+							
	**Briza maxima*		+	+	+		+		+	+
	**Briza minor*	+	+				+		+	+
	**Bromus diandrus*		+	+	+	+		+		
	**Bromus hordeaceus*	+					+			
	**Cynodon dactylon*	+							+	
	**Ehrharta calycina*		+							+
	**Ehrharta longiflora*		+	+	+	+		+	+	
	Eragrostis elongata	+								
	**Hordeum leporinum*		+		+				+	
	**Lolium rigidum*	+	+		+	+	+		+	+
	Microlaena stipoides		+	+					+	
	Neurachne alopecuroidea		+							
	**Vulpia bromoides*		+		+		+		+	+
	**Vulpia myuros*				+				+	
RESTIONACEAE	*Chaetanthus aristatus*									+
	Desmocladus fascicularis		+				+	+		+
	Hypolaena exsulca		+				+			+
	Loxocarya cinerea		+							+
	Lyginia inermis									+
	Meeboldina cana	+								
	Meeboldina coangustatus							+		
	Tremulina tremula						+			
XANTHORRHOEACEAE	*Xanthorrhoea brunonis*		+		+		+	+		+
	Xanthorrhoea preissii		+		+		+	+		+
APIACEAE	*Trachymene pilosa*		+							
	Xanthosia huegelii									+

FAMILY	SPECIES	VEGETATION UNIT								
		Aa	BaBm	BiKg	Cc	CcKa	CcPe	CcXp	Mp	Rc
ASTERACEAE	**Arctotheca calendula*		+				+		+	
	Asteridea pulverulenta		+							
	Brachyscome ciliaris	+								+
	Brachyscome iberidifolia									+
	**Carduus pycnocephalus*		+							
	Cotula coronopifolia	+							+	
	Hyalosperma cotula						+			
	**Hypochaeris glabra*	+	+	+	+	+	+	+	+	+
	Podolepis gracilis						+			
	Quinetia urvillei				+			+		+
	Siloxerus humifusus				+					+
	**Ursinia anthemoides*	+	+	+	+		+			
CALLITRICHACEAE	**Callitriche stagnalis*								+	
CASUARINACEAE	*Allocasuarina fraseriana*		+	+		+		+		
CRASSULACEAE	*Crassula colorata* subsp. *colorata*							+		
DILLENIACEAE	*Hibbertia huegelii*		+							
	Hibbertia hypericoides		+					+		
	Hibbertia vaginata		+							+
DROSERACEAE	*Drosera erythrorhiza*		+							
	Drosera glanduligera				+		+			+
	Drosera menziesii		+	+			+			+
	Drosera paleacea	+								
	Drosera stolonifera		+	+			+	+		+
EUPHORBIACEAE	*Monotaxis grandiflora*		+							
	Poranthera microphylla			+						
GOODENIACEAE	*Dampiera linearis*		+							+
	Goodenia micrantha	+								
HALORAGACEAE	*Myriophyllum drummondii*								+	
LOBELIACEAE	*Grammatotheca bergiana*						+			
LOGANIACEAE	*Mitrasacme paradoxa*									+
LORANTHACEAE	*Nuytsia floribunda*		+	+			+			
MIMOSACEAE	*Acacia huegelii*									+
	Acacia pulchella			+						
	Acacia stenoptera						+			+
MYRTACEAE	*Astartea affinis*	+					+			
	Corymbia calophylla		+		+	+	+	+	+	+
	Eucalyptus marginata subsp. *marginata*		+	+		+	+	+		+
	Eucalyptus patens							+		
	Hypocalymma angustifolium	+	+		+		+			
	Kunzea glabrescens			+						
	Kunzea micrantha subsp. *micrantha*	+								+
	**Leptospermum laevigatum*									+
	Melaleuca preissiana	+					+		+	+
	Melaleuca thymoides									+
	Pericalymma ellipticum						+			+
	Regelia ciliata									+
	Verticordia densiflora									+

FAMILY	SPECIES	VEGETATION UNIT								
		Aa	BaBm	BiKg	Cc	CcKa	CcPe	CcXp	Mp	Rc
OROBANCHACEAE	**Orobanche minor*		+							
PAPILIONACEAE	*Daviesia physodes*									+
	Euchilopsis linearis									+
	Gastrolobium capitatum									+
	Gompholobium acerosum									+
	Jacksonia furcellata		+							+
	Jacksonia sternbergiana						+			
	Kennedia prostrata		+					+		
	**Lotus suaveolens*	+	+		+		+		+	+
	**Ornithopus pinnatus*	+		+	+		+	+	+	+
	**Trifolium campestre*				+					
	**Trifolium hirtum*								+	+
PHILYDRACEAE	*Philydrella pygmaea*						+			+
PITTOSPORACEAE	*Billardiera variifolia*		+							
	Pronaya fraseri subsp. *fraseri*		+							
POLYGALACEAE	**Rumex crispus*								+	
PROTEACEAE	*Banksia attenuata*		+			+				
	Banksia grandis		+							
	Banksia ilicifolia		+	+						
	Banksia menziesii		+			+				
	Dryandra lindleyana						+			+
	Hakea prostrata						+			
	Persoonia elliptica		+							
	Stirlingia latifolia		+							
	Xylomelum occidentale		+					+		
RUTACEAE	*Boronia spathulata*									+
SCROPHULARIACEAE	*Gratiola peruviana*	+					+		+	+
	**Parentucellia latifolia*									+
SOLANACEAE	**Solanum nigrum*		+	+						
STYLIDIACEAE	*Stylidium brunonianum*			+						+
	Stylidium calcaratum	+					+			+
	Stylidium repens								+	+
THYMELAEACEAE	*Pimelea lehmanniana*		+							
VIOLACEAE	*Hybanthus calycinus*		+							

APPENDIX B

Quadrat and Relevee Data

ABBREVIATION	EXPLANATION
subsp.	subspecies
var.	variety
sp.	species. Used where the genus but not the species is known
*	weed
Opportunistic	recorded outside of the quadrat

QUADRAT 1

Location: Mostert Property
Datum (WGS84): 399727E; 6410445N
Soil: Grey sand
Vegetation Description: Low Closed Forest of *Banksia attenuata* with scattered *Banksia menziesii* and *Eucalyptus marginata* subsp. *marginata* over Shrubland of *Xanthorrhoea brunonis* over Open Low Heath dominated by *Hibbertia hypericoides*
Vegetation condition: 3, good
Other Notes: Several seedlings of *Banksia attenuata*
Lot of litter on ground
Heavily grazed by kangaroos

SPECIES	HEIGHT (cm)	% COVER	SPECIES	
Banksia attenuata	900	70	**Aira caryophyllea*	opportunistic
Banksia menziesii	800	10	*Allocasuarina fraseriana*	opportunistic
**Briza maxima*	40	3	*Asteridea pulverulenta*	opportunistic
Caladenia flava	30	<1	*Banksia grandis*	opportunistic
Conostylis serrulata	25	<1	**Bromus diandrus*	opportunistic
Dasypogon bromeliifolius	25	5	**Carduus pycnocephalus*	opportunistic
Desmocladus fascicularis	20	5	*Corymbia calophylla*	opportunistic
Drosera erythrorhiza	5	3	*Drosera stolonifera*	opportunistic
Eucalyptus marginata subsp. *marginata*	800	5	*Haemodorum laxum*	opportunistic
Hibbertia hypericoides	40	30	*Lomandra microcephala*	opportunistic
**Hypochaeris glabra*	40	1	*Microlaena stipoides*	opportunistic
Kennedia prostrata	Twiner	<1	*Neurachne alopecuroidea*	opportunistic
**Lotus suaveolens*	20	2	*Patersonia occidentalis*	opportunistic
Loxocarya cinerea	30	20	*Pterostylis recurva*	opportunistic
Monotaxis grandiflora	10	<1	*Thelymitra canaliculata*	opportunistic
Pimelea lehmanniana	40	1	*Tricoryne elatior*	opportunistic
Stirlingia latifolia	35	<1	**Ursinia anthemoides*	opportunistic
Tetraria octandra	30	1	**Vulpia bromoides*	opportunistic
Trachymene pilosa	10	<1		
Xanthorrhoea brunonis	120	10		
Xanthorrhoea preissii	120	5		
Xylomelum occidentale	500	1		

QUADRAT 2

Location: Mostert Property
Datum (WGS84): 399664E 6411230N
Soil: Grey sand
Vegetation Description: Low Woodland of *Banksia attenuata, Xylomelum occidentale* and *Allocasuarina fraseriana* over Low Shrubland dominated by *Hibbertia hypericoides*
Vegetation Condition: 3-4
Other Notes: Very open with only occasional dense areas
Some sections very weedy, dominated by **Briza maxima*

SPECIES	HEIGHT (cm)	% COVER	SPECIES	
**Aira caryophyllea*	10	<1	*Austrostipa compressa*	opportunistic
Allocasuarina fraseriana	900	5	*Banksia grandis*	opportunistic
Banksia attenuata	900	8	*Banksia menziesii*	opportunistic
**Briza maxima*	40	5	*Eucalyptus marginata* subsp. *marginata*	opportunistic
Caladenia flava	15	<1	*Hybanthus calycinus*	opportunistic
Chamaescilla corymbosa	15	<1	*Lomandra preissii*	opportunistic
Dasypogon bromeliifolius	30	5	*Pimelea lehmanniana*	opportunistic
Desmocladus fascicularis	25	<1	*Tetraria octandra*	opportunistic
Drosera stolonifera	45	5	*Thysanotus thyrsoideus*	opportunistic
Hibbertia hypericoides	40	15	*Xanthorrhoea preissii*	opportunistic
**Hypochaeris glabra*	25	<1		
Kennedia prostrata	Twiner	1		
**Lotus suaveolens*	20	<1		
Loxocarya cinerea	40	1		
Monotaxis grandiflora	15	<1		
Pronaya fraseri subsp. *fraseri*	Twiner	<1		
Thelymitra canaliculata	50	<1		
**Ursinia anthemoides*	50	<1		
Xanthorrhoea brunonis	110	1		
Xylomelum occidentale	600	5		

QUADRAT 3

Location: Mostert Property
Datum (WGS84): 399697E 6410877N
Soil: Sandy loam
Vegetation Description: Low Open Woodland of *Corymbia calophylla* over Tall Shrubland of *Pericalymma ellipticum* over a Low Shrubland of *Hypocalymma angustifolium*
Vegetation Condition: 4
Other Notes: Adjacent, damper pasture area includes *Cotula coronopifolia* and **Cyperus tenellus*

SPECIES	HEIGHT (cm)	% COVER	SPECIES	
Acacia stenoptera	30	<1	*Austrostipa mollis*	opportunistic
**Aira caryophyllea*	10	5	**Bromus diandrus*	opportunistic
Aphelia brizoides	5	5	*Chamaescilla corymbosa*	opportunistic
**Arctotheca calendula*	20	2	*Corymbia calophylla*	opportunistic
Astartea affinis	200	8	*Dasypogon bromeliifolius*	opportunistic
**Briza maxima*	30	60	*Drosera menziesii*	opportunistic
**Briza minor*	10	15	*Dryandra lindleyana*	opportunistic
Conostylis aculeata subsp. *aculeata*	40	<1	*Elythranthera emarginata*	opportunistic
Drosera glanduligera	5	<1	**Grammatotheca bergiana*	opportunistic
Drosera stolonifera	40	<1	*Philydrella pygmaea*	opportunistic
Gratiola peruviana	5	<1	*Prasophyllum drummondii*	opportunistic
Hyalosperma cotula	5	10	*Stylidium calcaratum*	opportunistic
Hypocalymma angustifolia	60	15	*Thelymitra pauciflora*	opportunistic
**Hypochaeris glabra*	40	5	*Tremulina tremula*	opportunistic
**Lolium rigidum*	30	<1	**Ursinia anthemoides*	opportunistic
**Lotus suaveolens*	30	10		
Microtis media	60	5		
**Ornithopus pinnatus*	20	15		
Pericalymma ellipticum	250	15		
**Romulea rosea*	30	5		
Schoenus asperocarpus	70	5		
Xanthorrhoea brunonis	40	1		
Xanthorrhoea preissii	100	1		

QUADRAT 4

Location: Mostert Property
Datum (WGS84): 399928E 6410725N
Soil: Grey sandy loam
Vegetation Description: Low Open Woodland of *Melaleuca preissiana* over a Closed Herbland of *Cotula coronopifolia* and **Lotus suaveolens*
Vegetation Condition: 4-5 good to degraded
Other Notes: Heavily grazed and used by cattle

SPECIES	HEIGHT (cm)	% COVER
**Arctotheca calendula*	5	<1
Cotula coronopifolia	25	50
**Cyperus tenellus*	5	1
Gratiola peruviana	5	<1
**Lolium rigidum*	15	5
**Lotus suaveolens*	20	30
Melaleuca preissiana	700	5
**Romulea rosea*	20	1
**Vulpia bromoides*	20	10
**Callitriche stagnalis*	opportunistic	
**Juncus bufonius*	opportunistic	
Myriophyllum drummondii	opportunistic	

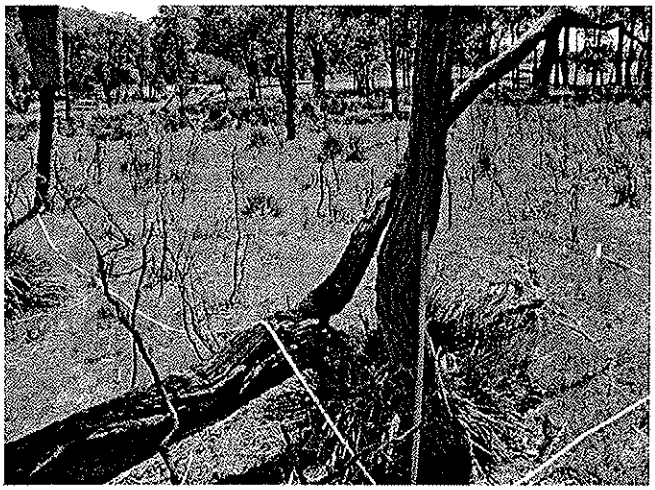
QUADRAT 5

Location: Mostert Property
Datum (WGS84): 399909E 6411082N
Soil: Pale grey to white sand
Vegetation Description: Open heath of *Astartea affinis* over a Herbland/Grassland of weeds
Vegetation Condition: 3-4
Other Notes: A very small remnant only

SPECIES	HEIGHT (cm)	% COVER
**Aira caryophyllea*	10	<1
**Aira cupaniana*	20	<1
Astartea affinis	200	70
**Bromus hordeaceus*	50	10
**Hypochaeris glabra*	50	<1
Juncus pallidus	70	<1
**Lolium rigidum*	50	<1
**Lotus suaveolens*	40	60
**Ursinia anthemoides*	25	1

QUADRAT 6

Location: Mostert Property
Datum (WGS84): 399907E 6411648N
Soil: Grey sand
Vegetation Description: Low Open Woodland of *Eucalyptus marginata* subsp. *marginata* and *Corymbia calophylla* over Tall Shrubland of *Pericalymma ellipticum* (most is dead) over a Herbland/Grassland of weeds
Vegetation Condition: 4-5, good to degraded
Other Notes: Area heavily grazed by stock and kangaroos
Majority of *Pericalymma ellipticum* shrubs are dead



SPECIES	HEIGHT (cm)	% COVER	SPECIES	
Aphelia brizoides	5	1	*Drosera glanduligera*	opportunistic
**Arctotheca calendula*	30	<1	*Drosera stolonifera*	opportunistic
**Briza minor*	20	20	*Dryandra lindleyana*	opportunistic
**Briza maxima*	5	5	*Hakea prostrata*	opportunistic
Corymbia calophylla	800	5	**Hypochaeris glabra*	opportunistic
**Cyperus tenellus*	5	30	*Hypolaena exsulca*	opportunistic
Dasypogon bromeliifolius	15	1	*Jacksonia sternbergiana*	opportunistic
Desmocladus fascicularis	15	2	*Melaleuca preissiana*	opportunistic
Drosera menziesii	Twiner	<1	*Nuytsia floribunda*	opportunistic
Elythranthera emarginatum	30	1	*Schoenus asperocarpus*	opportunistic
Eucalyptus marginata subsp. *marginata*	800	5	*Xanthorrhoea preissii*	opportunistic
**Gratiola peruviana*	5	3		
Kingia australis	300	10		
**Lotus suaveolens*	25	20		
Pericalymma ellipticum	250	2		
Podolepis gracilis	70	<1		
**Romulea rosea*	20	40		
**Vulpia bromoides*	40	10		

QUADRAT 7

Location: Mostert Property
Datum (WGS84): 400085E 6411474N
Soil: Grey sand
Vegetation Description: Tall Closed Forest of *Eucalyptus patens* over Tall Shrubland of *Xanthorrhoea preissii* over weeds or bare ground
Vegetation Condition: 4-5, good to degraded
Other Notes: Lot of litter and bare ground

SPECIES	HEIGHT (cm)	% COVER
Caladenia flava	15	<1
Centrolepis drummondii	5	<1
Desmocladus fascicularis	15	5
Drosera stolonifera	20	1
Eucalyptus patens	1600	60
Hibbertia hypericoides	20	5
**Hypochaeris glabra*	15	5
Kennedia prostrata	Twiner	<1
**Ornithopus pinnatus*	15	1
Pyrorchis nigricans	5	<1
Xanthorrhoea preissii	200	20
Allocasuarina fraseriana	opportunistic	
Corymbia calophylla	opportunistic	
Crassula colorata subsp. *colorata*	opportunistic	
**Disa bracteata*	opportunistic	
**Juncus bufonius*	opportunistic	
Meeboldina coangustatus	opportunistic	
Quinetia urvillei	opportunistic	

QUADRAT 8

Location: Mostert Property
Datum (WGS84): 400099E 6411059N
Soil: Grey sand
Vegetation Description: Closed Forest of *Corymbia calophylla* over Low Open Shrubland of *Xanthorrhoea preissii* over Very Open Herbland and Very Open Grassland of weeds
Vegetation Condition: 4-5, good to degraded
Other Notes: Lot of leaf litter
This unit fringes the damp area and the higher ground
Heavily grazed by kangaroos

SPECIES	HEIGHT (cm)	% COVER
**Bromus diandrus*	20	5
Corymbia calophylla	1800	80
**Ehrharta longiflora*	15	5
Xanthorrhoea brunonis	100	2
Xanthorrhoea preissii	100	5
Eucalyptus marginata subsp. *marginata*	opportunistic	
Xylomelum occidentale	opportunistic	

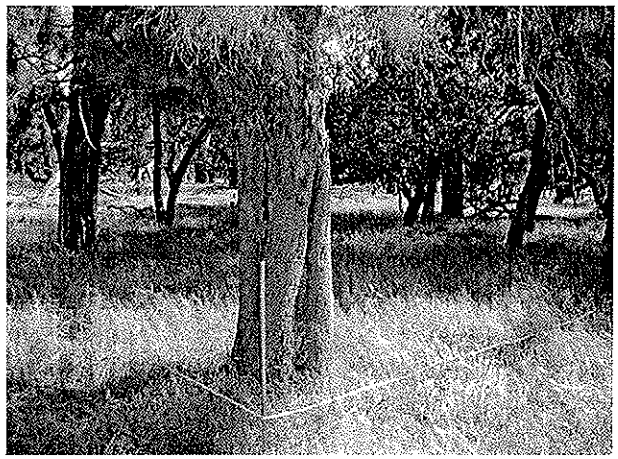
QUADRAT 9

Location: Mostert Property
Datum (WGS84): 400239E 6411134N
Soil: Grey sand
Vegetation Description: Open Forest of *Eucalyptus marginata* subsp. *marginata* over Low Open Woodland of *Xylomelum occidentale* over Low Open Shrubland dominated by *Hibbertia hypericoides*
Vegetation Condition: 5-6, degraded to completely degraded
Other Notes: Some tall trees with a great girth

SPECIES	HEIGHT (cm)	% COVER
Caladenia flava	10	<1
Desmocladus fascicularis	15	<1
Drosera erythrorhiza	5	<1
Drosera stolonifera	15	<1
Eucalyptus marginata subsp. *marginata*	1600	50
Hibbertia huegelii	30	<1
Hibbertia hypericoides	20	5
**Hypochaeris glabra*	5	5
Lepidosperma tenue	30	1
Lomandra hermaphrodita	40	<1
Tricoryne elatior	15	1
Xylomelum occidentale	800	10
Banksia attenuata	opportunistic	
Banksia menziesii	opportunistic	
Billardiera variifolia	opportunistic	
**Disa bracteata*	opportunistic	
Elythranthera emarginatum	opportunistic	
Xanthorrhoea preissii	opportunistic	

QUADRAT 10

Location: Lanstal Property
Datum (WGS84): 401504E 6406210N
Soil: Grey sand
Vegetation Description: Low Open Forest of *Banksia attenuata, Allocasuarina fraseriana, Xylomelum occidentale* and *Eucalyptus marginata* subsp. *marginata* over Closed Grassland of weeds
Vegetation Condition: 6, completely degraded
Other Notes: Sections where the tree cover is very good but the understorey has been completely replaced with weeds.



SPECIES	HEIGHT (cm)	% COVER
Allocasuarina fraseriana	800	20
**Arctotheca calendula*	10	2
Banksia attenuata	900	10
Banksia menziesii	600	10
**Bromus diandrus*	70	45
**Ehrharta longiflora*	40	2
**Hordeum leporinum*	50	20
**Lolium rigidum*	60	30
**Orobanche minor*	40	1
Xylomelum occidentale	900	10
**Avena barbata*	opportunistic	
Eucalyptus marginata subsp. *marginata*	opportunistic	

QUADRAT 11

Location: Lanstal Property
Datum (WGS84): 400925E 6406398N
Soil: Grey sand
Vegetation Description: Open Forest of *Corymbia calophylla* over Tall Open Shrubland of *Kingia australis* over Closed Grassland of weeds
Vegetation Condition: 6, completely degraded
Other Notes: Possibly a degraded remnant of Floristic Community Type 3a

SPECIES	HEIGHT (cm)	% COVER
**Bromus diandrus*	80	25
Corymbia calophylla	1800	70
**Ehrharta longiflora*	80	25
Kingia australis	300	10
**Lolium rigidum*	80	25
Allocasuarina fraseriana	opportunistic	
Banksia attenuata	opportunistic	
Banksia menziesii	opportunistic	
Eucalyptus marginata subsp. *marginata*	opportunistic	
**Hypochaeris glabra*	opportunistic	

QUADRAT 12

Location: Linga Property
Datum (WGS84): 399546E 6409973N
Soil: Grey sand
Vegetation Description: Open Forest of *Banksia attenuata, Banksia menziesii, Eucalyptus marginata* subsp. *marginata* and *Allocasuarina fraseriana* over Shrubland of *Xanthorrhoea brunonis*
Vegetation Condition: 4-5, Good to degraded
Other Notes: Large amount of timber lying on the ground
Several Banksia seedlings

SPECIES	HEIGHT (cm)	% COVER	SPECIES	
Allocasuarina fraseriana	1000	25	*Dampiera linearis*	opportunistic
Banksia grandis	1000	5	*Dasypogon bromeliifolius*	opportunistic
Banksia menziesii	1000	15	*Desmocladus fascicularis*	opportunistic
Burchardia umbellata	70	1	*Drosera erythrorhiza*	opportunistic
Caladenia flava	30	<1	*Drosera menziesii*	opportunistic
**Ehrharta longiflora*	60	50	*Drosera stolonifera*	opportunistic
Haemodorum laxum	70	1	*Eucalyptus marginata* subsp. *marginata*	opportunistic
Hibbertia hypericoides	30	1	*Hibbertia vaginata*	opportunistic
**Hypochaeris glabra*	40	15	*Hypocalymma angustifolia*	opportunistic
**Lolium rigidum*	60	5	*Hypolaena exsulca*	opportunistic
**Lotus suaveolens*	30	2	*Jacksonia furcellata*	opportunistic
Microlaena stipoides	40	20	*Juncus pallidus*	opportunistic
Patersonia occidentalis	80	1	*Mesomelaena tetragona*	opportunistic
Xanthorrhoea brunonis	150	30	**Solanum nigrum*	opportunistic
Xylomelum occidentale	700	5	*Thysanotus thyrsoides*	opportunistic
Agrostocrinum scabrum	opportunistic		*Tricoryne elatior*	opportunistic
Banksia attenuata	opportunistic			
Banksia ilicifolia	opportunistic			
**Briza maxima*	opportunistic			
**Briza minor*	opportunistic			
Caesia micrantha	opportunistic			
Conostylis setigera	opportunistic			
Cyathochaeta avenacea	opportunistic			

QUADRAT 13

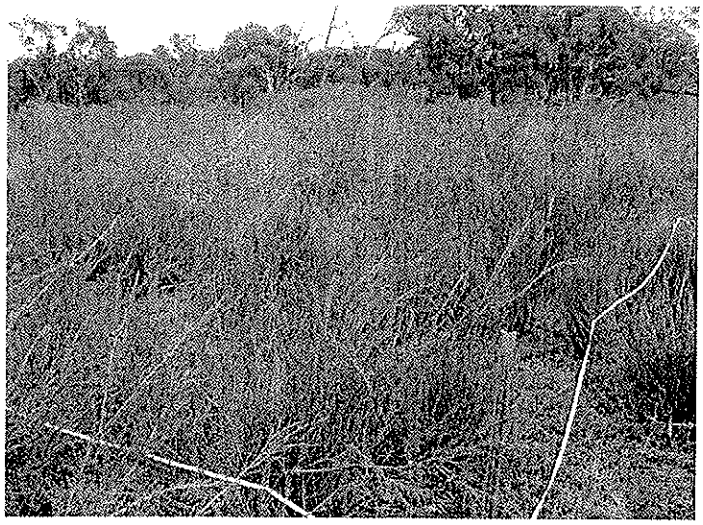
Location: Linga Property
Datum (WGS84): 399537E 6410074N
Soil: Sandy loam
Vegetation Description: Closed Tall Scrub of *Regelia ciliata* and *Pericalymma ellipticum*
Vegetation Condition: 2-3 good to very good
Other Notes: Good condition bushland only patchy as surrounded by degraded bushland

SPECIES	HEIGHT (cm)	% COVER
Acacia stenoptera	40	<1
Aphelia brizoides	5	<1
Conostylis aculeata subsp. *aculeata*	30	1
Cyathochaeta avenacea	90	10
Dasypogon bromeliifolius	30	2
Desmocladus fascicularis	5	3
Drosera menziesii	Twiner	<1
Hypocalymma angustifolia	40	3
**Hypochaeris glabra*	20	1
Hypolaena exsulca	490	5
Juncus pallidus	120	1
**Lotus suaveolens*	15	1
Lyginia inermis	50	1
Mesomelaena tetragona	70	1
Microtis media subsp. *media*	70	<1
Pericalymma ellipticum	100	15
Regelia ciliata	250	80
Schoenus curvifolius	30	<1
Siloxerus humifusus	5	<1
Stylidium calcaratum	5	<1
**Vulpia bromoides*	20	1
Xanthorrhoea preissii	90	1
Agrostocrinum scabrum	opportunistic	
Boronia spathulata	opportunistic	
Brachyscome iberidifolia	opportunistic	
Centrolepis aristatus	opportunistic	

SPECIES	
Chaetanthus aristatus	opportunistic
Conostylis setosa	opportunistic
Corymbia calophylla	opportunistic
**Cyperus tenellus*	opportunistic
Dampiera linearis	opportunistic
Daviesia physodes	opportunistic
Drosera glanduligera	opportunistic
Drosera stolonifera	opportunistic
Dryandra lindleyana	opportunistic
**Ehrharta calycina*	opportunistic
Euchilopsis linearis	opportunistic
Gratiola peruviana	opportunistic
Hibbertia vaginata	opportunistic
Kingia australis	opportunistic
Kunzea micrantha subsp. *micrantha*	opportunistic
Lomandra micrantha	opportunistic
Loxocarya cinerea	opportunistic
Melaleuca preissiana	opportunistic
Mitrasacme paradoxa	opportunistic
Patersonia occidentalis	opportunistic
Philydrella pygmaea	opportunistic
Phlebocarya ciliata	opportunistic
Schoenus efoliatus	opportunistic
Stylidium brunonianum	opportunistic
Thysanotus thyrsoideus	opportunistic
**Trifolium hirtum*	opportunistic
Verticordia densiflora	opportunistic
Xanthosia huegelii	opportunistic

QUADRAT 14

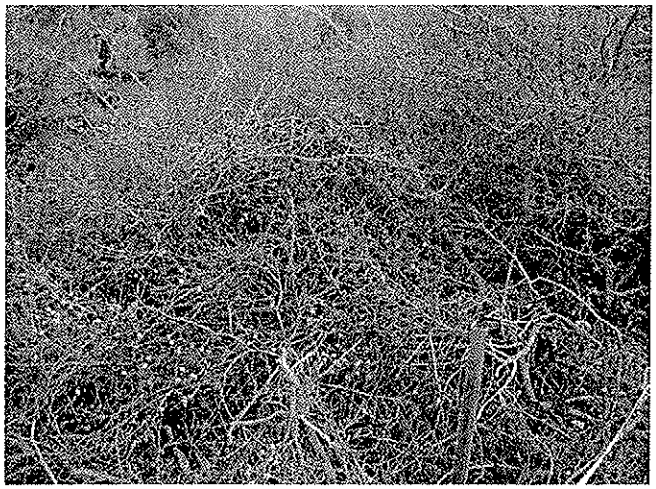
Location: Linga Property
Datum (WGS84): 399766E 6409981N
Soil: Dark brown loam
Vegetation Description: Open Heath of *Astartea affinis* over Open Sedgeland/Grassland
Vegetation Condition: 3-4, good to very good
Other Notes: Ground damp at survey



SPECIES	HEIGHT (cm)	% COVER
Astartea affinis	175	50
Brachyscome ciliaris	20	1
8Briza minor	10	1
Cotula coronopifolia	10	15
**Cynodon dactylon*	10	5
**Cyperus tenellus*	5	5
Drosera paleacea	5	<1
**Eragrostis elongata*	30	10
Gratiola peruviana	5	<1
Hypocalymma angustifolia	40	1
Juncus pallidus	70	1
Kunzea micrantha subsp. *micrantha*	125	8
**Lolium rigidum*	70	1
**Lotus suaveolens*	30	40
Meeboldina cana	100	10
**Ornithopus pinnatus*	15	1
Schoenus plumosus	5	1
Stylidium calcaratum	15	<1
Triglochin calcitrapa	10	1
Amphibromus nervosus	opportunistic	
Goodenia micrantha	opportunistic	
Melaleuca preissiana	opportunistic	

QUADRAT 15

Location: Linga Property
Datum (WGS84): 399551E 6410145N
Soil: Grey sandy loam
Vegetation Description: Tall Open Scrub of *Kunzea micrantha* subsp. *micrantha, Pericalymma ellipticum* and *Regelia ciliata* over a Herbland/Sedgeland
Vegetation Condition: 3-5, good to very good



SPECIES	HEIGHT (cm)	% COVER	SPECIES	
Aphelia brizoides	5	5	*Corymbia calophylla*	opportunistic
Brachyscome ciliaris	10	5	*Desmocladus fascicularis*	opportunistic
**Briza maxima*	10	1	*Drosera stolonifera*	opportunistic
**Briza minor*	15	1	*Eucalyptus marginata* subsp. *marginata*	opportunistic
Centrolepis aristatus	5	5	*Gastrolobium capitatum*	opportunistic
Centrolepis drummondii	5	1	*Gompholobium acerosum*	opportunistic
Cyathochaeta avenacea	70	5	*Hypolaena exsulca*	opportunistic
**Cyperus tenellus*	5	60	*Jacksonia furcellata*	opportunistic
Dasypogon bromeliifolius	70	1	**Leptospermum laevigatum*	opportunistic
Drosera menziesii	Twiner	<1	*Lomandra micrantha*	opportunistic
Hypocalymma angustifolia	50	1	*Lyginia inermis*	opportunistic
**Hypochaeris glabra*	15	1	*Melaleuca thymoides*	opportunistic
Kunzea micrantha subsp. *micrantha*	100	10	**Ornithopus pinnatus*	opportunistic
**Lolium rigidum*	40	<1	**Parentucellia latifolia*	opportunistic
**Lotus suaveolens*	20	5	*Patersonia occidentalis*	opportunistic
Melaleuca preissiana	500	5	*Pyrorchis nigricans*	opportunistic
Pericalymma ellipticum	100	5	*Quinetia urvillei*	opportunistic
Regelia ciliata	300	40	*Stylidium brunonianum*	opportunistic
Stylidium repens	20	<1	*Thelymitra cornicina*	opportunistic
Acacia huegelii	opportunistic		*Tricoryne elatior*	opportunistic
Acacia stenoptera	opportunistic		*Xanthorrhoea brunonis*	opportunistic
Agrostocrinum scabrum	opportunistic			
Boronia spathulata	opportunistic			
Conostylis juncea	opportunistic			

QUADRAT 16

Location: Linga Property
Datum (WGS84): 399422E 6410179N
Soil: Grey sand
Vegetation Description: Low Woodland of *Banksia attenuata, Banksia menziesii, Banksia ilicifolia* and *Allocasuarina fraseriana* over understorey of weeds
Vegetation Condition: 5-6, degraded to completely degraded
Other Notes: Lot of timber on the ground

SPECIES	HEIGHT (cm)	% COVER
Allocasuarina fraseriana	900	2
Amphibromus nervosus	80	10
Banksia ilicifolia	800	5
Banksia menziesii	800	10
**Briza maxima*	40	10
Burchardia umbellata	50	<1
Dasypogon bromeliifolius	50	1
**Ehrharta calycina*	70	1
**Hypochaeris glabra*	60	20
Patersonia occidentalis	90	1
**Ursinia anthemoides*	50	2
Xanthorrhoea brunonis	90	2
Austrostipa compressa	opportunistic	
Banksia attenuata	opportunistic	
Loxocarya cinerea	opportunistic	
Nuytsia floribunda	opportunistic	
Persoonia elliptica	opportunistic	
Xylomelum occidentale	opportunistic	

QUADRAT 17

Location: Linga Property
Datum (WGS84): 399242E 6410041N
Soil: Moist sandy clay
Vegetation Description: Low Open Forest of *Melaleuca preissiana* over Sedgeland
Vegetation Condition: 3-4 good to very good

SPECIES	HEIGHT (cm)	% COVER
**Briza maxima*	60	2
**Briza minor*	40	2
**Hypochaeris glabra*	50	15
Juncus pallidus	150	50
Lepidosperma drummondii	100	15
**Lotus suaveolens*	40	10
Melaleuca preissiana	1000	50
Microlaena stipoides	40	1
Microtis media subsp. *media*	60	1
**Ornithopus pinnatus*	15	3
Sowerbaea laxiflora	60	<1
**Aira caryophyllea*	opportunistic	
**Aira praecox*	opportunistic	
Corymbia calophylla	opportunistic	
Cotula coronopifolia	opportunistic	
**Cynodon dactylon*	opportunistic	
Lepidosperma longitudinale	opportunistic	
**Lolium rigidum*	opportunistic	
Prasophyllum giganteum	opportunistic	
Stylidium repens	opportunistic	
Thelymitra cornicina	opportunistic	
Triglochin calcitrapa	opportunistic	

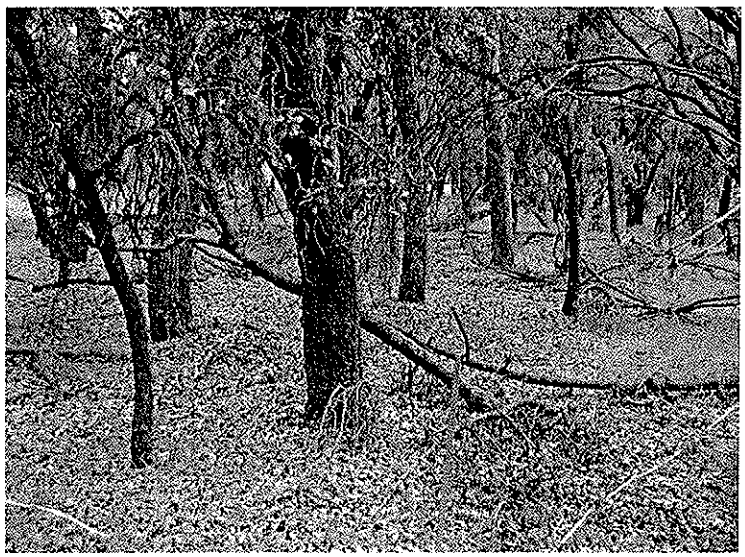
QUADRAT 18

Location: Linga Property
Datum (WGS84): 399384E 6409986N
Soil: Grey sand
Vegetation Description: Low Open Forest of *Banksia ilicifolia* and *Kunzea glabrescens* over Open Grassland of weeds
Vegetation Condition: 5 degraded
Other Notes: Very small area

SPECIES	HEIGHT (cm)	% COVER
**Aira caryophyllea*	30	15
Banksia ilicifolia	900	10
Burchardia umbellata	70	<1
Caladenia flava	20	<1
Drosera menziesii	Twiner	<1
Drosera stolonifera	40	2
**Ehrharta longiflora*	40	20
**Hypochaeris glabra*	40	2
Kunzea glabrescens	800	60
Lomandra hermaphrodita	15	<1
Microlaena stipoides	70	1
**Ornithopus pinnatus*	10	1
Poranthera microphylla	5	<1
**Ursinia anthemoides*	50	2
Banksia attenuata	opportunistic	
Banksia menziesii	opportunistic	
Nuytsia floribunda	opportunistic	

QUADRAT 19

Location: Linga Property
Datum (WGS84): 388520E 6409960N
Soil: Grey sand
Vegetation Description: Closed Forest of *Banksia ilicifolia* and *Kunzea glabrescens* over Open Grassland
Vegetation Condition: 5, degraded
Other Notes: Excellent tree cover
Dense litter cover of leaves



SPECIES	HEIGHT (cm)	% COVER
Banksia ilicifolia	1400	80
**Briza maxima*	40	10
**Bromus diandrus*	45	5
Burchardia umbellata	90	<1
Caladenia flava	40	1
**Ehrharta longiflora*	45	5
Kunzea glabrescens	1200	10
Lomandra hermaphrodita	30	<1
**Solanum nigrum*	10	<1
Thysanotus patersonii	Twiner	<1
Acacia pulchella	opportunistic	
Allocasuarina fraseriana	opportunistic	
**Disa bracteata*	opportunistic	
Eucalyptus marginata subsp. *marginata*	opportunistic	
Microtis media subsp. *media*	opportunistic	
Nuytsia floribunda	opportunistic	
Stylidium brunonianum	opportunistic	
Thelymitra cornicina	opportunistic	

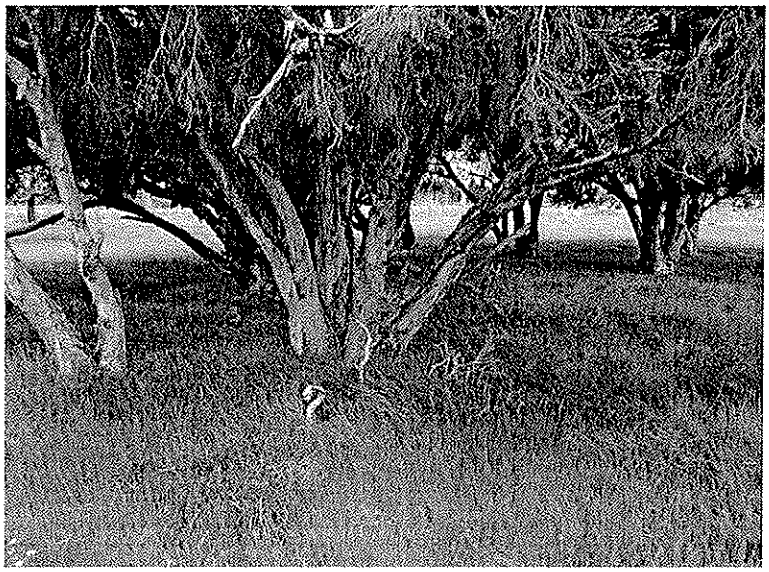
QUADRAT 20

Location: Linga Property
Datum (WGS84): 388734E 6410064N
Soil: Grey sand
Vegetation Description: Closed Forest of *Corymbia calophylla* over a Closed Grassland/Herbland of weeds
Vegetation Condition: 6 completely degraded
Other Notes: Small area
Horses and cows roam through area

SPECIES	HEIGHT (cm)	% COVER
**Bromus diandrus*	50	20
Corymbia calophylla	1800	80
**Ehrharta longiflora*	30	70
**Hordeum leporinum*	30	1
**Lolium rigidum*	60	2

QUADRAT 21

Location: Lanstal Property
Datum (WGS84): 399862E 6410178N
Soil: Sandy loam
Vegetation Description: Low Open Forest of *Melaleuca preissiana* over Closed Grassland of weeds
Vegetation Condition: 6 completely degraded
Other Notes: Small areas of this vegetation unit scattered through paddocks



SPECIES	HEIGHT (cm)	% COVER
**Arctotheca calendula*	5	5
**Cynodon dactylon*	10	5
**Ehrharta longiflora*	40	5
**Hordeum leporinum*	45	40
**Lolium rigidum*	30	40
**Lotus suaveolens*	30	5
Melaleuca preissiana	700	60
**Trifolium hirtum*	40	5

RELEVEE A

Location: Mostert Property
Datum (WGS84): 399591E 6411712N
Soil: Sandy loam
Vegetation Description: Closed Grassland/Herbland dominated by weeds
Vegetation Condition: 6 degraded
Other Notes: Cattle watering area

SPECIES	HEIGHT (cm)	% COVER
Cotula coronopifolia	5	5
**Arctotheca calendula*	25	3
**Callitriche stagnalis*	IN WATER	10
**Cyperus tenellus*	15	1
*Grasses	IN WATER	60
Juncus pallidus	50	<1
**Lotus suaveolens*	25	30
Corymbia calophylla	opportunistic	
Melaleuca preissiana	opportunistic	
**Rumex crispus*	opportunistic	
Triglochin procera	opportunistic	

RELEVEE B

Location: Lanstal Property
Datum (WGS84): 401344E 6406834N
Soil: Sandy loam
Vegetation Description: Closed Grassland/Herbland dominated by weeds
Vegetation Condition: 6 completely degraded
Other Notes: Along the drain through the area
Very degraded site

SPECIES
Cotula coronopifolia
**Cynodon dactylon*
**Lotus suaveolens*
**Vulpia myuros*

RELEVEE C

Location: Linga Property
Datum (WGS84): 399282E 6410042N
Soil: Sandy loam
Vegetation Description: Open Woodland of *Corymbia calophylla* over Open Low Heath of *Hypocalymma angustifolium*
Vegetation Condition: 5-6, degraded to completely degraded
Other Notes: Small area only

SPECIES	HEIGHT (cm)	% COVER	SPECIES	
Aphelia brizoides	10	70	**Ursinia anthemoides*	opportunistic
Corymbia calophylla	1600	5	**Vulpia bromoides*	opportunistic
**Cyperus tenellus*	5	15	**Vulpia myuros*	opportunistic
Hypocalymma angustifolium	100	50	*Xanthorrhoea brunonis*	opportunistic
Juncus pallidus	15	10	*Xanthorrhoea preissii*	opportunistic
**Aira caryophyllea*	opportunistic			
**Aira cupaniana*	opportunistic			
Aphelia cyperoides	opportunistic			
**Briza maxima*	opportunistic			
Drosera glanduligera	opportunistic			
**Hypochaeris glabra*	opportunistic			
**Juncus capitatum*	opportunistic			
**Juncus pauciflorus*	opportunistic			
**Lotus suaveolens*	opportunistic			
**Ornithopus pinnata*	opportunistic			
Quinetia urvillei	opportunistic			
Siloxerus humifusus	opportunistic			
**Trifolium campestre*	opportunistic			

APPENDIX C

Vegetation Map

ABBREVIATION	EXPLANATION
Aa	Open Heath of *Astartea affinis* over Open Sedgeland/Grassland
BaBm	Low Closed Forest of *Banksia attenuata* with scattered *Banksia menziesii* and *Eucalyptus marginata* subsp. *marginata* over Shrubland of *Xanthorrhoea brunonis* over Open Low Heath dominated by *Hibbertia hypericoides*
BiKg	Closed to Low Open Forest of *Banksia ilicifolia* and *Kunzea glabrescens* over Open Grassland
Cc	Closed Forest of *Corymbia calophylla* over a Closed Grassland/Herbland of weeds
CcKa	Open Forest of *Corymbia calophylla* over Tall Open Shrubland of *Kingia australis* over Closed Grassland of weeds
CcPe	Low Open Woodland of *Corymbia calophylla* over Tall Shrubland of *Pericalymma ellipticum* over a Low Shrubland of *Hypocalymma angustifolium*
CcXp	Tall Closed Forest of *Corymbia calophylla* or occasionally *Eucalyptus patens* over Tall Shrubland of *Xanthorrhoea preissii* over weeds
Mp	Low Open Forest of *Melaleuca preissiana* over Sedgeland
Rc	Closed Tall Scrub of *Regelia ciliata, Kunzea micrantha* subsp. *micrantha* and *Pericalymma ellipticum*

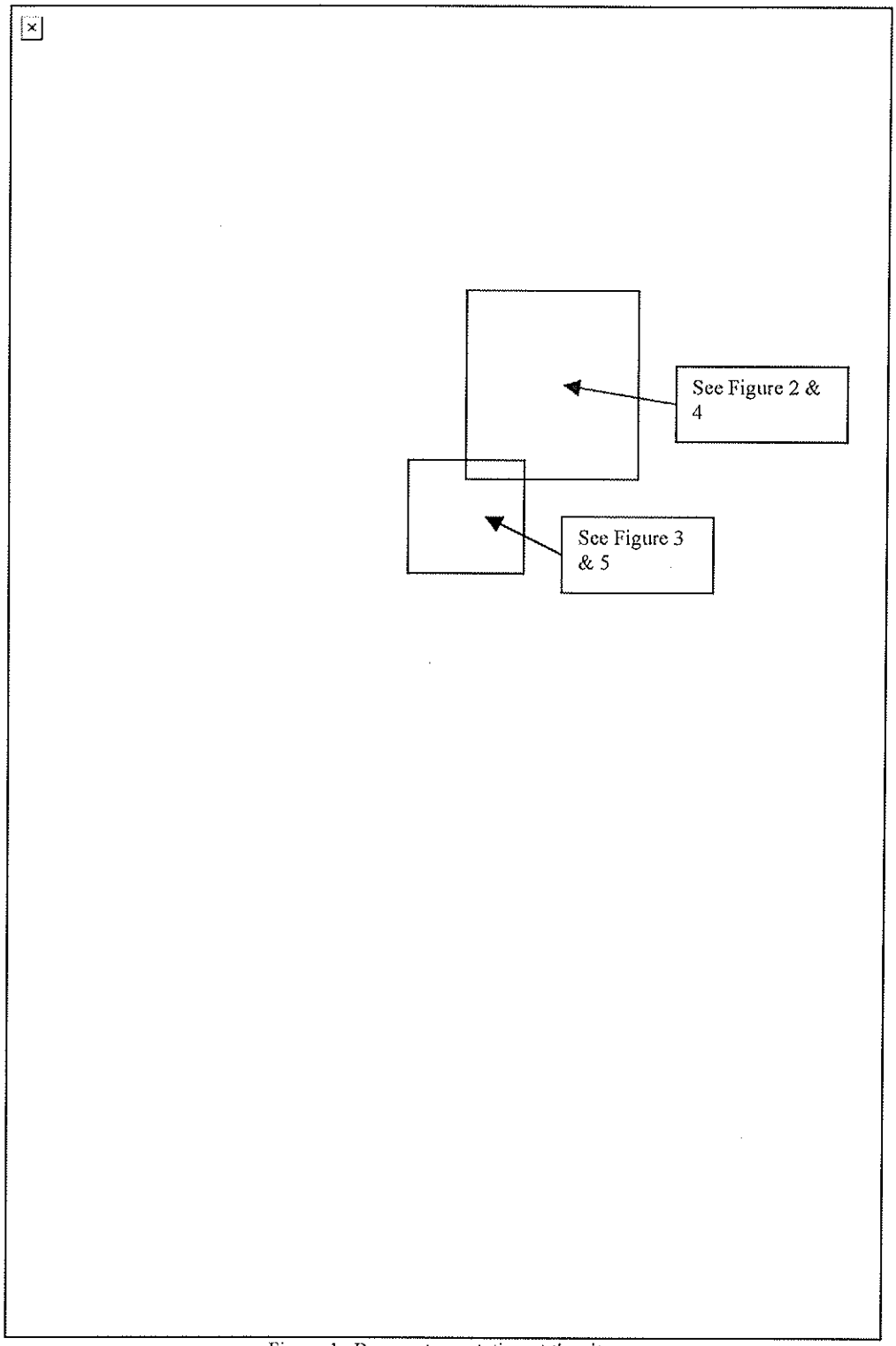


Figure 1. Remnant vegetation at the site.

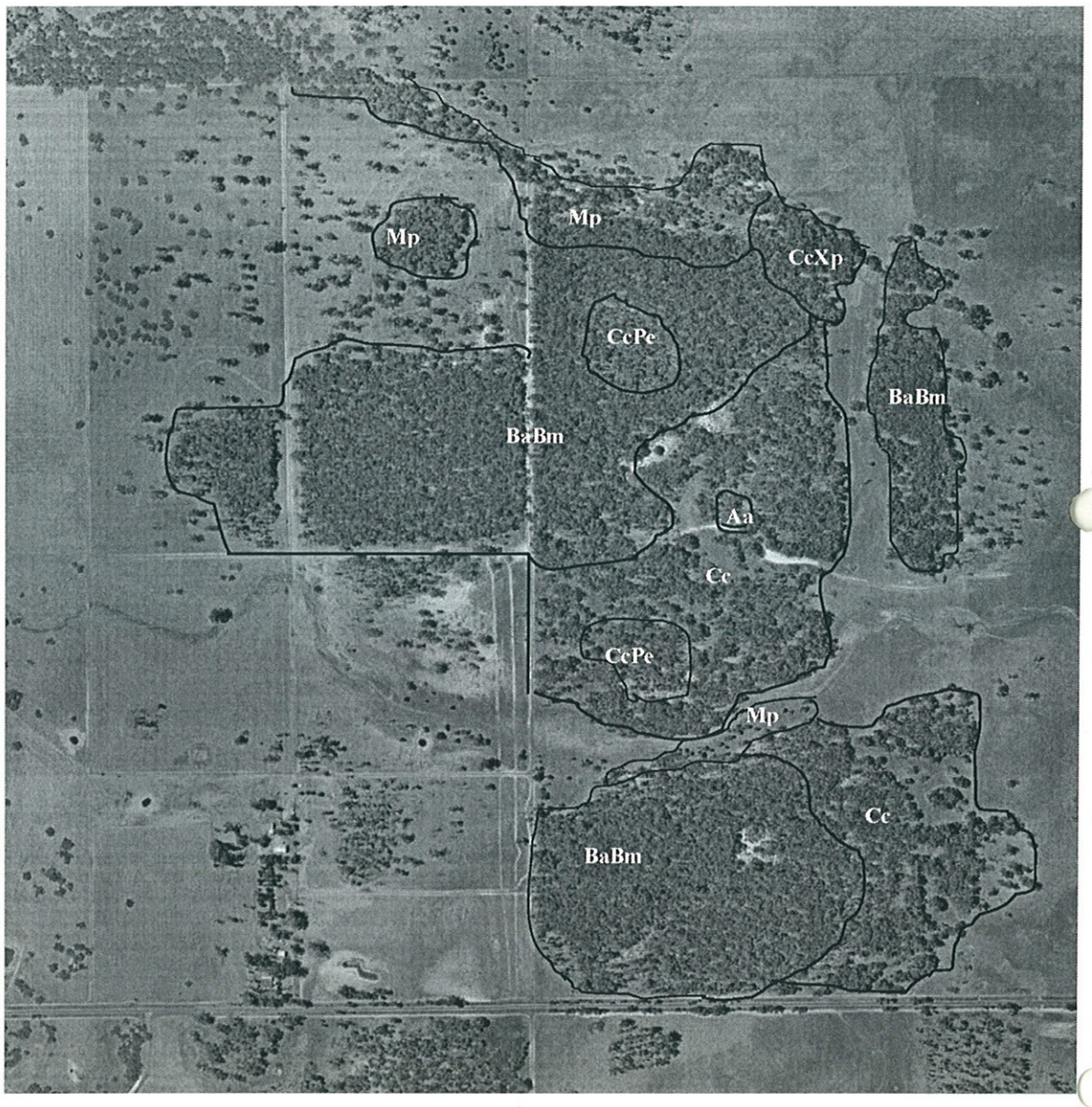


Figure 2. Remnant vegetation on Mostert property

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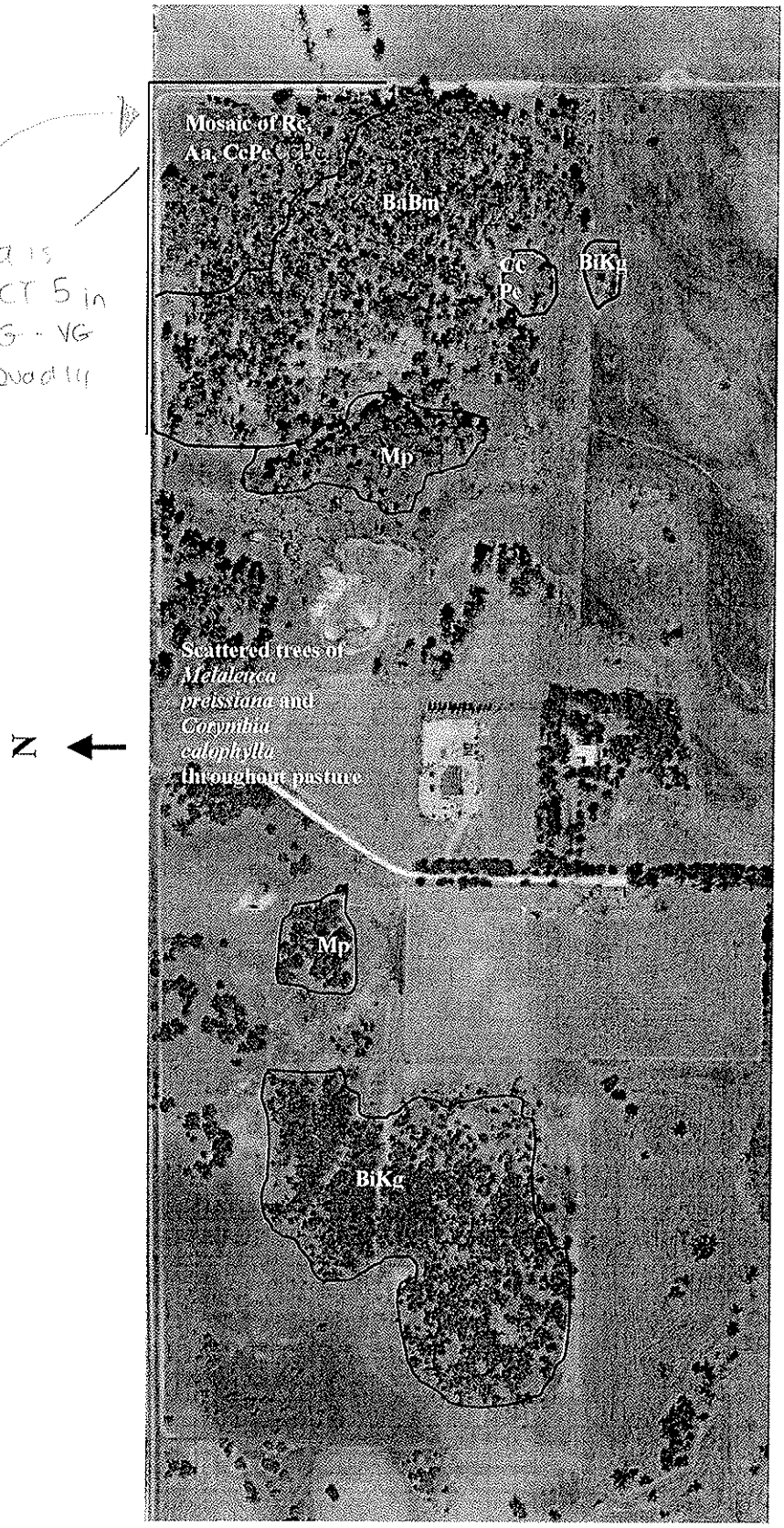


Figure 3: Remnant vegetation on Linga Property

APPENDIX D

Vegetation Condition Map

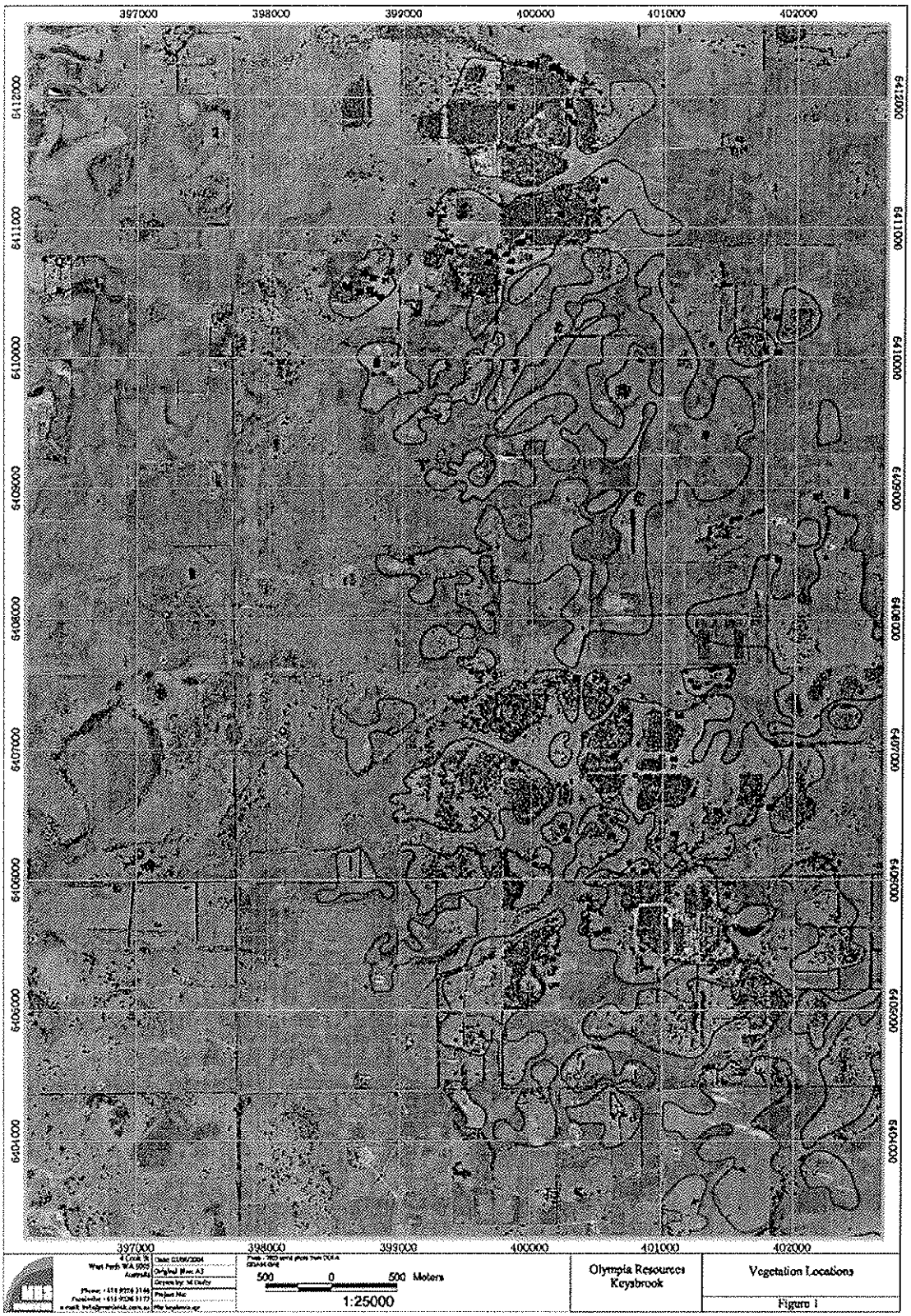
Rating	Description	Explanation
1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3	Very Good	Vegetation structure altered, obvious signs of disturbance.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management.
6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species.

Figure 4. Vegetation condition on Mostert property

Figure 5: Vegetation condition on Linga Property

APPENDIX E

MBS Survey Sites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Olympia Resources
Keysbrook
Vegetation Locations
Figure 1

Vegetation and Fauna Assessment of Exploration Licence 70/2407, Keysbrook

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Olympia Resources Limited

November 2004

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VEGETATION AND FAUNA ASSESSMENT OF EXPLORATION LICENCE 70/2407, KEYSBROOK

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1. SUMMARY

Exploration licence 70/2407 is situated along the eastern edge of the Swan Coastal Plain about 70 kilometres south of Perth and four kilometres west of the small township of Keysbrook situated on the South Western Highway.

The area of interest for the development of a mineral sands deposit consists of farmland on freehold titles. This study focussed mainly on the exploration licence overlying the properties belonging to the Mostert, Linga, Lanstal, Princi, Delborello and Thorn families.

A large portion of the exploration licence area has been cleared for agricultural use. Small areas of remnant native vegetation remain. The remnant vegetation ranges from stands of trees over pasture with little to no understorey to areas of trees with degraded understorey.

The vegetation and fauna assessment was undertaken between 19 and 20 of May 2004. The property owned by the Mostert family contains the largest area (72 hectares) of remnant native vegetation. This comprises *Banksia attenuata* woodland patches interspersed with Marri/Jarrah woodland and ranges from 'degraded' to 'excellent' on the Bush Forever vegetation condition scale. Land owned by the Linga family contains one hectare of wetlands with very dense *Regelia* and *Melaleuca* species and sedges and seven hectares of *Kunzea* thicket. The upland vegetation consisted of 11 hectares of *Banksia* open and grazed woodland with little leaf litter and understorey. The remnant vegetation on the Linga family property ranges from 'good' to 'very good' on the Bush Forever vegetation condition scale.

Land owned by the Lanstal family consisted of Marri and Sheoak woodland that has been fragmented into a series of moderate to small patches ranging from 'degraded' to 'completely degraded' on the Bush Forever vegetation condition scale. The properties owned or managed by the Mostert (South), Princi, Furfaro, Delborello and Thorn families have 'parkland' cleared vegetation remnants that are dominated by Marri over pasture grass or recently burnt stubble and are rated as 'completely degraded' on the Bush Forever vegetation condition scale.

A number of flora species listed under Federal and State acts as being of conservation significance may occur in the project area. These species were not observed during the vegetation and habitat assessment. This may be due to seasonality. It is recommended that a targeted flora search is undertaken in spring in the less degraded remnants of the Mostert, Linga and Landstal properties.

Five reptile species and six mammal species of conservation significance may occur in the project area. Forty birds of varying conservation significance that are expected to occur on the site. A large suite of these are recognised by the Western Australian Department of Environmental Protection (2000) as locally significant because they are declining in urban areas.

The primary issue for fauna in fragmented agricultural landscapes is connectivity of remnant vegetation. Reduction in the number of remnant blocks of native vegetation tends to reduce the value of remaining remnant blocks, as the movement of fauna will be impeded. Relatively few species use cleared areas, and those that do usually require areas of native vegetation to supply some of their needs.

The Short-billed (Carnaby's) Black-Cockatoo and the Forest Red-tailed Black-Cockatoo are likely to utilise remnant vegetation for feeding. Given the paucity of remnant vegetation in the area, these remnants may be important for this species, and any further loss may affect their persistence in the local area. The presence of a breeding population of these species should be considered when prioritising vegetation to be cleared.

A number of species of birds and mammals are dependent upon nest hollows for breeding and shelter and it is recommended that wherever possible, nest hollows be retained.

2. INTRODUCTION

2.1 BACKGROUND

2.1.1 Location

Exploration licence 70/2407 is situated along the eastern edge of the Swan Coastal Plain about 70 kilometres south of Perth and four kilometres west of the small township of Keysbrook situated on the South Western Highway (Figure 1).

2.1.2 Project Description

Olympia intends to mine mineral sands by dry mining methods using conventional earthmoving equipment. A conventional "wet" plant will be used onsite to produce a heavy mineral concentrate. These methods are widely used by the mineral sands industry of Western Australia. Mineral separation of the concentrate will be undertaken in a "dry" plant located elsewhere.

2.1.3 Geology

The typical geological section within the area consists of Bassendean Sand, 0.5 to five metres thick, overlying partly lateritised clayey sands of the Guildford Formation, in turn overlying sands and silts of the Yoganup Formation, which unconformably overlies basement Mesozoic sediments.

2.1.4 Vegetation

Vegetation of the Keysbrook area falls within two vegetation complexes - the Guildford Complex and the Bassendean Central and South Complex.

Vegetation of the Guildford complex is characterised by a mixture of open-forest, of Marri-Wandoo-Jarrah and woodland of wandoo, with minor components including the fringing woodland of *Eucalyptus rudis-Melaleuca rhaphiophylla* along streams. Other very commonly occurring species include *Banksia grandis*, *Kingia australis*, *Xanthorrhoea priessii* and species of *Hardenbergia* and *Hibbertia*.

Vegetation of the Bassendean Central and South Complex ranges from a woodland of Jarrah-Sheoak-Banksia on sand dunes to low woodland of *Melaleuca* and sedge lands on low-lying depressions and swamps. *Banksia attenuata*, *Banksia grandis* and *Banksia menziesii* are common on upper slopes. *Banksia ilicifolia*, *Banksia littoralis* and *Melaleuca preissana* are common on lower lying, moister soils, where Marri replaces Jarrah in dominance. Other common plant species include *Kunzea vestita*, *Hypocalymma angustifolium*, *Adenanthos obovatus* and *Verticordia* sp. (Department of Conservation and Environment Western Australia, 1980).

A large portion (around 90%) of the exploration licence area has been cleared for agricultural use. The balance consists of scattered blocks supporting remnant native vegetation. Remnant vegetation ranges from stands of trees over pasture grass with little to no understorey to areas of trees with a portion of degraded understorey.

The project area contains a number of low-lying pasture areas. No formal assessment of vegetation or habitat assemblages within the project area has been made at this stage.

2.1.5 Land Use

Land use within the project area is primarily concerned with agricultural activities (cattle grazing of improved pasture) on several properties. A number of free title farming properties occur on the areas of interest. This study focuses on the properties belonging to the Mostert, Linga, Lanstal, Princi, Delborello, and Thorn families (Figure 2).

2.1.6 Significant Flora

A database search of the coordinates 32°25'-32°31'S and 115°55'-15°59'E was undertaken for plant species listed under the *Wildlife Conservation Act* (1950) and the *Commonwealth Environment Protection and Biodiversity Conservation Act* (1999). The results are listed in Tables 1 and 2. Dr Eleanor Bennett has provided comments regarding the likelihood of species occurring on the project area.

None of the plant species listed in Tables 1 and 2 were opportunistically recorded during the habitat assessment. It is recommended that a more comprehensive search for species of conservation significance be undertaken within the vegetated remnants in spring 2004.

Table 1: Results from the Department of Conservation and Land Management Database Search for Threatened Flora Listed Under the Western Australian *Wildlife Conservation Act* 1950 that may occur on the Project Area

Species	Status	Habitat and Comments	Likelihood of Occurrence on Project Area
Synaphea sp. Pinjarra	DRF	Compact shrub, to 0.4 m high, to 0.5 m wide. Fl. yellow, Sep. Grey clayey sand. Swamp. Recorded from Dandalup and Pinjarra.	Low. Unlikely to occur in the area.
Tetraria australiensis	DRF	Rhizomatous, tufted perennial, grass-like or herb (sedge), to 1 m high. Fl. brown, Nov–Dec.	Low. Unlikely to occur at site.
Acacia oncinophylla subsp. *patulifolia*	P2	Shrub, 0.5–2.5(–3) m high, 'minni-ritchi' bark, phyllodes 4–9 cm long, 3–6 mm wide. Fl. yellow, Aug–Dec. Granitic soils, occasionally on laterite.	Low. Wrong soil type

Species	Status	Habitat and Comments	Likelihood of Occurrence on Project Area
Lambertia multiflora var. darlingensis	P3	Many-stemmed shrub, to 2 m high. Fl. yellow, Jun–Nov. Deep white-yellow sands or loamy, clayey or gravelly soils, laterite, granite. Flats, gorges, base of scarp, rocky hills, plateaus, roadsides.	Low. Occurs at the base of the Darling Scarp and therefore unlikely to occur in area.
Anthotium junciforme	P4	Open, erect to prostrate perennial, herb, 0.05–0.4 m high, leaves linear to terete, 0.5–1 mm wide; flowering stems 12–40 cm long. Fl. blue, violet, purple, Nov–Mar. Sandy clay, clay. Winter-wet depressions, drainage lines.	Moderate. Vague possibility in damp areas
Aponogeton hexatepalus	P4	Rhizomatous or cormous, aquatic perennial, herb, leaves floating. Fl. green, white, Jul–Oct. Mud. Freshwater: ponds, rivers, claypans	Moderate. If there is a wetland that contains standing water there is a possibility
Boronia tenuis	P4	Procumbent or erect & slender shrub, 0.1–0.5 m high. Fl. blue, pink, white, Aug–Nov. Laterite, stony soils, granite.	Low. Unlikely as wrong soil type
Calothamnus graniticus	P4	Shrub, 1–2.5 m high. Fl. red, May–Aug. Skeletal sandy soils, clay, laterite. Granite outcrops, hillsides.	High. subsp *leptophyllus* has been recorded from private property at Keysbrook.

Source: CALM (2004a). Likelihood of occurrence on project area provided by Dr Eleanor Bennett.

Table 2: Results from the Department of Heritage and Environment Database Search for Flora Species of Conservation Value Listed Under the Commonwealth *EPBC Act* 1999 that may occur on the Project Area

Species	Status	Habitat and Comments	Likelihood of occurrence on project area
Anthocercis gracilis (Slender Tailflower)	Vulnerable	Erect, spindly shrub, to 0.6(–1) m high. Fl. yellow, green, Sep–Oct. Sandy or loamy soils. Granite outcrops.	Low, soil type incorrect.
Caladenia sp. Jarrah forest	Vulnerable		
Drakea elastica (Glossy leaved Hammer-orchid)	Endangered	Tuberous, perennial, herb, 0.12–0.3 m high. Fl. red, green, yellow, Oct–Nov. White or grey sand. Low-lying situations adjoining winter-wet swamps.	Moderate. May occur in damp areas at the site.
Drakea micrantha	Vulnerable	Tuberous, perennial, herb, 0.15–0.3 m high. Fl. red, yellow, Sep–Oct. White-grey sand.	Low. Recorded from Pinjarra in Banksia woodland so may occur at the site. Most records are from further south.
Lasiopetalum pterocarpum	Endangered	Open shrub 0.2-1.2 m high x ca 0.2-0.5 m wide, growing through other plants. Riverbank. Brown clay-sand over granite.	Low. Unlikely to occur in area.

Source: DEH (2004). Likelihood of occurrence on project area provided by Dr Eleanor Bennett.

2.1.7 Significant Fauna

A database search of the coordinates 32°25'-32°31'S and 115°55'-15°59'E was undertaken for plant species listed under the *Wildlife Conservation Act* (1950) and the *Commonwealth Environment Protection and Biodiversity Conservation Act* (1999). The results are listed in Tables 3 and 4.

The Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*, Priority 3, CALM) was observed on the site, despite not listing in the database searches for the site. Signs of the Quenda (*Isoodon obesulus fusciventer*, Priority 3, CALM) were observed during the habitat assessment (Plate 6).

Assessment of conservation significance for Western Australian fauna is discussed in Section 4.3.

Table 3: Results from the Department of Conservation and Land Management Database Search for Fauna Species of Conservation Value Listed Under the Western Australian *Wildlife Conservation Act* 1950

Species	Common Name	Conservation Category	Comments
Calyptorhynchus latirostris	Short-billed (Carnaby's) Black- Cockatoo	Endangered	This species moves around seasonally in flocks to feeding areas in proteaceous scrubs and heaths and eucalypt woodland as well as pine plantations. Breeding occurs in winter/spring, mainly in the eastern forests and wheat belt where they can find mature hollow-bearing trees to nest in. There are also some recent records of nesting in the Mandurah area.
Dasyurus geoffroii	Chuditch	Vulnerable	This carnivorous marsupial occupies large home ranges, is highly mobile and appears able to utilise bush remnants and corridors.
Falco peregrinus	Peregrine Falcon	Other Specially Protected Species	This species is uncommon and prefers areas with rocky ledges, cliffs, watercourses, open woodland or margins with cleared land.
Isoodon obesulus fusciventer	Quenda	Priority 4	This species prefers areas with dense understorey vegetation, particularly around swamps and along watercourses, that provides ample protection from predators.

Source: CALM (2004b)

Table 4: Results from the Commonwealth Environment Protection and Biodiversity Conservation (EPBC) Database Search for Fauna Species of Conservation Value Listed Under the Commonwealth *EPBC Act* 1999

Species	Common Name	Conservation Category	Comments
Calyptorhynchus baudinii	Long-billed (Baudin's) Black-Cockatoo	Vulnerable	See Table 3
Calyptorhynchus latirostris	Short-billed (Carnaby's) Black-Cockatoo	Endangered	See Table 3
Dasyurus geoffroii	Chuditch	Vulnerable	See Table 3
Phascogale calura	Red-tailed Phascogale	Endangered	Unlikely to occur on the coastal plain (this is probably an error in the database)
Setonix brachyurus	Quokka	Endangered	Confined to dense vegetation around swamps on the mainland.
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory Species	Highly unlikely to occur, as this species is restricted to coastal habitats.

Source: DEH (2004)

Notes:

State Department of Conservation and Land Management Priority List

Declared Rare Flora R — Taxa, which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection, and have been gazetted as such.

Declared Rare Flora X — 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, and have been gazetted as such.

Priority 1 — Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat, eg road verges, urban areas, farmland, active mining leases etc, or the plants are under threat, eg from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.

Priority 2 — Taxa which are known from one or a few (generally <5) populations at least some of which are not believed to be under immediate threat) i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but are in urgent need for further study.

Priority 3 — Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally > 5), or known populations being large and either widespread or protected. Such taxa and under consideration for declaration as 'rare flora' but are in need of further study.

Priority 4 — Taxa which are considered to have been adequately surveyed and which, whilst being rare, are not commonly threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999

Extinct — A native species is eligible to be included in the *extinct* category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.

Endangered — A native species is eligible to be included in the *endangered* category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high

	risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria.
Vulnerable	A native species is eligible to be included in the *vulnerable* category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.

Western Australian *Wildlife Conservation Act 1950* - Fauna

Priority 1	Taxa with few, poorly known populations on threatened lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, active mineral leases. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 2	Taxa with few, poorly known populations on conservation lands. Taxa which are known from few specimens or sight records from one or a few localities on lands not under immediate threat of habitat destruction or degradation, e.g. national parks, conservation parks, nature reserves, State forest, vacant Crown land, water reserves, etc. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 3	Taxa with several, poorly known populations, some on conservation lands. Taxa which are known from few specimens or sight records from several localities, some of which are on lands not under immediate threat of habitat destruction or degradation. The taxon needs urgent survey and evaluation of conservation status before consideration can be given to declaration as threatened fauna.
Priority 4:	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change. These taxa are usually represented on conservation lands.

3. OBJECTIVES

The objectives of this study were to:

- Identify, assess and map vegetation types present within the northern portion of Exploration Lease E70/2407.
- Identify and assess vertebrate fauna species (expected or observed) within Exploration Lease 70/2407.
- Identify habitats where significant flora and fauna may occur on Exploration Lease 70/2407.
- Provide recommendations on further flora and fauna surveys if required.

4. METHODOLOGY

The vegetation and fauna assessment was undertaken between 19 and 20 of May 2004. Ms Kate George of MBS Environmental and Mr Robert Davis, Zoologist of Western Wildlife, on behalf of Bamford Consulting Ecologists, inspected the properties of the Mostert, Delborello, Linga, Harris, Furfaro, Lanstal and Princi families. Zoologist Mr Mike Bamford of Bamford Consulting Ecologists peer reviewed the habitat assessment and fauna sections of the report and Botanist Ms Eleanor Bennett identified the flora specimens collected on site.

Properties with significant patches of remnant vegetation were traversed by foot. Properties that were predominantly cleared were traversed by vehicle or assessed from the road or neighbouring property. Figure 2 shows the route taken through each property.

The dominant vegetation in each remnant was mapped and the remnant was assigned a vegetation condition category from the Bush Forever scale (Appendix 2) (Keighery 1994). Tree hollows were noted and the coordinates recorded (Appendix 3).

Fauna work carried out in the field included:

- Opportunistic observations of fauna at each site, including tracks and scats, were recorded.
- Fallen logs and other debris were also searched for reptiles and other fauna.
- Spotlighting was undertaken on the evening of 19 May 2004 for 30 minutes within two hours of dusk.

4.1 SURVEY LIMITATIONS AND CONSTRAINTS

4.1.1 Vegetation

The vegetation condition assessment was conducted at the level of reconnaissance survey as specified in EPA Guideline 51, targeting the areas of remnant native vegetation on the properties of interest (EPA 2004a). The survey was designed as a habitat survey rather than a complete inventory of plant species occurring in the remnants. A more detailed survey in spring will be required in order to compile a comprehensive species list and to determine whether any species of conservation value occur on the properties.

4.1.2 Fauna

The habitat assessment was conducted at the level of reconnaissance survey, targeting the areas of remnant vegetation on the properties of interest as specified in EPA Guideline 56 (EPA 2004b). The opportunistic evidence of fauna observed on the Keysbrook properties can provide only a snapshot of the more commonly observed fauna. A systematic survey regime including trapping would be necessary in order to provide an understanding of species abundance and diversity.

4.2 SOURCES OF INFORMATION

The observations were supplemented with records from a number of sources. These included publications that provide information on general patterns of distribution of amphibians (Tyler *et al.* 2000), reptiles (Storr *et al.* 1983, 1990, 1999 and 2002), birds (Johnstone and Storr 1998) and mammals (Strahan 1995). In addition, specimen records of frogs, reptiles and mammals held by the Western Australian Museum were obtained for the region bounded by 32°20' to 32°35'S, and 115°50' to 116°00'E. For additional information and records on threatened species, the EPBC protected matters search tool [maintained by the Department of the Environment and Heritage (DEH, formerly Environment Australia)] and the threatened fauna database maintained by the WA Department of Conservation and Land Management (CALM) were searched (Tables 2 and 3).

These sources of information were used to create lists of species expected to occur at the site. Expected species are those that are likely to utilise the project area. Such lists exclude species that have been recorded in the general region as vagrants or for which suitable habitat is absent. Particularly among birds, for example, vagrants can be recorded almost anywhere.

Taxonomy and nomenclature for fauna species used in this report generally follow the Western Australian Museum (2001) for amphibians, reptiles and mammals, and Christidis and Boles (1994) for birds.

Taxonomy for flora follows that of the Western Australian Herbarium. Taxa were checked using Max and the Western Australian Herbarium Master List.

4.3 ASSESSMENT OF CONSERVATION SIGNIFICANCE

4.3.1 Vegetation

Under the *Wildlife Conservation Act*, the Minister for the Environment may declare species of protected flora to be "Rare Flora" if they are considered to be in danger of extinction, rare or otherwise in need of special protection. Such species are referred to as Threatened Flora, and receive special management attention by CALM.

Those species listed as declared rare flora may not be taken without the specific written approval of the Minister for the Environment. This prohibition applies equally to both Crown and private land; to licensed and unlicensed persons; and to the owners and occupiers of land on which rare flora is found. The prohibition does not extend, however, to cultivated or domesticated plants.

Because of the large Western Australian flora, there are many species that are known from only a few collections, or a few sites, but which have not been adequately surveyed. Such flora may be rare or threatened, but cannot be considered for declaration as rare flora until such survey has been undertaken. These flora are included on a supplementary conservation list called the Priority Flora List.

There are three categories of priority flora covering these poorly known species. The categories are arranged to give an indication of the priority for undertaking further surveys based on the number of known sites, and the degree of threat to those populations. A fourth category of priority flora is included for those species that have been adequately surveyed and are considered to be rare but not currently threatened.

Where a person wishes to take rare flora, either for scientific or developmental purposes, an application must be made to the Minister for permission. CALM provides advice on the likely impact of the taking on the conservation of the species, and assesses alternatives to the proposed activity (CALM 2004c).

4.3.2 Fauna

The conservation status of fauna species is assessed under Commonwealth and State Acts such as the Commonwealth *Environment Protection and Biodiversity Conservation Act* (1999) (EPBC Act) and the Western Australian *Wildlife Conservation Act* (1950). The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994). The Western Australian *Wildlife Conservation Act* (1950) uses a set of Schedules but also classifies species using some of the IUCN categories. These categories and Schedules are described in Appendix 3.

The EPBC Act also has lists of migratory species that are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). The list of migratory species under the EPBC Act has been revised to include listed species only, thus excluding family listings (DEH, pers. comm.). Those species listed in JAMBA are also protected under Schedule 3 of the Western Australian *Wildlife Conservation Act* (1950). In addition, the DEH has supported the publication of reports on the conservation status of most vertebrate fauna species e.g. reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999). These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects as this report pre-dates Mace and Stuart's review (1994).

In Western Australia, CALM has produced a supplementary list of Priority Fauna, being species that are not considered Threatened under the WA Act, but for which the Department feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. Levels of Priority are described in Appendix 4.

Fauna species included under conservation acts and/or agreements are formally recognised as of conservation significance under state or federal legislation. Species listed only as Priority by CALM, or included in publications such as Garnett and Crowley (2000) and Cogger *et al.* (1993), but not in State or Commonwealth Acts, are also of recognised conservation significance. In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur in breeding colonies, such as some waterbirds, can be considered of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. The Western Australian Department of Environmental Protection (2000) used this sort of

interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan.

On the basis of the above comments, three levels of conservation significance are recognised in this report:

- *Conservation Significance (CS) 1*: Species listed under State or Commonwealth Acts.
- *Conservation Significance (CS) 2*: Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by CALM.
- *Conservation Significance (CS) 3*: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

5. RESULTS AND DISCUSSION

5.1 RARE FLORA

None of the listed plant species (*Wildlife Conservation Act* 1950 and *EBPC Act* 1999) were opportunistically recorded during the habitat assessment. A targeted comprehensive search for species of conservation significance should be undertaken on the vegetated remnants in spring 2004. In particular the remnants on 'Mostert' and 'Linga' properties should be targeted as they have intact lower, middle and upper stories.

5.2 VEGETATION CONDITION ASSESSMENT

5.2.1 Mostert

This is the largest area of remnant native vegetation. It comprised *Banksia attenuata* woodland patches interspersed with Marri/Jarrah woodland ranging from 'degraded' to 'excellent.'

The remnants on "Mostert" had a number of potential nest hollows present (Appendix 3), dense leaf litter cover, hollow and rotten logs, ephemeral streams and a diversity of other habitats that represented some of the best remaining habitat in the region for fauna.

Tables 5 to 9 summarise the vegetation units of the 'Mostert' property with a description of the vegetation at each surveyed location. Figure 2 shows the location of each vegetation unit corresponding to the waypoint in each table.

Table 5: Vegetation Unit of the 'Mostert' Property, Waypoints 11-15

Way Point	Vegetation Unit	Condition	Disturbance
11-15	Marri/Jarrah woodland with *Banksia attenuata* woodland patches.	Excellent (2) - Vegetation structure intact, disturbance affecting individual species and woods are non-aggressive species.	Fire, grazing
Vegetation description			
Eucalyptus marginata (Jarrah) - *Corymbia calophylla* (Marri) woodland with patches of *Banksia attenuata*. Scattered upperstorey species include *Allocasuarina fraseriana* and *Acacia saligna*. Dominant mid storey species include *Xylomelum occidentale*, *Pericalymma ellipticum* and *Banksia menziesii*. Juvenile *Xanthorrhoea priessii, Dryandra lindleyana* and *Hibbertia hypercoides* dominate the understorey.			

Table 6: Vegetation Unit of the 'Mostert' Property, Waypoint 16

Way Point	Vegetation Unit	Condition	Disturbance
16	Jarrah woodland with no understorey.	Degraded (5). Basic vegetation structure severely impacted on by disturbance. The stand of Jarrah is in intact and healthy.	Grazing, fire
Vegetation description			
Eucalyptus marginata over pasture grass.			

Table 7: Vegetation Unit of the 'Mostert' Property, Waypoints 18-22

Way Point	Vegetation Unit	Condition	Disturbance
18-22	Jarrah woodland.	Degraded (5). Basic vegetation structure severely impacted on by disturbance. Many dead Jarrah. Mid and lower storey becomes very sparse at the edge of the vegetation patch.	Cattle grazing, fire, kangaroo grazing
Vegetation description			
Eucalyptus marginata over an understorey of *Xanthorrhoea priessii*, *Xylomelum occidentale* and *Hibbertia hypercoides*. *Corymbia calophylla* and *Banksia attenuata* and *B. grandis* are *present in* low numbers only. The orchid *Pyrorchis nigricans* is present.			

Table 8: Vegetation Unit of the 'Mostert' Property, Waypoint 24

Way Point	Vegetation Unit	Condition	Disturbance
24	Marri woodland over pasture grass.	Degraded (5). Basic vegetation structure severely impacted on by disturbance. Many dead Jarrah. Mid and lower storey becomes very sparse at the edge of the vegetation patch.	Cattle grazing, fire, kangaroo grazing, parrot grazing.
Vegetation description			
Corymbia calophylla woodland over pasture grass with scattered juvenile *Xanthorrhoea priessii* with occasional *Nuytsia floribunda*.			

Table 9: Vegetation Unit of the 'Mostert' Property, Waypoint 25

Way Point	Vegetation Unit	Condition	Disturbance
25	Mixed Melaleuca *Kingia australis/ Xanthorrhea preissii.*	Degraded (5). Basic vegetation structure severely impacted on by disturbance.	Cattle grazing, fire, kangaroo grazing. Erosion along creek line.
Vegetation description			
Melaleuca rhaphiophylla stands with a mid storey of *Kingia australis* and/or *Xanthorrhea preissii* over a heavily grazed grass pasture with *Mesomelaena tetragona.* Occasional emergents include *Eucalyptus marginata, Hakea prostrata Melaleuca lateritica* and *Nuytsia floribunda.*			

5.2.2 Linga (West)

Tables 10 to 15 summarise the vegetation units of the 'Linga' property (vegetation remnants east and west) with a description of the vegetation at each surveyed location. Figure 2 shows the location of each vegetation unit corresponding to the waypoint in each table.

Dense thickets of *Kunzea glabrescens* with an overstorey of Holly-leaf Banksia (*Banksia ilicifolia*). Occasional emergents consisted of sheoak (*Allocasuarina fraseriana*) and Jarrah (*Eucalyptus marginata*).

Table 10: Vegetation Unit of the 'Linga (West)' Remnant, Waypoints 31-39

Way Point	Vegetation Unit	Condition	Disturbance
31-39	Thick *Kunzea glabrescens* with patches of *Banksia ilicifolia.*	Good (4). Vegetation structure significantly altered by obvious signs of multiple disturbances.	Fire (burning at time of inspection), heavily grazed.
Vegetation description			
Kunzea glabrescens thickets with patches of *Banksia ilicifolia.* Emergent species are dominated by *Corymbia calophylla and Eucalyptus marginata.* Occasional *Banksia menziesii* and *Nuytsia floribunda* occur. Understory is predominately pasture grass with a high litter cover.			

5.2.3 Linga (East)

This area contains areas of a strip of seasonal wetlands with very dense *Regelia* and *Melaleuca* species and sedges. The upland vegetation consisted of extensive *Banksia* woodland that was more open and grazed than "Mostert" with consequently less leaf litter and understorey.

Table 11: Vegetation Unit of the 'Linga (East)' Remnant, Waypoint 40

Way Point	Vegetation Unit	Condition	Disturbance
40	Open Marri woodland.	Good (4). Vegetation structure significantly altered by obvious signs of multiple disturbances. Some dead Marri.	Grazing
Vegetation description			
Open *Corymbia calophylla* woodland with occasional *Melaleuca rhaphiophylla* and *Allocasuarina fraseriana.* Understory species include the exotic grass *Eragrostis curvula*, juvenile *Xanthorrhoea priessii* and *Mesomelaena tetragona.*			

Table 12: Vegetation Unit of the 'Linga (East)' Remnant, Waypoint 41

Way Point	Vegetation Unit	Condition	Disturbance
41	*Regelia ciliata, Hypocalymma augustifolium* dominated seasonal wetland.	Good (4). Vegetation structure significantly altered by obvious signs of multiple disturbances. Some dead Marri.	Grazing
Vegetation description			
Regelia ciliata, Hypocalymma augustifolium dominated seasonal wetland with an upperstorey of *Corymbia calophylla, Eucalyptus marginata, Banksia menziesii, Banksia attenuata* and occasional *Nuytsia floribunda, Allocasuarina fraseriana* and *Pericalymma ellipticum.* Understorey is dominated by juvenile *Xanthorrhea preissii, Dryandra lindleyana, Hibbertia vaginata* and sedges: *Mesomelaena tetragona, Cyathochaeta avenacea, Dasypogon bromellifolius, Hypolaena exsulca* and *Juncea pallidus.* Exotic species include *Leptospermum laevigatum* and blackberry.			

Table 13: Vegetation Unit of the 'Linga (East)' Property, Waypoints 42 and 45

Way Point	Vegetation Unit	Condition	Disturbance
42 and 45	*Banksia* woodland with pasture grass understorey.	Very Good (3). Vegetation structure altered, obvious signs of disturbance. Dead Jarrah.	Grazing, dumped car bodies
Vegetation description			
Banksia menziesii and *Banksia attenuata* woodland with occasional *Banksia ilicifolia, Kunzea glabrescens, Corymbia calophylla and Eucalyptus marginata.* Occasional *Xanthorrhoea priessii.*			

Table 14: Vegetation Unit of the 'Linga (East)' Remnant, Waypoints 43-44

Way Point	Vegetation Unit	Condition	Disturbance
43-44	Open Marri woodland with pasture grass understorey.	Very Good (3). Vegetation structure altered, obvious signs of disturbance. Dead Jarrah.	Grazing
Vegetation description			
Very open *Corymbia calophylla* woodland with *Regelia ciliata* dominated midstorey with occasional *Banksia menziesii, Banksia attenuata, Banksia ilicifolia, Nuytsia floribunda* and occasional *Xanthorrhoea priessii* over pasture grass. Occasional *Pyrorchis nigricans.*			

Table 15: Vegetation Unit of the 'Linga (East)' Remnant, Waypoints 46-48

Way Point	Vegetation Unit	Condition	Disturbance
46-48	*Astartea fasicularis* dominated continuation of seasonal wetland as described in Table 12.	Very Good (3). Vegetation structure altered, obvious signs of disturbance.	Grazed
Vegetation description			
Astartea fasicularis dominated seasonal wetland with emergent *Melaleuca rhaphiophylla* and *Kingia australis.* Understorey consists of *Juncus pallidus, with occasional Philthea spicata, Acacia stenoptera and Drosera sp.* with the exotic *Watsonia bulbillifera* occurring along the adjacent roadside.			

5.2.4 Lanstal

This property primarily consisted of Marri and sheoak woodland that has been fragmented into a series of moderate to small patches. A number of opportunistic observations were taken at key remnants. These remnants could be broadly divided into four main groups:

1. Large remnants with some understorey.
2. Large remnants with little or no understorey.
3. Small remnants with some understorey.
4. Small remnants with little or no understorey.

The remnants that have the most habitat value for fauna are those that are large, with a relatively intact understorey (1).

Open paddock areas also supported a diversity of birds especially those that have capitalised on anthropogenic disturbance.

Tables 16 to 20 summarise the vegetation units of the 'Lanstal' property with a description of the vegetation at each surveyed location. Figure 2 shows the location of each vegetation unit corresponding to the waypoint in each table.

Table 16: Vegetation Unit of the 'Lanstal' Property, Waypoints 53-56

Way Point	Vegetation Unit	Condition	Disturbance
53-56	Jarrah woodland with Banksia midstorey and pasture grass understorey.	Degraded (5). Basic vegetation structure severely impacted by disturbance.	Grazed and cleared
Vegetation description			
Eucalyptus marginata over a midstorey of *Xylomelum occidentale, Banksia attenuata, Banksia grandis and Banksia menziesii*. Understorey is grass pasture.			

Table 17: Vegetation Unit of the 'Lanstal' Property, Waypoints 57-59

Way Point	Vegetation Unit	Condition	Disturbance
57-59	Jarrah-Marri woodland with pasture grass understorey.	Completely Degraded (6). The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. 'Parkland cleared'. Lots of dead Jarrah and Marri.	Grazed and cleared
Vegetation description			
Eucalyptus marginata-Corymbia calophylla over occasional *Banksia menziesii, Kingia australis, Banksia attenuata, Melaleuca rhaphiophylla, Xylomelum occidentale, Kunzea glabrescens* and *Allocasuarina fraseriana*. Understorey is grass pasture.			

Table 18: Vegetation Unit of the 'Lanstal' Property, Waypoint 60

Way Point	Vegetation Unit	Condition	Disturbance
60	Marri woodland with pasture grass understorey.	Completely Degraded (6). The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. 'Parkland cleared'.	Grazed and cleared
Vegetation description			
Corymbia calophylla over grass pasture.			

Table 19: Vegetation Unit of the 'Lanstal' Property, Waypoint 61

Way Point	Vegetation Unit	Condition	Disturbance
61	Sheoak woodland with pasture grass understorey.	Completely Degraded (6). The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. 'Parkland cleared'. Lots of dead Jarrah and Marri.	Grazed and cleared
Vegetation description			
Allocasuarina fraseriana over grass pasture with occasional *Corymbia calophylla* and *Eucalyptus marginata.*			

Table 20: Vegetation Unit of the 'Lanstal' Property, Waypoints 63-64

Way Point	Vegetation Unit	Condition	Disturbance
63-64	Jarrah, Marri, Sheoak woodland over pasture grass.	Completely Degraded (6). The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. 'Parkland cleared'. Lots of dead Jarrah and Marri.	Grazed and cleared
Vegetation description			
Corymbia calophylla, Eucalyptus marginata and *Allocasuarina fraseriana* over grass pasture with occasional *Kingia australis, Xylomelum occidentale and Banksia menziesii.*			

The properties "Mostert South", "Princi", "Delborello" and "Thorn" have 'parkland' cleared vegetation remnants that are dominated by Marri over pasture grass or recently burnt stubble and can be regarded as completely degraded. "Furfaro" is predominately pasture.

5.3 FAUNA ASSESSMENT

5.3.1 Fauna Species Expected or Observed to be Present

5.3.1.1 Amphibians

There were four amphibians recorded during the site visit, with 10 species expected to occur (Table 22). The Moaning Frog (*Heleioporus eyrei*) was recorded in paddocks near Mostert, and at Linga (east). The Sandplain Froglet (*Crinia insignifera*) was recorded at Mostert, Linga east and remnant 1 and 10 of Lanstal. Guenther's Toadlet (*Pseudophryne guentheri*) was recorded at Mostert. Table 21 shows the amphibians expected and recorded at

Keysbrook. Species of conservation significance are indicated in the status column, and species recorded by the Western Australian Museum are indicated by 'WAM'.

Table 21: Amphibians Recorded (+) or Expected to Occur on the Keysbrook Project Area

Species		Status	Observed or Recorded
Myobatrachidae (burrowing frogs)			
Quacking Frog	*Crinia georgiana*		WAM
Glauert's Frog	*Crinia glauerti*		
Sandplain Froglet	*Crinia insignifera*		+
Granite Froglet	*Crinia pseudinsignifera*		+ WAM
Moaning Frog	*Heleioporus eyrei*		+
Marbled Burrowing Frog	*Heleioporus psammophilus*		
Pobblebonk Frog	*Limnodynastes dorsalis*		
Turtle Frog	*Myobatrachus gouldii*		
Guenther's Toadlet	*Pseudophryne guentheri*		+ WAM
Hylidae (tree-frogs)			
Slender Tree Frog	*Litoria adelaidensis*		
Motorbike Frog	*Litoria moorei*		
	No. of frogs observed:		4
	No. of frogs observed or expected:		10

Some species of frog will only occur near wetlands such as the seasonal streams to the north of Mostert or the damp land at Linga East. Many species may also use roadside ditches to breed, such as those observed near Linga East.

Some of the species listed, such as the Pobblebonk and the Moaning Frog, utilise areas away from wetlands during the non-breeding season and access to these upland areas of native vegetation is important for their lifecycle. The Turtle Frog is a strictly terrestrial breeder and may be resident in the project area in Banksia woodland and other areas with sandy soils.

None of the amphibians expected to occur in the project area are of conservation significance.

5.3.1.2 Reptiles

There are 45 reptile species expected to occur in the project area, and one species, the Fence Skink, was observed during the site visit (Table 22). Most reptile species could be found anywhere in the project area, but some have more specific habitat requirements. Wetland-dependent species such as the Long-necked Tortoise, Tiger Snake, South-west Cool-Skink and Glossy Swamp Egernia, will only occur near wetlands such as at "Linga East"

Table 22 shows the reptiles that were expected and recorded at Keysbrook. Species of conservation significance are indicated in the status column, and species recorded by the Western Australian Museum are indicated by 'WAM'.

Table 22: Reptiles Recorded (+) or Expected to Occur on the Keysbrook Project Area

Species		Status	Observed or Recorded
Gekkonidae (geckoes)			
Marbled Gecko	*Christinus marmoratus*		WAM
Southern Spiny-tailed Gecko	*Strophurus spinigerus*		
Barking Gecko	*Underwoodisaurus milli*		WAM
Pygopodidae (legless-lizards)			
Sand-Plain Worm-Lizard	*Aprasia repens*		
Fraser's Legless Lizard	*Delma fraseri*		
Gray's Legless Lizard	*Delma grayii*		
Burton's Legless Lizard	*Lialis burtonis*		WAM
Common Scaleyfoot	*Pygopus lepidopodus*		
Agamidae (dragon lizards)			
Western Bearded Dragon	*Pogona minor*		
Varanidae (monitors or goannas)			
Gould's Sand Goanna	*Varanus gouldii*		WAM
Rosenberg's Goanna	*Varanus rosenbergi*		WAM
Scincidae (skink lizards)			
South-West Cool Skink	*Acritoscincus trilineatum*		WAM
Fence Skink	*Cryptoblepharus plagiocephalus*		+ WAM
West Coast Ctenotus	*Ctenotus fallens*		
Southwest Odd-striped Ctenotus	*Ctenotus impar*		
Red-legged Ctenotus	*Ctenotus labillardieri*		WAM
King's Skink	*Egernia kingii*		WAM
Glossy Swamp Egernia	*Egernia luctuosa*		
Salmon-bellied Skink	*Egernia napoleonis*		WAM
Two-toed Earless Skink	*Hemiergis quadrilineata*		
West Coast Four-toed Lerista	*Lerista elegans*		
Perth Lined Lerista	*Lerista lineata*	CS2	
Dwarf Skink	*Menetia greyii*		WAM
West Coast Morethia	*Morethia lineoocellata*		
Dusky Morethia	*Morethia obscura*		WAM
Bobtail	*Tiliqua rugosa*		WAM
Boidae (pythons)			
South West Carpet Python	*Morelia spilota imbricata*		WAM
Typhlopidae (blind-snakes)			
Southern Blind Snake	*Ramphotyphlops australis*		WAM

Species		Status	Observed or Recorded
Elapidae (front-fanged snakes)			
Narrow-banded Shovel-nosed Snake	*Brachyurophis fasciolata*		
Southern Shovel-nosed Snake	*Brachyurophis semifasciata*		WAM
Crowned Snake	*Elapognathus coronatus*		WAM
Bardick	*Echiopsis curta*		
Black-naped Snake	*Neelaps bimaculatus*		
Black-striped Snake	*Neelaps calonotos*	CS2	
Western Tiger Snake	*Notechis scutatus*		WAM
Gould's Snake	*Parasuta gouldii*		WAM
Black-backed Snake	*Parasuta nigriceps*		WAM
Dugite	*Pseudonaja affinis*		WAM
Jan's Bandy-Bandy	*Simoselaps bertholdi*		WAM
Half-ringed Snake	*Simoselaps semifasciatus*		
Chelidae (side-neck tortoises)			
South-West Long-necked Tortoise	*Chelodina oblonga*		
	No. of reptiles observed:		1
	No. of reptiles observed or expected:		45

Most species of reptile rely on areas of native vegetation for survival. Degraded areas, such as paddocks or heavily grazed remnants such as at Lanstal, with no understorey or leaf litter, will support only a limited number of disturbance-tolerant species. Species tolerant of disturbance include the Marbled Gecko, Dwarf Skink, Fence Skink, West-coast Four-toed Lerista, Two-toed Earless Skink, Bobtail and Dugite.

Most frogs and reptiles are generally poor dispersers with small home ranges. The regional persistence of such species may depend on connectivity of populations to form a meta-population thus ensuring gene flow and reducing the chance of extinction for isolated or small populations. If areas such as roadside corridors are lost, it could seriously restrict the movement of reptiles between vegetation remnants and have long-term implications for the regional persistence of some species.

There are five reptiles of conservation significance that may occur in the project area. Each species is discussed below.

a) Conservation Significance Level 1

Carpet Python (*Morelia spilota imbricata*)
This python is listed as 'other specially protected fauna' under the *Wildlife Conservation Act*, as Priority 4 by CALM and as vulnerable by Cogger *et al.* (1993). The Carpet Python is known from the Mandurah area (M. Bamford, pers. obs), although the likelihood that it persists in the fragmented project area is low.

b) Conservation Significance Level 2

Perth Lined Lerista (*Lerista lineata*)
This lizard is listed as rare or insufficiently known by Cogger *et al.* (1993). This lizard occurs where there are pale sandy soils, and particularly in association with banksias. The Perth Lined Lerista may occur in any of the areas with remnant vegetation, except where there are wetlands.

Black-striped Snake (*Neelaps calonotos*)
This snake is listed as endangered by Cogger *et al.* (1993). This snake occurs where there are sandy soils supporting Banksia and Eucalypt woodlands (Bush *et al.*, 1995). Therefore, the Black-striped Snake may occur in any of the areas with remnant vegetation, except where there are wetlands.

c) Conservation Significance Level 3

Barking Gecko (*Underwoodisaurus milli*)
This gecko is at the southern limit of its distribution in the region.

Red-legged Ctenotus (*Ctenotus labillardieri*)
This skink has a patchy distribution on the coastal plain and is at the northern limit of its distribution in the region. Furthermore, the taxonomic status of coastal plain records of this species from near Mandurah is currently under review (N. Dunlop pers. comm.).

5.3.1.3 Birds

As birds are highly mobile, almost any species that occurs in the general region could occur at some time in the project area. The list in Table 22 contains only those species that would be likely to use habitats within the project area on a regular basis. During the site visit, 44 species were observed.

The majority of species expected to be present are widespread in the South-West, but some species are of conservation significance as discussed below. A large suite of these has been recognised as locally significant (CS3) by the WA Department of Environmental Protection (2000) because they are declining in urban areas.

There are 40 birds of conservation significance that are expected to occur on the site, and these are discussed below.

a) Conservation Significance 1

Short-billed (Carnaby's) Black-Cockatoo (*Calyptorhynchus latirostris*)
This cockatoo is listed as endangered under the *EPBC Act*, the *Wildlife Conservation Act* and by Garnett and Crowley (2000). The Short-billed Black-Cockatoo has declined due to loss of breeding habitat in the wheatbelt and of non-breeding habitat along the west coast, partly due to urban expansion. While small areas of foraging habitat support only small numbers of birds for short periods of time, the progressive loss of such small areas is an ongoing concern for this species. This species was not present at any site during site visits, but would be expected to occur at any sites containing areas of Banksia or Eucalyptus woodland.

Long-billed (Baudin's) Black-Cockatoo (*Calyptorhynchus baudinii*)
This cockatoo is listed as vulnerable under both the *EPBC Act* and *Wildlife Conservation Act* and as 'near threatened' by Garnett and Crowley (2000). Although more restricted to the Eucalypt forests of the nearby escarpment than the previous species, the Long-billed Black-Cockatoo has been reliably reported from the Mandurah area (CALM's Threatened Fauna Database) and may therefore regularly visit the study site. This species feeds primarily on the seeds of Eucalypts. It is not known to breed on the coastal plain.

Peregrine Falcon (*Falco peregrinus*)
This falcon is listed as 'other specially protected fauna' under the *Wildlife Conservation Act*. The Peregrine Falcon is a wide-ranging bird of prey that may be an occasional visitor to the site. Evidence of breeding activity was not observed during the site visit.

Rainbow Bee-eater (*Merops ornatus*)
The Rainbow Bee-eater is classified as migratory under the JAMBA, CAMBA and Bonn Convention, and as such is protected under the *EPBC Act*. Its listing under JAMBA also means it is protected under the WA *Wildlife Conservation Act*. The Rainbow Bee-eater is almost certainly a regular, breeding visitor to the project area but, although listed as migratory, it is an abundant species.

Fork-tailed Swift (*Apus pacificus*)
This species is migratory under JAMBA, CAMBA and the Bonn Convention, and as such is protected under the *EPBC Act*. Its listing under JAMBA also ensures it is protected under the WA *Wildlife Conservation Act*. This species is largely aerial and is very unlikely to be affected by the proposed development.

b) Conservation Significance 2

Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) proposed Schedule P
This cockatoo is listed as Priority 3 by CALM and as 'near threatened' by Garnett and Crowley (2000). Although mainly known from the forested scarp, a pair of Forest Red-tailed Black Cockatoos was also observed in proximity to a nest hollow in a tall Marri at Mostert. This species may potentially breed at this site and is of conservation concern.

Barking Owl (*Ninox connivens*)
This owl is listed as Priority 2 by CALM and as 'near threatened' by Garnett and Crowley (2000).

Masked Owl (*Tyto novaehollandiae novaehollandiae*)
This owl is listed as Priority 3 by CALM and as 'near threatened' by Garnett and Crowley (2000). A Masked Owl was recently recorded just to the south of Mandurah (Lake Mealup Preservation Society 2001), and it may occur in the project area. The Masked Owl relies on very large hollows in eucalypts for breeding.

c) Conservation Significance Level 3
A total of 32 bird species are listed as being of Conservation Significance Level 3 (Table 23), with most of these being species listed in Bush Forever (Department of Environmental Protection 2000). Many of the species have restricted populations on the Swan Coastal Plain either naturally or as a result of European settlement and the associated issues of introduced predators e.g. foxes and cats, and habitat loss/degradation.

Of the below species, the Scarlet Robin, Grey Shrike-thrush, Weebill and Golden Whistler were present at Mostert and are expected to occur in other areas of woodland in good condition.

Table 23: Bird Species Listed as Conservation Significance Level 3 (Department of Environmental Protection 2000)

Common Name	Species
Whistling Kite	*Haliastur sphenurus*
Square-tailed Kite	*Lophoictinia isura*
Brown Goshawk	*Accipiter fasciatus*
Collared Sparrowhawk	*Accipiter cirrhocephalus*
Wedge-tailed Eagle	*Aquila audax*
Little Eagle	*Hieraaetus morphnoides*
Brown Falcon	*Falco berigora*
Painted Button-quail	*Turnix varia*
Common Bronzewing	*Phaps chalcoptera*
Rufous Tree-creeper	*Climacteris rufa*
Splendid Fairy-wren	*Malurus splendens*
Southern Emu-wren	*Stipiturus malachurus*
Spotted Pardalote	*Pardalotus punctatus*
White-browed Scrubwren	*Sericornis frontalis*
Weebill	*Smicrornis brevirostris*
Inland Thornbill	*Acanthiza apicalis*
Western Thornbill	*Acanthiza inornata*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Western Wattlebird	*Anthochaera lunullata*
Yellow-plumed Honeyeater	*Lichenostomus ornatus*
White-naped Honeyeater	*Melithreptus lunatus*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
White-cheeked Honeyeater	*Phylidonyris nigra*
Tawny-crowned Honeyeater	*Phylidonyris melanops*
Scarlet Robin	*Petroica multicolor*
Western Yellow Robin	*Eopsaltria griseogularis*
Varied Sittella	*Daphoenositta chrysoptera*
Golden Whistler	*Pachycephala pectoralis*
Grey Shrike-thrush	*Colluricincla harmonica*
Restless Flycatcher	*Myiagra inquieta*
Grey Currawong	*Strepera versicolor*

Table 24 shows the birds that were expected and recorded at Keysbrook. Species of conservation significance are indicated in the Status column. Species recorded by the Western Australian Museum are indicated by 'WAM', and 'BA' indicates species recorded by Birds Australia.

Table 24: Birds Recorded (+) or Expected to Occur on the Keysbrook Project Area

Species		Status	Observed or Recorded
Phasianidae (pheasants and quails)			
Stubble Quail	*Coturnix pectoralis*		
Anatidae (ducks and swans)			
Pacific Black Duck	*Anas superciliosa*		
Australian Wood Duck	*Chenonetta jubata*		
Australian Shelduck	*Tadorna tadornoides*		+
Accipitridae (kites, hawks and eagles)			
Black-shouldered Kite	*Elanus axillaris*		
Whistling Kite	*Haliastur sphenurus*	CS3	
Swamp Harrier	*Circus approximans*		
Brown Goshawk	*Accipiter fasciatus*	CS3	
Collared Sparrowhawk	*Accipiter cirrhocephalus*	CS3	
Wedge-tailed Eagle	*Aquila audax*	CS3	WAM
Little Eagle	*Hieraaetus morphnoides*	CS3	
Square-tailed Kite	*Hamirostra isura*	CS3	
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	CS1	
Falconidae (falcons)			
Peregrine Falcon	*Falco peregrinus*	CS1	
Australian Hobby	*Falco longipennis*		
Brown Falcon	*Falco berigora*	CS3	
Nankeen Kestrel	*Falco cenchroides*		+
Turnicidae (button-quails)			
Painted Button-quail	*Turnix varia*	CS3	
Charadriidae (lapwings and plovers)			
Banded Lapwing	*Vanellus tricolor*		
Columbidae (pigeons and doves)			
Rock Dove (Domestic Pigeon)	*Columba livia*	Int.	
Spotted Turtle-Dove	*Streptopelia chinensis*	Int.	
Laughing Turtle-Dove	*Streptopelia senegalensis*	Int.	
Common Bronzewing	*Phaps chalcoptera*	CS3	+
Crested Pigeon	*Ocyphaps lophotes*		+
Cacatuidae (cockatoos)			
Red-tailed Black-Cockatoo	*Calyptorhynchus banksii*	CS2	+ WAM

Species		Status	Observed or Recorded	
Baudin's Black-Cockatoo	*Calyptorhynchus baudinii*	CS1		WAM
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1		WAM
Galah	*Cacatua roseicapilla*			
Western Long-billed Corella	*Cacatua pastinator*			
Little Corella	*Cacatua sanguinea*	Int		
Sulphur-crested Cockatoo	*Cacatua leadbeateri*	Int		
Psittacidae (lorikeets and parrots)				
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*		+	
Red-capped Parrot	*Purpureicephalus spurius*		+	WAM
Regent Parrot	*Polytelis anthopeplus*		+	WAM
Western Rosella	*Platycercus icterotis*			WAM
Australian Ringneck	*Barnardius zonarius*		+	WAM
Elegant Parrot	*Neophema elegans*		+	
Cuculidae (cuckoos)				
Pallid Cuckoo	*Cuculus pallidus*			
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*			WAM
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*			
Strigidae (hawk-owls)				
Southern Boobook Owl	*Ninox novaeseelandiae*			WAM
Barking Owl	*Ninox connivens*	CS2		
Tytonidae (barn owls)				
Barn Owl	*Tyto alba*			
Masked Owl	*Tyto novaehollandiae novaehollandiae*	CS2		
Podargidae (frogmouths)				
Tawny Frogmouth	*Podargus strigoides*			
Caprimulgidae (nightjars)				
Spotted Nightjar	*Eurostopodus argus*			
Aegothelidae (owlet-nightjars)				
Australian Owlet-nightjar	*Aegotheles cristatus*			
Apodidae (swifts)				
Fork-tailed Swift	*Apus pacificus*	CS1		
Halcyonidae (forest kingfishers)				
Laughing Kookaburra	*Dacelo novaeguineae*	Int.	+	WAM
Sacred Kingfisher	*Todiramphus sanctus*			
Meropidae (bee-eaters)				
Rainbow Bee-eater	*Merops ornatus*	CS1		

Species		Status	Observed or Recorded
Climacteridae (treecreepers)			
Rufous Treecreeper	*Climacteris rufa*	CS3	WAM
Maluridae (fairy-wrens)			
Splendid Fairy-wren	*Malurus splendens*	CS3	+
Southern Emu-wren	*Stipiturus malachurus*	CS3	WAM
Pardalotidae (pardalotes and thornbills)			
Spotted Pardalote	*Pardalotus punctatus*	CS3	
Striated Pardalote	*Pardalotus striatus*		+ WAM
White-browed Scrubwren	*Sericornis frontalis*	CS3	+ WAM
Weebill	*Smicrornis brevirostris*	CS3	+
Western Gerygone	*Gerygone fusca*		+
Inland Thornbill	*Acanthiza apicalis*	CS3	+
Western Thornbill	*Acanthiza inornata*	CS3	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	CS3	+
Meliphagidae (honeyeaters and chats)			
Red Wattlebird	*Anthochaera carunculata*		+
Western Wattlebird	*Anthochaera lunulata*	CS3	+
Singing Honeyeater	*Lichenostomus virescens*		+
Yellow-throated Miner	*Manorina flavigula*		+
Brown-headed Honeyeater	*Melithreptus brevirostris*		
White-naped Honeyeater	*Melithreptus lunatus*	CS3	+
Brown Honeyeater	*Lichmera indistincta*		+
New Holland Honeyeater	*Phylidonyris novaehollandiae*	CS3	+
White-cheeked Honeyeater	*Phylidonyris nigra*	CS3	
Tawny-crowned Honeyeater	*Phylidonyris melanops*	CS3	
Western Spinebill	*Acanthorhynchus superciliosus*		+
White-fronted Chat	*Epthianura albifrons*		+
Petroicidae (Australian robins)			
Western Yellow Robin	*Eopsaltria griseogularis*	CS3	
Scarlet Robin	*Petroica multicolor*	CS3	+
Neosittidae (sittellas)			
Varied Sittella	*Daphoenositta chrysoptera*	CS3	+
Pachycephalidae (whistlers)			
Rufous Whistler	*Pachycephala rufiventris*		+
Golden Whistler	*Pachycephala pectoralis*	CS3	+
Grey Shrike-thrush	*Colluricincla harmonica*	CS3	+
Dicruridae (flycatchers)			
Restless Flycatcher	*Myiagra inquieta*	CS3	

Species		Status	Observed or Recorded	
Magpie-lark	*Grallina cyanoleuca*		+	
Grey Fantail	*Rhipidura fuliginosa*		+	
Willie Wagtail	*Rhipidura leucophrys*		+	
Campephagidae (cuckoo-shrikes)				
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*		+	
White-winged Triller	*Lalage sueurii*			
Artamidae (woodswallows)				
Black-faced Woodswallow	*Artamus cinereus*	CS3	+	
Dusky Woodswallow	*Artamus cyanopterus*	CS3		
Grey Butcherbird	*Cracticus torquatus*		+	
Australian Magpie	*Gymnorhina tibicen*		+	WAM
Corvidae (ravens and crows)				
Grey Currawong	*Strepera versicolor*	CS3	+	
Australian Raven	*Corvus coronoides*		+	
Motacillidae (pipits and true wagtails)				
Richard's Pipit	*Anthus novaeseelandiae*			

Table 25: Birds Observed at Each Site During Site Visit 19 to 20 May 2004 (see Table 24 for Scientific Names)

Species	Site								
	Mostert	Linga (west)	Linga (east)	Lanstal - Paddock	Lanstal - Remnant 1	Lanstal - Remnant 4	Lanstal - Remnant 8	Lanstal - Remnant 9	Lanstal - Remnant 10
Australian Shelduck	X	X							
Nankeen Kestrel		X							
Common Bronzewing		X							
Crested Pigeon	X								
Laughing Turtle-Dove		X							
Red-tailed Black-Cockatoo	X								
Purple-crowned Lorikeet					X				
Red-capped Parrot		X	X						X
Regent Parrot	X								X
Australian Ringneck	X	X	X	X	X	X	X	X	
Elegant Parrot				X					
Laughing Kookaburra	X								
Splendid Fairy-wren	X	X	X						
Striated Pardalote		X							
White-browed Scrubwren			X						
Weebill	X								
Western Gerygone	X	X	X						X
Inland Thornbill	X	X	X						
Yellow-rumped Thornbill	X	X	X	X		X	X		X
Red Wattlebird	X			X					
Western Wattlebird		X	X						
Singing Honeyeater		X							
Yellow-throated Miner				X	X				
White-naped Honeyeater		X							
Brown Honeyeater	X	X	X			X			
New Holland Honeyeater			X						
White-fronted Honeyeater			X						
Western Spinebill	X								
White-fronted Chat				X					
Scarlet Robin	X			X					X
Varied Sittella									X
Rufous Whistler	X	X		X	X	X			X

Species	Site								
	Mostert	Linga (west)	Linga (east)	Lanstal - Paddock	Lanstal - Remnant 1	Lanstal - Remnant 4	Lanstal - Remnant 8	Lanstal - Remnant 9	Lanstal - Remnant 10
Golden Whistler	X								X
Grey Shrike-thrush	X	X							X
Magpie-lark	X	X		X					
Grey Fantail	X	X	X	X		X			X
Willie Wagtail	X	X	X	X					
Black-faced Cuckoo-shrike	X		X						
Black-faced Woodswallow	X		X						
Grey Butcherbird	X	X				X			
Australian Magpie	X	X	X						
Grey Currawong	X								
Australian Raven	X	X	X	X	X	X		X	
Welcome Swallow	X	X		X					
Silvereye		X							
Total number of bird species:	**28**	**25**	**17**	**13**	**4**	**6**	**2**	**2**	**10**

5.3.1.4 Mammals

There are 30 species of mammal that may occur in the project area (Table 26) and another nine that are regionally extinct (Table 27). Five of the expected species are introduced and almost a third of the native species are bats. The characteristic diggings of the Quenda (Southern Brown Bandicoot) were recorded.

The Western Grey Kangaroo was recorded at Mostert, Linga (west), Linga (east) and Remnant 1. Western Grey Kangaroos are likely to be present at all sites although the Quenda is likely to be patchily distributed in the area in areas of dense understorey such as around wetlands.

Bats rely heavily on old trees that have crevices and hollows to provide shelter. A number of bat species are likely to be present (Table 26) at each site. Other native mammal species, such as the Chuditch and Brush-tailed Possum, also rely on tree hollows for shelter, while the Quenda (Southern Brown Bandicoot) and Moodit (Bush Rat) utilise dense understorey vegetation.

With the exception of the Western Grey Kangaroo, all the native mammals can be considered to be at least of regional conservation significance. The scarcity of information available for some taxa such as bats makes it difficult to be certain of their distribution and the likely impact of development in the region.

Table 26 shows the mammals that were expected and recorded at Keysbrook. Species of conservation significance are indicated in the status column, and species recorded by the WA Museum are indicated by 'WAM'.

Table 26: Mammals Recorded (+) or Expected to Occur on the Keysbrook Project Area

Species		Status	Observed or Recorded
Tachyglossidae (echidnas)			
Echidna	*Tachyglossus aculeatus*		
Dasyuridae (dasyurids)			
Chuditch	*Dasyurus geoffroii*	CS1	WAM
Brush-tailed Phascogale	*Phascogale tapoatafa*	CS2	WAM
Peramelidae (bandicoots)			
Quenda or Southern Brown Bandicoot	*Isoodon obesulus*	CS2	+ WAM
Phalangeridae (possums)			
Brush-tailed Possum	*Trichosurus vulpecula*		WAM
Burramyidae (pygmy possums)			
Western Pygmy Possum	*Cercartetus concinus*		
Tarsipedidae (honey possum)			
Honey Possum	*Tarsipes rostratus*		WAM
Macropodidae (kangaroos and wallabies)			
Western Grey Kangaroo	*Macropus fuliginosus*		
Brush or Black-gloved Wallaby	*Macropus irma*	CS2	
Mollosidae (mastiff bats)			
White-striped Bat	*Tadarida australis*		
Western Freetail Bat	*Mormopterus planiceps*		
Vespertilionidae (vesper bats)			
Gould's Wattled Bat	*Chalinolobus gouldii*		
Chocolate Wattled Bat	*Chalinolobus morio*		
Western False Pipistrelle	*Falsistrellus mackenziei*	CS2	WAM
Southern Forest Bat	*Vespadelus regulus*		
Lesser Long-eared Bat	*Nyctophilus geoffroyi*		
Gould's Long-eared Bat	*Nyctophilus gouldii*		
Greater Long-eared Bat	*Nyctophilus timoriensis*		
Muridae (rats and mice)			
Rakali or Water Rat	*Hydromys chrysogaster*	CS2	
House Mouse	*Mus musculus*	Int.	
Black Rat	*Rattus rattus*	Int.	

Species		Status	Observed or Recorded
Leporidae (rabbits and hares)			
Rabbit	*Oryctolagus cuniculus*	Int.	WAM
Canidae (foxes and dogs)			
European Red Fox	*Vulpes vulpes*	Int.	
Felidae (cats)			
Feral Cat	*Felis catus*	Int.	
No. of mammals observed:			
No. of mammals observed or expected:			

Table 27 shows the mammals that are extinct in the region.

Table 27: Mammals Extinct in the Region

Species		Comments
Dasyuridae (dasyurids)		
Mardo	*Antechinus flavipes*	
Fat-tailed Dunnart	*Sminthopsis crassicaudata*	
Grey-bellied Dunnart	*Sminthopsis griseoventor*	
Phalangeridae (possums)		
Western Ringtail Possum	*Pseudocheirus occidentalis*	
Myrmecobiidae (numbat)		
Numbat	*Myrmecobius fasciatus*	
Potoroidae (potoroos and bettongs)		
Woylie	*Bettongia penicillata*	
Macropodidae (kangaroos and wallabies)		
Tammar Wallaby	*Macropus eugenii*	
Quokka	*Setonix brachyurus*	
Muridae (rats and mice)		
Noodji (Ashy-grey Mouse)	*Pseudomys albocinereus*	
Bush Rat	*Rattus fuscipes*	

Of the mammal species present, six are considered to be of conservation significance. These species are discussed below.

a) Conservation Significance 1

Chuditch (*Dasyurus geoffroii*)
The Chuditch is listed as Vulnerable by the *EPBC Act*, the *Wildlife Conservation Act* and Maxwell *et al.* (1996). The Chuditch is occasionally recorded on the outskirts of Perth, particularly since Fox control has been undertaken in nearby reserves and state forests, but it would likely occur in the project area only as a vagrant.

b) Conservation Significance 2

Brush-tailed Phascogale (*Phascogale tapoatafa*)
The Brush-tailed Phascogale is listed as Priority 3 by CALM and as lower risk (near threatened) by Maxwell *et al.* (1996). Although this species may occur in the larger remnants of woodland such as Mostert, it is unlikely to occur in the region due to the fragmented nature of remnant habitats and the high density of foxes and cats in the region.

Quenda (Southern Brown Bandicoot, *Isoodon obesulus*)
The Quenda is listed as Priority 4 by CALM and as lower risk (near threatened) by Maxwell *et al.* (1996). The Quenda favours areas with dense understorey vegetation, and is particularly associated with wetlands. The characteristic diggings that the Quenda make while foraging were observed at Linga (east), but this species may also be present at Mostert, which is opposite Linga East.

Brush Wallaby (*Macropus irma*)
This wallaby is listed as Priority 4 by CALM and as lower risk (near threatened) by Maxwell *et al.* (1996). This species may be present in areas of woodland with dense understorey such as Mostert. It requires large areas of native vegetation for survival and usually does not survive in extensively fragmented landscapes such as the study area (R.Davis, pers. obs).

Western False Pipistrelle (*Falsistrellus mackenziei*)
This bat is listed as Priority 4 by CALM and as lower risk (near threatened) by Duncan *et al.* (1999). It is known from areas of Jarrah and Tuart on the coastal plain, and has been recorded in the area by the WA Museum (Table 25).

Water Rat (Rakali, *Hydromys chrysogaster*)
The Water Rat is listed as Priority 4 by CALM. Water Rats are unlikely to be present in the region due to the absence of permanent wetlands.

6. RECOMMENDATIONS

The vegetation remnants represent patches of available habitat within a matrix of generally inhospitable cleared areas such as paddocks. There is a great diversity with remnants ranging from high quality Banksia woodlands to open degraded *Eucalyptus* stands with no understorey.

The primary issue for fauna in fragmented agricultural landscapes is connectivity of remnant vegetation. Any reduction in the number of remnants may lead to the reduction in value of the remaining remnants, as the movement of fauna will be impeded. Relatively few species use cleared areas, and those that do usually require areas of native vegetation to supply at least some of their needs. It is recommended that all practical measures be undertaken to ensure that regional connectivity of habitats is maintained.

The Short-billed (Carnaby's) Black-Cockatoo is likely to utilise the remnants for feeding. Given the paucity of remnant vegetation in the area, these remnants are probably important for his species, and any further loss may affect their persistence in the local area. Loss of feeding habitat for Carnaby's Cockatoo is identified as a key threatening process under the *EPBC Act* by DEH. The Forest Red-tailed Black-Cockatoo may similarly utilise remnants in the area for feeding, but additionally this species may breed in suitable nest hollows in the region. The presence of a breeding population of this species should be established prior to any habitat clearing.

In general, a number of species of birds and mammals are dependent upon nest hollows for breeding and shelter and it is recommended that wherever possible, nest hollows be retained.

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PLATES

Plate 1: *Marri* woodland with *Banksia* midstorey and *Xanthorrhoea priesii* understorey. 'Mostert' is rated as 'excellent'

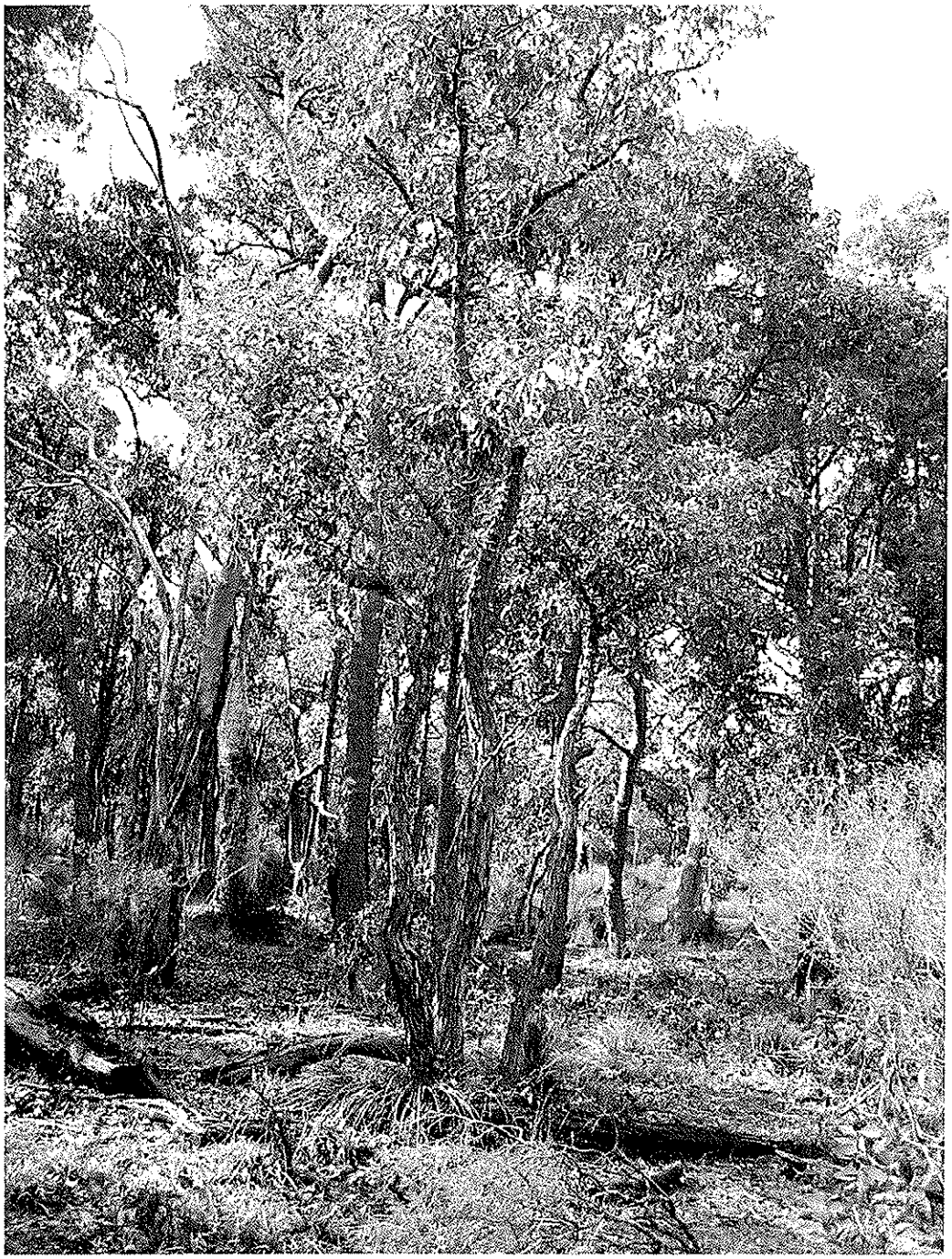


Plate 2: *Marri* woodland with Woody Pear (*Xylomelum occidentale*) midstorey. 'Mostert' is rated as 'excellent'

Plate 3: *Jarrah* stand with no understorey. 'Mostert' rated as 'degraded'

Plate 4: Hollow in *Marri*. 'Mostert'

Plate 5: Seasonal wetland on 'Linga East'. Rated as 'very good'

Plate 6: Quenda diggings on 'Linga East' seasonal wetland area

Plate 7: *Regelia ciliata, Hypocalymma augustifolium* dominated seasonal wetland on 'Linga East'. Rated as 'good'. Weeds include blackberry (foreground)

Plate 8: *Kunzea glabrescens* thicket on 'Linga West'. Rated as 'good'

Plate 9: *Banksia ilicifolia* on the 'Linga West' remnant

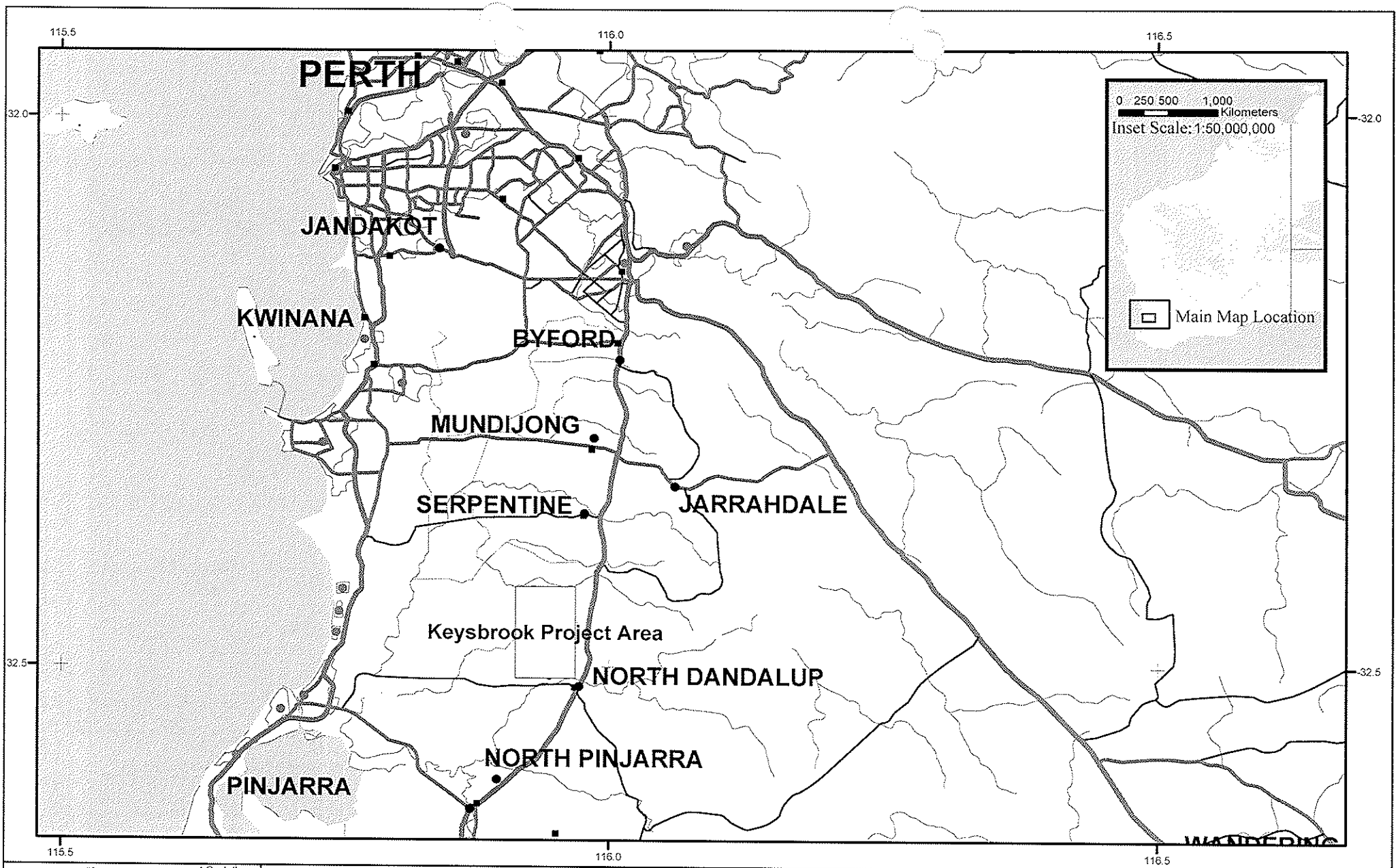
Plate 10: Recently burnt stubble on 'Thorn'. Completely degraded

Plate 11: *Marri* 'parkland' paddock. Rated as 'completely degraded'. Typical of 'Mostert South', 'Princi', 'Delborello' and 'Furfaro'

Plate 12: Cattle grazing remnant vegetation

Plate 13: Fox diggings

FIGURES



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Scale: 1:499,978.019027

0 5 10 20 30 Kilometers

Orig Size: A4 Date:24/11/04 Drawn by M. Duffy

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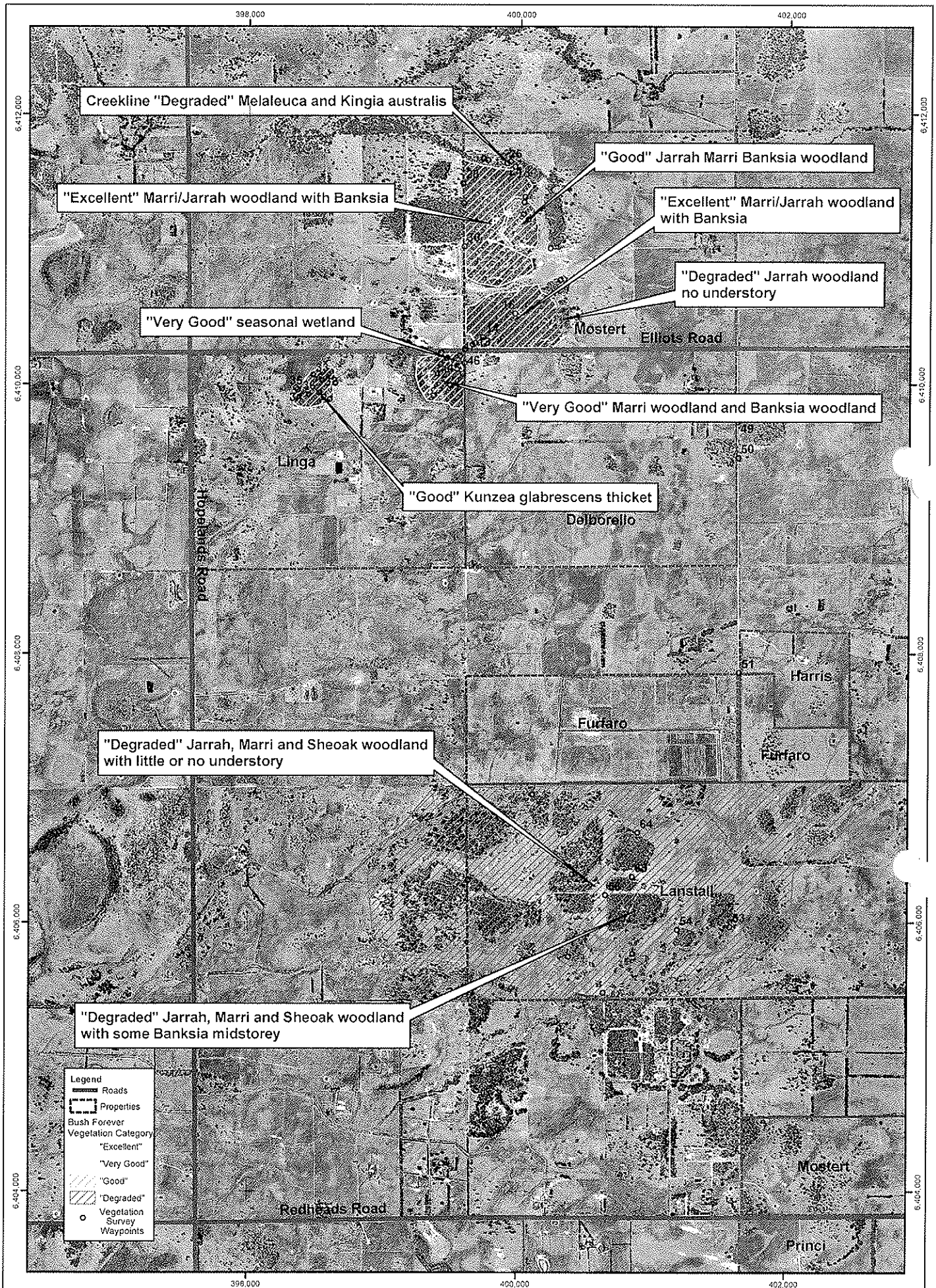
Olympia Resources
Keysbrook Project

Location Plan

Figure 1



MBS Environmental 4 Cook St West Perth WA 6005 Australia Phone: +618 9226 3166 Facsimile: +618 9226 3177 e-mail: info@mattbrick.com.au	Date: 28/10/2004 Original Size: A3 Drawn by: M Duffy Project No: OlyKeys File: keysbrook.mxd	Photo - 2003 aerial photo from DOLA, GDA94 Grid Meters 0 250 500 1,000 1,500 1:25,000	Olympia Resources Keysbrook	Aerial Photograph Figure 2

APPENDICES

APPENDIX 1

Vegetation Mapping Sheets

Date: 19/05/2004

Waypoint	AMG E	AMG N
11	399598	6410257
12	399654	6410294
13	399673	6410304
14	399730	6410346
15	399964	6410522
16	400296	6410772
17	400222	6411005
18	400057	6411219
19	400022	6411258
20	400027	6411345
21	400033	6411387
22	400041	6411554
23	399959	6411611
24	399927	6411649
25	399901	6411638
26	399762	6411658
27	399731	6411671
28	399580	6411487
29	399584	6411338
30	399590	6411019
31	398637	6410006
32	398539	6410028
33	398473	6410068
34	398347	6409972
35	398359	6409958
36	398440	6409922
37	398518	6409935
38	398551	6409906
39	398597	6409886
40	399121	6410234
41	399422	6410232
42	399420	6410146
43	399365	6409915
44	399489	6409996
45	399583	6410078
46	399594	6410155
47	399561	6410209
48	399469	6410194
49	401623	6409721
50	401627	6409455
51	401639	6407861
52	403338	6406303

Waypoint	AMG E	AMG N
53	401583	6405970
54	401188	6405948
55	400860	6405770
56	400654	6406205
57	400403	6406360
58	400106	6406954
59	399636	6406317
60	400040	6405722
61	400378	6405746
62	400639	6405478
63	400854	6406341
64	400892	6406670

Dom species up/storey and condition	Dom species mid/storey and condition	Dom species understorey and condition	Comments eg. grazing, opp.sitings, weeds	Waypoint
Grass	Grazing	Grass	Grass	11
Corymbia calophylla = Dom	*Some Xylomelum occidentale* (took photo)	*Xanthorrhoea preissii* , *Mesomelaena tetragona*	Regen as *Xanthorrhoea preissii* are young. Grazed prob by parrots	12
Banksia grandis with occasional Acacia saligna		*Dryandra lindleyana, Hibbertia hypericoides*	No weeds.	13-14
Banksia attenuata	*Daviesia* sp. 1 (took photo)		Juvenile *Xylomelum occidentale, Dryandra lindleyana*	13-14
Eucalyptus marginata and Corymbia calophylla dom with scattered Allocasuarina fraseriana	*Pericalymma ellipticum*		Occasional dead *Banksia grandis*	14-15
Banksias as above	*Banksia menziesii*		Occasional *Drosera*	14-15
Bare batch of sand, no upper storey - dom by *Xanthorrhoea preissii*			Fox diggings	15
Excluding 15 = 2 (BF) ob up, mid lower		Edges of patch dominated by *Corymbia calophylla* - more *Eucalyptus marginata/Corymbia calophylla* inside	Habitat for birds, some hollows, no weeds, frequently burnt. Some cow poo, fox diggings, maybe a conical bandi digging.	
Eucalyptus marginata patch - no understorey at all	2x RTB at top of Eucalyptus marginata , 5x BF, but good *Eucalyptus marginat* a stand		No aggres weeds	16
As above but not as many dead				17

Dom species up/storey and condition	Dom species mid/storey and condition	Dom species understorey and condition	Comments eg. grazing, opp.sitings, weeds	Waypoint
Same as 13-15, except dominated by *Eucalyptus marginata* with occ *Corymbia calophylla*	*Xanthorrhoea preissii, Xylomelum occidentale, not any banksia*		As move inward to 19 get occ. *Allocasuarina fraseriana., Banksia attenuata, Xylomelum occidentale, Banksia grandis, no Corymbia calophylla*	18
				19
Lots of dead young *Eucalyptus marginata*	*Pericalymma ellipticum, Xanthorrhoea preissii*	*Hibbertia hypericoides*		20
Same as 18			End of patch	21
Less mid and u/storey as come to edge		*Pyrorchis nigricans*	Saw 40 roos on adj. Paddock	22
				23
Corymbia calophylla dom, occasional *Nuytsia floribunda*	Sparse *Xanthorrhoea preissii* (v. juvenile) eaten by parrots	Pasture Grass		24
Melaleuca rhaphiophylla (took photo), occasional *Hakea prostrata* (x1), *Jacksonia* sp. (took pods)	*Kingia australis*	*Juvenile Kingia australis* - heavily grazed, grass pasture weed very open, *Mesomelaena tetragona*	Cond 5 - BF	25
		Juvenile *Xanthorrhoea preissii* , grass	Following creekline. Very open parkland, emergent *Eucalyptus marginata* , *Hakea prostrata* , *Melaleuca lateritia.* Heavily grazed in patches along creek, Nuytsia floribunda	26
				27

Dom species up/storey and condition	Dom species mid/storey and condition	Dom species understorey and condition	Comments eg. grazing, opp.sitings, weeds	Waypoint
			To RHS fence - patches of open with emergent Corymbia calophylla and juvenile Xanthorrhoea preissii lower storey. Grass only as u/storey.	28
Banksia grandis, Allocasuarina fraseriana, Eucalyptus marginata, Corymbia calophylla	*Banksia grandis, Banksia menziesii*	*Xanthorrhoea preissii*	2 - BF. RHS fence. Very good condition	29
			Regen's parrot. RHS fence - 6. Some *Corymbia calophylla* but just paddock underneath	30
Corymbia calophylla , some dead	None	Grass	Grazed by cattle basically a parkland. Some large Corymbia calophylla to 30m possibility of hollows	Mostert South Paddock but not checked
Corymbia calophylla , dominant	None	Grass	Same as above for hollows	Princi (same AMG but LHS road)
Corymbia calophylla, *Melaleuca rhaphiophylla*		Stubble	Recently burnt, cows	Linga (RHS) Elliots Rd
Same as above but not burnt			Top pipe	Linga (LHS)

Dom species up/storey and condition	Dom species mid/storey and condition	Dom species understorey and condition	Comments eg. grazing, opp.sitings, weeds	Waypoint
Banksia ilicifolia with occ. Allocasuarina fraseriana	*Kunzea glabrescens*	Grass and pasture weed (thicket), bubble bea grass, juvenile *Kunzea glabrescens* , lots of litter - not like a parkland grazed		31
Kunzea glabrescens with occ emerg Juvenile Corymbia calophylla and Banksia ilicifolia, Eucalyptus marginata, Nuytsia floribunda, lots of dead Eucalyptus marginatas	Nothing	Little bit of grass, lots of leaf litter	3 - BF, 1x fox	32
				33
				34
Banksia ilicifolia clump, Banksia menziesii	Nothing/occasional *Kunzea glabrescens*	Nothing	Burning grass/pasture weed; heavily grazed	35
				36
Banksia ilicifolia, as above			Birds feeing on ilicifolia	37
				38
				39
Corymbia calophylla occasional Allocasuarina fraseriana	Occasional *Melaleuca rhaphiophylla*	Juvenile Xanthorrhoea preissii, *Eragrostis curvula, Mesomelaena tetragona	Very open, some dead *Corymbia calophylla* . 4 - BF. Too open to be of great value.	40
Corymbia calophylla - Eucalyptus marginata with *Banksia menziesii, Banksia attenuata* occasional *Nuytsia florabunda*	*Regelia ciliata, Hypocalymma angustifolium. Occasional Pericalymma ellipticum, Allocasuarina fraseriana*	Juvenile Xanthorrhoea preissii, Mesomelaena tetragona, Cyathochaeta avenacea, Dryandra lindleyana, Dasypogon bromellifolius, Hibbertia vaginata, hypolaena exsulca, Juncea pallidus	**Leptospermum laevigatum* , blackberry, grazed	41

Dom species up/storey and condition	Dom species mid/storey and condition	Dom species understorey and condition	Comments eg. grazing, opp.sitings, weeds	Waypoint
Banksia menziesii and attenuata dom. Occasional Banksia ilicifolia, dead Eucalyptus marginata, Kunzea glabrescens (2 thickets)		Grass and leaf litter, fallen logs	Good condition, just no understorey. BF: 2-3, grazing	42
Corymbia calophylla - dom. Occasional *Nuytsia florabunda* . Banksia - all	*Regelia ciliata*	*Xanthorrhoea preissii, grass*	End of patch. Very open - parkland	43
				44
			Same as 41 but more Corymbia calophylla. 2x car bodies	45
Melaleuca rhaphiophylla clump				46
Astartea fascicularis; couple emergent *Melaleuca rhaphiophylla, Kingia australis*		*Juncus pallidus* , *Astartea fascicularis* . Weedy really on edges	Squelching frog. Very open patch, no emergence. *Watsonia bulbillifera* along roadside	47
Up the back, *Pyrorchis nigricans* in Banksia	As before in swamp	Occasional *Philothea spicata* , *Acacia stenoptera* , *Drosera* sp.	BF 3. In swamp like area, bandicoot diggings	48
				49
				50
				51
Corymbia calophylla - nothing else			Start, remnant 1. Parkland, grazed	52

Dom species up/storey and condition	Dom species mid/storey and condition	Dom species understorey and condition	Comments eg. grazing, opp.sitings, weeds	Waypoint
Eucalyptus marginata	*Kingia australis, Banksia menziesii, Banksia grandis, Banksia attenuata, Xylomelum occidentale*		BF 5-6. Quite degraded, very little parkland. Nothing amazing. Big fox den.	53
Same as previous				54
				55
Same as previous but more extensive			Remnant 3.	56
Basically same as previous, but more *Corymbia calophylla* . Occasional *Banksia menziesii, Kingia australis, Banksia attenuata, Allocasuarina fraseriana*			Remnant 4. 2x fox.	57
Typically *Corymbia calophylla* dominated. One small *Melaleuca rhaphiophylla* patch. Trees are nice.	No	No	Parkland understorey - grazing. 5-6	58
Corymbia calophylla upland. *Melaleuca rhaphiophylla* adjacent to creek.	Couple of *Kingia australis, Kunzea glabrescens* (occasional)	Grass	Forgot to mark but on map. Parkland, no weeds	R5
Corymbia calophylla, Banksia menziesii, Allocasuarina fraseriana, occasional Melaleuca rhaphiophylla patch	*Xylomelum occidentale*	Grass	Lanstal, R6	59

Dom species up/storey and condition	Dom species mid/storey and condition	Dom species understorey and condition	Comments eg. grazing, opp.sitings, weeds	Waypoint
Kevin Thorn as above however no Banksia menziesii, Corymbia calophylla dom, occasional Allocasuarina fraseriana /Eucalyptus marginata				RHS of 59
Corymbia calophylla dom no banksia	Nothing much else		R7. Parkland, no weeds	60
Dominated by *Allocasuarina fraseriana* . A lot of dead *Corymbia calophylla* and *Eucalyptus marginata* . Occasional *Eucalyptus marginata, Corymbia calophylla*	Occasional *H. prostrata, Kingia australis*		R8. Parkland	61
			To the LHS going east - property we have no access to swamp area similar to mark 41. Will need to gain access for better look at future time. Electric fence.	62
Eucalyptus marginata, Allocasuarina fraseriana, Corymbia calophylla	Occasional Kingia australis Xylomelum occidentale, Banksia menziesii	Grass	Parkland	63
Corymbia calophylla , etc as above	Occasional *Kingia australis*		R10. Lots of birds.	64

Flora Species Occurring on Project Area

Family	Species
Casuarinaceae	
	Allocasuarina fraseriana
Cyperaceae	
	Cyathochaeta avenacea
	Mesomelaena tetragona
Dasypogonaceae	
	Dasypogon bromeliifolius
Dilleniaceae	
	Hibbertia hypericoides
	Hibbertia vaginata
Juncaceae	
	Juncus pallidus
Loranthaceae	
	Nuytsia floribunda
Mimosaceae	
	Acacia saligna
	Acacia stenoptera
Myrtaceae	
	Astartea fascicularis
	Corymbia calophylla
	Eucalyptus marginata
	Hypocalymma angustifolium
	Kunzea glabrescens
	*Leptospermum laevigatum**
	Melaleuca lateritia
	Melaleuca rhaphiophylla
	Pericalymma ellipticum
	Regelia ciliata
Orchidae	
	Pyrorchis nigricans
Papilionaceae	
	Daviesia sp.
Poaceae	
	*Eragrostis curvula**
Proteaceae	
	Banksia grandis
	Banksia ilicifolia
	Banksia menziesii
	Dryandra lindleyana
	Hakea prostrata
	Xylomelum occidentale

Family	Species
Restionaceae	
	Hypolaena exsulca
Rutaceae	
	Philotheca spicata
Xanthorrhoeaceae	
	Xanthorrhoea preissii

* = Alien species

APPENDIX 2

Vegetation Condition Scale

Vegetation Structural Classes (Keighery, B), 1994 (adapted from Muir 1997 and Aplin 1979)

Life Form/Height Class	Canopy Cover (percentage)			
	100 - 70%	70 - 30%	30 - 10%	10 - 2%
Trees over 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland
Trees 10 - 30m	Closed Forest	Open Forest	Woodland	Open Woodland
Trees under 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland
Tree Mallee	Closed Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Shrub Mallee	Closed Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs over 2m	Closed Tall Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 1 - 2m	Closed Heath	Open Heath	Shrubland	Open Shrubland
Shrubs under 1m	Closed Low Heath	Open Low Heath	Low Shrubland	Low Open Shrubland
Grasses	Closed Grassland	Grassland	Open Grassland	Very Open Grassland
Herbs	Closed Herbland	Herbland	Open Herbland	Very Open Herbland
Sedges	Closed Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland

Source: Bush Forever, Table 11

Vegetation Condition Scales commonly used in the Perth Metropolitan Region

Condition scale used in BUSH FOREVER, VOL. 2, from Keighery BJ (1994)	
Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and woods are non-aggressive species.
Very Good (3)	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good (4)	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure of ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded (5)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded (6)	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed outcrop species with isolated native tress or shrubs.

Source: Bush Forever, Table 12

APPENDIX 3

Opportunistic Hollow Data Sheets

	Date: 17/05/2004					
Property	**Species**	**Diameter**	**Height above ground**	**AMG E**	**AMG N**	**Comments**
Mostert	Jarrah old	See comments	Side = 5m above ground	399729	6410345	Old. 4 top spouts @ 7m high (~30-40cm diam.). 1 side hollow (60cm diam.).
	Jarrah dead	<20cm	6m	399751	6410367	Top spout <20cm, bees.
	Jarrah dead	~30-40cm	10m	399772	6410404	~4 top spouts, ~30-40cm
	Large Marri		~20m	399800	6410433	No hollow but nice big tree - possum habitat
	Dead Jarrah	20-30cm		399871	6410441	At least 3 small top spouts, 1 side hoolow colonised by bees.
	Dead Jarrah	20-30cm	~6m	399881	6410440	Top spout
	Dying Jarrahs and dead	10-20cm	Smallish tres x5, 15m	040135	6410598	Top and side
	Alive Jarrah	20cm	30m	400296	6410772	3x hollows: 2x front, 1x side
	Dead Jarrah	30cm	20m	400296	6410772	1x front hollow
	Alive Jarrah	More a split	35m	399987	641285	
	Alive Jarrah	10cm	25m	400041	6411554	Side hollow
	Dead Jarrah	Split in fork	20m	399959	6411611	
	Dead Marri	10cm	10m			Very small things, e.g. pardalotes
Linga	Dead Jarrah		10m	398473	6410068	Bees in side hollow. 1x front, 2x top/side hollow.
	Alive Jarrah	20-30cm	10m	398347	6409972	3 top spouts
	Dead Jarrah	10-20cm	10m	398440	6409922	
	Dead Jarrah	50cm	10m	398551	6409906	
	Dead Jarrah x2	80cm, 20cm	7m	398597	6409886	Very large - cockatoo friendly

Property	Species	Diameter	Height above ground	AMG E	AMG N	Comments
	Dead Jarrah	Can't tell	15m	399489	6409996	2x top pipes
LHS Delberello (but not)	Marri and Allocas			401623	6409721	Parkland cleared under Marri and Allo. Lots of fallen logs.
Delberello	Jarrah - dominant. Occasional Allocas, Marri			401627	6409455	As above.
Harris				401639	6407861	All cleared with maj shelter belts (introduced) grazed, no trees in middle of paddock.
Furfaro	Marri	15cm	10m	400860	6405770	As above without shelter belts. 1x side hollow.

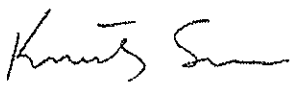
MBS ENVIRONMENTAL REPORT DISTRIBUTION RECORD

REPORT TITLE: VEGETATION AND FAUNA ASSESSMENT OF EXPLORATION LICENCE 70/2407, KEYSBROOK

COPY NUMBER: OLYKEY00

NAME/TITLE	COMPANY	COPY NO.	DATE	AUTHORISED BY
John Baxter Technical Director	Olympia Resources Limited	01	9/12/2004	Kristy Sell
	MBS Environmental	02	9/12/2004	Kristy Sell

APPROVAL SIGNATURE:



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Environmental Protection Authority

EPA Service Unit
Environmental Impact Assessment Division

Level 8 The Atrium 168 St Georges Terrace
Perth Western Australia 6000
Direct phone: (08) 6467 5405
Fax: (08) 6467 5525
Email: Ruwani.Ehelepola@dec.wa.gov.au

TO: Bridget Hyder, A/Manager Terrestrial Ecosystems Branch
Sarah McEvoy, Manager Native Vegetation and Wetlands Branch

FROM: Ruwani Ehelepola, Env Officer, Mining and Industrial Assessments Branch

SUBJECT: **DEC advice on vegetation clearing for the Keysbrook Mineral Sands Mine**

DATE OF REQUEST: 9 January 2008

DATE ADVICE REQUIRED: **15 January 2008**

Background

The EPA released its report and recommendations Bulletin 1269 on the Keysbrook Mineral Sands Mine on 29 October 2007. The proposal is to develop a mineral sands mine on the eastern edge of the Swan Coastal Plain, and requires clearing of up to 182ha of remnant native vegetation and up to 1,184ha of pasture with scattered native trees.

The EPA recommended that the proposal be allowed to proceed, subject to conditions.

Stage in the process

A number of appeals against the EPA report and recommendations were made to the Appeals Convenor. The EPA's response report to the appeals raised is in preparation.

Advice requested

The Mining and Industrial Assessments Branch requires your advice to assist in the preparation of the EPA's appeal report.

Bulletin 1269 is attached to assist you in providing your advice (vegetation is addressed in section 3.1 of the report). Biological survey reports are provided on the attached CD, which include:

- *The value of remnant vegetation in the Keysbrook area to three species of threatened cockatoo* by Wilcox (Nov 05).
- *Additional fauna investigation* by Bamford (Sept 06).
- *Vegetation and flora of exploration licence 70/2407 Keysbrook Western Australia* by Bennett (May 06).

Advice required from Terrestrial Ecosystems Branch:

1. What is the outlook for the vegetation in the proposed mine area over time, if the vegetation was to remain?
2. Recommended condition 7-2 of Bulletin 1269 requires the preparation of an Excised Area Management Plan, which requires the protection and security (in perpetuity) of a consolidated area of vegetation within Lots 59 and/or 62 of the mine area to provide fauna habitat. This area would be fenced to exclude grazing and be managed for flora and fauna conservation purposes. Based on the information currently provided in Bulletin 1269 and the biological survey reports, and DEC's knowledge of the area, what area on Lots 59 and/or 62 would DEC consider to be an appropriate excised area?

   Can you please mark this area on the attached map.

Advice required from the Native Vegetation and Wetlands Branch

1. If the vegetation in the proposed mine area was to remain, could DEC require the landowner to protect the vegetation (e.g. by fencing the vegetation to avoid grazing)?
2. Supposing that an application was made under the Clearing Regulations to clear the vegetation in the proposed mine area (based on the information currently provided in Bulletin 1269 and the biological survey reports, and DEC's knowledge of the area), is it likely that a clearing permit would be issued?

Please note that EPA decision-making is subject to statutory timelines. If you cannot respond within the time provided in this notice, or if you need further information, please contact Ruwani Ehelepola as soon as possible. It is requested that your advice be provided in hard copy with the Branch Manager or Progam Manager's signature.

THANK YOU.

Strategic Policy Division

Draft Internal Memorandum

TO: RUWANI EHELEPOLA

FROM: TERRESTRIAL ECOSYSTEMS BRANCH

CC:

DATE: 15 JANUARY 2008

RE: KEYSBROOK MINERAL SANDS MINE ADVICE FOR APPEAL REPORT

FILE NO:

With regard to the above project you requested advice on the following;

1. **What is the outlook for the vegetation in the proposed mine area over time, if the vegetation was to remain?**

   The vegetation described as in Very Good to Degraded condition is important habitat for regionally significant fauna species including statutory listed threatened species, Priority fauna species listed by DEC, and regionally declining species listed by Government of Western Australia (2000).

   Particularly in this highly cleared landscape, any areas with mature trees and pockets of vegetation maintain significant fauna values for regionally significant fauna, including statutory listed threatened species, Priority fauna species listed by DEC, and regionally declining species including Weebill, Broad-tailed and Yellow-rumped Thornbills, Scarlet Robin, Forest Red-tailed Black Cockatoo, Splendid Fairy-wren, Golden Whistler, Yellow-throated Miner, Black-faced Wood-swallow and Common Bronzewing listed by Government of Western Australia (2000). EPA Guidance 10 states with regard to representation of ecological communities;

   'Remnants in largely undisturbed condition, which retain the highest values, are preferred; remnants with basic vegetation structure and floristics intact (bushland) are the next best alternative. However, in cases where no other choices are available (generally where <30% remains), remnants in lesser condition are included. Areas containing scattered native species, especially a tree canopy, can retain vital roles as fauna habitat and ecological linkage for some species.' (page 45). This would apply to those vegetation complexes within the site that have 30% or less in secure tenure.

2. **Based on the the information currently provided in Bulleting 1269, the biological survey reports and DEC's knowledge of the area, what areas on Lots 59 and /or 62 would DEC consider to be an appropriate excised area?**

   Most of the fauna assemblage in the area includes species that rely exclusively on the remnant native vegetation for all or part of their resource requirements including food

resources, breeding resources, or roosting and shelter resources. Additionally a number of these species are regionally significant fauna including statutory listed threatened species, Priority fauna species listed by DEC, and regionally declining species listed by Government of Western Australia (2000).

The Terrestrial Ecosystem Branch does not support the proposed clearing of any of the vegetation on Lots 62 and 59 (see attached aerial photograph) as they support regionally significant fauna including statutory listed threatened species, Priority fauna species listed by DEC, and regionally declining species listed by Government of Western Australia (2000) known from the area including, but not limited to, the following species: Weebill, Broad-tailed and Yellow-rumped Thornbills, Scarlet Robin, Forest Red-tailed Black Cockatoo, Splendid Fairy-wren, Golden Whistler, Yellow-throated Miner, Black-faced Wood-swallow and Common Bronzewing Pigeon.

In addition no trees suitable as breeding trees for threatened cockatoos should be cleared.

3. Buffer

Expected impacts, including dewatering need to be taken into account with regard to protection and buffering of native vegetation. Any buffer that is applied will need to take into account all expected impacts, and ensure that native vegetation is not impacted either directly or indirectly by these impacts.

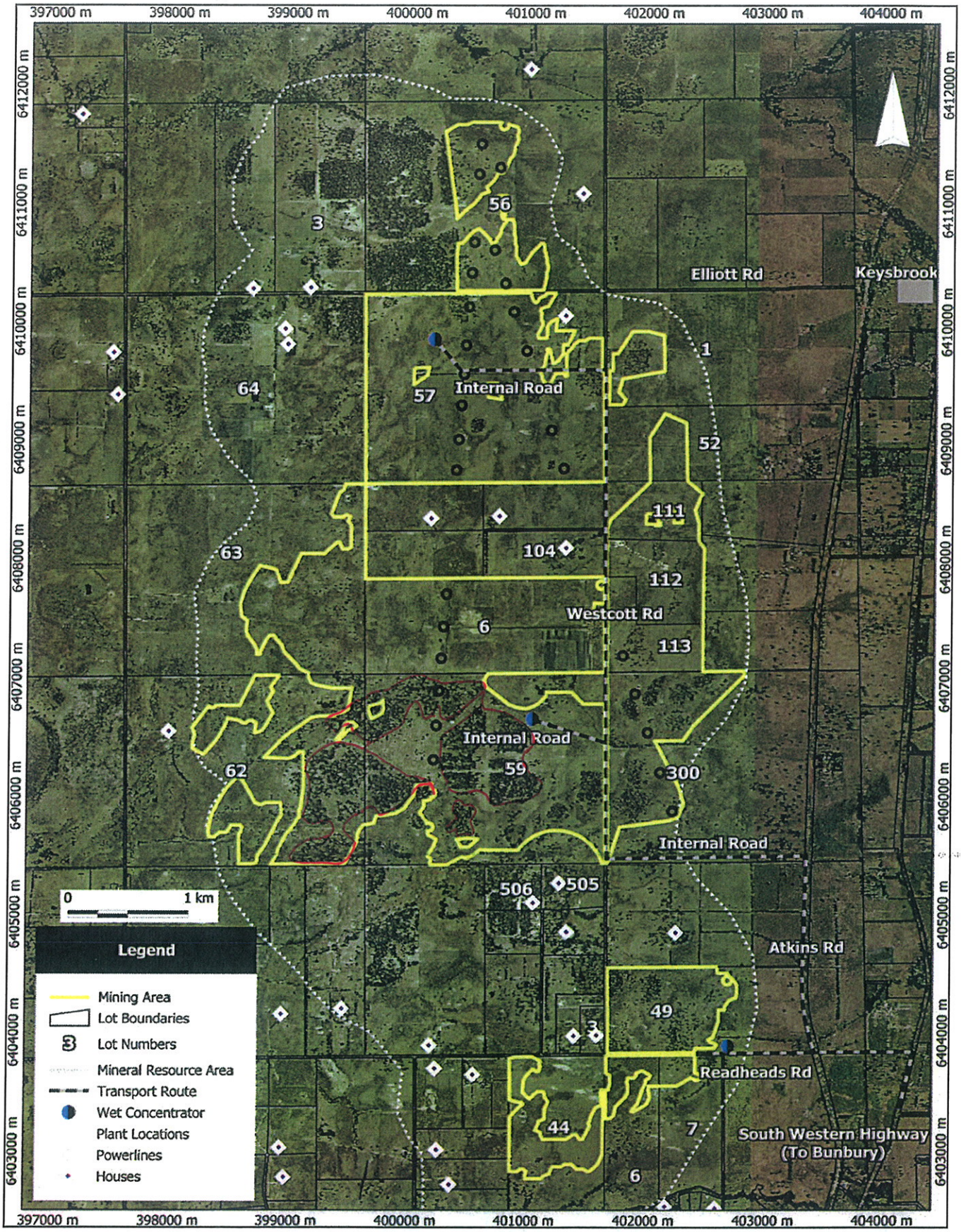

Figure 2: Project area

Mr Peter Gazzard
General Manager
Olympia Resources Limited
Suite 29, Level 4, 25 Walters Drive
HERDSMAN WA 6151

Our Ref: DOC 11011 File No 625/05-05
Enquiries: Ruwani Ehelepola (6467 5405)
Email: ruwani.ehelepola@dec.wa.gov.au

Dear Mr Gazzard

KEYSBROOK MINERAL SANDS MINE – PUBLIC ENVIRONMENTAL REVIEW RESPONSE TO SUBMISSIONS

Thank you for your Public Environmental Review Response to Submissions document, submitted on your behalf by MBS Environmental.

The proponent's responses have not adequately addressed some of the submissions. The inadequacies lie in a lack of justification for the proponent's responses against the technical comments made in the submissions, and apparent omissions of some of the comments made in the submissions.

Please find attached comments on the document from the EPA Service Unit (Attachment 1), Department of Environment and Conservation Air Quality Branch (Attachment 2), Department of Environment and Conservation Land and Water Quality Branch (Attachment 3) and Department of Water (Attachment 4).

I expect that comments provided on the response to submissions document by the various government agencies will be addressed in a revised document, with a letter to highlight where the issues have been addressed in the revised document.

Please telephone Ms Ruwani Ehelepola of the EPA Service Unit, on 6467 5405, if you wish to discuss these matters in greater detail.

Yours sincerely

C J Murray
A/DIRECTOR
ENVIRONMENTAL IMPACT ASSESSMENT DIVISION

22 December 2006

encl

ATTACHMENT 1

EPA SERVICE UNIT

COMMENTS ON THE KEYSBROOK MINERAL SANDS MINE PER RESPONSE TO SUBMISSIONS

1. FIGURES

Section
Table of contents.

Comment
Figures 4, 5, 6, 7, 9, 10, 11 and 12 are absent from the main body of the document. Although some of these figures appear in Appendix 3 under different figure numbers.

2. LOCATION OF KEYSBROOK AND NORTH DANDALUP TOWNSITES

Section
Section 1.1 (Background) p1.

Comments

- Quote: *Keysbrook is located approximately 70 kilometres south of Perth, on the eastern edge of the Swan Coastal Plain (Figures 1 and 2).*

Keysbrook is not identified in Figure 1. Keysbrook and North Dandalup are not identified in Figure 2.

- Quote: *The mine area is 1,234 hectares. Of this, 930 hectares...*

The revised mine area should be included here (i.e. total 1,218ha and 914ha open pasture).

3. DAY TIME MINING

Section
Key characteristics table p8.

Comment
Quote: *Daytime mining only in the southern section of the project closer to residences.*
The Lot numbers where daytime mining only is proposed should be provided.

4. TRANSPORT ROUTE

Section
Key characteristics table p9.

Comment
The change to the transport route (i.e. transport to Bunbury rather than Picton) should be included in the 'Changes to project description' column. Also, Figure 22 of the PER illustrates the proposed transport route, not Figure 19.

5. MANAGEMENT ACTIONS

Section
Section 4 (Revised management actions) p11.

Comment
The revised management actions should be consolidated with the management actions in section 1.6 of the PER, so that there is one complete table with all of the current management actions.

6. REHABILITATION MANAGEMENT PLAN

Section
Section 4.2 (Revised rehabilitation management plan) p11.

Comment
It was expressed at the EPA site visit on 16 October 2006 that a revised Rehabilitation Management Plan should be prepared as part of the assessment process, to ensure the EPA has adequate information to make its recommendations to the Minister. The proponent is encouraged to prepare all management plans during the assessment process, and include recommendations from the various decision-making authorities in these plans.

Further to the advice provided by government agencies regarding appropriate management of environmental issues associated with the proposal, the proponent is encouraged to refer to previous mineral sands mines assessed by the EPA, and approved by the Minister for the Environment for likely environmental conditions and management plans required. These Ministerial Statements can be found on the EPA website www.epa.wa.gov.au.

7. REVISED FAUNA MANAGEMENT PLAN

Section
Section 4.3 (Revised fauna management plan) p12.

Comments

- Quote: *Modification to the southern mine exclusion area to remove degraded portions from the area and include them in the mine area.*

It should be made clearer where the southern mine exclusion area is. It is assumed that this is the area in Lot 56 previously referred to as the 'Environmental exclusion area' in the PER.

- Quote: *The list of further surveys, recommended in Bamford (2006), has been added to those already specified in Section 5 of the Fauna Management Plan.*

The recommended additional fauna surveys should be carried out as part of the assessment process, to ensure the EPA has adequate information to make its recommendations to the Minister.

8. PROJECT TIMING

Section
Section 4 (Revised management actions) p11.

Comment
Different project timing stages have been referred to in this section (i.e. project operations, site construction and mining). It is understood that construction activities (which includes site preparation works as described in section 4.2 of the PER) will occur concurrently with mining activities (which includes vegetation clearing, excavation and processing). As advised in point 6, it is recommended that all management plans be prepared by the proponent and assessed as part of the EPA assessment process.

9. SUB HEADINGS FOR EACH SUBMISSION

Section
Section 5 (Response to submissions) p14-145.

Comment
To assist in reading the document, and referring to various sections in the document, each submission should have a subheading relating to the subject of the submission. For example:
5.1 Flora and vegetation
5.1.1 Subheading for the submission (followed by the response)
5.1.2 Subheading for the next submission (followed by the response)

10. SUBMISSIONS

Section

Section 5 (Response to submissions) p14-145.

Comment

In comparing the points raised in the original submissions to those that appear in the proponent's document, there appears to be a number of issues.

1. Submitters are quoted as expressing an issue in the proponent's document, which do not appear in the original submission.

E.g. Section 5.1.6 p17 – it is unclear where the Community 1 and Community 2 submissions made comment regarding DRFs on Lot 56, which appear in the document.

Section 5.3.2 p48 – it is unclear where the Community 2 submission made comment regarding the quenda population.

The document should be reviewed to ensure that only the comments made by the various submitters appear in the document.

2. Some issues raised in the submissions do not appear to be addressed in the document.

E.g. Community 1 p9 second dot point regarding sound impact diagram not including the residence on Lot 105 has not been addressed in section 5.10.5 as outlined in Appendix 1.

There are a number of topics in Appendix 1 whereby the submission is not included in the response reference section.

The document should be reviewed to ensure that issues raised in the submission are addressed in the document, particularly where Appendix 1 gives reference to the issue being addressed.

11. FENCING OF UNDISTURBED REMNANT AREAS

Section

Section 5.1.2 (Flora and vegetation) p15 and 5.1.12 (Flora and vegetation).

Comment

Quote: *The proponent will include fencing of undisturbed remnant areas in discussion with landowners.*

The proponent's response to issues relating to impacts on native vegetation and potential for protection of remaining areas, places significant emphasis on the fact that the subject land is currently privately owned, and that negotiations with the land owners may affect the degree to which native vegetation on these properties can be actively managed for conservation in the long-term. The response does not reflect the obligation that the proponent should accept for designing and implementing the project in a way that avoids a long-term net loss to conservation values (for example by including evidence of discussion with the landholders and agreed outcomes regarding fencing of undisturbed remnant areas, or providing financial or other incentives to landowners for fencing and exclusion of grazing stock).

12. TRANSPLANTING

Section

Section 5.1.14 (Flora and vegetation) p20 and Section 5.2.9 (Rehabilitation) p35.

Comment

- Quote: *Transplanting of Xanthorrhoea and Kingia sp. is advocated in the Rehabilitation Management Plan and will be undertaken.*

Where will these plants be located to? What investigations has the proponent undertaken to ensure that these plants will survive once translocated?

- The response to submission 5.2.9 does not address propagation potential of the species or the likely success of translocating the plants.

13. DEWATERING DURING SUMMER

Section

Section 5.1.15 (Flora and vegetation) p22.

Comment

- Quote: *During summer, as the water table is naturally at this level, there will be no need for dewatering.*

This statement is not consistent with other statements in the document (refer to pages 74, 87, 91 and 103) that there may be some dewatering during summer.

- Quote: *It is expected that most native vegetation obtain their water supply from root systems within the Guildford and upper Leederville formations, not the superficial Bassendean sands which dry out over summer.*

This statement should be supported by field or scientific information.

14. LONG-TERM STOCKPILING OF TOPSOIL

Section
Section 5.2.2 (Rehabilitation) p32.

Comment
Further information is required as to why the topsoil stockpile will be long-term, particularly when rehabilitation is to be progressive, immediately following mining.

15. DEPARTMENT OF AGICULTURE AND FOOD ADVICE ON WEEDS

✓ v. straight forward

Section
Section 5.2.6 (Rehabilitation) p33.

Comment
Quote: *The VMP Section 6 states "Advice on the most effective control means for weed species may be sought from DoA..."*
Advice from the Department of Agriculture and Food on weed control should be sought during the assessment process.

16. REVEGETATION

Section
Section 5.2.8 (Rehabilitation) p34.

Comment
Quote: *The proponent's objective for the native species rehabilitation areas is to obtain landowner support for a plan that provides for rehabilitation and for long term stock exclusion from these areas.*
The objectives for the proposal need to be achievable. What will be the outcome if landowners do not support the proponent's objective for rehabilitation? Support from the landowners should be attained as part of the assessment process.

17. REVISED REHABILITATION MANAGEMENT PLAN AND REVEGETATION LIST

Sections
Section 5.2.10 and 5.2.12 (Rehabilitation) p36-p37.

Comment
Quote: *The revised Rehabilitation Management Plan includes a greater diversity of species for rehabilitation.*
Quote: *The revised Rehabilitation Management Plan has incorporated comments made...*
These statements imply that the Plan has already been prepared, but section 4.2 says that the Plan has not yet been prepared.
Further, the proponent's response to the request to identify the source of native seed used in rehabilitation is not considered adequate. The source of native seed to be used in the rehabilitation has not been identified. There is a paucity of areas capable of producing the

quantity of local provenance seed required to establish the native vegetation the proponent is committing to. The seed collecting process can have adverse impacts on native vegetation if not managed appropriately and any seed sourced should be from within agreed areas.

18. WETLAND MAPPING

Section
Section 5.2.18 (Rehabilitation) p37.

Comment
The response has not addressed the issue about the lack of on-ground mapping of wetlands. Appendix 1 states that this issue has been addressed in sections 5.2.18 and 5.15.2, but responses to this issue do not appear in these sections.

19. REHABILITATION BOND

Section
Section 5.2.29 (Rehabilitation) p44.

Comment
The proponent's response to comments that the PER does not define or set out the size of any rehabilitation bonds is not considered adequate. As the project is not on land the subject of a mining lease, and therefore rehabilitation bonds set by DoIR do not apply to this project, bank guaranteed performance bonds may be appropriate in this case to achieve rehabilitation outcomes acceptable to the public if required. This is consistent with the EPA assessment of the Iluka Resources Mineral Sands Mine in Gingin (Bulletin No. 1146) and subsequent Ministerial Statement No. 666.

20. RELOCATING TREE HOLLOWS

Sections
Section 5.1.10 (Flora and vegetation) p20 and 5.2.22 (Rehabilitation) p41.

Comment
Quote: *Relocating suitable hollows will minimise any potential loss of nest sites as a result of implementing the project.*
The proponent needs to demonstrate that relocated hollows in landscapes are effectively used by cockatoos. Figures on the number of relocated hollows in other sites and the number successfully used by cockatoos need to be presented.

& logistics of it

21. FAUNA HABITAT

Section
Section 5.3.1 (Fauna) p46-47.

Comment

- Quote: *The fauna of the project area is depauperate due to extensive clearing, fragmentation and degradation of native vegetation.*

The significance of the larger patches of remnant vegetation and the linkage roles of these together with smaller patches and scattered trees is understated in the document. While it is recognised that the majority of the proposed mine area is "depauperate due to extensive clearing" the regional significance of the vegetation remnants is understated for both statutory protected species and species listed in Bush Forever as regionally significant because of declines on the Coastal Plain.

accurately state significance

- Quote: *The excision of an additional 5.55 hectares of good condition remnant vegetation in the north of Lot 56.*

The proponent's efforts to excise good condition remnant vegetation are acknowledged. However, the size of remnants required for the assemblage of bird species in this area is not recognised. The size of remnant required to support populations, and the area requirements of breeding units of these species (which generally require areas of several hectares for each breeding unit) are not considered.

The response outlines the proposed changes to the mine plan that are intended to reduce or minimise the impact on regionally significant fauna habitat. However the revised table of key characteristics indicates that the area of native vegetation in good condition to be cleared will remain the same. Furthermore, the 'Environmental exclusion area' identified in Figure 4 of the PER (southern section of Lot 56) is less in Figure 3 of the Response to Submissions document. Therefore the total area excised from mining appears to be the same.

- Quote: *The proponent considers the progressive clearing and rehabilitation during the eight year mine life will allow sufficient time, especially for the understorey species in the rehabilitated areas, to establish to a level to provide habitat for these species to recolonise mined areas.*

Information is required to support this statement. Which species are being referred to here? What are the recolonisation sources? Not all of the regionally significant species occurring in this and other remnants are understorey dependent species, some are canopy dependent species requiring upperstorey canopies of considerable age.

- In response to the DEC submission indicating that offsets may be considered to mitigate impacts to fauna habitat, the proponent does not appear to have addressed this issue and in the absence of clear information to substantiate the view that there will not be a net loss of habitat in the proposal area, the response is not considered adequate. The proponent's position in relation to the provision of offsets for loss of native vegetation (effectively fauna habitat) is provided elsewhere in the response (indicating a view that offsets are not warranted) but the justification for this position in relation to fauna habitat is unclear.

22. FAUNA

Section
Section 5.3.8 (Fauna) p51.

Comment
Quote: *The proponent disagrees that the PER does not present faunal information over the mine area.*
The response fails to recognise that all areas of remnant vegetation containing regionally significant species are thus regionally significant. The response is to the submission that the PER does not present detailed information on each of the remnants in the proposed mine area. This information is necessary to assess the significance of each remnant.

23. FAUNA RECOLONISATION

Section
Section 5.3.9 (Fauna) p51.

Comment
Quote: *There are numerous scientific papers on the subject of faunal recolonisation of rehabilitated areas after mining...*
While this is true, no consideration is made that this is generally referring to recolonisation of restored areas within larger population reservoir areas and that removing small remnants in generally cleared landscapes leads to local extinctions as has been demonstrated by widespread literature on Coastal Plain remnants that lack many species because of inability to recolonise after local extinctions.

24. ECOLOGICAL LINKAGES

Section
Section 5.3.11 (Fauna) p53.

Comment
The role of larger remnants in the area to sustain resident populations of sedentary, habitat specialist, dietary specialist species is not adequately recognised. The role of smaller remnants in facilitating dispersal, particularly of offspring is not considered at all. Accordingly the role of ecological linkages is poorly understood and not adequately addressed.

25. COCKATOO SURVEYS

Oct → Banding.

Oct - Nov RTBC

Jul - mid Oct Carnabys inland semi-arid

Section
Section 5.3.20 (Fauna) p57.

Comment
Quote: *The proponent does not consider that the surveys conducted have been inadequate and carried out at the incorrect time of the year.*
The proponent is advised that the Forest Red-tailed Black Cockatoo and Baudin's Black Cockatoo only breed every second year. Therefore for surveys to be comprehensive they should be conducted over two breeding years.

26. KANGAROOS

Section
Section 5.3.22 (Fauna) p57.

Comment
Information regarding the kangaroo population in the area, and the home ranges of the kangaroos should be provided to determine the relocation behaviour of the kangaroos during clearing and validate the proponent's statement that kangaroos are highly mobile and can relocate to undisturbed areas.

27. WATER SUPPLIES TO SURROUNDING USERS

Section
Section 5.4.5 (Groundwater) p69.

Comment
Quote: *Olympia will provide substitute water supplies at locations where existing supplies are significantly reduced as a result of mining/dewatering.*
Where will this substitute water be sourced from? The levels at which a significant reduction in surrounding bore water levels has been achieved needs to be determined as part of the assessment process.

28. WATER QUALITY FROM HMC STOCKPILE

Section
Section 5.6.5 (Nutrients and salinity) p97.

Comment
The response has not addressed the issue in the submission about the lack of information on the quality of the water draining from the HMC stockpile.

29. PROXIMITY OF RESIDENCES

Section
Section 5.9.2 (Emissions and dust) p110.

Comment
Quote: *The low residential density and relatively large individual rural landholdings within the project area also mean that there are a low number of sensitive premises in close proximity to operational areas.*
This statement does not reflect that there are a number of residences within 300 metres of mining areas.

30. RADIATION MANAGEMENT PLAN

Section
Section 5.11.1 (Radiation) p120.

Comment
It is preferred to have the Radiation Management Plan prepared as part of the assessment process. If this is not possible, then an outline of the procedures to ensure radiation exposure is minimised should be provided.

31. MONAZITE INVESTIGATIONS

Section
Section 5.11.2 (Radiation) p121.

Comment
An overview of the results of the search for monazite in the mineral assays from the exploration drill holes in the proposal area should be provided.

32. HEALTH IMPACTS ON RESIDENTS

Section
Section 5.9.6 (Emissions and dust) p114.

Comment
In addition to consultation, the response should outline specific measures the proponent will undertake to minimise and manage impacts from air emissions on residents.

33. ABORIGINAL HERITAGE

Section
Section 5.13.8 (Social impact) p126.

Comment
An overview of the outcomes of the on-ground surveys and consultation should be provided.

34. COMMUNITY CONCERNS

Section
Section 5.13.30 (Social impact) p134.

Comment
The response has not adequately addressed the submission. For example, concerns and questions raised at a community meeting were not addressed.

35. INCREASE IN TRUCK MOVEMENTS

Section
Section 5.14.5 (Transport) p141.

Comment
The proponent should seek advice from Main Roads as to whether the extra truck movements required for the proposal will create a significant impact on the existing roads and road users.

36. PRESENTATION

The proponent should consider that the document will be available to the public, and should be of a high standard in content and presentation. There are a number of typographical and grammatical errors in the document that should be corrected in the revised version. Some of these errors are listed below.

Section / Comment

- Table of contents / There are a large number of acronyms in the document. To assist the readers, it would be useful to have a page with all of the acronyms used in the document.
- Section 1.1 (Background) p1 / The public review period was from **26 June 2006** to 21 August 2006.
- Section 1.2 (Key issues and concerns raised in submissions) and 1.3 (Other issues raised) p2 / **Loss of visual amenity** appears in sections 1.2 and 1.3.
- Section 1.5 (Structure of this document) p3 / It should be made clear that the Rockwater Report in Appendix 3 also provides responses to groundwater issues arising from submissions on the PER.
- Section 4.5 (Noise management plan) p12 / The Plan should be prepared in consultation with the DEC **Noise Section**, not the LWQB.
- Section 5.1.6 (Flora and vegetation) p17 / Paragraph 4 regarding the KNAG submission does not make sense.
- Section 5.1.11 (Flora and vegetation) p20 / CC Submission "...higher quality **than** asserted by the proponent..."
- Section 5.1.17 (Flora and vegetation) p24 / Paragraph 1 – What is KNAG **22**?
- Section 5.1.17 (Flora and vegetation) p24 / Paragraph 3 – "The Community 1 submission raised a number **of** similar points..."
- Section 5.1.17 (Flora and vegetation) p24 / Paragraph 5 – "... the mine area has been modified to exclude **an** additional area in the northern portion of lot 56."
- Section 5.1.28 (Flora and vegetation) p28 / "Government funded and local Landcare programs – revegetation efforts will be desecrated." Should be re-written in a proper sentence.
- Section 5.2.8 (Rehabilitation) p35 / "In addition, it is recognised that **tree** shelter areas..."
- Section 5.2.10 (Rehabilitation) p35 / "Values lost through clearing mature revegetation are not re-gained with no net loss by revegetating an equivalent area." Comment was made by the **Peel Harvey Catchment Council**, not KNAG.
- Section 5.2.12 (Rehabilitation) p36 / 3rd last paragraph – "The PHCC, SJS and SJLC submissions raised concern that a reduction in remnant **vegetation** will reduce the..."
- Section 5.8.1 (Dieback) p106 / "The Community 1, Community 60, Community 65 and KNAG submissions state specific action on dieback management issues **is required**."
- Section 5.9.6 (Emissions and dust) p114 / "Anonymous 1 and Community 60 are concerned that dust contamination will end up in the only source of drinking water, **the** rain tank."
- Section 5.11.1, 5.11.4 and 5.11.5 (Radiation) p120-122 / Radiation Council should be **Radiological** Council.
- Section 5.11.1 and 5.11.3 (Radiation) p120-121 / Reference to processing at Picton should be changed to **Bunbury**.
- Section 5.14.5 (Transport) p141 / "It is not **considered that** the 12 – 14 extra vehicle movements will create any additional significant impact."
- Section 5.13.32 (Social impact) p134 / "Mineral concentrations **vary** widely between ore deposits."

ATTACHMENT 2

DEPARTMENT OF ENVIRONMENT AND CONSERVATION AIR QUALITY BRANCH COMMENTS ON THE KEYSBROOK MINERAL SANDS MINE PER RESPONSE TO SUBMISSIONS

1. The proponent's plan to undertake monitoring over seven days per month is inadequate. Given the location of sensitive receptors, there should be daily monitoring during the construction period and for the initial stages of mine operation. Standard continuous monitoring methods should be used in proximity to sensitive receptors. Portable continuous monitors may be useful as part of site management to give real-time indication of dust levels, however, there are limitations associated with portable monitoring systems that the proponent would need to be aware of. These limitations include reductions in efficiency in areas with high wind speeds.

2. A monitoring plan should detail the monitoring methods, dates and locations. In addition to monitoring during the construction and operation of the sand mine, the proponent should consider an initial period of monitoring to obtain estimates of background particle levels. In the absence of representative background data, DEC would take a conservative line in assessment of elevated particles measured during operation.

3. If dust levels regularly exceed the NEPM PM_{10} standard in areas where people live, then monitoring of PM_{10} levels should be ongoing. If initial intensive monitoring during mine operation indicates low levels of dust, then it may be possible to reduce monitoring requirements.

4. Dust management plan
   - The plan should include an adaptive dust management system that can respond to factors such as: monitored dust levels, observations of dust coming from the development, or community complaints. Specific actions should be developed to respond to increased emissions from different sources.
   - The plan notes that an alarm will sound when the wind speed reaches a threshold of 45 km/h, but does not specify what actions will be taken in response.
   - The plan should include a process to evaluate the success (or otherwise) of dust management strategies.

5. Modelling
   - The proponent has stated that the Department's guidelines are primarily applicable to point source emissions; this interpretation is incorrect. The guidelines are also applicable to fugitive dust from point, area, volume and line sources.
   - It is possible to estimate fugitive dust emissions and a number of techniques are available for producing estimates suitable for use in modelling.
   - It is the responsibility of the proponent to estimate fugitive emissions and provide evidence that verify their claims of emissions being insignificant.
   - It is understood that the distance between the proposal and sensitive receptors is approximately 300 metres. The recommended separation distance given in the EPA Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* for sand mining operations ranges from 1000m to 5000m. Further, the Guidance states that:

     "Where the separation distance is ***less*** *than the generic distance, a scientific study based on site- and industry-specific information must be presented to demonstrate that a lesser distance will not result in unacceptable impacts."*

- There has been no scientific study as required above. The proponent should undertake modelling of particle emissions from the development to better assess potential impacts. There is a large degree of uncertainty associated with modelling of fugitive dust emissions, however, it can provide indications of the general features of particle dispersion and can be a useful guide in assessment of the air quality impacts of this type of development. Modelling is also useful in the assessment of the relative effect of different dust management regimes. It is essential that modelling be validated by a comprehensive monitoring programme.

The proponent is encouraged to engage a suitably qualified consultant to carry out appropriate air quality modelling and monitoring to identify potential impacts from air emissions as a result of the proposal.

The Air Quality Branch of the DEC is also available to provide further advice to the proponent.

ATTACHMENT 3

DEPARTMENT OF ENVIRONMENT AND CONSERVATION LAND & WATER QUALITY BRANCH COMMENTS ON THE KEYSBROOK MINERAL SANDS MINE PER RESPONSE TO SUBMISSIONS

1. Both sampling occasions were targeted to low lying areas which are associated with high risk of acid sulfate soil occurrence. The sampling results revealed low sulfidic acidity with the exception of an area at 8H:1, which is outside the mining lease. The larger proportion of the mining area is categorised as medium to low risk. If mineral sand mining is restricted to within the 2.0m below ground surface and no dewatering is undertaken, then the risk is considered low.

2. However there are areas within the mining lease where wet excavation and dewatering are expected. For such areas it is recommended that further soil investigation be undertaken to quantify the acidity risk.

3. The regional groundwater in the area is already showing elevated iron concentration (3-19 mg/L) at Lake Thompson site in the vicinity of the proposed mining area. Our experience in the Swan Coastal Plain e.g. Ellen Brook and Baldivis has revealed that abstracted groundwater enriched with iron and aluminium has caused progressive groundwater acidification due to the oxidation and hydrolysis of iron. This can impact areas some distance away from the site.

4. A critical issue for this proposal is the management of groundwater drawdown from soil dewatering. Groundwater drawdown should be managed to avoid adverse environmental impact from acidification within and outside the mining area. LWQB recommends strategic wells be located to monitor groundwater levels and quality. Attached is a copy of the *Dewatering Effluent and Groundwater Monitoring Guidance (June 2006)* for further clarification of our requirements.

5. Another factor to be considered is the treatment and disposal of the wastewater from the washing plant. The proponent should prepare a Dewatering and Wastewater Management Plan that addresses water quality trigger and contingency measures.

ATTACHMENT 4

DEPARTMENT OF WATER
COMMENTS ON THE KEYSBROOK MINERAL SANDS MINE PER RESPONSE TO SUBMISSIONS

Reference 5.4.7 regarding processing water requirements:
The proponent has stated the total water requirement.

Reference 5.4.8 regarding numerical modelling, Reference 5.4.9, 5.4.2, 5.4.5 regarding the concerns that dewatering from the superficial and the pumping from the Leederville may impact on local bores.
DoW did not state that the modelling was accepted. DoW commented that it was an "approximation" of the local hydrogeology. In this case, an "approximation" does not adequately assess the level of risk to surrounding users.

DoW commented that the parameters were "accepted as representative of the aquifer units on a regional scale". Parameters on a regional scale are not appropriate for a model on a local scale for this particular situation. There is a very high level of local concern about potential impacts on surrounding users, the environment and the aquifers.

The proponent should conduct investigation work to determine the hydrogeologic parameters on a local scale. The parameters can then be applied to the local scale numerical model. The investigation should also quantify the potential drawdown impacts on surrounding users as a result of the proposed mining operation.

These investigations are likely to include the drilling of production bores, monitoring bores and test pumping. This level of investigation is consistent with the draft DoW policy on the preparation of hydrogeologic reports associated with a groundwater well license. The policy takes into consideration the volume of water proposed for extraction, the potential impacts on the other users, the environment and the aquifer. In the case of the Keysbrook mine, the third and highest level of hydrogeologic reporting would be required. The "H3" level of investigation requires an investigation drilling program and numerical modelling.

DoW will need to review any modelling the proponent uses for the assessment of this project. A full report on the modelling should be submitted for review. The modelling should be developed in accordance with the Murray Darling Basin Modelling Guidelines (Murray Darling Basin Commission, 2000). It may be necessary to obtain a copy of the digital model files for further review.

The request for investigation drilling and testing is not only for the development of local scale hydrogeologic parameters, but also to measure potential impact on surrounding land users, the environment and the aquifers.

Reference 5.4.9 regarding concerns to surrounding users and how the proponent will address the impacts.
The proponent's response is inadequate. It refers to a monitoring program that will be implemented after production commences. This implies that impacts on surrounding users will be dealt with after the fact. The proponent should determine the level of impact on surrounding users. The proponent should refer to the comments on this issue provided in the Department's submission on the PER.

Reference 5.4.3 regarding the impact to EPP wetlands and the modelled simulation of the results.

The investigation drilling proposed above will provide a better estimate of potential impact on the surrounding ecosystems.

Reference 5.4.10 concerns about upward flow from the Leederville.
DoW accepts the response that there will be no upward flow from the Leederville to the Superficial.

Reference 5.4.2 regarding the concern that the operation may reduce recharge to the Leederville aquifer.
The proponent should provide a zone budget for the layers representing the Bassendean Sand and the Leederville aquifer to determine if the volume of vertical flow downward is reduced as a result of the mining operation. This can easily be achieved with numerical modelling.

Reference 5.4.5 regarding the risk assessment of bores that may be impacted.
The proponent acknowledges that "watering points" in the superficial will be affected by dewatering. At this time, neither DoW nor the proponent knows if there may be any watering points in the superficial. This needs to be resolved and DoW considers that, consistent with previous advice, the area should be surveyed, and the risks to bores that may be in the superficial aquifer and which may be at risk assessed.

It is not uncommon to find bores previously thought to be in the superficial to actually be completed in the Leederville. The proponent comments that the Bassendean Sand is approximately 1 to 2 metres in thickness (Drawing 4-A11-2) and that the thickness of the underlying Guildford Clay is about 8 metres (5.4.2). As the top of the Leederville is at depths of 9 to 10 metres, there is the possibility that local domestic bores supposedly completed in the superficial are actually completed in the Leederville. The proponent needs to identify all bores in the area that could be impacted, not just the ones on the DoW licensing database.

It is insufficient to state that if there are any impacts to local bores that the proponent will "provide substitute water supplies at locations where existing supplies are significantly reduced as a result of mining/dewatering". The impacts should be defined in advance of the commencement of mining operation, not after the fact. This can best be facilitated through a drilling and pump testing program. Refer to comments made in the Department's submission on the PER.

Section 5.15.2 (Wetlands) p142
Quote: *In response to submissions the proponent has increased all buffers to the Conservation Category wetlands to a minimum of 50 metres.*
The proponent's efforts to increase the buffer distance between the mining area and the wetlands are acknowledged. However, 50m is the minimum buffer requirement and should be based on site specific biophysical criteria. The proponent has not conducted any site specific groundwater monitoring, or determined the environmental water requirements of these wetlands. Furthermore, the proponent has stated that the potential impact on the wetlands will only result in a minimal reduction of peak groundwater levels. This statement was based on modelling of the potential groundwater impacts from dewatering. However, no on-site monitoring of groundwater levels was conducted and no evaluation of the wetlands has occurred. It is not considered appropriate to model the potential impact of dewatering on a wetland that has no site-specific data and no information on the water requirements of the wetlands.

Consistent with previous advice made in submissions, it is recommended that the environmental water requirements and conservation values of all Resource Enhancement and Conservation Category Wetlands are determined. The determination of the wetland's water requirements will indicate if the dewatering of these wetlands is acceptable without detrimental impact to the wetlands, and will also proscribe an appropriate buffer to protect the wetlands from detrimental impact.

From: DELL John
Sent: Tuesday, 19 December 2006 2:16 PM
To: EHELEPOLA Ruwani
Subject: FW: Keysbrook Response to PER submissions

Hi Ruwani
Below are my comments on section 5.3 in the submissions responses document.

The significance of the larger patches of remnant vegetation and the linkage roles of these together with smaller patches and scattered trees is understated in the document. While it is recognized that the majority of the proposed mine area is "depauperate due to extensive clearing" (page 47) the regional significance of the vegetation remnants is understated for both statutary protected species and species listed in BUsh Forever as regionally significant because of declines on the Coastal Plain. The proposal to excise a "additional area of 5.55 hectares of good condition remnant vegetation in the north of Lot 56" does not recognize the size of remnants required for the assemblage of bird species in this area. No consideration is made of the size of remnant required to support populations and no consideration is made of the area requirements of breeding units of these species which generally require areas of several hectares for each breeding unit.

What evidence is there for the statement that "the proponent considers the progressive clearing and rehabilitation during the eight year mine life will allow sufficient time, especially for the understorey species in the rehabilitated areas, to establish to a level to provide habitat for these species to recolonise mined areas." Which species are being referred to here? and what are the recolonization sources? Not all of the regionally significant species occurring in this and other remnants are understorey dependent speces, some are canopy dependent species requiring upperstorey canopies of considerable age.

The response fails to recognize that all areas of remnant vegetation containing regionally significant species are thus regionally significant. The response (page 51) that "The proponent disagrees that the PER does not present faunal information over the mine area" is responding to the submission that the PER does not present detailed information on each of the remnants in the proposed mine area. This information is necessary to assess the significance of each remnant.

Section 9 refers to "numerous scientific papers on the subject of faunal recolonisation of rehabilitated areas after mining". While this is true, no consideration is made that this is generally referring to recolonization of restored areas within larger population reservoir areas and that removing small remnants in generally cleared landscapes leads to local extinctions as has been demonstrated by widespread literature on Coastal Plain remnants that lack many species because of inability to recolonize after local extinctions.

The role of larger remnants in the area to sustain resident populations of sedentary, habitat specialist, dietary specialist species is not adequately recognized. The role of smaller remnants in facilitating dispersal particularly of offspring is not considered at all. Accordingly the role of ecological linkages is poorly understood and not adequately addressed.

Also see comments below.

From: EHELEPOLA Ruwani
Sent: Tuesday, 19 December 2006 9:57 AM
To: DELL John
Subject: RE: Keysbrook Response to PER submissions

Hi John

Just wondering if you have any comments on the response to submissions document?

In particular, can you please confirm the following responses made by the proponent:

1. Paragraph 1 p41 "Relocating suitable hollows will minimise any potential loss of nest sites as a result of implementing the project."
Will the cockatoos use relocated hollows?
Use of relocated hollows is very problematic. The proponent needs to demonstrate that relocated hollows in landscapes are effectively used by cockatoos. Figures on the number of relocated hollows in other sites and the number successfully used by cockatoos need to be presented.

2. Paragraph 4 p57 "The proponent does not consider that the surveys conducted have been inadequate and carried out at the incorrect time of the year."
A number of community submissions considered that the cockatoo surveys were not done in the correct season. Can you please advise on the adequacy of the proponent's cockatoo surveys.
Considering that the Forest Red-tailed Black and Baudin's Cockatoo only breed every second year comprehensive surveys should have been conducted over two breeding years.

3. Last paragraph p57 "As the active mine area is only a very small proportion of the total mine area at any one time, it is considered there will be sufficient undisturbed area for kangaroos to relocate."
A number of community submissions were concerned at the impact on kangaroos in the area. Can you please advise whether there is sufficient areas for the kangaroos to relocate.
Not enough information is available on the kangaroo population in the area or the home ranges of indiiduals to determine relocation behaviour of kangaroos during clearing.
Thanks
Ruwani

From: EHELEPOLA Ruwani
Sent: Friday, 1 December 2006 1:01 PM
To: DELL John; COFFEY Daniel
Subject: Keysbrook Response to PER submissions

Dear John and Daniel

Olympia has submitted its response to submissions document (attached).

John - It would be great if you could review the responses in section 5.3 (Fauna).
Daniel - Could you please review the responses, particularly in sections 5.1 (Flora and vegetation) and 5.2 (Rehabilitation).

I would appreciate it if you could provide me with any comments on adequacy of responses by 14 Dec 2006.

Regards
Ruwani

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ECOLOGICAL SYSTEMS BRANCH
(TERRESTRIAL SECTION)
Memorandum

ATTENTION:	RUWANI EHELEPOLA
FROM:	JOHN DELL
DATE:	21 AUGUST 2006
SUBJECT:	OLYMPIA RESOURCES KEYSBROOK MINERAL SANDS PROJECT PER – Comments on fauna values
FILE NO.:	

Note: This advice only covers fauna issues

This PER does not provide adequate information to enable the interested public to reasonably evaluate the likely impacts of this proposal on faunal biodiversity values. Moreover it makes technically incorrect and invalid statements that significantly understate the biodiversity values of the project area.

On 5 October 2005 Terrestrial Ecosystems Branch provided advice that the level of proposed assessment in the Draft Scoping document was not adequate for a PER to provide an assessment of the fauna values of the area. On 2 May 2006 further advice was provided that many of the issues raised in the advice of 5 October 2005 had not been addressed and the information and level of survey provided in the draft PER was not adequate to assess fauna values of the project area. As fauna values had not been adequately addressed it was advised that the draft PER was not suitable for public review.

Despite this advice the draft PER was released for public review as a final PER.

The PER dated June 2006 has not adequately addressed fauna values in the project area and the level of survey is significantly below the level expected according to EPA Guidance 56.

Advice provided on 2 May 2006 summarized levels of survey required to meet expectations of Guidance 56, viz.:

> "Specifically, the fauna assessment needs to provide an inventory of vertebrate fauna species occurring in the study area, based on actual survey of remnants in the project area, as well as assessment of appropriate literature records. The regional and local conservation value of the area for Conservation significant species occurring or likely to occur within the project area, including *Environment Protection and Biodiversity Act 1999* listed species, Scheduled Fauna (as listed under the WA *Wildlife Conservation Act 1950*) and CALM Priority fauna, and birds listed in Table 15 by Government of Western Australia (2000) as having special conservation significance on the Swan Coastal Plain as they are either habitat specialists with a reduced distribution on the Swan Coastal Plain or they are wide-ranging species with reduced populations on the Swan Coastal Plain needs to be determined.
>
> The fauna survey scope and intensity needs to be in accordance with the Environmental Protection Authority's (EPA) Guidance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia. The regional conservation value for fauna of all natural areas affected by the proposal also requires reference to the Criteria in Guidance 10.
>
> Based on the location and the scale of the project, EPA Position Statement 3 and Guidance Statement No. 56 would require that a Level 2 Detailed survey be undertaken.

The purpose of a Detailed Survey is to enhance the level of knowledge at a local scale, and requires:
"One or more visit/s in each season appropriate to the bioregion and the faunal group being surveyed. Generally maximum survey will be the season that follows the season of maximum rainfall but there will be need to time surveys according to seasonal activity patterns of some faunal groups.)"

The current PER proposes to undertake additional surveys "during June 2006". The results of these surveys have not been provided and accordingly it is not possible to adequately assess the fauna values of the project area.

Page 7 of the Executive Summary in the PER states that the "majority of the area to be mined (95%) has been either totally or parkland cleared for agricultural purposes, with the remaining native vegetation areas highly fragmented." This statement grossly understates the importance of faunal habitats in the project area as was revealed through a single brief site visit on 25 July 2006 when two areas with significant habitat were visited. The value of other areas was not determined as access to other areas had not been organized prior to the visit.

During the visit a large area of contiguous or near contiguous habitat comprising a dense canopy of Jarrah (*Eucalyptus marginata*), Marri (*Corymbia calophylla*), *Banksia attenuata, B. menziesii*, and *Allocasuarina fraseriana* was examined on Lot 56 and in a relatively short period of time at least 8 bird species listed as significant on the Coastal Plain (Bush Forever Table 15) were recorded. Another remnant with similar canopy species was visited on Lot 59 and at least 4 regionally significant bird species were recorded.

The significance of the remaining vegetation in the proposal area as fauna habitat reflects the density and diversity of plant species in the canopy, the range of upland and lowland (including wetland) environments represented and the close proximity of a series of patches of remnant bushland/vegetation that are ecologically linked, and contrast with the surrounding more extensively cleared environments.

The PER presents no fauna information on these or similar areas, and does not recognize their value for fauna especially regionally significant declining bird species. A survey of the faunal values of these areas needs to be undertaken as part of the PER to determine their regional significance. Areas determined as regionally significant habitat should be removed from areas proposed for mining.

Additionally a number of unsubstantiated statements have been made without supporting data or data sources: e.g. comments that recolonisation of fauna will occur when areas cleared for mining are rehabilitated. This ignores the inability of many poorly dispersing fauna species to recolonise areas once they are locally exterminated by clearing and habitat isolation.

From the limited site inspection in July 2006 and the limited information presented in the PER, it is clearly apparent that habitats present in the project area are far more significant than the PER states. Collectively the remnant bushland in the northern areas on Lots 3 and 56 comprise close to 100 ha of mature vegetation that has been unburnt for many years and represents excellent habitat for at least 8 habitat sensitive bird species (including Weebill, Broad-tailed and Yellow-rumped Thornbills, Scarlet Robin, Forest Red-tailed Black Cockatoo, Splendid Fairy-wren, Golden Whistler and Common Bronzewing) listed as significant on the Coastal Plain (Bush Forever Table 15).

now 11 id.

The remnants on Lots 62 and 59 together with the adjoining vegetation on Lots 505, 506, 507 etc that will not be mined comprise further habitat of similar size, although more fragmented, and appears to contain reasonable ecological linkage for habitat sensitive bird species.
These areas are relatively large isolated representations of Bassendean dune sands and associated upland and wetland vegetation surrounded by the heavier Pinjarra Plain soils more typical of the eastern side of the Swan Coastal Plain that have been very extensively cleared. It represents collectively one of the larger areas of mature vegetation and associated fauna habitat remaining on the eastern side of the Swan Coastal Plain south of Perth and for this reason retains greater fauna significance than might be expected. From a single short duration of only a few hours site visit to only some of the remnants the following significant bird species were observed: Weebill, Broad-tailed and Yellow-rumped Thornbills, Scarlet Robin, Forest Red-tailed Black Cockatoo, Splendid Fairy-wren, Golden Whistler, Yellow-throated Miner, Black-faced Wood-swallow and Common Bronzewing These are mainly sedentary habitat specialist species, indicating that they have maintained populations despite decades of isolation through extensive clearing of the surrounding areas for agriculture etc.

The following specific comments are made on the PER.
Note: Many of the technical errors in the PER are based on similar errors in Appendix 5 Vegetation and Fauna Assessment (MBS Environmental 2004) which has not been updated as part of the current PER.

Executive Summary page 8. This section grossly understates the regional significance of faunal habitat in the project area. Additionally there are technical errors. Some statements in regard to Priority fauna species are incorrect. The Forest Red-tailed Black Cockatoo is a Schedule 1 listed species not a Priority species, the Quenda is given an incorrect Priority status (it is given correct status in Table 24 but incorrect on page 94 and page 133). The Forest Red-tailed Black Cockatoo is described as "potential presence" and then as "directly observed".

Executive Summary Table 1 page 12. A statement is made that there are no established corridor linkages within the mine area. No criteria are provided to define corridor linkages. For many species not only does the project area contain significant habitat remnants for regionally significant species but numerous dispersal features including remnants of various sizes as well as scattered or clumped trees in paddocks. All of these facilitate movement for a range of species.

Executive Summary Table 2 page 24. The PER proposes targeting areas for further survey as part of the Fauna Management Plan. This should be provided as part of the PER assessment of the faunal values of the project area.

Page 91. The section on Regional Surveys and Information is extremely limited. The only comments made are in reference to mammals which typically for this region are largely absent. Reptiles, amphibians, birds, and invertebrates are not discussed at all.

Table 24 page 92, and page 94. Incorrect status for Forest Red-tailed Black Cockatoo.

Page 94. It is incorrect to state that Conservation Significant (CS3) species are only of local significance. Most of them are of regional significance on the Swan Coastal Plain. It is not true that most reptiles could be found anywhere in the project area. Most would be found in particular habitat remnants.

Page 95. No list is provided of the 40 bird species of conservation significance; Table does not include that number. Yellow-throated Miner in Table 25 should be denoted as conservation significant.

Page 96. There is confusion regarding potential presence and observed directly. The same species are given both categories.

Page 97. Some statements on cockatoos are incorrect. Recent studies show that Forest Red-tailed Black Cockatoo breeds frequently on the southern part of the Swan Coastal Plain in the region of the project area.

Page 129. The statement that "clearing for the project is temporary" is a misstatement. Clearing habitat of mature trees that are hundreds of years old and planting young trees cannot be described as temporary. The statement that "The site was not included in the BushPlan-Bush Forever process as worthy of conservation" is misleading. Much privately owned land in the region was not accessible to the Bush Forever process and accordingly the conservation values were not known.

Additional errors in Appendix 5 not referred to in comments on the PER above.
Page 27. *lunulata* is misspelt.
Page 28. White-breasted Sea-Eagle is not expected to occur in the project area and should be deleted.
Page 31. Grey Currawong is placed in the wrong Family.
Page 33 Western Grey Kangaroo was recorded in several sites but on page 34 (Table 26) it is not included as recorded
Page 35 (Table 27). The Mardo and Grey-bellied Dunnart are incorrectly listed as "extinct in the region". These species should be transferred to species "recorded or expected to occur in the region" in Table 26 on Page 34.

HYDER Bridget

From: DELL John
Sent: Tuesday, 13 February 2007 3:00 PM
To: HYDER Bridget
Subject: FW: Meeting with Olympia Resources regarding Keysbrook
Attachments: Ltr to Olympia re response to submissions 22.12.06.doc

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From: EHELEPOLA Ruwani
Sent: Tuesday, 30 January 2007 11:40 AM
To: DELL John
Subject: Meeting with Olympia Resources regarding Keysbrook

Hi John

Olympia Resources would like to have a meeting to discuss some of the points raised on the proponent's response to submissions document (EPASU letter attached).

In particular, they are seeking further clarification on the following points from Attachment 1:

- Item 11, 13, 15, 16, 18, 20, 21, 22, 23, 24, 25, 26

It would be good if you could attend this meeting to discuss the points relating to fauna.
Please let me know of your availability to attend a meeting this week.

Regards
Ruwani

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HYDER Bridget

From: EHELEPOLA Ruwani
Sent: Friday, 9 February 2007 12:44 PM
To: HYDER Bridget
Subject: Meeting with Olympia Resources regarding Keysbrook
Attachments: Ltr to Olympia re response to submissions 22.12.06.doc

Hi Bridget

I have attached the EPASU letter on the proponent's response to submissions document. The proponent, Olympia Resources, wants to meet to seek further clarification on the following points from Attachment 1 of the EPASU letter:

- Item 11, 13, 15, 16, 18, 20, 21, 22, 23, 24, 25, 26

Can I book you in tentatively for Tues 20.2.07 from 10-11am. I need to confirm that Ray Claudius can also attend.
Proponent reps attending are: Roley Carroll (Mining Manager, Olympia), Sandra Jamieson (Public Relations Manager, Olympia) and Paul Rokich (MBS Environmental).

Regards
Ruwani

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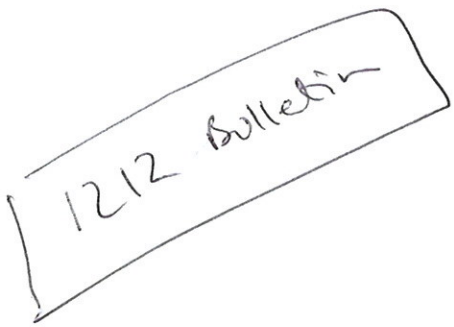

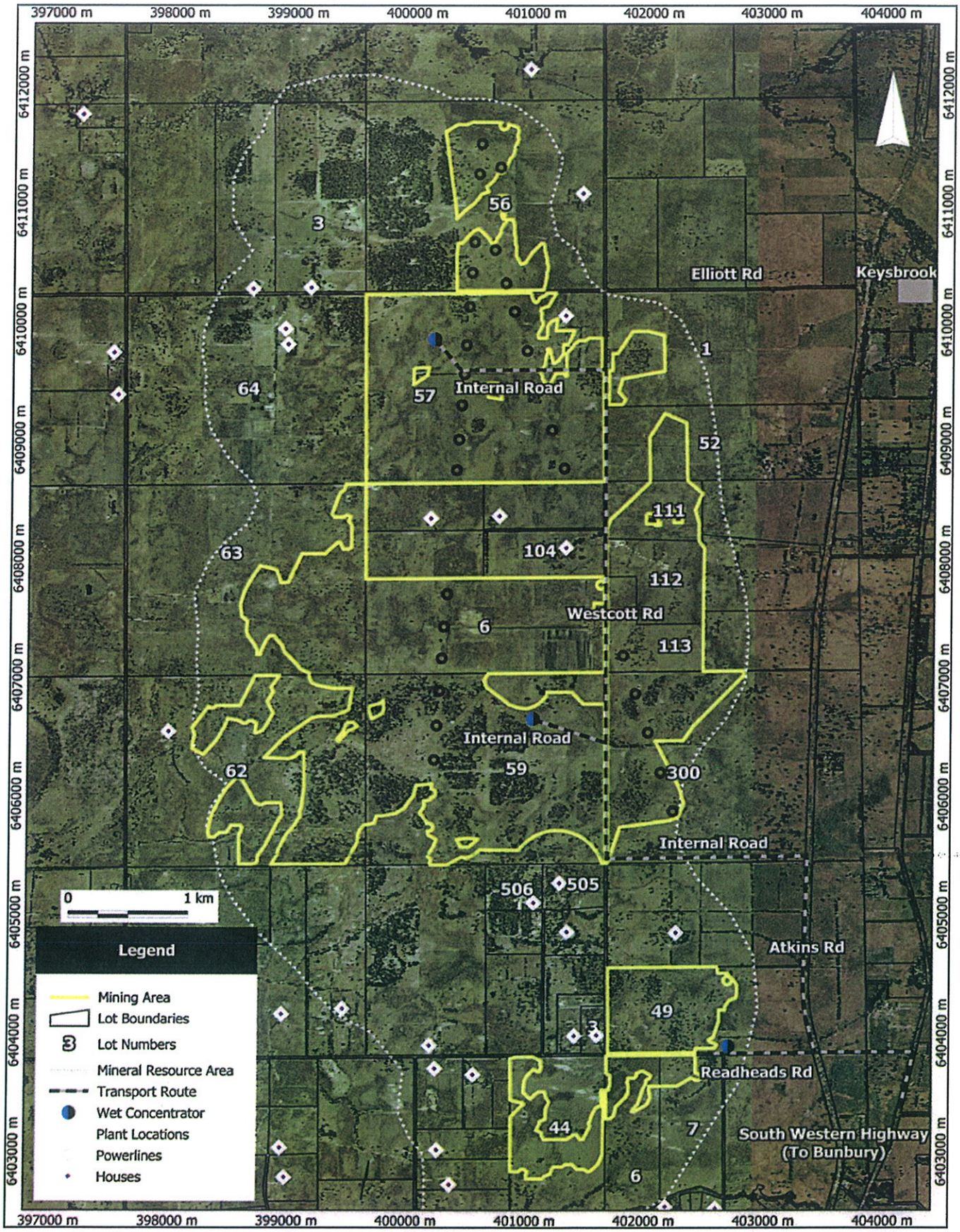

Figure 2: Project area