

Tutunup South Mineral Sands Project

Public Environmental Review

ILUKA-TR-T15787

EPA Assessment No. 1660

April 2008

ILUKA

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INVITATION

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal. The environmental impact assessment process is designed to be transparent and accountable, and includes specific points for public involvement, including opportunities for public review of environmental review documents. In releasing this document for public comment, the EPA advises that no decisions have been made to allow this proposal to be implemented.

Iluka Resources Limited proposes to develop a mineral sands mine, located approximately 15 km south east of Busselton. The mine will include the construction of mine pits, solar drying dams, ore concentrator and associated mine infrastructure. The life of the project is expected to be approximately five to six years.

In accordance with the *Environment*al Protection Act 1986, a Public Environmental Review (PER) has been prepared which describes this proposal and its likely effects on the environment. The PER is available for a **public review period of 4 weeks from Thursday 24 April 2008, closing on Thursday 22 May 2008**.

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

Where to get copies of this document

Printed copies of this document may be obtained from **Iluka Resources reception, Level 23, 140 St Georges Terrace, Perth WA 6000, (08) 9360 4700** at a cost of **$10**.

Copies may also be obtained from www.iluka.com

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach. It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Electronic submissions will be acknowledged electronically. The proponent will be required to provide adequate responses to points raised in submissions. In preparing its assessment report for the Minister for the Environment, the EPA will consider the information in submissions, the proponent's responses and other relevant information. Submissions will be treated as public documents unless provided and received in confidence, subject to the requirements of the Freedom of Information Act, and may be quoted in full or in part in each report.

Why not join a group?

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

Developing a submission

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

When making comments on specific proposals in the PER:

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

Points to keep in mind

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

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

Remember to include:

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

The closing date for submissions is: **Thursday 22 May 2008**

The EPA prefers submissions to be made electronically using one of the following:
- the submission form on the EPA's website: www.epa.wa.gov.au/submissions.asp; or
- by email to submissions.eia@dec.wa.gov.au;

Alternatively submissions can be:
- posted to: Chairman, Environmental Protection Authority, Locked Bag 33, CLOISTERS SQUARE WA 6850, Attention: (I-Lyn Loo); or
- delivered to the Environmental Protection Authority, Level 4, The Atrium, 168 St Georges Terrace, Perth, Attention: (I-Lyn Loo); or
- faxed to (08) 6467 5562.

If you have any questions on how to make a submission, please ring the EPA assessment officer, I-Lyn Loo on 6467 6467 5439.

EXECUTIVE SUMMARY

Iluka Resources Limited ("Iluka") (the Proponent) proposes to establish a mineral sands mine located approximately 195 kilometres south of Perth and 15 km southeast of Busselton (Figure 1). The project is part of Iluka's ongoing South West Operations and will replace operations at Wagerup which are scheduled to conclude in 2009. Development of the Tutunup South mineral sands mine will provide longevity to Iluka's South West operations with resulting economic benefits that flow through to the State and community from mineral sands mining.

Project Description and Schedule

The project is currently scheduled to commence operations in early 2009. The actual date is dependent on internal planning processes and the timely receipt of environmental and other approvals. Pre-production will commence up to six months prior to operations and include topsoil stripping, overburden removal, installation of drainage, preparation of haul roads and construction of infrastructure. The current mineable reserve is approximately 10.4 million tonnes with an average grade of 11.0% heavy mineral. Construction and the majority of heavy equipment operations will be restricted to day shift between 7 am and 7 pm, Monday to Saturday. The ore will be mined progressively from several pits using dry mining techniques. Dewatering of groundwater inflows into the pit will be required to enable dry mining to occur. The mining direction is scheduled from north to south, requiring diversion of the Vasse Highway which bisects the orebody.

Processing of ore at Tutunup South will be conducted 24 hours a day, seven days a week with the use of one scraper to transport ore to the hopper. The site will require the establishment of an in-pit hopper, screenplant, concentrator, workshops, fuel storage areas, solar drying dams, a process water dam and ancillary infrastructure including offices and pipelines. Much of key infrastructure will be re-used from Iluka's Wagerup site. Ore will be screened and processed through the on-site concentrator at an anticipated throughput of 200 tonnes per hour (rougher head feed) to produce over 1,200,000 tonnes of heavy mineral concentrate ("HMC") over the life of the project. HMC will be transported to Capel for further processing.

Process water supply demands will be preferentially met by surface water run-off and mine dewatering. It is proposed that additional water will be sourced from a Yarragadee production bore. The volume of extracted waters will be within the existing allocation of Iluka's Yarragadee Aquifer Water Abstraction Licence.

The Tutunup South mine will be staffed by approximately 40 Iluka personnel and contractors. The mine will also be supported by Iluka's existing South West operations. The project is expected to have a life of 5-6 years. The key characteristics of the proposal are outlined in the following table.

Characteristic	Description
Life of Mine (Mine Production)	5-6 years
Mineable Reserve	10.4 million tonnes
Area of Disturbance	230 ha
Vegetation Disturbance	31.6 ha
Hours of Operation	24 hours a day, 7 days a week
Processing Equipment	Mining Unit & Concentrator
Anticipated Throughput Rate	200 tonnes per hour
Heavy Mineral Concentrate Production	1,200,000 tonnes over the life of the project
Water Supply Sources	Superficial/Leederville aquifers – 1,040 ML per year
	Yarragadee – 1,500 ML per year
Heavy Mineral Concentrate Transport to Capel	24 completed trips (48 total movements) per day

Existing Environment

The project area includes mining tenements M70/611, M70/612, M70/1261 and E70\2699. Much of the project area has been cleared for agricultural purposes. The area does however contain two “multiple use” wetlands, isolated trees and some areas of native vegetation. Land tenure over the project area includes freehold land, State Forest, a Gravel Reserve, vacant crown land and the Vasse Highway Road Reserve. There are six freehold landowners within the project area. Iluka is in the process of establishing access agreements to mine on these properties.

The project area is situated at the foot of the Whicher Scarp on the Abba Plain. Five soil profiles have been defined over the area, which are influenced by marine deposition and subsequent transportation of soils from decay of the Whicher Scarp. Potential Acid Sulfate Soils (PASS) exist in the ore zone and west of the pit.

Flora surveys conducted over an area that extends beyond the project (survey area) have located 399 taxa, including 10 priority flora and 14 significant flora species. A WA Herbarium record indicates the presence of the Declared Rare Flora *Dryandra nivea* subsp. *uglinosa*, north of the disturbance area. However, despite searching this location, no Declared Rare Flora was found within the survey area. The declared plants (agricultural weeds) Arum Lily and Cape Tulip occur within the survey area.

Thirteen vegetation communities (including pine plantation) have been defined with most being in the State Forest adjacent to the southeast boundary of the project area. Each area of vegetation has been classified according to the Bush Forever condition rating system. One community (C2) has a very low level of similarity with the Threatened Ecological Community (TEC) SCP 03a, although it is located well outside of the disturbance area. Communities S1 and S2 have low levels of similarity to the TEC SCP 02. A small degraded area of S2 community exists within the disturbance area. None of the S1 community will be disturbed. On the agricultural land are two vegetated areas of multiple use wetlands dominated by *Melaleuca* spp. and classified as community M1. The M1 vegetation community has similarities to SCP 09. The wetlands have been disturbed by agricultural practices and fire but retain some conservation value. The wetlands are isolated from State Forest by cleared agricultural land.

Fauna studies conducted over the proposed disturbance area and its surrounds have recorded 110 native vertebrate fauna species, comprised of 69 bird, 13 mammal, 21 reptile, five amphibian and fish species. Of these, six species are of significance under Commonwealth and/or State legislation. A further nine species of significance may also potentially utilise the survey area as part of their range. A study of short range endemic fauna found no rare species. A survey of aquatic fauna in 2005 found 98 invertebrate species at the two wetlands and a creek south of the disturbance area. Four species of the macroinvertebrate species sampled were considered to be 'rare' (species new to science or not previously recorded in Western Australia). A follow up survey in 2007 found two more 'rare' species, however studies of other south west wetlands since the 2005 survey also located four of the 'rare' species located at Tutunup South and nine other 'rare' species. The conservation significance of these macroinvertebrates is difficult to determine as they are poorly studied. Consequently, studies recording such 'rare' taxa are not uncommon.

Carnaby's and Baudin's Cockatoo, which are classified as Endangered and Vulnerable respectively under the *Environment Protection and Biodiversity Conservation Act 1999,* were recorded during fauna surveys. Iluka has referred the project to the Commonwealth Department of the Environment, Water, Heritage and the Arts, who have subsequently advised the project will be assessed as a controlled action through the State/Commonwealth bilateral agreement process.

The project area lies within the catchments of both the Sabina and Abba Rivers, with the site drainage reporting to the Sabina River, which is then diverted into the Vasse Diversion Drain. Surface water quality is typically fresh to brackish and acidic.

Mining activities are expected to intercept the superficial and Yoganup aquifers, with the upper parts of the Leederville Aquifer present at the base of the pits. There are 21 active bores located within 1 km of the project of which most are expected to be intercepting the superficial aquifer for livestock, irrigation and domestic use. The Yarragadee Aquifer is a minimum of 50 m below the proposed mining zone. Iluka has installed a production bore into this aquifer as a secondary water source when dewatering and surface water runoff is insufficient to meet processing requirements.

One Aboriginal heritage scar tree site has been identified within the disturbance area and will be avoided by the project. A search of the Department of Indigenous Affairs' Aboriginal Heritage Register has identified one ethnographic site comprising the Abba River. This site is located north of the project area and therefore will not be impacted. No European heritage locations have been recorded on the Register of National Estate, Heritage Council of Western Australia or Shire of Busselton inventories, though McGibbon Track is known to exist in the area.

Environmental Factors and Management

Iluka has an environmental health and safety management system (EHSMS) in place to provide effective EHS management and continuous improvement in performance at all its mineral sands operations.

A number of environmental factors applicable to the Tutunup South project were identified during the Scoping Study, which was approved by the Environmental Protection Authority (EPA) on 9 May 2007. The key environmental factors are briefly outlined below. Table A summarises all of the environmental factors identified during preparation of this public environmental review and addressed in the body of the document.

Vegetation, Fauna and Rehabilitation

Development of Tutunup South will disturb approximately 230 ha of land of which 25.6 ha is native vegetation for which community and condition could be assessed and 6 ha is isolated trees in agricultural paddocks. The groundwater dependence of vegetation communities and risk of being affected by dewatering has been determined. An additional 11.5 ha of vegetation may be affected by the dewatering impacts.

Most of the disturbance is on cleared agricultural land with three priority flora, *Gratiola pedunculata* (P2), *Aotus cordifolia* (P3), and *Loxocarya magna* (P3) and three significant flora, *Callistemon glaucus*, *Corymbia haematoxylon* and *Taxandria fragrans* expected to be impacted by mining. With the exception of *G. pedunculata*, these taxa should be readily established in rehabilitation. Further clarification of regeneration strategies for *G. pedunculata* will be sought from relevant botanical experts. No priority species were determined to be groundwater dependent and therefore are unlikely to be impacted by groundwater drawdown.

Vegetation community C2 that has very low level similarities with TEC SCP 03a will not be disturbed by mining. Community S1 has low level similarities to TEC SCP 02 but will not be disturbed by mining.

0.8 ha of the degraded S2 community that has low similarities to TEC SCP 02 will be directly impacted by clearing. 0.9 ha of S2 community has a low - moderate risk and 1.1 ha of S2 community has a high risk of groundwater drawdown impacts. A moderate to high risk is shown by a measurable change in the demographics of some species. A high risk is shown by overstorey or understorey decline and/or loss of species. Of the 7 ha of S2 vegetation community surveyed, 11.5 % will be cleared and 28.5 % has potential drawdown impacts. This community is known from other areas on the Swan Coastal Plain.

The northern wetland (4.4 ha of vegetation community M1) is within the orezone and will be cleared during mining. Another 2.5 ha of M1 on the Vasse Highway road reserve will be cleared. 5 ha of M1 vegetation in the southern wetland has a high risk of groundwater drawdown impacts. This is expected to result in overstorey or understorey decline and/or loss of species and possibly complete drying out of wetland basin or reduction in period of inundation. In addition, 3.5 ha of M1 on the

Ludlow-Hithergreen road has a moderate to high risk of groundwater drawdown impacts. Of the 17.3 ha of M1 vegetation community surveyed, 40 % will be cleared and 49.5 % has potential drawdown impacts. This community is well represented on the Swan Coastal Plain.

15 ha of vegetation community E2 will be cleared. This community is well represented in the adjacent State Forest. 2.9 ha of vegetation to be cleared is disturbed vegetation which was not assigned a vegetation community and there is approximately 6 ha of isolated trees in agricultural paddocks.

Wetland habitat survey sites TUT05 (within vegetation community M1 in the northern wetland) and TUT02 (within vegetation community S2) had the highest numbers of fauna species and highest numbers of individuals, however numbers of species and individuals found were still considered to be low (Biota, 2007b). TUT05 is within the disturbance area and currently isolated from the State Forest, however TUT02 is outside and upstream of the disturbance area, within State Forest. In recognition of this, Iluka plans to conduct trapping and relocation of fauna in the northern wetland prior to the commencement of clearing.

The State Forest areas cleared for mining and the northern wetland will be rehabilitated to native vegetation targeting rehabilitation communities present prior to mining. Any areas impacted by groundwater dewatering will be in-fill planted following mining.

In addition to Carnaby's and Baudin's Cockatoos being present, the Forest Red-tailed Black Cockatoo has also been recorded during fauna surveys at Tutunup South. Targeted cockatoo surveying for nesting hollows, feeding, and roosting sites has identified three possible hollows that are likely to be disturbed, with a further five hollows that will not be disturbed. In addition to disturbance to three nesting hollows, numerous feeding trees will also be disturbed. A large roosting site exists along the southeast boundary of the project but will not be disturbed by mining. Efforts will be made to recover the identified hollows during clearing for use in either the post mining landscape or surrounding vegetation.

Other fauna impacts may include the potential for fauna displacement from the boundary of the State Forest due to disturbance from mining and increased potential for vehicle mortalities for susceptible species reflecting the increased traffic associated with the project.

Considering the impacts expected from development of Tutunup South, Iluka will provide for improvements to the flora and fauna at Tutunup South as identified by the following mitigation sequence:

1. Avoid – the economic value of the contained mineral located within the areas of native vegetation is considerable in the context of the project; these areas are integral to the overall project economics. The edge of the pit has been altered to avoid clearing of the southern area of wetland vegetation and to avoid disturbance to two of the possible black cockatoo nest hollows within

the Gravel Reserve. In total, Iluka will not disturb five of the eight possible black cockatoo nest hollows.

2. Minimise – impacts have been minimised by locating infrastructure and stockpiles outside areas of native vegetation. Further monitoring of cockatoo usage is being undertaken to identify the black cockatoo's behaviour/status (use of feeding and nesting hollows) in the area.

3. Rectify – areas of native vegetation will be rehabilitated to native vegetation following mining. Some of the areas to be cleared are in poor condition and improvements will be made to vegetated areas by controlling weeds, introducing understorey and excluding grazing. To replace the three potential hollows removed during mining, it is proposed to install artificial nest hollows made specifically for cockatoos.

4. Reduce – adverse impacts will be rectified as soon as possible with rehabilitation commencing during mining. The impact will be eliminated following mining.

5. Offset – three direct offsets have been identified for Tutunup South: improvement of rehabilitated areas by fencing and creating vegetation corridors; installing artificial cockatoo hollows; and placing a covenant over an area of high conservation value with vulnerable TECs which is also located on the Whicher Scarp.

A Flora, Vegetation and Dieback Management Plan, Native Fauna Management Plan and Preliminary Closure and Rehabilitation Plan have been prepared for Tutunup South. These are appended to the PER.

Ground and Surface Water

Dewatering of the superficial and Yoganup aquifers will be required to safely conduct dry mining operations. A licence to dewater will be required from the Department of Water (DoW). Extraction volumes will be measured regularly and reported according to licence conditions. Predictions from the groundwater model will also be compared with extraction volumes and piezometric levels, to continuously improve the accuracy of Iluka's modelling.

Modelled contours of groundwater drawdown at various stages of mining indicate that at approximately 1.5 km from the project, the cone of depression will reach a maximum drawdown of 0.2 m. The cone of depression will extend for up to two years after the cessation of groundwater extraction. However in most areas, the cone of depression is expected to have recovered to within 90% of pre-mine levels within three years and 95% of pre-mine levels within five years.

It is expected that there will be negligible impacts on adjacent groundwater users. There are only five bores within a zone where maximum modelled drawdown exceeds 0.5 m, while two bores are in an area where drawdown exceeds 1 m. On the assumption that current bores extend at least 5 m into the current groundwater level, no significant reduction in the ability of these bores to supply water is anticipated.

Dewatering is expected to vary from an initial 20 ML per month to 40 ML per month. Towards the end of the project, there is a dewatering peak at 112 ML per month. Dewatering volumes will be transferred to the process water dam for ore processing.

The process water dam will be the main holding body for surface water generated within the site. The project's catchment will be isolated to divert runoff from the upper catchment around the site, through the installation of bunding and drains. Due to minimisation of the site footprint, space is a key limitation at Tutunup South, reducing the site's water management flexibility. It is anticipated that the operation will need to release water at various times during the project in accordance with licence conditions. An agricultural drain has been identified as a release point. A second drain has also been identified as a supplementary release point if water release volumes exceed the capacity of the primary release point. There may also be emergency occasions when the site may need to release excess water to maintain safe operating levels in which water quality exceeds licence conditions. Should this contingency arise, an emergency controlled release has been recommended which must follow a protocol of Statutory and landowner notifications and investigations.

A Ground and Surface Water Management Plan and Operating Strategy for dewatering has been prepared for Tutunup South, and is appended to this PER.

Acid Sulfate Soils

Disturbance of Acid Sulfate Soils and in particular Potential Acid Sulfate Soils (PASS) can result in the generation of acid in groundwater which may be subsequently dewatered or surface runoff, which could affect the values of surface water bodies and degrade soils for use in rehabilitation.

The two main exposures of PASS are through mining (as ore or overburden) and dewatering of in-situ PASS. Using a conservative assessment of PASS occurrence, it is estimated that of a total of 4,652,000 tonnes of overburden, 514,600 tonnes (11%) is PASS. Of a total of 10,402,000 tonnes of ore, it is estimated that 1,430,000 tonnes (approximately 14%) is PASS. Where modelling and monitoring identifies PASS, the mine planners will minimise the amount of time the material is exposed, to prevent oxidation. Overburden PASS will be returned as close to the base of the pit as possible. PASS ore will be prioritised for direct feeding into the in-pit hopper and processing. PASS in sand and clay tails will be prioritised for placement in the mining void. PASS Heavy Mineral Concentrate (HMC) will be placed in stockpiles and will be prioritised for transportation to Capel to minimise the time available for oxidation.

PASS material also occurs adjacent to the western pit margin and may experience localised oxidation due to dewatering. Limiting the extent of the cone of depression and backfilling voids as quickly as possible will assist in the prevention of oxidation of in-situ PASS. In addition, sump management will be altered to prevent drying of the pit floor and the use of sealant products to form a barrier to oxygen diffusion on pit walls in the vicinity of the in-pit hopper is being investigated.

An Acid Sulfate Soils Management Plan has been prepared for Tutunup South and is appended to this PER.

Noise

The processing facilities and hauling of ore to the in-pit hopper will operate continuously, while mobile equipment will be largely restricted to day time.

Ten residential locations (representing 15 houses) in the vicinity of Tutunup South have been identified as having a potential noise exposure. Modelling (including allowances for tonality and influencing factors) suggests that under worst case scenarios, noise levels will result in excursions from the *Environmental Protection (Noise) Regulations 1997* for eight of the ten residences during day operations and six of the ten residences at night. Eight of the ten residences are landowners and noise factors will be addressed in landowner agreements to allow access to properties for mining. The remaining 2 residences modelled are neighbours, modelled as R5 and R10.

Day-time noise is over the assigned level of 46 dB(A) at R5 during daytime mining by up to 3.3 dB(A). Night-time noise is modelled as less than the assigned level of 36 dB(A). Iluka proposes to develop neighbour agreements with residences R5a, R5b and R5c.

Night-time noise is over the assigned level of 35 dB(A) at R10 during night-time by 1.7 dB(A). This includes a 5 dB(A) penalty for tonality. Iluka proposes to develop a neighbour agreement with residence R10.

A Noise Management Plan has been prepared for Tutunup South, and is appended to this PER.

Conclusion

The impact assessment concludes that development and operation of the Tutunup South mineral sands mine can be conducted without causing significant adverse environmental impacts. The project has been considered utilising the sustainable development principles of ecological, social and planning options. Impacts or potential impacts have been identified, with alternatives evaluated during project definition to avoid impacts wherever possible and management controls developed for implementation during construction and operations to minimise these impacts.

Through implementation of the noise, ground and surface water, acid sulfate soils, flora vegetation and dieback, native fauna and preliminary closure and rehabilitation management plans, environmental impacts will be minimised and/or mitigated. The application of conservation offsets, including artificial hollows, establishing a vegetation corridor between the southern wetland on the Swan Coastal Plain and State Forest on the Whicher Scarp and placing a conservation covenant over an area of high conservation value with vulnerable TECs will enable the project to deliver a net environmental benefit.

Development of this project is a continuation of Iluka's South West operations which benefits the community through infrastructure support, partnerships with local government and continued employment of a local workforce. Iluka's South West operations contribute to the local economy through local expenditure and investment in capital and people. These benefits flow to both the State and Commonwealth, through royalties, payroll, income and other indirect taxes and duties. The sum of these benefits makes a compelling argument for approval to develop the Tutunup South mineral sands mine.

Table A: Summary of Environmental Factors

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Biophysical					
Landform and Soils	To maintain the integrity, ecological functions and environmental values of the soil and landform.	Five soil mapping units located over the project area dominated by yellow sands and grey sands.	Disturbance of soils during mining.	Stripping and stockpiling of soils will take into account soil properties to enhance rehabilitation value. Mining area will be rehabilitated to pre-mining landforms and agreed end land use. A Preliminary Closure and Rehabilitation Plan has been prepared.	Environmental values, ecological function and integrity of the soils are maintained.
Surface Hydrology	To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that emissions do not adversely affect environmental values of the surface water and groundwater resources or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Surface hydrology dominated by two wetlands, a creek to the south of the project and two minor drainage lines across the disturbance area. Water exits the site into an agricultural drain reporting to the Sabina River. Disturbance area has space limitations for water storage. Surface water is fresh to brackish, and used for livestock watering.	Minor drainage lines across the disturbance area will be disrupted by mining. Water erosion affecting turbidity of surface water and runoff. Contaminants in surface water from mining operations.	Surface water will be controlled by the installation of diversion bunds and graded banks. Stabilise exposed areas and minimise open areas. On-site contaminants will be fully contained to avoid potential adverse effects on surface water quality. Site discharge to be managed and controlled in accordance with licence conditions. Surface water will meet licence criteria most of the time, possible exceptions being in extreme events. A Ground and Surface Water Management Plan has been prepared.	Surface water quality and quantity will not be adversely affected by mine activities.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Groundwater	To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance are protected. 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 and acceptable standards.	Major aquifers present are the Guildford, Yoganup and Leederville aquifers. At depth is the Yarragadee Aquifer. 21 active bores within a 1 km buffer of Tutunup South. Groundwater is fresh and used for livestock watering irrigation and domestic supply.	Dewatering from superficial aquifer affecting other nearby water users. Cone of depression to be up to 0.2 m, 1.5 km from mine. 90% recovery of groundwater levels within three years. Additional water sourced from Yarragadee Aquifer impacting other water uses.	A Ground and Surface Water Management Plan has been prepared. Groundwater drawdown to be monitored.	Water supply from local bores and wells unlikely to be significantly affected. No significant impact on Yarragadee Aquifer. Groundwater quality will not be adversely affected by mine activities.
Acid Sulfate Soils	To maintain the integrity, ecological functions and environmental values of the soil and landform.	Acid Sulfate Soil study has identified Potential Acid Sulfate Soils within and to the west of the pit.	Potential for acid generation by oxidation of PASS disturbed by mining. PASS west of the pit may generate acid from dewatering. Potential mobilisation of metals at low pH.	PASS management is aimed at avoiding or minimising the rate of oxidation; and neutralising acidic material. An Acid Sulfate Soils Management Plan has been prepared.	Acid generation will be minimised by reducing the amount of time PASS is exposed for oxidation. No release of water with unacceptable acidity.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Flora and Vegetation	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Majority of disturbance area is on cleared agricultural land, with some State Forest and a degraded Gravel Reserve. 399 flora taxa recorded over the disturbance area. No declared rare flora recorded in the disturbance area. Ten priority flora and 14 significant flora over the survey area. Declared plants Arum Lily and Cape Tulip present. S2 community with low similarity to SCP 02 present inside and adjacent to disturbance area. One multiple use wetland inside the disturbance area and one adjacent to disturbance area. Several communities identified with some degree of dependence on groundwater (GDEs). Most of the State Forest and Gravel Reserve above the disturbance area is dieback infected. Some areas present are considered protectable.	Disturbance of 230 ha requiring clearing of 25.6 ha of native vegetation of variable condition and 6 ha of isolated trees. Three priority flora and three significant flora species inside the disturbance area. Potential for proliferation of declared plants offsite and in rehabilitation. 0.8 ha of S2 will be disturbed by clearing with a further 2 ha potentially impacted by dewatering. Northern wetland to be cleared, southern wetland likely to be impacted by dewatering. Potential for dieback to be transmitted into protectable areas.	The proponent will minimise clearing of native vegetation outside the ore reserves. Clearing of native vegetation will be restricted to areas identified. Clearing will avoid southern wetland vegetation. Site will be managed as dieback infested. Vehicles required to be clean on entry into protectable areas. Vehicles will be clean on exiting Tutunup South to prevent spread of declared plants. A Vegetation, Flora and Dieback Management Plan has been prepared. A Ground and Surface Water Management Plan has been prepared. A Preliminary Closure and Rehabilitation Plan has been prepared. At least 25.6 ha of native vegetation rehabilitation will be conducted and will be covenanted.	There will be some loss of vegetation due to clearing, and further potential drawdown impacts to the structure of several GDEs. Implementation of the Preliminary Closure and Rehabilitation Plan will: • replace vegetation lost by clearing; • result in overall improved vegetation condition compared to current condition; • place rehabilitated land on more secure tenure; and • establish priority and significant flora in rehabilitation. Protectable forest will remain uninfested. Declared weeds will be eradicated as they occur and not be spread off site. Offset will result in a net environmental benefit.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Fauna	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.	Surveys have located 110 native vertebrate fauna species including 69 avifauna, 13 mammals, 26 herpetofauna and two fish species over the survey area. Most diverse habitats sites were within S2 and M1 communities. Six fauna species of significance recorded during surveys. A further nine species not recorded have the potential to utilise area as part of their range. Three species of Black Cockatoo recorded over the survey area. Search for short-range endemic terrestrial invertebrates found no rare species. 98 aquatic invertebrates located in two wetlands and a creekline in 2005. Six microinvertebrates defined as ‘rare’.	Three possible black cockatoo nesting hollows and numerous feeding sites located within disturbance area. Potential loss of habitat from vegetation clearing and impacts from groundwater drawdown. Mining activity affecting fauna at the edge of the disturbance area, e.g. noise/vibration. Increased traffic mortalities of susceptible species.	Minimise clearing of native vegetation and cockatoo habitat outside the ore reserves. Conduct fauna trapping and relocation at northern wetland prior to clearing. Efforts will be made to collect Cockatoo hollows for re-establishment after mining, and will be supplemented by artificial hollows. A Native Fauna Management Plan has been prepared. Rehabilitation to re-establish wetlands and establish vegetation corridors between wetlands and State Forest. A Preliminary Closure and Rehabilitation Management Plan has been prepared.	Although there will be some loss of fauna habitat and food resources, rehabilitation will improve linkages between the Swan Coastal Plain and Whicher Scarp through vegetation corridor establishment between the State Forest and the southern wetland and between State Forest and Roberts Block as part of a conservation offset.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Pollution Management					
Dust	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	15 residences surrounding Tutunup South. Limited potential for dust generation in excess of current agricultural land use.	Potential for dust generation by earthmoving activities and exposed stockpiles and rehabilitated areas.	Dust will be controlled within the disturbance area through a number of management practices which may include: • wetting and grading unsealed mine roads; • concurrent rehabilitation; • vegetating bunds and stockpiles; • not disturbing topsoil until required • use of biodegradable tackifiers to "glue" the surface down; • use of hydromulch or clay fines to stabilise open areas and rehabilitation surfaces; and • growing temporary crops to bind the soil and lift the wind from the surface.	No significant adverse impacts from dust.
Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	15 residences surrounding Tutunup South. Most residences will have landowner access agreements.	Most mobile equipment restricted to daytime operations. Processing will occur 24 hours a day. Noise modelling indicates worst case conditions may result in excursions to Noise Regulations.	Constructing noise bunds around key noise sources. Hopper and screen plant to be installed below ground level. Minimise numbers of equipment. A Noise Management Plan has been prepared.	Activities will be in accordance with Noise Regulations most of the time. Under worst case conditions, noise levels may result in excursions to Noise Regulations. Landowner agreements and Neighbour agreements to address noise amenity.
Radiation	To ensure that radiological impacts to the public and the environment are kept as low as reasonably achievable and comply with acceptable standards.	Tutunup South is a similar orebody to Iluka's other South West operations. Radiation levels are expected to be low.	Exposure to low level radioactive minerals.	Implement South West Radiation Management Plan	Post mining levels will be similar to the pre-mining value.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Light	To avoid or manage potential impacts from light overspill and comply with acceptable standards.	Several nearby residences are potential light receptors, as are road users of the Vasse Highway.	Continuous operation of mine site may result in light overspill affecting surrounding residents and/or traffic.	In-pit hopper and screenplant to be located below natural surface level or behind constructed bunds to minimise nuisance light. Majority of earthmoving restricted to 7am to 7pm, limiting the impact of mobile equipment nuisance light. Light towers will be constructed such that redirecting of lights is not difficult.	No significant adverse impacts from site lighting.
Non-Process Waste	Iluka's objective is to ensure that wastes are managed and disposed of in a manner that does not result in long-term impacts on groundwater, surface water and the natural environment.	Existing discarded waste in forested areas, particularly Gravel Reserve	Mismanagement of waste creates large waste streams that are difficult or environmentally unacceptable to dispose or creates contamination.	Priorities for waste management are: 1. avoid/reduce 2. reuse/recycle 3. treat 4. dispose appropriately	No long term impacts from non-process waste.
Process Waste	Iluka's objective is to ensure waste streams from the process are returned to the mining pit in a manner consistent with closure objectives and end uses of the site.	No previous mining conducted over the project area.	Insufficient freeboard, may result in overtopping of solar drying dams. Overburden material returned to the pit creates unsuitable soil profile.	Non-mineralised materials are returned to the pit void.	Return of process wastes to pits will result in re-establishment of the pre-mining land use. No long term impacts from process waste.
Greenhouse gases	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.	Iluka's South West operations run three concentrators and associated mining infrastructure. The concentrator currently located at Wagerup will be relocated to Tutunup South.	Carbon dioxide levels will result in greenhouse gas emissions from the operation of standard diesel and petrol combustion engines and the use of electricity.	Ensure efficient use of all machinery. Monitor and report greenhouse gas emissions in Annual Environmental Report.	Negligible net increase in greenhouse emissions after decommissioning the Wagerup mine and commissioning of Tutunup South.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Social Surrounds					
Aboriginal Heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and to comply with relevant heritage legislation.	One scar tree has been located within the disturbance area. Ethnographic site (Abba River) located north of the project.	Potential for disturbance to the scar tree. Potential for discovery of further aboriginal heritage sites within the disturbance area. The Ethnographic site will not be impacted.	Mine infrastructure has been designed to avoid impacting the scar tree. Provisions of the Aboriginal Heritage Act will be complied with. Sites discovered during operations will be reported to DoIR and DIA.	The scar tree will not be disturbed during mining. The ethnographic site at the Abba River will not be impacted.
European heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and to comply with relevant heritage legislation.	No known sites of European heritage over the project area.	No impact identified.	No impacts requiring management.	No impact on European heritage.
Transport	Ensure that traffic activities resulting from the Tutunup South project can be managed to an adequate level of public safety and have minimal impact on surrounding landowners and traffic congestion.	The key transportation corridors are the Bussell Highway, Vasse Highway and Sues Road (all Main Roads WA heavy haulage routes). Transport along the minor Ludlow Hithergreen Road will be approximately 1 km. HMC transport will comprise of approximately 48 movements (24 completed trips a day).	Increased heavy traffic has the potential to impact on public safety, noise and amenity. Construction traffic (wide loads) may cause short term disruptions to traffic. Diversion of the Vasse Highway required to allow mining.	Appropriate design of intersection and highway diversion in liaison with the Shire of Busselton and MRWA to ensure a adequate level of public safety and minimise impacts on residences and traffic. Transport provider to hold appropriate permits and abide by conditions.	Some short term disruption to traffic during construction and diversion of the Vasse Highway. Minimal disruption to traffic from transport of heavy mineral concentrate (HMC) to Capel.
Visual amenity	Ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape to as low as reasonably practicable.	Agricultural land adjacent to the Whicher State Forest. 15 residences surrounding the project area. The Vasse Highway bisects the project.	Some residents and Vasse Highway road users will be able to see the mining operation.	Minimisation of clearing. Topsoil stockpiles will be placed around the perimeter of the disturbance boundary and concentrator. Conduct progressive rehabilitation to minimise the active disturbance footprint.	Visual impact will be reduced to as low as reasonably practical.

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Provided on Attached CD

Pre-mine Soil Survey for the Proposed Tutunup South Minesite (SWC 2007a)

Acid Sulfate Soil Survey for the Proposed Tutunup South Minesite (SWC 2008)

Third party review of Acid Sulfate Soils Assessment and Management in selected mining operations in south-west Western Australia (Sullivan 2007).

Third party review of Acid Sulfate Soil Management Plan for Tutunup South mineral sands project (Sullivan 2008)

Groundwater Dependent Ecosystem Assessment for the Proposed Tutunup South Minesite (SWC 2007b)

Tutunup South Groundwater Impact Assessment (Aquaterra 2007)

Tutunup South Hydrogeological Investigation (Parsons Brinckerhoff 2006)

Completion report for Yarragadee Bores TSPB1 and TS009, Tutunup South (Parsons Brinckerhoff 2007)

Tutunup South Project Baseline Aquatic Biology & Water Quality Study (WRM 2007)

Tutunup South Wetlands Review (Biota 2007c)

Flora and Vegetation Assessment of the Tutunup South Lease Area (Mattiske Consulting Pty Ltd 2007)

Tutunup South Project Area – Dieback Survey (Department of Environment and Conservation 2007)

A Vertebrate Fauna Survey Assessment of the Tutunup South Mineral Sands Project Area (Ninox Wildlife Consulting 2006)

Tutunup South Fauna Habitats and Fauna Assemblage Survey (Biota 2007a)

Tutunup South Fauna Habitats and Fauna Assemblage Survey (Biota 2007d)

Assessment of Significant Habitat Trees at the Tutunup South Project Area (Johnstone, Johnstone and Kirkby 2007)

The Report of an Aboriginal Archaeological Survey of the Proposed Tutunup South Mineral Sands Mine (M70/611, M70/612, M70/1261), South West Region, Western Australia (Anthropos Australis Pty Ltd 2007)

Report of an Ethnographic Survey of the Proposed Tutunup South Mine Development (M70/611, M70/612, M70/1261), near Busselton, Western Australia (Ethnosciences 2007)

Environmental Noise Assessment of the Tutunup South Minesite (SVT Engineering Consultants 2008)

Transport Operations Tutunup South: Traffic Summary (Wyntak Pty Ltd 2007)

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1 PURPOSE AND STRUCTURE OF DOCUMENT

The Tutunup South project was referred to the Environmental Protection Authority (EPA) on 26 October 2006. The EPA determined that the likely environmental impacts are sufficient to warrant assessment at the level of Public Environmental Review (PER) with a four week public review period. This level of assessment is typically applied to proposals of local or regional significance that raise a number of environmental factors, some of which are considered complex and require detailed assessment. The EPA advertised the level of assessment in *The West Australian* on 20 November 2006. An Environmental Scoping Report describing the project, surrounding environment and detail to be documented in the Public Environmental Review (PER) was prepared by the proponent and submitted to the EPA on 22 February 2007 and was approved on 9 May 2007.

This PER aims to identify and assess the environmental effects of the proposal and to describe the management strategies the proponent will adopt to manage and minimise any adverse environmental affects.

The document provides the following information:

- a description of the project;
- the legislative considerations used to assess the project;
- a description of the existing environment;
- details of Iluka's community and stakeholder consultation programme;
- an overview of Iluka's approach to environmental management;
- identification of environmental factors;
- expected impacts and management from development of the project;
- details on planned closure and rehabilitation; and
- discussion of offsets associated with this proposal.

A range of technical studies have been completed in preparing this document. Management plans have been prepared for key environmental factors associated with the project and are appended to the PER. The technical studies are provided as supporting documents on a compact disc at the back of the PER.

2 PROPONENT

The Proponent for the proposed Tutunup South Mineral Sands Project is Iluka Resources Limited ("Iluka"). Iluka is a major participant in the global mineral sands sector and involved in the sales and marketing of titanium based products (rutile, ilmenite, leucoxene and synthetic rutile) and zircon. Titanium minerals and zircon produced in Western Australia are used in every-day products such as paints, ceramics, cosmetics and food products. Currently, Iluka's mining and mineral processing operations in Western Australia are located in the South West, Peel & Midwest regions. Iluka has successfully mined and rehabilitated many mineral sands deposits since the 1950's. Iluka employs a total of approximately 1400 employees and contractors across its Australian operations. For the year ended 31 December 2006, Iluka had sales of $1,003 million dollars across its operations.

Iluka has received several awards for environmental, community and operational performance, including a Golden Gecko for environmental performance in the South West WA in 1999, a gold award for community engagement excellence for the Douglas Project in the Murray Basin in 2005 and the Australian Maintenance excellence award 2004.

The proponent can be contacted at:

Iluka Resources Limited
Level 23, 140 St Georges Terrace
Perth Western Australia, 6000.

The nominated contact is:

Shannon Jones, Environmental Advisor
Tel: (08) 9360 4700
Fax: (08) 9360 4777
Email: shannon.jones@iluka.com

Table 1: Key Characteristics of the Project

Characteristic	Description
Life of Mine (Mine Production)	5 - 6 years
Mineable Reserve	10.4 million tonnes
Area of Disturbance	230 ha
Vegetation Disturbance	31.6 ha
Hours of Operation	24 hours a day, 7 days a week
Processing Equipment	Mining Unit & Concentrator
Anticipated Throughput Rate	200 tonnes per hour
Heavy Mineral Concentrate Production	1,200,000 tonnes over the life of the project
Water Supply Sources	Superficial/Leederville aquifers – 1,040 ML per year
	Yarragadee – 1,500 ML per year
Heavy Mineral Concentrate Transport	24 completed trips (48 total movements) per day

3 PROJECT DESCRIPTION

Iluka proposes to establish the Tutunup South mineral sands mine located approximately 195 kilometres south of Perth and 15 km southeast of the township of Busselton (Figure 1). The project area includes mining tenements, M70/611, M70/612, M70/1261 and E70/2699 (Figure 2). Development of Tutunup South is required to maintain Iluka's current production level of mineral sands.

There are six private landowners within the proposed disturbance area. Individual agreements are in the process of being developed with each landowner to allow access. The disturbance area also includes areas of State Forest, vacant crown land, a gravel reserve vested with the Shire of Busselton and road reserves vested with Main Roads WA (MRWA) (Figure 3). The project will require a temporary diversion of the Vasse Highway. The proposed diversion route is also included within the disturbance area.

This project is part of Iluka's ongoing South West Operations, being a continuation of mining and production of heavy mineral concentrate (HMC) as other sites conclude mining. The project is currently scheduled to commence operations in 2009, dependent on internal planning processes and the timely receipt of environmental and other approvals. The site will be established and operated in a similar fashion to other Iluka mines in the South West.

3.1 Construction

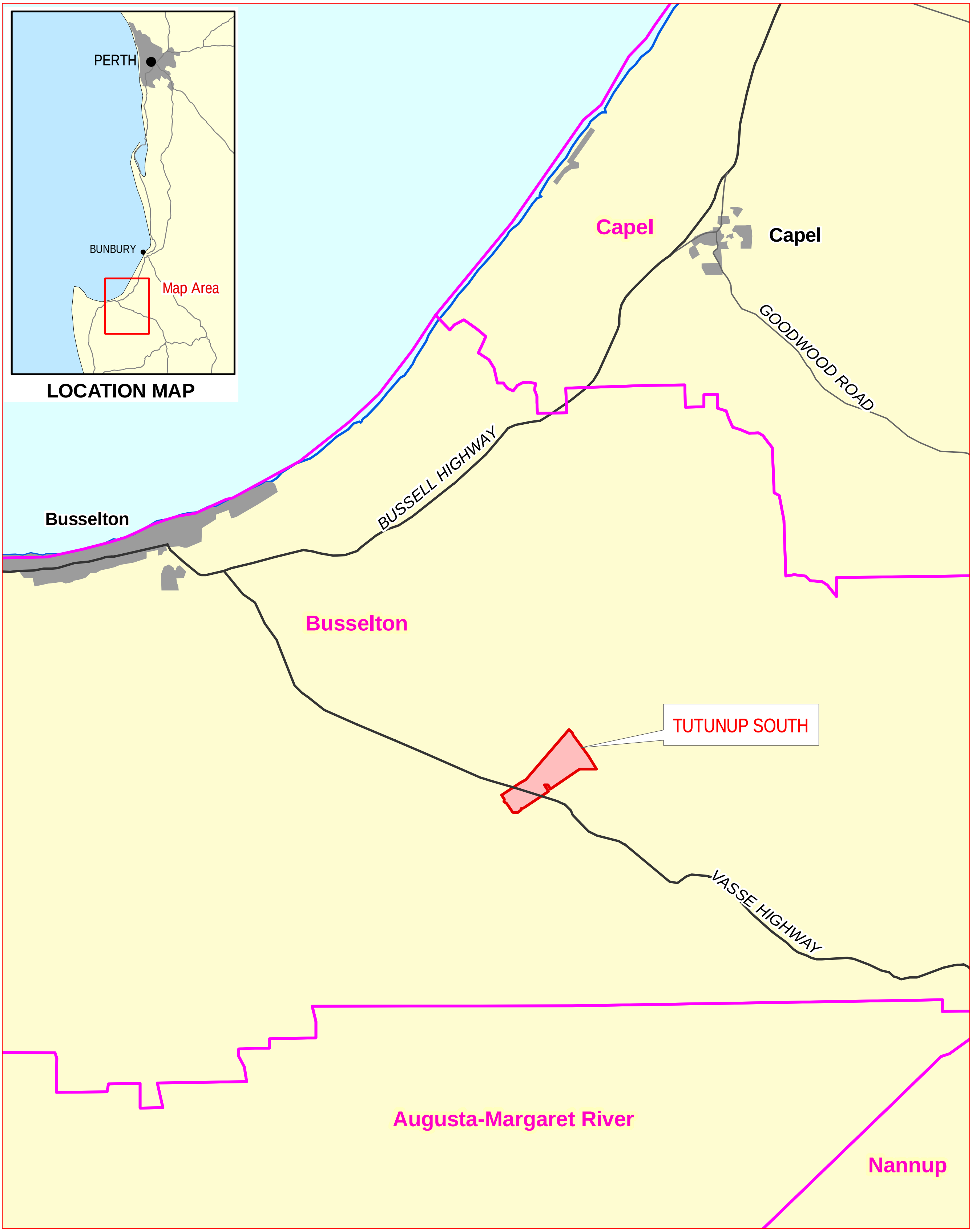
Pre-production earthworks will include topsoil stripping, overburden removal, installation of drainage and noise bunds, preparation of haul roads and construction of infrastructure.

3.2 Mining Operations

The proposed overburden mining method is likely to incorporate scrapers, excavators and trucks. The majority of earthmoving operations will be restricted to occur between 7 am and 7 pm to minimise equipment noise at nearby local residences.

The current ore reserve is approximately 10.4 million tonnes with an average grade of 11.0% heavy mineral ("HM"). The ore will be mined progressively from several open-cut pits using dry mining techniques. Dewatering of groundwater inflows into the pit will be required to enable dry mining to occur.

The proposed ore mining method involves excavating the ore and hauling it to the in-pit hopper. The in-pit hopper is likely to be moved to two different locations over the life of the mine (Figure 4). The ore is then conveyed to a wet screening plant where oversize material greater than 2.5 mm will be removed (Figure 5).



Legend

- Project area
- Shire Boundaries

N

0 5 10 km

ILUKA

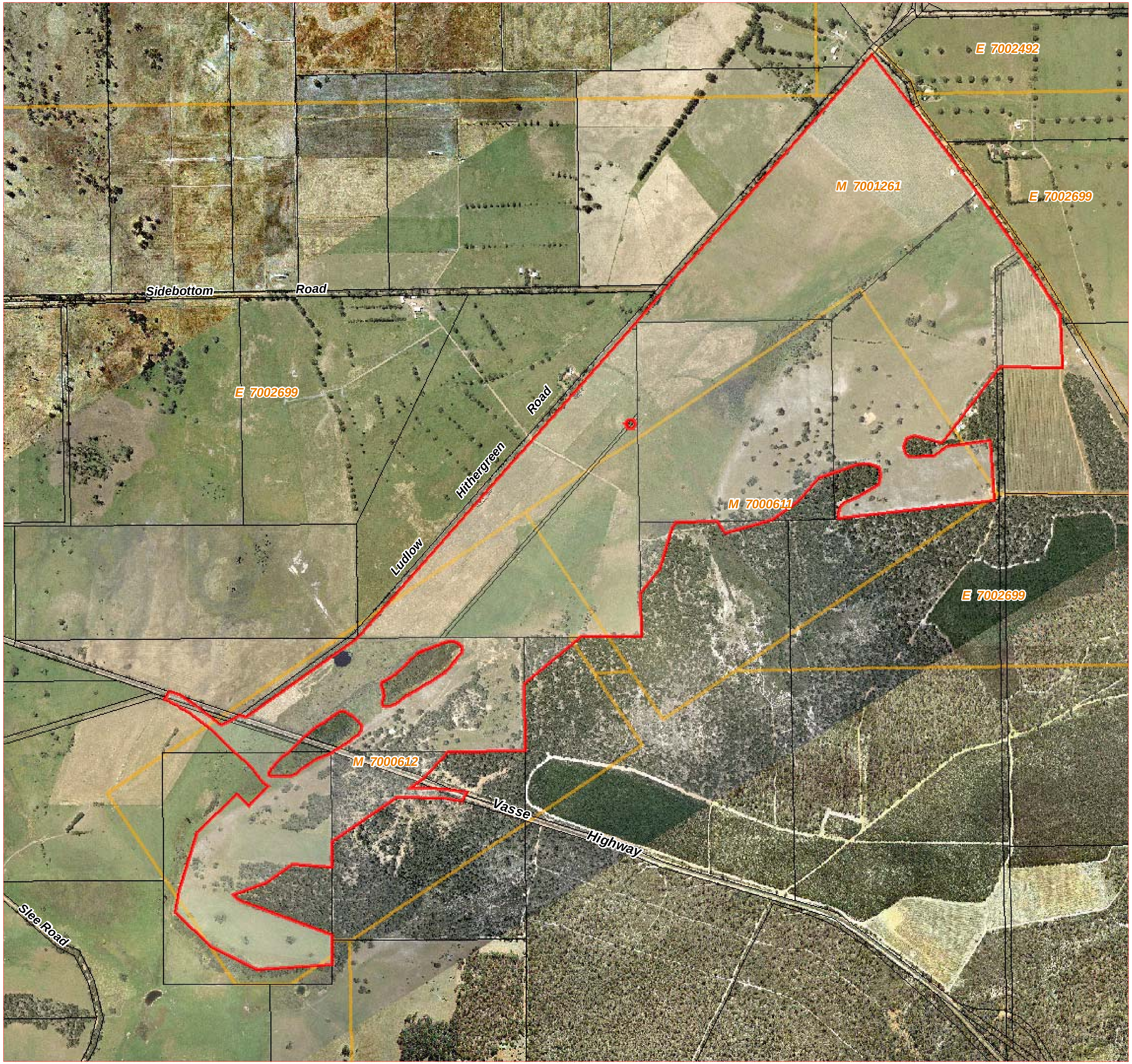
ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:200 000
DATE:	14 Sept. 2007

TUTUNUP SOUTH

REGIONAL LOCATION PLAN

DWG No: 153903 ver.03

FIGURE: 1



REVISIONS				
Ver.	ORIG	DESIGN	DATE	COMMENTS

Legend

- Disturbance area
- Iluka tenements

Date of photography
Inset: 19 Nov. 2007 Regional: 2001

N

0 250 500 m

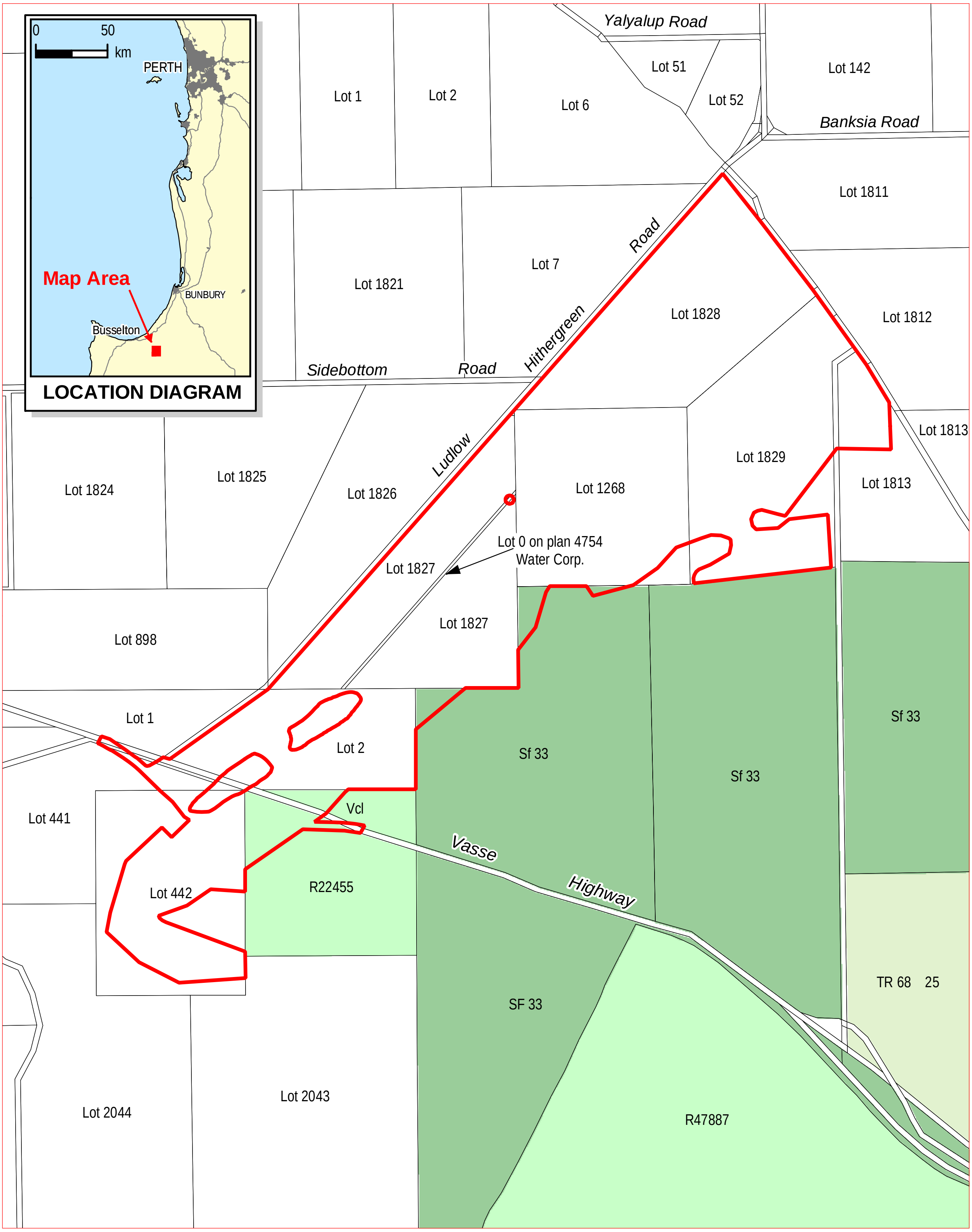
ILUKA

TUTUNUP SOUTH

SITE PLAN

ORIG:	L Sadler
DRAWN:	D.G.S.
SCALE:	1:12,500
DATE:	12 Sept. 2007

DWG No: 176770 ver.00 | A3 | FIGURE: 2



Legend

Proposed disturbance area

Land Use

- VCL
- Reserve
- State Forest
- Timber Reserve

N

0 500 1,000 m

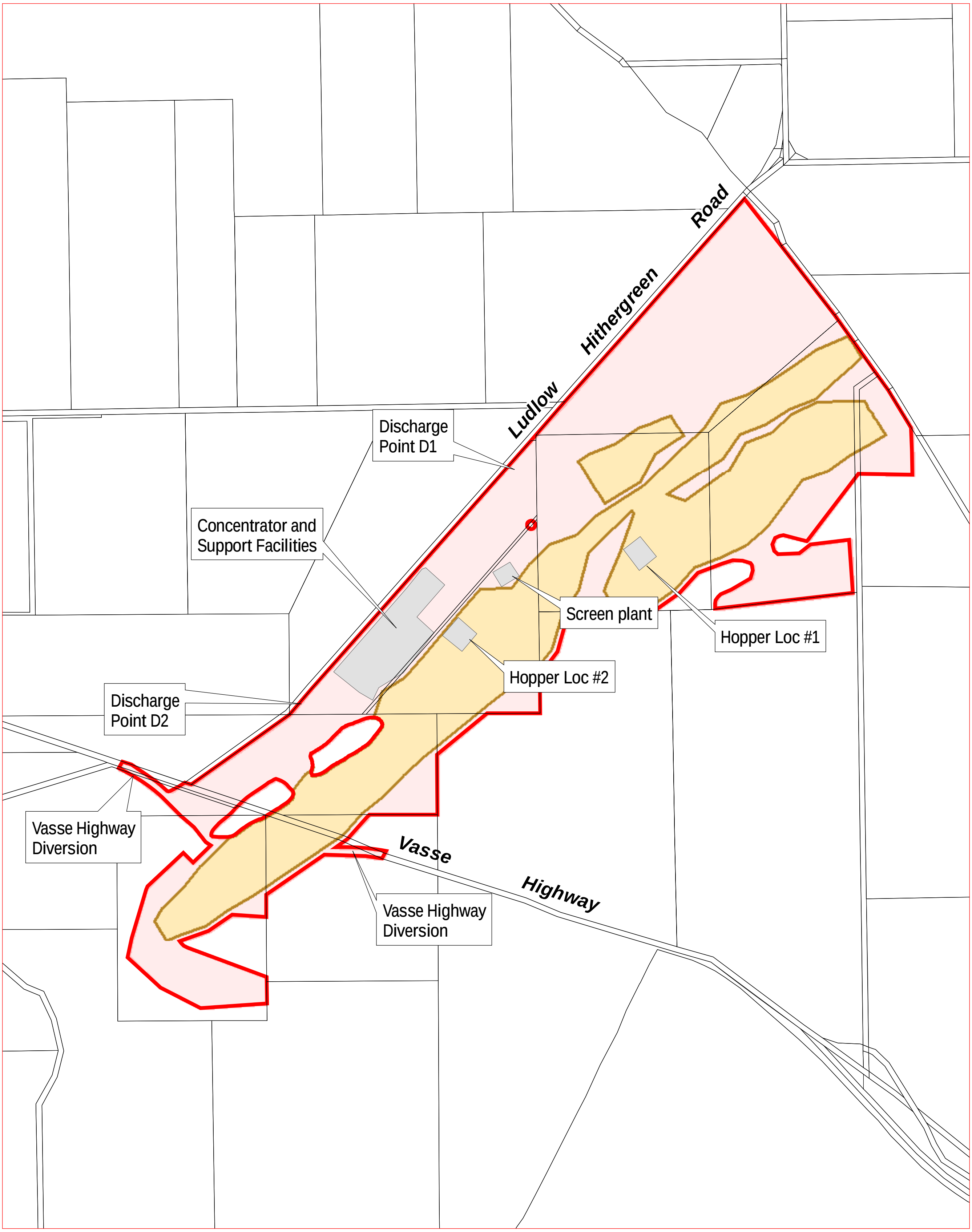
ILUKA

TUTUNUP SOUTH

LAND TENURE

ORIG:	S.Jones
DRAWN:	T.L.G
SCALE:	1:20,000
DATE:	8 April 2008

DWG No: 173828 ver.03 | A4 | FIGURE: 3



Legend

Mine pit

Disturbance area

N

0 250 500 750 m

ILUKA

TUTUNUP SOUTH

MINE PLAN

ORIG: S.Jones

DRAWN: T.L.G

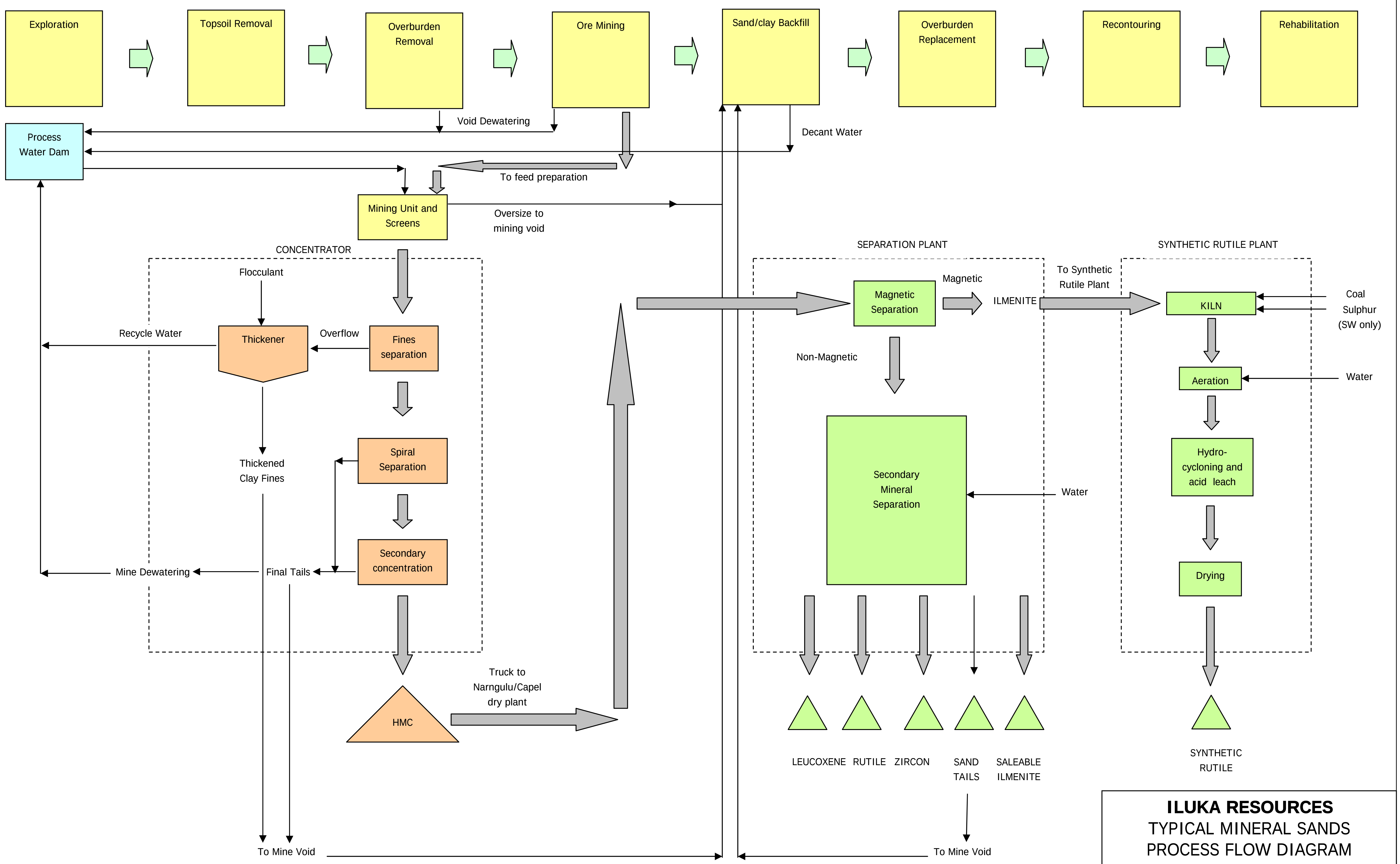
SCALE: 1:20,000

DATE: 8 April 2008

DWG No: 176776 ver.04

A4

FIGURE: 4



ILUKA RESOURCES
TYPICAL MINERAL SANDS
PROCESS FLOW DIAGRAM

FIGURE 5

3.3 Ore Processing

From the screen plant, the ore is transported via pumps and pipeline to the wet concentrator where the ore is separated into HMC, clay fines and sand tails (Figure 5).

The concentrator and screen plant infrastructure will remain in one position throughout the life of the mine (Figure 4).

Ore will be processed through the concentrator at an anticipated throughput rate of 200 tonnes per hour (rougher head feed rate) to produce over 1,200,000 tonnes of HMC over the life of the project. The orebodies will be mined progressively over a 5 - 6 year period. HMC will be transported to the Capel separation plant for further processing.

Clay tails will be placed in solar drying dams to allow settlement and drying prior to being placed in-pit with sand tails and overburden removed during the mining process. Following backfill, the area will be rehabilitated to a landform and land use similar to the surroundings.

3.4 Resource Requirements

Support infrastructure such as offices and workshops will be located on-site.

3.4.1 Workforce

To operate the Tutunup South site, Iluka will employ 40 people (either directly or as contractors). Most of the workforce will be sourced from within Iluka's existing workforce.

3.4.2 Power

Approximately 30,000 MWh of electricity will be used at the Tutunup South site over the life of the operation. This is based on the Wagerup operation which is similar in size to Tutunup South.

3.4.3 Fuel

Approximately 6,500 kL of diesel will be used at the Tutunup South site over the life of the operation. This is based on the Wagerup operation which is similar in size to Tutunup South.

3.4.4 Water

Mine pits will be dewatered to allow dry mining to occur. The water demand for this Project is expected to be approximately 1.5 GL / year. Pit dewatering and incidental runoff will be preferentially utilised as the project water supply with make-up water sourced from a Yarragadee production bore (TSPB1).

Yarragadee extraction will be kept to a minimum with dewatering, recycled water and captured rainfall and runoff used preferentially. Yarragadee extraction requirements are estimated to be between 1,120 and 1,500 ML/annum.

Superficial groundwater inflows into the mining void are predicted to range from less than 20 ML/month initially, increasing to between 50 and 60 ML/month by the third year of mining. Inflows are expected to peak at 112 ML/month at the end of mining. The highest total 12 month groundwater inflows are 1,040 ML.

A process water dam is proposed to be developed adjacent to the concentrator (Figure 4).

3.5 Project Benefits

The Tutunup South Project is part of Iluka's ongoing South West Operations. Continuation of mining and processing operations provides economic benefits including:

- direct and indirect local and regional employment and training opportunities;
- export earnings;
- revenue to State and Federal Governments through taxes on earnings, royalties and through purchases; and
- regional and national economic growth.

Mineral Sands mining is a temporary land use which has the ability to maximise utilisation of natural resources. In applying sustainable development objectives to the project (Section 7.3) the mining area will be returned to a landform consistent with the surrounds and previous agricultural land use. Mining of the deposit allows for a contribution to the natural environment. The proposed disturbance area is mostly cleared pasture land with isolated vegetation. It is proposed to improve this through fencing of remnant vegetation and linking isolated vegetation with State Forest through native vegetation corridors. The agricultural potential of the proposed disturbance area will benefit through improved farm planning, windbreaks, fences and watering points (Section 12). The sustainable development approach to the project allows for significant economic, environmental and social benefits to be achieved.

3.6 Consideration of Alternatives and Preferred Options

The current proposal is part of Iluka's ongoing South West Operations, being a continuation of operations as mining and production of HMC reserve at other sites ceases. It is currently proposed that the concentrator from Iluka's current operation at Wagerup will be relocated for the Tutunup South operations. This is scheduled to occur in 2009 in line with the Iluka mine planning process. This schedule is updated on an annual basis and changes may occur based on the remaining reserves at current operations, market fluctuations and processing plant blending requirements.

Feasibility studies have identified the ore bodies and associated site layout and infrastructure requirements. Options that have been considered for this proposal include:

- mining within State Forest and gravel reserves;
- deviation of the Vasse Highway;

- alternative locations of facilities outside the HM reserve;
- alternative transportation routes, truck combinations and schedules;
- strategies for clay and sand disposal, with consideration of new disposal techniques;
- strategies to minimise noise impacts on neighbours and landowners including alternative locations for topsoil and overburden stockpiles, and operating methodology; and
- implementation of water efficiency measures.

4 LEGISLATIVE CONSIDERATIONS FOR THE PROJECT

The project will adhere to the requirements of all applicable legislation and regulations. Current Commonwealth and Western Australian State legislation that is applicable to the project is outlined in Table 2.

Table 2: Legislation and policies relevant to the proposal

State	Commonwealth
Aboriginal Heritage Act 1972	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (which operates concurrently with any existing State laws in so far as those laws would not be consistent with this Act)*
Bush Fires Act 1954	*Native Title Act 1993*
Conservation and Land Management Act 1984	*Environment Protection and Biodiversity Conservation Act 1999*
Environmental Protection Act 1986	*National Strategy for Ecologically Sustainable Development 1992*
Environmental Protection (Noise) Regulations 1997	*Intergovernmental Agreement on the Environment 1992*
Explosives and Dangerous Goods Act 1961	*National Strategy for Conservation of Australia's Biological Diversity 1996*
Land Administration Act 1997	*Dangerous Goods Regulations 1998.*
Local Government Act 1995	
Occupational Safety and Health Act 1984	
Rights in Water and Irrigation Act 1914	
Town Planning and Development Act 1928	
Waterways Conservation Act 1976	
Wildlife Conservation Act 1950.	
Environmental Protection (Clearing of Native Vegetation) Regulation 2004	
Mining Act 1978	
Mines, Safety and Inspection Act, 1994	
Mines, Safety and Inspection Regulations, 1995	
Soil and Land Conservation Act, 1945	
Water Authority Act, 1984	

A number of policies, EPA position statements, EPA guidance statements and relevant environmental guidelines and Codes of Practice are applicable to the proposal, including:

- EPA Position Statement No. 2: Environmental Protection of Native Vegetation (EPA 2000a)

- EPA Position Statement No. 3: Terrestrial Biological Surveys (EPA 2002a)
- EPA Position Statement No. 4: Protection of Wetlands (EPA 2004a)
- EPA Position Statement No. 6: Towards Sustainability (EPA 2004b)
- EPA Position Statement No. 7: Principles of Environmental Protection (EPA 2004c)
- EPA Position Statement No 8: Environmental Protection In Natural Resource Management (EPA 2005a)
- EPA Position Statement No. 9: Environmental Offsets (EPA 2006a)
- EPA Guidance No. 6: Rehabilitation of Terrestrial Ecosystems (EPA 2006b)
- EPA Guidance No. 8: Environmental Noise (EPA Draft 2007a)
- EPA Guidance No. 10: Level of Assessment for Proposals Affecting Natural Areas Within the System 6 Region or the Swan Coastal Plain Portion of the System 1 Region (EPA 2006c)
- EPA Guidance No. 12: Minimising Greenhouse Gas Emissions (EPA 2002b)
- EPA Guidance No. 18: Prevention of Air Quality Impacts from Land Development Sites (EPA 2000b)
- EPA Guidance No. 19: Environmental Offsets (EPA Draft 2007b)
- EPA Guidance No. 33: Environmental Guidance for Planning and Development (EPA Draft 2005b)
- EPA Guidance No. 41: Assessment of Aboriginal Heritage (EPA 2004d)
- EPA Guidance No. 51: Terrestrial Flora and Vegetation Surveys (EPA 2004e)
- EPA Guidance No. 55: Implementing Best Practice (EPA 2003)
- EPA Guidance No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (EPA 2004f)

4.1 Environment Protection & Biodiversity Conservation Act 1999

Due to the presence of cockatoo nesting and feeding trees within the proposed disturbance area the project has been referred to the Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA - previously DEH) under the *Environment Protection and Biodiversity Conservation Act 1999*, as likely to have significant impacts on the listed species Carnaby's Cockatoo (*Calyptorhynchus latirostris)* and Baudin's Cockatoo *(C. baudinii)*. On 8 June 2007, the DEWHA advised Iluka that the project will be a controlled action requiring approval from the Commonwealth Minister for the Environment. The project is being assessed through the State/Commonwealth bilateral approval process.

4.2 Rights in Water and Irrigation Act 1914

Iluka is required to obtain groundwater licenses under the *Rights in Water and Irrigation Act 1914 (RIWI Act).* This will include an amendment to Iluka's existing licence for the Yarragadee Aquifer (GWL 161847 (2)) and a new licence for dewatering of the superficial aquifer.

A small portion of the proposed disturbance area falls within the newly proclaimed Geographe Bay Rivers Surface Water Area (GBRSWA). Dam construction, the taking or diversion of surface water and interference with beds and banks within this area requires permits or licenses from the Department of Water (DoW), in accordance with the *RIWI Act*.

4.3 Responsible Authorities

The main agencies with an interest in the environmental assessment and management of the proposed Tutunup South project are:

- Environmental Protection Authority (EPA);
- Department of Water (DoW);
- Department of Environment and Conservation (DEC);
- Department of Industry and Resources (DoIR);
- Department of Indigenous Affairs (DIA);
- Department of Agriculture and Food (DAF);
- Main Roads of Western Australia (MRWA);
- Commonwealth Department of the Environment, Water, Heritage and the Arts (DEWHA); and
- Shire of Busselton.

5 EXISTING ENVIRONMENT

5.1 Regional Setting

The Tutunup South deposit is located between Ludlow-Hithergreen Road and the base of the Whicher Scarp approximately 15 km southeast of the township of Busselton (Figure 1). The Whicher Scarp is a prominent topographic feature orientated parallel to the present day coastline. The project area is covered by four mining leases M70/611, M70/612, M70/1261 and E70\2699 (Figure 2). The majority of Tutunup South is on the northern side of Vasse Highway with some of the proposed disturbance area stretching south of the highway.

The disturbance area for Tutunup South has largely been cleared for agricultural purposes. Vineyards occur to the east of the disturbance area. Drainage from the site is to the north west, with most runoff entering an agricultural drain that flows to the Sabina River then the Vasse Diversion Drain. 15 houses are located within close proximity to the project area. The majority of the houses are towards the northern end of the disturbance area.

5.2 Climate

The region has a Mediterranean climate characterised by warm, dry summers and cool, wet winters. The Busselton Shire has an average annual maximum daily temperature of 21.9^{o}C and an average, annual minimum daily temperature of 10.4^{o}C. Approximately 90% of rainfall occurs between the months of April and October. The Bureau of Meteorology records rainfall at the Busselton Shire, where the long-term (from 1877 to 2004) average annual rainfall is 817.2 mm/annum. Total annual rainfall recorded since 1998 at the Busselton Airport Weather Station, located approximately 9.2 km from the Tutunup South deposit, is presented in Table 3. Between 2001 and 2004, rainfall was below average. However, in 2005 total annual rainfall was above the historical annual average rainfall.

Table 3: Busselton Airport Weather Station

Years	Total Annual Rainfall (mm)
1998	730.0
1999	895.4
2000	888.0
2001	517.0
2002	630.6
2003	693.2
2004	693.4
2005	877.6

5.3 Geology

The Tutunup South disturbance area covers parts of the Yoganup Formation and younger littoral and marginal marine units deposited on the Western Australian continental shelf during the Pliocene and Pleistocene periods. As previously outlined it is located along the foot of the Whicher Scarp, a prominent topographic feature orientated parallel to the present day coastline. The scarp has formed the limit of numerous Tertiary marine transgressions. Palaeo-shorelines along this part of the scarp are collectively referred to as the Yoganup Shorelines.

The Yoganup Formation is partly buried by estuarine and fluvial clays of the Guildford Formation and by later alluvial fan deposits and thin aeolian quartz dunes of the Bassendean dune systems.

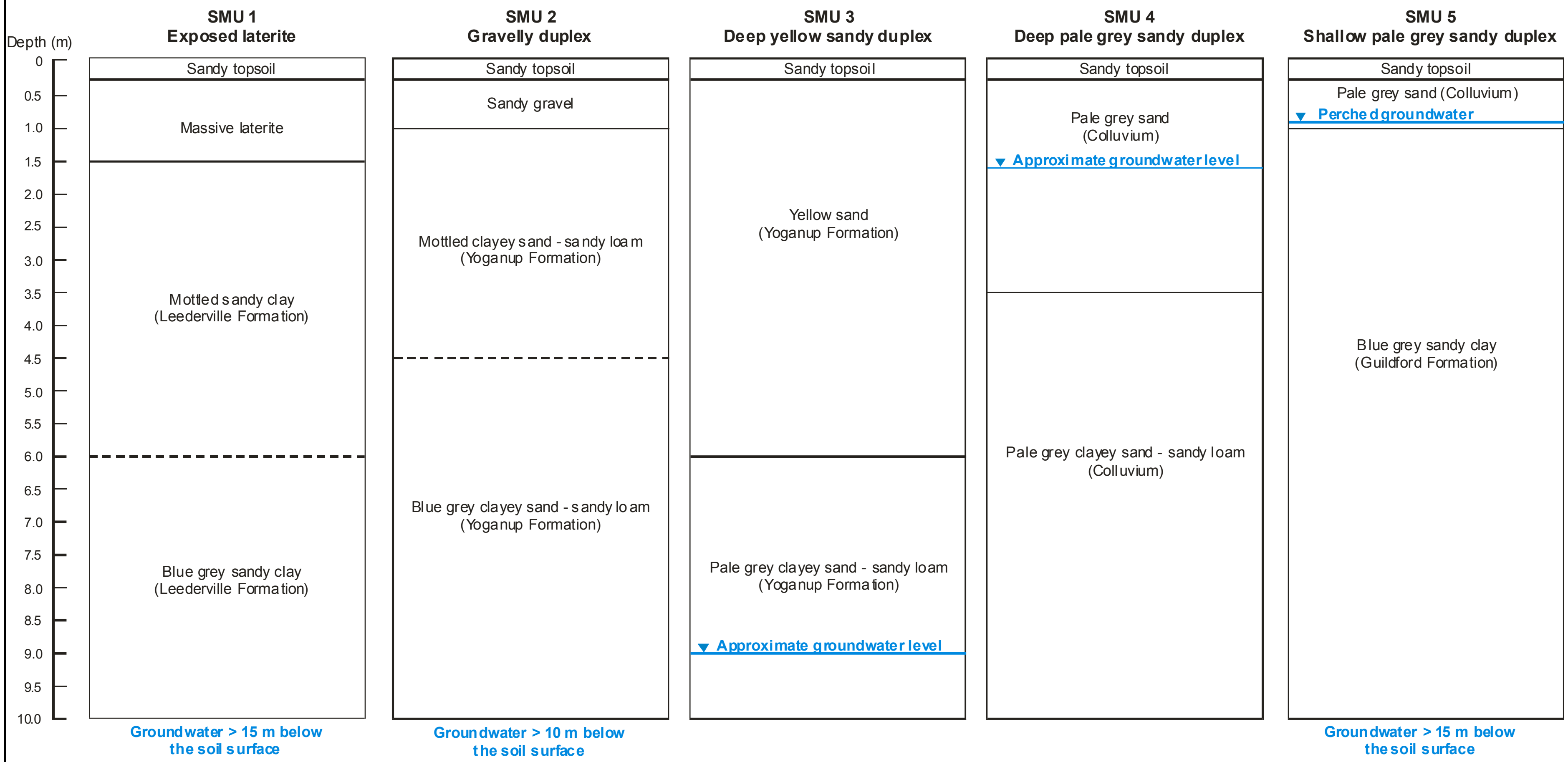
There have been numerous phases of heavy mineral accumulation in the Tutunup South deposit, which contains mineral ranging from 28 to 47 m above sea level, and each concentration itself is a result of numerous individual accumulation events.

Subsequent to deposition, the deposit has been subject to topographic deflation, erosion by drainage channels off the scarp, induration through lateritisation and ironstone development, and alteration of the mineral constituents.

5.4 Landform and Soils

Tutunup South occurs in the Southern Perth Basin. This basin represents a southern extension of the Perth Basin, and is composed of up to 10 km of Permian to Quaternary sediments. Of particular importance to mining are the Quaternary – Late Tertiary Guildford and Yoganup formations, and the Mesozoic Leederville Formation and Bunbury Basalts. All of these surficial geological formations have either been formed or strongly influenced by marine regression and transgression events since the Early to Mid Tertiary (ca. 50 million years ago).

Several soil assessments have been conducted over the Tutunup South disturbance area (SWC, 2007a; 2007b; 2008). The physical and chemical properties of the soils have been characterised and soils that may develop adverse properties during mining and rehabilitation identified. The baseline soil studies describe five soil mapping units (SMU) that exist over the disturbance area (Figure 6).



PN	PN0094-1-1-IR-069		Iluka Resources Limited TUTUNUP SOUTH **TYPICAL SMU PROFILES**
Prep by	ASP	29/05/07	
Rev'd by	AJH	29/05/07	
Revision No.		0	

Figure 6

5.4.1 Soil Mapping Units

The following five SMU have been mapped over the Tutunup South soil survey area (Figure 7):

- SMU 1: Exposed Laterite

  Exposed laterite occurs east of the disturbance area. Limited soil cover occurs over the laterite (approximate thickness 1.5 m), indicating that this area is subject to erosive influences. Any soil development from weathering or breakdown of laterite is transported downslope. Below the laterite layer are mottled sandy clays of the Leederville Formation.

- SMU 2: Gravelly Duplex Soil

  Gravelly duplex soils exist downslope of the exposed laterite, which have formed by deposition of gravels from the exposed laterites. The soil profile consists of a dark brown loamy sand of approximately 15 cm depth overlying yellow sandy gravel up to 1 m deep. Beneath the gravel there is a horizon of mottled clayey sand to sandy loam of the Yoganup Formation to about 4.5 m below ground level before transitioning into blue grey sandy clay of the Yoganup Formation.

- SMU 3: Deep Yellow Sandy Duplex

  SMU 3 is downslope of SMU 2, formed by the deposition of yellow sands from the upslope laterites of the Whicher Scarp onto sandy clays. The soil profile comprises a topsoil of dark brown loamy sand overlying 6 m of yellow sand (Yoganup Formation). Pale grey clayey sand/sandy loam lies beneath the yellow sand.

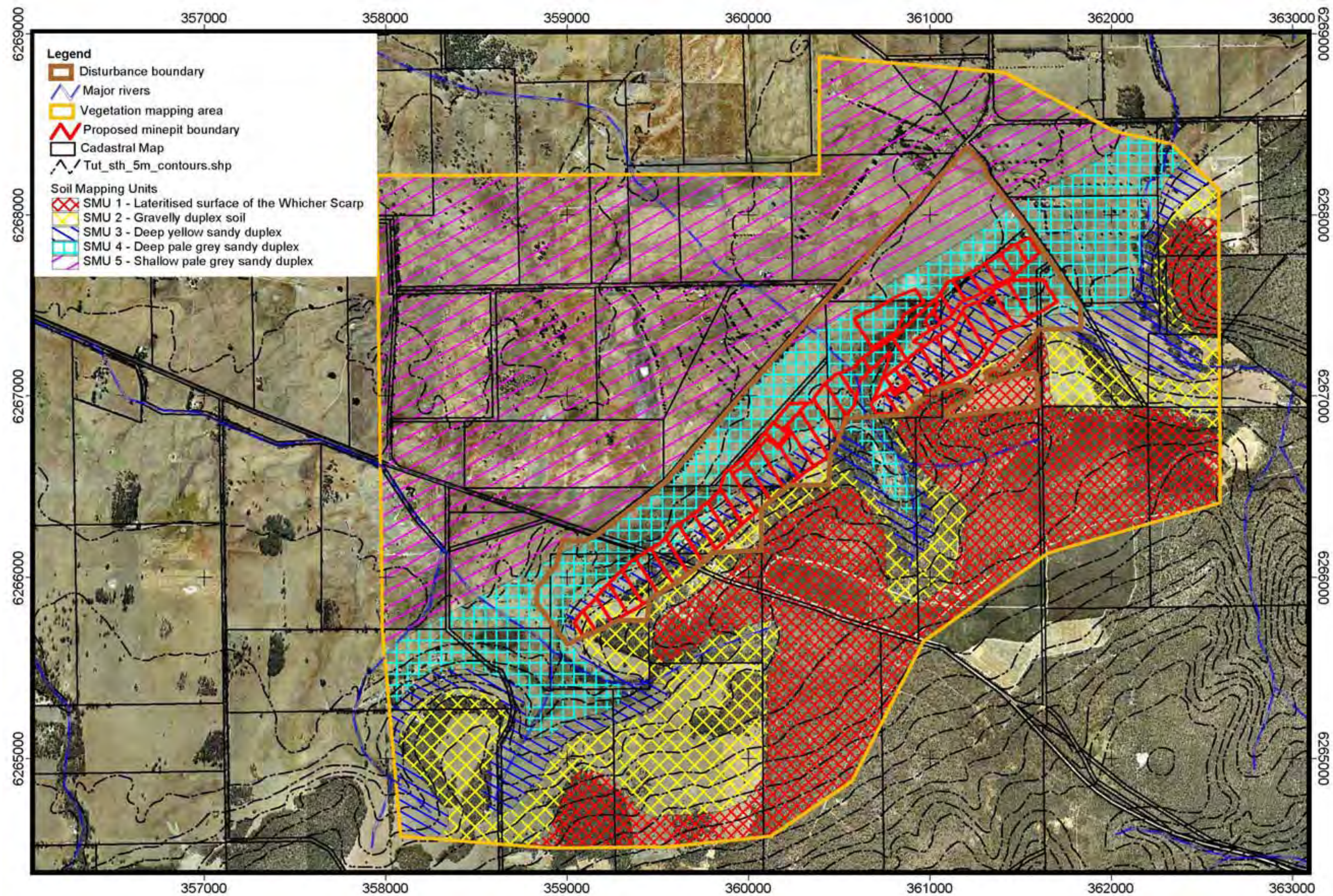
  SMU 3 is predominant in the northern end of the survey area, having a width of up to 400 m, whilst at the southern end of the survey area the width varies from less than 20 m to 150 m.

- SMU 4: Deep Pale Grey Sandy Duplex

  The deep pale grey sandy duplex is further downslope of SMU 3 representing soils under permanent reducing conditions characterised by shallow groundwater levels and subject to seasonal inundation. The soil profile is comprised of dark brown loamy sand overlying approximately 3.5 m of pale grey sand (Bassendean Sands). Below this is the pale grey clayey sand/sandy loam of the Yoganup Formation. These soils generally extend over the western half of the mine pit and the intrastructure areas to the west of the mine pit.

- SMU 5: Shallow Pale Grey Sandy Duplex

  The shallow pale grey sandy duplex is present over a relatively small area at the northern end of the project. It is comprised of a dark brown sandy loam overlying approximately 1 m of pale grey sand. Below the sand is a blue grey sandy clay representing the Guildford Formation.



PN	PN0095-1-1-IR-074		Iluka Resources Limited TUTUNUP SOUTH GDE ASSESSMENT **SOIL DISTRIBUTION (SWC, 2007)**	**Figure 7**
Prep by	ASP	29/05/07		SWC
Rev'd by	AJH	29/05/07		
Revision No.		0		

5.4.2 Radiation

All naturally occurring rocks and soils contain small amounts of radioactive elements Thorium and Uranium (radionuclides). The background gamma radiation level of the earth's surface is largely due to the presence of these elements. These radionuclides are not soluble and do not break free from the sand. The reason they are still present is due to the decay half life being millions of years.

Background radiation levels in the South West region of Western Australia are typically in the order of 0.2 to 0.3 micrograys per hour (uGy/h), however this varies commensurate with the concentration and composition of soils and minerals present. For example the Darling Scarp comprised of a mostly granitic lithology, tends to have higher background radiation levels than sandy soils.

Mineral sands naturally contain more radionuclides than the clays and sands on the surface soil horizons. Throughout the mining process, controls are in place to prevent any potential alteration to the natural background radiation of mining areas. Both "pre-mining" and "post-mining" radiation surveys are conducted. This ensures that the natural background radiation levels remain unchanged as a result of mining.

5.5 Groundwater

5.5.1 Superficial Aquifer

The project is located at the foot of the Whicher Scarp on the Swan Coastal Plain within the Southern Perth Basin. It is within the Capel subdivision of the Busselton-Capel Groundwater Area.

An unconfined groundwater lens in the Bassendean Sands is caused by low permeability clays of the Guildford Formation retarding the downward flow of groundwater (Figure 8). This results in perching of shallow groundwater, seasonal waterlogging and the expression of wetlands in local depressions. The Guildford Formation itself is described by Parsons Brinkerhoff (2006) as a discontinuous aquifer/aquitard having a low transmissivity due to its clay particle size, thus forming a hydraulic barrier below and above it.

Below the Guildford Formation lies the sandy beds of the Yoganup Formation. Test pit excavations at Tutunup South have confirmed this to be a greater yielding aquifer than those above it. The mineral sands ore zones are also within Yoganup Formation and thus are expected to be where the bulk of groundwater interception during mining will be encountered. Recharge is limited where the Guildford Formation overlies the Yoganup Formation. However, the presence of the Whicher Scarp enables recharge of the Yoganup Aquifer where the Guildford Formation is absent and from the Leederville Formation which is elevated in the Whicher Scarp, compared to the Yoganup Formation on the coastal plain (SWC 2008).

Groundwater flow is to the north-west between Capel and Donnybrook, and salinity is generally less than 500 mg/L, deteriorating with depth.

5.5.2 Leederville Aquifer

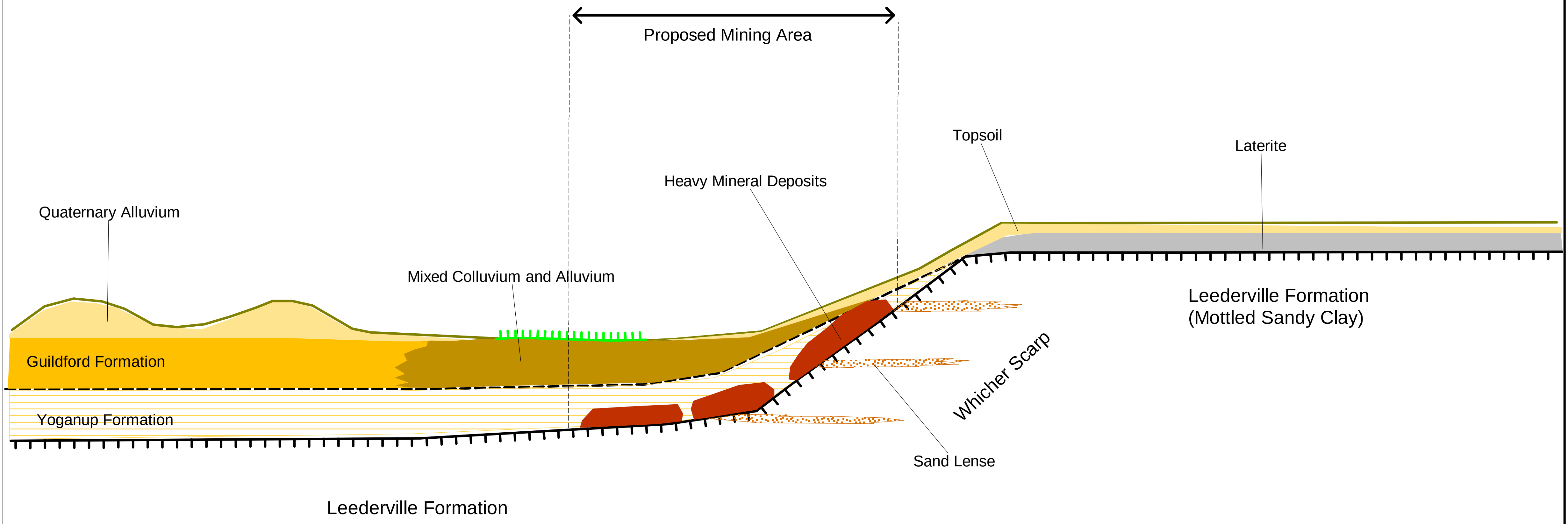
The Leederville Aquifer subcrops extensively beneath the superficial aquifer in the area and comprises inter-layered sandstones and shales of the Leederville Formation (Figure 8). Regional recharge is provided through infiltration of rainfall on the Blackwood Plateau to the south and by localised downward leakage from the superficial aquifer or upward leakage from the Yarragadee Formation. Where present, the Bunbury Basalts act as a strong aquiclude impeding vertical groundwater movement. Bunbury Basalts have been encountered by exploration drilling towards the northern end of the project. Groundwater flow in the Leederville Aquifer is to the northwest, discharging into the ocean via the Leschenault Inlet.

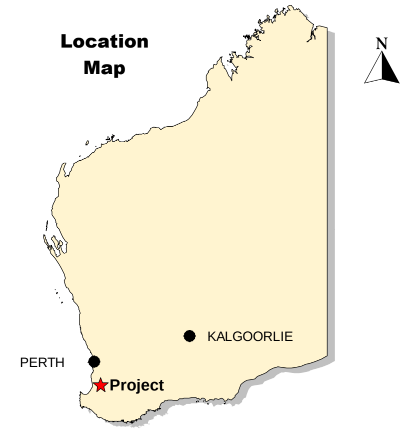
5.5.3 Yarragadee Aquifer

The Yarragadee Aquifer forms the major groundwater resource in the Bunbury-Busselton region. The aquifer is hosted by the weakly consolidated sandstone, siltstone and shales of the Yarragadee Formation (Figure 8). Recharge is principally achieved by leakage from superficial aquifers where the Leederville Formation and Bunbury Basalts are absent.

5.5.4 Local Groundwater Users

Groundwater users close to the Tutunup South site are agricultural residences extracting water predominantly from the superficial aquifer from shallow bores and wells. The main use of groundwater is stock water supply, but also includes domestic supply and irrigation.





LEGEND

- Ground
- Sand Lenses
- Yoganup Formation
- Guildford Formation
- Quaternary Alluvium
- Mixed Colluvium and Alluvium
- Heavy Mineral Deposits
- Laterite
- Leederville Formation

Not To Scale

aquaterra

Figure 8

Geology Cross-Section

Date: 10/05/07
Revised:23/05/07
Report No.:
Scale: Not to Scale

Projection: N/A

F:\jobs\F:\Jobs\706\Data\Mapinfo\Figures

5.6 Acid Sulfate Soils

Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS) are collectively known as Acid Sulfate Soils (ASS). AASS are soils or sediments that once contained pyrite or other sulphide minerals that have been exposed to air to generate sulphuric acid, giving these soils a pH of <4. PASS are soils or sediments which contain pyrite or other sulphide minerals that have not been exposed to air. Thus, PASS soils typically have pH values >4 and can be neutral to alkaline (pH 7-9; SWC 2008).

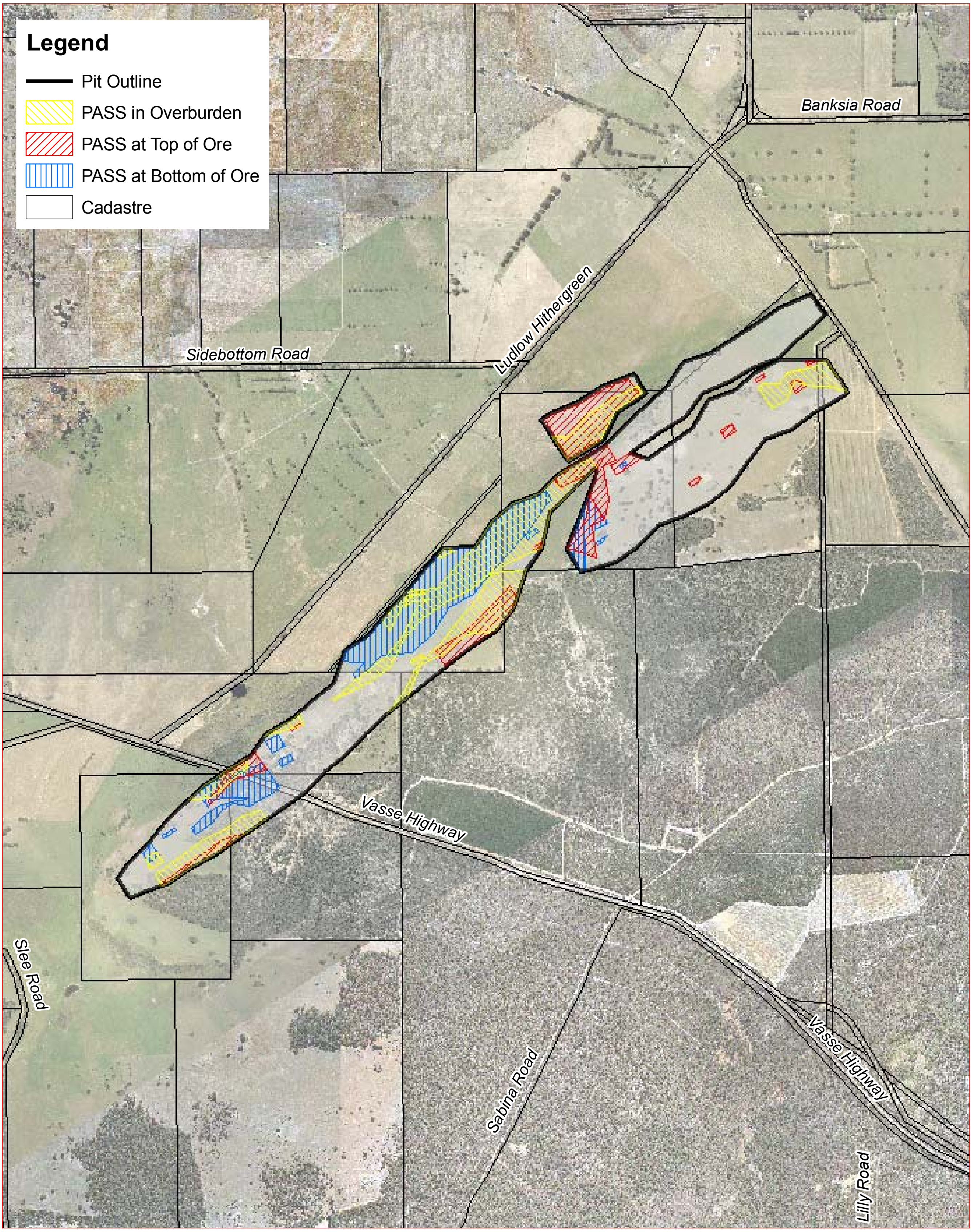
An extensive ASS drilling and analysis program was undertaken in 2006-2007 to identify the occurrence of AASS and PASS across the site (SWC 2008). In addition a third party review of the program was undertaken (Sullivan 2007). Many of the recommendations made by this peer review have been incorporated into the program and Acid Sulfate Soil Management Plan included as Appendix 3.

ASS occurs within the proposed disturbance area (Figure 9). In response to the geomorphic setting at this site the distribution of ASS is restricted to the central and western portions of this area, and only mining along the western margin of the proposed mine pit will actively disturb ASS materials. In the disturbance area both AASS and PASS occur. The presence of AASS in this area indicates that oxidation of PASS has already occurred at this site.

No AASS was identified within the overburden material, however a minor amount occurs along the western margin of the proposed mine pits. Only the deepest orebody is likely to intersect AASS.

Using a conservative assessment of PASS occurrence (see Appendix 3, section 2.1.1), it is estimated that of a total of 4,652,000 tonnes of overburden, 514,600 tonnes (11 %) is potentially PASS affected. Of a total of 10,402,000 tonnes of ore, it is estimated that 1,430,000 tonnes (approximately 14 %) is PASS affected.

PASS occurs adjacent to the proposed mine pit on the western side of the disturbance area (Appendix 3). This material occurs throughout the soil profile and previous oxidation of this PASS has occurred resulting in AASS being present. Although direct disturbance of this material will not occur during mining, indirect disturbance through pit dewatering and reducing groundwater levels has the potential to oxidise this PASS and release of acidity into groundwater.



NOTE:
Aerial Photography dates:
Site - Nov 2005
Regional - 2001

N

0 500 1000 1500 m

MGA Coordinates, GDA94

ILUKA

ORIG: S.J.

DRAWN: D.L.S.

SCALE: 1:20,000

DATE: Sept 2007

TUTUNUP SOUTH

DISTRIBUTION OF PASS WITHIN MINE PITS (pH FOX <3.31)

DWG No: 176751v00

A4 **FIGURE:** 9

5.7 Surface Hydrology

The project is located over two catchment areas, the Vasse-Wonnerup Estuary catchment (Abba River) and the Upstream Vasse-Sabina catchment (Sabina River) (Figure 10). Despite the close proximity of the Abba River east of the project, the site drains to the north and west, reporting to the Sabina River (Figure 11 and Figure 12). A small creekline (Woddidup Creek) exists to the south-west of the disturbance area (represented as T3 on Figure 11) and two small seasonal drainage lines cross the project (represented as D1 and D2 on Figure 11). The northern drainage line flows from the Whicher Scarp across the project area. The southern drainage line originates within the project area. Site topography and drainage is shown in Figure 12. Flow from both drainage lines and Woddidup Creek is diverted into a roadside drain at Sidebottom Road (Government of Western Australia, 2002). The drains flow into the Sabina River over 6 km downstream of the project. Approximately 200 m further downstream, flow in the Sabina River is diverted to the Vasse Diversion Drain (Government of Western Australia, 2002).

Extensive modification has occurred as a result clearing and the installation of drainage systems (Government of Western Australia, 2002).

Wetland Research and Management (WRM 2006) surveyed Woddidup Creek (T3 on Figure 11) and found it to be slightly disturbed due to local weed infestations and cattle access. Overstorey along the creek consists of a moderately dense stand of *Eucalyptus patens*. The understorey consists of dense, tall sedges, Myrtaceaous species and bracken fern. The sedge *Lepidosperma tetraquetrum* fringes the creek. No erosion or bank slumping was evident, although sedimentation was present at cattle crossing points. Given the extensive clearing in the area, the creekline was considered by WRM (2006) to be of high conservation value. The River Action Plan for the Sabina, Abba and Ludlow Rivers (Government of Western Australia, 2002) describes this section of the creek as unfenced and grazed with a number of weeds present.

There are extensive wetland areas in the region. Wetland areas can be significant at a number of levels. Internationally significant wetlands are recognised as being listed under the Ramsar convention. Wetlands of national significance are listed under the Directory of Important Wetlands and/or on the Australian Heritage Commission's Register. There are also three levels of protection afforded to wetland areas by the State. The highest level of protection is for Conservation Category wetlands, followed by Resource Enhancement Category wetlands and Multiple Use wetlands.

The nearest wetland of international significance is the Vasse-Wonnerup Estuary, which lies more than 13 km to the northwest of the Tutunup South project area (Figure 10) and is not hydrologically linked to the project area.

The closest Wetland of National Significance to the project is McCarley's Swamp, 14 km to the north (ANCA 1996, cited in WRM 2006). This fresh wooded swamp is one of the few permanent wetlands of its type remaining in the south of the Coastal Plain (ANCA 1996, cited in WRM 2006). McCarley's Swamp is not hydrologically linked to the Project area and lies outside the zone of influence from mine-dewatering activities (Figure 10).

There are no EPP wetlands or Conservation Category wetlands within 1km of the project area. The nearest Conservation Category wetland is 2 km east of the project on the Abba River. This wetland is located on the Whicher Scarp and thus is not hydrologically linked to the wetlands at Tutunup South.

The lower land within the project area contains two Multiple Use wetlands as mapped by Hill *et al* (1996). They are UFI 596, classified as floodplain, closer to the scarp, and UFI 13199, classified as Palusplain wetland. The wetlands are remnants of a linear paluslope/riverine wetland system that originally ran south-west across the site prior to historical clearing for agricultural purposes. Paluslope-type wetlands are seasonally waterlogged wetlands with a gentle topographic gradient (Semeniuk and Semeniuk 2004).

There is a high degree of disturbance within the wetlands and vegetation remains in two areas of the floodplain wetland, occurring over 1 km apart. The rest of the wetlands mapped by Hill *et al* (1996) are cleared for agricultural purposes. The areas with vegetation remaining which retain greater wetland function than the areas actively used for agriculture are discussed as the ‘northern’ and ‘southern’ wetlands. The northern wetland is represented as T1 and the southern wetland is represented as T2 on Figure 11.

A site surface water assessment has been conducted by Wetland Research and Management (WRM 2006). The survey work considered the northern and southern wetlands within the project to be compatible with Resource Enhancement category wetlands. Further assessment and liaison with DEC was undertaken, though the wetland classification has remained as Multiple Use.

A further wetland review was undertaken in 2007 by Biota to consolidate existing studies on the biological aspects of the Tutunup South wetlands and to place their attributes into context with similar ecological systems in the locality (Biota 2007c). Four other wetlands were considered to be equivalents to the Tutunup South wetlands at a broad comparison level being located within the south-eastern extent of the Swan bioregion, remnant paluslope wetlands and Cartis complex vegetation. DEC (pers. comm., author unknown) notes that wetlands associated with the Cartis vegetation complex are recognised as Foothills Paluslope Wetlands. Four wetland sites were selected and the comparative measures are summarised below.

Table 4: Summary comparison of wetland attributes (Biota, 2007)

Attributes	Tutunup South Wetlands	Comparison Sites			
		Cable Sands Wetland	Gavin's Road Wetland	Yoganup Wetland	Yoganup S Wetland
Approximate extent	9.3 ha (four discontinuous units)	4.0 ha	17.7 ha	69.6 ha	8.8 ha
Location relative to Tutunup South		27km to the north east	25km to the north east	14km to the north east	12km to the north east
Geomorphology	Gentle sloping sand and clay flats, incised drainage in south-west	Gentle sloping sand and clay flats	Gentle sloping sand and clay flats	Gentle sloping sand and clay flats, mosaiced with low linear sand ridges	Gentle sloping sand and clay flats
Hydrology	Seasonal waterlogging, seasonal inundation	Seasonal water-logging	Seasonal water-logging	Seasonal water-logging	Seasonal water-logging
Wetland types	Paluslope/Palusplain	Paluslope/Palusplain	Paluslope/Palusplain	Paluslope/Palusplain	Paluslope/Palusplain
Flora diversity	101 plant taxa	No data available	No data available	No data available	300 taxa in project area (a subset occurs in the wetland)
Dominant flora taxa:					
M. preissiana	Yes	Yes	Yes	Yes	Yes
M. rhaphiophylla	Yes			Yes	Yes
T. linearifolia	Yes		Yes	Yes	Yes
A. fascicularis	Yes	Yes	Yes	Yes	
A. scoparia	Yes				Yes
C. avenacea	Yes		Yes		Yes
Vegetation Complex	Cartis complex	Cartis complex	Cartis complex	Cartis complex	Cartis complex
Mammals	6 species recorded, one Priority 4 taxon (*Isoodon obesulus fusciventer*)	4 of the Tutunup South mammal species recorded from adjacent area	4 of the Tutunup South mammal species recorded from adjacent area	No site specific data, but 3 of the Tutunup South mammal species recorded from nearby Yoganup 215	No site specific data, but 3 of the Tutunup South mammal species recorded from nearby Yoganup 215

Attributes	Tutunup South Wetlands	Comparison Sites			
		Cable Sands Wetland	Gavin's Road Wetland	Yoganup Wetland	Yoganup S Wetland
Herpetofauna	9 species recorded, all common in the bioregion	6 of the Tutunup South herpetofauna species recorded from adjacent area	5 of the Tutunup South herpetofauna species recorded from adjacent area	No site specific data, but 5 of the Tutunup South herpetofauna species recorded from nearby Yoganup 215	No site specific data, but 5 of the Tutunup South herpetofauna species recorded from nearby Yoganup 215
Avifauna	35 species recorded, all common in the bioregion	19 of the Tutunup South bird species recorded from adjacent area	No data available	No data available	21 species recorded, 60% of which also occurred at Tutunup South
Aquatic Invertebrates	98 taxa recorded. Six 'rare'* species, two of which were not found in any other wetland	No data available	One 'rare' species recorded that was not found at any other wetland.	No data available – dry at time of survey in November 2007	Three 'rare' species found, two of which were also identified from Tutunup South.
Survey Effort	Site inspection Systematic fauna survey Systematic flora survey Wetland survey	Site inspection Systematic fauna survey (data from 800m outside site) Systematic flora survey Wetland survey	Site inspection Systematic fauna survey (data from 200m outside site) Wetland survey	Site inspection Wetland survey	Site inspection Systematic flora survey Wetland survey

* Microinvertebrate species new or potentially new to science and/or new records for Western Australia, as collected by WRM in 2005 and 2007.

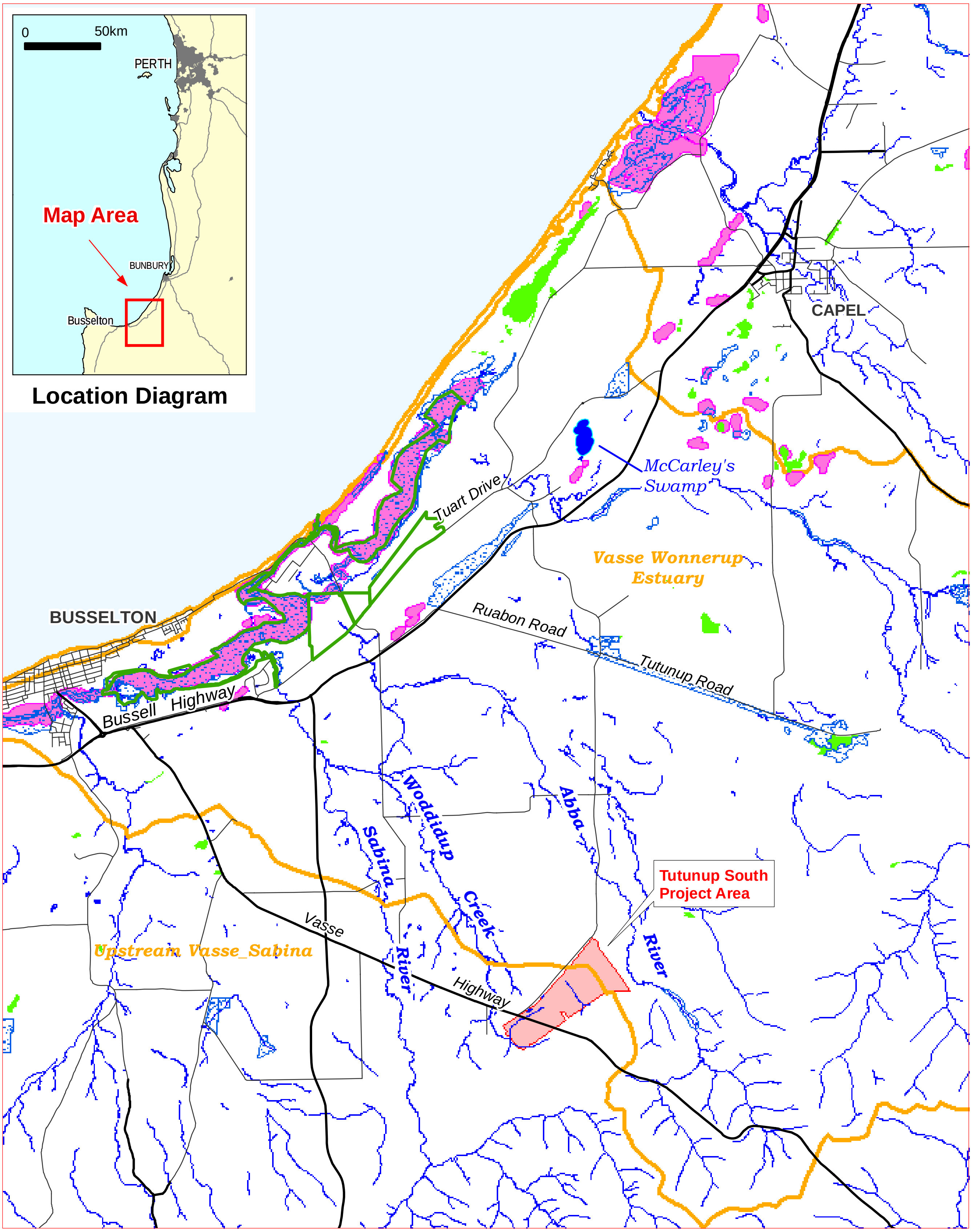
The results of this review indicate that there are other broadly similar wetlands in the locality that clearly replicate some of the ecological attributes of the Tutunup South wetlands. This includes occurring in the same locality, within the same bioregion, the same vegetation complex and being of the same wetland type. Through the comparative wetland study it was identified that:

- a number of other larger and more intact wetlands that are hydrologically and geomorphologically similar to the Tutunup South wetlands occur in the Whicher Scarp locality;
- none of the terrestrial fauna species associated with the Tutunup South wetlands are restricted to that site;
- none of the terrestrial flora species occurring at the Tutunup South wetlands are restricted to that site; and
- 98% of the aquatic taxa at the Tutunup South wetlands (both macro and microinvertebrates) are not restricted to the site (Biota 2007c).

Surface water quality samples were taken from Tutunup South during the aquatic survey in November 2005. From the results obtained, all sites (two wetlands plus minor stream-flow from the seasonal creek) contained fresh water ranging from 443 uS/cm to 693 uS/cm. Water quality was also described as being acidic for all sites (4.53 to 5.98) when compared with the ANZECC/ARMCANZ (2000) trigger values. Total suspended solids (TSS) were low at all sites ranging from 2 mg/L to 11 mg/L.

In terms of eutrophic potential, all sites had a low dissolved oxygen concentration (57-59%), although only the southern wetland had nitrogen (1.5 mg/L) and phosphorous (0.06 mg/L) concentrations in excess of ANZECC/ARMCANZ (2000) trigger values for freshwater ecosystems. The northern wetland and stream site T3 both had low concentrations of nutrients, indicating these have less exposure to agricultural influences than the southern wetland.

Using the ANZECC/ARMCANZ (2000) 95% guidelines for the protection of freshwater ecosystems aluminium and zinc were found to exceed trigger levels. The result for aluminium is not unexpected as it has been previously recorded in high concentrations during assessment for other sites and is expected to be related to the known occurrence of acid sulphate within the project area. All hydrocarbon analyses returned low concentrations.



Legend

- Wetland - Conservation category
- Wetland - Resource enhancement
- Important wetland
- Wetlands (DEP)
- Hydrographic catchments
- Drainage
- Ramsar site
- Project area

N

0 2.5 5 km

ILUKA

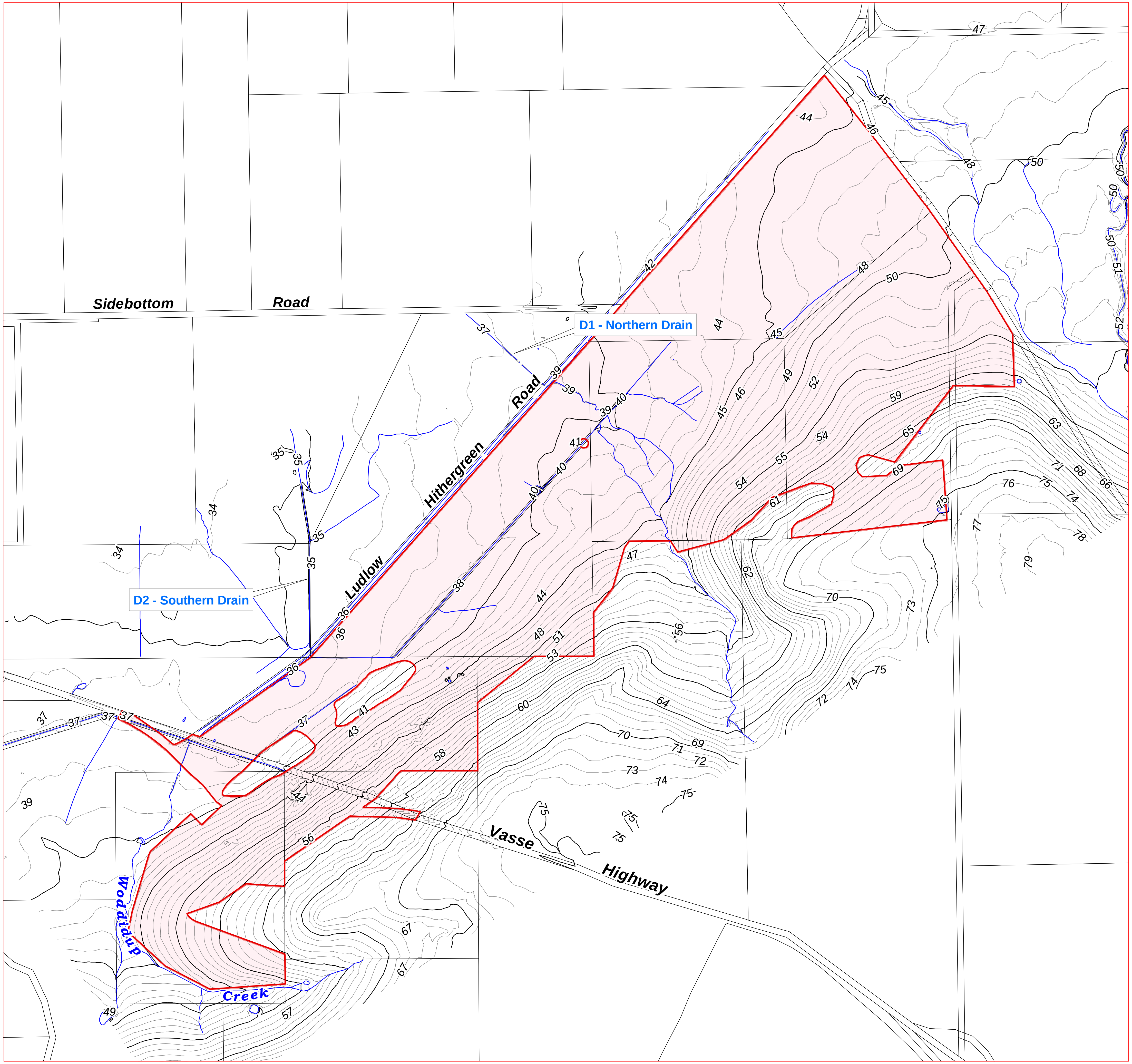
ORIG:	S.Edwards
DRAWN:	D.G.S.
SCALE:	1:150,000
DATE:	22 Jan. 2008

TUTUNUP SOUTH

CATCHMENT PLAN

DWG No: 178083 ver.0 A4 FIGURE: 10

Legend
Aquatic Monitoring Locations
Photo locations and direction
Drains
Proposed disturbance area
Inundation Areas
Regional Aerial Photo - Skyview 2001
Photo 12 - August 2007
Photo 1 - August 2007
Photo 2 - August 2007
Photo 3 - August 2007
Photo 4 - August 2007
Photo 11 - August 2007
Photo 10 - August 2007
Photo 9 - August 2007
Photo 8 - August 2007
Photo 7 - August 2007
Photo 6 - August 2007
Photo 5 - August 2007
23/08/2007
Photo 12
Photo 11
Photo 10
Photo 1
Photo 2
Photo 3
Photo 4
Photo 5
Photo 6
Photo 7
Photo 8
Photo 9
D1 - Northern Drain
D2 - Southern Drain
T1
T2
T3
Woddidup Creek
SABINA RIVER
N
0
500
1,000 m
ILUKA
TUTUNUP SOUTH
REGIONAL DRAINAGE
ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:15,000
DATE: 8 April 2008
DWG No: 176769 ver.02
A2
FIGURE: 11



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	S.E	D.G.S	04.12.07	Original Design
01	S.J	T.L.G	08.04.08	Update of disturbance area

Legend

- Drainage features
- Disturbance area
- Contour (1m)
- Index contour (5m)

N

0 250 500 m

ILUKA

ORIG:	S.Jones
DRAWN:	T.L.G
SCALE:	1:12,500
DATE:	8 April 08

TUTUNUP SOUTH

EXISTING SURFACE DRAINAGE

DWG No: 178472 ver.01 A3 FIGURE: 12

5.8 Flora and Vegetation

A flora and vegetation assessment was conducted over the Tutunup South project area and surrounds (survey area) by Mattiske Consulting Pty Ltd in November 2005, supplemented by further work in January 2007 and September 2007 (Mattiske Consulting Pty Ltd 2007). Due to unseasonably cool and wet spring weather received in 2005, November was identified as being within an optimal range for surveying at Tutunup South. The November 2005, January 2007 and September 2007 survey work complemented earlier flora work by Hart Simpson and Associates Pty Ltd (1996).

The survey work and vegetation assessment was conducted in accordance with EPA Position Statement No. 2 (EPA 2000) and Guidance Statement No. 51 (EPA 2004d).

Natural areas present have been considered in respect of the criteria outlined in Guidance Statement 10 (EPA, 2006c). The following criteria have been identified as relevant to the Tutunup South Project and discussion on these criteria can be found in the sections noted:

Table 5: Guidance Statement 10 criteria - flora

Criterion	Consideration in regard to natural areas at Tutunup South
Representation of ecological communities	The ecological communities present are detailed in section 5.8, specifically under sections 5.8.2 and 5.8.3. These sections provide detail on the vegetation complexes within the survey area and their significance (in reference to Swan Coastal Plain and RFA mapping); and provides detail on the specific vegetation communities located within the survey area, as well as their similarities to floristic communities as defined by Gibson et al. (1994) with specific consideration of those floristic community types which are listed TECs. Section 9.5.3 outlines the potential for impact to ecological communities directly through clearing and indirectly through dewatering. The combined potential impact and broad management strategies are addressed in section 0.
Diversity	The diversity of the flora within the survey area is detailed in section 5.8.1. This section details the number of taxa (including subspecies and varieties), genera and families recorded in the area surveyed, as well as detailing how many of those are introduced and how many are listed priority flora (no DRF were located) or otherwise considered to be significant. Sections 9.5.3 and 0 detail the potential for impact to significant flora
Rarity	As above, listed rare or priority flora as well as other species considered to be significant are detailed in section 5.8.1 and similarities to TECs are outlined in section 5.8.3. Sections 9.5.3 and 0 detail the potential for impact to significant flora.
Maintaining ecological processes or natural systems	The presence and degree of disturbance of existing ecological linkages is noted in section 5.8.2 and the potential for disturbance to linkages and therefore to the maintenance of ecological processes is discussed in section 9.5.3. The opportunity to improve ecological function between the wetlands and the State Forest is described in section 13.

Criterion	Consideration in regard to natural areas at Tutunup South
Protection of wetlands and streamline vegetation	Description of watercourses and wetlands present at the site is provided in section 5.7. The potential for impact to the southern wetland and its associated vegetation (vegetation areas 6 and 7) and to Woddidup Creek and its associated vegetation (vegetation area 57) is discussed in section 9.5.3. Further management of these areas is described in the Flora, Vegetation and Dieback Management Plan.
Scientific or evolutionary importance	The investigations carried out at Tutunup South did not find species or habitats that are of scientific or evolutionary importance

5.8.1 Flora

A total of 399 taxa (including subspecies and varieties) from 206 genera and 66 families have been recorded over multiple seasons in the area surveyed. This includes 58 introduced taxa with two of these, the Arum Lily (*Zantedeschia aethiopica*) and Cape Tulip (*Moraea flaccida*) being Declared Plants pursuant to Section 37 of the *Agriculture and Related Resources Protection Act 1976.* Both the Arum Lily and Cape Tulip have P1 and P4 classifications, prohibiting the movement of contaminated machinery, plants and seeds from the property, and obliging the landowner to treat to destroy Declared Plants (Mattiske Consulting Pty Ltd 2007).

A review of the Department of Environment and Conservation (2007a) Declared Rare and Priority Flora List indicates that 11 Rare, two Priority 1, four Priority 2, 15 Priority 3 and 11 Priority 4 species may occur in the Tutunup South area. Of note was a WA Herbarium record of the Declared Rare Flora (DRF) *Dryandra nivea* subsp. *uliginosa* at the northeastern corner of the project area (Figure 13). Despite searching for species recorded on the Declared Rare and Priority Flora List, no DRF under the *Wildlife Conservation Act 1950* or flora listed pursuant to section 179 of the *Environment Protection and Biodiversity Conservation Act 1999* were identified during any of the three flora studies.

Ten priority flora species pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act 1950* and as listed by the Department of Environment and Conservation (2007a and 2007b) were located in the vicinity of the project (Mattiske Consulting Pty Ltd 2007; Figure 13). These are identified below:

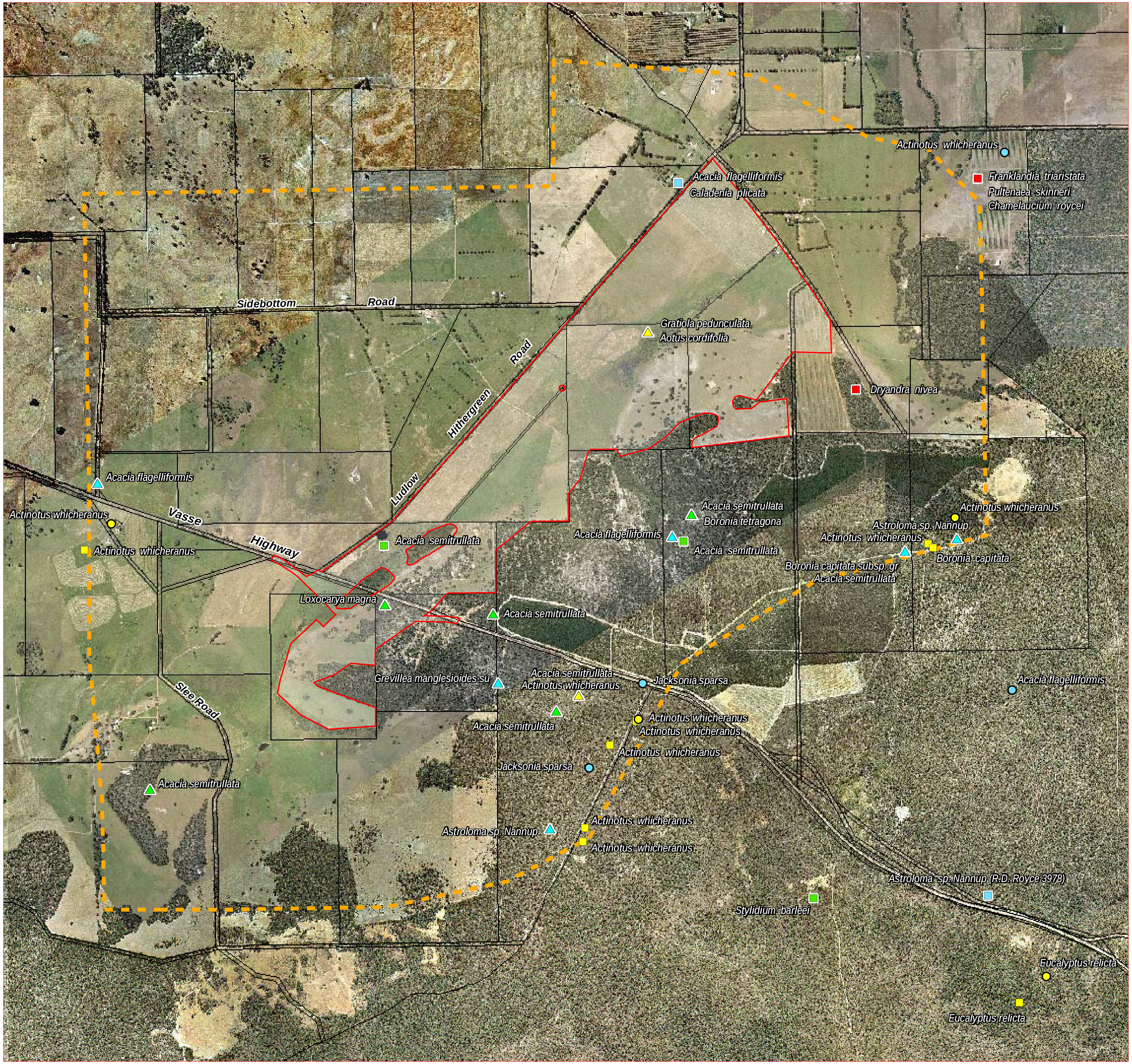
- *Acacia flagelliformis* (P4) – known from 23 records at the WA Herbarium;
- *Acacia semitrullata* (P3) – known from 62 records at the WA Herbarium;
- *Actinotus whicheranus* (P2) – known from 7 records at the WA Herbarium;
- *Aotus cordifolia* (P3) – known from 36 records at the WA Herbarium;
- *Astroloma* sp. Nannup (P4) – known from 55 records at the WA Herbarium;
- *Boronia capitata* subsp. *gracilis* (P2) – known from 15 records at the WA Herbarium;
- *Boronia tetragona* (P3) – known from 9 records at the WA Herbarium;
- *Gratiola pedunculata* (P2) – known from 5 records at the WA Herbarium (one previous record on the Swan Coastal Plain);

- *Grevillea manglesioides* subsp. *ferrricola* (P2) known from 21 records at the WA Herbarium; and
- *Loxocarya magna* (P3) – known from 18 records at the WA Herbarium.

Cyathochaeta teretifolia (P3) is currently known from 28 records at the WA Herbarium. This taxon occurs in winter wet sands on the southern Swan Coastal Plain from Yarloop southwards towards Augusta and the Donnybrook Sunklands (Department of Environment and Conservation 2007a). This taxon was not recorded in the survey area, but from discussions with other botanists, may potentially be in the locality (Mattiske Consulting Pty Ltd, 2007). As this taxon occurs in a range of locations and is protected in state forest areas south of the proposal area, this taxon is not threatened by this proposal (E. M. Mattiske, pers. comm.).

In addition to the aforementioned list of priority flora, several other taxa found within the surveyed area are considered to be significant by Webb *et al* (2006). These represent key species within the remnant vegetation of the Whicher Scarp and Swan Coastal Plain given much of the surrounding land has been cleared for agriculture. These significant species are described below (Mattiske Consulting Pty Ltd 2007):

- *Grevillea pulchella* subsp. *ascendens* - recorded in E1 plant community.
- *Actinostrobus acuminatus* - recorded in E1 plant community. This taxon is known from disjunct distributions and as such is of bio-geographical interest.
- *Andersonia micrantha* - recorded in E1 and S1 plant communities. This taxon is known from scattered collections.
- *Beaufortia squarrosa* - recorded in B1 and S1 plant communities.
- *Conospermum acerosum* - recorded in E1 plant community.
- *Daviesia divaricata* subsp. *divaricata* - recorded in E1 plant community.
- *Eremaea pauciflora* var. *pauciflora* - recorded in E1 plant community.
- *Corymbia haematoxylon* - this species was recorded regularly in the E1, E2, M1, M2, S1 and S2 communities. Although of interest, this species occurs northwards to Mount Lesueur and from the Darling Scarp to the Whicher Scarp. Its dominance in the Whicher Scarp communities is more evident.
- *Hibbertia acerosa* - recorded in E1 plant community.
- *Petrophile serruriae* - recorded in E1 plant community.
- *Pityrodia bartlingii* - recorded in E1 and S1 plant communities.
- *Pultenaea radiata* - recorded in E1 and E2 plant communities.
- *Synaphea whicherensis* - recorded in E1 plant community.
- *Taxandria fragans* (ms) - recorded in M1 and S2 plant communities and is an indicator species for the S2 vegetation community.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S.	D.G.S.	12.09.07	Original version
01	S.J.	D.G.S.	10.03.08	Rare flora (DEFL) added

Legend

Study area

Disturbance area

Rare and priority species

	Herbarium	MCPL	DEFL
Rare	■	▲	●
P1	■	▲	●
P2	■	▲	●
P3	■	▲	●
P4	■	▲	●

Date of photography
Inset: 19 Nov. 2007 Regional: 2001

N

0 500 1,000 m

ILUKA

TUTUNUP SOUTH

LOCATIONS OF PRIORITY FLORA

ORIG: S.Jones
DRAWN: D.G.S.
SCALE: 1:20,000
DATE: 10 March 2008 | DWG No: 176772 ver.01 | A3 | FIGURE: 13

5.8.2 Vegetation

The survey area lies within the Drummond Botanical Subdistrict of the South-western Botanical Province (Diels, 1906; Gardner, 1942; and Beard, 1979 and 1980; cited in Mattiske Consulting Pty Ltd, 2007).

In vegetation mapping it is necessary to define and map the plant communities into groups with common characteristics in structure and floristics (Mattiske Consulting Pty Ltd, 2007). The classification system of Heddle *et al*, 1980a) utilised the concept of vegetation complexes and emphasised the relationships between the underlying landforms, soils and the plant communities. This classification system incorporated linkages with the previous work by Havel (1975a and b) (cited in Mattiske Consulting Pty Ltd, 2007).

The complexes on the Swan Coastal Plain were defined and mapped by Heddle *et al* (1980a). The vegetation complexes on the adjacent Darling Scarp and Plateau were revised and mapped by Mattiske and Havel (1998) for the purposes of the Regional Forest Agreement (RFA) (Mattiske Consulting Pty Ltd, 2007).

The Tutunup South survey area occurs near the interface between Cartis and Abba vegetation complexes as defined by Heddle *et al* (1980a), namely:.

- **Abba** - A mixture of open forest of *Corymbia calophylla – Eucalyptus marginata – Banksia* spp. and woodland of *Corymbia calophylla.* Abba is similar to Forrestfield and Guildford vegetation complexes, but differs in the lack of *Eucalyptus wandoo*.
- **Cartis** - Low open forest to open forest of Eucalyptus marginata subsp. marginata – *Corymbia calophylla-Corymbia haematoxylon* over *Banksia* species on the Whicher Escarpment.

Both the Abba and Cartis vegetation complexes have been cleared by agricultural land uses.

In the recent Regional Forest Agreement (RFA) vegetation project, Mattiske and Havel (1998) further refined these complexes, though only a small portion of the Abba complex fell within the RFA area (E M Mattiske, pers. comm.). Within the Tutunup South survey area, the refined complexes include the Abba (AB and Aw), Yelverton (Y, Yd and Yw) and Whicher Scarp (WC) complexes:

- **Abba** (AB) – Woodland and Open Forest of *Corymbia calophylla* on flats and low rises in humid zones.
- **Abba** (Aw) - Mosaic of Tall Shrubland of *Melaleuca viminea* and Woodland of *Eucalyptus rudis - Melaleuca rhaphiophylla* with occasional *Corymbia calophylla* on broad depressions in the humid zone.
- **Yelverton** (Y) – Woodland of *Eucalyptus marginata* subsp. *marginata – Corymbia calophylla – Allocasuarina fraseriana – Agonis flexuosa* and open woodland of *Corymbia calophylla* on undulating uplands in the humid zone.
- **Yelverton** (Yw) – Woodland *of Allocasuarina fraseriana – Nuytsia floribunda – Agonis flexuosa – Banksia attenuata* on slopes and open forest of *Corymbia calophylla – Eucalyptus patens – Eucalyptus marginata* subsp. *marginata* on the lower slopes and woodland of

Eucalyptus rudis – Melaleuca rhaphiophylla on valley floors in the humid zone.

- **Whicher Scarp** (WC) – Open forest of *Eucalyptus marginata* subsp. *marginata – Corymbia calophy*lla on escarpment with some *Corymbia haematoxylon, Banksia attenuata* and *Xylomelum occidentale* in the humid zone.

According to the South West Biodiversity Project Mapping & Information Instalment 2 (2007), which incorporates the Heddle *et al* (1980a) and the Mattiske and Havel (1998) mapping, the total area of native vegetation remaining in the Abba complexes is 4,482 ha; the total area of native vegetation remaining in the Yelverton complexes is 5,946 ha and the total area of native vegetation remaining in the Whicher Scarp complex is 3,339 ha.

The Whicher Scarp and Yelverton vegetation communities are significant in that this area supports a range of species that are either restricted to the area or that occur as disjunct distributions in a biogeographical context. Such species include *Corymbia haematoxylon, Actinotus whicheranus* and *Petrophile serruriae*. The Whicher vegetation complexes and the majority of the Yelverton vegetation complexes that occur on the Tutunup South survey area are less disturbed than many other vegetation complexes (as defined by Mattiske and Havel (1998); cited in Mattiske Consulting Pty Ltd (2007)). All exceed 20% remaining of the pre-European extent (Webb 2006).

The Whicher vegetation complexes currently have 76% (WC vegetation complex) and 70.8% (WCv vegetation complex) remaining uncleared (Webb 2006) and 15.4% and 10.0% respectively in the reserve system (Conservation Commission 2004; cited in Mattiske Consulting Pty Ltd (2007)). The Yelverton and Abba vegetation complexes occur primarily on private land (Conservation Commission 2004; cited in Mattiske Consulting Pty Ltd (2007)) and as such extend beyond the RFA mapping areas. Therefore, estimates of reservation cannot be retrieved from data used in the Forest Management Plans (E M Mattiske, pers. comm.).

Information on the pre-mining extent and area in reserve for each vegetation complex could not be obtained from the South West Biodiversity Project Mapping & Information Instalment 2 (2007) as data is not provided for the Capel area.

The Yelverton and Abba mapping units on the flats between the Whicher Escarpment and the coast are not well represented in the conservation estate. This is in part due to the problem of assessing a mapping unit on the edge of the RFA area, but also the extent of the agricultural activities on the flats of the Swan Coastal Plain below the Whicher Escarpment. Despite the difficulty of assessing the degree of representation, it is clear that these vegetation complexes on the flats between the Whicher Escarpment and the coast are not well represented in the conservation estate. A comparison of the vegetation with the regional vegetation datasets on the Swan Coastal Plain is less relevant as the majority of the Coastal Plain areas within the lease area have been cleared for many decades or are degraded as a result of grazing and agricultural activities (Mattiske Consulting Pty 2007).

Twelve vegetation communities were defined in the Tutunup South survey area by Mattiske Consulting Pty Ltd (2007), with three being dominated by *Eucalyptus* *marginata* or *E. patens*, three dominated by *Corymbia calophylla*, two *Melaleuca* woodlands, one *Banksia attenuata* woodland, two Myrtaceous shrublands and one pine plantation. However, with the majority of the project sited amongst agricultural land or in a degraded state, the condition of the vegetation was rated according to the scale used for assessing Bush Forever sites (Government of Western Australia 2000; Table 6).

Table 6: Vegetation Condition Rating Scale from Bush Forever

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. Disturbance to vegetation structure covers repeated fire, aggressive weeds, dieback, logging, grazing.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure covers frequent fires, aggressive weeds at high density, partial clearing, dieback and grazing.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure includes frequent fires, presence of very aggressive weeds, partial clearing, dieback and grazing.
6	Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas often described as “parkland cleared” with the flora comprising weed or crop species with isolated native trees or shrubs.

The floristic description of each vegetation community is described in Table 7 and mapped in Figure 14. The Bush Forever condition of each community is also noted in Table 7 and presented in Figure 15.

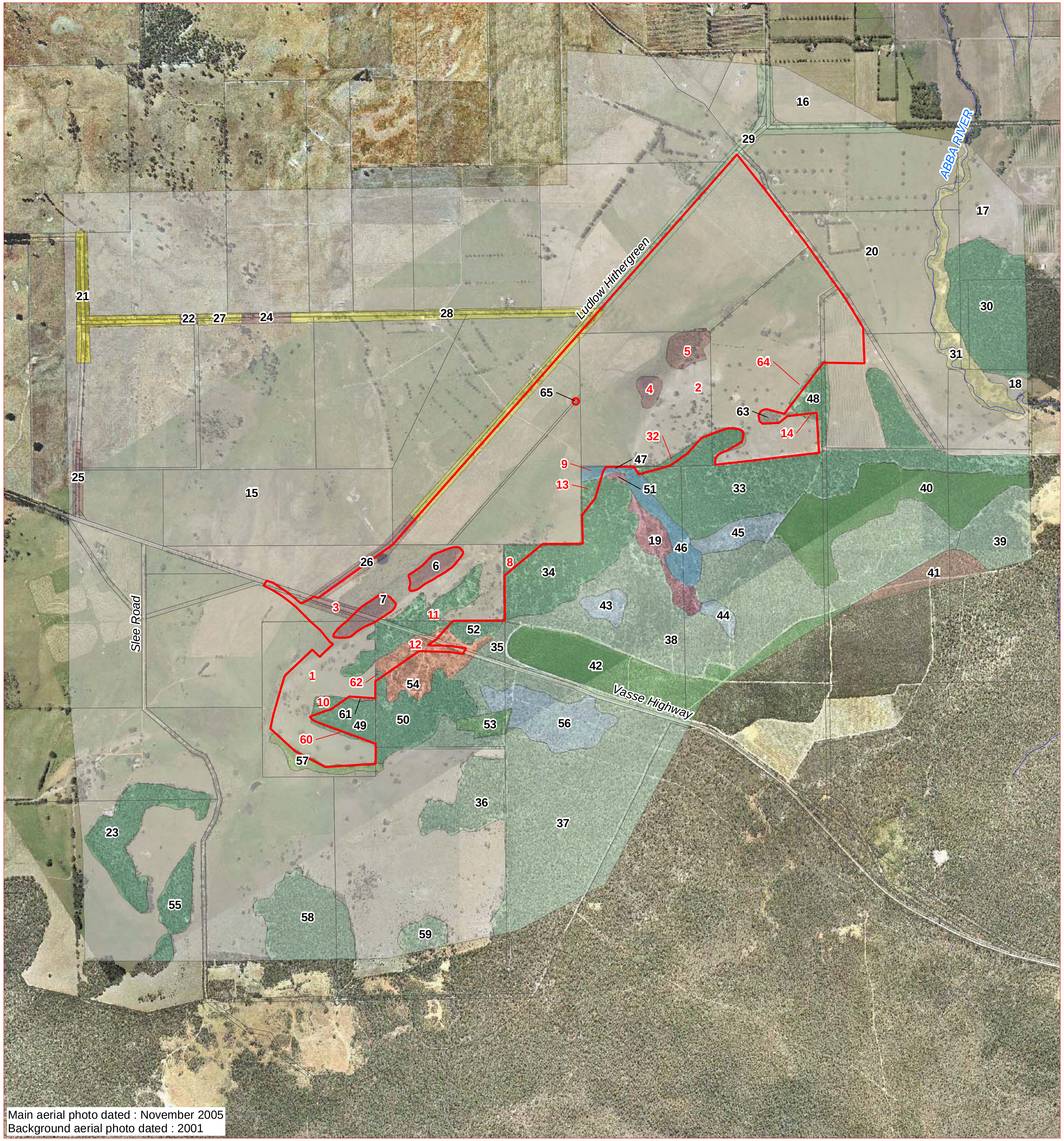
The native species within the Mattiske Consulting defined vegetation communities were compared with the floristic communities as defined by Gibson *et al*. (1994) using two approaches. The first of these approaches was based on the Sorenson Similarity Index and the second was based on the percentage overlap between the plant communities as defined and the data as presented in Gibson *et al.* (1994) for the respective communities. The comparative floristic community is noted in Table 7 and the comparison between the communities, using the Sorenson Similarity index (SSI) and the percentage overlap of native species (PONS) is provided in Table 8.

Table 7: Vegetation Communities

Code	Description	Bush Forever Condition	Comparison with Gibson et al 1994
B1	Woodland of *Banksia attenuata* over *Beaufortia squarrosa*, *Adenanthos meisneri, Melaleuca thymoides, Stirlingia latifolia* and *Melaleuca trichophylla* on sandy soils.	2	SCP21a
C1	Open Forest of *Corymbia calophylla* over *Taxandria linearifolia (ms)* and *Astartea scoparia* over mixed sedges on flowlines.	4	None
C2	Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and *Kingia australis* on loam soils.	4	SCP3a
C3	Woodland of *Corymbia calophylla* over pasture on loam soils.	5	None
E1	Open Forest of *Eucalyptus marginata subsp. marginata – Corymbia haematoxylon* with *Banksia grandis* and *Banksia attenuata* over *Xanthorrhoea preissii, Podocarpus drouynianus, Stirlingia latifolia, Melaleuca thymoides* and *Dasypogon hookeri* over *Anarthria scabra* and *Phlebocarya ciliata* on gravelly sandy loams on middle to upper slopes of the Whicher Range escarpment.	2, 3, 4	SCP1a
E2	Open Forest of *Eucalyptus marginata subsp. marginata – Corymbia calophylla* with *Banksia grandis* and *Xanthorrhoea preissii* over *Hibbertia hypericoides* on gravelly sandy loams on lower slopes of the Whicher Range escarpment.	2, 3, 4	SCP1a
E3	Woodland of *Eucalyptus patens, Taxandria linearifolia (ms)* and *Astartea scoparia* over *Gahnia decomposita, Lepidosperma tetraquetrum* and *Cyathochaeta avenacea* on loam soils.	3	None
M1	Woodland of *Melaleuca rhaphiophylla* and *Melaleuca preissiana* with *Taxandria linearifolia (ms), Astartea scoparia* and *Acacia divergens* over *Cyathochaeta avenacea* and mixed sedges and rushes on clay-loam soils.	3, 4, 5	SCP9
M2	Open Woodland of *Melaleuca preissiana* with *Kunzea ericifolia, Xanthorrhoea preissii* and *Baxteria australis* on sandy-loam soils.	5	SCP9
S1	Low Shrubland of *Melaleuca thymoides* and *Beaufortia squarrosa* over *Kunzea micrantha subsp. micrantha, Stirlingia latifolia, Callistemon glaucus, Dasypogon bromeliifolius* with emergent *Allocasuarina fraseriana, Nuytsia floribunda, Banksia attenuata* and *Xanthorrhoea preissii* on sandy loam soils.	2, 3	SCP2
S2	Tall Shrubland of *Taxandria linearifolia (ms), Taxandria fragrans (ms), Astartea scoparia, Kunzea recurva, Pericalymma spongiocaule* over *Cyathochaeta avenacea* on sandy-loam soils	3, 5	SCP2
D	Degraded areas - with degraded or completely degraded condition rating. These areas only support an isolated tree or native understorey species.	5	None
P	Pine Plantation	6	None

REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
05	L.S.	D.G.S.	16.09,07	Numbering of veg polygons changed
06	P.F.	D.G.S.	7.02.08	Permanent Veg Monitoring Locations
07	S.J	T.L.G	8.04.08	Update Disturbance Area
08	S.J	T.L.G	10.04.08	Remove veg monitoringlocations



Legend

Disturbance Area

Tutunup South Existing Vegetation

Vegetation Code

Code	Description
B1	Woodland of Banksia attenuata over Beaufortia squarrosa, Adenanthos meisneri , Melaleuca thymoides , Stirlingia latifolia and Melaleuca trichophylla on sandy soils. - Site 41
C1	Open Forest of Corymbia calophylla over Taxandria lineariifolia (ms) and Astartea scoparia over mixed sedges on flowlines. - Site 31
C2	Woodland of Corymbia calophylla over Xanthorrhoea preissii and Kingia australis on loam soils. - Site 21
C3	Woodland of Corymbia calophylla over pasture on loam soils. - Sites 27,28
E1	Open Forest of Eucalyptus marginata subsp. marginata Corymbia haematoxylon with Banksia grandis and Banksia attenuata over Xanthorrhoea preissii , Podocarpus drouynianus , Stirlingia latifolia , Melaleuca thymoides and Dasypogon hookeri over Anarthria scabra and Phlebocarya ciliata on gravelly sandy loams on middle to upper slopes of the Whicher Range escarpment. Sites 29,35,36,37,38,39,58,59
E2	Open Forest of Eucalyptus marginata subsp. marginata Corymbia calophylla with Banksia grandis and Xanthorrhoea preissii over Hibbertia hypericoides on gravelly sandy loams on lower slopes of the Whicher Range escarpment. Sites 8, 10, 11, 13, 14, 23, 30, 32, 33, 34, 48, 49, 50, 52, 55, 60, 62, 64
E3	Woodland of Eucalyptus patens, Taxandria linearifolia (ms) and Astartea scoparia over Gahnia decomposita, Lepidosperma tetraquetrum and Cyathochaeta avenacea on loam soils. Site 57
M1	Woodland of Melaleuca rhaphiophylla and Melaleuca preissiana with Taxandria lineariifolia (ms), Astartea scoparia and Acacia divergens over Cyathochaeta avenacea and mixed sedges and rushes on clay-loam soils. Sites 3, 4, 5, 6, 7, 22, 24, 25, 26
M2	Open Woodland of Melaleuca preissiana with Kunzea ericifolia , Xanthorrhoea preissii and Baxteria australis on sandy-loam soils - Sites 19, 51
S1	Low Shrubland of Melaleuca thymoides and Beaufortia squarrosa over Kunzea micrantha subsp. micrantha, Stirlingia latifolia, Dasypogon bromeliifolius with emergent Allocasuarina fraseriana, Nuytsia floribunda, Banksia attenuata and Xanthorrhoea preissii on sandy loam soils. Sites 43, 44, 45, 56
S2	Tall Shrubland of Taxandria linearifolia (ms), Taxandria fragrans (ms), Astartea scoparia, Kunzea recurva, Pericalymma spongiocaule over Cyathochaeta avenacea on sandy-loam soils. Sites 9, 46, 47
CL	Cleared - Sites 1, 2, 15, 16, 17, 18, 20, 61, 63, 65
PL	Plantation - Sites 40, 42, 53
D	Degraded - Sites 12, 54

Survey conducted November 2005 by Mattiske Consulting PTY LTD

0 500 1,000 m

N

ILUKA

TUTUNUP SOUTH

VEGETATION AREAS

ORIG: S.Jones

DRAWN: T.L.G

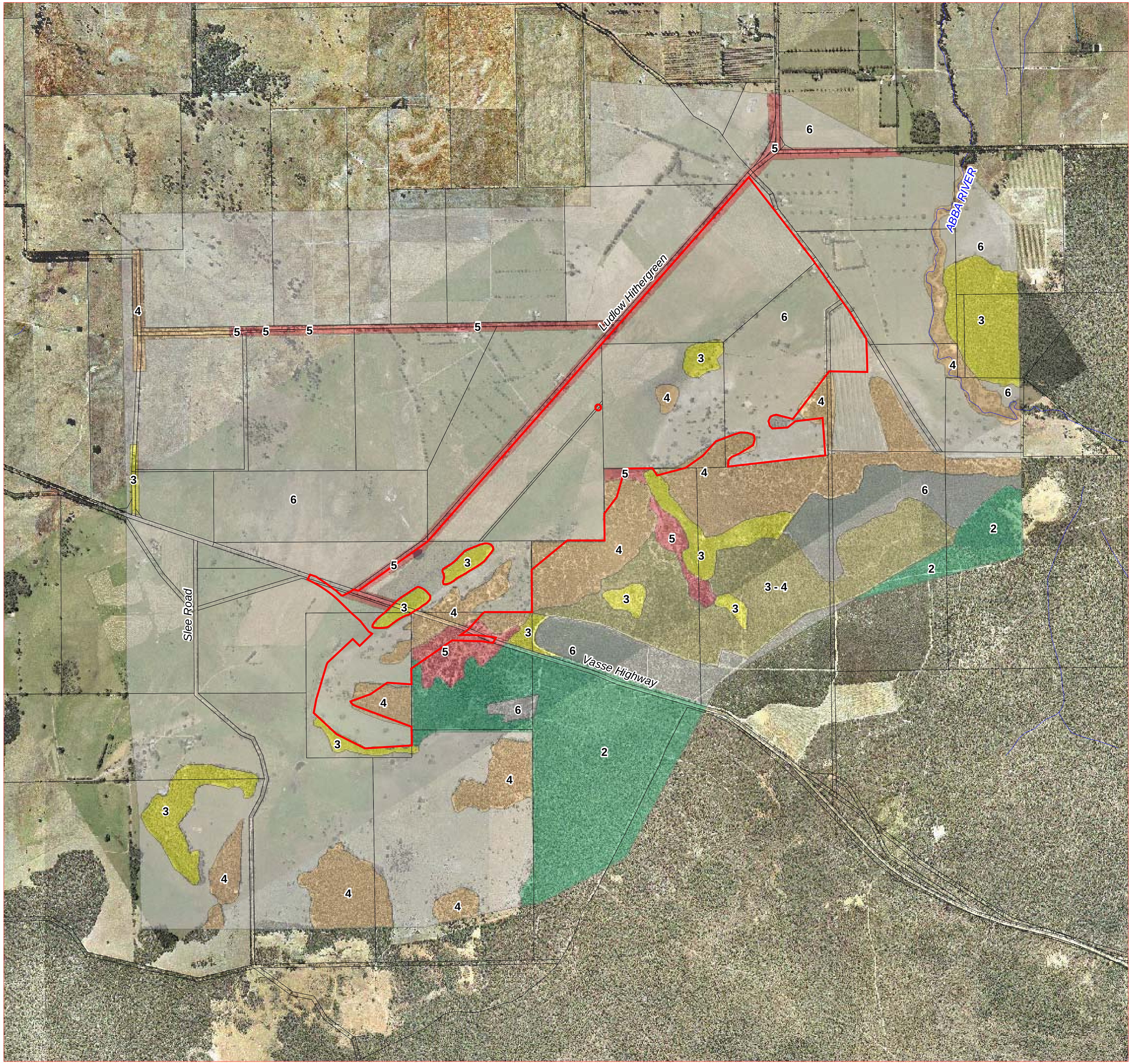
SCALE: 1:20,000

DATE: 10 Apr. 2008

DWG No: 168824 ver.07

A3

FIGURE: 11



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
02	S.E	T.L.G	09.02.07	Update of disturbance boundary
03	S.E	T.L.G	15.02.07	Update legend descriptions
04	L.S.	D.G.S.	14.9.07	Disturbance area ammeded

Legend

Disturbance area

Vegetation Condition

Rating

- 2 Excellent
- 3 Very Good
- 4 Good
- 5 Degraded
- 6 Completely Degraded
- 3-4 Mosaic of 3 and 4

Main aerial photo dated : November 2005
Background aerial photo dated : 2001

Condition rating scale from Bush Forever (Government of Western Australia 2000 based on Keighery 1994)

Survey conducted November 2005 by Mattiske Consulting PTY LTD

N

0 500 1,000 m

ILUKA

ORIG: L.Sadler
DRAWN: D.G.S.
SCALE: 1:20,000
DATE: 14 Sept. 2007

TUTUNUP SOUTH

BUSH FOREVER VEGETATION CONDITION

DWG No: 168825 ver.04 A3 FIGURE: 15

Table 8: Comparison of vegetation communities with floristic communities as defined by Gibson *et al* (1994)

Vegetation types	Sorenson Similarity Index (SSI)	Percentage Overlap with Native Species (PONS)
B1 and SCP 21a	0.10	9%
C2 and SCP 3a	0.02	4%
E1 and SCP 1a	0.39	56%
E2 and SCP 1a	0.42	47%
M1 and SCP 9	0.24	2%
M2 and SCP 9	0.07	4%
S1 and SCP 2	0.04	16%
S2 and SCP 2	0.20	16%

Linkages between the Whicher Scarp vegetation and Yelverton vegetation, and more specifically, linkages between the wetland vegetation and the Swan Coastal Plain have historically been fragmented and degraded by a range of agricultural activities. These processes have led to higher degrees of disturbance in many of the ecological linkages and wetlands (Mattiske Consulting Pty Ltd 2007).

5.8.3 Threatened Ecological Communities

Vegetation community C2 is a woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and *Kingia australis* on loam soils which shares key dominant species with Gibson *et al's* (1994) community SCP 3a *Corymbia calophylla – Kingia australis* woodlands on heavy soil, however none of the other typical or common species listed for community SCP 3a by Gibson *et al* (1994) are present in community C2 and there is therefore a very low level of similarity between the two. SCP 3a is a Threatened Ecological Community (TEC) listed by both the State and Commonwealth and is protected under the EPBC Act (Table 9).

Communities S1 and S2 (myrtaceous shrublands) have low floristic similarities to community SCP 02 of Gibson *et al* (1994) (Southern wet shrublands). SCP 02 is listed as a TEC by the DEC but not under the EPBC Act (Table 9). The floristic similarities were described as low by Mattiske Consulting Pty Ltd (2007) as three of the 16 typical species and five of the 18 common species were present in community S1, whilst four of the 16 typical species and four of the 18 common species were present in community S2.

Table 9: Threatened Ecological Communities

Tutunup South Plant Community	Gibson et al (1994) Community Type	EPBC 1999 Listing	DEC listing
C2	SCP 3a (shared key dominant species, very low similarity)	EN – Endangered facing a very high risk of extinction in the near wild in the near future	CR B) ii) – Critically Endangered, current distribution is limited; there are very few occurrences, each of which is small and/or isolated and extremely vulnerable to known threatening processes.

Tutunup South Plant Community	Gibson et al (1994) Community Type	EPBC 1999 Listing	DEC listing
S1, S2	SCP 02 (low similarity)	Not listed	EN B) ii) – Endangered, current distribution is limited, there are very few occurrences each of which is small and/or isolated and extremely vulnerable to known threatening processes.

5.8.4 Dieback

A dieback survey of the disturbance and surrounding area was undertaken by DEC, Forest Management Branch (2007) to field demarcate infested/uninfested areas, map infested/uninfested areas and provide hygiene recommendations.

From this survey, both infested and uninfested areas upslope of the disturbance area were identified. Protection of the uninfested areas is the key focus of dieback management at Tutunup South. Whilst the agricultural land was uninterpretable, the presence of infestations above makes it unprotectable. Thus, the agricultural land will be managed as dieback infested for hygiene measures.

Dieback boundaries as presented in Figure 16 have been marked in the field with bright orange flagging tape to clearly delineate boundaries between infested and uninfested areas. As recommended by DEC, follow-up survey to ensure boundaries are current will be conducted prior to mining.

5.8.5 Groundwater Dependent Ecosystems

The impact that groundwater drawdown has on ecosystems is related to the level of dependence that the ecosystem has on groundwater, the level of drawdown, the rate of drawdown and the duration of drawdown.

The first step in determining the potential for impact from groundwater drawdown is determining whether the ecosystem is dependent on groundwater, that is, whether it is a groundwater dependent ecosystem (GDE) and if so, the degree of that dependence.

Investigations have been conducted at Tutunup South to provide a site specific assessment of the potential for ecosystems to be groundwater dependent (SWC, 2007b). This assessment includes information on soil properties and observed vegetation rooting depths at the site and the water use requirements of the vegetation to determine groundwater dependence of each ecosystem present (SWC, 2007b).

The water retention characteristics of the soil strongly influence the dependence of vegetation on groundwater. For example, if there is sufficient plant available water stored in the soil profile to meet the transpiration requirements of the vegetation then there is no need to access groundwater; thus the vegetation is not dependent on groundwater. Further, the soil held water content is not influenced by changes in groundwater, as moisture stored within the soil profile is replenished by rainfall, rather than upward movement of water from groundwater (A. Pratt, pers. comm.).

Water retention data and soil distribution mapping from a soil survey conducted at Tutunup South (SWC, 2007a) were used to determine the average plant available water content (PAWC) for the entire above groundwater soil profile for each of five SMUs present (Table 10).

Table 10: Plant Available Water Content for each Soil Management Unit

Soil Management Unit (SMU)	PAWC (m3/m3)
SMU1	0.078
SMU2	0.085
SMU3	0.053
SMU4	0.069
SMU5	0.084

Each vegetation community identified in the vegetation survey (Mattiske Consulting Pty Ltd 2007) was broken down into vegetation areas and assessed, considering the soil profile and the depth to groundwater underlying it, determined from the soil distribution model. The transpiration for all vegetation was assumed to be 700 mm/yr. Given the quality and density of the vegetation remaining in the Tutunup South area, this transpiration rate is likely to overestimate the actual water use requirements of the vegetation in the area, and will result in a conservative overestimation of the groundwater dependence of the vegetation.

By multiplying the PAWC of the soil beneath vegetation by the depth to groundwater beneath that vegetation, the amount of soil water available to that vegetation can be determined. By dividing that amount by the volume of water transpired by the vegetation, the percentage of the vegetation's water requirements which are available from the soil profile can be determined. Where the volume of water available in the soil profile exceeds the volume required by the vegetation, the vegetation is not dependent on groundwater for survival. Where the volume of water available in the soil profile is less than the volume required by the vegetation, the vegetation is dependent on groundwater. The level of dependence is determined by the percentage of the vegetation's water requirements that can be supplied from the soil profile. SWC (2007c) designates GDE classes as follows:

- Class 1: 80 % dependence on groundwater
- Class 2: 50 % dependence on groundwater
- Class 3: 20 % dependence on groundwater
- Class 4: No dependence on groundwater

In total, 11 vegetation areas were considered to have some degree of groundwater dependency and are subsequently rated as GDEs. These are vegetation areas 6, 7, 19, 26, 30, 31, 34, 46, 47, 51 and 57 (Figure 14).

With the exception of the three priority flora species identified within the disturbance area for clearing, all other priority flora locations are at groundwater levels in excess of 15 m below surface and are thus not groundwater dependent (SWC 2007b).

Of the other significant vegetation noted, *Corymbia haematoxylon* was recorded regularly in six of the 12 communities mapped, including several community types with risk of impact from drawdown. Drawdown will not have a significant impact on this species, as the species is locally widespread. No other significant flora was located within areas at potential risk of drawdown impact.

5.8.6 Summary

No DRF species have been located within the survey area. 10 priority species have been located and 14 other taxa located within the survey area are considered to be significant by Webb *et al* (2006).

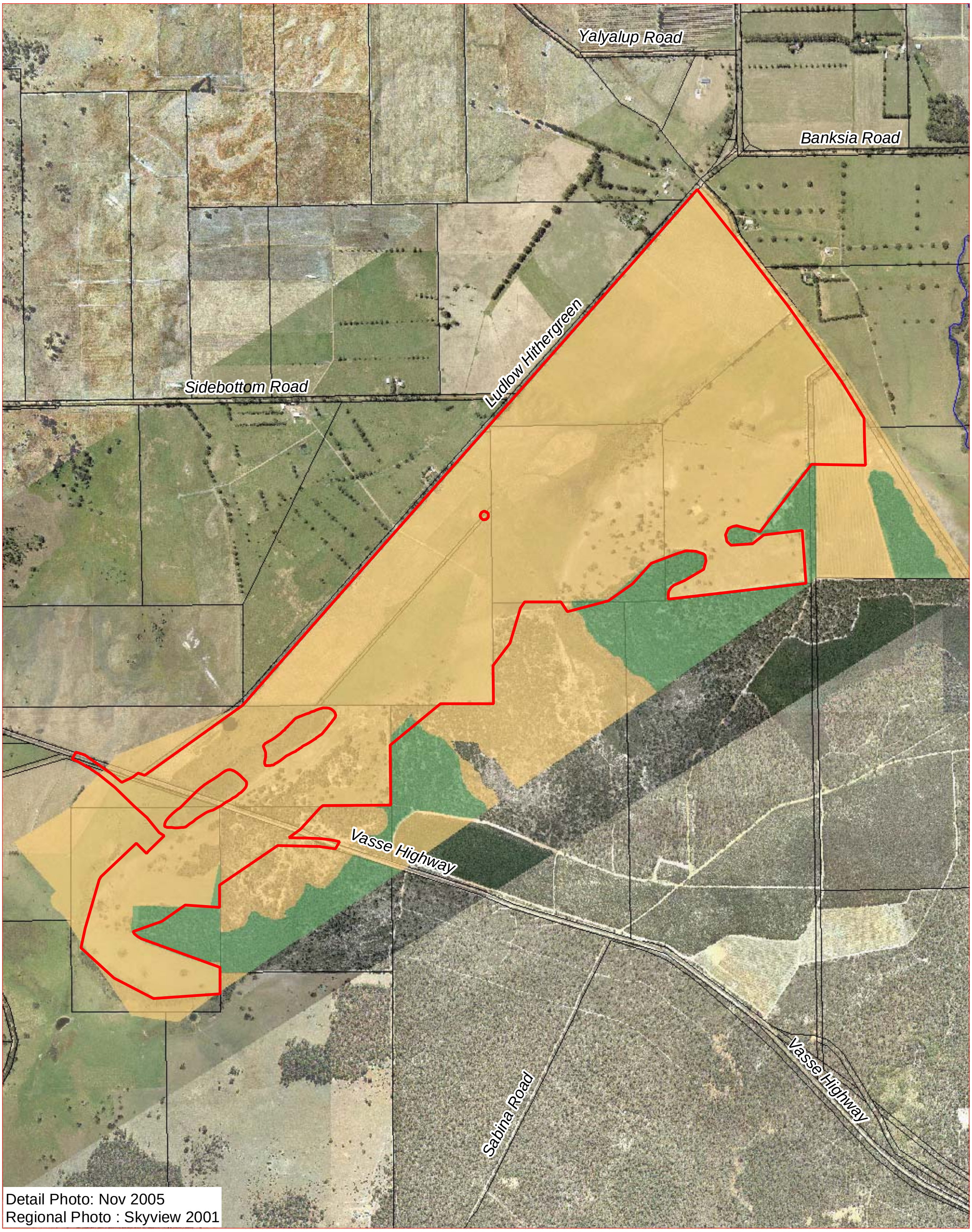
The Tutunup South survey area occurs near the interface of the Cartis and Abba vegetation complexes as defined by Heddle *et al* (1980a), both of which have been extensively cleared by agricultural land uses. These complexes were further refined in the RFA vegetation project (Mattiske and Havel (1998) into the Whicher Scarp and Yelverton Complexes. These communities support a range of species that are either restricted to the area or occur as disjunct distributions and are less disturbed than many other vegetation complexes.

Site survey identified twelve vegetation communities, however the majority of the site is cleared agricultural land or in a degraded condition. Linkages between the Whicher Scarp vegetation and Yelverton vegetation, and specifically between the wetland vegetation and the Swan Coastal Plain have been fragmented and degraded by agricultural activities.

Vegetation community C2 shares key dominant species with Gibson *et al*s (1994) community SCP 3a, which is a State and Federally listed TEC, however none of the other typical or common species for SCP 3a are present in the C2 community and there is a very low level of similarity between the two. Communities S1 and S2 have low floristic similarity to SCP 02 (Gibson *et al*, 1994), a State listed TEC. None of the other communities identified were commensurate with listed TECs.

The potential for vegetation to be groundwater dependent has also been assessed, and classes of dependence allocated to each area of vegetation. In total, 11 vegetation areas were considered to have some level of groundwater dependence.

In respect of the criteria outlined in Guidance Statement 10 (EPA, 2006c), the Tutunup South site occurs within an area of regional significance, in terms of the vegetation complexes represented and the occurrence of priority and other significant flora. Little wetland vegetation remains and linkages between the scarp vegetation and wetland vegetation are lacking due to past agricultural activities, limiting the ability for ecological processes to be maintained across the site. No linkages exist between scarp vegetation and vegetation below the site.



Legend

Disturbance Area

Dieback Areas

Infested / unprotectable

Uninfested / protectable

N

0 500 1,000 m

ILUKA

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:20,000
DATE:	14 Sept. 2007

TUTUNUP SOUTH

DIEBACK MAP

DWG No: 171042 ver.01 | A4 | FIGURE: 16

5.9 Fauna

The extent of clearing and degraded nature of the remaining vegetation in the Tutunup South disturbance area limits the diversity and number of expected native fauna.

The fauna surveys and assessments were conducted in accordance with EPA Position Statement No. 3 (EPA 2002a) and Guidance Statement No. 56 (EPA 2004f). A desktop review and field assessment (level 1 survey) was conducted by Ninox Wildlife Consulting in February 2006, followed by a more detailed (level 2) fauna survey (including trapping) by Biota in February 2007 and a further seasonal survey in October 2007. A field survey of aquatic biology was conducted in November 2005 (WRM 2006) and November 2007 (WRM 2007). This survey also collected vertebrate fauna data associated with wetland habitats. The results of these studies have been collated and synthesised below.

Fauna has also been considered in respect of the criteria outlined in Guidance Statement 10 (EPA, 2006c). The following criteria have been identified as relevant to the Tutunup South Project and discussion on these criteria can be found in the sections noted:

Table 11: Guidance Statement 10 criteria - Fauna

Criterion	Consideration in regard to natural areas at Tutunup South
Representation of ecological communities	The habitats present are discussed in section 5.9.1 and potential impacts related to the clearing of habitat are discussed in section 9.6.4.
Diversity	The numbers of species both present and potentially present are discussed in sections 5.9.1 to 5.9.5.
Rarity	Species noted as significant for one or more of the following reasons are described in section 5.9.5: • listed as Endangered or Vulnerable under the EPBC Act; • listed under the JAMBA and/or CAMBA treaties; • listed as a scheduled species under the Wildlife Conservation Act; • listed on the DEC's Priority Fauna List; • other significant species e.g. Southwest endemics; or • invertebrate species considered rare or notable by WRM The potential for impact to these species is discussed in section 9.6.4.
Maintaining ecological processes or natural systems	The presence and degree of disturbance of existing ecological linkages is noted in section 5.8.2 and the potential for disturbance to linkages and therefore to the maintenance of ecological processes is discussed in section 9.5.3. In specific relation to fauna, habitats present in the Tutunup South area and potential impact on fauna in relation to habitat is discussed in sections 5.9.1 and 9.6.4 respectively.
Scientific or evolutionary importance	One Gondwanic or relict insect species and several aquatic invertebrate species potentially new to science or new to Western Australia are discussed in section 5.9.5.

5.9.1 Habitats

The Biota survey identified 3 fauna habitats within the study area, including open Jarrah/Marri forest of varying density and condition and two Melaleuca woodland wetland habitats, one surrounded by pasture and one surrounded by Jarrah/Marri woodland. Ninox (2006) noted that there were no fauna habitats of particular significance present within the survey area and no significant corridors of vegetation connecting Whicher Scarp vegetation with remnant Swan Coastal Plain vegetation. Biota (2007b) noted that the study area had a relative lack of habitat diversity, resulting in reduced avifauna numbers, with the habitats present largely lacking widespread features such as understorey vegetation, leaf litter and other debris. This is noted to be a contributor to the low numbers of species recorded in the surveys.

5.9.2 Vertebrate Fauna

During the initial Biota (2007a) fauna survey, seven survey grids were installed over the three primary habitats (Figure 17). This yielded 86 native vertebrate species, comprising of 52 native bird species, 13 mammal species and 21 herpetofauna species. In November 2007, the seasonal survey found 79 native vertebrate species, comprising of 56 bird species, 4 mammal species and 19 hereptofauna species (Table 12). When added to observations made by Ninox Wildlife Consulting (2006) and WRM (2006) the number of native vertebrate species recorded increased to 69 bird species, 13 native mammals, 26 herpetofauna, and two native fish species.

Wetland habitat survey sites TUT05 (within the M1 vegetation community in the northern wetland) and TUT02 (within the S2 vegetation community) had the highest numbers of fauna species and highest numbers of individuals, however numbers of species and individuals found were still considered to be low (Biota, 2007b). TUT05 is within the disturbance area and currently isolated from the State Forest, however TUT02 is outside and upstream of the disturbance area, within State Forest.

Table 12: Summary Fauna Groups Recorded During Site Surveys

Fauna Group	Biota Species Recorded			Ninox Additional Species Recorded	WRM Additional Species Recorded	Total Species Recorded	Ninox Potential Species but not Recorded	Total Potential and Recorded Species
	I*	S**	Total					
Native Avifauna	52	56	68	1	0	**69**	31	100
Introduced Avifauna	1	1	1	-	-	**1**	1	2
Native Mammals	13	4	13	-	-	**13**	9	22
Introduced Mammals	2	2	3	-	-	**3**	4	7
Amphibians	3	4	5	-	2	**5**	6	11
Reptiles	18	15	21	-	-	**21**	18	39
Fish	-	-	-	-	2	**2**	-	2

Fauna Group	Biota Species Recorded			Ninox Additional Species Recorded	WRM Additional Species Recorded	Total Species Recorded	Ninox Potential Species but not Recorded	Total Potential and Recorded Species
	I*	S**	Total					
Total Native Species	86	79	107	1	4	**110**	64	174
Total Species	89	82	111	1	5	**114**	69	183

*I = Initial Biota fauna survey (February 2007)

**S = Seasonal Biota fauna survey (November 2007)

Avifauna

A total of 69 species, including 28 non-passerines and 41 passerines, have been recorded in the Tutunup South survey area. The Australian Raven and Grey Fantail were the most prevalent avifauna species present, a result consistent with the project area being at the interface between forest and agricultural systems. The greatest number of species recorded at the site were from the Parrot family (Psittacidae) and the Honeyeaters (Melphagidae), each represented by eight species, followed by the Thornbills (Acanthizidae) with five species recorded.

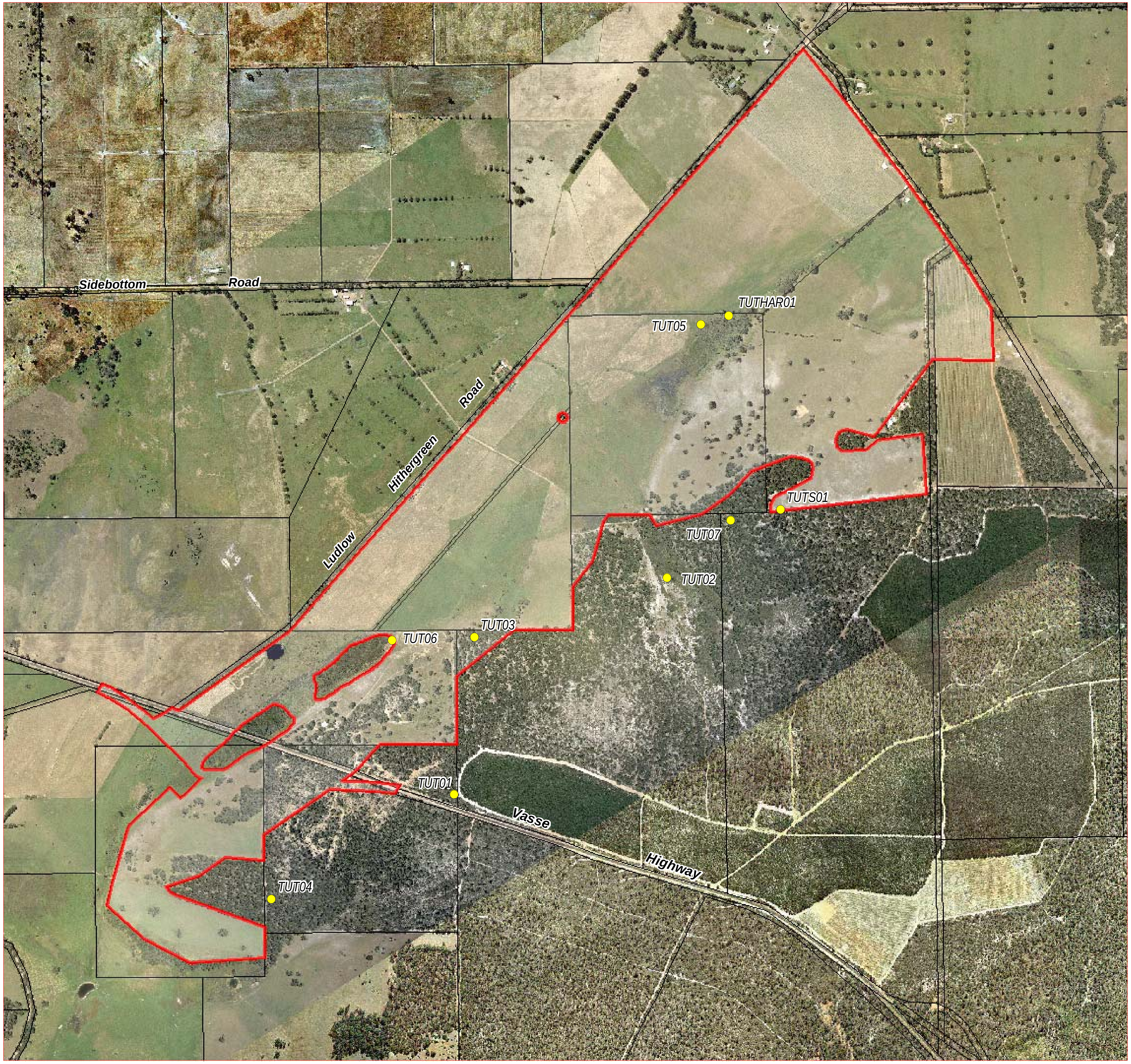
The M2/S2 vegetation units and the northern wetland in the M1 vegetation unit recorded the highest numbers of species and individuals.

The noted absence of waterfowl in the survey was most likely to be a reflection of the lack of standing water bodies at the time of the surveys. However WRM (2006) did record a Straw Necked Ibis (*Threskiornis spinicollis*) during the wetland study.

The area was noted as important to three species of Black Cockatoo, including Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*C. baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*).

As such, detailed investigations were undertaken by Johnstone, Johnstone and Kirkby (2007) to assess the value of remnant vegetation in the proposed Tutunup South disturbance and surrounding area to provide nesting, feeding and roosting sites for Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo.

Eight trees were identified with possible nesting hollows (Figure 18). All of the hollows located displayed evidence of cockatoo use during the previous year. Of the eight hollows identified, one is adjacent to the northern wetland, whilst a further two potential nest sites were located east of the southern wetland. The remaining five hollows are in close proximity to each other south of the current Vasse Highway in the gravel reserve.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS

Legend

- Fauna survey site
- Disturbance area

Date of photography
Inset: 19 Nov. 2007 Regional: 2001

N

0 250 500 m

ILUKA

TUTUNUP SOUTH

FAUNA SURVEY LOCATIONS

ORIG:	L Sadler
DRAWN:	D.G.S.
SCALE:	1:12,500
DATE:	14 Sept. 2007

DWG No: 176773 ver.00 | A3 | FIGURE: 17

Johnstone et al (2007) noted feeding sites by species at Tutunup South. The most prolific feeding sites recorded were those for Baudin's Cockatoo, which tended to be clustered at the southern end of the project area. A number of other sites were recorded around the forest/agricultural interface. For the Forest Red-tailed Black Cockatoo, there were also numerous feeding sites mapped, although mostly south of Vasse Highway and within the gravel reserve. There were however far less feeding sites mapped for Carnaby's Cockatoo, with only six sites mapped by Johnstone *et al* (2007).

One roosting site was located midway along the southeastern boundary of the disturbance area (Johnstone et al 2007). This was described as having been used over a long period of time primarily by Forest Red-tailed Cockatoos. At the time of survey, the roost was being used by over 50 birds (Figure 18).

Regular visits to the survey area have been conducted to continue monitoring the possible nesting hollows. As yet, no hollows are being utilised by Black Cockatoos.

Mammals

The Western Grey Kangaroo (*Macropus fuliginosus*), was the most abundant mammal recorded during the survey followed by the House Mouse (*Mus musculus*). Of the flightless mammals or non-volants, the Dasyuridae family recorded the most species, with three species recorded. Four species from the bat family Vespertilionidae were recorded, thus making this the family with the greatest number of species.

Three introduced species were also observed; the Rabbit (*Oryctolagus cuniculus*), the Domestic Dog (*Canis familiaris*) and the House Mouse (*Mus musculus*) (Biota 2007d).

The non-volant inventory of ten species at Tutunup South was similar to that found during the Yoganup 215 study (Biota 2007b). Biota (2007a) considered this to be a number consistent with habitats that largely lack widespread features such as understorey vegetation, leaf litter and other debris.

Herpetofauna

Five frog species and 21 reptile species were recorded during the Biota survey (2007d). WRM also recorded three amphibian species, according to the 2006 report. The most abundant species recorded were the Moaning Frog (*Helioporous eyrei*) and *Crinia georgiana*. The most speciose family present was the Scincidae with 13 species recorded during the survey. The herpetofauna at this site was less diverse than the nearby Yoganup 215 extension survey site (Biota 2007a). Biota (2007a) suggested that a lack of suitable microhabitats for herpetofauna, such as understorey vegetation, leaf litter and other debris, limited the number of species present.

Fish

WRM recorded two species of native fish in the creekline (site T3) south of the disturbance area whilst conducting the aquatic baseline study (see section 5.9.3

below). The Western Minnow (*Galaxias occidentalis*) and Nightfish (*Bostockia porosa*) are common, ubiquitous and widely distributed throughout southwestern Western Australia. In terms of abundance, the Western Minnow was described as common, whilst the Nightfish was described as present (WRM 2006). No fish were located in either of the wetlands located in the disturbance area.

5.9.3 Invertebrates

The wetland study recorded 98 macroinvertebrate and microinvertebrate taxa, representing a moderately diverse fauna for seasonal waters. Community composition was similar to other disturbed seasonal and perennial watercourses on the coastal plain. The fauna was dominated by Insecta (over 61%), with the majority being Diptera (33% of the insects). Molluscs only comprised 1% and Crustacea 14% of the total fauna. The majority of taxa (57%) were cosmopolitan in distribution, occurring across Australia and overseas. Species new or potentially new to science and/or new records for Western Australia have been defined by WRM (2006) as 'rare'. The existence of 'rare', restricted or endemic species was determined by taxa lists from the University of Western Australia database, the CALM Wildlife Conservation (Specially Protected Fauna) Notice and the IUCN Red List of Threatened Species. Four species were considered 'rare', whilst another six were endemic to the South West of Western Australia, along with a further 4 indeterminate species (WRM, 2006).

The following species were reported in 2006 as being rare:

- the rotifer, *Lepadella oblonga* in the southern wetland (T2) was the first recording of this species in Western Australia, and the second record of the taxon in Australia. Its only other record is from a Goulburn River billabong in Victoria;
- the notommatid rotifer *Cephalodella n*. sp from wetland T2, a species which has not been previously described;
- the cyclopoid copepod *Paracyclops n*. sp in the northern wetland (T1). This taxon is analogous to CALM sp. 2, thus has been previously recorded but is yet to be described; and
- an indeterminate Difflugiidae Rhizopod in the northern wetland. Whilst this species is also yet to be described, it has been previously recorded in the Iluka Burekup survey.

A further notable taxon recorded during the survey was the synthemistid dragonfly *Archaeosynthemis leachii* at the creekline site T3. This species is a Gondwanic or relict insect which has survived in the southwest despite climatic and environmental change. This taxon is uncommon and has a restricted distribution.

Taxa richness was comparable across sites. The invertebrate assemblages of the Tutunup South area are considered tolerant of a wide range of environmental conditions and are generally common, ubiquitous and frequently encountered in freshwater systems within Western Australia.

WRM undertook additional sampling of aquatic invertebrates of Tutunup South whilst surveying nearby wetlands in November 2007. Preliminary results indicate that of the ten surveyed wetland sites, eight had 'rare' aquatic microinvertebrates located within them. It should also be noted that the 2007 Tutunup South wetland samples included only one of the four 'rare' species recorded from the 2005 samples, and that the 2007 samples found two species not recorded in 2005. The other wetlands sampled also generated new 'rare' species unique to that wetland.

Table 13 details the 'rare' microinvertebrate species types and location found within Tutunup South and the surrounding wetlands.

Table 13: Microinvertebrate species identified as 'rare'

Taxa		**Burekup**		**Elgin**	**Gavin's Road**	**Tutunup South**		**Yoganup South**	**Yoganup 'Carter's'**
		B3	B9	E1		T1	T2	Y7	Y8
RHIZOPODA									
Centropyxidae	*Centropyxis* n. sp.						2007	2007	2007
Difflugiidae	*Difflugia* potential n. sp.	2007							
	Difflugia n. sp.		2005			2005 2007	2007	2007	2007
ROTIFERA									
Unknown	Rotifer n. sp.							2007	2007
Dicranophoridae	*Dicranophoroides caudatus* NR for WA	2005							
Hexarthridae	*Hexarthra* cf. *intermedia* n. sp.								2007
Lepadellidae	*Lepadella oblonga* NR for WA			2005			2005		
Notommatidae	Cephalodella n. sp.						2005		
	Resticula melandocus NR for WA								200
Trochosphaeridae	*Filinia* cf. *passa* NR for WA	2005				2007	2007		
CLADOCERA									2007
Chydoridae	*Alona* cf. *rectangular novaezealandie* pot.n.	2007							
	Alona sp. pot.n.	2007							
	Alona sp. pot.n.				2007				
Daphniidae	*Ceriodaphnia* n.sp.	2007							
COPEPODA									
Cyclopoida	*Paracyclops* n.sp.					2005			

5.9.4 *Short Range Endemic (SRE) Fauna*

During the Biota (2007a) study, focus was also directed to the range of invertebrates with naturally small distributions. Such fauna are characterised by poor dispersal capabilities, confinement to isolated habitats and/or low capability for producing offspring. Despite targeted searching, only four species were collected, being two pseudoscorpion and two scorpion species. None of these taxa were considered to be SRE taxa (Dr M Harvey, WA Museum pers comm.; cited in Biota 2007a).

5.9.5 *Species of Significance*

Through the course of surveying and assessments at Tutunup South, several species were noted as significant for one or more of the following reasons:

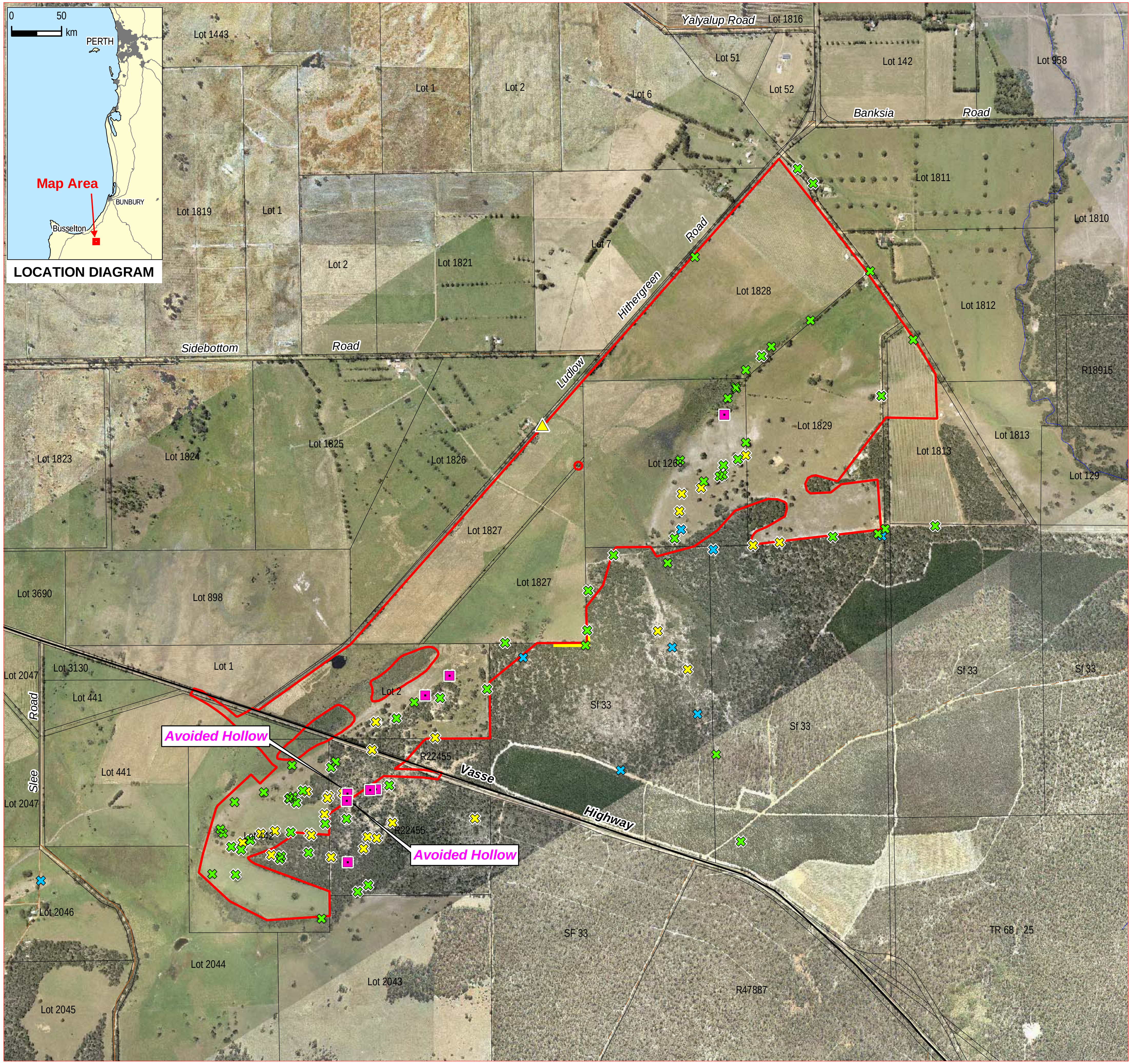
- Listed as Endangered or Vulnerable under the EPBC Act;
- Listed under the JAMBA and/or CAMBA treaties;
- Listed as a scheduled species under the *Wildlife Conservation Act;*
- Listed on the DEC's Priority Fauna List;
- Other significant species e.g. Southwest endemics; or
- Invertebrate species considered rare or notable by WRM (2006).

Table 14 identifies 13 species that have some form of statutory recognition as being of significance. Of these 13 species, six were recorded during the Biota (2007a) fauna survey (by either trapping, or other evidence of their presence). In addition to statutory recognized species, the 6 microinvertebrates and dragonfly *Archaeosynthemis leachii* have been added due to their potential significance.

Table 14: Potentially Occurring or Recorded Fauna of Significance

Species	Records During Survey	Level of Protection		Other Reason for Significance
		State	Commonwealth	
Carnaby's Cockatoo *Calyptorhynchus latirostris*	3	Schedule 1	Endangered	
Baudin's Cockatoo *Calyptorhynchus baudinii*	28	Schedule 1	Vulnerable	
Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*	13	Schedule 1		
Chuditch *Dasyurus geoffroii*	Potential	Schedule 1	Vulnerable	
Brush-tailed Phascogale *Phascogale tapoatafa tapoatafa*	Potential	Schedule 1		
Western Ringtail Possum *Pseudocheirus occidentalis*	Potential	Schedule 1	Vulnerable	
Quokka *Setonix brachyurus*	Potential	Schedule 1	Vulnerable	
Peregrine Falcon *Falco*	Potential	Schedule 4		

Species	**Records During Survey**	**Level of Protection**		**Other Reason for Significance**
		State	**Commonwealth**	
peregrinus				
Carpet Python *Morelia spilota imbricata*	Potential	Schedule 4		
Western False Pipistrelle *Falsistrellus mackenzei*	Evidence of species present	Priority 4		
Southern Brown Bandicoot (Quenda) *Isoodon obesulus fusciventer*	2	Priority 5		
Lined Skink *Lerista lineata*	Potential	Priority 3		
Western Brush Wallaby *Macropus irma*	Potential	Priority 4		
Rainbow Bee-eater *Merops ornatus*	4		EPBC Migratory Species and JAMBA	
Fork-tailed Swift *Apus pacificus*	Potential		EPBC Migratory Species, JAMBA & CAMBA	
Rhizopod *Centropyxis* n.sp.	present			WRM Rare
Rotifer *Lepadella oblonga*	2-10			WRM Rare
Notommatid Rotifer *Cephalodella* n. sp	2-10			WRM Rare
Trochosphaeridae Rotifer *Filinia* cf. *passa*	20-30			WRM Rare
Cyclopoid Copepod *Paracyclops* n. sp	2-10			WRM Rare
Indeterminate Difflugiidae Rhizopod	2-10			WRM Rare
Synthemistid Dragon Fly *Archeosynthemis leachii*	2-10			WRM Relict species



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
01	L.S.	D.G.S.	12.09.07	Disturbance area ammeded
02	S.E.	D.G.S.	19.11.07	New roosting site for red tailed cokatoo
03	S.J	T.L.G	07.04.08	Added "Protected hollow" labelling

Legend

Cockatoo Survey

General

- Nesting sites

Baudin's Cockatoo

- Feeding sites

Carnaby's Cockatoo

- Feeding sites

Forest Red-Tailed Black Cockatoo

- Feeding sites
- Drinking Record
- Roosting site
- Disturbance Area

Survey conducted by R.E and C. Johnstone and T. Kirkby - Jan 2007

Detailed Photo : November 2005
Regional Photo : Skyview 2001

N

0 500 1,000 m

ILUKA

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:15,000
DATE: 7 Apr. 2008

TUTUNUP SOUTH

COCKATOO NESTING, FEEDING & ROOSTING SITES

DWG No: 170666 ver.03 A3 FIGURE: 2

5.10 Social Environment

The estimated resident population in the Shire of Busselton was 27,546 in 2005 with an annualised average growth rate over the 2000-2005 period of 4.4 % (sourced South West Development Commission (SWDC) statistics). The unemployment rate for June Quarter 2006 was 3.3 %.

The land use of the disturbance area is agriculture. There are several rural landholdings surrounding the disturbance area, with a diverse range of agricultural activities including horticulture, horse agistment, dairying and beef farming. This diversity is reflective of the Shire of Busselton's diverse industrial base including beef, sheep and dairy farming, tree farming, earthmoving, grape vines, market growers, engineering and mining.

SWDC statistics show that agriculture is an important industry within the Shire of Busselton with 337 individual enterprises within the Shire and occupying more than 75,207 ha.

The Bemax Tutunup mineral sands mine operates 3 km to the north-east of the proposed Tutunup South mine.

5.10.1 Aboriginal Heritage

Archaeological and ethnographic studies have been conducted over the Tutunup South disturbance area. One archaeological site, a scar tree, was located during the course of the archaeological survey (Anthropos Australis Pty Ltd 2007a). Despite being within the disturbance area, this site can be avoided by mining operations and associated infrastructure (Figure 19). From the ethnographic survey, there are no sites registered with the Department of Indigenous Affairs (DIA) sites register within the disturbance area. The closest registered site is at the Abba River, approximately 300m to the north-east of the disturbance area (Figure 19).

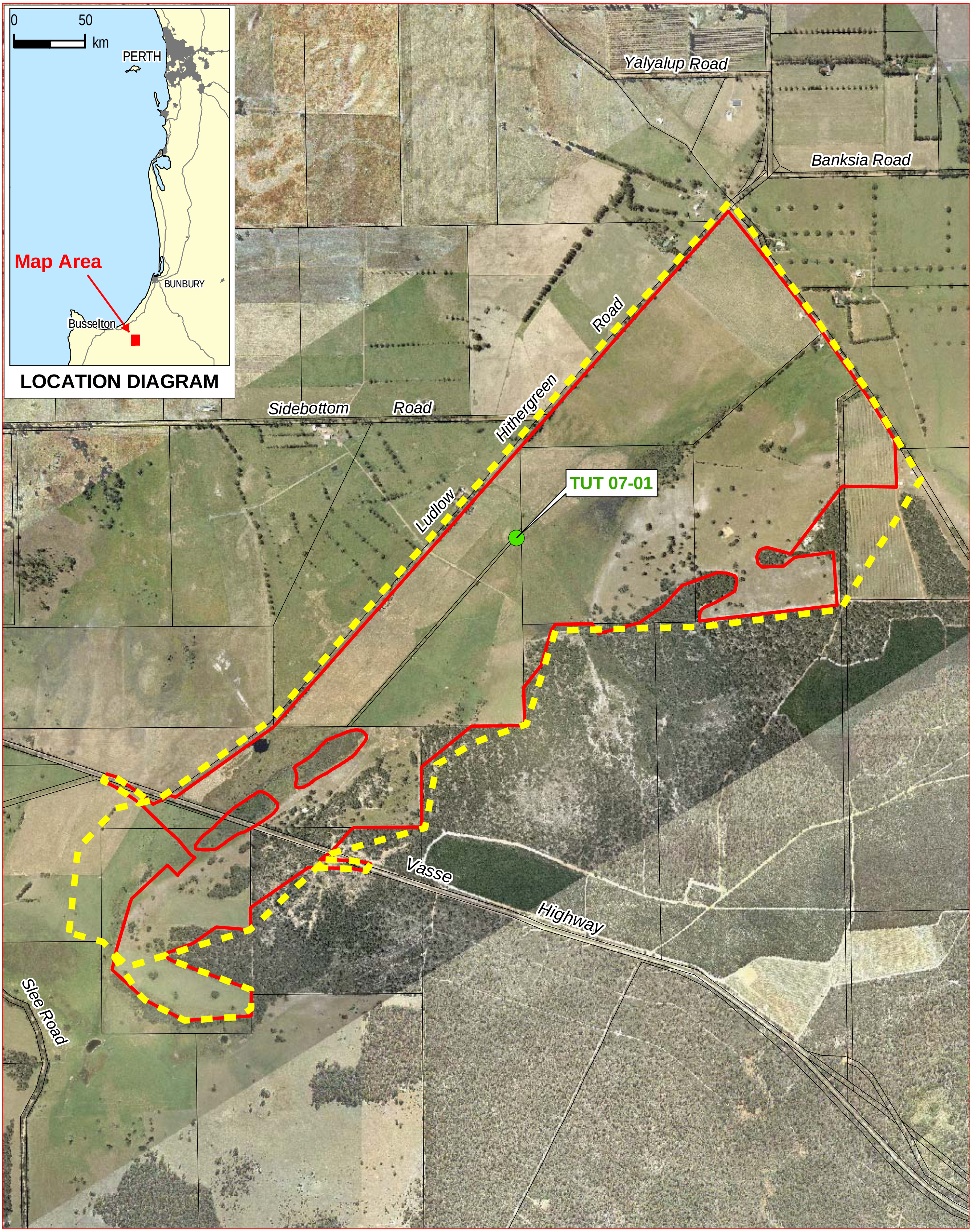
5.10.2 European Heritage

A search was conducted of the Register of the National Estate, National Trust and of the Heritage Council of Western Australia for heritage sites within the disturbance area. No sites were identified as being located within the disturbance area. There were no heritage sites identified within the Tutunup South disturbance area or surrounds in the Busselton Municipal Inventory. McGibbon Track is known to occur to the north of the proposed disturbance area and there is anecdotal evidence that the track extends past the north eastern boundary of the disturbance area. Whilst the track has not appeared in any heritage searches conducted for the site, its exact location is being verified.

5.10.3 Transport

HMC will be transported from Tutunup South to Capel by pocket road trains, requiring 48 journeys (24 round trips) per day. Traffic studies have been undertaken in consultation with the Shire of Busselton to identify routes that minimise impacts on public safety, road use, amenity and maximise the use of gazetted heavy haulage routes. The proposed transport route from the mine is:

- turn left into Ludlow Hithergreen Road (Shire of Busselton);
- right into Vasse Hwy (MRWA);
- right into Sues Road (MRWA);
- right into Bussell Hwy (MRWA); and
- right into Yeardy Road (Capel Shire) (Figure 20).



Legend

- Aboriginal Heritage Site TUT 07-01
- Aboriginal Heritage Survey Area
- Proposed Disturbance Area

Detailed Photo : November 2005
Regional Photo : Skyview 2001

0 500 1,000 m

N

ILUKA

ORIG:	S.Jones
DRAWN:	T.L.G
SCALE:	1:20,000
DATE:	8 April 2008

TUTUNUP SOUTH

ARCHAEOLOGICAL & ETHNOGRAPHIC SITES

DWG No: 173831 ver.03 | A4 | FIGURE: 19

Legend

- Proposed transport route
- Project area

N

0 100 200 km

ILUKA

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:150,000
DATE:	12 Sept. 2007

TUTUNUP SOUTH

PROPOSED TRANSPORT ROUTE

DWG No: 176774 ver.00 | A4 | FIGURE: 20

6 COMMUNITY AND STAKEHOLDER CONSULTATION PROGRAM

6.1 Objective

In Western Australia the environmental approvals process is a public process, whereby the proponent is expected to consult with the public and government agencies to ensure that the most current information about local issues and concerns is used in the environmental impact assessment of the proposed project.

The objective of the consultation process conducted during the preparation of this PER was to allow all individuals, groups and agencies that will potentially be affected by the proposal to have their interests considered during the impact assessment process. This will ensure that issues raised are addressed adequately both in this environmental review and following the implementation of the proposal.

6.2 Consultation Program

The community and stakeholder consultation program for the Tutunup South project, was designed in accordance with the draft DoE Industry Guide to Community Involvement (DoE 2003a). Effective community and stakeholder consultation is an essential component of the approval process.

To be 'valued by the community', Iluka takes a leading role in working with its neighbours, employees, indigenous groups and other stakeholders, to add value to the communities in the Company's operational and proposed project areas. Iluka has established partnerships by listening and acting on the following priorities:

- open and meaningful communication;
- participation in community activities;
- support for community initiatives;
- timely provision of planning and operational information;
- effective response to community concerns; and
- respect for indigenous culture and aspirations.

All Iluka's community interactions are based around the pillars of Communication, Transparency, Integrity and Collaboration.

The aims of the program are to:

- inform stakeholders of the proposed operation;
- explore reaction and potential concerns regarding the proposal;
- gauge and/or gain public support for the proposal;
- implement and maintain a process through which residents, other interested groups and the Shire can communicate effectively with the company, and encourage the use of this process;
- ensure that all issues and disputes are dealt with in a timely manner and followed up effectively; and

- incorporate stakeholder input into the design and management of the proposed Project and report back on these outcomes.

6.3 Stakeholders

Interested stakeholders in the project have been identified as community members in the immediate surrounds of the project, people within the local shire, special interest groups and decision making authorities. There were no responses to the EPA advertisement in The West Australian that the project would be assessed as a PER. Identified stakeholders are listed in Table 15.

Table 15: Tutunup South Stakeholders

Stakeholder	
Community Members	Landowners within disturbance area
	Neighbours in vicinity of project
	Communities of Tutunup, Ruabon and Ludlow
	South West Boojarah native title claimants
Government (State, Local and Federal)	Dept of Industry & Resources (DoIR)
	Department of Environment and Conservation (DEC)
	Dr Steve Thomas, Capel MLA, Shadow Minister for Environment
	Main Roads WA (MRWA)
	Environmental Protection Authority (EPA)
	South West Development Commission (SWDC)
	Shire of Busselton
	Shire of Capel
	Department of Environment, Water, Heritage and the Arts (DEWHA)
Non Government Organisations	Capel Land Conservation District Committee (LCDC)
	Conservation Council
	Vasse Wonnerup LCDC
	Wildflower Society
	GeoCatch
	SW Environment Centre
	South West Aboriginal Land and Sea Council
	Busselton-Dunsborough Environment Centre

6.4 Dissemination of Information and Identification of Issues

6.4.1 Community Members

The definition of landowners is residences where Iluka has agreement to mine on their property. Neighbours are residences adjacent to the Iluka operations. There are 6 landowners with property that will be directly impacted by the operations.

Landowners and neighbours have been briefed on the Tutunup South proposal via face to face meetings. The results of environmental studies, such as noise and groundwater drawdown, will be provided to landowners and neighbours. Agreements are currently being developed with six landowners and four neighbours on land access and/or other social amenity issues, including noise. The PER will be provided and discussed with landowners and neighbours.

The proponent has consulted with the South West Boojarah native title claimants and the South West Aboriginal Land and Sea Council regarding the project.

6.4.2 State and Local Government

Iluka has briefed both the Capel and Busselton Shires and the local Member of Parliament on the Tutunup South proposal. Prior to operations, Iluka will extend an offer to both Capel and Busselton Shire, and the local MLA to attend a site tour.

Discussions, meetings, correspondence and site visits have taken place with the key decision making authorities for the Tutunup South project.

6.4.3 Non Government Organisations

Iluka regularly conducts detailed briefings with the Conservation Council and affiliated organisations on an operational and project level and Tutunup South has been discussed with these organisations on several occasions.

Geocatch staff and Board members were briefed on the project in November 2006.

Iluka maintains regular consultation with the local LCDC groups like the Capel LCDC and the Vasse Wonnerup LCDC.

Iluka has briefed the Busselton Dunsborough Environment Centre and extended an offer to the South West Environment Centre which has not been taken up.

Table 16: Issues raised in Consultation Program

Stakeholder Groups	Issues Raised	Response
Community Members	Concern regarding noise from mining.	Iluka will minimise noise emissions from the operation and will develop agreements with neighbours and landowners if noise exceeds assigned levels.
	Concern regarding groundwater drawdown impacting bores from mining.	The groundwater modelling predicts negligible impacts on surrounding bores. Iluka commit to providing make-up water supplies if any bores are found to be impacted by mining.
	Concern regarding the potential for dust from the operation	Iluka will manage machinery operations and open areas to ensure that there are no offsite dust impacts.

Stakeholder Groups	Issues Raised	Response
	Concern regarding the potential for neighbouring properties to be devalued by the mining operation.	Neighbours who demonstrate devaluation of their property due to Iluka's mining operations may be entitled to compensation under the Mining Act 1978, provided certain criteria are satisfied. Where neighbours fall within those criteria Iluka will meet its compensation obligations in accordance with the Mining Act.
	Concern regarding the transport route, and the additional number of trucks it will add to the road.	Iluka has reviewed several transport routes and selected the route that adds the least incremental trucks to the roads. Transport will be managed to minimise any impacts on road users.
	Concern that the project may not go ahead if environmental values and approvals processes were too costly and timely.	Iluka has endeavoured to address all government approval requirements in a satisfactory manner to get the project approved.
Government	Concern regarding impacts on micro-invertebrate species.	Wetland study undertaken including liaison with experts in micro-invertebrate field.
	Concern regarding ASS requirements.	Investigation program undertaken and management plan developed.
Non Government Organisations	Concern regarding clearing of wetlands.	Avoid clearing the southern wetland vegetation and commit to minimising drawdown impacts. Rehabilitation of the northern wetland following mining.
	Concern regarding clearing of heritage scar tree.	Avoid clearing scar tree during operations.

6.5 Ongoing Consultation

Iluka will continue to liaise closely with local authorities and the local community during the construction of the project and will implement a comprehensive consultation program which includes regular meetings with landowners and neighbours.

The consultation program following the release of this PER will involve:

- ongoing liaison with government agencies;
- discussions with Shires regarding traffic management;
- meetings with councillors and staff of local authorities;
- ongoing discussions with the landowners and neighbours of the project;
- providing the PER and other project information on the Iluka website; and
- dissemination of information through community newspapers and Iluka's community updates.

7 ENVIRONMENTAL MANAGEMENT

7.1 Iluka's Environmental Management System

Iluka has an environment, health and safety management system (EHSMS) in place to provide effective EHS management and continuous improvement in performance at all its mineral sands operations. Iluka's EHSMS is designed to provide a framework for:

- developing and implementing a common approach to environmental, health and safety management across Iluka;
- integrating environment, health and safety management systems and processes into all business processes;
- effectively communicating company expectations to all employees, contractors and visitors;
- establishing clear environment, health and safety performance criteria against which all areas of the company can be monitored and audited;
- measuring environment, health and safety performance at all levels of the organisation;
- reporting environment, health and safety performance to stakeholders and interested parties; and
- ensuring continuous improvement in our environment, health and safety performance.

The EHSMS comprises:

- one corporate EHS policy;
- twelve EHSMS standards that describe the minimum requirement for all Iluka areas; and
- associated guidelines and tools to assist with the implementation and maintenance of the EHSMS (Figure 21).

7.2 Iluka's EHS Policy

Iluka's EHS Policy is a statement of the company's commitment to environmental protection. It is a general condition of employment that Iluka employees at all levels behave in accordance with the policy. Iluka's EHS Policy commits Iluka to:

- not compromise on safety;
- comply with all legislative requirements;
- work closely with our customers and maintain a product stewardship approach to our products to enable their ongoing use;
- identify, assess and manage environmental, health and safety hazards, risks and impacts of our operations;
- maintain an EHS management system to apply uniform standards to all operations and personnel;
- promote continuous improvement practices;

- minimise workplace exposure to hazards, ecosystem disturbance or degradation;
- re-establish disturbed areas as sustainable ecosystems and community assets;
- strive to use resources more efficiently by reducing, reusing and recycling waste products;
- encourage and support our employees to make positive lifestyle changes;
- understand and work to meet the expectations of the community; and
- provide appropriate training to employees and contractors to ensure environmental, health and safety issues and responsibilities are clearly understood.

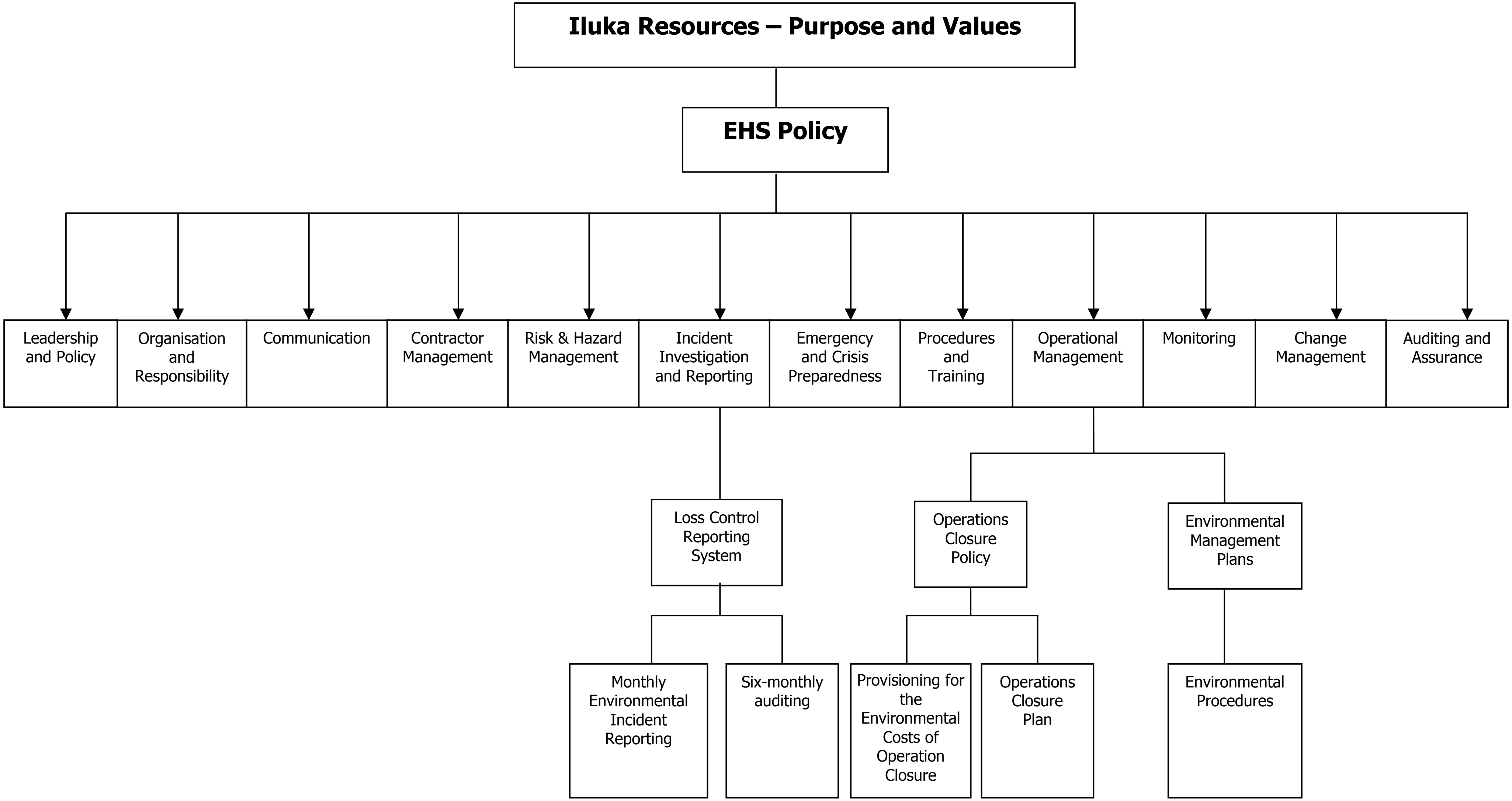
7.3 Sustainable Development

The EPA Position Statement 6 (EPA, 2004b) discusses the concepts of sustainability and outlines that sustainable development requires the integration of ecological thinking into all social and economic planning and actions. The EPA objective for sustainability is to ensure, as far as practicable, that the proposal meets or is consistent with the sustainability principles in the National Strategy for Ecological Sustainable Development (Commonwealth of Australia, 1992). The National Strategy for Ecologically Sustainable Development outlines three objectives for the mining industry in addressing sustainable development.

These are:

- to ensure minesites are rehabilitated to sound environmental and safety standards, and to a level at least consistent with the condition of surrounding land;
- to provide appropriate community returns for using mineral resources and achieve better environmental protection and management in the mining sector; and
- to improve community consultation and information, improve performance in occupational health and safety and achieve social equity objectives.

Concepts raised for the resource industry in the above guidelines have been integrated into the planning of Tutunup South and the sustainable development strategies outlined below. In producing mineral products and supporting sustainable development at Tutunup South, a number of sustainable principles are considered and applied. These are detailed in Table 17.



ILUKA RESOURCES

EHS MANAGEMENT SYSTEM STRUCTURE

Figure 21

Table 17: Implementation of Sustainability

Iluka sustainability principles	Tutunup south project implementation
Integrate social and ecological considerations with economic evaluations of mine planning.	Mine planning has been conducted to include social and ecological considerations. This has resulted in the following outcomes: • majority of heavy vehicle activities restricted to between 6 am and 7 pm, 7 days a week; • altering the disturbance area and pit boundary to avoid southern wetland and possible cockatoo hollows; • site perimeter bunding; and • site access from Ludlow-Hithergreen Road.
Ensure that mining operations enhance existing biological diversity where possible.	Existing biological diversity will be enhanced through: • corridor of vegetation from the southern wetlands to the State Forest; • rehabilitation of the northern wetland; • restoration of the southern wetland; and • rehabilitation of equivalent hectares to native vegetation
Ensure that mining areas are rehabilitated to sound environmental and safety standards, and to a level at least consistent with the condition of the surrounding land that enables the agreed post mining land use.	The disturbance area will be rehabilitated to agricultural land and to forest/wetland systems.
Provide for effective involvement and prior informed consent of communities regarding all decisions and actions that affect them, and engage stakeholders and government in order to gain their views and take their interests into account.	A comprehensive community consultation program has been conducted during the feasibility studies. This is detailed in Section 6.
Provide support to communities through Iluka's Community Development Program.	Iluka provides a wide range of support to local communities. This is detailed in Section 6.
Ensure that current and future economic growth of WA and Australia will benefit from developments by Iluka and optimise economic return to local communities from mining.	Mining of the resource will provide economic benefit to Iluka, the State and local community. Local employment and services will be utilised where possible.
Efficiently manage resources and wastes.	Mining allows for the efficient management of the mineral sands resource. Wastes will be minimised and managed as outlined in Section 10.5.

Iluka sustainability principles	Tutunup south project implementation
Be accountable for all our actions by regularly reporting to the community, stakeholders and the government on performance.	An annual environmental report will be prepared and submitted to government detailing performance against Ministerial Conditions and licence commitments. Company environmental performance and management is also reported in the Iluka Annual Report to shareholders.
Support sustainable development through commitment towards continual improvement in all aspects of environmental, health and safety programs.	The management plans and annual reporting process provide a regular review and improvement program.
Development and support of generic and site-specific research and development programs on technologies and techniques to improve the effectiveness and efficiency of environmental protection measures.	Iluka conducts and supports a range of research programs across the organisation. These include continuous noise monitoring trials, rehabilitation trials and process waste management research.

7.4 Iluka's Closure Plan Policy

In order to demonstrate its commitment to achieve environmentally and socially acceptable closure of all operations, Iluka has adopted an Operations Closure Policy that is supported by procedures for provisioning for the environmental costs of operation closure and the development of a closure plan. Iluka's closure procedures have been developed in accordance with the Australia and New Zealand Minerals and Energy Council (ANZMEC) Strategic Framework for Mine Closure (2000) which outlines a range of objectives and principles including stakeholder involvement, planning, financial provisioning, implementation, standards and relinquishment and the Minerals Council of Australia Mine Closure Policy (1999). Iluka has submitted a Preliminary Closure and Rehabilitation Plan to supplement this PER, which addresses the following aspects of mine closure:

- definition of the legal framework in which closure will be undertaken;
- definition of closure objectives regarding factors such as safety, land use and socioeconomic considerations;
- stakeholder consultation;
- closure planning for rehabilitation and decommissioning; and
- annual review and continual improvement.

The primary closure objective for Tutunup South is "in consultation with relevant landholders return the land profile consistent with the surrounding topography and establish either productive agricultural land or native vegetation considering past land uses". Rehabilitation and closure is addressed in more detail in Section 13.

7.5 Environmental Management Plans

Appropriate management of key environmental issues for the Tutunup South Project is detailed in Environmental Management Plans (EMPs) for the Project (outlined in sections 9 and 10). Management Plans will be updated over the life of the mining operation.

The following Environmental Management Plans have been developed and are submitted with this document:

- Vegetation, Flora and Dieback Management Plan (Appendix 1);
- Native Fauna Management Plan (Appendix 2);
- Acid Sulfate Soils Management Plan (Appendix 3);
- Surface and Groundwater Management Plan and Operating Strategy for dewatering (Appendix 4);
- Noise Management Plan (Appendix 5); and
- Preliminary Closure and Rehabilitation Plan (Appendix 6);

7.6 Environmental Reporting

Statutory annual reports are submitted to government departments detailing compliance with conditions of approval and environmental performance.

Environmental performance at Iluka sites is monitored through a system including monthly reporting of incidents and reported through to the board of directors. Monthly internal environmental reports are generated. The system of environmental incident reporting is maintained at all Iluka sites through the use of the Loss Control Reporting System. This system ensures timely notification of any incidents, internal investigation into causes and actions arising from environmental incidents or potential incidents to resolve them and reduce the risk of repetition.

8 IDENTIFICATION OF ENVIRONMENTAL FACTORS

The scoping report identified the environmental factors outlined in Table 18 are applicable to the proposed Tutunup South mineral sands mine.

The relevant EPA objectives, potential impacts, investigations conducted, additional investigations and potential management are detailed for these environmental factors in sections 9, 10 and 11 of this document.

Table 18: Environmental Factors

Biophysical Factors	Pollution Factors	Social Factors
Landform and Soils	Dust	Aboriginal Heritage
Surface Hydrology	Noise	European Heritage
Groundwater	Radiation	Transport
Acid Sulfate Soils	Light	Visual Amenity
Flora and Vegetation	Non-Process Waste	
Fauna	Process Waste	
	Greenhouse Gases	

9 BIOPHYSICAL ENVIRONMENT: IMPACTS & MANAGEMENT

9.1 Landform and Soils

9.1.1 Objective

The EPA objective is to maintain the integrity, ecological functions and environmental values of the soil and landform.

9.1.2 Relevant Standards

As there are no regulatory standards for general soil and landforms, the standard is to be assessed against the objective. Iluka has a well established approach to delineating and managing soils that minimises the risks of adverse effects and maximises suitability and quality of soils for re-establishment of post mining land uses of native vegetation and pasture.

9.1.3 Issue Definition

Disturbance to the landform will come from pit excavations, the creation of topsoil, subsoil and overburden stockpiles and installation of other infrastructure. Topsoils and subsoils have beneficial physical, chemical and biological properties that are conducive to plant growth. The soils need to be handled in a manner such that these properties are retained for rehabilitation. During mining operations, there is also the potential for wind and water erosion resulting in the loss of soil resources.

Pre-mining agricultural productivity assessments have been conducted on the agricultural properties. These have assessed the capability of the land and assist in defining rehabilitation targets.

9.1.4 Assessment and Management

The pre-mining landform will be altered during the mine's life, principally by development of pits, and construction of overburden stockpiles. The extraction of minerals sands utilises pits to place overburden and tails allowing for concurrent rehabilitation. Thus the post mining landform will be comparable to the pre-mining landform, suitable for agricultural and native vegetation land uses. The Preliminary Closure and Rehabilitation Plan provides further information on re-establishing the landform.

Mining at Tutunup South will result in disturbance to SMUs 2 to 5 inclusive. Soil mapping has identified that SMUs 3 and 4 will be the largest units to be disturbed. In the course of disturbance, topsoils and subsoils will need to be stripped and stockpiled separately to retain their beneficial qualities. SWC (2007a) has identified that the topsoils from SMUs 2 and 3 and SMUs 4 and 5 can be managed as two soils.

Soil management is proposed to include the following:

- Native vegetation soils will be removed in the dry summer months where possible to minimise the loss of soil propagules.

- Topsoil will be handled so that any dieback uninfested soils remain separate.
- Topsoils will be double stripped to ensure optimal preservation of the soil seed bank.
- Subsoil shall then be stripped and stockpiled separately.
- Native topsoil stockpile heights will be limited to 2 m.
- Agricultural topsoil will be restricted to 3 m in height.
- A cover will be established on topsoil stockpiles to protect against erosion.

All machinery will be cleaned down prior to commencing work on topsoil or subsoil during construction, mining and rehabilitation activities to minimise the risk of dieback spread and/or weed introduction from agricultural areas.

Iluka's goals for the final restored landform will be to:

- Achieve a post mining landform similar to the pre mining condition and acceptable to the landowners;
- Achieve soil profile, structure and infiltration characteristics which enable the land to be returned to its pre-mining land capability;
- Reinstate surface drainage; and
- Keep erosion to acceptable levels.

The Preliminary Closure and Rehabilitation Plan in Appendix 6 further details the management plan for soil removal, stockpiling and landform restoration.

Implementation of the above management practices and the Preliminary Closure and Rehabilitation Plan will ensure the EPA objective to maintain the integrity, ecological functions and environmental values of the soil and landform are achieved.

9.2 Surface Hydrology

9.2.1 Objective

The EPA objective for surface water quantity is to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance, are protected.

The EPA objective for surface water quality is to ensure that emissions do not adversely affect environmental values of the surface water and groundwater resources or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.

9.2.2 Relevant Standards

Protection of the environmental values of surface waters on the Swan Coastal Plain are addressed in the *Environmental Protection (Swan Coastal Plan Lakes) Policy*. Principles for the protection of wetlands are addressed in Position Statement No. 4 (2004a).

A pollution prevention licence will be issued for the operation of the site under Part V of the *Environmental Protection Act 1986*. This is likely to include conditions on surface water, drainage and waste management.

The ANZECC (2000) *Australian and New Zealand Water Quality Guidelines*, while not a regulation, provide trigger levels for assessing water quality and developing appropriate strategies for water release. Of particular relevance to this project are the trigger values for livestock water quality.

9.2.3 Issue Definition

Mining activities will disrupt surface flows over the disturbance area including several minor drainage lines, which will be diverted or mined as appropriate. Hydrocarbons and biodegradable flocculants will be used at Tutunup South, providing the potential for some water to become contaminated. There is the potential for surface water from open areas to carry sediment, resulting in increased turbidity.

Site water will be principally stored in the process water dam. At some stage in the mine's life it is likely that the site will have excess water (from stormwater and/or dewatering). Controlled or uncontrolled release of water may contain analytes that are in excess of DEC licence conditions, contribute to erosion and or sedimentation, and in extreme cases, physical disruption to external infrastructure. An agricultural drain has been identified as a preferred release site, which flows to the north, reporting to the Sabina River then the Vasse Diversion Drain.

Clearing and groundwater drawdown impacts to surface water features (including vegetated wetland areas) are addressed in Section 9.5.

9.2.4 Assessment and Management

Development of the Tutunup South project will involve the construction of a number of facilities that have the potential for contamination. All hydrocarbons will be contained and managed to prevent contamination to the environment. Refuelling facilities will comprise of self-bunded tanks on imperviously lined pads reporting to an oil/water separator. Treated water from this system and runoff from the contractor area will report to the process water dam. Iluka's environmental incident reporting system will be utilised to report and manage any spillage of hydrocarbons.

There will be open areas throughout the life of the operation that may generate more runoff than agricultural or natural systems. To reduce runoff, areas will be rehabilitated and / or stabilised as soon as practicable during mining. To prevent overland runoff entering the site, topsoil stockpiles or graded banks will be used to direct flow into external drainage systems where possible. Rainfall and run-off collected on site will be directed to the process water dam for use in processing.

Woddidup Creek (T3 in Figure 11) will be bunded from the operations to ensure that there is no uncontrolled drainage from the cleared areas to the creekline. The edge of the disturbance area will be 10 m from the centreline of the creek and will be fenced. It is planned to have a topsoil bund located 20m from the creek with other stockpiles located behind the topsoil bund.

The northern drainage line (D1 in Figure 11) will be collected in a dam and water will be directed to either the process water dam for processing or piped across the disturbance area and returned to the D1 drainage line on the downstream side of the disturbance area. The northern drainage line has minimal flows with a 1 in 10 year Annual Recurrence Interval flow anticipated to be 252 m^3/hr. The sump at this location will be designed to accommodate and transfer these volumes.

The southern drainage line (D2 in Figure 11) originates on site. Much of this area will be mined and internal drainage will be installed and water kept within the disturbance area.

There will be times when there is a water deficit and times when there is a surplus. As much water as practicable will be held on site within the process water system, in order to both minimise the volume of water required to be discharged, and minimise the volume of water required to be drawn from the production bore.

The recycling and management mechanisms in place within the mineral processing facilities further reduce the requirement for drawing from the production bore. Processing is expected to require approximately 12 000 ML water per annum, however approximately 85 % of the site water requirement is expected to be sourced from recycled water sources including water decanted from clay fines and sand tails.

At times when there is excess water for site requirements (e.g. construction, peak groundwater inflows and peak water flows during winter), water will be released via an open channel or pipeline into the southern drainage line (D2). As a contingency, water may also be released to the northern drainage line (D1), as shown on Figure 4. The maximum predicted discharge is 810 m^3/hr during worst case winter conditions. This discharge is anticipated due to the large variation in volumes of pit dewater predicted over the life of the mine. The drains may need to be enlarged or otherwise improved to accommodate maximum anticipated discharge. An initial assessment of the receiving drainage channel has been conducted. The assessment found that the existing channel is sufficient to cater for 1 in 100 year flows with little additional maintenance. The existing road culvert is also sufficient to cater for 1 in 100 year flows. Further assessment will be used to determine maintenance requirements for the receiving channel.

Water discharge from site will be conducted in accordance with the site’s prescribed premises licence. Compliance against these criteria is expected to be reported in the site’s Annual Environmental Report.

Due to the conditions that will be applied to water discharge, the existing condition of the receiving environment, the distance from the Sabina River and the diversion of flow from the Sabina River to the Vasse Diversion Drain approximately 200 m downstream from where the drain enters the River, mining will not cause a significant impact to the Sabina River.

It is possible that there may be times when excess water does not meet licence conditions. Should this occur, Iluka’s preference will be to release water that meets licence conditions first, store water that does not meet licence criteria within the process water dam, then within available pits and/or solar drying dams. As a last resort Iluka may need to have a non-standard controlled release that does not meet water quality criteria. Should a non-standard controlled release be required, the following will occur:

- time permitting, contact the DEC to report the pending release and why the water is suspected to be outside of quality criteria;
- contact the adjacent landowner to advise of the non-standard release;
- monitor the drain and process water dam water quality before the release (if possible);
- monitor drain water quality during release;
- monitor water quality after the release has ceased and normal operating conditions resumed; and
- investigate impacts of the release and conduct remediation where required.

This process has been identified in the PER for Tutunup South as the site is spatially constrained, with reduced water storage and operational flexibility.

A Ground and Surface Water Management Plan and Operating Strategy for Dewatering has been developed that incorporates the above mitigation and management strategies (Appendix 4). Implementation of the Management Plan will ensure the EPA objectives for surface water quality and quantity are achieved.

9.2.5 Commitments

- Implement the Ground and Surface Water Management Plan and Operating Strategy for Dewatering.

9.3 Groundwater

9.3.1 Objective

The EPA objective for groundwater is to maintain the quantity of water so that existing and potential environmental values, including ecosystem maintenance are protected.

The EPA objective for groundwater quality is 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 and acceptable standards.

9.3.2 Relevant Standards

The use of groundwater is controlled under the *Rights in Water and Irrigation Act 1914*, administered by the Department of Water. The Act requires the regulation of water systems in certain localities, limits water extraction rates and requires monitoring and reporting.

A pollution prevention licence will be issued for the operation of the site under Part V of the *Environmental Protection Act 1986*. This is likely to include conditions on groundwater monitoring and management.

The ANZECC (2000) *Australian and New Zealand Water Quality Guidelines*, while not a regulation, provides trigger levels for assessing water quality and developing appropriate water management strategies.

9.3.3 Issue Definition

Dewatering of the superficial aquifer will be required to enable dry mining activities. The water will be utilised for a process water supply. The following potential impacts may arise from dewatering:

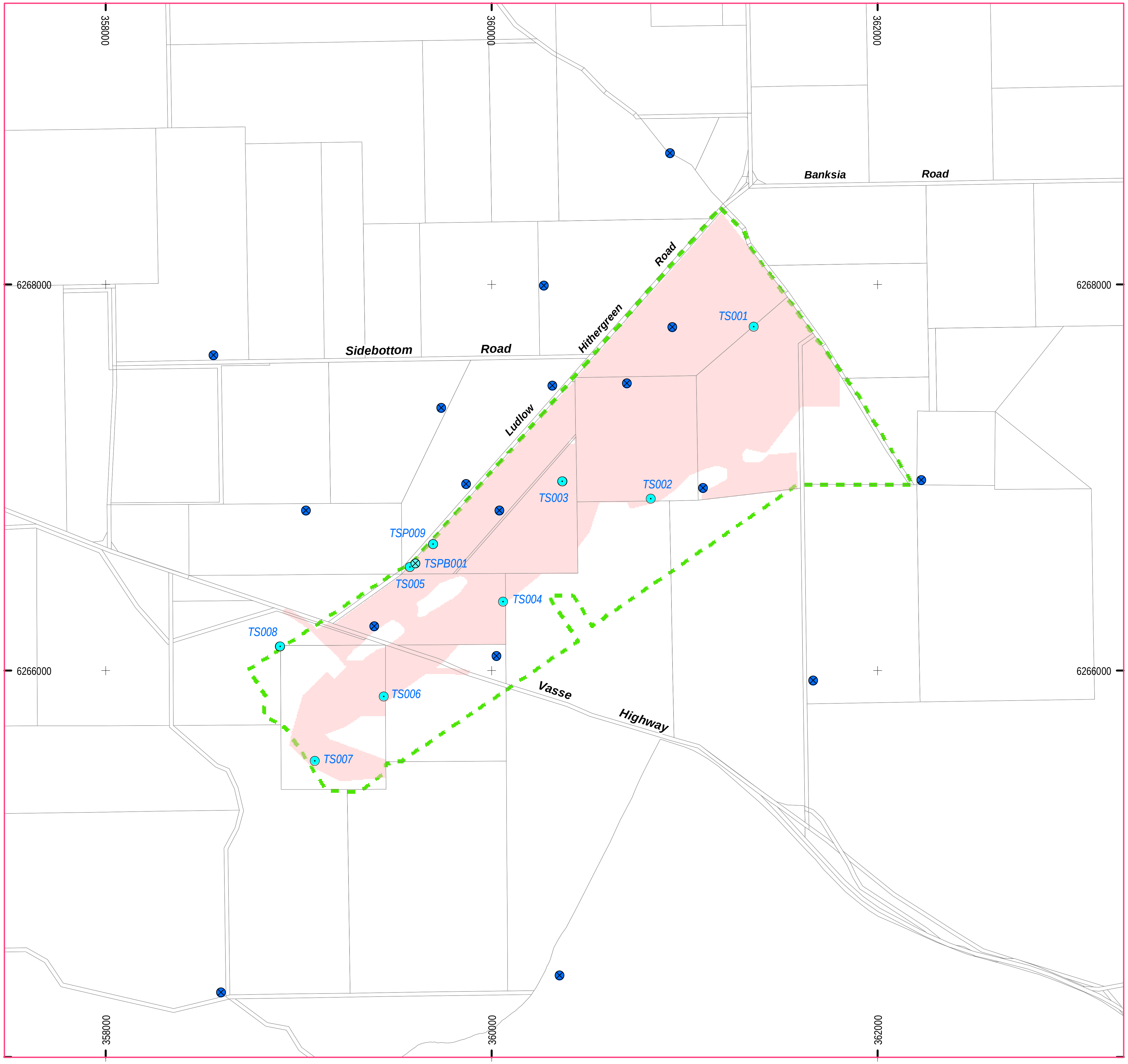
- reductions in available water for groundwater dependent ecosystems (GDEs) that are both within and outside of the disturbance area (addressed in Section 9.5);
- reduction of groundwater levels may indirectly cause the oxidation of potentially acid sulfate soils (addressed in Section 9.4);
- the need to discharge water from site when process demands are insufficient to consume the entire dewatering volume (addressed in Section 9.2.1); and
- loss of amenity for nearby residences utilising shallow groundwater resources for stock and irrigation purposes.

Abstraction from the Yarragadee Aquifer will be required to supplement dewatering for process water supplies. This will be undertaken within Iluka's existing Yarragadee Aquifer Groundwater Abstraction Licence 161847 (2). No increase in the licence allocation is required.

9.3.4 Assessment and Management

Aquaterra (2007) have undertaken a groundwater impact assessment, which focussed on the development of a groundwater flow model and the prediction of groundwater drawdown. Groundwater drawdown impacts over the life of mine are shown in the appended Ground and Surface Water Management Plan and Operating Strategy for Dewatering. At the conclusion of mining, a 0.2 m groundwater drawdown is expected 1.5 km from the project area. The majority of groundwater levels recover to 90% of their pre-mining levels within two to three years after the completion of dewatering, with 95% recovery expected after four to five years (Aquaterra 2007).

The cone of depression resulting from dewatering can be minimised by backfilling mine pits to the bottom of the Guildford Formation (clay layer) as quickly as possible after the ore is removed. Backfilling to the bottom of the Guildford Formation seals the higher transmissivity Yoganup Formation below, from where water flow is greatest. Sealing off the Yoganup Aquifer as quickly as possible minimises the length of time that pits need to be dewatered and the volume of water abstracted.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S.	D.G.S.	9.08.07	Original version
01	L.S.	D.G.S.	14.09.07	Proposed piezos added

Legend

- Piezometer
- Production Bore
- Proposed Piezometer
- Disturbance area
- Project area

N

0 500 1,000 m

MGA Coordinates, GDA94

ILUKA

ORIG: L.Sadler
DRAWN: D.G.S.
SCALE: 1:20,000
DATE: 14 Sept. 2007

TUTUNUP SOUTH

GROUNDWATER MONITORING LOCATIONS

DWG No: 176489 ver.01 | A3 | FIGURE: 22

Abstraction from the Yarragadee Aquifer will be required to provide sufficient process water. Iluka has recently agreed to a substantial reduction in its water allocation under GWL 161847(2) but believes that this project can be managed within the volumes allowed under the current licence. Yarragadee abstraction requirements are estimated to be between 1,120 and 1,500 ML/annum and will be kept to a minimum with dewatering, recycled water and captured rainfall and runoff used preferentially for project water supply.

Mine pits will be dewatered to allow dry mining to occur. Superficial groundwater inflows into the mining void are predicted to range from initially less than 20 Ml/month and increase to between 50 and 60 Ml/month by the third year of mining. Inflows are expected to peak at 112 Ml/month at the end of mining. The highest total 12 month groundwater inflows are 1,040 ML.

In anticipation of dewatering, a piezometer network has been installed and monitored by Iluka since September 2006 (Figure 22). In addition to the existing groundwater monitoring network, Aquaterra (2007) and SWC (2007b) have recommended installation of additional monitoring piezometers, to allow monitoring of potential impacts further away from the site. To assist continual improvement of the accuracy of groundwater modelling, Iluka will conduct a verification of the groundwater model after 6 months of operating conditions.

From Iluka's bore census, only five bores have been identified as being within the zone where maximum drawdown exceeds 0.5 m, whilst two bores are within a maximum predicted drawdown of 1 m. Thus, if these bores extend to 5 m in depth, it is unlikely that their water supply will be significantly reduced. Most of the bores in close proximity to Tutunup South are either on land owned by Iluka or subject to landowner agreements. In the event a landowner notes a change in the capability of their bore to deliver water, which is believed to be a consequence of Iluka's operations, a review of data from the nearest Iluka monitoring bores will be conducted. If the review shows that Iluka's operations have impacted the landowner's water supply, Iluka will liaise with the landowner to make good the water supply.

A Ground and Surface Water Management Plan and Operating Strategy for Dewatering, incorporating the above mitigation and management measures has been developed and is appended to this PER (Appendix 4). Implementation of this management plan will ensure the EPA objective to maintain the quantity and quality of water so that existing and potential environmental values are protected is achieved.

9.3.5 Commitments

- As per commitment under Section 9.2.5

9.4 Acid Sulfate Soils

9.4.1 Objective

The EPA objective is to maintain the integrity, ecological functions and environmental values of the soil and landform.

9.4.2 Relevant Standards

The DoE has released a General Guidance on Managing Acid Sulfate Soils (DoE, 2003b) to direct those involved in areas where ASS are present to sources of information, and provide a framework for decision-making associated with ground-disturbing activities in ASS risk areas. This guideline is aimed at minimising the risk to the environment resulting from the exposure of any PASS, to be achieved by implementing appropriate detection and management strategies.

9.4.3 Issue Definition

Mining within an area where ASS material exists presents the potential for acidic drainage to develop by exposing PASS to air and mobilising acids within AASS. Acidic drainage from the soils, if allowed to develop, can create adverse impacts on mine-site water, infrastructure, groundwater and surface water quality, downstream beneficial uses, environmental values and post-mining rehabilitation.

At Tutunup South, the potential sources of acid drainage are the overburden, ore, HMC, oversize, clay fines, sand tails and the pit walls and floor.

9.4.4 Assessment and Management

During the mining process, non mineralised soils over the orebody (overburden) will be excavated and either stockpiled for later return to the mining pit or returned directly to another part of the mining void. Soils containing mineral (ore) are mined and processed to remove rock (oversize) and extract heavy mineral concentrate (HMC). Non-mineral soil components separated in this process are returned to the pit (sand tails) or solar drying dams (clay fines). Water is used in processing and is recycled through the system.

As each of the soil components are handled differently during the mining process, the potential pathways for development of acid drainage differ. These include:

- Overburden - placement of overburden containing PASS in temporary stockpiles exposes the sulfides to atmospheric oxygen and may result in acid generation and acid drainage. Placement of AASS affected overburden in temporary stockpiles facilitates leaching and therefore may result in acid drainage.
- Stockpiled ore - short-term stockpiling of ASS ore prior to processing may result in acid generation (PASS) and acid drainage (PASS and AASS).
- Heavy Mineral Concentrate (HMC) - when the ore is processed through the concentrator, sulfides are typically concentrated in the HMC. HMC will be stockpiled on site prior to transport off site. Thus, stockpiled HMC is a potential source of acid generation and acid drainage.

- Process by-products including clay fines (<53 µm), sand tails (>53 µm, <2 mm) and oversize (>2 mm, recovered at the screenplant) - sulfide concentrations in sand tails and oversize are generally significantly reduced and oxidation within clay fines is significantly retarded, however there is some potential for acid generation and acid drainage.
- In situ pit wall and basement materials - mining of the Tutunup South deposit will occur below the water table and dewatering will be required. Dewatering creates a cone of depression around the pit. This may lead to sulphide oxidation and acid generation within the cone of depression. Pit dewatering waters may therefore contain decreased pH or increased levels of metals.

9.4.5 Management

The management approaches proposed for Tutunup South are in line with those that have been developed by Iluka over the course of managing other acid sulfate soil sites in the south west. A third party review of the ASS investigation was conducted (Sullivan 2007). Many of the recommendations made in this report have been adopted during preparation of the Acid Sulfate Soils Management Plan. A third party review of the ASSMP has also been conducted and revisions have been made based on that review (Sullivan, 2008).

The priorities for management of PASS are:

- avoid oxidation;
- minimise the rate of oxidation;
- neutralisation of acid; and
- treatment of acidic waters prior to release.

The priorities for management of AASS are:

- reduce water infiltration into affected soils, thus reducing the potential to mobilise acidity; and
- treatment of acidic waters prior to release.

The proposed management measures for ASS affected material at Tutunup South are described below.

Overburden material (Bassendean Sand / Guildford Clay)

Approximately 4 652 000 t of overburden lies over the orebody at Tutunup South and therefore needs to be removed before the ore can be mined. The overburden is primarily pale grey sands and sandy clay soils from the depositional basin (sumpland area) on the western side of the proposed mine pit (SWC, 2008). Removed overburden will be either stockpiled on the surface or returned directly to the mine void as mining progresses.

There is no AASS within the overburden, but an estimated 514 602 tonnes of PASS affected overburden, which is approximately 11 % of the total volume of overburden.

PASS locations identified through modelling will be incorporated into mine planning. Any PASS identified through operational monitoring will be highlighted to mine planners immediately; so that all PASS material can be separated from non-PASS overburden and managed appropriately.

The preference in managing PASS overburden is to directly return the material to the base of the mine pit (preferably below the water table). Where PASS overburden is returned directly to the pit void, once the dumping location is no longer to be used, or no dumping occurs at that location for a period of 1 week in summer and 3 weeks during winter, it will be covered with at least 1 m of non-PASS overburden.

Where direct return is not possible, PASS overburden will be placed in a designated PASS overburden stockpile. During summer, if PASS overburden is stockpiled for more than 1 week, it will be covered with at least 2 m of non-PASS overburden. During winter, if PASS overburden is stockpiled for more than 3 weeks, it will be covered with at least 2 m of non-PASS overburden. The thicker cover of non-PASS overburden is required on stockpiles due to the greater capacity for moisture loss from stockpiled overburden. Bunding will be installed where required to control surface runoff from PASS affected overburden stockpiles. Runoff will be directed to the process water system as per all site water (see also ‘Site Water’).

Due to the high clay content and resultant low permeability of the overburden, the risk of impact to groundwater from leachate is very low; however a “guard” layer of limestone will be used as a base for PASS overburden stockpiles.

On return, stockpiled PASS overburden will be placed as close to the base of the mine pit as possible

PASS affected overburden will not be used in the construction of noise bunds.

Stockpiled Ore

Ore stockpiles will be established in the mine pits near the hopper locations to provide feed to the plant at night. Stockpiled AASS ore has the potential to leach and stockpiled PASS ore has the potential to oxidise, causing acidic leachate.

Where possible, AASS and PASS will be fed directly into the hopper, rather than being stockpiled in the pit. Should stockpiling of AASS or PASS be required, stockpiles will be sited such that drainage is toward a dewatering sump, so that any leachate from stockpiles will be captured in dewatering water and directed to the process water system, enabling treatment if required.

Oversize

Oversize makes up a small component of the ore. For Tutunup South, there is expected to be approximately 263 500 t of oversize, which is 2.5 % of the ore. Approximately 46 000 t of oversize (3.2 % of the PASS-affected ore) is predicted to be PASS affected. A very small quantity of oversize is predicted to be AASS affected.

Due to the small volumes of AASS and PASS affected oversize, no specific treatment or neutralisation is required (SWC, 2008). AASS and PASS affected oversize will be returned to the mining void at depth as soon as practically possible (within one to two weeks of stockpiling). Re-submergence will prevent oxidation of PASS from occurring (SWC, 2008).

Clay Fines

Clay fines generally contain significant quantities of pyrite. Whilst the potential for acidic material is acknowledged, the properties of the clay fines will limit the extent of oxidation and removal of oxidation products. Clay textured materials do not acidify as rapidly as sandy textured materials (Sullivan, 2007). Kinetic investigations conducted on Yoganup West clay fines material (GCA, 2005) indicate that pyrite oxidation is significantly limited by particle size and pore size, restricting water movement and retarding oxidation and the removal of products of oxidation in clay fines. SO_4 and soluble-acidity forms, are effectively trapped within micro-pores when the clayey-fines are relocated to the mine void (GCA, 2006).

When the ore is separated in the concentrator, one of the products is clay fines. These are the very fine materials that are less than 53 µm in size. Clay fines exit the process in a slurry form. This material cannot be directly returned to the pit due to the very high water content, but is first deposited into dams known as solar drying dams. The dams allow the fine materials to settle out of the slurry and for water to be decanted off the top and returned to the process water system for reuse. As noted in section 7.4, once the clay fines material is in a state where it can be handled by excavators and trucks, it is removed from the dam and returned to the mine void. Solar drying dams to be used for PASS affected clay fines will either have a clay base or will be lined with lime sand to neutralise any potentially acidic leachates.

Sand Tailing

Due to the particle characteristics of sand tails (predominantly sand grains with particle density of 2.65 g/cm^3 and particle size greater than 53 µm), it contains little pyrite. However, also due to its particle characteristics, tails sand has high permeability and low water retention properties, such that it is well aerated, allowing oxidation. The poor buffering capacity of sand tails means that when PASS materials in sand tails oxidise, the pH can drop rapidly (SWC, 2008). This characteristic also means that overdosing with lime results in high pH (pers. comm., A. Pratt, 2007).

Sand tails are returned directly to the mine void in slurry form. The time between excavation of material to deposition of sand tails in the mine void varies, however is estimated at approximately 2 hours. It is estimated that a total of 1000 kT of PASS sand tails is present at Tutunup South. Due to the volumes of PASS affected sand tails, and the very small quantities of lime that would be required to treat it, treatment of sand tails is likely to result in overliming. PASS affected sand tails will be treated with lime sand and deposited into the mine void at depths greater than 1 m below the final soil surface, in areas to be rehabilitated to pasture only.

Heavy Mineral Concentrate

The HMC from Tutunup South will contain significant amounts of pyrite. HMC is temporarily stockpiled on site before being transported to Capel for further processing. HMC stockpiles cannot be neutralised with limestone as calcium contaminates the HMC.

While stockpiling HMC cannot be avoided completely, where possible, stockpiling of ASS affected HMC will be scheduled to a minimum to minimise oxidation time for PASS and limit the opportunity for rainfall to cause acidic leachates from AASS and PASS materials.

The HMC stockpile pad will be located within a bunded area and will be constructed to allow capture of leachate from the stockpile.

Site Water

Water is removed from the mine pit to allow dry mining to occur. All dewatering water from the mine pit will be directed to the process water dam to be used in processing. Surface runoff from disturbed areas and decant water from solar drying dams will also be directed to the process water system. Dewatering water, surface runoff and decant water from solar drying dams is preferentially used in the process over bore water to maximise water efficiency.

If site water exceeds processing requirements and storage capacities, water may be required to be discharged through a discharge point licensed by the DEC under the prescribed premise licence. If discharge is required and monitoring indicates that the pH is unsuitable for discharge, the water will be treated to correct the pH.

In situ soils

Dewatering of the mine pit causes drawdown of the water table, which has the potential to result in oxidation of pyritic soils around the pit. The degree of oxidation outside of the pit will be largely governed by the duration that such strata are locally unsaturated, and the diffusive supply of oxygen (GCA, 2006). Dewatering also has the potential to mobilise acidity from AASS material, which predominantly occurs in the northern section of the proposed mine pit.

At several locations at Tutunup South, the base of the pit is within 2 m of the upper surface of the underlying PASS material. PASS materials were also located adjacent to the western margin of the mine within the depositional basin. Groundwater dewatering may result in disturbance of this PASS, causing oxidation to occur.

When drawdown of the water table occurs, the soils along the pit face come into direct contact with the atmosphere.

Oxygen diffusion, and therefore oxidation, is strongly related to the water content, air filled pores and total porosity of the soil (SWC, 2006). In a saturated soil, the air-filled porosity is zero, so oxygen diffusion is minimal. As water is removed, the air-filled porosity increases and so does the oxygen diffusion rate.

The sediments within the depositional basin hold strongly onto water and therefore have a very low permeability and a high field capacity, which facilitates this material existing in a saturated or near saturated condition. At this moisture content, the air-filled porosity will be very small, resulting in reducing conditions (SWC, 2008). Dewatering during mining will only result in 'drying' of soil moisture levels to field capacity directly adjacent to the pit wall. At distances greater than 2 m from the pit wall, no appreciable change in soil moisture content is likely to occur, hence reducing conditions are likely to continue in the majority of the depositional basin during mining (SWC, 2008).

Limiting the extent of the cone of depression and the opportunity for oxidation is best achieved by minimising abstraction and backfilling the voids as quickly as possible. In the vicinity of the in-pit hopper located within PASS material, this method alone may be insufficient to prevent significant oxidation, as the hopper location will remain open for up to 3.7 years. Iluka is investigating the use of sealant products that can be applied to the pit wall in this location to form a barrier to oxygen diffusion and allow moisture retention in the material behind the pit wall. Several products are being investigated.

Sumps are located in the lowest areas of the mine pit so that pit water drains toward them. Three of the four sumps that will be required to operate the mine will be located within areas modelled as containing PASS. One of these three sumps is associated with an in-pit hopper. Sumps in areas of PASS can be managed to maintain moist conditions on the pit floor.

Management will include:

- Standard sump design involves digging a sump into the lowest part of the pit floor and installing a dewatering pump to remove water from the pit to allow safe working conditions for heavy equipment. At Tutunup South, for the three sumps located within PASS-affected material, dewatering will be modified to prevent PASS materials in the pit floor from becoming exposed. This will include managing sump pumping using float switches set to turn the pump off close to floor level, rather than manual operation, where there is the risk that the pump will be left running longer than necessary, which may result in exposure of PASS materials. This will ensure that the pit floor remains saturated. Maintaining high water levels may mean that scrapers cannot be used to mine the last half metre of ore. In this case, excavators or other machinery may be used to remove ore from the pit floor.
- in-pit hoppers are built on a hopper pad, consisting of a one metre thick pad of gravel and limestone. Standard practice is to dig a sump into the pit floor to collect water from the mine pit to prevent the hopper location from flooding. At Tutunup South, the depth of the sump near the PASS affected hopper location will be reduced to prevent dewatering into the PASS affected zone, with the hopper pad built up clear of water level. By doing this, water levels around the hopper can be maintained at the pit floor, so that any PASS material in the pit floor remains saturated.
- Any PASS material excavated from sumps will be handled as appropriate.

Monitoring of groundwaters, surface waters and soil materials will be implemented to allow for the verification of ASS modelling and the determination of when management actions are required.

An Acid Sulfate Soils Management Plan, incorporating the above mitigation and management measures, monitoring and contingency plans has been developed and is appended to this PER (Appendix 3). Implementation of this management plan will ensure the EPA objective to maintain the integrity, ecological functions and environmental values of the soil and landform will therefore be achieved.

9.4.6 Commitment

- Implement the Acid Sulfate Soils Management Plan.

9.5 Flora and Vegetation

9.5.1 Objective

The EPA objective is to maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

9.5.2 Relevant Standards

The EPA has developed Position Statement No. 2 for the Environmental Protection of Native Vegetation in Western Australia, Clearing of Native Vegetation with particular reference to the agricultural region of Western Australia (EPA, 2000a). The Tutunup South project is not within the agricultural area as defined in this position statement. However, the position statement also covers clearing in other areas of Western Australia. In assessing a proposal outside of the agricultural area, the EPA's consideration of biological diversity will include the following elements:

- different development options have been considered and reasonable steps have been taken to avoid disturbing native vegetation;
- no species or community of plants or animals is likely to become extinct as a consequence of the development and risks to threatened species are considered to be acceptable;
- no association or community of indigenous plants or animals ceases to exist as a result of the project;
- vegetation removal does not compromise any vegetation type by taking it below the "threshold level" of 30% of the pre-clearing extent of vegetation;
- where a proposal would result in a reduction below the 30% level it is expected that alternative mechanisms are developed to address the protection of biodiversity;
- scarce or endangered habitats are comprehensively, adequately and securely represented within or in areas biologically comparable to the Project Area;
- in a large project area, there is a comprehensive and adequate network of conservation areas and linking corridors whose integrity and biodiversity is secure and protected; and

- the on-site and off-site impacts are identified and the proponent demonstrates that these impacts can be managed.

In addition, the EPA has issued a Guidance Statement 10: Level of assessment for proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 Region (EPA, 2006c). The guidance aims at ensuring that developments are compatible with the intent of the recommendations for and/or conservation values of these areas. Criteria included within Guidance Statement 10 have been used to assess the potential impact on the regional significance of the natural areas within the Project (see Table 5).

The *Wildlife Conservation Act 1950* (WA) provides for the protection of all native flora, including declared rare and priority flora and the *Environmental Protection and Biodiversity Conservation Act 1999* provides for the protection of threatened flora and communities.

In June 2004, the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* came into operation. Under the regulations, areas subject to the formal environmental approvals process do not require a separate clearing permit. Thus, approval of disturbance in this PER negates the need to obtain a separate clearing permit for development of Tutunup South.

9.5.3 Issue Definition

Clearing

Implementation of the project will require disturbance of 230 ha of agricultural land which contains 6 ha of isolated remnant trees and 25.6 ha of native vegetation.

The vegetation community condition ratings and areas identified for clearing are detailed in Table 19, whilst the vegetation areas to be cleared are mapped in Figure 14.

The main botanical values occur within the more intact and less disturbed communities on the eastern edge of the survey area. These communities will be subject to very little clearing. Ecological linkages in these areas and therefore ecological processes such as reproduction opportunities and dispersal will be maintained. There is a relatively high degree of degradation within the remainder of the communities surveyed and this is reflected in the lack of native species and the presence of introduced plant species.

The vegetation communities as defined by Mattiske and Havel (1998) which occur within the disturbance area are Abba (AB and Aw) and Yelverton (Y and YW). None of the Whicher Scarp (WC) community occurs within the proposed disturbance area.

The bulk of the clearing is in vegetation community E2 (14.9 ha) with a Bush Forever condition of 4 (good). 0.1 ha of E2 with a condition of 2 will be cleared. Vegetation community E2 has similarities to floristic community SCP 1a.

The S2 vegetation community, which has a low similarity with the TEC SCP 02, has up to 0.8 ha within the disturbance area requiring clearing. The S2 within the disturbance area is rated as condition 5 (degraded). The degradation of this area is reflected in the lack of native species and the presence of introduced species (Mattiske Consulting Pty Ltd 2007).

The vegetation community C2, which has a very low level of similarity with TEC SCP 03a, occurs over 1 km outside of the disturbance area for the Tutunup South project and will therefore not be cleared.

The northern wetland is within the pit footprint, resulting in the loss of 4.4 ha of M1 vegetation. The other 2.5 ha of M1 is located along the Vasse Highway road reserve. The M1 vegetation community has similarities to floristic community SCP 9. The 2.9 ha of disturbed vegetation is degraded, containing only isolated species, and was therefore not assigned a vegetation community.

Table 19: Vegetation Areas to be Cleared

Vegetation Community	Bush Forever Condition	Vegetation Area	Area in hectares
E2 – open forest	2 – excellent	62	0.1
E2 – open forest	4 - good	8, 10, 11, 13, 14, 32, 60, 64	14.9
S2 – tall shrubland	5 - degraded	9	0.8
M1 – Melaleuca woodland	3 – very good	5	3.0
M1 – Melaleuca woodland	4 - good	4	1.4
M1 – Melaleuca woodland	5 - degraded	3	2.5
D - Disturbed	5 - degraded	12	2.9
		Total	**25.6**
Isolated trees in agricultural paddocks	NA	NA	6
		Total	**31.6**

The DRF record of *Dryandra nivea* subsp. *uliginosa* listed on the WA herbarium database was not recorded during the past three surveys. However, the location is outside of the mine's disturbance area.

Whilst most of the priority flora populations identified in field surveys occur outside of the disturbance area, populations of *Gratiola pedunculata, Aotus cordifolia* and *Loxocarya magna,* were located within the disturbance area (Figure 13). The potential for impact on these species is discussed in section 0:

- *Gratiola pedunculata* (P2) was located at the northern wetland, which is within the pit footprint, requiring disturbance. This species is a short lived annual herb, known from only five records in the Cape Arid National Park and southern jarrah forest. This record is the second on the Swan Coastal Plain. It has not been previously recorded in the Busselton/Capel area, representing a significant westward extension of its previously known range (Mattiske Consulting Pty Ltd 2007).
- *Aotus cordifolia* (P3) was identified at the same location as *G. pedunculata*, thus requiring disturbance. This taxon is known from 36 records at the WA Herbarium and occurs on the southern section of the Swan Coastal Plain and

Whicher foothills (Mattiske Consulting Pty Ltd 2007). *Aotus cordifolia* (P3) is expected to be rehabilitated from seed and will be targeted during the rehabilitation program. Given this species has been recorded at locations along the Swan Coastal Plain, clearing is unlikely to have a significant impact.

- *Loxocarya magna* (P3) was identified in the gravel reserve immediately south of the Vasse Highway. This location will also require disturbance. *L. magna* has a preference for seasonally inundated soils, with a geographical range extending from Donnybrook to Capel and as far south as the Scott River. This species is known from 18 records at the WA Herbarium (Mattiske Consulting Pty Ltd 2007). *Loxocarya magna* (P3), will also be targeted for rehabilitation with propagules and cuttings. Given this species has been recorded at locations along the Swan Coastal Plain, clearing is unlikely to have a significant impact.

In addition to these three known locations of priority flora, there is also a WA Herbarium record of *Acacia semitrullata* (P3), north of the southern wetland. This population was not located in recent flora surveying thus is unlikely to still exist. Mattiske Consulting Pty Ltd (2007) have found a further four populations of this species in the vicinity of the project (of which three are in State Forest; Figure 13). In total, there are 62 records of this taxon at the WA Herbarium (Mattiske Consulting Pty Ltd 2007).

Most of the other significant species discussed in Section 5.8.1, were recorded at the eastern fringe of the flora survey area (and hence well to the east of the disturbance area). However three species occur within vegetation communities that will be disturbed by the project (Mattiske Consulting Pty Ltd 2007). All species extend well beyond the project area and therefore impacts will be minimal in a regional context:

- *Callistemon glaucus* was recorded at one location in the northern paddocks and will be disturbed. This species is potentially locally significant but can be readily established in rehabilitation areas.
- *Corymbia haematoxylon* occurs in three of the vegetation communities identified for clearing, however is relatively widespread, being present in six of the communities surveyed. The species is locally more dominant in Whicher Scarp communities although in a regional context is relatively restricted. This species is represented outside the proposed mining areas and also northwards along the Whicher escarpment.
- *Taxandria fragrans* occurs in the M1 community, which is situated within the disturbance area, and the S2 community, which is located outside the disturbance area. The species occurs more commonly in the regional context and therefore any clearing will have minimal impacts on its conservation status (Mattiske Consulting Pty Ltd, 2007).

Impact on Groundwater Dependent Ecosystems

There is the potential for groundwater drawdown to impact on the 11 Groundwater Dependent Ecosystems (GDEs) identified by SWC (2007c) (Section 5.5) (Figure 23). Groundwater drawdown impacts on vegetation have been assessed using maximum predicted groundwater drawdown contours and the GDE class. The response curves and risk assessment methodology from Froend, Bowen and Associates (2004) has been adapted to assess risk levels (Table 20). The potential impacts on vegetation associated with the assigned risk level are outlined in Table 21.

Table 22 shows the GDE vegetation areas and associated areas at risk of impact. Detail of expected drawdown impacts on the GDE vegetation areas is provided in the Flora, Vegetation and Dieback Management Plan.

Table 20: Assignment of Risk Category to GDE Class

GDE Class	Groundwater Drawdown Threshold			
	< 0.75	> 0.75	> 1.25	> 1.75
1	Low	Moderate - High	High	High
2	Low	Low - Moderate	Moderate – High	Moderate - High
3	Low	Low	Low	Low - Moderate
4	None	None	None	None

Table 21: Expected Impact associated with GDE risk categories

Risk	Expected Impact
Low	No significant change in distribution of species
Low - Moderate	Some evidence of changing distribution of species and encroachment of more drought tolerant species
Moderate - High	Measurable change in the demographics of some species with encroachment of more drought tolerant species
High	Overstorey or Understorey decline and/or loss of species. Greater than 50% reduction in abundance of dominant species. For wetland vegetation possibly complete drying out of wetland basin or reduction in period of inundation.

Table 22: Potential areas of Drawdown Impact to Vegetation Communities

Vegetation Community	Vegetation Area	Bush Forever Condition	Area in hectares			
			Low	Low - Mod	Mod –High	High
C1 Open Forest	31 (Abba River)	4	12.4			
E2 Open Forest	30	3	21.1			
	34a	4		0.6		
	34b	4	0.9			
E3 Woodland	57 (Woddidup Creek)	3	2.7			
M1 Woodland	6, 7 (southern wetland)	3				5.0
	26	5			3.5	
M2 Open Woodland	51	5				0.3
	19a	5		0.08		

Vegetation Community	Vegetation Area	Bush Forever Condition	Area in hectares			
			Low	Low - Mod	Mod –High	High
	19b	5	0.3			
S2 Tall Shrubland	46a	3				0.7
	46b	3		0.9		
	46c	3	0.6			
	47	5				0.4
	Total		**38**	**1.58**	**3.5**	**6.4**

With the exception of the three species identified within the disturbance area for clearing, all other priority flora locations are at groundwater levels in excess of 15 m below surface and are thus not groundwater dependent (SWC 2007b).

Of the other significant vegetation noted, *Corymbia haematoxylon* was recorded regularly in six of the 12 communities mapped, including several community types with risk of impact from drawdown. Drawdown will not have a significant impact on this species, as the species is locally widespread. No other significant flora was located within areas at potential risk of drawdown impact.

Weeds

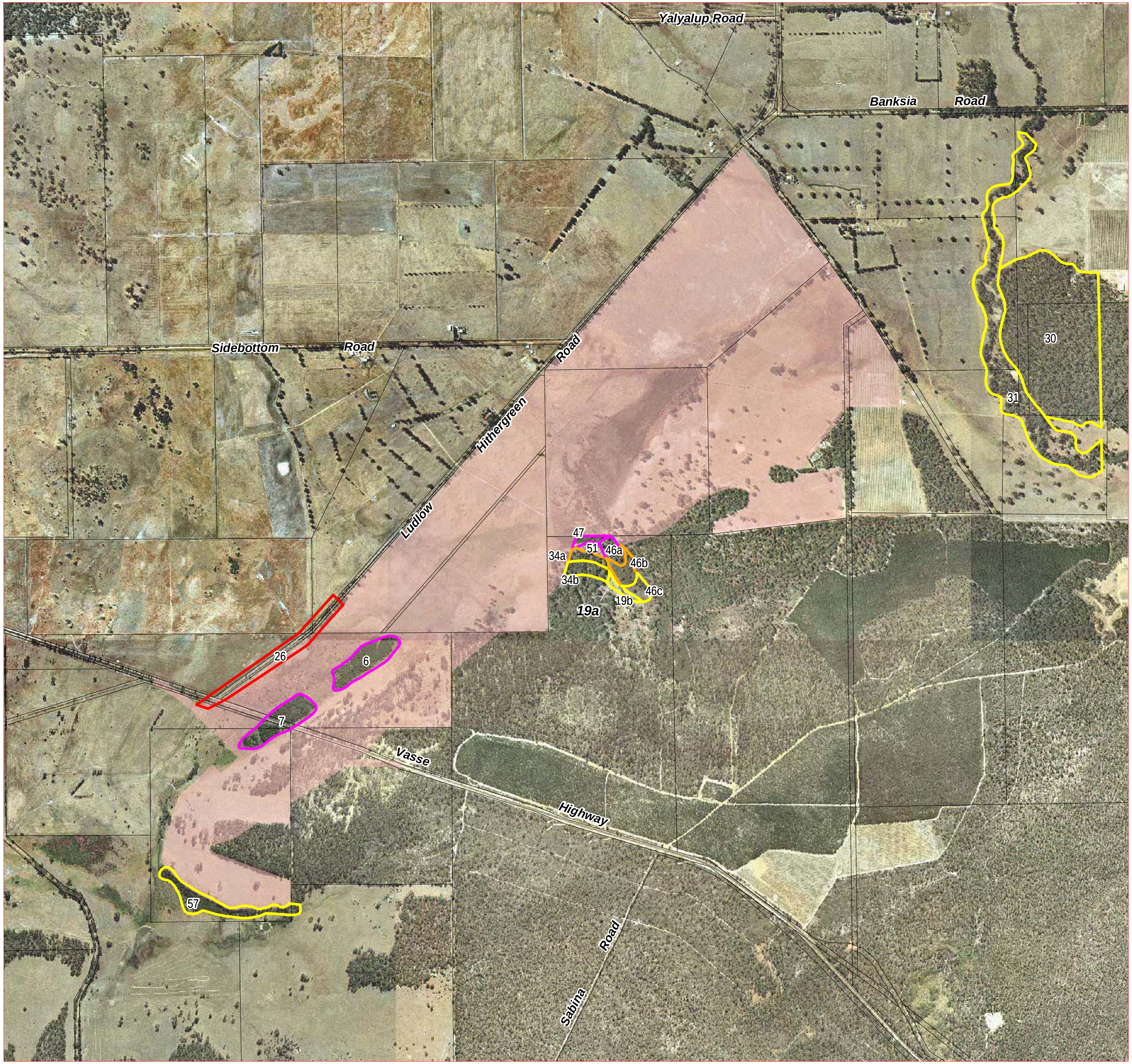
The weeds Arum Lily (*Zantedeschia aethiopica*) and Cape Tulip (*Moraea flaccida*) have been recorded at Tutunup South. With both being P1 and P4 Declared Plants under the *Agriculture and Related Resources Protection Act* in the Busselton Shire, the movement of plant material is prohibited and landowners are and obliged to treat the weeds for extermination. Earthmoving activities are expected to disturb the locations of these weeds, which may lead to their spread if they are not controlled prior to mining.

Dieback

Most of the site is on agricultural land, which is both uninterpretable and unprotectable for dieback. The State Forest and Gravel Reserve is mostly infested, although some areas are uninfested and protectable. If mobile machinery is not controlled when operating between protectable forest and unprotectable areas, there is the potential to infest the remnant dieback free areas. The project involves disturbance to both unprotectable (infested) areas and a small area of protectable (uninfested) native vegetation (at the southern end of the project).

Fire

Fire is a natural feature of the environment, although frequent fires can prevent the re-establishment of susceptible species, resulting in changes to community structure and providing opportunity for weed colonisation. There is potential for unplanned fires to be generated within the minesite from machinery, and from the State Forest from both human vectors and natural causes such as lightning strikes.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S	D.G.S	14.09.07	Original Design
01	S.J	T.L.G	10.04.08	Update of legend items

Legend

Disturbance area

Groundwater dependent ecosystems

Potential Risk

- Low
- Moderate
- Moderate - High
- High

Date of photography: 2001

Vegetation Community	Vegetation Area	Vegetation Condition	Impact Risk	Hectares
C1	31	4	Low	12.4
E2	30	3	Low	21.1
	34a	4	Moderate	0.6
	34b	4	Low	0.9
E3	57	3	Low	2.7
M1	6	3	High	2.4
	7	3	High	2.6
	26	5	Moderate - High	3.5
M2	51	5	High	0.3
	19a	5	Moderate	0.08
	19b	5	Low	0.3
S2	46a	3	High	0.7
	46b	3	Moderate	0.9
	46c	3	Low	0.6
	47	5	High	0.4

N

0 500 1,000 m

ILUKA

TUTUNUP SOUTH

GROUNDWATER DEPENDENT ECOSYSTEMS

RISK OF IMPACT

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:15,000
DATE: 10 Apr. 2008

DWG No: 176497 ver.01 | A3 | FIGURE: 23

Summary

Potential impact to vegetation present has been considered in respect of the criteria outlined in Guidance Statement 10 (EPA, 2006c), as below.

Table 23: Summary of potential impacts in respect to GS #10 criteria

Criterion	Consideration in regard to natural areas at Tutunup South
Representation of ecological communities	The project involves clearing of 25.6 ha of native vegetation and 6 ha of trees in paddock; and 11.6 ha of vegetation at greater than low risk of impact from drawdown. Very little disturbance is proposed within the more intact Whicher Scarp communities on the eastern edge of the survey area. No impact is proposed to community C1, which has very low similarity to TEC SCP 3a. No impact is proposed to community S1 which has low similarity to SCP 02 and a total of 2.8 ha of S2 vegetation (low similarity to SCP 02) is expected to be impacted.
Diversity	The diversity of vegetation and flora occurring in the region will not be altered by the project.
Rarity	Three priority flora species have been identified during site surveys as occurring within the disturbance area. Three other significant species occur within the disturbance area, though all three extend well beyond the disturbance area.
Maintaining ecological processes or natural systems	Very little clearing is proposed within the more intact Whicher Scarp communities on the eastern edge of the survey area and therefore ecological processes within these areas will be maintained. In the remainder of the disturbance area, the high degree of disturbance currently existing means that ecological linkages and therefore ecological processes are currently highly disturbed, with small areas of remaining wetland vegetation being isolated by surrounding clearing. The proposal is not expected to impact on ecological processes.
Protection of wetlands and streamline vegetation	The isolated areas of wetland vegetation remaining will be impacted by the proposal. The northern wetland is proposed to be removed and replaced during rehabilitation. The new northern wetland will be designed to replicate the M1 community previously present (see section 13). The southern wetland vegetation has been excised from mining, however risk of impact from groundwater drawdown remains. The risk of impact to this wetland area will be minimised by management of water levels (see section 9.5.4). During rehabilitation, the condition of this wetland area will be improved and a native vegetation corridor linking this wetland to the State Forest will be developed. Woddidup Creek, outside of the disturbance area will be protected from impact by bunding.
Scientific or evolutionary importance	The investigations carried out at Tutunup South did not find species or habitats that are of scientific or evolutionary importance, therefore the proposal will have not impact on this criterion.

In summary, it is considered that the proposal will not have significant impact to the representation of ecological communities, diversity, rarity, maintenance of ecological processes and natural systems, or scientific or evolutionary importance of the region. This is largely due to the existing degraded nature of the site and the design of the proposal to avoid the more intact areas which retain higher natural values wherever possible. Impact to the small, isolated areas of wetland that remain vegetated is expected, however rehabilitation measures are aimed to provide long term benefit to these areas, particularly in relation to restoring linkage between the southern wetland and the State Forest.

9.5.4 Assessment and Management

Vegetation Impacts

Given consideration of direct (clearing) and indirect (groundwater drawdown) impacts, the maximum potential impact on vegetation communities is outlined in Table 24.

Table 24: Summary of Direct and Indirect Vegetation Impacts

Vegetation Community	Condition	Area Surveyed (ha)	Clearing (ha)	Groundwater Drawdown (ha)*	Total Impact Area	% of Area Surveyed
B1 Woodland	2	5.7	0	0	0	0
C1 Open Forest	4	12.4	0	0	0	0
C2 Woodland	4	6.1	0	0	0	0
C3 Woodland	5	12.6	0	0	0	0
D Degraded	5	9.9	2.9	0	2.9	29%
E1 Open Forest	2 – 5	188.9	0	0	0	0
E2 Open Forest	2 – 4	136.1	15	0.6	15.6	11.5%
E3 Woodland	3	2.7	0	0	0	0
M1 Woodland	3 – 5	17.2	6.9	8.5	15.4	89.5%
M2 Open woodland	5	5.3	0	0.38	0.38	7%
S1 Low shrubland	2 – 3	20.8	0	0	0	0
S2 Tall shrubland	3 – 5	7.0	0.8	2	2.8	40%
TOTAL		424.7	25.6	11.48	37.08	

* Areas of > low - moderate risk as identified in Table 22

None of the B1, C1, C2, C3, E1, E3 or S1 vegetation communities will be impacted by the proposal.

Less than 12% of the varying condition E2 vegetation communities surveyed will be impacted. This community is well represented on the Swan Coastal Plain (Mattiske Consulting Pty Ltd 2007).

A total of 40% of the M1 vegetation community within the area is within the disturbance area. A further 49.5% of this varying condition community is at risk of indirect impact through potential groundwater drawdown. This community is locally not restricted and is well represented on the Swan Coastal Plain (Mattiske Consulting Pty Ltd 2007).

Of the degraded M2 community present within the survey area, none occurs within the disturbance area, though approximately 7% is at low or low to moderate risk of impact from groundwater drawdown. The M2 community is well represented on the Swan Coastal Plain (Mattiske Consulting Pty Ltd, 2007).

The S2 vegetation community within the survey area ranges in condition from 3 to 5. 11% of the surveyed S2 community is within the disturbance area and 28.5% is at varying levels of risk of impact from groundwater drawdown. This community is also present in other areas of the Swan Coastal Plain (Mattiske Consulting Pty Ltd 2007).

Detailed soil hydrology studies on areas of greater than low-moderate risk of drawdown impact are underway and strategies will be implemented to minimise impacts where possible. It is anticipated at this stage that residual moderate-high impacts will remain. Iluka will monitor vegetation impacts through photo points and plot monitoring and commits to infill planting in vegetation adversely affected by groundwater drawdown. Permanent plots are located both in the southern wetland (4 plots) and S2 vegetation (1 plot).

Flora Impacts

Three priority flora species *Aotus cordifolia* (P3), *Loxocarya magna* (P3) and *Gratiola pedunculata* (P2), are expected to be impacted by mining at Tutunup South.

Aotus cordifolia is rehabilitated from seed and therefore will be targeted during the rehabilitation program. *Loxocarya magna* will also be targeted for rehabilitation through vegetative propagules. Given that both species have also been recorded at locations along the Swan Coastal Plain, clearing of these priority flora is unlikely to have a significant impact on either species.

Further clarification of the regeneration strategies for *Gratiola pedunculata* will be sought from relevant botanical experts.

It is unlikely that the WA Herbarium record of *Acacia semitrullata* (P3) is still present as it was not located by Mattiske Consulting Pty Ltd in either survey. If the individual from this species is present, clearing is unlikely to have a significant impact on its regional population as it has many records on the Swan Coastal Plain.

There are three species of significant flora that may be influenced by the proposed mining activities. All species extend beyond the project area and therefore impacts will be minimal in a regional context. *Callistemon glaucus* will be disturbed. This species is potentially locally significant but can be readily established in rehabilitation areas. A portion of the *Corymbia haematoxylon* population will be disturbed, however it is relatively widespread, being present in six of the vegetation communities described by Mattiske Consulting Pty Ltd (2007). This species is locally more dominant in the Whicher Scarp although in a regional context is relatively restricted. *Taxandria fragans* was recorded in two communities, one of which will be impacted by the mining activities. The species occurs more commonly in the regional context and therefore any proposed activities will have minimal impacts on its conservation status.

Weeds

All Arum Lily and Cape Tulip populations within the disturbance area will be controlled prior to the commencement of mining. If these or any other declared weed establishes during the operation or in rehabilitation, it will be removed as required.

Dieback

Vehicles and machinery that need to move from unprotectable (uninterpretable or disease infested) into protectable (uninfested) forest areas will be cleaned down at the dieback boundary before entering the disease free area.

Topsoils will be stripped and placed according to the forest hygiene classification. Dieback infested and uninfested soils will be segregated during stripping and placement to prevent the spread of dieback.

Fire

There will be little grassed area in the Tutunup South site during operations, resulting in a low potential for fire to spread. Nevertheless, Iluka will ensure firebreaks are installed in accordance with the requirements of the Shire of Busselton. Members of the site team will be trained to minimise risk and manage both grass and forest fires. Iluka will allow access and provide support to other authorities such as DEC and FESA in the event of a forest fire in the State Forest.

Assessment and Management Summary

Iluka sought to minimise the clearing of native vegetation when designing Tutunup South and any further review of plans and designs will continue to aim at minimising the project’s clearing footprint. Controls to prevent unplanned, excessive or unapproved clearing will be implemented, and may include bunding, signage or fencing. Rehabilitation will be conducted as soon as possible after mining is completed to assist in maximising recruitment from soil stored seed.

Water in vegetation areas 6 and 7 will be managed to mimic the winter conditions. Post mining, this area will be infill planted to create a corridor link to the State Forest. Other GDE areas at risk of impact will be monitored and revegetation will occur if impacts eventuate.

Declared Weeds will be controlled as required. Vehicles required to move from dieback infested or uninterpretable areas into uninfested State Forest will be cleaned before entering. Infested and uninfested soils will be segregated. Firebreaks will be installed in accordance with Shire of Busselton requirements.

Permanent vegetation plots in the M1 and S2 vegetation communities will be monitored annually. Re-emergence of declared weeds will be monitored opportunistically. Dieback mapping will occur every second year.

In the event that adverse impacts to vegetation that are attributable to mining occur, restoration will be undertaken.

A Flora, Vegetation and Dieback Management Plan has been prepared and appended to this PER, which provides detailed management recommendations and methods (Appendix 1). Iluka will implement avoidance, mitigation and management strategies as outlined in this management plan.

In addition, a Preliminary Closure and Rehabilitation Plan has been prepared and appended to this PER (Appendix 6). The Preliminary Closure and Rehabilitation Plan details strategies to be used to effect successful rehabilitation of both native vegetation and pasture. This is outlined further in Section 12.

Suitable offsets for residual impacts of the project have been developed in accordance with EPA Position Statement No. 9 (2006a) and are outlined further in Section 12.

The implementation of the Flora, Vegetation and Dieback Management Plan and Preliminary Closure and Rehabilitation Plan will ensure the EPA objective to maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels is achieved. In addition a net environmental benefit will be achieved through implementation of the offsets strategy.

9.5.5 Commitments

- Implement the Flora, Vegetation and Dieback Management Plan.
- Implement the Preliminary Closure and Rehabilitation Plan.
- Implement the offsets strategy.

9.6 Fauna

9.6.1 Objective

The EPA objective is 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.

9.6.2 Relevant Standards

The *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) provides protection for listed threatened fauna species and habitat listed as Threatened Ecological Communities. Any proposal likely to have a significant impact on a listed species is required to be referred to the Commonwealth DEWHA to determine if Commonwealth approval is required.

The Commonwealth is a signatory to the Japan Australia Migratory Bird Agreement (JAMBA) and China Australia Migratory Bird Agreement (CAMBA). Birds listed under these agreements are listed as migratory species under the EPBC Act.

The *Wildlife Conservation Act 1950* (WA) provides for the protection of rare fauna and other special fauna that are listed on specified schedules. Other species for which the status of abundance is unclear and there is some concern, are listed as Priority Fauna by the DEC.

Guidance Statement 10: Level of Assessment for Proposals Affecting Natural Areas within the System 6 Region or the Swan Coastal Plain Portion of the System 1 Region (EPA 2006c) provides a criteria for assessing the regional significance. The fauna aspects are assessed and detailed below, according to each criterion. Criteria included within Guidance Statement 10 have been used to assess the potential impact on the regional significance of the natural areas within the Project (see Table 11).

9.6.3 Issue Definition

The Tutunup South proposal involves the clearing of 31.6 ha of native vegetation and isolated trees as outlined in section 9.5. Potential impacts to fauna may come from loss of habitat through vegetation clearing, dust, noise, dewatering, lighting and vehicle movements.

Terrestrial fauna studies have recorded six protected rare or specially protected fauna species under State and Commonwealth legislation. A further nine species that were not recorded during surveys have the potential to occur in the vicinity of Tutunup South as identified in Table 14. Six aquatic macroinvertebrates species were identified as being rare during wetland studies. A survey for short range endemic invertebrates did not locate any rare species.

Three possible Black Cockatoo nesting trees are likely to be directly impacted within the disturbance area (Figure 18). There are also a number of identified feeding sites including one Carnaby's Cockatoo feeding site that will be impacted.

9.6.4 Assessment and Management

Vertebrate Fauna

The loss of potential nesting sites and feeding resources has the potential to have a significant impact on Black Cockatoo populations (Johnstone, Johnstone and Kirkby 2007). However, other than these impacts, both Ninox Wildlife Consulting (2006) and Biota (2007a) have concluded that the Tutunup South project will have little to no impact on fauna.

Habitat loss is unlikely to be a major potential impact to any of the other conservation significant species recorded or potentially present within the study area, as very little clearing is taking place (Biota, 2007b). Biota note that as disturbance has been tailored to maximise the use of degraded pasture and minimise the need to clear intact terrestrial fauna habitat, impact on local and regional fauna values associated with the project will be minimised. It is also noted that it is unlikely that any of the species recorded would be restricted to the study area (Biota, 2007b).

Although there may be some disturbance in relation to dust, light, noise and vibration, this would lead to a short-range displacement of individuals to the adjacent State Forest, with no impact to the conservation status of species.

Management strategies suggested below recognise the edge of the State Forest is where impacts are most likely to be prevalent. Specific measures targeting Black Cockatoos are also included in the discussion below.

Iluka sought to minimise the clearing of native vegetation when designing Tutunup South. This includes the preservation of the southern wetland adjacent to a mining pit, to a maximum of 31.6 ha. Any further review of plans and designs will continue to aim at minimising the project's clearing footprint. Within the 230 ha of agricultural land clearing there may be opportunities to avoid clearing some isolated remnant trees that form part of the food resource for one of the Black Cockatoo species.

There are three potential Black Cockatoo nesting sites likely to be cleared within the disturbance area. The hollows will be assessed by fauna experts at the time of felling to confirm their suitability as habitat hollows. Hollows that are suitable for cockatoo use will be relocated into nearby forest areas.

The Vasse Highway diversion will be designed and constructed to avoid nest trees and minimise traffic impacts as far as practicable.

The potential for impact on the *EPBC Act 1999* listed cockatoos has been referred to the DEWHA. The project will be assessed as a controlled action under the Act.

The main noise activities likely to impact the State Forest area will be during construction and soil stripping when earthmoving activities will be at ground level. Noise levels are controlled to minimise impacts on nearby residences under the *Environmental Protection (Noise) Regulations*. Noise levels to the southeast should be comparable to those at nearby residences.

As a continuous operation, lighting will be required to ensure safe operations. Whilst much of the infrastructure and lighting will be located below the surface level (e.g. in-pit hopper), light towers will be constructed to enable flexibility of lighting direction. Thus lighting can be directed to minimise penetration into the forest.

The northern wetland lies within the pit area where clearing cannot be avoided. As identified earlier, this wetland has no direct vegetation corridor linking it to the nearby State Forest. Prior to clearing Iluka will conduct trapping amongst the wetland vegetation and relocate fauna such as Southern Brown Bandicoots and Common Brushtail Possums to the adjacent State Forest or other forested areas in consultation with the DEC. Iluka has previously conducted a similar programme at the Waroona Mineral Sands Mine resulting in relocation of five Southern Brown Bandicoots and two Common Brushtail Possums.

Iluka has previously installed, with some success, artificial nest boxes to provide additional nesting site for cockatoos. In consultation with the DEC and the W.A. Museum, it is planned to install artificial nest boxes in the State Forest area.

Aquatic Invertebrates

After the 2005 aquatic survey (WRM, 2006), Iluka contacted the W.A. Museum (as advised by the EPASU), DEC's Woodvale Research facilities (as advised by the W.A. Museum) and other experts to ascertain the context for the impacts proposed to the aquatic fauna considered 'rare'. The aforementioned contacts believe these species are likely to be far more common and widespread throughout the South West of

Western Australia due to a lack of surveying conducted in the South West. As a result, there are limited records of microinvertebrate species common to the South West. Also due to the dynamic successional changes within microinvertebrate assemblages that can occur over very short time frames (hours, days or weeks), further survey work may not again find these species, but instead reveal other new or 'rare' species. These views are supported by the results of 2007 microinvertebrate sampling conducted in the area, which did record new 'rare' species and only located one of the four previously recorded 'rare' species in the Tutunup South wetlands. The specialists consulted recommended that Iluka is not in a position to survey the aquatic fauna at Tutunup South any further or within the region as it is not likely to assist in establishing a context for the impacts proposed to these species. It is therefore concluded that impacts on the aquatic fauna found at Tutunup South will not be significant to the overall survival of these potentially rare species.

A review was undertaken comparing the Tutunup South wetlands to other wetlands in the region. Four equivalent wetlands were identified at a broad scale. These wetlands had similar attributes to the Tutunup South wetlands being located within the south-eastern extent of the Swan bioregion, remnant paluslope wetlands and Cartis complex vegetation (Biota 2007c). As outlined above, additional aquatic fauna studies are unlikely to assist in establishing a regional context. Rather than invest considerable effort in further survey without satisfactorily addressing the regional context it is considered that providing an offset by securing one of the wetlands through a conservation covenant to remove threats of future grazing or development is considered the best environmental outcome (Biota 2007c).

Assessment and Management Summary

As discussed above, the following management actions will be implemented at Tutunup South:

- Clearing has been and will continue to be minimised;
- Hollows that are suitable for cockatoo use will be relocated into nearby forest areas;
- The Vasse Highway diversion will be designed and constructed to avoid nest trees and minimise traffic impacts as far as practicable;
- Noise levels will be controlled to minimise impacts under the Environmental Protection (Noise) Regulations;
- Much of the infrastructure and lighting will be located below the surface level (e.g. in-pit hopper), and light towers will be constructed to enable flexibility of lighting direction;
- Prior to clearing Iluka will conduct trapping amongst the northern wetland vegetation and relocate fauna such as Southern Brown Bandicoots and Common Brushtail Possums to the adjacent State Forest or other forested areas in consultation with the DEC; and

- In consultation with the DEC and the W.A. Museum, it is planned to install artificial nest boxes in the State Forest area.

A Native Fauna Management Plan has been developed and is appended to this PER (Appendix 2).

Offsets which will provide fauna improvements are further discussed in Section 12.

Implementation of this plan and environmental offsets will ensure that the EPA objective to maintain the abundance, diversity, geographic distribution and productivity of fauna at species and ecosystem levels is achieved.

9.6.5 Commitments

- Implement the Native Fauna Management Plan.

10 POLLUTION: IMPACTS & MANAGEMENT

10.1 Dust

10.1.1 Objective

The EPA objective is 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 and acceptable standards.

10.1.2 Relevant Standards

The DEC will regulate dust emissions for Tutunup South and are likely to set a licence limit for total suspended particulates (TSP) allowed at the site boundary when a prescribed premise licence is issued for the site.

The only legislated dust criteria for Western Australia are those promulgated for the Environmental Protection (Kwinana) Atmospheric Wastes Policy. These specify standards and limits for TSP concentrations within residential areas, an intermediate buffer zone area and industrial areas.

In addition, the DEC uses a value of 1,000 $\mu g/m^3$ for a 15-minute average limit not to be exceeded for very short term dust events.

The EPA Guidance Statement 18 (EPA, 2000b) outlines the measures for controlling dust and smoke on new development sites.

The National Environmental Protection Measure (NEPM) for air quality lists a standard for particulates with an aerodynamic diameter less than 10 µm (PM_{10}) of 50 $\mu g/m^3$ averaged over 24 hours. It is recommended that this level not be exceeded more than 5 days per year.

An ambient air quality goal for $PM_{2.5}$ of 24 $\mu g/m^3$ for a 24-hour averaging period and 8 $\mu g/m^3$ for an annual average was introduced into the NEPM in May 2003.

10.1.3 Issue Definition

The operations at the Tutunup South site have the potential to generate dust from clearing of topsoil and overburden, through vehicle movement and lift-off from exposed surfaces during dry and windy conditions. Dust may also be generated through the course of conducting rehabilitation activities or on rehabilitated areas prior to the establishment of vegetation. Dust generated from the disturbance area has the potential to impact on nearby residences.

The risk of dust impacts is increased during the summer months when strong winds have the potential to carry dust over local residences, Vasse Highway and Ludlow-Hithergreen Road.

10.1.4 Assessment and Management

Dust will be controlled within the disturbance area through a number of management practices. These include:

- regular wetting and grading of all unsealed mine site roads;
- commencing rehabilitation as soon as possible after mining;
- vegetating bunds and stockpiles;
- not disturbing topsoil until required;
- using biodegradable chemical tackifiers that "glue" the surface down;
- hydromulch or clay-fines to stabilise open areas and rehabilitation surfaces; and
- growing temporary crops to bind the soil and lift the wind from the surface.

Implementation of the above dust control measures will minimise dust from site. Monitoring of dust emissions will be conducted according to the licence conditions. The EPA objective to ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses will be achieved.

10.2 Noise

10.2.1 Objective

The EPA objective is to protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

10.2.2 Relevant Standards

Noise limits are defined in the *Environmental Protection (Noise) Regulations (1997)*. The Environmental Protection Agency (EPA) addresses the assessment of environmental noise, including identification of potentially significant noise emissions and demonstration of compliance, in Guidance Statement 8 (EPA, Draft 2007a).

The Guidance includes assessment of operational noise, which involves the determination of ambient noise, predicted noise levels, adjustments to predicted noise levels, comparison with noise criteria, noise reduction measures, consideration of other activities associated with the operation, blasting and monitoring and construction noise assessment, involving on-site operations, construction traffic and blasting.

Under Regulation 13 (Construction Sites) of the *Environmental Protection (Noise) Regulations 1997*, Regulation 7 (Prescribed Standard for Noise Emission) does not apply to noise emitted from a construction site as a result of construction work carried out between 7 am and 7 pm on any day excepting Sundays and public holidays, provided that:

- construction work is carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;
- the equipment used is the quietest reasonably available; and
- if required, a noise management plan in respect of the construction site is prepared, approved by the CEO and adhered to during construction.

10.2.3 Issue Definition

Haulage of ore to the in-pit hopper (one scraper) and processing activities (screen plant and concentrator) will be undertaken on a continuous basis 24 hours a day, seven days a week. Noise impacts during the life of the project will depend on operational areas and atmospheric conditions.

15 residences, including both landowners and neighbours, have been identified in the vicinity of the Tutunup South project (Figure 24).

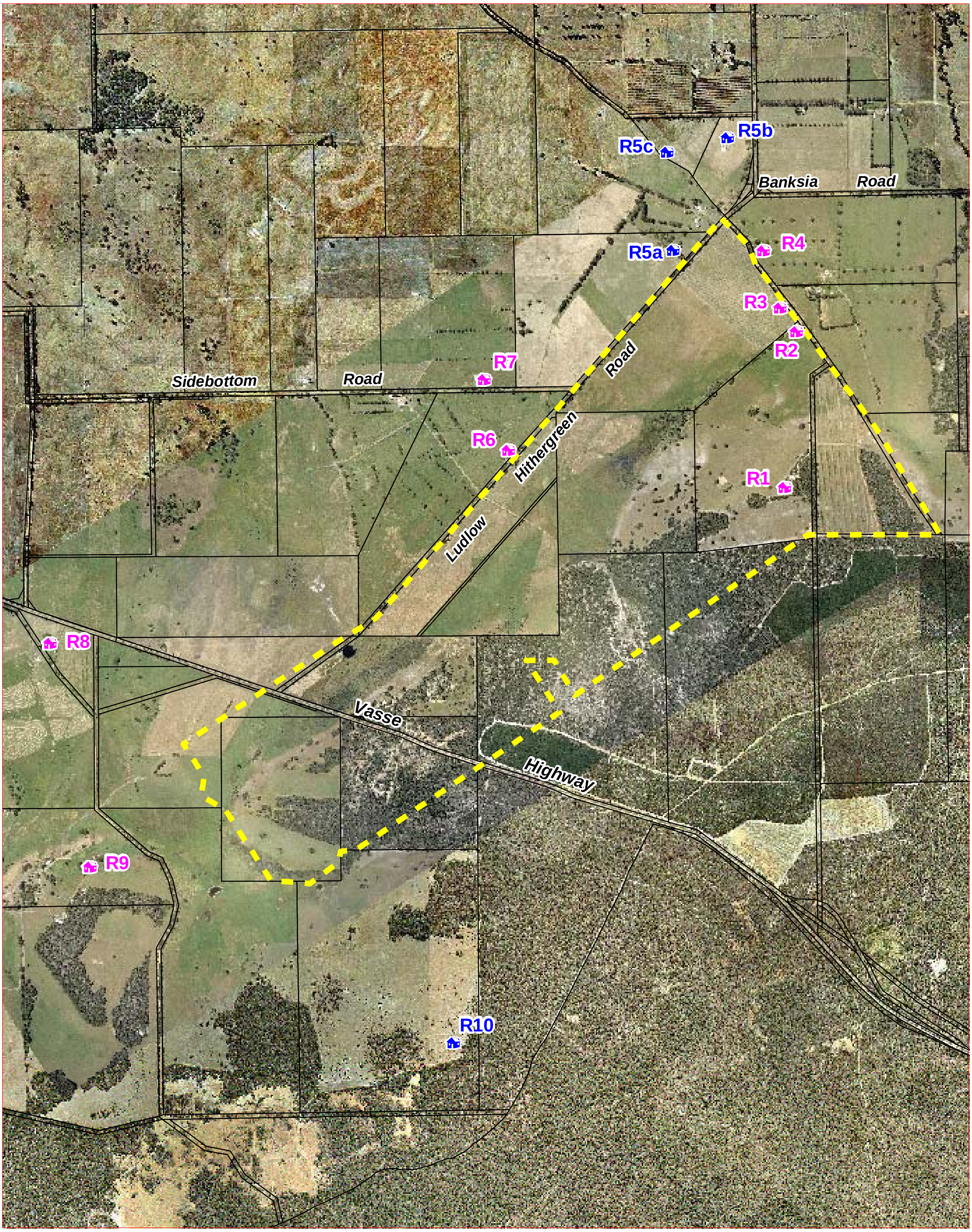
10.2.4 Assessment and Management

Noise Modelling and Compliance

Influencing factors are noise allowances for use when applying the limits prescribed in the *Environmental Protection (Noise) Regulations 1997*. In the case of Tutunup South, the influencing factor for each residence is dependent on the distance of the residence from the mine's location. The relevant influencing factor for each residence has been calculated by SVT (2007) and is presented in Table 25.

Table 25: Assigned Noise Limits Including Influencing Factors

Closest Residences	Influencing Factor in dB	Assigned Noise Limits (LA10) in dB(A)		
		Day	Evening	Night
R1	9	54	49	44
R2	5	50	45	40
R3	3	48	43	38
R4 (2 houses)	0	45	40	35
R5 (3 houses)	1	46	41	36
R6	7	52	47	42
R7	1	46	41	36
R8	0	45	40	35
R9 (3 houses)	0	45	40	35
R10	0	45	40	35



Legend

- Landowners
- Neighbours
- Project area

N

Photography dates:
Inset: 19 Nov. 2005, Regional: 2001

0 500 1,000 1,500 m

ILUKA

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	6 Aug. 2007

TUTUNUP SOUTH

RESIDENCES

DWG No: 176474 ver.00 A4 FIGURE: 24

Modelling has determined pre-mining and mining related impacts on landowners and neighbours using data obtained from the other operations, equipment manufacturers, local topography and atmospheric conditions. The results indicate that under worst case scenarios, noise emissions are likely to exceed the *Environmental Protection (Noise) Regulations 1997* at seven residences during day operations and at five residences at night (Table 26 and Table 27). Scenario 1 is construction and scenarios 2 – 5 are selected cases during operations.

Table 26: Modelled Worst Case Noise Levels

Closest Residence	Adjusted worst-case day and night noise levels in dB(A)*								
	Scenario 1	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	Day	Day	Night	Day	Night	Day	Night	Day	Night
R1	58.5	**50.6**	**45.1**	**59.1**	**45.1**	41.2	32.5	**48.3**	**38.0**
R2	53.9	**52.2**	33.4	**64.3**	33.0	**46.1**	29.0	39.9	**34.0**
R3	53.5	**51.3**	32.7	**61.9**	32.3	**46.3**	28.6	39.7	**33.9**
R4	51.6	**47.0**	**34.6**	**55.6**	**34.4**	**44.6**	27.4	38.2	24.3
R5	53.2	**46.7**	**37.7**	**54.3**	**37.5**	**47.2**	29.2	39.4	24.4
R6	65.2	46.0	**50.0**	**53.7**	**50.0**	**54.5**	**49.9**	**55.3**	**47.3**
R7	59.1	42.2	**45.4**	**51.2**	**45.4**	45.4	**43.9**	**51.4**	**44.2**
R8	46.0	29.2	27.6	30.9	**32.6**	44.4	28.8	36.1	28.3
R9	44.1	31.1	30.8	31.9	**35.8**	**51.8**	31.2	35.9	**36.0**
R10	44.8	29.3	27.7	31.3	27.7	40.1	31.9	37.2	**36.7**

* A penalty of 5 dB(A) for tonality has been applied to all levels shown in bold.

Table 27: Noise Compliance Assessment

Residence	Adjusted Assigned Noise Levels dB(A)	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
		Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions
R1 Day	54	Yes		No	SW-NE	Yes		Yes	
R1 Night	44	No	S-NW	No	S-NW	Yes		Yes	
R2 Day	50	No	S-W	No	ALL	Yes		Yes	
R2 Night	40	Yes		Yes		Yes		Yes	
R3 Day	48	No	SE-W	No	ALL	Yes		Yes	
R3 Night	38	Yes		Yes		Yes		Yes	
R4 Day	45	No	SE-W	No	ALL	Yes		Yes	
R4 Night	35	Yes		Yes		Yes		Yes	
R5 Day	46	No	SE-W	No	NE-W	No	SE-SW	Yes	
R5 Night	36	No	SE-W	No	SE-W	Yes		Yes	
R6 Day	52	Yes		No	NE-SE	No	SE-W	No	E-SW

Residence	Adjusted Assigned Noise Levels dB(A)	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
		Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions
R6 Night	42	No	All	No	All	No	All	No	E-NW
R7 Day	46	Yes		No	NE-S	Yes		No	SE-S
R7 Night	36	No	All	No	All	No	All	No	ALL
R8 Day	45	Yes		Yes		Yes		Yes	
R8 Night	35	Yes		Yes		Yes		Yes	
R9 Day	45	Yes		Yes		No	N-SE	Yes	
R9 Night	35	Yes		No	N-SE	Yes		No	N-SE
R10 Day	45	Yes		Yes		Yes		Yes	
R10 Night	35	Yes		Yes		Yes		No	NW-E

Eight of the 10 residences are landowners and noise factors will be addressed in the landowner agreement to allow access to property for mining. This includes R6 and R1, which will be vacant during mining. The remaining 2 residences modelled are neighbours, modelled as R5 and R10. R5 represents 3 houses, R5a, R5b and R5c. The modelled R5 is R5a, which is the closest of the 3 houses.

Day-time noise is over the assigned level of 46 dB(A) at R5 during daytime mining by up to 3.3 dB(A). Night-time noise is modelled to exceed the assigned level of 36 dB(A). Iluka proposes to develop neighbour agreements with R5a, R5b and R5c.

Night-time noise is over the assigned level of 35 dB(A) at R10 during night-time by 1.7 dB(A). This includes a 5 dB(A) penalty for tonality. Iluka proposes to develop neighbour agreements with R10.

Noise Mitigation and Management

Noise bunds have been integrated into the mine design as needed to minimise noise emissions. These noise bunds will be constructed from earthen material as appropriate material becomes available.

Noise measures developed during mine planning and incorporated into the model include:

- a noise bund 10 m high will be installed adjacent to the concentrator;
- screening plant will be placed in the pit, 4 m below surface and surrounded by 10 m noise bunds; and
- ore mining at night in pit 2 will be conducted behind the ore stockpile.

The in-pit hopper, screen plant and concentrator locations were selected as far away from receiving residences as possible. Conveyors will be used to transport ore from the in-pit hopper to the screen plant. The conveyors emit lower noise levels than mobile equipment. From the screen plant, the ore will be pumped via a pipeline to the wet concentrator. Pumps will be installed in enclosures to suppress noise and where possible, will be contained behind stockpiles.

During construction and operations, mobile equipment will be managed to ensure efficient operations maximising material movement whilst minimising noise emissions.

The following practices will be implemented at Tutunup South:

- minimising the number of equipment operating in the same area at once;
- minimising number of machines starting up at once;
- ensuring the mobile machinery parking area (go-line) is as far from residences as possible and noise bunds are constructed around the go-line as early as possible; and
- equipment will be subject to regular maintenance.

Recent experience at other sites has been directed to reducing the intermittent noises from the operation. These intermittent noises have been recognised as having a high level of annoyance. All mobile machinery at the Tutunup South site will be required to have directional broadband white noise alarms rather than standard reversing beepers. The use of horns as an alert system has also been reduced at Iluka sites as standard practice.

Monitoring of noise will be conducted prior to, as well as during, construction and operations. Noise monitoring results and any complaints will be reported through the Annual Environmental Report.

A Noise Management Plan has been developed incorporating the above management and mitigation measures and is appended to this PER (Appendix 5). Implementation of this management plan will ensure the EPA objective to protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal, is achieved.

10.2.5 Commitments

- Implement the Noise Management Plan.

10.3 Radiation

10.3.1 Objective

The EPA objective is to ensure that radiological impacts to the public and the environment are kept as low as reasonably achievable and comply with acceptable standards.

10.3.2 Relevant Standards

The *Mines Safety and Inspection Regulations 1995* requires that any mine involved with the mining of radioactive materials that may result in employees receiving radiation doses in excess of 0.001 Sv/year have a Radiation Management Plan. A guideline has been developed by DoIR (1997) that provides details on the development of a suitable detailed plan for the control and monitoring of radiation exposure and the management of radioactive wastes, as required under Regulation 16.7 of the *Mines Safety and Inspection Regulations 1995* and administered by the Department of Consumer and Employment Protection (DOCEP).

The Radiation Management Plan must consider measures that can be taken to minimise exposure of employees and the general public to radiation by addressing use of appropriate facilities and equipment, monitoring programs, dosage assessments, reporting, training and inductions, and waste disposal.

Monazite is a naturally occurring mineral often found in association with the target minerals rutile, ilmenite and zircon. It is classified as a "Class 7" material and a Low Specific Activity (LSA) radioactive substance under the *Dangerous Goods Regulations 1998*.

10.3.3 Issue Definition

The HMC from the Tutunup South Project contains the mineral monazite. Monazite contains the naturally occurring radioactive elements thorium and uranium, which are associated with all heavy minerals mined by Iluka. The concentration of thorium and uranium in the HMC produced is variable but typically in the order of 800 ppm thorium and 100 ppm uranium and is significantly dependent on the concentration of the mineral monazite. The mineral monazite typically contains around 60,000 ppm thorium and 2,500 ppm uranium.

This mineral is the main source of possible radiation exposure at Iluka Operations. Monazite is the rare earth phosphate [Ce, La, Nd, Th (PO_4)]. Monazite content in mineral sand deposits is typically confined to the orebody at concentrations of about 0.1%. It increases through the concentration process to approximately 1-2% in the HMC.

There is potential to return waste products from the Capel Dry Plant (known as town tails). Town tails will be disposed into the mining void in accordance with the South West Radiation Management Plan. This will be conducted in consultation with DoCEP and DoIR.

10.3.4 Assessment and Management

The Tutunup South project will follow the Iluka South West Radiation Management Plan which has been prepared in accordance with the DoIR (1997) guidelines. The program includes pre-mining background surveys, ongoing radiation management during operations and post-mining radiation surveys. Post mining values must be similar to the pre-mining value. Appropriate approvals and licenses will be obtained as required by DOCEP and the Iluka South West Radiation Management Plan.

Implementation of the Radiation Management Plan will ensure the EPA objective to ensure that radiological impacts to the public and the environment are kept as low as reasonably achievable is achieved.

10.4 Light

10.4.1 Objective

The EPA objective is to avoid or manage potential impacts from light overspill and comply with acceptable standards.

10.4.2 Relevant Standards

Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting outlines a range of management measures that can be utilised to assist in reducing the amount of diffusion and spill lighting created from proposals.

10.4.3 Issue Definition

Processing operations at Tutunup South will be undertaken on a 24 hour basis. Night lighting is required to ensure that the safety and security of operations is not compromised. However, lighting of night operations can also have negative external effects on nearby residents and traffic.

Potential impacts arising from illumination at night can arise from obtrusive light spill, by general luminance diffusion, reflection from existing surfaces or through atmospheric scattering. These effects may impact directly on neighbouring dwellings, can potentially create safety hazards on adjacent roads due to glare reducing the visibility of objects, interfere with night time navigation signalling and reduce the overall environmental night amenity.

10.4.4 Assessment and Management

The majority of earthmoving activities will be restricted to between 7 am and 7 pm, with only one scraper operating 24 hours per day taking ore to the in-pit hopper. Thus the impact of light will be limited to mobile equipment and processing activities.

The in-pit hopper and screen plant will be located below the natural surface level and behind constructed bunds which will minimise nuisance light overspill from this area. The concentrator will require bunding which will minimise nuisance light overspill from this area.

Light towers will be erected to enable redirection of lights in response to light issues identified by neighbours, the general public or into forested areas.

The Australian Standard AS 4282-1997 Control of the Obtrusive Effects of Outdoor Lighting, which outlines a range of management measures that can be utilised to assist in reducing the amount of diffusion and spill lighting created from operations, will be adhered to.

The above measures will ensure the EPA objective to avoid or manage potential impacts from light overspill is achieved.

10.5 Non-process Solid Waste

10.5.1 Objective

There is no EPA objective specifically for waste. Iluka’s objective is to ensure that wastes are managed and disposed of in a manner that does not result in long-term impacts on groundwater, surface water and the natural environment.

10.5.2 Relevant Standards

The DEC has published guidelines including Guidelines for Acceptance of Solid Waste to Landfill (2002), Waste Management Bill (2000), Rural Landfill Management (2000), and the Western Australian Waste Reduction and Recycling Policy (1997) that address the appropriate disposal and management of solid wastes and recommendations for waste minimisation.

10.5.3 Issue Definition

Mining operations at Tutunup South will generate a suite of solid wastes including domestic waste, recyclables (for example paper, steel, waste oil, tyres, batteries) and septic waste that may result in environmental contamination if not appropriately managed. No chemical waste will be generated in association with the mining operations.

10.5.4 Assessment and Management

Iluka encourages the use of alternatives to landfill with the priorities for waste management being:

1. Waste avoidance/reduction
2. Reuse/recycle
3. Waste treatment
4. Waste disposal

Domestic and workshop refuse will be collected in bins for disposal at a licensed landfill. Recyclables will be collected separately before removal from site. The handling, use, storage, and disposal of hydrocarbons will be managed to ensure that there is minimal environmental impact.

Wastes will be managed in a manner that does not result in long-term impacts on groundwater, surface water and the natural environment.

Non-process waste produced by the operations would include the following:

- Green Waste: Where viable, timber will be salvaged for use. Timber that cannot be mulched, chipped or milled (due to excessive sand, rock or other impediment), will be stacked and burnt or stored for habitat creation in rehabilitation of remnant vegetation.
- Hydrocarbon Products: All waste oils will be collected in a sump by the contractor and collected as part of Iluka’s waste management system. All hydrocarbon contaminated waste will be removed from site and disposed of according to waste regulations.
- Structural Waste: Some structural waste will be generated from maintenance activities. This waste will be recycled through a scrap metal merchant.
- Domestic Waste: Rubbish generated on the site such as food scraps, food wrappings and waste paper will be collected and disposed at the local Shire disposal site or an approved alternative.

Implementation of the above practices will ensure the objective ensure that wastes are managed and disposed of in a manner that does not result in long-term impacts on groundwater, surface water and the natural environment is achieved.

10.6 Process Waste

10.6.1 Objective

There is no EPA objective specifically for process waste. Iluka's objective is to ensure waste streams from the process are returned to the mining pit in a manner consistent with closure objectives and end uses of the site.

10.6.2 Relevant Standards

DoCEP has two guidelines for tailings management. Guidelines on the Safe Design and Operating Standards for Tailings Storage (DME 1999) is designed to assist in the design, construction, management and decommissioning of tailings storage facilities so as to achieve efficient, cost effective, safe and environmentally acceptable outcomes. Guidelines on the Development of an Operating Manual for Tailings Storage (DME 1998) is designed to ensure consistency of approach in developing Operating Manuals and an administrative framework which meets the requirements of regulations affecting the mining industry.

The Water and Rivers Commission Water Quality Protection Guidelines No. 2 Tailings Facilities (2000) provides guidance in managing the impact of tailings containment facilities on the quality of the region's water resources.

10.6.3 Issue Definition

Clay fines are removed from the ore prior to the wet concentrator process (Figure 5). The clay fines are pumped to a thickener and the underflow is pumped to shallow solar drying dams. The clay is allowed to partially dry prior to being returned to the mining pit.

Sand tails are produced by wet concentration and are pumped to the mining void. The sand and water streams separate. The water component is returned to the process water dam with the dewatering water.

There is the potential to implement co-disposal of sand and clay tails directly from the concentrator to the mine void. If successful, this strategy will reduce solar drying dam requirements.

10.6.4 Assessment and Management

The process waste streams from the operation shown in Figure 5 will be managed using the same strategies used at other Iluka mine sites as described below:

- Overburden: Overburden (non-mineralised) waste will be returned to the mining void during mining and in the closure/rehabilitation phase of the project.
- Oversize: The wet concentration process requires all particles greater than approximately 2.4 mm to be removed from the ore. All material greater than

2.4 mm will be removed in the screening process, in a number of stages. The oversize will be treated as overburden and returned to the mining void or utilised for dust suppression and road maintenance activities.

- Clay Fines: Clay fines will be removed from the ore prior to wet concentrator processing by hydro-cyclones. The clay fines will be pumped to thickeners and underflow from the thickeners will be pumped to shallow solar drying dams. Once dry, the clay fines will be excavated from the solar drying dams and placed into the mining void before being covered with topsoil and overburden. Some of the clay fines may be incorporated into the subsoil to improve soil for rehabilitation purposes.
- Sand Tailings: Sand tailings will be produced in the mine site wet-concentrator and pumped to the mine void as slurry. The sand tailings will consist principally of silica sand. Rehabilitation of the sand tails will commence once the material is dry.

Management of process waste streams as outlined above will ensure the objective to ensure waste streams from the process are returned to the mining pit in a manner consistent with closure objectives and end uses of the site is achieved.

10.7 Greenhouse Gases

10.7.1 Objective

The EPA objective is to minimise emissions to levels as low as practicable on an ongoing basis and consider offsets to further reduce cumulative emissions.

10.7.2 Relevant Standards

State and Commonwealth legislation relevant to the emission of greenhouse gases from the Tutunup South project includes:

- the National Greenhouse Strategy for providing a framework for meeting international commitments;
- the Greenhouse Challenge as a voluntary program between government and industry to abate greenhouse emissions;
- the Energy Efficiency Opportunities Programme;
- the Western Australian Greenhouse Strategy; and
- EPA Guidance Statement No 12 – Minimising Greenhouse Gases (EPA, 2002b)

10.7.3 Issue Definition

Implementation of the Tutunup South project will result in the emission of carbon dioxide, directly or indirectly, as a result of the following activities:

- consumption of electricity;
- mobile mining plant and equipment, and transportation of HMC to Capel; and
- clearing of vegetation.

Tutunup South is a continuation of Iluka operations in the South West. Iluka's greenhouse gas emissions will be not be significantly altered by this project as it will be replacing another Iluka operation.

Clearing of native vegetation will result in some emissions of greenhouse gases. Commercial harvesting of timber will occur in areas identified for clearing prior to mining. The residual vegetation will be mulched where possible for use on-site or pushed into heaps and burnt.

Total consumption of diesel by the project in mining and transportation of the HMC will be approximately 6,500 kL/year and total imported electricity for the processing plant 30,000 MWh/year. This will result in the production of approximately 192,500 tonnes of CO_2 emissions per annum.

10.7.4 Assessment and Management

Greenhouse gas emissions will come from standard petrol and diesel combustion engines and from electricity generation. Tutunup South is a continuation of mining operations in the South West, commencing following the cessation of mining at another site. Therefore, overall emissions from Iluka operations will not significantly change as a result of this project. Projected greenhouse gas emissions are expected to be minimal based on other South West operations.

Iluka will ensure efficient use of all machinery. The company will also estimate emissions and implement practices in line with the EPA Guidance Statement No. 12 - Guidance Statement for Minimising Greenhouse Gas Emissions (EPA 2002b).

11 SOCIAL ENVIRONMENT: IMPACTS & MANAGEMENT

11.1 Aboriginal Heritage

11.1.1 Objective

The EPA objective is to ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

11.1.2 Relevant Standards

The *Aboriginal Heritage Act 1972* provides for the recording and protection of areas and artefacts used by the original inhabitants of Australia.

The EPA also considers aspects of Aboriginal heritage and have developed a Guidance Statement for the Assessment of Aboriginal Heritage (EPA, 2004). This sets out objectives to ensure that the changes to the biological and physical environment resulting from the proposed development do not adversely affect matters of heritage significance to Aboriginal people. It is suggested in the Guidance Statement that the following actions be taken:

- consultation with the Department of Indigenous Affairs (DIA) and desktop review of site records in accordance with the Aboriginal Heritage Act;
- undertake an Aboriginal heritage survey including consultation with appropriate Aboriginal people and/or an archaeological survey;
- informing the relevant Aboriginal people of the proposal, including potential impacts;
- consultation with relevant Aboriginal people to highlight their concerns regarding the proposal; and
- demonstrating that these concerns have been adequately considered in impact management strategies.

11.1.3 Issue Definition

Baseline archaeological and anthropological/ethnographic surveys have been conducted over the project area in conjunction with the South West Boojarah registered native title claimants and the South West Aboriginal Land and Sea Council (Anthropos Australis Pty Ltd, 2007a and 2007b; Ethnosciences, 2007). One archaeological site, a scar tree, was located within the disturbance area (Anthropos Australis, 2007a). No listed ethnographic sites occur within the disturbance area of Tutunup South, with the nearest site (DIA site 17354) being along the Abba River (Figure 19).

11.1.4 Assessment and Management

The Tutunup South mine and infrastructure has been designed to avoid disturbing the scar tree located within the disturbance area. Construction and operation of the mine site will comply with provisions of the Aboriginal Heritage Act (1972). If any sites are discovered during mining operations, they will be investigated by an anthropologist or archaeologist and reported to the Department of Indigenous Affairs

(DIA). In the event that any Aboriginal sites cannot be avoided, a Section 18 application will be submitted.

The nearest ethnographic site at the Abba River is beyond the disturbance area of the project. The South West Boojarah noted the significance of the river and were satisfied with the distance between the mine and the river (Ethnosciences 2007).

Iluka has consulted with the claimant group and will continue to do so over the life of the project. Any concerns identified will be addressed with site management strategies.

By conducting surveys, liaising with local claimants and avoiding the identified scar tree, Iluka will ensure that the EPA objective to ensure that changes to the biophysical environment do not adversely affect historical and cultural associations is achieved.

11.2 European Heritage

11.2.1 Objective

The EPA objective is to ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and comply with relevant heritage legislation.

11.2.2 Relevant Standards

The factor has been assessed against the objective.

11.2.3 Issue Definition

A search of the Register of National Estate and Heritage database held by the Heritage Council of Western Australia indicated that no heritage sites are listed for the Tutunup South disturbance area or surrounding areas. The Busselton Shire has searched the Municipal Heritage database and has advised that there are no heritage items listed for the disturbance area. McGibbon Track is known to occur to the north of the proposed disturbance area and there is anecdotal evidence that the track extends past the north eastern boundary of the disturbance area. Whilst the track has not appeared in any heritage searches conducted for the site, its exact location is being verified.

11.2.4 Assessment and Management

As searches of heritage databases have not located any European heritage sites within the disturbance area, no impacts are anticipated, however the exact location and significance of McGibbon Track will be verified.

11.3 Transport

11.3.1 Objective

There is no EPA objective for transport. Iluka's objective is to ensure that traffic activities can be managed to an adequate level of public safety and have minimal impact on surrounding neighbours and landowners and traffic congestion.

11.3.2 Relevant Standards

As there are no regulatory standards, the factor is to be assessed against the objective.

11.3.3 Issue Definition

HMC will be transported using “Pocket Road Trains” from Tutunup South to Capel. To satisfy the production schedule, an estimated maximum of 24 completed trips (48 movements per day) will be required. This could be configured as either four truck combinations completing six return trips per day, or eight truck combinations completing three return trips per day.

Additional traffic has the potential to add to noise, amenity and safety issues.

Development of the project is expected to require diversion of the Vasse Highway to the south of its current alignment, and then back to its current alignment once mining has sufficiently progressed.

11.3.4 Assessment and Management

Traffic studies have been undertaken to identify transport routes where impacts upon public safety, road use and amenity can be minimised (Wyntak 2007).

The proposed transport route from the mine is shown in Figure 20 and the current and expected average daily traffic movements are presented in Table 28.

The route selected maximises use of gazetted heavy haulage routes by MRWA (all roads proposed for use are gazetted heavy haulage routes).

Increased traffic along the Bussell and Vasse Highways is minimal. However, there will be substantial increases in traffic movements along the Ludlow Hithergreen Road (travel distance approximately 1 km), which is attributed to considerably lower baseline traffic. During construction, some disruption to normal traffic flows will be caused by transport of the concentrator and other support infrastructure to site. Transporting oversize loads to site during construction will be coordinated with MRWA and the Shire of Busselton to ensure an adequate level of public safety.

Bussell Highway, Vasse Highway and Sues Road are all Unconditional Permit Network State Roads. The traffic volume experienced on the Bussell Highway, Vasse Highway and Sues Road (from most recent MRWA data available) is in the order of 8 430, 1 250 and 896 movements per day respectively. The increase in traffic due to the mining operation is insignificant. Sues Road forms part of a MRWA designed Mineral Sands haulage route to Bunbury. Heavy haulage makes up almost 25% of the total traffic volume on this road.

Yeardy Road is an Unconditional Permit Network Local Road and Ludlow Hithergreen Road is a Conditional Permit Network Local Road. Yeardy Road is the access road to Iluka’s North Capel Processing facilities and no other landowners or facilities are located on this road.

The current use of Ludlow Hithergreen Road is approximately 200 movements per day. The transport route has been selected such that trucks do not travel down the length of Ludlow Hithergreen Road past residences (14.5km), but arrive at the site via Vasse Highway, travelling approximately 0.8km along Ludlow Hithergreen Road. This is considered to be a safer and logistically favourable alternative than accessing the Vasse Highway directly from the mine site. No residences are passed between Vasse Highway and the site entrance. The nearest residence is approximately 670 m beyond the site entrance (R6). This residence will be vacant during mining. R7 occurs approximately 900 m from the site entrance and is subject to an agreement of informed consent (landowner agreement). No other residences occur within 1 km of the portion of Ludlow Hithergreen Road to be used for HMC haulage.

The conditions on the use of Ludlow Hithergreen Road as a heavy haulage road (allowing pocket road trains) include:

- maximum speed of 80 km/hour
- curfews apply – no operations are to occur on school days between the hours of 7 am and 8:30 am and 3:30 pm and 5 pm; and no operations are to occur on Christmas day and Easter Sunday.

In addition, Iluka will prohibit the use of exhaust brakes on the approach to and from the mine (along Ludlow Hithergreen Road).

In order to utilise this route, the transport provider is required to hold a haulage permit from Main Roads Department. This permit may apply further operation restrictions and curfews, based on safety, amenity and noise impacts. All permit conditions will be adhered to.

There will also be a requirement to provide suitable access at the Tutunup South mine entry/Ludlow Hithergreen Road and Ludlow Hithergreen/Vasse Highway intersections. The configuration of these roadworks will be discussed with MRWA and the Shire of Busselton.

Table 28: Average daily traffic movements

Road	**Km travelled**	**Average Daily Traffic Movements**				
		Pre-mine Heavy Movements	Mining Heavy Movements	Pre-mine Total Movements	Mining Total Movements	% Increase of Total Vehicle Movements
Vasse Hwy	5.7	26	74	1 250	1298	3.8%
Bussell Hwy	22.5	330	378	8 430	8,474	<1%
Sues Road	6.7	230	278	895	943	5.4 %
Ludlow Hithergreen Rd	0.8	4	52	200	252	26%

The Vasse Highway will be diverted a maximum of 160 m south of its current alignment to allow mining to occur. The exact route and requirements of the diversion will be determined in consultation with MRWA. DEC will also be consulted.

The nearest residences are approximately 1 km from the proposed alignment and will be subject to an agreement of informed consent (landowner agreement).

Traffic impacts are minimal, with some short term disruptions expected to traffic flow. Appropriate design of intersections and diversions in liaison with MRWA and the Shire of Busselton will ensure that traffic activities can be managed to an adequate level of public safety and have minimal impacts on surrounding neighbours and landowners and traffic congestion.

11.4 Visual Amenity

11.4.1 Objective

The EPA objective is to ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape to as low as reasonably practicable.

11.4.2 Relevant Standards

As there are no regulatory standards, the standard is to be assessed against the objective.

11.4.3 Issue Definition

The project is located some 15 km southeast of Busselton and at the foot of the Whicher Scarp. The Vasse Highway bisects the project and will require diversion to mine the southern portion of the deposit. The entrance to the minesite will be approximately 1 km from the intersection of the Ludlow Hithergreen Road/Vasse Highway intersection along the Ludlow Hithergreen Road.

11.4.4 Assessment and Management

Several properties and residences are likely to be able to see the mine activities. The mine will also be visible from Vasse Highway and Ludlow-Hithergreen Road.

Topsoil stockpiles will be placed around the outer boundary of the site to minimise visual impacts.

Further management of visual impacts will involve:

- minimising the area disturbed and stabilise where possible;
- maintaining the site in a neat and tidy condition;
- keeping plant and equipment in good presentable order;
- confining all disused equipment to selected areas (i.e. pipe and conveyor laydown areas);
- implementing dust suppression measures;
- implementing measures to minimise light overspill and glow; and
- undertaking progressive rehabilitation throughout the mine's life.

Implementation of the above management practices will ensure the EPA objective to ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape to as low as reasonably practicable is achieved.

12 ENVIRONMENTAL OFFSETS

Offsets for Tutunup South have been designed for the project in accordance with EPA Position Statement No. 9 (EPA 2006a) in accordance with the following principles.

1. Environmental offsets will only be considered after all other reasonable attempts to mitigate adverse impacts have been exhausted.
2. The offset package will address both direct offsets and contributing offsets.
3. Offsets will ideally be ‘like for like or better’.
4. Positive environmental offset ratios will apply where risk of failure is apparent.
5. A robust, consistent and transparent assessment process will be utilised to develop the offsets package.
6. Offsets will meet all statutory requirements.
7. Offsets will be clearly defined, transparent and enforceable.
8. Offsets will provide a long lasting benefit (EPA, 2006).

The EPA Position Statement states that environmental benefits should only be considered where on-site mitigation has been reasonably considered or demonstrated, and where residual adverse impacts are considered significant, but not significant enough to make the project unacceptable. The impact mitigation sequence has been followed for each environmental factor for the Tutunup South Project as outlined below.

1. Avoid – the economic value of the contained mineral located within the areas of native vegetation is considerable in the context of the project; these areas are integral to the overall project economics. The edge of the pit will be moved slightly to avoid clearing of the southern wetland and disturbance to two of the possible black cockatoo nest hollows within the Gravel Reserve. In total, Iluka will not disturb five of the eight possible black cockatoo nest hollows.

2. Minimise – impacts have been minimised by locating infrastructure and stockpiles outside areas of native vegetation. Further monitoring of cockatoo usage is being undertaken to identify the black cockatoo’s behaviour/ status (use of feeding and nesting hollows) in the area.

3. Rectify – areas of native vegetation will be rehabilitated to native vegetation following mining. Some of the areas to be cleared are in poor condition and improvements will be made to vegetated areas by controlling weeds, introducing understorey and excluding grazing. To replace the three potential hollows removed during mining, it is proposed to install artificial nest hollows made specifically for cockatoos.

4. Reduce – adverse impacts will be rectified as soon as possible with rehabilitation commencing during mining. The impact will be eliminated following mining.

5. Offset – three direct offsets have been identified for Tutunup South: improvement of rehabilitated areas by fencing and creating vegetation corridors; installing artificial cockatoo hollows; and placing a covenant over an area of high conservation value with vulnerable TECs which is also located on the Whicher Scarp.

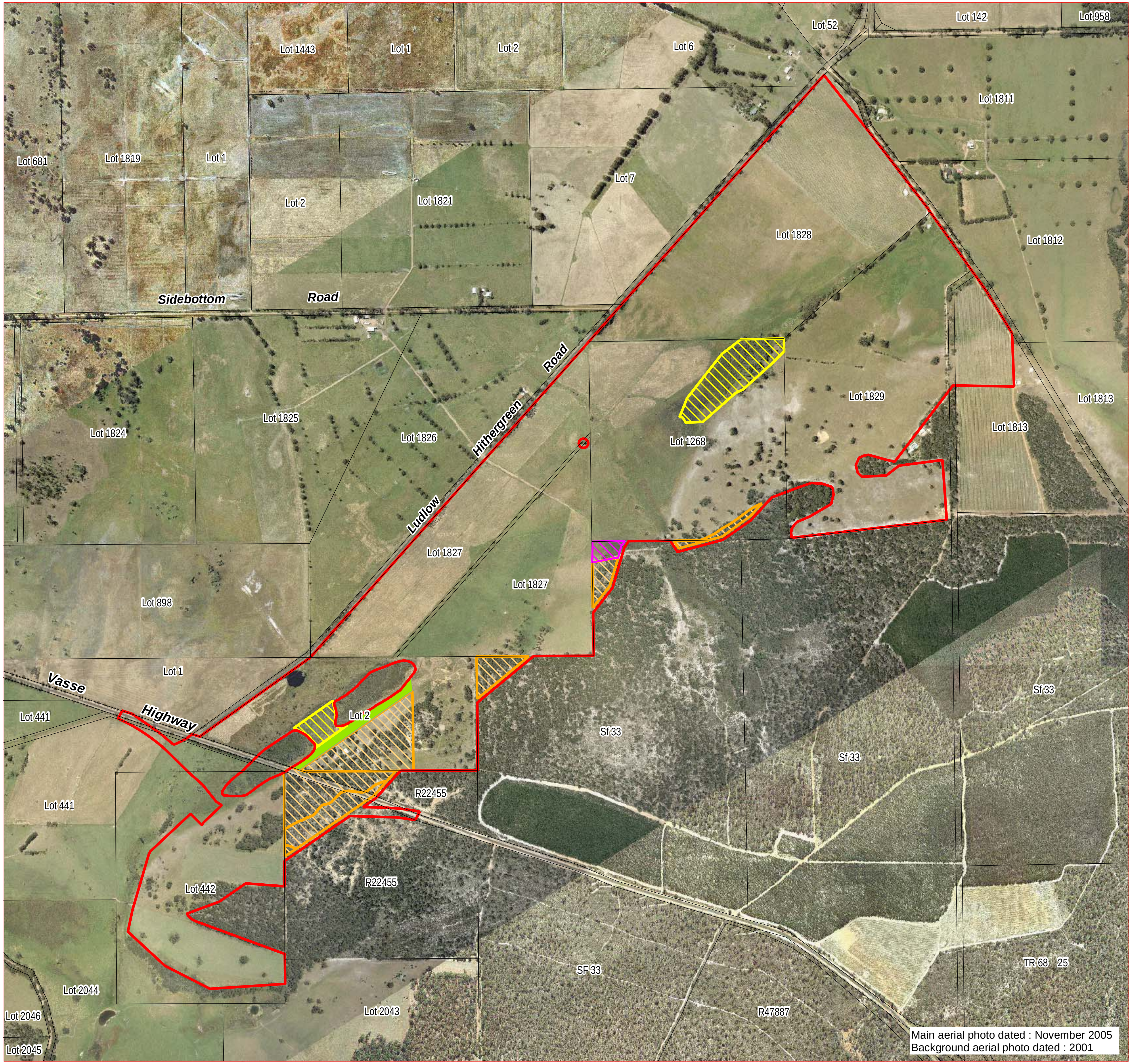
Three direct offsets are provided for Tutunup South. Further detail is provided in Appendix 7 in the format requested by EPA Draft Guidance Statement Number 19 (EPA 2007b) and summarised below.

It is proposed to improve the post-mining native vegetation through providing a linkage between the southern wetland and State Forest. This area will then be fenced from stock and a conservation covenant applied over the rehabilitated and restored area. This will reduce current threats of grazing on the wetland. This is shown in Figure 25 and discussed further in Section 13.

The second site offset initiative would be to provide artificial cockatoo hollows in adjacent State Forest, to provide additional breeding hollows. This offset would be implemented by Iluka's cockatoo consultant with the artificial hollows monitored on a regular basis to check usage rates or invasion by feral species.

In addition to the on-site native vegetation improvements, it is proposed to place a conservation covenant over an area of native vegetation on Iluka private property at Yoganup. This area is referred to as the Roberts Block. The area to be covered by a covenant would be approximately 92 ha (Figure 26). To improve linkages between this block and State Forest Iluka will commit to developing a vegetation corridor between the State Forest and Roberts Block. This is expected to be 25 m wide and cover 7 ha. Roberts Block has been surveyed by DEC on several occasions and is well recognised as having a high conservation value and being worthy of protection. Community types 4 and 7 have been identified by DEC as occurring in the block. Community type 7 "Herb rich saline shrublands in clay pans" is a TEC classified as vulnerable.

These offsets will deliver a net environmental benefit from implementation of the Tutunup South mineral sands project.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S	T.L.G	16.09.07	Original Design
01	S.J.	T.L.G	10.04.08	Added Cadastre layer

Legend

Disturbance Area

Target Vegetation Communities

- M1
- C1
- E2
- S2

N

0 250 500 m

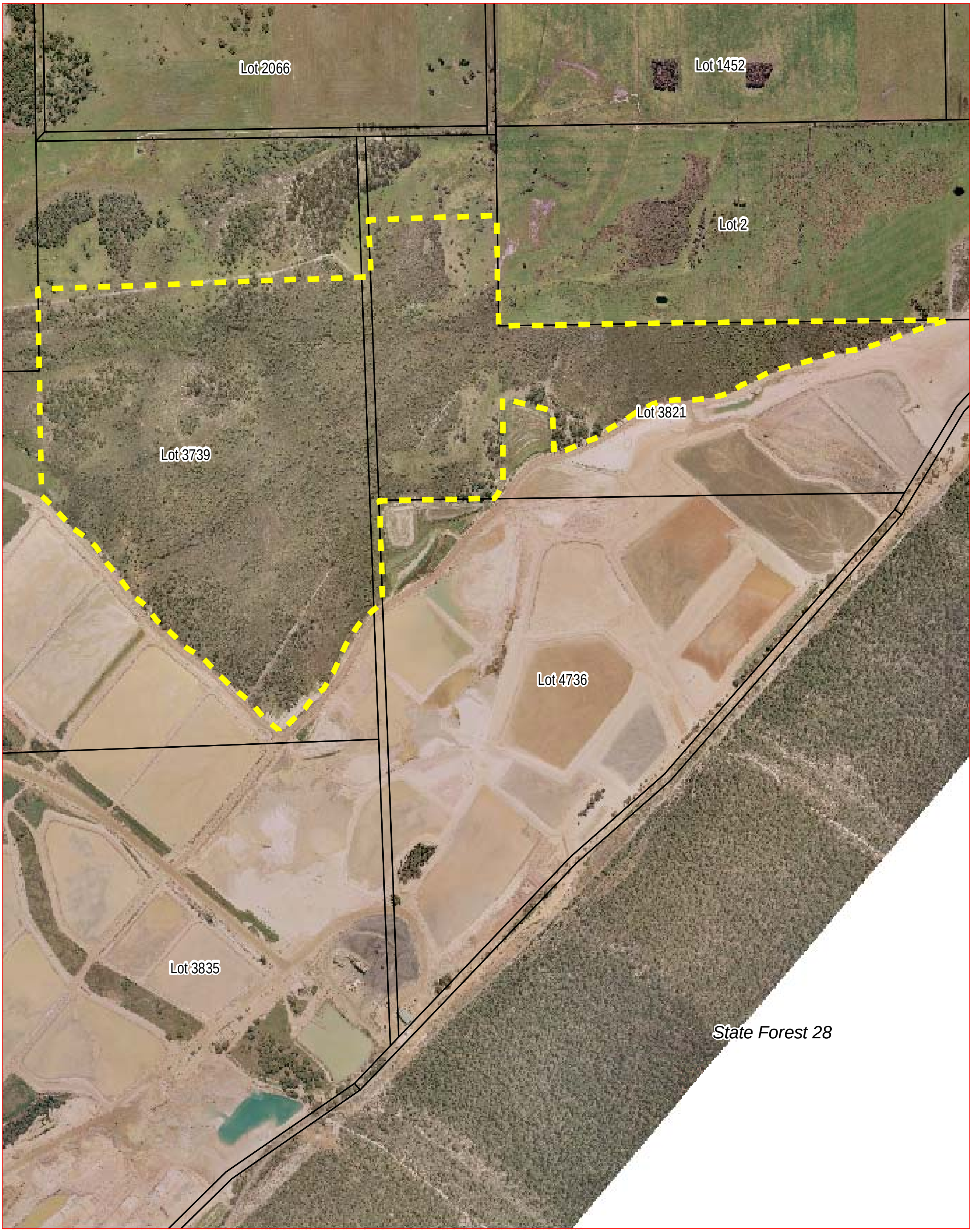
ILUKA

TUTUNUP SOUTH

REHABILITATION AREAS

ORIG:	S.Jones
DRAWN:	T.L.G
SCALE:	1:12,500
DATE:	10 April 2008

DWG No: 176777 ver.01 A3 FIGURE: 25



Legend

Roberts block covenant area

Date of photography: Sept 2006

0 250 500 m

N

ILUKA

ORIG: L.Sadler
DRAWN: D.G.S.
SCALE: 1:12,500
DATE: 14 Sept. 2007

YOGANUP

ROBERTS OFFSET BLOCK

DWG No: 176775 ver.00 A4 FIGURE: 26

13 CLOSURE AND REHABILITATION

A noticeable impact of Iluka's activities is disturbance to the landscape during the mining phase. Recognising mining's role as a temporary land use, rehabilitation is required to restore, improve or develop the land into a landform that enables the next beneficial land use. To facilitate the transition from mining to a rehabilitated landscape, a Preliminary Closure and Rehabilitation Plan has been prepared (Appendix 6). The plan is consistent with EPA Guidance Statement No. 6 (EPA 2006b) requiring Environmental Impact Assessment (EIA) to include environmental significance of land, identify major limitations to rehabilitation and set rehabilitation objectives and definition.

The primary objective of closure of the disturbed area is to, in consultation with relevant landholders, return the land profile consistent with the surrounding topography and establish either productive agricultural land or native vegetation considering past land uses.

Standard objectives for rehabilitation as defined by the EPA (2006) and adopted by Iluka are:

- Safe, stable and resilient landforms and soils.
- Appropriate hydrology.
- Providing visual amenity, retaining heritage values and being suitable for agreed land use.
- Resilient and self sustaining vegetation comprised of local provenance species.
- Reaching agreed numeric targets for vegetation recovery.
- Comprising habitats capable of supporting all types of biodiversity.

For Tutunup South, Iluka plans to return the disturbance area to an agricultural system with at least a comparable agricultural value to that before mining, and at least 25.6 ha of native vegetation rehabilitated to compensate the clearing of native vegetation. In essence the disturbance area will comprise a flat to shallow sloped area providing an effective integration of the Whicher Scarp with the Abba Plain. Most of the area will be suitable for a variety of agricultural purposes, although with an emphasis on sustainability in landform design and practices.

Within the agricultural area of the project will be the southern wetland (avoided by mining as shown in Figure 25) and a new northern wetland that replaces the wetland cleared by mining. Whilst the southern wetland is currently in a reasonably poor state (although still of conservation value), Iluka will conduct restoration activities over this wetland to improve its structure and ultimately its habitat value. The new northern wetland will be designed to replicate an M1 vegetation community (which was previously present). The value of the southern wetland will be enhanced by developing a native vegetative corridor linking the wetland to the State Forest, improving the linkage and value of the wetland community and improving the ecological function between the wetlands and upland areas (Figure 25). The lots occupied by the southern wetland, the northern wetland and the land between are all privately owned by different landowners. Rehabilitation works on landowner properties will be conducted in accordance with the landowner requirements. The lot occupied by the southern wetland is planned to be purchased by Iluka, hence additional rehabilitation works have been planned for that property.

The areas of State Forest and gravel reserve required for clearing, will be rehabilitated with native vegetation. Rehabilitation will focus on returning species reflecting vegetation communities affected by clearing.

The Vasse Highway, which requires diversion for mining, will be re-diverted back to its original alignment prior to closure.

As part of Iluka's continuing operations, much of the infrastructure used for mining is relocated to the next project for mine development. Once items for re-use have been relocated, recyclable infrastructure will be removed by a salvage contractor leaving a landscape dominated by foundations and open areas.

Inert or structural waste that cannot be recycled will be excavated and placed in an inert landfill created at the base of the remaining open pit, with consideration of applicable recommendations in *Water Quality Protection Note No. 24 - Landfilling with inert materials* (Department of Water, 2006). The foundations around workshops, refuelling areas, laydown areas and below fixed plant will be investigated for the potential of contamination. Where contaminated material is encountered, it will be excavated for remediation. Internal (Iluka owned) powerlines will be removed.

Clay material stored within the solar drying dams and any remaining overburden stockpiled or as part of noise bunds will be transferred into the remaining open pit, effectively removing the solar drying dams as structures in the landscape.

After completion of decommissioning infrastructure, the site will be ready to commence rehabilitation on the remaining open area.

The Preliminary Closure and Rehabilitation Plan has assessed these limitations (or areas of risk) in detail. The strategies employed to achieve the rehabilitation and suggested performance criteria are also detailed within the plan (Appendix 6).

14 CONCLUSION

The impact assessment concludes that development and operation of the Tutunup South mineral sands mine can be conducted without causing significant environmental impacts. The project has been considered utilising the sustainable development principles of ecological, social and planning options. Impacts or potential impacts have been identified, with alternatives evaluated during project definition to avoid impacts wherever possible and management controls developed for implementation during construction and operations to minimise these impacts.

Iluka has made the following commitments in this PER:

1. Implement the Ground and Surface Water Management Plan and Operating Strategy for Dewatering.
2. Implement the Acid Sulfate Soils Management Plan.
3. Implement the Flora, Vegetation and Dieback Management Plan.
4. Implement the Preliminary Closure and Rehabilitation Plan.
5. Implement the Offsets Strategy.
6. Implement the Native Fauna Management Plan.
7. Implement the Noise Management Plan.

Through implementation of the Management Plans, environmental impacts will be minimised and/or mitigated. The application of the proposed offsets strategy including installation of artificial hollows, establishing a vegetation corridor between the southern wetland on the Swan Coastal Plain and State Forest on the Whicher Scarp and placing a conservation covenant over an area of high conservation value with vulnerable TECs will enable the project to deliver a net environmental benefit.

Development of this project is a continuation of Iluka's South West operations which benefits the community through infrastructure support, partnerships with local government and communities and continued employment of a local workforce. Iluka's South West operations contribute to the local economy through local expenditure and investment in capital and people. These benefits flow to both the State and Commonwealth, through royalties, payroll, income and other indirect taxes and duties. The sum of these benefits makes a compelling argument for approval to develop the Tutunup South mineral sands mine.

Table 29: Summary of Environmental Factors

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Biophysical					
Landform and Soils	To maintain the integrity, ecological functions and environmental values of the soil and landform.	Five soil mapping units located over the project area dominated by yellow sands and grey sands.	Disturbance of soils during mining.	Stripping and stockpiling of soils will take into account soil properties to enhance rehabilitation value. Mining area will be rehabilitated to pre-mining landforms and agreed end land use. A Preliminary Closure and Rehabilitation Plan has been prepared.	Environmental values, ecological function and integrity of the soils are maintained.
Surface Hydrology	To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance, are protected. To ensure that emissions do not adversely affect environmental values of the surface water and groundwater resources or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	Surface hydrology dominated by two wetlands, a creek to the south of the project and two minor drainage lines across the disturbance area. Water exits the site into an agricultural drain reporting to the Sabina River. Disturbance area has space limitations for water storage. Surface water is fresh to brackish, and used for livestock watering.	Minor drainage lines across the disturbance area will be disrupted by mining. Water erosion affecting turbidity of surface water and runoff. Contaminants in surface water from mining operations.	Surface water will be controlled by the installation of diversion bunds and graded banks. Stabilise exposed areas and minimise open areas. On-site contaminants will be fully contained to avoid potential adverse effects on surface water quality. Site discharge to be managed and controlled in accordance with licence conditions. Surface water will meet licence criteria most of the time, possible exceptions being in extreme events. A Ground and Surface Water Management Plan has been prepared.	Surface water quality and quantity will not be adversely affected by mine activities.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Groundwater	To maintain the quantity and quality of water so that existing and potential environmental values, including ecosystem maintenance are protected. 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 and acceptable standards.	Major aquifers present are the Guildford, Yoganup and Leederville aquifers. At depth is the Yarragadee Aquifer. 21 active bores within a 1 km buffer of Tutunup South. Groundwater is fresh and used for livestock watering irrigation and domestic supply.	Dewatering from superficial aquifer affecting other nearby water users. Cone of depression to be up to 0.2 m, 1.5 km from mine. 90% recovery of groundwater levels within three years. Additional water sourced from Yarragadee Aquifer impacting other water uses.	A Ground and Surface Water Management Plan has been prepared. Groundwater drawdown to be monitored.	Water supply from local bores and wells unlikely to be significantly affected. No significant impact on Yarragadee Aquifer. Groundwater quality will not be adversely affected by mine activities.
Acid Sulfate Soils	To maintain the integrity, ecological functions and environmental values of the soil and landform.	Acid Sulfate Soil study has identified Potential Acid Sulfate Soils within and to the west of the pit.	Potential for acid generation by oxidation of PASS disturbed by mining. PASS west of the pit may generate acid from dewatering. Potential mobilisation of metals at low pH.	PASS management is aimed at avoiding or minimising the rate of oxidation; and neutralising acidic material. An Acid Sulfate Soils Management Plan has been prepared.	Acid generation will be minimised by reducing the amount of time PASS is exposed for oxidation. No release of water with unacceptable acidity.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Flora and Vegetation	To maintain the abundance, diversity, geographic distribution and productivity of flora at species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.	Majority of disturbance area is on cleared agricultural land, with some State Forest and a degraded Gravel Reserve. 399 flora taxa recorded over the disturbance area. No declared rare flora recorded in the disturbance area. Ten priority flora and 14 significant flora over the survey area. Declared plants Arum Lily and Cape Tulip present. S2 community with low similarity to SCP 02 present inside and adjacent to disturbance area. One multiple use wetland inside the disturbance area and one adjacent to disturbance area. Several communities identified with some degree of dependence on groundwater (GDEs). Most of the State Forest and Gravel Reserve above the disturbance area is dieback infected. Some areas present are considered protectable.	Disturbance of 230 ha requiring clearing of 25.6 ha of native vegetation of variable condition and 6 ha of isolated trees. Three priority flora and three significant flora species inside the disturbance area. Potential for proliferation of declared plants offsite and in rehabilitation. 0.8 ha of S2 will be disturbed by clearing with a further 2 ha potentially impacted by dewatering. Northern wetland to be cleared, southern wetland likely to be impacted by dewatering. Potential for dieback to be transmitted into protectable areas.	The proponent will minimise clearing of native vegetation outside the ore reserves. Clearing of native vegetation will be restricted to areas identified. Clearing will avoid southern wetland vegetation. Site will be managed as dieback infested. Vehicles required to be clean on entry into protectable areas. Vehicles will be clean on exiting Tutunup South to prevent spread of declared plants. A Vegetation, Flora and Dieback Management Plan has been prepared. A Ground and Surface Water Management Plan has been prepared. A Preliminary Closure and Rehabilitation Plan has been prepared. At least 25.6 ha of native vegetation rehabilitation will be conducted and will be covenanted.	There will be some loss of vegetation due to clearing, and further potential drawdown impacts to the structure of several GDEs. Implementation of the Preliminary Closure and Rehabilitation Plan will: • replace vegetation lost by clearing; • result in overall improved vegetation condition compared to current condition; • place rehabilitated land on more secure tenure; and • establish priority and significant flora in rehabilitation. Protectable forest will remain uninfested. Declared weeds will be eradicated as they occur and not be spread off site. Offset will result in a net environmental benefit.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Fauna	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.	Surveys have located 110 native vertebrate fauna species including 69 avifauna, 13 mammals, 26 herpetofauna and two fish species over the survey area. Most diverse habitats sites were within S2 and M1 communities. Six fauna species of significance recorded during surveys. A further nine species not recorded have the potential to utilise area as part of their range. Three species of Black Cockatoo recorded over the survey area. Search for short-range endemic terrestrial invertebrates found no rare species. 98 aquatic invertebrates located in two wetlands and a creekline in 2005. Six microinvertebrates defined as 'rare'.	Three possible black cockatoo nesting hollows and numerous feeding sites located within disturbance area. Potential loss of habitat from vegetation clearing and impacts from groundwater drawdown. Mining activity affecting fauna at the edge of the disturbance area, e.g. noise/vibration. Increased traffic mortalities of susceptible species.	Minimise clearing of native vegetation and cockatoo habitat outside the ore reserves. Conduct fauna trapping and relocation at northern wetland prior to clearing. Efforts will be made to collect Cockatoo hollows for re-establishment after mining, and will be supplemented by artificial hollows. A Native Fauna Management Plan has been prepared. Rehabilitation to re-establish wetlands and establish vegetation corridors between wetlands and State Forest. A Preliminary Closure and Rehabilitation Management Plan has been prepared.	Although there will be some loss of fauna habitat and food resources, rehabilitation will improve linkages between the Swan Coastal Plain and Whicher Scarp through vegetation corridor establishment between the State Forest and the southern wetland and between State Forest and Roberts Block as part of a conservation offset.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Pollution Management					
Dust	To ensure that emissions do not adversely affect environment values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.	15 residences surrounding Tutunup South. Limited potential for dust generation in excess of current agricultural land use.	Potential for dust generation by earthmoving activities and exposed stockpiles and rehabilitated areas.	Dust will be controlled within the disturbance area through a number of management practices which may include: • wetting and grading unsealed mine roads; • concurrent rehabilitation; • vegetating bunds and stockpiles; • not disturbing topsoil until required • use of biodegradable tackifiers to "glue" the surface down; • use of hydromulch or clay fines to stabilise open areas and rehabilitation surfaces; and • growing temporary crops to bind the soil and lift the wind from the surface.	No significant adverse impacts from dust.
Noise	To protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.	15 residences surrounding Tutunup South. Most residences will have landowner access agreements.	Most mobile equipment restricted to daytime operations. Processing will occur 24 hours a day. Noise modelling indicates worst case conditions may result in excursions to Noise Regulations.	Constructing noise bunds around key noise sources. Hopper and screen plant to be installed below ground level. Minimise numbers of equipment. A Noise Management Plan has been prepared.	Activities will be in accordance with Noise Regulations most of the time. Under worst case conditions, noise levels may result in excursions to Noise Regulations. Landowner agreements and Neighbour agreements to address noise amenity.
Radiation	To ensure that radiological impacts to the public and the environment are kept as low as reasonably achievable and comply with acceptable standards.	Tutunup South is a similar orebody to Iluka's other South West operations. Radiation levels are expected to be low.	Exposure to low level radioactive minerals.	Implement South West Radiation Management Plan	Post mining levels will be similar to the pre-mining value.

Environmental Factor	**EPA Objective**	**Existing Environment**	**Potential Impact**	**Environmental Management**	**Predicted Outcome**
Light	To avoid or manage potential impacts from light overspill and comply with acceptable standards.	Several nearby residences are potential light receptors, as are road users of the Vasse Highway.	Continuous operation of mine site may result in light overspill affecting surrounding residents and/or traffic.	In-pit hopper and screenplant to be located below natural surface level or behind constructed bunds to minimise nuisance light. Majority of earthmoving restricted to 7am to 7pm, limiting the impact of mobile equipment nuisance light. Light towers will be constructed such that redirecting of lights is not difficult.	No significant adverse impacts from site lighting.
Non-Process Waste	Iluka's objective is to ensure that wastes are managed and disposed of in a manner that does not result in long-term impacts on groundwater, surface water and the natural environment.	Existing discarded waste in forested areas, particularly Gravel Reserve	Mismanagement of waste creates large waste streams that are difficult or environmentally unacceptable to dispose or creates contamination.	Priorities for waste management are: 1. avoid/reduce 2. reuse/recycle 3. treat 4. dispose appropriately	No long term impacts from non-process waste.
Process Waste	Iluka's objective is to ensure waste streams from the process are returned to the mining pit in a manner consistent with closure objectives and end uses of the site.	No previous mining conducted over the project area.	Insufficient freeboard, may result in overtopping of solar drying dams. Overburden material returned to the pit creates unsuitable soil profile.	Non-mineralised materials are returned to the pit void.	Return of process wastes to pits will result in re-establishment of the pre-mining land use. No long term impacts from process waste.
Greenhouse gases	To minimise emissions to levels as low as practicable on an on-going basis and consider offsets to further reduce cumulative emissions.	Iluka's South West operations run three concentrators and associated mining infrastructure. The concentrator currently located at Wagerup will be relocated to Tutunup South.	Carbon dioxide levels will result in greenhouse gas emissions from the operation of standard diesel and petrol combustion engines and the use of electricity.	Ensure efficient use of all machinery. Monitor and report greenhouse gas emissions in Annual Environmental Report.	Negligible net increase in greenhouse emissions after decommissioning the Wagerup mine and commissioning of Tutunup South.

Environmental Factor	EPA Objective	Existing Environment	Potential Impact	Environmental Management	Predicted Outcome
Social Surrounds					
Aboriginal Heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and to comply with relevant heritage legislation.	One scar tree has been located within the disturbance area. Ethnographic site (Abba River) located north of the project.	Potential for disturbance to the scar tree. Potential for discovery of further aboriginal heritage sites within the disturbance area. The Ethnographic site will not be impacted.	Mine infrastructure has been designed to avoid impacting the scar tree. Provisions of the Aboriginal Heritage Act will be complied with. Sites discovered during operations will be reported to DoIR and DIA.	The scar tree will not be disturbed during mining. The ethnographic site at the Abba River will not be impacted.
European heritage	To ensure that changes to the biophysical environment do not adversely affect historical and cultural associations and to comply with relevant heritage legislation.	No known sites of European heritage over the project area.	No impact identified.	No impacts requiring management.	No impact on European heritage.
Transport	Ensure that traffic activities resulting from the Tutunup South project can be managed to an adequate level of public safety and have minimal impact on surrounding landowners and traffic congestion.	The key transportation corridors are the Bussell Highway, Vasse Highway and Sues Road (all Main Roads WA heavy haulage routes). Transport along the minor Ludlow Hithergreen Road will be approximately 1 km. HMC transport will comprise of approximately 48 movements (24 completed trips a day).	Increased heavy traffic has the potential to impact on public safety, noise and amenity. Construction traffic (wide loads) may cause short term disruptions to traffic. Diversion of the Vasse Highway required to allow mining.	Appropriate design of intersection and highway diversion in liaison with the Shire of Busselton and MRWA to ensure a adequate level of public safety and minimise impacts on residences and traffic. Transport provider to hold appropriate permits and abide by conditions.	Some short term disruption to traffic during construction and diversion of the Vasse Highway. Minimal disruption to traffic from transport of heavy mineral concentrate (HMC) to Capel.
Visual amenity	Ensure that aesthetic values are considered and measures are adopted to reduce visual impacts on the landscape to as low as reasonably practicable.	Agricultural land adjacent to the Whicher State Forest. 15 residences surrounding the project area. The Vasse Highway bisects the project.	Some residents and Vasse Highway road users will be able to see the mining operation.	Minimisation of clearing. Topsoil stockpiles will be placed around the perimeter of the disturbance boundary and concentrator. Conduct progressive rehabilitation to minimise the active disturbance footprint.	Visual impact will be reduced to as low as reasonably practical.

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Appendix 1

Flora, Vegetation and Dieback Management Plan

Iluka Resources Limited

Flora, Vegetation and Dieback Management Plan

Tutunup South Mineral Sands Project

April 2008

ILUKA-TR-T15788

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1. INTRODUCTION

This plan relates to the management of flora, vegetation and dieback on the Tutunup South mine site. This plan has been developed in conjunction with the Public Environmental Review (PER) impact assessment document. Implementation of this plan and compliance during operations is a commitment of the PER document.

2. ENVIRONMENTAL OBJECTIVE

The objective of this plan is to minimise the impact of mining activities on the flora and vegetation at Tutunup South.

3. PRE- MINE ENVIRONMENT

The Tutunup South site is located at the foot of the Whicher Scarp on mostly agricultural land, 15 km southeast of Busselton. The project also extends into forested areas on its southeastern side which includes both private and State forest and a Gravel Reserve vested with the Shire of Busselton.

A flora and vegetation assessment was conducted over the Tutunup South project area and surrounds (survey area) by Mattiske Consulting Pty Ltd in November 2005, supplemented by further work in January 2007 and September 2007 (Mattiske Consulting Pty Ltd 2007). Due to unseasonably cool and wet spring weather received in 2005, November was identified as being within an optimal range for surveying at Tutunup South. The November 2005, January 2007 and September 2007 survey work complemented earlier flora work by Hart Simpson and Associates Pty Ltd (1996).

The survey work and vegetation assessment was conducted in accordance with EPA Position Statement No. 2 (EPA 2000) and Guidance Statement No. 51 (EPA 2004d).

Natural areas present have been considered in respect of the criteria outlined in Guidance Statement 10 (EPA, 2006c). The following criteria have been identified as relevant to the Tutunup South Project and discussion on these criteria can be found in the sections noted:

Table 1: Guidance Statement 10 criteria

Criterion	Consideration in regard to natural areas at Tutunup South
Representation of ecological communities	The ecological communities present are detailed in section 3: Pre-mine environment, specifically under sections 3.2 and 3.4. These sections provide detail on the vegetation complexes within the survey area and their significance (in reference to Swan Coastal Plain and RFA mapping); and provides detail on the specific vegetation communities located within the survey area, as well as their similarities to floristic communities as defined by Gibson *et al*. (1994) with specific consideration of those floristic community types which are listed TECs. Section 4 outlines the potential for impact to ecological communities directly through clearing (section 4.1) and indirectly through dewatering (section 4.2). The combined potential impact is addressed in section 4.3. Management actions to minimise the impact to ecological communities are

Criterion	Consideration in regard to natural areas at Tutunup South
	outlined in section 5 and monitoring of communities is outlined in section 6.
Diversity	The diversity of the flora within the survey area is detailed in section 3.1. This section details the number of taxa (including subspecies and varieties), genera and families recorded in the area surveyed, as well as detailing how many of those are introduced and how many are listed priority flora (no DRF were located) or otherwise considered to be significant. Sections 4.1 and 4.2 detail the potential for impact to significant flora due to both clearing and dewatering and the clearing controls outlined in section 5.1 are applicable to individuals as well as communities, in that implementation of these controls will ensure that no unplanned clearing of individuals occurs. Monitoring of vegetation by plots as outlined in section 6.1 will include monitoring of the floristic composition of communities, and therefore monitor the diversity present.
Rarity	As above, listed rare or priority flora as well as other species considered to be significant are detailed in section 3.1 and similarities to TECs are outlined in section 3.2. Sections 4.1 and 4.2 detail the potential for impact to significant flora, section 5.1 outlines clearing controls to prevent unplanned disturbance and section 6.1 outlines monitoring requirements.
Maintaining ecological processes or natural systems	The presence and degree of disturbance of existing ecological linkages is noted in section 3.2 and the potential for disturbance to linkages and therefore to the maintenance of ecological processes is discussed in section 4.1. The opportunity to improve ecological function between the wetlands and the State Forest is described in the Preliminary Closure and Rehabilitation Management Plan.
Protection of wetlands and streamline vegetation	Description of watercourses and wetlands present at the site is provided in section 5.7. The potential for impact to the southern wetland and its associated vegetation (vegetation areas 6 and 7) and to Woddidup Creek and its associated vegetation (vegetation area 57) is discussed in section 4.2. Measures to prevent inadvertent clearing of these areas are outlined in section 5.1 and measures to address drawdown impacts to the southern wetland vegetation are addressed in section 5.2.1.
Scientific or evolutionary importance	The investigations carried out at Tutunup South did not find species or habitats that are of scientific or evolutionary importance

3.1. Flora

A total of 399 taxa (including subspecies and varieties) from 206 genera and 66 families were recorded over multiple seasons in the area surveyed. This included 58 introduced taxa with two of these, the Arum Lily (*Zantedeschia aethiopica*) and Cape Tulip (*Moraea flaccida*) being Declared Plants pursuant to Section 37 of the *Agriculture and Related Resources Protection Act*. Both the Arum Lily and Cape Tulip have P1 and P4 classifications, prohibiting the movement of contaminated machinery, plants and seeds from the property, and obliging the landowner to treat to destroy Declared Plants (Mattiske Consulting Pty Ltd 2007).

A review of the Department of Environment and Conservation (2007a) Declared Rare and Priority Flora List indicates that 11 Rare, two Priority 1, four Priority 2, 15 Priority 3 and 11 Priority 4 species may occur in the Tutunup South area. Of note was a WA Herbarium record of the Declared Rare Flora (DRF) *Dryandra nivea* subsp. *Uliginosa* at the northeastern corner of the project area (Figure 1). Despite searching for species recorded on the

Declared Rare and Priority Flora List, no DRF under the *Wildlife Conservation Act 1950* or flora listed pursuant to section 179 of the *Environment Protection and Biodiversity Conservation Act 1999* were identified during any of the three flora studies.

Ten priority flora species pursuant to subsection (2) of section 23F of the *Wildlife Conservation Act 1950* and as listed by the Department of Environment and Conservation (2007a and 2007b) were located in the vicinity of the project (Mattiske Consulting Pty Ltd 2007). These are identified below:

- *Acacia flagelliformis* (P4) – known from 23 records at the WA Herbarium;
- *Acacia semitrullata* (P3) – known from 62 records at the WA Herbarium;
- *Actinotus whicheranus* (P2) – known from 7 records at the WA Herbarium;
- *Aotus cordifolia* (P3) – known from 36 records at the WA Herbarium;
- *Astroloma* sp. Nannup (P4) – known from 55 records at the WA Herbarium;
- *Boronia capitata* subsp. *Gracilis* (P2) – known from 15 records at the WA Herbarium;
- *Boronia tetragona* (P3) – known from 9 records at the WA Herbarium;
- *Gratiola pedunculata* (P2) – known from 5 records at the WA Herbarium;
- *Grevillea manglesioides* subsp. *Ferrricola* (P2) known from 21 records at the WA Herbarium; and
- *Loxocarya magna* (P3) – known from 18 records at the WA Herbarium.

Cyathochaeta teretifolia (P3) is currently known from 28 records at the WA Herbarium. This taxon occurs in winter wet sands on the southern Swan Coastal Plain from Yarloop southwards towards Augusta and the Donnybrook Sunklands (Department of Environment and Conservation 2007a). This taxon was not recorded in the survey area, but from discussions with other botanists, may potentially be in the area (Mattiske Consulting Pty Ltd, 2007b). As this taxon occurs in a range of locations and is protected in state forest areas south of the proposal area, this taxon is not threatened by this proposal (E. M. Mattiske, pers. comm.).

In addition to the aforementioned list of priority flora, several other taxa found within the surveyed area are considered to be significant by Webb (2006). These represent key species within the remnant vegetation of the Whicher Scarp and Swan Coastal Plain given much of the surrounding land has been cleared for agriculture. These significant species are described below (Mattiske Consulting Pty Ltd 2007):

- *Grevillea pulchella* subsp. *Ascendens* – recorded in E1 plant community.
- *Actinostrobus acuminatus* – recorded in E1 plant community. This taxon is known from disjunct distributions and as such is of bio-geographical interest.
- *Andersonia micrantha* – recorded in E1 and S1 plant communities. This taxon is known from scattered collections.
- *Beaufortia squarrosa* – recorded in B1 and S1 plant communities.
- *Conospermum acerosum* – recorded in E1 plant community.
- *Daviesia divaricata* subsp. *Divaricata* – recorded in E1 plant community.

- *Eremaea pauciflora* var. *pauciflora* – recorded in E1 plant community.
- *Corymbia haematoxylon* – this species was recorded regularly in the E1, E2, M1, M2, S1 and S2 communities. Although of interest, this species occurs northwards to Mount Lesueur and from the Darling Scarp to the Whicher Scarp. Its dominance in the Whicher Scarp communities is more evident.
- *Hibbertia acerosa* – recorded in E1 plant community.
- *Petrophile serruriae* – recorded in E1 plant community.
- *Pityrodia bartlingii* – recorded in E1 and S1 plant communities.
- *Pultenaea radiata* – recorded in E1 and E2 plant communities.
- *Synaphea whicherensis* – recorded in E1 plant community.
- *Taxandra fragans* (ms) – recorded in M1 and S2 plant communities and is an indicator species for the S2 vegetation community.

3.2. Vegetation

The survey area lies within the Drummond Botanical Subdistrict of the South-western Botanical Province (Diels, 1906; Gardner, 1942; and Beard, 1979 and 1980; cited in Mattiske Consulting Pty Ltd, 2007).

In vegetation mapping it is necessary to define and map the plant communities into groups with common characteristics in structure and floristics (Mattiske Consulting Pty Ltd, 2007). The classification system of Heddle *et al*, 1980a) utilised the concept of vegetation complexes and emphasised the relationships between the underlying landforms, soils and the plant communities. This classification system incorporated linkages with the previous work by Havel (1975a and b) (cited in Mattiske Consulting Pty Ltd, 2007).

The complexes on the Swan Coastal Plain were defined and mapped by Heddle *et al* (1980a). The vegetation complexes on the adjacent Darling Scarp and Plateau were revised and mapped by Mattiske and Havel (1998) for the purposes of the Regional Forest Agreement (RFA) (Mattiske Consulting Pty Ltd, 2007).

The Tutunup South survey area occurs near the interface between Cartis and Abba vegetation complexes as defined by Heddle *et al* (1980a), namely:

- **Abba** – A mixture of open forest of *Corymbia calophylla* – *Eucalyptus marginata* – *Banksia* spp. And woodland of *Corymbia calophylla.* Abba is similar to Forrestfield and Guildford vegetation complexes, but differs in the lack of *Eucalyptus wandoo*.
- **Cartis** – Low open forest to open forest of Eucalyptus marginata subsp. Marginata – *Corymbia calophylla-Corymbia haematoxylon* over *Banksia* species on the Whicher Escarpment.

Both the Abba and Cartis vegetation complexes have been cleared by agricultural land uses.

In the recent Regional Forest Agreement (RFA) vegetation project, Mattiske and Havel (1998) further refined these complexes, though only a small portion of the Abba complex fell within the RFA area (E M Mattiske, pers. comm.). Within the Tutunup South survey area, the refined complexes include the Abba (AB and Aw), Yelverton (Y, and Yw) and Whicher Scarp (WC) complexes:

- **Abba** (AB) – Woodland and Open Forest of *Corymbia calophylla* on flats and low rises in humid zones.
- **Abba** (Aw) – Mosaic of Tall Shrubland of *Melaleuca viminea* and Woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* with occasional *Corymbia calophylla* on broad depressions in the humid zone.
- **Yelverton** (Y) – Woodland of *Eucalyptus marginata* subsp. *Marginata – Corymbia calophylla – Allocasuarina fraseriana – Agonis flexuosa* and open woodland of *Corymbia calophylla* on undulating uplands in the humid zone.
- **Yelverton** (Yd) – Woodland of *Allocasuarina fraseriana – Eucalyptus marginata* subsp. *Marginata – Xylomelum occidentale – Banksia attenuata* on sandy slopes in the humid zone.
- **Yelverton** (Yw) – Woodland *of Allocasuarina fraseriana – Nuytsia floribunda – Agonis flexuosa – Banksia attenuata* on slopes and open forest of *Corymbia calophylla – Eucalyptus patens – Eucalyptus marginata* subsp. *Marginata* on the lower slopes and woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* on valley floors in the humid zone.
- **Whicher Scarp** (WC) – Open forest of *Eucalyptus marginata* subsp. *Marginata – Corymbia calophylla* on escarpment with some *Corymbia haematoxylon, Banksia attenuata* and *Xylomelum occidentale* in the humid zone.

According to the South West Biodiversity Project Mapping & Information Instalment 2 (2007), which incorporates the Heddle *et al* (1980a) and the Mattiske and Havel (1998) mapping, the total area of native vegetation remaining in the Abba complexes is 4,482 ha; the total area of native vegetation remaining in the Yelverton complexes is 5,946 ha and the total area of native vegetation remaining in the Whicher Scarp complex is 3,339 ha.

The Whicher Scarp and Yelverton vegetation communities are significant in that this area supports a range of species that are either restricted to the area or that occur as disjunct distributions in a biogeographical context. Such species include *Corymbia haematoxylon, Actinotus whicheranus* and *Petrophile serruriae*. The Whicher vegetation complexes and the majority of the Yelverton vegetation complexes that occur on the Tutunup South survey area are less disturbed than many other vegetation complexes (as defined by Mattiske and Havel (1998); cited in Mattiske Consulting Pty Ltd (2007)). All exceed 20% remaining of the pre-European extent (Webb 2006).

The Whicher vegetation complexes currently have 76% (WC) and 70.8% (WCv) remaining uncleared (Webb 2006) and 15.4% and 10.0% respectively in the reserve system (Conservation Commission 2004; cited in Mattiske Consulting Pty Ltd (2007)). The Yelverton and Abba vegetation complexes occur primarily on private land (Conservation Commission 2004; cited in Mattiske Consulting Pty Ltd (2007)) and as such extend beyond the RFA mapping areas. Therefore, estimates of reservation cannot be retrieved from data used in the Forest Management Plans (Mattiske Consulting Pty Ltd 2007).

Information on the pre-mining extent and area in reserve for each vegetation complex could not be obtained from the South West Biodiversity Project Mapping & Information Instalment 2 (2007) as data is not provided for the Capel area.

The Yelverton mapping units on the flats between the Whicher Escarpment and the coast are not well represented in the conservation estate. This is in part due to the problem of assessing a mapping unit on the edge of the RFA area, but also the extent of the agricultural activities on the flats of the Swan Coastal Plain below the Whicher Escarpment. Despite the difficulty of assessing the degree of representation, it is clear that these vegetation complexes on the flats between the Whicher Escarpment and the coast are not well represented in the conservation estate. A comparison of the vegetation with the regional vegetation datasets on the Swan Coastal Plain is less relevant as the majority of the Coastal Plain areas within the lease area have been cleared for many decades or are degraded as a result of grazing and agricultural activities (Mattiske Consulting Pty 2007).

Despite the difficulty of assessing the degree of representation, it is clear that these vegetation complexes on the flats between the Whicher Escarpment and the coast are not well represented in the conservation estate. A comparison of the vegetation with the regional vegetation datasets on the Swan Coastal Plain is less relevant as the majority of the Coastal Plain areas within the lease area have been cleared for many decades or are degraded as a result of grazing and agricultural activities (Mattiske Consulting Pty Ltd, 2007).

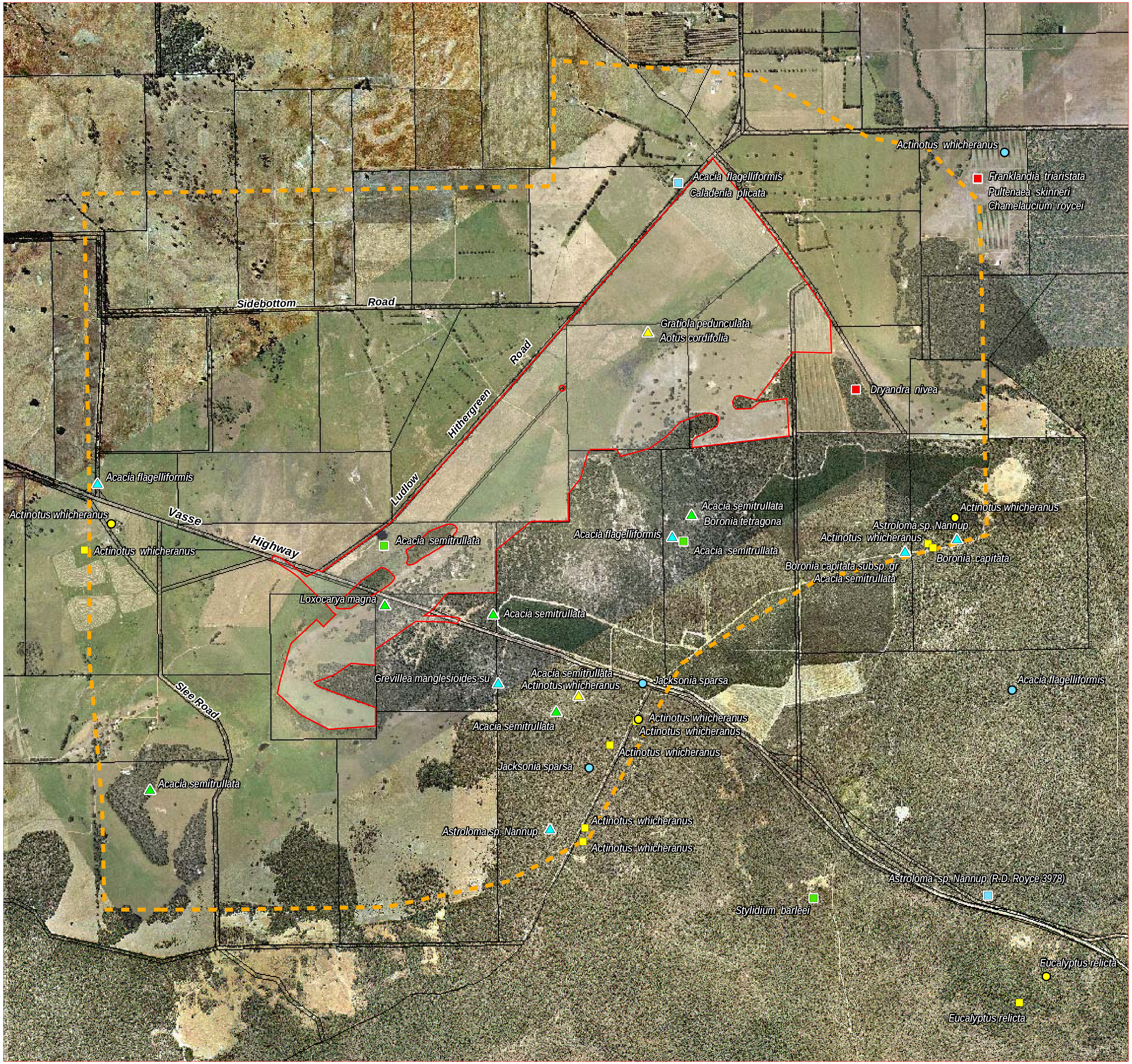
Twelve vegetation communities were defined in the Tutunup South survey area by Mattiske Consulting Pty Ltd (2007), with three being dominated by *Eucalyptus marginata* or *E. patens*, three dominated by *Corymbia calophylla*, two *Melaleuca* woodlands, one *Banksia attenuata* woodland, two Myrtaceous shrublands and one pine plantation. However, with the majority of the project is sited amongst agricultural land or in a degraded state. The condition of vegetation was rated according to the scale used for assessing Bush Forever sites (Government of Western Australia 2000; Figure 3).

Table 2: Vegetation Condition Rating Scale from Bush Forever (Government of Western Australia 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. Disturbance to vegetation structure covers repeated fire, aggressive weeds, dieback, logging, grazing.
4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. Disturbance to vegetation structure covers frequent fires, aggressive weeds at high density, partial clearing, dieback and grazing.
5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. Disturbance to vegetation structure includes frequent fires, presence of very aggressive weeds, partial clearing, dieback and grazing.
6	Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas often described as “parkland cleared” with the flora comprising weed or crop species with isolated native trees or shrubs.

REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S.	D.G.S.	12.09.07	Original version
01	S.J.	D.G.S.	10.03.08	Rare flora (DEFL) added



Legend

Study area

Disturbance area

Rare and priority species

	Herbarium	MCPL	DEFL
Rare	■	▲	●
P1	■	▲	●
P2	■	▲	●
P3	■	▲	●
P4	■	▲	●

Date of photography
Inset: 19 Nov. 2007 Regional: 2001

N

0 500 1,000 m

ILUKA

TUTUNUP SOUTH

LOCATIONS OF PRIORITY FLORA

ORIG: S.Jones
DRAWN: D.G.S.
SCALE: 1:20,000
DATE: 10 March 2008 DWG No: 176772 ver.01 A3 FIGURE: 1

The floristic description of each vegetation community is described in Table 3 and mapped in Figure 2. The Bush Forever condition of each community is also noted in Table 3 and presented in Figure 3.

The native species within the Mattiske Consulting defined vegetation communities were compared with the floristic communities as defined by Gibson *et al*. (1994) using two approaches. The first of these approaches was based on the Sorenson Similarity Index and the second was based on the percentage overlap between the plant communities as defined and the data as presented in Gibson *et al.* (1994) for the respective communities. Full details of comparison data are provided in Mattiske Consulting Pty Ltd (2007). The comparative floristic community is noted in Table 3 and the comparison between the communities, using the Sorenson Similarity Index (SSI) and the percentage overlap of native species (PONS) is provided in Table 4.

Table 3: Vegetation Communities in the Tutunup South Area

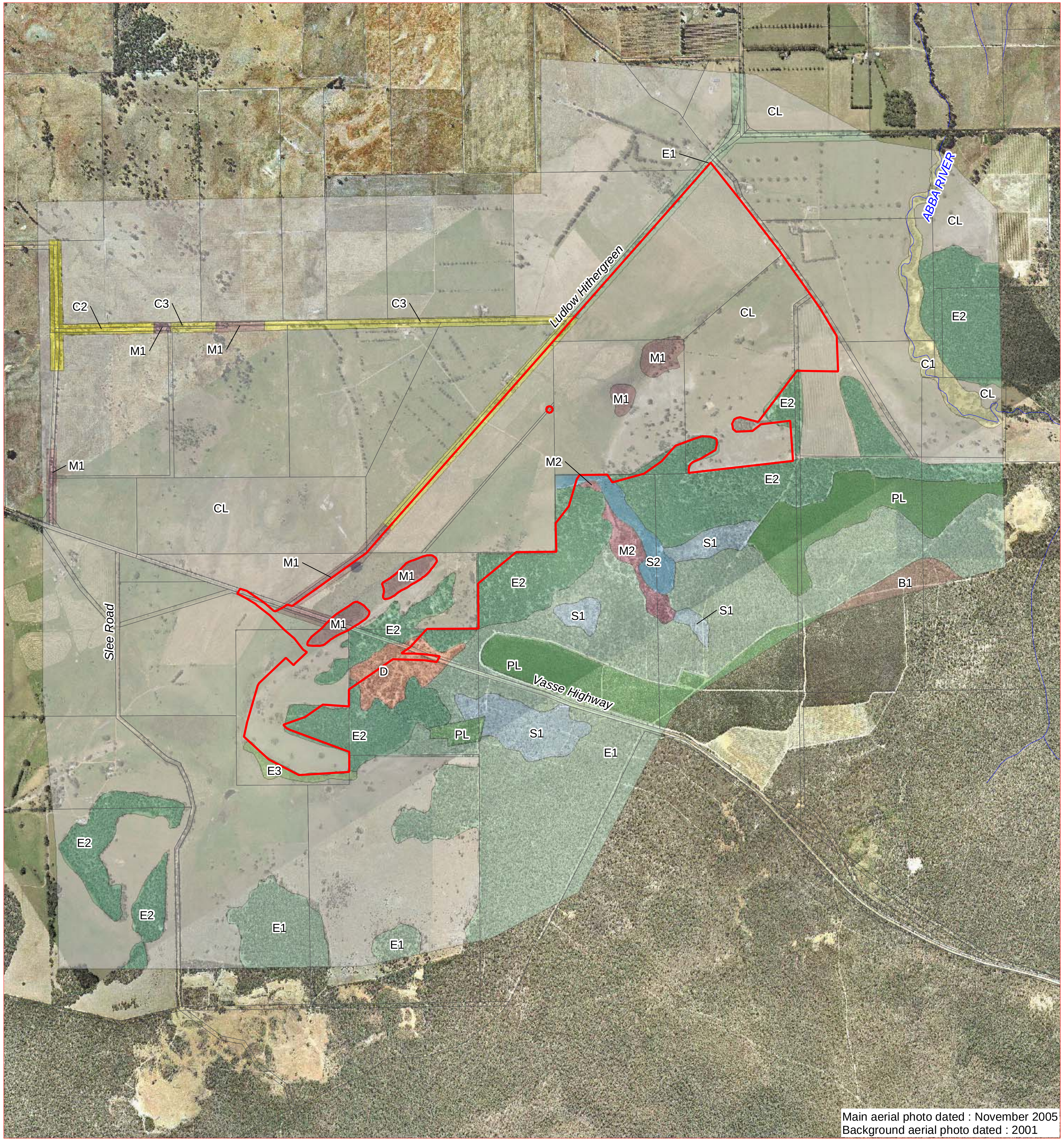
Code	Description	Bush Forever Condition	Comparison with Gibson et al 1994
B1	Woodland of *Banksia attenuata* over *Beaufortia squarrosa*, *Adenanthos meisneri*, *Melaleuca thymoides*, *Stirlingia latifolia* and *Melaleuca trichophylla* on sandy soils.	2	SCP21a
C1	Open Forest of *Corymbia calophylla* over *Taxandria linearifolia* (ms) and *Astartea scoparia* over mixed sedges on flowlines.	4	None
C2	Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and *Kingia australis* on loam soils.	4	SCP3a
C3	Woodland of *Corymbia calophylla* over pasture on loam soils.	5	None
E1	Open Forest of *Eucalyptus marginata* subsp. *Marginata* – *Corymbia haematoxylon* with *Banksia grandis* and *Banksia attenuata* over *Xanthorrhoea preissii*, *Podocarpus drouynianus*, *Stirlingia latifolia*, *Melaleuca thymoides* and *Dasypogon hookeri* over *Anarthria scabra* and *Phlebocarya ciliata* on gravelly sandy loams on middle to upper slopes of the Whicher Range escarpment.	2, 3, 4	SCP1a
E2	Open Forest of *Eucalyptus marginata* subsp. *Marginata* – *Corymbia calophylla* with *Banksia grandis* and *Xanthorrhoea preissii* over *Hibbertia hypericoides* on gravelly sandy loams on lower slopes of the Whicher Range escarpment.	2, 3, 4	SCP1a
E3	Woodland of *Eucalyptus patens, Taxandria linearifolia* (ms) and *Astartea scoparia* over *Gahnia decomposita, Lepidosperma tetraquetrum* and *Cyathochaeta avenacea* on loam soils.	3	None
M1	Woodland of *Melaleuca rhaphiophylla* and *Melaleuca preissiana* with *Taxandria linearifolia* (ms), *Astartea scoparia* and *Acacia divergens* over *Cyathochaeta avenacea* and mixed sedges and rushes on clay-loam soils.	3, 4, 5	SCP9
M2	Open Woodland of *Melaleuca preissiana* with *Kunzea ericifolia*, *Xanthorrhoea preissii* and *Baxteria australis* on sandy-loam soils.	5	SCP9
S1	Low Shrubland of *Melaleuca thymoides* and *Beaufortia*	2, 3	SCP2

Code	Description	Bush Forever Condition	Comparison with Gibson et al 1994
	squarrosa over *Kunzea micrantha* subsp. *Micrantha, Stirlingia latifolia, Callistemon glaucus, Dasypogon bromeliifolius* with emergent *Allocasuarina fraseriana, Nuytsia floribunda, Banksia attenuata* and *Xanthorrhoea preissii* on sandy loam soils.		
S2	Tall Shrubland of *Taxandria linearifolia* (ms), *Taxandria fragrans* (ms), Astartea *scoparia, Kunzea recurva, Pericalymma spongiocaule* over *Cyathochaeta avenacea* on sandy-loam soils	3, 5	SCP2
D	Degraded areas – with degraded or completely degraded condition rating. These areas only support an isolated tree or native understorey species.	5	None
P	Pine Plantation	6	None

Table 4: Comparison of vegetation communities with floristic communities as defined by Gibson *et al* (1994)

Vegetation types	Sorenson Similarity Index (SSI)	Percentage Overlap with Native Species (PONS)
B1 and SCP 21a	0.10	9%
C2 and SCP 3a	0.02	4%
E1 and SCP 1a	0.39	56%
E2 and SCP 1a	0.42	47%
M1 and SCP 9	0.24	2%
M2 and SCP 9	0.07	4%
S1 and SCP 2	0.04	16%
S2 and SCP 2	0.20	16%

Linkages between the Whicher Scarp vegetation and Yelverton vegetation, and more specifically, linkages between the swamp vegetation and the Swan Coastal Plain have historically been fragmented and degraded by a range of agricultural activities. These processes have led to higher degrees of disturbance in many of the ecological linkages and wetlands (Mattiske Consulting Pty Ltd 2007).



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
01	S.E	T.L.G	19.10.06	Removed Iluka tenements
02	S.E	T.L.G	09.02.07	Update of disturbance area
03	S.E	T.L.G	15.02.07	Update legend descriptions

Legend

ts_Disturbance Area_sedgar_modified_20070605

Tutunup South Existing Vegetation

Vegetation Code

Code	Description
B1	Woodland of Banksia attenuata over Beaufortia squarrosa, Adenanthos meisneri , Melaleuca thymoides , Stirlingia latifolia and Melaleuca trichophylla on sandy soils.
C1	Open Forest of Corymbia calophylla over Taxandria lineariifolia (ms) and Astartea scoparia over mixed sedges on flowlines.
C2	Woodland of Corymbia calophylla over Xanthorrhoea preissii and Kingia australis on loam soils.
C3	Woodland of Corymbia calophylla over pasture on loam soils.
E1	Open Forest of Eucalyptus marginata subsp. marginata Corymbia haematoxylon with Banksia grandis and Banksia attenuata over Xanthorrhoea preissii , Podocarpus drouynianus , Stirlingia latifolia , Melaleuca thymoides and Dasypogon hookeri over Anarthria scabra and Phlebocarya ciliata on gravelly sandy loams on middle to upper slopes of the Whicher Range escarpment.
E2	Open Forest of Eucalyptus marginata subsp. marginata Corymbia calophylla with Banksia grandis and Xanthorrhoea preissii over Hibbertia hypericoides on gravelly sandy loams on lower slopes of the Whicher Range escarpment.
E3	Woodland of Eucalyptus patens, Taxandria linearifolia (ms) and Astartee scoparia over Gahnia decomposita, Lepidosperma tetraquetrum and Cyathochaeta avenacea on loam soils.
M1	Woodland of Melaleuca rhaphiophylla and Melaleuca preissiana with Taxandria lineariifolia (ms), Astartea scoparia and Acacia divergens over Cyathochaeta avenacea and mixed sedges and rushes on clay-loam soils.
M2	Open Woodland of Melaleuca preissiana with Kunzea ericifolia , Xanthorrhoea preissii and Baxteria australis on sandy-loam soils
S1	Low Shrubland of Melaleuca thymoides and Beaufortia squarrosa over Kunzea micrantha subsp. micrantha, Stirlingia latifolia, Dasypogon bromeliifolius with emergent Allocasuarina fraseriana, Nuytsia floribunda, Banksia attenuata and Xanthorrhoea preissii on sandy loam soils.
S2	Tall Shrubland of Taxandria linearifolia (ms), Taxandria fragrans (ms), Astartea scoparia, Kunzea recurva, Pericalymma spongiocaule over Cyathochaeta avenacea on sandy-loam soils
CL	Cleared
PL	Plantation
D	Degraded

Survey conducted November 2005 by Mattiske Consulting PTY LTD

N

0 500 1,000 1,500 Meters

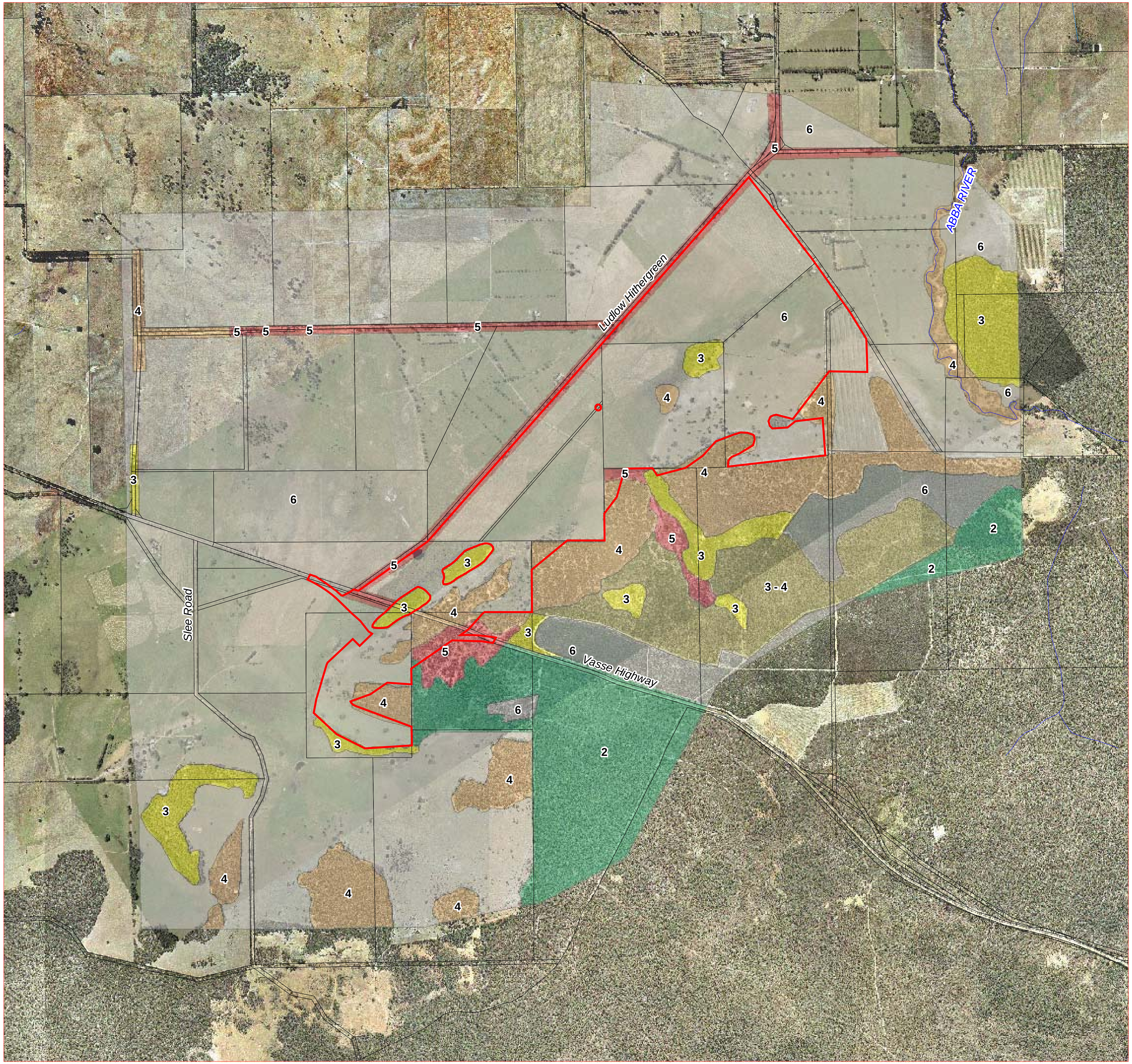
ILUKA

ORIG: S.Edgar
DRAWN: T.L.G
SCALE: 1:20,000
DATE: 15 Feb 2007

TUTUNUP SOUTH

VEGETATION COMMUNITIES

DWG No: 168824 ver.03 A3 FIGURE: 2



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
02	S.E	T.L.G	09.02.07	Update of disturbance boundary
03	S.E	T.L.G	15.02.07	Update legend descriptions
04	L.S.	D.G.S.	14.9.07	Disturbance area ammeded

Legend

Disturbance area

Vegetation Condition

Rating

- 2 Excellent
- 3 Very Good
- 4 Good
- 5 Degraded
- 6 Completely Degraded
- 3-4 Mosaic of 3 and 4

Main aerial photo dated : November 2005
Background aerial photo dated : 2001

Condition rating scale from Bush Forever (Government of Western Australia 2000 based on Keighery 1994)

Survey conducted November 2005 by Mattiske Consulting PTY LTD

N

0 500 1,000 m

ILUKA

ORIG: L.Sadler

DRAWN: D.G.S.

SCALE: 1:20,000

DATE: 14 Sept. 2007

TUTUNUP SOUTH

BUSH FOREVER VEGETATION CONDITION

DWG No: 168825 ver.04

A3

FIGURE: 3

3.3. Threatened Ecological Communities

Vegetation community C2 is a woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and *Kingia australis* on loam soils which shares key dominant species with Gibson *et al's* (1994) community SCP 3a *Corymbia calophylla – Kingia australis* woodlands on heavy soil, however none of the other typical or common species listed for community SCP 3a by Gibson *et al* (1994) are present in community C2 and there is therefore a very low level of similarity between the two. SCP 3a is a Threatened Ecological Community (TEC) listed by both the State and Commonwealth and is protected under the EPBC Act (Table 5).

Communities S1 and S2 (myrtaceous shrublands) have low floristic similarities to community SCP 02 of Gibson *et al* (1994) (Southern wet shrublands). SCP 02 is listed as a TEC by the DEC but not under the EPBC Act (Table 5). The floristic similarities were described as low by Mattiske Consulting Pty Ltd (2007) as three of the 16 typical species and five of the 18 common species were present in community S1, whilst four of the 16 typical species and four of the 18 common species were present in community S2.

Table 5: Threatened Ecological Communities in the Vicinity of Tutunup South

Tutunup South Plant Community	**Gibson *et al* (1994) Community Type**	**EPBC 1999 Listing**	**DEC listing**
C2	SCP 3a (shared key dominant species, very low similarity)	EN – Endangered facing a very high risk of extinction in the near wild in the near future	CR B) ii) – Critically Endangered, current distribution is limited, there are very few occurrences each of which is small and/or isolated and extremely vulnerable to known threatening processes.
S1, S2	SCP 02 (low similarity)	Not listed	EN B) ii) – Endangered, current distribution is limited, there are very few occurrences each of which is small and/or isolated and extremely vulnerable to known threatening processes.

3.4. Groundwater Dependent Ecosystems

The impact that groundwater drawdown has on ecosystems is related to the level of dependence that the ecosystem has on groundwater, the level of drawdown, the rate of drawdown and the duration of drawdown.

The first step in determining the potential for impact from groundwater drawdown is determining whether the ecosystem is dependent on groundwater, that is, whether it is a groundwater dependent ecosystem (GDE) and if so, the degree of that dependence.

Investigations have been conducted at Tutunup South to provide a site specific assessment of the potential for ecosystems to be groundwater dependent (SWC, 2007). This assessment includes information on soil properties and observed vegetation rooting depths at the site and the water use requirements of the vegetation to determine groundwater dependence of each ecosystem present (SWC, 2007).

The water retention characteristics of the soil strongly influence the dependence of vegetation on groundwater. For example, if there is sufficient plant available water stored in the soil profile to meet the transpiration requirements of the vegetation then there is no need to access groundwater; thus the vegetation is not dependent on groundwater. Water retention data and soil distribution mapping from a soil survey conducted at Tutunup South (SWC, 2007) were used to determine the average plant available water content (PAWC) for the entire above groundwater soil profile for each of five SMUs present (Table 6).

Table 6: Plant Available Water Content

Soil Management Unit (SMU)	PAWC (m3/m3)
SMU1	0.078
SMU2	0.085
SMU3	0.053
SMU4	0.069
SMU5	0.084

Each vegetation community identified in the vegetation survey (Mattiske Consulting Pty Ltd 2007) was broken down into vegetation areas (Figure 4) and assessed, considering the soil profile and the depth to groundwater underlying it, determined from the soil distribution model. The transpiration for all vegetation was assumed to be 700 mm/yr. Given the quality and density of the vegetation remaining in the Tutunup South area, this transpiration rate is likely to overestimate the actual water use requirements of the vegetation in the area, and will result in an overestimation of the groundwater dependence of the vegetation.

By multiplying the PAWC of the soil beneath vegetation by the depth to groundwater beneath that vegetation, the amount of soil water available to that vegetation can be determined. By dividing that amount by the volume of water transpired by the vegetation, the percentage of the vegetation's water requirements which are available from the soil profile can be determined. Where the volume of water available in the soil profile exceeds the volume required by the vegetation, the vegetation is not dependent on groundwater for survival. Where the volume of water available in the soil profile is less than the volume required by the vegetation, the vegetation is dependent on groundwater. The level of dependence is determined by the percentage of the vegetation's water requirements that can be supplied from the soil profile. SWC (2007) designates GDE classes as follows:

- Class 1: 80 % dependence on groundwater
- Class 2: 50 % dependence on groundwater
- Class 3: 20 % dependence on groundwater
- Class 4: No dependence on groundwater

In total, 11 vegetation areas were considered to have some degree of groundwater dependency and are subsequently rated as GDEs. These are vegetation areas 6, 7, 19, 26, 30, 31, 34, 46, 47, 51 and 57 (Figure 4).

3.5. Dieback

A dieback survey of the disturbance and surrounding area was undertaken by DEC, Forest Management Branch (2007b) to field demarcate infested/uninfested areas, map infested/uninfested areas and provide hygiene recommendations.

From this survey, it was identified that there are both infested and uninfested areas upslope of the disturbance area. Protection of the uninfested areas is the key focus of dieback management at Tutunup South. Whilst the agricultural land is uninterpretable, the presence of infestations above makes it unprotectable. Thus, the agricultural land will be managed as dieback infested for hygiene measures.

Dieback boundaries have been marked in the field with bright orange flagging tape to clearly delineate boundaries between infested and non-infested areas. As recommended by the DEC, follow-up survey to ensure boundaries are current will be conducted prior to mining.

3.6. Summary

No DRF species have been located within the survey area. 10 priority species have been located and 14 other taxa located within the survey area are considered to be significant by Webb *et al* (2006).

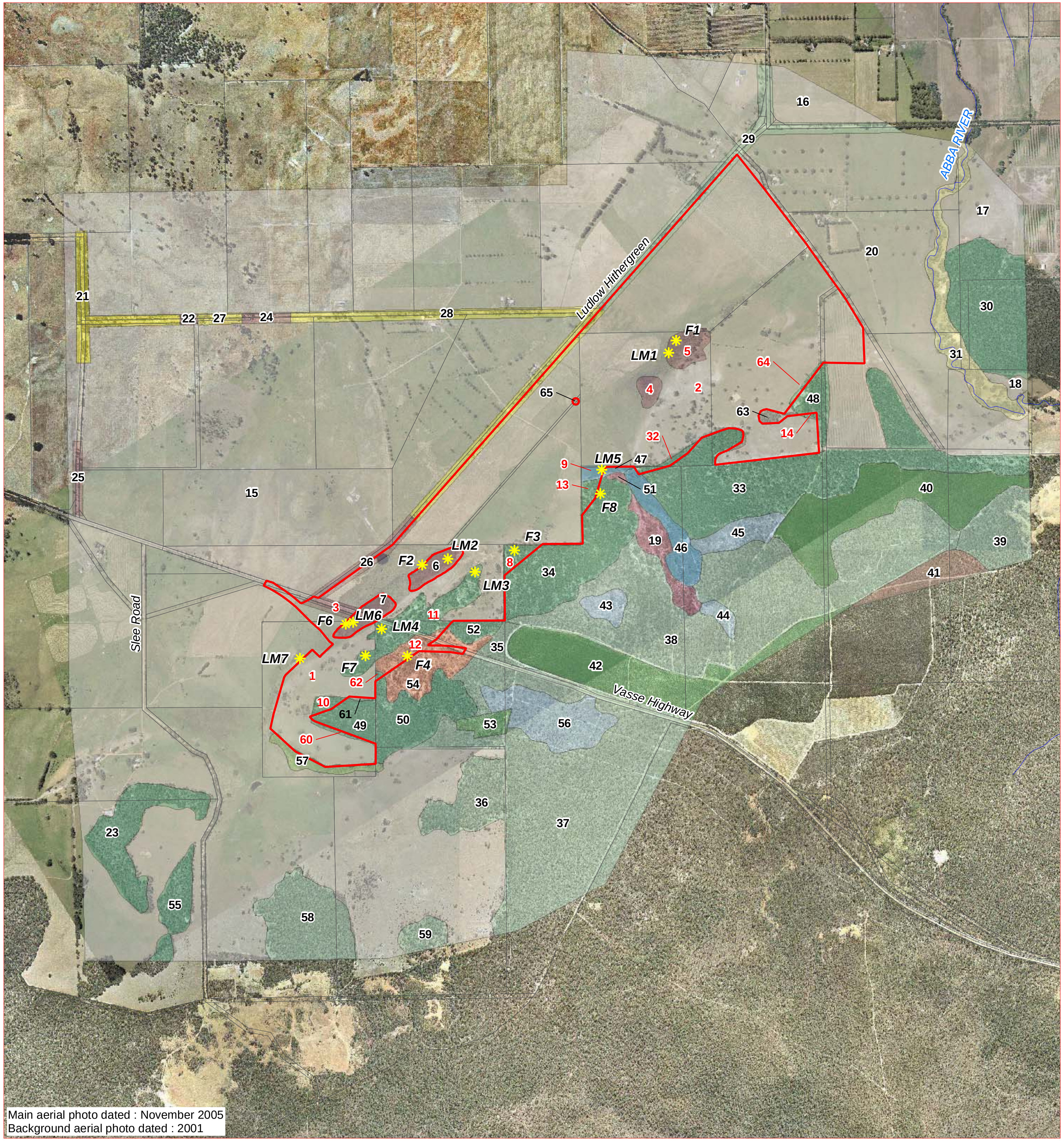
The Tutunup South survey area occurs near the interface of the Cartis and Abba vegetation complexes as defined by Heddle *et al* (1980a), both of which have been extensively cleared by agricultural land uses. These complexes were further refined in the RFA vegetation project (Mattiske and Havel (1998) into the Whicher Scarp and Yelverton Complexes. These communities support a range of species that are either restricted to the area or occur as disjunct distributions and are less disturbed than many other vegetation complexes.

Site survey identified twelve vegetation communities, however the majority of the site is cleared agricultural land or in a degraded condition. Linkages between the Whicher Scarp vegetation and Yelverton vegetation; and specifically between the wetland vegetation and the Swan Coastal Plain have been fragmented and degraded by agricultural activities.

Vegetation community C2 shares key dominant species with Gibson *et al*s (1994) community SCP 3a, which is a State and Federally listed TEC, however none of the other typical or common species for SCP 3a are present in the C2 community and there is a very low level of similarity between the two. Communities S1 and S2 have low floristic similarity to SCP 02 (Gibson *et al*, 1994), a State listed TEC. None of the other communities identified were commensurate with listed TECs.

The potential for vegetation to be groundwater dependent has also been assessed, and classes of dependence allocated to each area of vegetation. In total, 11 vegetation areas were considered to have some level of groundwater dependence.

In respect of the criteria outlined in Guidance Statement 10 (EPA, 2006c), the Tutunup South site occurs within an area of regional significance, in terms of the vegetation complexes represented and the occurrence of priority and other significant flora. Little wetland vegetation remains and linkages between the scarp vegetation and wetland vegetation are lacking due to past agricultural activities, limiting the ability for ecological processes to be maintained across the site. No linkages exist between scarp vegetation and vegetation below the site.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
04	L.S.	D.G.S.	21.8.07	Update disturbance boundary
05	L.S.	D.G.S.	16.09,07	Numbering of veg polygons changed
06	P.F.	D.G.S.	7.02.08	Permanent Veg Monitoring Locations
07	S.J	T.L.G	8.04.08	Update Disturbance Area

Legend

F1 Permanent vegetation monitoring locations

Disturbance Area

Tutunup South Existing Vegetation

Vegetation Code

Code	Description
B1	Woodland of Banksia attenuata over Beaufortia squarrosa, Adenanthos meisneri , Melaleuca thymoides , Stirlingia latifolia and Melaleuca trichophylla on sandy soils. - Site 41
C1	Open Forest of Corymbia calophylla over Taxandria linneariifolia (ms) and Astartea scoparia over mixed sedges on flowlines. - Site 31
C2	Woodland of Corymbia calophylla over Xanthorrhoea preissii and Kingia australis on loam soils. - Site 21
C3	Woodland of Corymbia calophylla over pasture on loam soils. - Sites 27,28
E1	Open Forest of Eucalyptus marginata subsp. marginata Corymbia haematoxylon with Banksia grandis and Banksia attenuata over Xanthorrhoea preissii , Podocarpus drouynianus , Stirlingia latifolia , Melaleuca thymoides and Dasypogon hookeri over Anarthria scabra and Phlebocarya ciliata on gravelly sandy loams on middle to upper slopes of the Whicher Range escarpment. Sites 29,35,36,37,38,39,58,59
E2	Open Forest of Eucalyptus marginata subsp. marginata Corymbia calophylla with Banksia grandis and Xanthorrhoea preissii over Hibbertia hypericoides on gravelly sandy loams on lower slopes of the Whicher Range escarpment. Sites 8, 10, 11, 13, 14, 23, 30, 32, 33, 34, 48, 49, 50, 52, 55, 60, 62, 64
E3	Woodland of Eucalyptus patens, Taxandria linearifolia (ms) and Astartea scoparia over Gahnia decomposita, Lepidosperma tetraquetrum and Cyathochaeta avenacea on loam soils. Site 57
M1	Woodland of Melaleuca rhaphiophylla and Melaleuca preissiana with Taxandria linneariifolia (ms), Astartea scoparia and Acacia divergens over Cyathochaeta avenacea and mixed sedges and rushes on clay-loam soils. Sites 3, 4, 5, 6, 7, 22, 24, 25, 26
M2	Open Woodland of Melaleuca preissiana with Kunzea ericifolia , Xanthorrhoea preissii and Baxteria australis on sandy-loam soils - Sites 19, 51
S1	Low Shrubland of Melaleuca thymoides and Beaufortia squarrosa over Kunzea micrantha subsp. micrantha, Stirlingia latifolia, Dasypogon bromeliifolius with emergent Allocasuarina fraseriana, Nuytsia floribunda, Banksia attenuata and Xanthorrhoea preissii on sandy loam soils. Sites 43, 44, 45, 56
S2	Tall Shrubland of Taxandria linearifolia (ms), Taxandria fragrans (ms), Astartea scoparia, Kunzea recurva, Pericalymma spongiocaule over Cyathochaeta avenacea on sandy-loam soils. Sites 9, 46, 47
CL	Cleared - Sites 1, 2, 15, 16, 17, 18, 20, 61, 63, 65
PL	Plantation - Sites 40, 42, 53
D	Degraded - Sites 12, 54

Survey conducted November 2005 by Mattiske Consulting PTY LTD

0 500 1,000 m

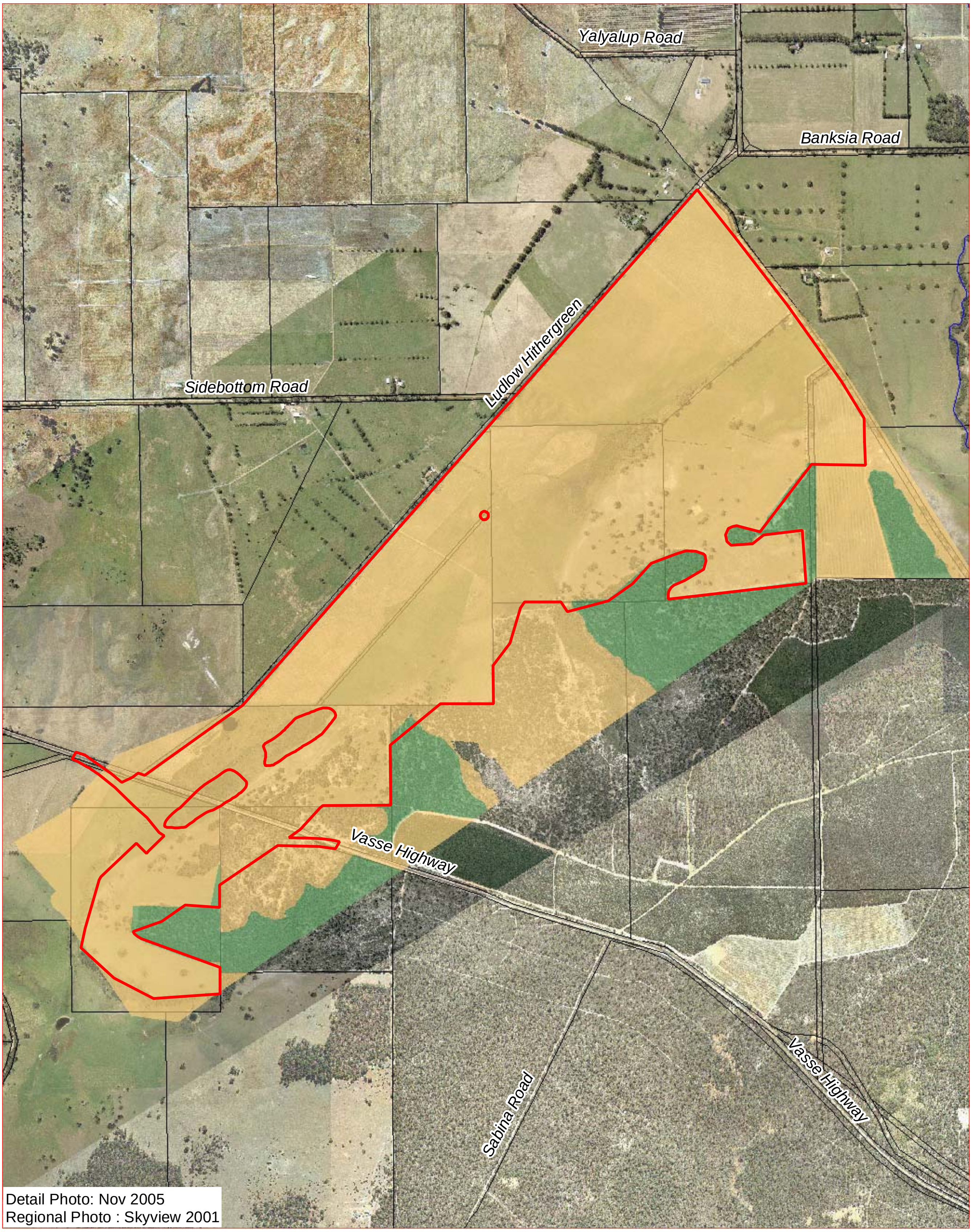
N

ILUKA

TUTUNUP SOUTH

VEGETATION AREAS

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:20,000
DATE: 7 Feb. 2008
DWG No: 168824 ver.07
A3
FIGURE: 4



Legend

Disturbance Area

Dieback Areas

Infested / unprotectable

Uninfested / protectable

N

0 500 1,000 m

ILUKA

TUTUNUP SOUTH

DIEBACK MAP

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:20,000
DATE:	14 Sept. 2007

DWG No: 171042 ver.01 | A4 | FIGURE: 5

4. POTENTIAL IMPACTS

4.1. Clearing

Implementation of the project will require disturbance of 230 ha of agricultural land which contains 6ha of isolated remnant trees and 25.6 ha of native vegetation. The vegetation community condition ratings and area identified for clearing are detailed in Table 7, whilst the vegetation areas to be cleared are mapped in Figure 4.

The main botanical values occur within the more intact and less disturbed communities on the eastern edge of the survey area (Figure 2 and Figure 3). These communities will be subject to very little clearing. Ecological linkages in these areas and therefore ecological processes such as reproduction opportunities and dispersal will be maintained. There is a relatively high degree of degradation within the remainder of the communities surveyed and this is reflected in the lack of native species and the presence of introduced plant species.

The vegetation communities as defined by Mattiske and Havel (1998) which occur within the disturbance area are Abba (AB and Aw) and Yelverton (Y and YW). None of the Whicher Scarp (WC) community occurs within the proposed disturbance area.

The bulk of the clearing is in vegetation community E2 (14.9 ha) with a Bush Forever condition of 4 (good). Vegetation community E2 has similarities to floristic community SCP 1a.

The S2 vegetation community, which has a low similarity with the TEC SCP 02, has up to 0.8 ha within the disturbance area requiring clearing. The S2 within the disturbance area is rated as condition 5 (degraded). The degradation of this area is reflected in the lack of native species and the presence of introduced species (Mattiske Consulting Pty Ltd 2007).

The C2 vegetation community, which has a very low level of similarity with TEC SCP 3a occurs over 1 km outside of the disturbance area for the Tutunup South project and will therefore not be cleared.

The northern wetland is within the pit footprint, resulting in the loss of 4.4 ha of M1 vegetation. The other 2.5 ha of M1 is located along the Vasse Highway road reserve. The M1 vegetation community has similarities to floristic community SCP 9. The 2.9 ha of disturbed vegetation is degraded, containing only isolated species, and was therefore not assigned a vegetation community.

Table 7: Areas of Vegetation Identified for Clearing at Tutunup South

Vegetation Community	Bush Forever Condition	Vegetation Area	Area in hectares
E2 – open forest	2 – excellent	62	0.1
E2 – open forest	4 – good	8, 10, 11, 13, 14, 32, 60, 64	14.9
S2 – tall shrubland	5 – degraded	9	0.8
M1 – Melaleuca woodland	4 – good	4	1.4
M1 – Melaleuca woodland	3 – very good	5	3.0
M1 – Melaleuca woodland	5 – degraded	3	2.5
D – Disturbed	5 – degraded	12	2.9
		Total	25.6
Isolated Trees in agricultural paddocks	NA	NA	6
		Total	31.6

The DRF record of *Dryandra nivea* subsp. *Uliginosa* listed on the WA herbarium database was not recorded during the past three surveys. However, the location is outside of the mine's disturbance area.

Whilst most of the priority flora populations identified in field surveys occur outside of the disturbance area, populations of *Gratiola pedunculata, Aotus cordifolia* and *Loxocarya magna,* were located within the disturbance area (Figure 1). The potential for impact on these species is discussed below:

- *Gratiola pedunculata* (P2) was located at the northern wetland, which is within the pit footprint, requiring disturbance. This species is a short lived annual herb, known from only five records in the Cape Arid National Park and southern jarrah forest. It has not been previously recorded in the Busselton/Capel area, representing a significant westward extension of just previously known range (Mattiske Consulting Pty Ltd 2007).

- *Aotus cordifolia* (P3) was identified at the same location as *G. pedunculata*, thus requiring disturbance. This taxon is known from 36 records at the WA Herbarium and occurs on the southern section of the Swan Coastal Plain and Whicher foothills (Mattiske Consulting Pty Ltd 2007). *Aotus cordifolia* (P3) is expected to be rehabilitated from seed and will be targeted during the rehabilitation program. Given this species has been recorded at locations along the Swan Coastal Plain, clearing is unlikely to have a significant impact.

- *Loxocarya magna* (P3) was identified in the gravel reserve immediately south of the Vasse Highway. This location will also require disturbance. *L. magna* has a preference for seasonally inundated soils, with a geographical range extending from Donnybrook to Capel and as far south as the Scott River. This species is known from 18 records at the WA Herbarium (Mattiske Consulting Pty Ltd 2007). *Loxocarya magna* (P3) will also be targeted for rehabilitation through with propagules and cuttings. Given this species has been recorded at locations along the Swan Coastal Plain, clearing is unlikely to have a significant impact.

In addition to these three known locations of priority flora, there is also a WA Herbarium record of *Acacia semitrullata* (P3), north of the southern wetland. This population was not located in recent flora surveying thus is unlikely to still exist. Mattiske Consulting Pty Ltd (2007) have found a further four populations of this species in the vicinity of the project (of which three are in State Forest; Figure 1). In total, there are 62 records of this taxon at the WA Herbarium (Mattiske Consulting Pty Ltd 2007).

Most of the other significant species were recorded at the eastern fringe of the flora survey area (and hence well to the east of the disturbance area). However three species occur within vegetation communities that will be disturbed by the project and may therefore be influenced by mining (Mattiske Consulting Pty Ltd 2007b). All species extend beyond the project area and therefore impacts will be minimal in a regional context:

- *Callistemon glaucus* was recorded at one location in the northern paddocks and will be disturbed. This species is potentially locally significant but can be readily established in rehabilitation areas.
- *Corymbia haematoxylon* occurs in three of the vegetation communities identified for clearing, however is relatively widespread, being present in six of the communities surveyed. The species is locally more dominant in Whicher Scarp communities although in a regional context is relatively restricted. This species is represented outside the proposed mining areas and also northwards along the Whicher escarpment.
- *Taxandria fragrans* occurs both inside and outside of the disturbance area in vegetation communities M1 and S2. The species occurs more commonly in the regional context and therefore any clearing will have minimal impacts on its conservation status (Mattiske Consulting Pty Ltd, 2007b).

4.2. Dewatering

Dewatering is required to access ore in the Yoganup formation. The cone of depression from dewatering is expected to extend beyond the disturbance area, thus potentially impacting the identified GDEs.

Groundwater drawdown impacts on vegetation have been assessed using maximum predicted groundwater drawdown contours and the GDE class. The response curves and risk assessment methodology from Froend, Bowen and Associates (2004) has been adapted to assess risk levels (Table 8). The potential impacts on vegetation associated with the assigned risk level are outlined in Table 9. Table 10 shows the GDE vegetation areas and associated areas at risk of impact. A summary of expected drawdown impacts on the GDE vegetation areas is provided below.

Table 8: Assignment of Risk Category to GDE Class

GDE Class	Groundwater Drawdown Threshold			
	< 0.75	> 0.75	> 1.25	> 1.75
1	Low	Moderate – High	High	High
2	Low	Low – Moderate	Moderate – High	Moderate – High
3	Low	Low	Low	Low – Moderate
4	None	None	None	None

Table 9: Expected Impact

Risk	Expected Impact
Low	No significant change in distribution of species
Low – Moderate	Some evidence of changing distribution of species and encroachment of more drought tolerant species
Moderate – High	Measurable change in the demographics of some species with encroachment of more drought tolerant species
High	Overstorey or Understorey decline and/or loss of species. Greater than 50% reduction in abundance of dominant species. For wetland vegetation possibly complete drying out of wetland basin or reduction in period of inundation.

Table 10: Drawdown Impacts on Vegetation

Vegetation Community	Vegetation Area	Condition	Area in hectares			
			Low	Low – Mod	Mod – High	High
C1 Open Forest	31 (Abba River)	4	12.4			
E2 Open Forest	30	3	21.1			
	34a	4		0.6		
	34b	4	0.9			
E3 Woodland	57 (Woddidup Creek)	3	2.7			
M1 Woodland	6, 7 (southern wetland)	3				5.0
	26	5			3.5	
M2 Open Woodland	51	5				0.3
	19a	5		0.08		
	19b	5	0.3			
S2 Tall Shrubland	46a	3				0.7
	46b	3		0.9		
	46c	3	0.6			
	47	5				0.4
	Total		**38**	**1.58**	**3.5**	**6.4**

Vegetation Area 31 – Vegetation Community C1

This vegetation is located to the east of the project area along the Abba River. Groundwater is likely to be 1 to 2 m below the soil surface and has subsequently been described as a class 1 GDE. Despite the high degree of groundwater dependency, there is no groundwater drawdown in this area. Therefore the risk of impact is low, with no significant changes expected.

Vegetation Area 30 – Vegetation Community E2

This area is located to the east of the Abba River. The majority of the vegetation is likely to have a class 4 GDE classification, although vegetation along the margins of the interface with the C1 vegetation type is likely to have groundwater levels <5 m from surface and would therefore be a class 1 GDE. As no groundwater drawdown is expected for this area, no significant changes are expected.

Vegetation Area 34a, 34b – Vegetation Community E2

The majority of this vegetation area has been classified as a class 4 GDE (no groundwater dependence) whilst the northern margin of this vegetation is likely to warrant a class 3 GDE classification (indicating 20% groundwater dependence) as a consequence of groundwater depth of approximately 5 m. In the Class 3 GDE classification area, vegetation area 34a has a predicted maximum groundwater drawdown is 2 to 2.5 m, resulting in a low-moderate risk. With a low-moderate risk of impact on this vegetation, there is expected to be some evidence of change in species distribution. Vegetation area 34b has <1.75m of predicted maximum drawdown and therefore risk is low with no changes expected.

Vegetation Area 57 – Vegetation Community E3

This vegetation area is along Woddidup Creek to the south of the disturbance area. At its closest, the vegetation community is 150 m south of the pit and has been classified as a class 1 GDE (80% groundwater dependent). It is expected that the maximum groundwater drawdown is 0.4 m, inferring a low risk of impact on this vegetation community. Thus no significant changes are expected.

Vegetation Areas 6 & 7 – Vegetation Community M1

Vegetation areas 6 & 7 comprise the vegetated areas of the southern wetland. Mining will occur up to the edge of the southern wetland, enabling it to be physically preserved. However, being at the edge of the pit, the hydrology of this wetland is likely to be significantly altered. The groundwater levels are 1 – 2 m below the soil surface, making this vegetation a class 1 GDE (80% reliance on groundwater).

Groundwater drawdown is expected to be up to 4 m for up to nine months during mining, with a 1 m drawdown persisting for at least two years. Thus the southern wetland community is expected to be at high risk of impact. Changes likely to be encountered include a >50% reduction in abundance of dominant species and/or significant change in dominant populations, reduced periods of inundation and possibly complete drying out of the wetland basin.

Vegetation Area 26 – Vegetation Community M1

This remnant vegetation along the verge of the Ludlow – Hithergreen Road is likely to have groundwater levels within 3 m of surface, making this vegetation a class 1 to 2 GDE (50 to 80% dependence on groundwater). Groundwater drawdown has been modelled to the order of between 0.5 and 0.75 m in this area. As a consequence there is a moderate to high risk of impact to this vegetation from dewatering. This is likely to be manifest as a measurable change in species distribution.

Vegetation Area 51 – Vegetation Community M2

Groundwater levels are approximately 2 to 3 m below the soil surface, making this vegetation a class 1 GDE (80% dependence on groundwater). Maximum groundwater drawdown of 2 to 2.5 m is predicted to occur in this area. Thus, there is a high risk of impact on this vegetation, which is expected to result in both overstorey and understorey decline and/or loss of species.

Vegetation Area 19a, 19b – Vegetation Community M2

This vegetation area has GDE classifications varying from class 2 to class 4. A maximum groundwater drawdown of 0.75m is expected giving the class 2 (19a) areas a low-moderate risk of impact. No impacts are likely to occur further upslope (19b) from the disturbance boundary as groundwater dependence reduces significantly.

Vegetation Areas 46a, 46b, 46c, 47 – Vegetation Community S2

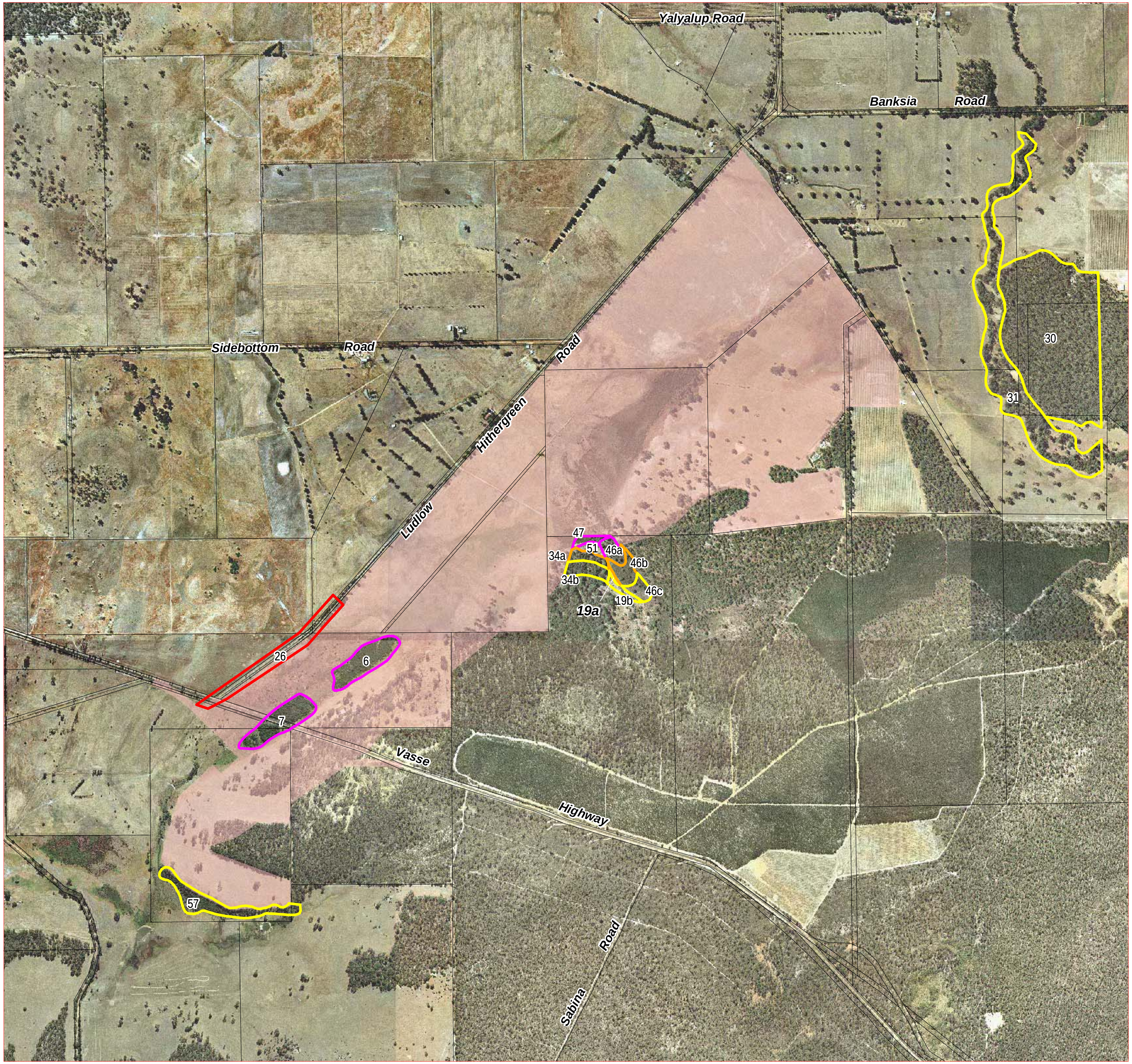
These vegetation areas are associated with a creekline on the eastern margin of the disturbance area. The depth to groundwater underlying this vegetation increases with distance from the disturbance boundary. Thus it is a class 1 GDE adjacent to the disturbance boundary and a class 4 GDE classification upslope on the Whicher Scarp.

Groundwater drawdown has been predicted to be 2 to 2.5 m along the northwestern margin of this vegetation, resulting in a high risk of impact on the vegetation area immediately adjacent to the disturbance boundary (46a and 47). This is likely to result in measurable changes in species distribution with encroachment of more drought tolerant species to replace those in decline. There is a low – moderate risk on vegetation area 46b resulting in some evidence of changing distribution of species and encroachment of more drought tolerant species. Low impacts are expected in vegetation area 46c with no impacts further upslope as groundwater dependence reduces significantly.

Priority and Significant Species

With the exception of the three species identified within the disturbance area for clearing, all other priority flora locations are at groundwater levels in excess of 15 m below surface and are thus not groundwater dependent (SWC 2007).

Of the other significant vegetation noted, *Corymbia haematoxylon* was recorded regularly in six of the 12 communities mapped, including several community types with risk of impact from drawdown. Drawdown will not have a significant impact on this species, as the species is locally widespread. No other significant flora was located within the areas at risk of drawdown impact.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S	D.G.S	14.09.07	Original Design
01	S.J	T.L.G	10.04.08	Update of legend items

Legend

Disturbance area

Groundwater dependent ecosystems

Potential Risk

- Low
- Moderate
- Moderate - High
- High

Date of photography: 2001

Vegetation Community	Vegetation Area	Vegetation Condition	Impact Risk	Hectares
C1	31	4	Low	12.4
E2	30	3	Low	21.1
	34a	4	Moderate	0.6
	34b	4	Low	0.9
E3	57	3	Low	2.7
M1	6	3	High	2.4
	7	3	High	2.6
	26	5	Moderate - High	3.5
M2	51	5	High	0.3
	19a	5	Moderate	0.08
	19b	5	Low	0.3
S2	46a	3	High	0.7
	46b	3	Moderate	0.9
	46c	3	Low	0.6
	47	5	High	0.4

N

0 500 1,000 m

ILUKA

TUTUNUP SOUTH

GROUNDWATER DEPENDENT ECOSYSTEMS

RISK OF IMPACT

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:15,000
DATE: 10 Apr. 2008

DWG No: 176497 ver.01

A3 FIGURE: 6

4.3. Assessment of Vegetation Impacts

Given consideration of direct (clearing) and indirect (groundwater drawdown) impacts as outlined in Sections 4.1 and 4.2 the maximum potential impact on vegetation communities is outlined in Table 11.

Table 11: Assessment of Vegetation Impacts

Vegetation Community	Condition	Area Surveyed (ha)	Clearing (ha)	Groundwater Drawdown (ha) *	Total Impact Area	% of Area Surveyed
B1 Woodland	2	5.7	0	0	0	0
C1 Open Forest	4	12.4	0	0	0	0
C2 Woodland	4	6.1	0	0	0	0
C3 Woodland	5	12.6	0	0	0	0
D Degraded	5	9.9	2.9	0	2.9	29%
E1 Open Forest	2 – 5	188.9	0	0	0	0
E2 Open Forest	2 – 4	136.1	15	0.6	15.6	11.5%
E3 Woodland	3	2.7	0	0	0	0
M1 Woodland	3 – 5	17.2	6.9	8.5	15.4	89.5%
M2 Open Woodland	5	5.3	0	0.38	0.38	7%
S1 Low shrubland	2 – 3	20.8	0	0	0	0
S2 Tall shrubland	3 – 5	7.0	0.8	2	2.8	40%
TOTAL		**424.7**	**25.6**	**11.48**	**37.08**	

* Area > low-moderate as shown in Table 10.

None of the B1, C1, C2, C3, E1, E3 or S1 vegetation communities will be impacted by the proposal.

Less than 12% of the varying condition E2 vegetation communities surveyed will be impacted. This community is well represented on the Swan Coastal Plain (Mattiske Consulting Pty Ltd 2007).

A total of 40% of the M1 vegetation community within the area is within the disturbance area. A further 49.5% of this varying condition community is at risk of indirect impact through potential groundwater drawdown. This community is locally not restricted and is well represented on the Swan Coastal Plain (Mattiske Consulting Pty Ltd 2007).

Of the degraded M2 community present within the survey area, none occurs within the disturbance area, though approximately 7% is at low or low to moderate risk of impact from groundwater drawdown. The M2 community is well represented on the Swan Coastal Plain (Mattiske Consulting Pty Ltd, 2007).

The S2 vegetation community within the survey area ranges in condition from 3 to 5. 11% of the surveyed S2 community is within the disturbance area and 28.5% is at varying levels of risk of impact from groundwater drawdown. This community is also present in other areas of the Swan Coastal Plain (Mattiske Consulting Pty Ltd 2007).

4.4. Weeds

As a Declared Plant under the *Agriculture and Related Resources Protection Act*, the Arum Lily and Cape Tulip have the potential to spread if seeds or root stock are transferred from contaminated machinery leaving Tutunup South. As a P1 and P4 weed in the Capel Shire, obligations are imposed on Iluka, as the landowner, to treat the plant to eradication on its land, and to prevent its spread offsite.

4.5. Dieback

Most of the site is on agricultural land, which is both uninterpretable and unprotectable for dieback. The State Forest and Gravel Reserve is mostly infested, although with some areas that are uninfested and protectable. If mobile machinery is not controlled when operating between protectable forest and unprotectable areas, there is the potential to infest the remnant dieback free areas. The project involves disturbance to both unprotectable (infested) areas and a small area of protectable (uninfested) native vegetation (at the southern end of the project).

4.6. Fire

There is the potential for fires to start within the disturbance area, which in a worst case scenario could spread to the adjacent State forest.

4.7. Summary

Potential impact to vegetation present has been considered in respect of the criteria outlined in Guidance Statement 10 (EPA, 2006c), as outlined in Table 12.

Table 12: Summary of potential impacts in respect to GS #10 criteria

Criterion	Consideration in regard to natural areas at Tutunup South
Representation of ecological communities	The project involves clearing of 25.6 ha of native vegetation and 6 ha of trees in paddock; and 11.6 ha of vegetation at greater than low risk of impact from drawdown. Very little disturbance is proposed within the more intact Whicher Scarp communities on the eastern edge of the survey area. No impact is proposed to community C1, which has very low similarity to TEC SCP 3a. No impact is proposed to community S1 which has low similarity to SCP 02 and a total of 2.8 ha of S2 vegetation (low similarity to SCP 02) is expected to be impacted.
Diversity	The diversity of vegetation and flora occurring in the region will not be altered by the project.
Rarity	Three priority flora species have been identified during site surveys as occurring within the disturbance area. Three other significant species occur within the disturbance area, though all three extend well beyond the disturbance area.
Maintaining ecological processes or natural systems	Very little clearing is proposed within the more intact Whicher Scarp communities on the eastern edge of the survey area and therefore ecological processes within these areas will be maintained. In the remainder of the disturbance area, the high degree of disturbance currently existing means that ecological linkages and

Criterion	Consideration in regard to natural areas at Tutunup South
	therefore ecological processes are currently highly disturbed, with small areas of remaining wetland vegetation being isolated by surrounding clearing. The proposal is not expected to impact on ecological processes.
Protection of wetlands and streamline vegetation	The isolated areas of wetland vegetation remaining will be impacted by the proposal. The northern wetland is proposed to be removed and replaced during rehabilitation. The new northern wetland will be designed to replicate the M1 community previously present (see section 13). The southern wetland vegetation has been excised from mining, however risk of impact from groundwater drawdown remains. The risk of impact to this wetland area will be minimised by management of water levels (see section 9.5.4). During rehabilitation, the condition of this wetland area will be improved and a native vegetation corridor linking this wetland to the State Forest will be developed. Woddidup Creek, outside of the disturbance area will be protected from impact by bunding.
Scientific or evolutionary importance	The investigations carried out at Tutunup South did not find species or habitats that are of scientific or evolutionary importance, therefore the proposal will have not impact on this criterion.

In summary, it is considered that the proposal will not have significant impact to the representation of ecological communities, diversity, rarity, maintenance of ecological processes and natural systems, or scientific or evolutionary importance of the region. This is largely due to the existing degraded nature of the site and the design of the proposal to avoid the more intact areas which retain higher natural values wherever possible. Impact to the small, isolated areas of wetland that remain vegetated is expected, however rehabilitation measures are aimed to provide long term benefit to these areas, particularly in relation to restoring linkage between the southern wetland and the State Forest.

5. MANAGEMENT

5.1. Clearing Controls

Iluka has sought to minimise clearing of native vegetation when designing Tutunup South. Preservation of the southern wetland is an example of avoiding clearing impacts wherever possible. Whilst there is unlikely to be scope to further reduce clearing, review of plans and designs will further continue to aim at minimising the project's clearing footprint.

Whilst clearing is necessary for the development of Tutunup South, Iluka uses controls to prevent unplanned, excessive or unapproved clearing. Iluka will conduct its clearing operations at Tutunup South using these same controls as it does at other operations. At Tutunup South the southern wetland boundaries will be bunded and sign-posted to prevent unapproved clearing of these areas. Fencing or bunding will also be erected along the disturbance boundary, preventing access to State forest and disturbing vegetation. This also provides site security and dieback management advantages. In the vicinity of Woddidup Creek, a setback, fencing and the use of grassed topsoil stockpiles, is proposed to protect the area from inadvertent access.

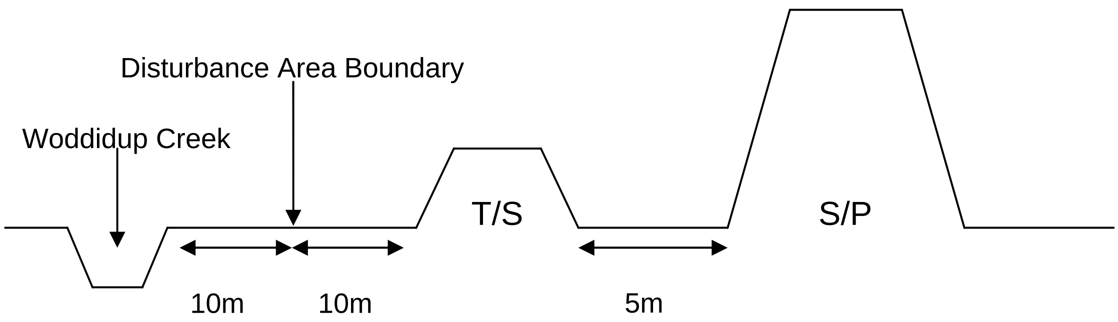


Figure 7: Setback from Woddidup Creek

Rehabilitation will be conducted as soon as practicable after areas have been completed. This assists to maximise the recruitment from soil stored seed in rehabilitation.

5.2. Groundwater Dependent Ecosystems

Detailed soil hydrology studies on areas of greater than low-moderate impact are underway and mitigation strategies will be implemented to minimise impacts where possible. It is anticipated at this stage that residual impacts will remain.

5.2.1. Vegetation Areas 6 & 7

The wetland has a high risk of impact. It is proposed that the vegetation areas will be bunded to separate from mining. It is proposed to install an inlet and outlet into the wetland to allow the area to be periodically flooded with water to mimic winter conditions. Further details on mitigation and management strategies will be developed following detailed studies. Due to the close proximity of the pit it is anticipated that residual impacts to this wetland will remain as high.

On completion of mining this wetland area will be infill planted with local native species, weed control undertaken, fenced off from grazing and a vegetated corridor link created to the State Forest. This is detailed further in the Preliminary Closure and Rehabilitation Plan.

5.2.2. Vegetation Areas 19a, 34a, 46a, 46b, 47, 51

The creekline vegetation represented by these vegetation areas has a low-medium to high risk of impact. It is anticipated that residual risk will remain as low-medium to high. Given the high degree of conservatism applied in both the soils and groundwater assessments it is considered that monitoring of impacts and commitment to revegetate if impacts eventuate is suitable for this area.

5.2.3. Vegetation Area 26

The roadside vegetation represented by vegetation area 26 has a moderate-high risk of impact. It is anticipated that residual risk will remain as medium to high. Given the high degree of conservatism applied in both the soils and groundwater assessments it is considered that monitoring of impacts and commitment to revegetate if impacts eventuate is suitable for this area.

5.3. Weeds

All Arum Lily and Cape Tulip populations within the disturbance area will be controlled prior to the commencement of mining. If these or any other declared weed establishes during the operation or in rehabilitation, it will be removed as required.

5.4. Dieback

Dieback boundaries have been marked in the field with bright orange flagging tape to clearly delineate boundaries between infested and non-infested areas. Vehicles and machinery that need to move from uninterpretable or disease infested into uninfested forest areas will be cleaned down at the dieback boundary before entering the disease free area.

Topsoils will be stripped and placed according to the forest hygiene classification. Dieback infested and uninfested soils will be segregated during stripping and placement to prevent the spread of dieback.

5.5. Fire

There will be little grassed area in Tutunup South during the project, resulting in a low potential for fire to spread. Nevertheless, Iluka will ensure firebreaks are installed in accordance with the requirements of the Shire of Busselton. Members of the site team will be trained to combat both grass and forest fires. Iluka will allow access and provide support to other authorities such as DEC and FESA in the event of a forest fire in the State Forest.

6. MONITORING

6.1. Vegetation Monitoring

The permanent vegetation plots installed in the M1 (southern wetland – 4 plots) and S2 vegetation communities (1 plot) will be monitored annually to determine if dewatering has influenced the condition of vegetation and floristic composition. The location of the permanent monitoring plots is shown on Figure 4. Should changes in the M1 and S2 communities be observed, communities C1, E2, E3 and M2 identified as areas of potential impact will also be monitored. Control sites will be established in the M2 and S2 communities further from the disturbance area and baseline monitoring of these sites will be conducted in 2008, prior to mining commencing in early 2009.

Rehabilitation will also be monitored consistent with Iluka's established monitoring programmes as described in the Rehabilitation Management Plan.

6.2. Weeds

The re-emergence of the Arum Lily and Cape Tulip within the project area will be opportunistically monitored and eradicated during the mining and rehabilitation phases.

6.3. Dieback Monitoring

The remnant forest areas of the project will be mapped for dieback prior to commencing on site and every second year during the operations. Dieback monitoring will aim to determine if the *Phytophthora cinnamomi* has spread and to adjust management boundaries where appropriate.

7. CONTINGENCY PLANS

In the event that it is found that there has been an adverse impact to vegetation, and that the impact is attributable to mining, restoration activities will be undertaken, as agreed with the DEC.

If the Arum Lily or Cape Tulip is found during the operational phase of the project or in rehabilitation, actions will be taken to destroy the weed as soon as practicable.

8. REPORTING

The results of monitoring programmes will be reported annually in the Annual Environmental Report (AER).

9. REVIEW AND REVISE

This management plan will be reviewed to assess its suitability, adequacy and effectiveness in meeting the set objectives annually, or more frequently as deemed necessary by Iluka. Where necessary, the plan will be revised and revisions will be submitted to the DEC for approval.

10. KEY MANAGEMENT ACTIONS TABLE

Table 13: Key Management Actions

Key Management Actions	**Evidence of demonstration**
Clearing boundaries surveyed in the field with flagging tape	Flagging tape present
Install fencing or bunding around the disturbance area	Structure installed
Conduct rehabilitation as soon as practicable after mining	Rehabilitation progress reported annually in the Annual Environmental Report
Ongoing treatment of Arum Lily, Capel Tulip and any other Declared Plants prior to commencement of, and during mining and rehabilitation	Records of weed extermination
Stockpile dieback infested and uninfested topsoils separately	Record of dieback status of each stockpile
Install firebreaks in accordance with the requirements of the Busselton Shire	Firebreaks installed

11. REFERENCES

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Webb A, Keighery BJ, Keighery GJ & Longman V (2006) *A Preliminary Consideration of Whicher Scarp Foristic Patterns.*

12. DOCUMENT CONTROL

Revision	Reviews/changes	Create date
A	First Draft	20 August 2007
B	Incorporated comments from LKS	25 August 2007
C	Incorporated further comments from E Mattiske and LKS	28 August 2007
D	Incorporated comments from RB and NMc	9 September 2007
E	Incorporated comments from group review	14 September 2007
F	Incorporated comments from external review and 2007 spring survey	16 November 2007
G	Revised following EPASU review	10 April 2008

Appendix 2

Native Fauna Management Plan

ILUKA

Iluka Resources Limited

Native Fauna Management Plan

Tutunup South Mineral Sands Project

April 2008

ILUKA-TR-T15789

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1. INTRODUCTION

This plan relates to the management of fauna impacts at the proposed Tutunup South mine. This plan has been developed in conjunction with the Public Environmental Review (PER) impact assessment document. Implementation of this plan and compliance during operations is a commitment of the PER document.

2. ENVIRONMENTAL OBJECTIVE

The objective of this plan is to minimise the impact of mining activities on the fauna at Tutunup South.

3. PRE-MINE ENVIRONMENT

The Tutunup South site is located at the foot of the Whicher Scarp on mostly agricultural land, 15 km southeast of Busselton. The project also extends into forested areas on its southeastern side which includes both private and State forest and a gravel reserve vested with the Shire of Busselton.

As part of establishing the fauna baseline at Tutunup South, Iluka have commissioned the following studies over the project area:

- Ninox Wildlife Consulting (2006) – Fauna review and site assessment;
- Biota (2007a) – Baseline fauna surveys including trapping;
- Biota (2007b) – Seasonal fauna survey;
- Johnstone, Johnstone and Kirkby (2007) – Habitat and site observations for Black Cockatoos; and
- Wetland Research and Management (2006) – Wetland study which included observations of aquatic fauna.

Ongoing site observations by Johnstone, Johnstone and Kirkby have been conducted for cockatoo's.

3.1. Vegetation and Fauna Habitat

Whilst a separate Flora, Vegetation and Dieback Management Plan has been developed for this project, any discussion of fauna habitat cannot be made without some reference to vegetation communities. Based on a flora and vegetation study conducted by Mattiske Consulting Pty Ltd (2007), 11 habitat types have been identified by Ninox Wildlife Consulting (2006), which were subsequently simplified to three types by Biota (2007a). The integration of vegetation and habitat types is presented in Table 1.

Table 1: Vegetation Community Descriptions for Fauna Habitats at Tutunup South

Vegetation Mapping Code (Mattiske Consulting Pty Ltd 2007)	Vegetation Community Description	Fauna Habitat Number Ninox Wildlife Consulting (2006)	Biota Primary Fauna Habitat Type (2007a)
E1	Open Forest of *Eucalyptus marginata* subsp. *marginata – Corymbia haematoxylon* with *Banksia grandis* and *Banksia attenuata* over *Xanthorrhoea preissii*, *Podocarpus drouynianus*, *Stirlingia latifolia*, *Melaleuca thymoides* and *Dasypogon hookeri* over *Anarthria scabra* and *Phlebocarya ciliata* on gravelly sandy loams on middle to upper slopes of the Whicher Range escarpment.	1	Open Jarrah/Marri Forest
E2	Open Forest of *Eucalyptus marginata* subsp. *marginata – Corymbia calophylla* with *Banksia grandis* and *Xanthorrhoea preissii* over *Hibbertia hypericoides* on gravelly sandy loams on lower slopes of the Whicher Range escarpment.	1	Open Jarrah/Marri Forest
E3	Woodland of *Eucalyptus patens*, *Taxandria linearifolia* (ms) and *Astartea scoparia* over *Gahnia decomposita, Lepidosperma tetraquetrum* and *Cyathochaeta avenacea* on loam soils.	2	-
B1	Woodland of *Banksia attenuata* over *Beaufortia squarrosa*, *Adenanthos meisneri*, *Melaleuca thymoides*, *Stirlingia latifolia* and *Melaleuca trichophylla* on sandy soils.	3	-
C1	Open Forest of *Corymbia calophylla* over *Taxandria linearifolia* (ms) and *Astartea scoparia* over mixed sedges on flowlines.	4	-
C2	Woodland of *Corymbia calophylla* over *Xanthorrhoea preissii* and *Kingia australis* on loam soils.	4	-
M1	Woodland of *Melaleuca rhaphiophylla* and *Melaleuca preissiana* with *Taxandria linearifolia* (ms), *Astartea scoparia* and *Acacia divergens* over *Cyathochaeta avenacea* and mixed sedges and rushes on clay-loam soils.	5	Melaleuca wetland surrounded by pasture
M2	Open Woodland of *Melaleuca preissiana* with *Kunzea ericifolia*, *Xanthorrhoea preissii* and *Baxteria australis* on sandy-loam soils.	5	Melaleuca wetland surrounded by Jarrah/Marri Forest
S1	Low Shrubland of *Melaleuca thymoides* and *Beaufortia squarrosa* over *Kunzea micrantha* subsp. *micrantha, Stirlingia latifolia, Callistemon glaucus, Dasypogon bromeliifolius* with emergent *Allocasuarina fraseriana, Nuytsia floribunda, Banksia attenuata* and *Xanthorrhoea preissii* on sandy loam soils.	6	-
S2	Tall Shrubland of *Taxandria linearifolia* (ms), *Taxandria fragrans* (ms), *Astartea scoparia, Kunzea recurva, Pericalymma spongiocaule* over *Cyathochaeta avenacea* on sandy-loam soils.	7	Melaleuca wetland surrounded by Jarrah/Marri Forest
C3	Woodland of *Corymbia calophylla* over pasture on loam soils.	8	-
P	Pine Plantation.	9	-
-	Open water in very small soak (no surrounding native vegetation).	10	-
CL	Cleared pasture.	11	-

Most of the Tutunup South project area has been cleared for agricultural purposes, which abuts the Abba State forest block on the southeast side. Within the project area are two areas of vegetated multiple use wetlands considered to be of conservation value (WRM 2006). The northern wetland (vegetation community M1; wetland T1 in WRM 2006) has been previously fenced to exclude stock from the remnant vegetation and fauna habitat. It is currently isolated from the State Forest boundary by approximately 500 m. In contrast, the southern wetland (vegetation community T2 in WRM 2006) is more degraded and is isolated by 100 m of cleared land before the State Forest boundary.

Ninox (2006) noted that there were no fauna habitats of particular significance present within the survey area and no significant corridors of vegetation connecting Whicher Scarp vegetation with remnant Swan Coastal Plain vegetation. Biota (2007b) noted that the study area had a relative lack of habitat diversity, resulting in reduced avifauna numbers, with the habitats present largely lacking widespread features such as understorey vegetation, leaf litter and other debris. This is noted to be a contributor to the low numbers of species recorded in the surveys.

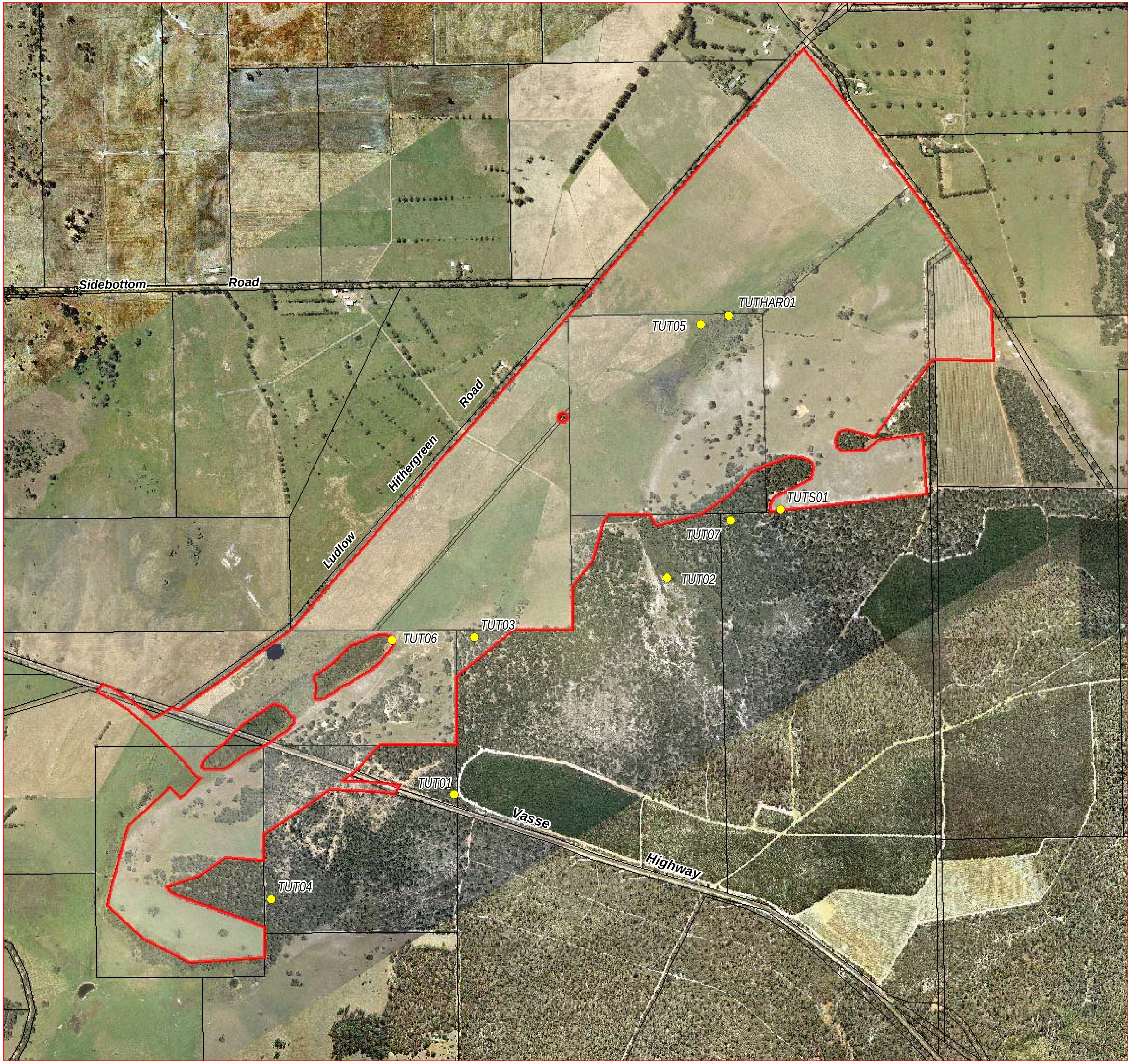
3.2. Baseline Fauna

During the initial Biota (2007a) fauna survey, seven survey grids were installed over the three primary habitats (Figure 1). This yielded 86 native vertebrate species, comprising of 52 native bird species, 13 mammal species and 21 herpetofauna species (Table 2). In November 2007, the seasonal survey found 79 native vertebrate species, comprising of 56 bird species, 4 mammal species and 19 hereptofauna species. When added to observations made by Ninox Wildlife Consulting (2006) and WRM (2006) the number of native vertebrate species recorded increased to 53 bird species, 13 native mammals, 23 herpetofauna, and two native fish species (Appendix 1).

Table 2: Summary Vertebrate Groups Recorded During Site Surveys

Fauna Group	Biota Species Recorded			Ninox Additional Species Recorded	WRM Additional Species Recorded	Total Species Recorded	Ninox Potential Species but not Recorded	Total Potential and Recorded Species
	I*	S**	Total					
Native Avifauna	52	56	68	1	0	**69**	31	100
Introduced Avifauna	1	1	1	-	-	**1**	1	2
Native Mammals	13	4	13	-	-	**13**	9	22
Introduced Mammals	2	2	3	-	-	**3**	4	7
Amphibians	3	4	5	-	2	**5**	6	11
Reptiles	18	15	21	-	-	**21**	18	39
Fish	-	-	-	-	2	**2**	-	2
Total Native Species	86	79	107	1	4	**110**	64	174
Total Species	89	82	111	1	5	**114**	69	183

*I = Initial Biota fauna survey (February 2007); **S = Seasonal Biota fauna survey (November 2007)



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS

Legend

- Fauna survey site
- Disturbance area

Date of photography
Inset: 19 Nov. 2007 Regional: 2001

N

0 250 500 m

ILUKA

TUTUNUP SOUTH

FAUNA SURVEY LOCATIONS

ORIG: L Sadler
DRAWN: D.G.S.
SCALE: 1:12,500
DATE: 14 Sept. 2007
DWG No: 176773 ver.00
A3
FIGURE: 1

3.2.1. Avifauna

A total of sixty-nine species, including twent-eight non-passerines and forty-one passerines, were recorded during the initial and seasonal phases of the Tutunup South survey. The Australian Raven and Grey Fantail were the most prevalent avifauna species present, a result consistent with the project being at the interface between forest and agricultural systems. The most speciose family present was the Parrots (Pssittacidae) and the Honeyeaters (Melphagidae), each represented by eight species. Thornbills (Acanthizidae) were also abundant, with 315 records from five species.

The M2/S2 vegetation communities, and the northern wetland in the M1 vegetation community were the most speciose habitats and experienced the highest number of individuals recorded.

The noted absence of waterfowl in the survey was most likely to be a reflection of the lack of standing water bodies at the time of the surveys. However WRM (2006) did record a Straw Necked Ibis (*Threskiornis spinicollis*) during the wetland study.

3.2.2. Mammals

The Western Grey Kangaroo (*Macropus fuliginosus*), was the most dominant mammal recorded during the survey followed by the House Mouse (*Mus musculus*). Of the flightless mammals (non-volants), the Dasyuridae family recorded the most species, with three species recorded. Four species from the bat family Vespertilionidae were recorded, thus making this the family with the greatest number of species.

Three introduced species were also observed; the Rabbit (*Oryctolagus cuniculus*), the Domestic Dog (*Canis familiaris*) and the House Mouse (*Mus musculus*) (Biota 2007d).

The non-volant inventory of ten species at Tutunup South was similar to that found during the Iluka Yoganup 215 study (Biota 2007b). Biota (2007a) considered this to be a reasonable result reflecting that the habitats generally lacked understorey vegetation, leaf litter and debris that forms habitat.

3.2.3. Herpetofauna

Five frog species and 21 reptile species were recorded during the Biota survey (2007d). WRM also recorded seven amphibian species, according to the 2006 report. The most abundant species recorded were the Moaning Frog (*Helioporous eyrei*) and *Crinia georgiana*. The most speciose family present was the Scincidae with 13 species recorded during the survey. The herpetofauna at this site was less diverse than the nearby Yoganup 215 survey site. Biota (2007a) suggested that a lack of suitable microhabitats for herpetofauna, such as understorey vegetation, leaf litter and other debris, limited the number of species present.

3.2.4. Fish

Whilst conducting the wetland study, WRM (2006) noted the presence of two species of native fish in the creekline to the south of the disturbance area. The Western Minnow (*Galaxias occidentalis*) and Nightfish (*Bostockia porosa*) are common, ubiquitous and widely distributed throughout southwestern Western Australia. In terms of abundance, the Western

Minnow was described as common, whilst the Nightfish was described as present (WRM 2006). No fish were located in either of the wetlands located in the disturbance area.

3.2.5. Aquatic Invertebrates

Macroinvertebrate and microinvertebrate sampling from the two wetlands and creekline in November 2005 found a total of 98 taxa, dominated by the Insecta (61%). Whilst most of the species present were considered by WRM (2006) to be cosmopolitan in distribution, only 14 species were recorded at all three sampling sites (consisting of amphipods, chironomids, *Diptera* species and coleopteran beetles. A further 19 taxa were found at two sites and 65 being found at only one site. A high proportion of single species collected is common in studies of freshwater systems (WRM 2006). Species richness was similar at both wetland sites (54 species), and whilst the creekline recorded less species, this was due to macroinvertebrates not being collected from the creekline. Excluding macroinvertebrates from the wetlands, the creekline has a similar diversity to the wetlands. Despite this, the species structural composition was different between the lentic (wetland) and lotic (creekline) systems.

Amongst the 98 invertebrate taxa sampled, most were believed to be tolerant of a wide range of environmental conditions, and are frequently encountered within freshwater systems in Western Australia.

Species new or potentially new to science and/or new records for Western Australia have been defined by WRM (2006) as "rare". The existence of 'rare', restricted or endemic species was determined by taxa lists from the University of Western Australia database, the CALM Wildlife Conservation (Specially Protected Fauna) Notice and the IUCN Red List of Threatened Species.

Four aquatic macroinvertebrate species found during the 2005 survey were considered by WRM (2006) to be 'rare':

- the rotifer, *Lepadella oblonga* in the southern wetland (T2) was the first recording of this species in Western Australia, and the second record of the taxon in Australia (Figure 2). Its only other record is from a Goulburn River billabong in Victoria;
- the notommatid rotifer *Cephalodella n*. sp from the southern wetland (Figure 3). This species has not been previously described;
- the cyclopoid copepod *Paracyclops n*. sp in the northern wetland (T1; Figure 4). This taxon is analogous to CALM sp. 2, thus has been previously recorded but is yet to be described; and
- an indeterminate Difflugiidae Rhizopod in the northern wetland (Figure 5). Whilst this species is also yet to be described, it has been previously recorded in the Iluka Burekup survey.

Encountering new taxa in surveys such as that conducted for Tutunup South is not uncommon and reflects a paucity of data relating to invertebrate fauna in the southwest of Western Australia.

A further notable taxon recorded during the survey was the synthemistid dragonfly *Archaeosynthemis leachii* at the creekline site T3. This species is a Gondwanic or relict insect which has survived in the southwest despite climatic and environmental change. This taxon is uncommon and has a restricted distribution.

WRM undertook additional sampling of aquatic invertebrates of Tutunup South whilst surveying nearby wetlands in November 2007. Preliminary results indicate that of the ten surveyed wetland sites, eight had 'rare' aquatic microinvertebrates located within them. It should also be noted that the 2007 Tutunup South wetland samples included only one of the four 'rare' species recorded from the 2005 samples, and that the 2007 samples found two species not recorded in 2005. The other wetlands sampled also generated new 'rare' species unique to that wetland.

Table 3 details the 'rare' microinvertebrate species types and location found within Tutunup South and the surrounding wetlands.

Table 3: Microinvertebrate species identified as 'rare'

Taxa		**Burekup**		**Elgin**	**Gavin's Road**	**Tutunup South**		**Yoganup South**	**Yoganup 'Carter's'**
		B3	B9	E1		T1	T2	Y7	Y8
RHIZOPODA									
Centropyxidae	*Centropyxis* n. sp.						2007	2007	2007
Difflugiidae	*Difflugia* potential n. sp.	2007							
	Difflugia n. sp.		2005			2005 2007	2007	2007	2007
ROTIFERA									
Unknown	Rotifer n. sp.							2007	2007
Dicranophoridae	*Dicranophoroides caudatus* NR for WA	2005							
Hexarthridae	*Hexarthra* cf. *intermedia* n. sp.								2007
Lepadellidae	*Lepadella oblonga* NR for WA			2005			2005		
Notommatidae	Cephalodella n. sp.						2005		
	Resticula melandocus NR for WA								200
Trochosphaeridae	*Filinia* cf. *passa* NR for WA	2005				2007	2007		
CLADOCERA									2007
Chydoridae	*Alona* cf. *rectangular novaezealandie* pot.n.	2007							
	Alona sp. pot.n.	2007							
	Alona sp. pot.n.				2007				
Daphniidae	*Ceriodaphnia* n.sp.	2007							
COPEPODA									
Cyclopoida	*Paracyclops* n.sp.					2005			

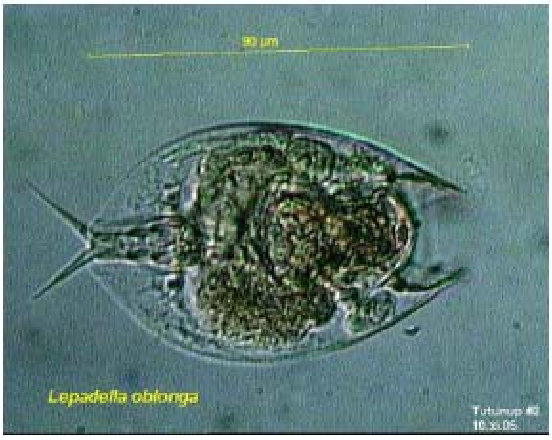


Figure 2: *Lepadella oblonga* (photo Russ Shiel)

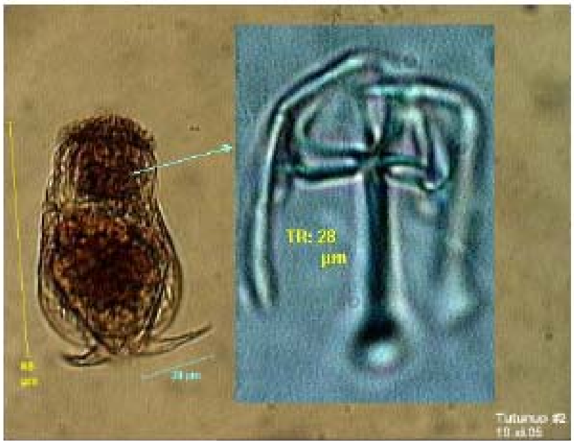


Figure 3: *Cephalodella* n. sp (photo Russ Shiel)

Figure 4: *Paracyclops n.* sp (photo Russ Shiel)

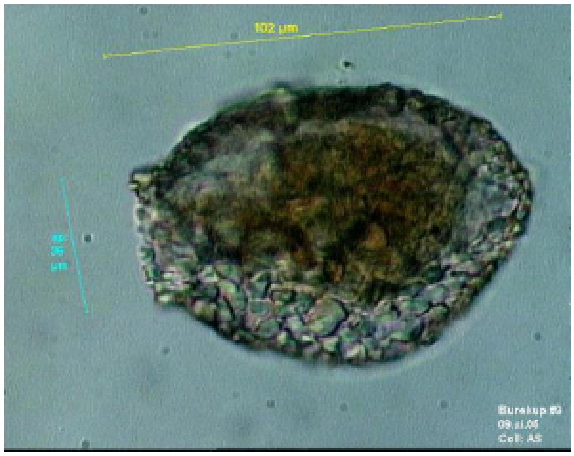


Figure 5: Difflugiidae Rhizopod (photo Russ Shiel)

3.2.6. Invertebrate Short Range Endemic (SRE) Fauna

During the Biota (2007a) study, focus was also directed to the range of invertebrates with naturally small distributions. Such fauna are characterised by poor dispersal capabilities, confinement to disjunct habitats and/or low capability for producing offspring. Despite targeted searching, only four species were collected, being two pseudoscorpion and two scorpion species. None of these taxa were considered to be SRE taxa (Dr M Harvey, WA Museum pers comm.; cited in Biota, 2007a).

3.3. Species of Significance

Through the course of surveying and assessments at Tutunup South, several species were noted as significant as they were listed for one or more of the following reasons:

- Endangered or Vulnerable under the EPBC Act;
- JAMBA and/or CAMBA treaties;

- Scheduled species under the *Wildlife Conservation Act;*
- DEC's Priority Fauna List;
- Other significant species eg Southwest endemics; or
- Invertebrate species considered rare or notable by WRM (2006)

Table 4 identifies 13 species that have some form of statutory recognition as being of significance. Of these 13 species, six were recorded during the Biota (2007a) fauna survey (by either trapping, or other evidence of their presence). Of most significance was the presence of Carnaby's Cockatoo (*Caylptorhynchus latirostris*) and Baudin's Cockatoo (*Calyptorhynchus baudinii*). These are listed under the EPBC Act as "Endangered" and "Vulnerable" respectively. The species listed under Commonwealth or State protection in Table 4 are further discussed in Section 4.

Table 4: Potentially Occurring or Recorded Fauna of Significance

Species	**Records During Survey**	**Level of Protection**		**Other Reason for Significance**
		State	**Commonwealth**	
Carnaby's Cockatoo *Calyptorhynchus latirostris*	3	Schedule 1	Endangered	
Baudin's Cockatoo *Calyptorhynchus baudinii*	28	Schedule 1	Vulnerable	
Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*	13	Schedule 1		
Chuditch *Dasyurus geoffroii*	Potential	Schedule 1	Vulnerable	
Brush-tailed Phascogale *Phascogale tapoatafa tapoatafa*	Potential	Schedule 1		
Western Ringtail Possum *Pseudocheirus occidentalis*	Potential	Schedule 1	Vulnerable	
Quokka *Setonix brachyurus*	Potential	Schedule 1	Vulnerable	
Peregrine Falcon *Falco peregrinus*	Potential	Schedule 4		
Carpet Python *Morelia spilota imbricata*	Potential	Schedule 4		
Western False Pipistrelle *Falsistrellus mackenzei*	Evidence of species present	Priority 4		
Southern Brown Bandicoot (Quenda) *Isoodon obesulus fusciventer*	2	Priority 5		
Lined Skink *Lerista lineata*	Potential	Priority 3		
Western Brush Wallaby *Macropus irma*	Potential	Priority 4		
Rainbow Bee-eater *Merops ornatus*	4		EPBC Migratory Species and	

Species	Records During Survey	Level of Protection		Other Reason for Significance
		State	Commonwealth	
			JAMBA	
Fork-tailed Swift *Apus pacificus*	Potential		EPBC Migratory Species, JAMBA & CAMBA	
Rhizopod *Centropyxis* n.sp.	present			WRM Rare
Rotifer *Lepadella oblonga*	2-10			WRM Rare
Notommatid Rotifer *Cephalodella n.* sp	2-10	-		WRM Rare
Trochosphaeridae Rotifer *Filinia* cf. *passa*	20-30			WRM Rare
Cyclopoid Copepod *Paracyclops n.* sp	2-10			WRM Rare
Indeterminate Difflugiidae Rhizopod	2-10			WRM Rare
Synthemistid Dragon Fly *Archeosynthemis leachii*	2-10			WRM Relict species

3.4. Assessment of Black Cockatoo Habitat

With the known presence of Carnaby's, Baudin's and the Forest Red-tailed Black Cockatoo, a study was conducted by Johnstone, Johnstone and Kirkby (2007) to locate and determine the value of habitat for Black Cockatoo nesting, feeding and roosting over the disturbance and adjacent areas at Tutunup South.

3.4.1. Nesting Hollows

Eight trees were identified with possible nesting hollows (Figure 6). All of the hollows located displayed evidence of cockatoo use during the previous year. Of the eight hollows identified, one is adjacent to the northern wetland, whilst a further two potential nest sites were located east of the southern wetland. The remaining five hollows are in close proximity to each other south of the current Vasse Highway in the gravel reserve.

3.4.2. Feeding

Johnstone, Johnstone and Kirkby (2007) noted feeding sites by species at Tutunup South. The most prolific feeding sites recorded were those for Baudin's Cockatoo, which tended to be clustered at the southern end of the project both within and on the edge of the disturbance area, and near the northern wetland (Figure 6). A number of other sites were recorded around the forest/agricultural interface. For the Forest Red-tailed Black Cockatoo, there were also numerous feeding sites mapped although mostly south of Vasse Highway and within the gravel reserve, although some were located at the edge of the disturbance area and some inside the disturbance area. There were however far less feeding sites mapped for Carnaby's Cockatoo with only six sites mapped by Johnstone, Johnstone and Kirkby (2007).

3.4.3. Roosting

One roosting site was located midway along the southeastern boundary of the disturbance area which was described as having been used over a long period of time and was being used by over 50 birds at the time of the survey, although it was not specified which species used the roosting site (Figure 6).

Regular visits to the survey area have been conducted to continue monitoring the possible nesting hollows. As yet, no hollows are being utilised by Black Cockatoos.

4. POTENTIAL IMPACTS

The impacts of the Tutunup South project are discussed below for both impacts to significant habitat for fauna and specifically for species of significance.

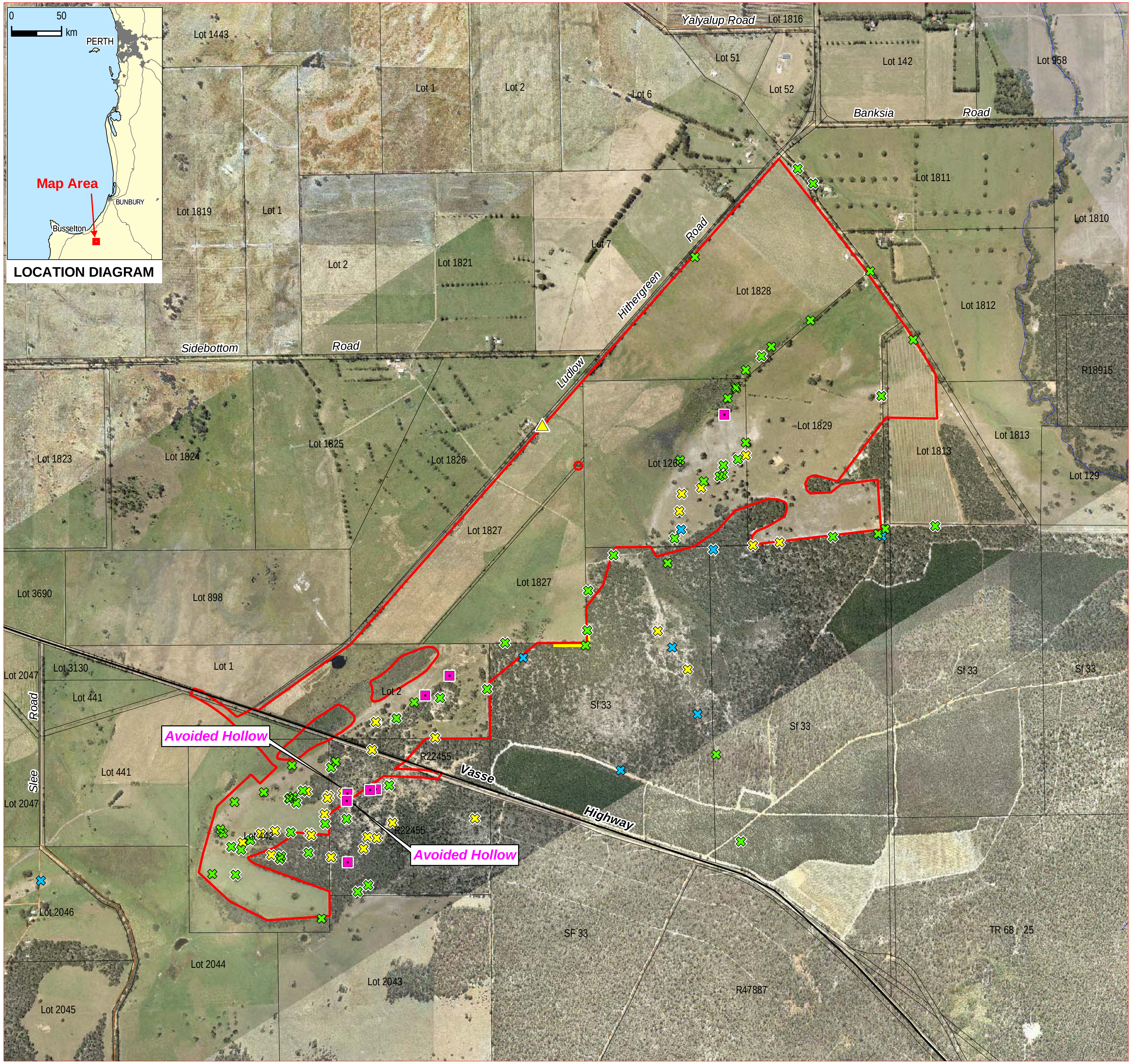
4.1. Impacts to Significant Vegetation/Habitat for Fauna

The Tutunup South project is expected to result in clearing of 31.6 ha of native vegetation, including 25.6 ha for which vegetation community and condition could be assessed and 6 ha of isolated trees within cleared agricultural land. As a consequence of clearing, three possible Black Cockatoo nesting trees are likely to be directly impacted. In addition there are a number of feeding sites identified by Johnstone, Johnstone and Kirkby (2007), including one Carnaby's Cockatoo feeding site.

The northern wetland will be cleared as part of the pit, resulting in the loss of this habitat. As noted in section 3.1, this wetland is approximately 500 m from the State forest. The southern wetland may experience a decline in habitat value due to dewatering, noise and light as a consequence of mining activities being conducted adjacent to the wetland.

Up to 0.8 ha of the S2 vegetation is anticipated to be cleared. Whilst this vegetation unit had the highest richness of species and individuals trapped (from a larger area of this community in State forest), the area identified for clearing as at the edge of agriculture and has been assessed by Mattiske Consulting Pty Ltd (2007) using the *Bush Forever* criteria as "degraded".

As the mine progresses southwards, Iluka proposes to temporarily divert the Vasse Highway to the south before mining and reinstating the highway in its original position. Whilst a design is yet to be finalised, the diversion will pass close to the nesting hollows in the gravel reserve. Iluka will design and construct the diversion to avoid nest trees and minimise traffic impacts as far as practicable.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
01	L.S.	D.G.S.	12.09.07	Disturbance area ammeded
02	S.E.	D.G.S.	19.11.07	New roosting site for red tailed cokatoo
03	S.J	T.L.G	07.04.08	Added "Protected hollow" labelling

Legend

Cockatoo Survey

General

Nesting sites

Baudin's Cockatoo

Feeding sites

Carnaby's Cockatoo

Feeding sites

Forest Red-Tailed Black Cockatoo

Feeding sites

Drinking Record

Roosting site

Disturbance Area

Survey conducted by R.E and C. Johnstone and T. Kirkby - Jan 2007

Detailed Photo : November 2005
Regional Photo : Skyview 2001

N

0 500 1,000 m

ILUKA

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:15,000
DATE: 7 Apr. 2008

TUTUNUP SOUTH

COCKATOO NESTING, FEEDING & ROOSTING SITES

DWG No: 170666 ver.03 | A3 | FIGURE: 6

4.2. Carnaby's Black Cockatoo *Calyptorhynchus latirostris*

Carnaby's Cockatoo is restricted to the southwestern corner of Western Australia ranging from the Murchison River to Esperance, inland to Coorow, Kellerberin, Lake Cronin, Cape Arid and the Oldfield River (Saunders 1977, Saunders and Ingram 1998, Johnstone and Storr 1998, Biota and Johnstone 2003). The species occurs within an area of 32,000 km^2, occupying an area of 2,000 km^2 (Garnett and Crowley 2000).

The time taken to develop nesting hollows can be 150 to 250 years. Competition with other birds and insects for hollows makes the loss of nesting sites a key impact on this species. At Tutunup South, it is expected that up to three nesting trees and one feeding site will be the limit of direct impacts on the Carnaby's Cockatoo. Indirect impacts such as vehicle disturbance and noise may also deter usage within or directly adjacent to the disturbance area such as the roosting site.

4.3. Baudin's Cockatoo *Calyptorhynchus baudinii*

Baudin's Cockatoo is more associated with taller, open jarrah/marri woodlands where it feeds predominantly on marri seeds and wood boring grubs (Blakers *et al* 1984). There is some conflicting literature regarding the decline of this species, however the loss of nesting sites is a potential threat to this species (Saunders and Ingram 1998).

4.4. Forest red-tailed Black Cockatoo *Calyptorhynchus banksii naso*

The Forest Red-tailed Black Cockatoo has a distribution from Gingin and Gidgegannup in the north to Chidlow, Boddington, Rocky Gully, Upper King River and Porongerup Range in the East, with some interaction into the urbanised areas along the southern coastal strip. It is believed to have once been common, but is now rare to uncommon as its range has been reduced. The total population is estimated to be in the order of 10,000 to 15,000 birds but the effective breeding population is estimated to be only 10-20% of the total.

The preferred nesting sites are in large top entry hollows of *Corymbia calophylla, Eucalyptus marginata, E. wandoo, E. megacarpa, E. gomphocephala* and *E. diversicolor*. It is not known whether the hollows in the three nesting trees in the disturbance area are top entry hollows. The species mainly feeds on the seeds of *C. calophylla, E. marginata, E. patens, E. diversicolor, Allocasuarina fraseriana* and *Persoonia longifolia*. Many of these species exist at Tutunup South, with numerous Forest Red-tailed Black Cockatoo feeding sites identified within the disturbance area (Ninox Wildlife Consulting 2006).

4.5. Chuditch *Dasyurus geoffroii*

The Chuditch was once widely distributed around Australia, though is now only found in forest remnants in the southwest of Western Australia. Whilst no observations or evidence of Chuditch were recorded during the survey, it is possible that the species may inhabit the forest adjacent to the disturbance area, and was previously observed at the nearby Yoganup 215 survey area (Ninox Wildlife Consulting 2006). However, upon completion of the fauna survey, Biota (2007a concluded that Chuditch are unlikely to be present in the study area.

The impact of the development of Tutunup South on this species is likely to be limited to short range displacement, with Chuditch only likely to use the disturbance area as part of their home range rather than for habitation. Chuditch are able to adapt to disturbance and have readily incorporated rehabilitation areas into their territorial range (Ninox Wildlife Consulting 2006).

4.6. Brush-tailed Phascogale *Phascogale tapoatafa tapoatafa*

The Brush-tailed Phascogale is an arboreal carnivore inhabiting open sclerophyll forest areas with reliable rainfall. The species has a reasonably widespread distribution, though is vulnerable to localised extinction due to low population densities and an annual male die-off (Strahan 1995).

Whilst no Phascogales were caught during the fauna survey, suitable habitat is available in the State forest adjacent to the disturbance area. The major impact for this species is expected to be by localised displacement resulting from mining activities (eg noise, light overspill) from the State Forest adjacent to the mine. There is evidence that Brush-tailed Phascogales are tolerant of some mining disturbance with trapping of this species close to mining and haulage areas at Boddington (Ninox Wildlife Consulting 2006). As an arboreal species, there is some potential for loss of habitat due to direct clearing of vegetation along the southeastern edge of the disturbance area.

4.7. Western Ringtail Possum *Pseudocheirus occidentalis*

The Western Ringtail Possum's preferred habitat comprises coastal peppermint woodlands. The abundance and distribution of the species is considerably reduced since European occupation and it is now restricted to coastal and near coastal peppermint associations from the Australind – Eaton area to Waychinicup National Park (How *et al*, 1987; Burbidge and de Tores 1998).

No Western Ringtail Possums were caught during the fauna survey and the species is considered unlikely to occur due to a lack of suitable habitat.

4.8. Quokka *Setonix brachyurus*

The Quokka is currently found on Rottnest and Bald Islands and at least 25 sites on the mainland, where they prefer densely vegetated swamps and thickets along creek systems and dense heath on slopes, where they are less vulnerable to predation. Fox predation has had a significant adverse impact on the mainland population. The Quokka has not been recorded near the study area and no suitable habitat is available within the study area. It is therefore unlikely to occur.

4.9. Peregrine Falcon *Falco peregrinus*

The Peregrine falcon is widespread throughout Australia except for desert areas. The population is believed to comprise of between 3000 and 5000 pairs (Cade 1982). It uses a wide range of habitats as its home range, which is dependent on the availability of prey (other birds), although is not less than 480 ha (Marchant and Higgins 1993). Other than the availability of prey, the Peregrine Falcon has a distinct habitat preference for breeding on cliffs (>80% of nests in Australia). However, records do exist of this species constructing stick nests or using tree hollows.

Whilst the species was not recorded during surveys, it may utilise parts of the site as an occasional visitor as part of its home range. Given its large range, broad habitat preferences and nesting requirements, no impacts are expected from the development of Tutunup South on this species.

4.10. Southern Carpet Python *Morelia spilota imbricata*

The Southern Carpet Python inhabits areas with winter rains and dry summers such as the southwest of Western Australia. Its range has been reduced due to habitat removal for urban development, fires and the effect of feral predators (Bush *et al* 1995).

Whilst this species was not recorded during the survey, it has a low population density and cryptic behaviour, making detection difficult. Thus the species could be present in the disturbance area, particularly remnants such as the wetlands, though more likely in the adjacent State forest.

Development of Tutunup South may result in impact to individuals inhabiting the disturbance area. However, increased local traffic associated with the project may lead to impacts on this species through road mortalities.

4.11. Western False Pipistrelle *Falsistrellus mackenzei*

This species of bat is endemic to the south-west coast of Western Australia, and has been relatively poorly collected with most records from wet sclerophyll forests of *Eucalyptus diversicolor* or higher rainfall zones of *E. marginata* or *E. gomphocephala* (Churchill 1998). The Western False Pipistrelle is a gregarious insectivorous bat which roosts as small colonies and forages in the space between trees.

Biota (2007a) considered this species to be the most significant mammal recorded during its surveys. Development of Tutunup South may affect this species by clearing of roost sites (it was recorded in vegetation inside the disturbance area). However, short range displacement at the edge of the State forest is the most likely impact to be encountered.

4.12. Southern Brown Bandicoot *Isoodon obesulus fusciventer*

The Southern Brown Bandicoot is locally common in dense swamps in the southwest of Western Australia and more widespread at a lower density in forested areas and heathlands (Friend 1990). During the Biota Survey (2007a), the species was recorded in association with dense understorey at two locations, and was also recorded as breeding during the survey). One of the recorded locations was near the southwest wetland within the disturbance area.

There are several impacts that development of Tutunup South could have on this species. At a localised individual level, disturbance to wetland habitat could have a direct impact on resident individuals.

As a nocturnal species, excessive lighting may result in withdrawal further into the forest from the southeast boundary of the disturbance area.

4.13. Lined Skink *Lerista lineata*

The Lined Skink is found in the lower west coast of Western Australia from Perth to Mandurah, with records also from Busselton, Rottnest Island, Garden Island and an isolated population at Woodleigh Station. The skink has a habitat preference for sandy heath and shrublands, particularly in association with Banksias. This species was not observed at Tutunup South although suitable habitat is present.

Development of Tutunup South could result in direct impacts to individuals of this species if present near the northern wetland.

4.14. Western Brush Wallaby *Macropus irma*

The Western Brush Wallaby is distributed across the southwest corner of Western Australia from Kalbarri to Cape Arid (Strahan 1995). The species inhabits shrublands, open forest or woodlands with grassy understorey. Whilst the species was not recorded during the survey suitable habitat is present in the State forest adjacent to the disturbance area.

Development of Tutunup South may lead to short range displacement of Western Brush Wallaby's at the edges of the State forest from noise and increased human activity (eg machinery etc). If the pasture is used for grazing, a considerable proportion of this resource within the disturbance area will not be available during mining. However, much of the land surrounding the disturbance area is agricultural land providing the same resource. It is also possible that increased local traffic may result in road mortalities of this species.

4.15. Rainbow Bee-eater *Merops ornatus*

The Rainbow Bee-eater is listed under the Japan-Australia Migratory Bird Agreement (JAMBA), with four individuals of this species recorded from three sites during the survey (two outside of the disturbance area). The Rainbow Bee-eater forages for aerial insects and nests in burrows in the ground, with most habitats in the area providing suitable soil for nesting and a tall stratum of vegetation for perching. Biota (2007a) have concluded that there is no evidence to suggest that the Tutunup South project is a regionally important location for this species. Thus any impact will be limited to an insignificant loss of area available to a species with very broad habitat preferences.

4.16. Fork-tailed Swift *Apus pacificus*

The Fork-tailed Swift is listed as both a JAMBA and China-Australia Migratory Bird Agreement (CAMBA) species. The species was not recorded during the Biota (2007a) survey although may be present at irregular intervals over all habitat types near Tutunup South. However, this species rarely lands in Australia (Ninox Wildlife Consulting 2006) and is therefore not likely to be impacted by development at Tutunup South.

4.17. Rare Microinvertebrates

After the 2005 aquatic survey (WRM, 2006), Iluka contacted the W.A. Museum (as advised by the EPASU), DEC's Woodvale Research facilities (as advised by the W.A. Museum) and other experts to ascertain the context for the impacts proposed to the aquatic fauna considered rare. The aforementioned contacts believe these species are likely to be far more common and widespread throughout the South West of Western Australia due to a lack of surveying conducted in the South West. As a result, there are limited records of microinvertebrate species common to the South West. Also due to the dynamic successional changes within microinvertebrate assemblages that can occur over very short time frames (hours, days or weeks), further survey work may not again find these species, but instead reveal other new or “rare” species. These views are supported by the results of 2007 microinvertebrate sampling conducted in the area, which did record new ‘rare’ species and only located one of the four previously recorded ‘rare’ species in the Tutunup South wetlands. The specialists consulted recommended that Iluka is not in a position to survey the aquatic fauna at Tutunup South any further or within the region as it is not likely to assist in establishing a context for the impacts proposed to these species. It is therefore concluded that impacts on the aquatic fauna found at Tutunup South will not be significant to the overall survival of these potentially rare species.

A review was undertaken comparing the Tutunup South wetlands to other wetlands in the region (Biota 2007c). Four equivalent wetlands were identified at a broad scale. These wetlands had similar attributes to the Tutunup South wetlands being located within the south-extern extent of the Swan bioregion, remnant paluslope wetlands and Cartis complex vegetation (Biota 2007c). The comparative wetland study identified that:

- a number of other larger and more intact wetlands that are hydrologically and geomorphologically similar to the Tutunup South wetlands occur in the Whicher Scarp locality;
- none of the terrestrial fauna species associated with the Tutunup South wetlands are restricted to that site;
- none of the terrestrial flora species occurring at the Tutunup South wetlands are restricted to that site; and
- 98 % of the aquatic taxa at the Tutunup South wetlands (both macro and microinvertebrates) are not restricted to the site (Biota 2007c).

As such, there is the possibility that such wetland systems would contain suitable habitat for rare microinvertebrate species. However, as outlined above, additional aquatic fauna studies are unlikely to assist in establishing a regional context. Rather than invest considerable effort in further surveys without satisfactorily addressing the regional context, it is considered that providing an offset by securing one of the wetlands through a conservation covenant to remove threats of future grazing or development is considered the best environmental outcome (Biota 2007c). The offsets are addressed further in the Public Environmental Review document.

5. MANAGEMENT

5.1. Minimisation of Clearing

Iluka has sought to minimise clearing of native vegetation when designing Tutunup South. Preservation of the southern wetland is an example of avoiding clearing impacts wherever possible. Whilst there is unlikely to be scope to further reduce clearing, review of plans and designs will further continue to aim at minimising the project’s clearing footprint.

5.2. Noise

The main noise activities likely to impact the State forest area will be during construction and stripping soils when earthmoving machinery will be at ground level. Beyond this, the main noise sources will be earthmoving equipment feeding the in-pit hopper. Noise levels are controlled to minimise impacts on nearby residences under the *Environmental Protection (Noise) Regulations*. Measures adopted to control noise are designed to minimise noise impacts in all directions, thus impacts to the southeast should be comparable to those of nearby residences.

5.3. Light Overspill

As a continuous operation, lighting will be required to ensure safe operations. Whilst much of the infrastructure and lighting will be located below the surface level (eg in-pit hopper) light towers will be constructed to enable flexibility in lighting direction. Thus lighting can be directed to minimise penetration into the forest.

5.4. Trap and Relocate Fauna

The northern wetland lies within the pit area where clearing cannot be avoided. As identified earlier, this wetland has no direct vegetation corridor linking it to the nearby State forest. Prior to clearing, Iluka will conduct trapping amongst the wetland vegetation and relocate fauna such as Southern Brown Bandicoots and Common Bushtail Possums to the adjacent State forest or other forested areas in consultation with the DEC. Iluka has previously conducted a similar programme at the Waroona mineral sands mine resulting in relocation of five Southern Brown Bandicoots and two Common Brushtail Possums.

5.5. Salvaging Disturbed Nesting Trees

There are three possible Black Cockatoo nesting sites likely to be cleared within the disturbance area. The trees will be marked for felling separately. The hollows will be assessed by fauna experts at the time of felling to confirm their suitability as habitat hollows. If suitable, the hollows will be salvaged to make artificial hollows to place into nearby forest areas.

5.6. Provision of Artificial Nesting Hollows

Iluka has previously installed with some success artificial nesting hollows to provide additional nesting sites for black cockatoos in areas near mining activities. In consultation with the DEC and the WA Museum, it is planned to install artificial nesting hollows in the State Forest area. There are few competitor species in the immediate Tutunup South area (R. Johnstone pers. comm.) however hollows will be designed such that the type, size and orientation are suitable for black cockatoos and unfavourable for competitor species. Any installed hollows that do appear to be favoured by competitor species will be removed.

For the first few years after installation, some maintenance of artificial hollows may be required, including replacing the sacrificial post. Iluka will maintain the hollows until 1 year after landform reestablishment. At this time, the success of the hollows will be reviewed with the DEC.

6. MONITORING

Regular visits to the Tutunup South project area by Johnstone, Johnstone and Kirkby are being conducted to determine whether any hollows are being utilised by black cockatoos for breeding.

Monitoring of the usage of relocated and artificial hollows will also be conducted from the time of installation until 1 year post landform reestablishment. Data obtained on the use of the artificial hollows will assist in continual improvement of hollow design.

7. REPORTING

Any fauna relocation activities undertaken will be reported to the DEC.

Monitoring of the usage of relocated and artificial hollows will be reported in the AER.

8. REVIEW AND REVISE

This management plan will be reviewed to assess its suitability, adequacy and effectiveness in meeting the set objectives annually, or more frequently as deemed necessary by Iluka. Where necessary, the plan will be revised and revisions will be submitted to the DEC for approval.

9. KEY MANAGEMENT ACTIONS TABLE

Table 5: Key management actions

Key Management Actions	Evidence of demonstration
Minimise clearing of fauna habitat	Southern wetland retained
Conduct trapping and relocate fauna near northeast wetland prior to clearing	Trapping conducted, report to DEC
Salvage of hollows from nesting trees in disturbance area	Number of hollows retained
Install artificial hollows	Hollows installed
Monitor usage of salvaged and artificial hollows	Results reported in AER

10. REFERENCES

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11. DOCUMENT CONTROL

Revision	**Reviews/changes**	**Create date**
A	First Draft	17 August 2007
B	Review and Comments by LKS	25 August 2007
C	Review and Comments by PJM	9 September 2007
D	Comments from internal review	15 September 2007
E	Revised after 2007 spring survey	23 January 2008
F	Revised after EPASU review	4 April 2008

Appendix 1: List of Fauna Species Recorded by Biota (2007a and 2007d), Ninox Wildlife Consulting (2006) and Wetland Research and Management (2006), and Fauna not Recorded that may be Present at Tutunup South

Scientific Name	Common Name	Status	Biota	Ninox	WRM	Potential
BIRDS						
CASUARIIDAE						
Dromaius noveahollandiae	Emu		X	X		X
ANATIDAE						
Tadorna tadornoides	Australian Shelduck					X
Anas gracilis	Grey Teal		X			
Chenonetta jubata	Australian Wood Duck		X			X
Anas superciliosa	Pacific Black Duck		X			X
PHALACROCORACIDAE						
Phalacrocorax varius	Pied Cormorant		X			
ARDEIDAE						
Ardea pacifica	White-necked Heron					X
Ardea novaehollandiae	White-faced Heron		X			X
THRESKIORNITHIDAE						
Threskiornis molucca	Australian White Ibis					X
Threskiornis spinicollis	Straw-necked Ibis		X		X	X
ACCIPITRIDAE						
Elanus caeruleus	Black-shouldered Kite					X
Hamirostra isura	Square-tailed Kite					X
Haliastur sphenurus	Whistling Kite					X
Accipiter fasciatus	Brown Goshawk					X
Accipiter cirrhocephalus	Collared Sparrowhawk					X
Aquila morphnoides	Little Eagle					X
Aquila audax	Wedge-tailed Eagle		X	X		X
Circus approximans	Swamp Harrier		X			X
FALCONIDAE						
Falco berigora	Brown Falcon					X
Falco cenchroides	Australian Kestrel		X			X
Falco longipennis	Australian Hobby		X			X
Falco peregrinus	Peregrine Falcon	OP				X
TURNICIDAE						
Turnix varia	Painted Button-quail					X
PHASIANIDAE						
Coturnix ypsilphora	Brown Quail		X			
CHARADRIIDAE						
Vanellus tricolor	Banded Lapwing					X
RALLIDAE						
Gallinula tenebrosa	Dusky Moorhen		X			
COLUMBIDAE						

Scientific Name	Common Name	Status	Biota	Ninox	WRM	Potential
Streptopelia senegalensis	Laughing Turtle-Dove		X			
Streptopelia chinensis	Spotted Turtle-Dove		X			
Phaps chalcoptera	Common Bronzewing		X			X
Ocyphaps lophotes	Crested Pigeon		X			X
PSITTACIDAE						
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	VU	X	X		X
Calyptorhynchus latirostris	Carnaby's Cockatoo	E V	X	X		X
Calyptorhynchus baudinii	Baudin's Cockatoo	V VU	X			X
Glossopsitta porphyrocephala	Purple-crowned Lorikeet					X
Polytelis anthopeplus	Regent Parrot		X			X
Platycercus zonarius	Australian Ringneck		X	X		X
Platycercus spurius	Red-capped Parrot		X	X		X
Platycercus icterotis	Western Rosella		X			X
Neophema elegans	Elegant Parrot		X			X
CUCULIDAE						
Cuculus pallidus	Pallid Cuckoo					X
Cacomantis flabelliformis	Fan-tailed Cuckoo					X
Chrysococcyx basalis	Horsfield's Bronze-Cuckoo		X			X
Chrysococcyx lucidus	Shining Bronze-Cuckoo		X			X
STRIGIDAE						
Ninox novaeseelandiae	Southern Boobook					X
TYTONIDAE						
Tyto novaehallandiae	Masked Owl					X
Tyto alba	Barn Owl					X
PODARGIDAE						
Podargus strigoides	Tawny Frogmouth					X
APODIDAE						
Apus pacificus	Fork-tailed Swift	J/C				X
HALCYONIDAE						
Todiramphus sanctus	Sacred Kingfisher					X
MEROPIDAE						
Merops ornatus	Rainbow Bee-eater	J	X			X
CLIMACTERIDAE						
Climacteris rufa	Rufous Treecreeper					X
MALURIDAE						
Stipiturus malachurus	Southern Emu Wren		X			
Malurus elegans	Red-winged Fairy-wren		X			X
Malurus splendens	Splendid Fairy-wren		X	X		X
PARDALOTIDAE						
Pardalotus punctatus	Spotted Pardalote		X			X
Pardalotus striatus	Striated Pardalote		X	X		X

Scientific Name	Common Name	Status	Biota	Ninox	WRM	Potential
ACANTHIZIDAE						
Sericornis frontalis	White-browed Scrubwren		X			X
Smicrornis brevirostris	Weebill					X
Gerygone fusca	Western Gerygone		X	X		X
Acanthiza apicalis	Broad-tailed Thornbill		X	X		X
Acanthizia inornata	Western Thornbill		X			X
Acanthizia chrysorrhoa	Yellow-rumped Thornbill		X	X		X
MELIPHAGIDAE						
Lichmera indistincta	Brown Honeyeater		X	X		
Lichenostomus virescens	Singing Honeyeater		X			
Melithreptus chloropsis	Western White-naped Honeyeater					X
Phylidonyyis nigra	White-cheeked Honeyeater		X			
Phylidonyis melanops	Tawny Crowned Honeyeater		X			
Phylidonyris novaehollandiae	New Holland Honeyeater		X	X		X
Acanthorhynchus superciliosus	Western Spinebill		X	X		X
Anthochaera lunulata	Western Little Wattlebird			X		X
Anthochaera carunculata	Red Wattlebird		X	X		X
Epthianura albifrons	White-fronted Chat		X			
PETROICIDAE						
Petroica multicolor	Red Capped Robin		X			
Petroica multicolor	Scarlet Robin		X	X		X
Petroica cucullata	Hooded Robin					X
Eopsaltria australis	Western Yellow Robin		X			X
Eopsaltria georgiana	White-breasted Robin		X	X		X
NEOSITTIDAE						
Daphoenositta chrysoptera	Varied Sittella		X			X
PACHYCEPHALIDAE						
Pachycephala pectoralis	Golden Whistler		X	X		X
Pachycephala rufiventris	Rufous Whistler		X	X		X
Colluricincla harmonica	Grey Shrike-thrush		X	X		X
DICRURIDAE						
Myiagra inquieta	Restless Flycatcher		X			
Rhipidura fuliginosa	Grey Fantail		X	X		X
Rhipidura leucophrys	Willie Wagtail		X	X		X
Grallina cyanoleuca	Magpie-lark		X			X
CAMPEPHAGIDAE						
Coracina novaehollandiae	Black-faced Cuckoo-shrike		X	X		X
Lalage tricolor	White-winged Triller					X
ARTAMIDAE						
Artamus cinereus	Black-faced Woodswallow		X			
Artamus cyanopterus	Dusky Woodswallow		X	X		X

Scientific Name	Common Name	Status	Biota	Ninox	WRM	Potential
CRACTICIDAE						
Cracticus torquatus	Grey Butcherbird		X			
Cracticus tibicen	Australian Magpie		X	X		X
Strepera versicolor	Grey Currawong					X
CORVIDAE						
Corvus coronoides	Australian Raven		X	X		X
HIRUNDINIDAE						
Hirundo neoxena	Welcome Swallow		X			X
Hirundo nigricans	Tree Martin		X			X
ZOSTEROPIDAE						
Zosterops lateralis	Grey-breasted White-eye		X	X		X
DICAEIDAE						
Dicaeum hirundinaceum	Mistletoebird					X
PASSERIDAE						
Stagonopleura oculata	Red-eared Firetail					X
MOTACILLIDAE						
Anthus australis	Australian Pipit		X			X
	Total Number of Species		**68**	**28**	**1**	**83**
NATIVE MAMMALS						
TACHYGLOSSIDAE						
Tachyglossus aculeatus	Echidna					X
DASYURIDAE						
Dasyurus geoffroii	Chuditch	V VU				X
Antechinus flavipes	Mardo		X	X		X
Phascogale tapoatafa	Wambenger	P3				X
Sminthopsis gilberti	Gilbert's Dunnart		X			X
Sminthopsis griseoventer	Grey-bellied Dunnart		X			X
PERAMELIDAE						
Isoodon obesulus fusciventer	Southern Brown Bandicoot	P5	X	X		X
MACROPODIDAE						
Macropus irma	Western Brush Wallaby	P4				X
Macropus fuliginosus	Western Grey Kangaroo		X	X		X
PHALANGERIDAE						
Trichosurus vulpecula	Common Brushtail Possum		X	X		X
BURRAMYIDAE						
Cercartetus concinnus	Western Pygmy-possum		X			X
TARSIPEDIDAE						
Tarsipea rostratus	Honey Possum					X
VESPERTILIONIDAE						
Chalinolobus gouldii	Gould's Wattled Bat		X			X
Chalinolobus morio	Chocolate Wattled Bat		X			X
Falsistrellus mackenziei	Western False Pipistrelle	P4	X			X

Scientific Name	Common Name	Status	Biota	Ninox	WRM	Potential
Nyctophilus geoffroyi	Lesser Long-eared Bat					X
Nyctophilus gouldii	Gould's Long-eared Bat					X
Nyctophilus timoriensis	Greater Long-eared Bat					X
Vespadelus regulus	Southern Forest Bat		X			X
MOLOSSIDAE						
Mormopterus planiceps	Southern Freetail-bat					X
Nyctinomus australis	White-striped Freetail-bat		X			X
MURIDAE						
Rattus fuscipes	Bush Rat		X			X
	Total Number of Species		**13**	**4**	**0**	**22**
AMPHIBIANS						
HYLIDAE						
Litoria adelaidensis	Slender Tree Frog		X		X	X
Litoria moorei	Motorbike Frog					X
MYOBATRACHIDAE						
Crinia insignifera	Squelching Froglet		X		X	
Crinia georgiana	Quacking Frog		X			X
Crinia glauerti	Glauert's Froglet		X		X	X
Crinia pseudinsignifera	Bleating Frog					X
Heleioporus eyrei	Moaning Frog		X			X
Heleioporus psammophilus	Sand Frog					X
Limnodynastes dorsalis	Banjo Frog					X
Metacrinia nichollsi	Nicholl's Froglet					X
Pseudophryne guentheri	Crawling Frog					X
	Total Number of Species		**5**	**0**	**3**	**10**
REPTILES						
AGAMIDAE						
Pogona minor minor	Western Bearded Dragon		X			X
GEKKONIDAE						
Christinus marmoratus	Marbled Gecko		X			X
Diplodactylus polyophthalmus						X
Underwoodisaurus milii						X
PYGOPODIDAE						
Aprasia pulchella	Granite Worm Lizard		X			X
Delma fraseri						X
Lialis burtonis	Burton's Legless Lizard		X			X
Pygopus lepidopodus						X
SCINCIDAE						
Acritoscincus trilineatum	South-western Cool Skink		X			X
Cryptoblepharus plagiocephalus	Fence or Wall Skink		X			X
Ctenotus catenifer						X
Ctenotus impar	Odd-striped Skink		X			X

Scientific Name	Common Name	Status	Biota	Ninox	WRM	Potential
Ctenotus labillardieri	Red-legged Skink		X			X
Egernia kingii	King's Skink		X			X
Egernia luctuosa						X
Egernia napoleonis						X
Glaphyromorphus gracilipes			X			X
Hemiergis peronii	Four-toed Earless Skink		X			X
Hemiergis quadrilineata						X
Lerista distinguenda			X			X
Lerista elegans			X			X
Lerista microtis						X
Menetia greyii	Common Dwarf Skink		X			X
Morethia lineoocellata			X			X
Morethia obscura	Woodland Flecked Skink		X			X
Tiliqua rugosa	South-western Bobtail		X			X
VARANIDAE						
Varanus gouldii						X
Varanus rosenbergi	Southern Heath Monitor		X	X		X
TYPHLOPIDAE						
Ramphotyphlops australis			X			X
Ramphotyphlops pinguis						X
BOIDAE						
Morelia spilota imbricata		OP				X
ELAPIDAE						
Echiopsis curta						X
Elapognathus coronatus						X
Notechis scutatus	Tiger Snake		X			X
Parasuta gouldii						X
Parasuta nigriceps	Black-backed Snake		X			X
Pseudonaja affinis						X
Rhinoplocephalus bicolor						X
Simoselaps bertholdi						X
	Total Number of Species		**21**	**1**	**0**	**39**
INTRODUCED SPECIES						
BIRDS						
COLUMBIDAE						
Streptopelia chinensis	Spotted Turtle-Dove					X
HALCYONIDAE						
Dacelo novaeguineae	Laughing Kookaburra		X	X		X
	Total Number of Species		**1**	**1**	**0**	**2**
MAMMALS						
MURIDAE						
Mus musculus	House Mouse		X			X

Scientific Name	Common Name	Status	Biota	Ninox	WRM	Potential
Rattus rattus	Black Rat					X
LEPORIDAE						
Oryctolagus cuniculus	Rabbit		X	X		X
CANIDAE						
Vulpes vulpes	Red Fox					X
FELIDAE						
Felis catus	Feral Cat					X
SUIDAE						
Sus scrofa	Feral Pig					X
CANIDAE						
Canis familiaris	Domestic Dog		X			
	Total Number of Species		**3**	**1**	**0**	**6**

Conservation Status – Commonwealth	Conservation Status - Western Australia
V = Vulnerable under the *EPBC Act 1999* E = Endangered under the *EPBC Act 1999* J = JAMBA treaty C = CAMBA treaty	CR = Critically Endangered under the *Wildlife Conservation Act 1950* VU = Vulnerable under the *Wildlife Conservation Act 1950* OP = Other Specially Protected Fauna under the *Wildlife Conservation Act 1950* P# = Listed under DEC's Priority Fauna list

Appendix 3
Acid Sulfate Soil Management Plan

Iluka Resources Limited

Acid Sulfate Soil Management Plan

Tutunup South Mineral Sands Project

April 2008

ILUKA-TR-T15790

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1. INTRODUCTION

This plan outlines the acid sulfate soil (ASS) management practices that will be applied during mining of the Tutunup South mine site. This plan has been developed in conjunction with the Public Environmental Review (PER) impact assessment document. Implementation of this plan and compliance during operations is a commitment of the PER document.

1.1. Objective

The objective of the plan is to ensure that mining and mining associated activities which have the potential to disturb acid sulfate soils are planned and managed to ensure that environmental values are protected.

2. PRE-MINE ENVIRONMENT

2.1. Geology

The Tutunup South site covers parts of the Yoganup formation and younger littoral and marginal marine units deposited on the Western Australian continental shelf during the Pliocene and Pleistocene periods. The site is located along the foot of the Whicher Scarp, a prominent topographic feature orientated parallel to, the present day coastline. The scarp has formed the limit of numerous Tertiary marine transgressions. Palaeo-shorelines along this part of the scarp are collectively referred to as the Yoganup Shorelines.

The Yoganup formation is partly buried by estuarine and fluvial clays of the Guildford formation and by later alluvial fan deposits and thin aeolian quartz dunes of the Bassendean dune systems.

There have been numerous phases of HM accumulation at Tutunup South, which contains mineral ranging from 28 to 47 m above sea level, and each concentration itself is a result of numerous individual accumulation events.

Subsequent to deposition, the deposit has been subject to topographic deflation, erosion by drainage channels off the scarp, induration through lateritisation and ironstone development, and alteration of the mineral constituents.

2.2. Landform and Soils

Tutunup South occurs in the southern Perth Basin. This basin represents a southern extension of the Perth Basin (Iasky, 1993), and is composed of up to 10 km of Permian to Quaternary sediments. Of particular importance to mining are the Quaternary – Late Tertiary Guildford and Yoganup Formations, and the Mesozoic Leederville formation and Bunbury Basalts. All of these surficial geological formations have either been formed or strongly influenced by marine regression and transgression events since the Early to Mid Tertiary (ca. 50 Mya).

Soil assessments have been conducted over the Tutunup South disturbance area (SWC 2007a, 2007b). The physical and chemical properties of the soils were characterised and soils that may develop adverse properties during mining and rehabilitation identified. The baseline soil studies described five soil mapping units to exist over the disturbance area.

- SMU 1: Exposed Laterite
- SMU 2: Gravelly Duplex Soil
- SMU 3: Deep Yellow Sandy Duplex
- SMU 4: Deep Pale Grey Sandy Duplex
- SMU 5: Shallow Pale Grey Sandy Duplex

2.3. ASS

Actual Acid Sulfate Soils (AASS) and Potential Acid Sulfate Soils (PASS) are collectively known as ASS. AASS are soils or sediments which contain iron sulfides and/or other sulfidic minerals that have previously been oxidised to produce sulphuric acid. This results in existing acidity in the soil and often yellow and/or red mottling (jarosite/iron oxide) in the soil profile. PASS are soils or sediments containing iron sulfides and/or other sulfidic minerals which have not been oxidised (DoE, 2006, cited in SWC, 2007).

Other Potentially Problematic Acid-generating Substrates are also grouped with ASS under the draft guideline for identifying ASS (DoE, 2006, cited in SWC, 2007), including:

- Recent Sand Units – Pale Grey Sands and Iron Cemented Organic Rich Sands (Coffee Rock) which may contain inorganic sulfides (E.g. pyrite and iron monosulfides) and easily hydrolysable iron and manganese oxides; and
- Dredge spoil, which may contain significant quantities of iron sulphide minerals (pyrite and iron monosulfides).

Acid sulfate soil investigations at Tutunup South commenced with a desktop assessment and site inspection to identify any indicators of ASS within the disturbance area (Soil Water Consultants (SWC), 2007).

The desktop assessment involved review of (SWC, 2007):

- ASS Risk Maps (Western Australian Planning Commission (WAPC), 2003)
- Regional soil maps
- Environmental geological maps
- Topographic maps
- Aerial photographs
- Geological and metallurgical drilling data

The above information was reviewed in consideration of the list of areas where ASS can be found, in section 3.2 of the *Draft identification and investigation of acid sulfate soils* guideline (DoE, 2006). The review found that the area to be disturbed is likely to contain ASS.

The ASS risk maps (WAPC, 2003) suggest that the area to be disturbed has a high risk of both AASS and PASS occurring in the surface 3m of the soil profile on the western side of the disturbance area, associated with a depositional basin (SWC, 2007).

Site inspection confirmed that a series of discrete low-lying depressions subject to seasonal inundation are located in this region (SWC, 2007). This area is likely to have been an old estuary formed during marine regression. The depositional basin is currently a saturating, reducing environment with an accumulation of organic matter (SWC, 2007). These conditions are ideal for ASS formation (Stone *et al.*, 1998, cited in SWC, 2007). A deep trench excavated in the area as part of soil studies released a strong hydrogen sulphide smell, another possible indication of PASS in the area (SWC, 2007).

During the site inspection, the pH of surface waters throughout the site were tested and found to be slightly acidic to neutral, and no evidence of iron staining, corrosive shells or jarosite was observed, indicating that no AASS are present in near surface horizons (SWC, 2007).

Review of the exploration drilling data revealed the presence of black soils at depth within the low-lying areas, which typically relate to organic rich layers. These soils are typically PASS (A Pratt, pers comm). East of the depressions, the soils are well oxidised yellow sands and gravely sands overlying lateritised sandy clay. Neither PASS nor AASS are likely to occur here (SWC, 2007).

Findings from the desktop assessment (see Table 1) and the site inspection suggest a high risk of PASS occurring within the low-lying sumpland areas adjacent to the western margin of the proposed mine. Detailed ASS survey was therefore conducted to confirm the presence or absence of ASS and if present, to accurately delineate its distribution (SWC, 2007).

While standard desktop review may assist in to identifying the potential for ASS near the soil surface, it is limited for identifying ASS at depth. Geological and metallurgical data collected during exploration drilling is therefore reviewed for this purpose (SWC, 2007). Exploration drilling was to a final density of 3.3 drillholes/ha, with samples taken at 1 m intervals. Drillholes generally extended to the Leederville Formation. A total of 4,261 samples were collected and analysed for soil texture, lithology/stratigraphy, soil colour and heavy mineral content. Selected samples from each stratigraphic zone were also analysed for total sulphur content, mineralogy and elemental composition. Data obtained from exploration drilling has been calibrated with actual soil morphological and physical properties obtained during soil surveys and a good relationship was found to exist (SWC, 2007).

Exploration drilling data was used to model soil distribution and associated hydrological conditions throughout the site. Soil colour was used to map the redoximorphic status of the soils and soil colour and texture were used to map the presence of peaty, organic rich layers (SWC, 2007). This mapping was then used to identify any areas that may potentially contain ASS, from the surface to the upper surface of the Leederville Formation (SWC, 2007).

The information gained from desktop assessment and site inspection was used to design a field investigation program appropriate to the site, to confirm the presence or absence of ASS in the disturbance area (SWC, 2007).

Table 1: ASS Desktop Assessment

1. Will the proposed work be conducted in areas where ASS may occur			
Areas where ASS may occur	Will the proposed work be conducted in this area		Comments
	Yes	No	
Areas depicted on geology and/or geomorphological maps as geologically recent such as:			
Shallow tidal flats or tidal lakes		✓	
Shallow estuarine, shallow marine deposits		✓	
Stranded beach ridges and adjacent swales		✓	
Interdunal swales or coastal sand dunes		✓	
Coastal alluvial valleys		✓	
Wetlands	✓		Seasonally inundated sumpland at foot of Whicher Scarp
Floodplains		✓	
Waterlogged areas	✓		
Scalded areas		✓	
Sump land	✓		
Marshes	✓		
Swamps	✓		
Areas depicted in vegetation mapping as:			
Mangroves		✓	
Wetland dependant vegetation such as reeds and paperbarks (*Melaleuca* spp.)	✓		
Areas where the dominant vegetation is tolerant of salt, acid and/or waterlogging conditions (i.e. mangroves, swamp-tolerant reeds, rushes, paperbarks and swamp oak (*Casuarina* spp.)	✓		
Areas identified in geological descriptions or in maps as:			
Bearing acid sulphide minerals (i.e. pyrite)		✓	
Former marine or estuarine shales and sediments	✓		
Coal deposits		✓	

Mineral sand deposits	✓		
Areas known to contain peat or a build-up of organic material		✓	
Areas where the highest known water table level is within three (3) meters of the surface		✓	
Land with an elevation less than 5 m AHD		✓	
Any areas where a combination of all the following pre-disposing factors exists:			
Organic matter	✓		
Iron minerals	✓		
Waterlogged conditions or a high water table	✓		
Sulfidic minerals		✓	
Deep estuarine sediments below ground surface	✓		
2. Will the proposed work involve any of the following types of work			
Nature of the disturbance	Will the proposed work involve this disturbance		Comments
	Yes	No	
Soil or sediment disturbance > 100 m³ in ASS High Risk Areas	✓		
Lowering of the water table (whether temporary or permanent) in areas depicted in the ASS Risk Map as ‘high risk of AASS or PASS occurrence’, or dewatering operations in areas depicted in the ASS Risk Map as ‘moderate to low risk of AASS or PASS occurrence’ within 500 m from a high risk area	✓		
Where there is evidence of a significant risk of disturbing acid sulphate soils in the ‘Moderate to low risk areas of ASS occurrence at depths > 3 m’.	✓		
Any dredging operations		✓	
Extractive industry works (i.e. mineral sands mining)	✓		
Flood mitigation works including construction of levees and flood gates.		✓	
Disturbance of soil or sediments in any areas listed above (i.e. Part 1 of this Desktop Assessment) that may contain ASS	✓		

2.3.1. Field Investigations

The field investigations involved a drilling program designed specifically for ASS identification and analysis of samples collected. Drilling intensity varied across the disturbance area, based on the likelihood of ASS occurring (as determined by desktop assessment) (SWC, 2007). In high risk areas (i.e. the depositional basin), drilling was conducted at 2 drillholes/ha, and in low risk areas, drilling was conducted at 0.5 drillholes/ha. This distribution provides a regional understanding of the distribution of ASS in the disturbance area (SWC, 2007). A total of 190 holes were drilled, varying in depth from 4 to 21 m. All drillholes extended at least 2 m below the pit floor (SWC, 2007).

Samples were collected every 1 m over the length of the drillhole. Given the existing knowledge of the soils and geology in the area, this sampling interval is sufficient to allow accurate identification and delineation of ASS presence. A total of 2,486 samples were collected, varying from 0.5 kg to 1 kg in size, ensuring the sample is sufficient to allow detailed chemical and physical analysis (SWC, 2007).

All samples were analysed for field pH (pH_F) and field peroxide pH (pH_{FOX}). All samples with pH_F < 4.0 plus selected samples were analysed for Total Actual Acidity (TAA). Selected samples were analysed for Chromium Reducible Sulphur (S_{CR}). Leach tests were conducted on selected non-pyritic soils (S_{CR} < 0.03%) to determine potential hydrolysis and metals release (SWC, 2007).

Results

AASS

The pHF values ranged from 3.30 to 7.89. 74 % of samples were between 5.0 and 7.0 (slightly to moderately acidic). Approximately 25 % of samples were between 4.0 and 5.0 and approximately 1 % of samples were less than 4.0. The 1 % of samples less than 4.0 are likely to be AASS (SWC, 2007). The 25% of samples between 4.0 and 5.0 may also indicate previous oxidation of ASS (DoE, 2006, cited in SWC, 2007).

A total of 40 samples were analysed for TAA to confirm pH_F results and to establish a relationship between pH_F and TAA. A good relationship was found between pH_F and pH_{KCL} (r^2 = 0.83). A reasonable relationship was found between pH_F and TAA (r^2 = 0.6) (SWC, 2007).

Using the critical acidity content of a soil as defined by the DoE (18 mol H^+/tonne) (SWC, 2007), and the relationships determined between pH_{KCL} and TAA and between pH_F and TAA at Tutunup South, the pH_F values corresponding to the critical acidity content are 5.14 and 5.38 respectively. Using the pH_F/TAA correlation, the critical acidity content determined by the DoE would mean that soil with a pH less than 5.38 would be classified as an AASS (SWC, 2007).

The majority of soils on the SCP have soil pH values between 5.0 and 7.0 (SWC, 2007). On the Whicher Scarp, most lateritic soils have pH values between 5.0 and 5.5, due to age, kaolinite content and Fe and Al oxyhydroxide contents (McArthur and Bettenay, 1974, cited in SWC, 2007) and most topsoils and subsoils have pH values between 4.5 and 5.0 due to fertiliser use (SWC, 2007). A critical soil pH value of 5.26 for AASS is therefore considered too high for defining AASS (SWC, 2007). It is considered that a soil pH value of 4.5 would be a more realistic value for identification of AASS, or 4.0 for a definitive presence assessment (SWC, 2007). A value of 4.0 is in line with DoE's definition of AASS (DoE, 2006, cited in SWC, 2007). The view that a TAA action criterion of 0.18 mol H+/tonne is not suitable for management of soils at Tutunup South as AASS is supported by independent expert review of the Tutunup South ASS survey report (Sullivan, 2007).

The AASS distribution maps based on critical soil pH_F values of 4.5 and 4.0 are shown in Figure 1. The areas that contain AASS are within the depositional basin and in the Yoganup Formation underlying the Guildford Formation (Figure 2) (SWC, 2007). Mining will intersect a small portion of AASS on the north western edge of the central pits.

No AASS is located within the overburden and minimal AASS is located within the ore.

PASS

The pH_{FOX} values ranged from 1.10 to 8.46. 70 % of samples were below 4.0. Of these samples, 31% were between 2.0 and 3.0, and 2 % were between 1 and 2. There is therefore significant PASS located at Tutunup South (SWC, 2007).

The S_{CR} content of 98 samples was measured to determine the actual amount of pyrite (or PASS) in those samples, and to then develop a relationship with pH_{FOX} values. S_{CR} results ranged from < 0.01 to 1.75 %. A good relationship was found between S_{CR} and pH_{FOX} (r2 = 0.91), so the pH_{FOX} values for all samples were converted to S_{CR} values (SWC, 2007). The predicted S_{CR} values ranged from <0.01 to 4.57 %. The critical sulphur content used by the DoE for identification of PASS is 0.03 %. There is considerable pyrite (PASS) at Tutunup South. Using the relationship between pH_{FOX} and S_{CR}, the critical sulphur content of 0.03 % equates to a pH_{FOX} value of 2.67. Therefore, a soil with a pH_{FOX} value less than 2.67 is considered to be a PASS (SWC, 2007). These soils are depicted in Figure 3.

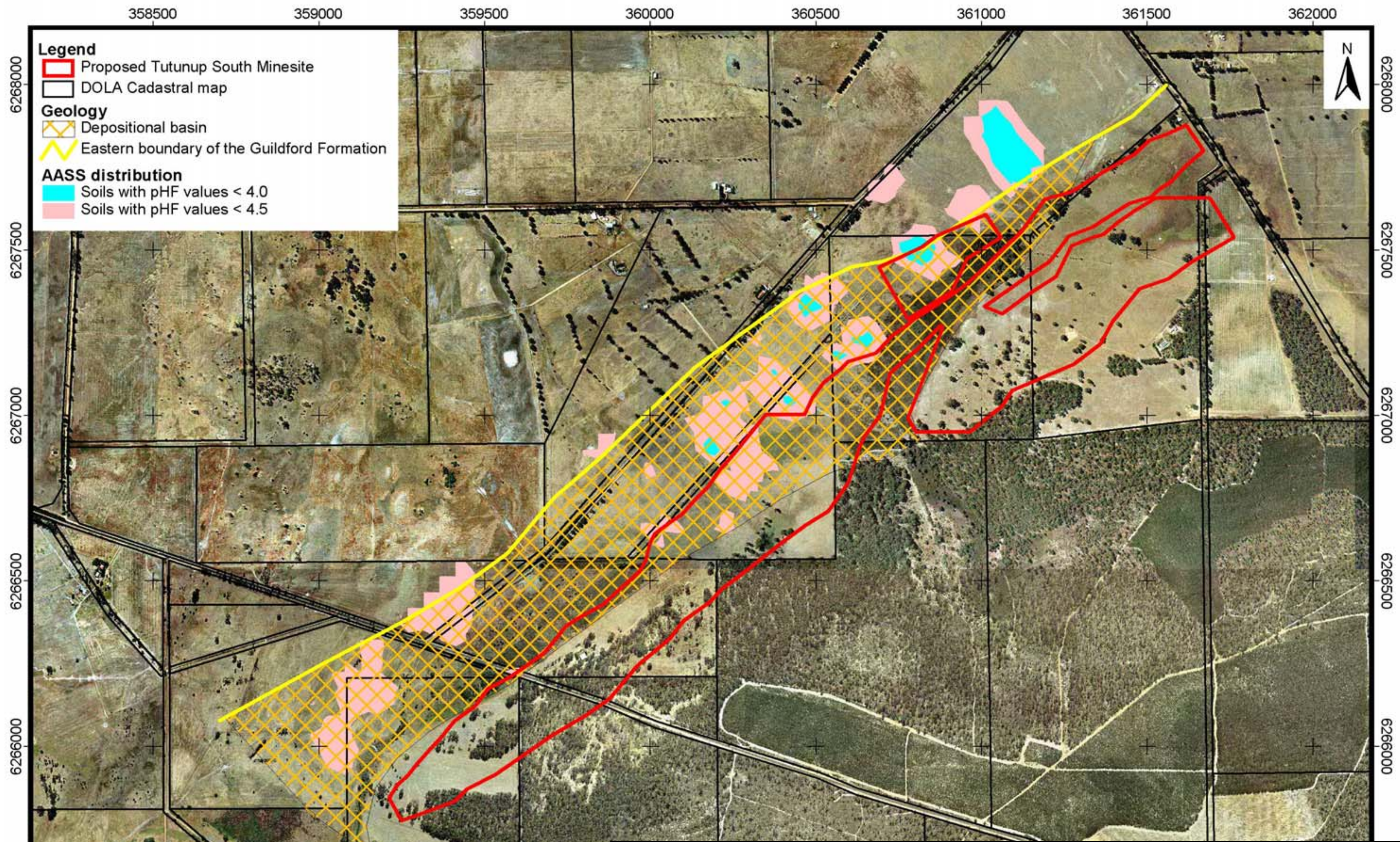
To ensure that the assessment of PASS is conservative, a second method of interpretation was used, whereby the highest pH_{FOX} value which returned an SCR of greater than 0.03 was considered to represent the critical sulphur content. The conservative pH_{FOX} cutoff would then be 3.31 (pers. comm., A. Pratt, 2007). Therefore all soils with a pH_{FOX} value equal to or less than 3.31 is considered to be a PASS.

This conservative estimation of PASS was then used to model the distribution of PASS throughout the deposit (Figure 4). It is estimated that of a total of 4,652,000 tonnes of overburden, 514,600 tonnes is potentially PASS affected (11 %). Of a total of 10,402,000 tonnes of ore, it is estimated that 1,430,000 tonnes (approximately 14 %) is PASS affected. Significant PASS is expected to occur in in-situ soil outside pit boundaries.

PN	PN0075-1-5-IR-065	
Prep by	ASP	02/05/07
Rev'd by	AJH	02/05/07
Revision No.		1

Iluka Resources Limited
TUTUNUP SOUTH MINESITE ASS SURVEY
DISTRIBUTION MAPS FOR THE VARIOUS AASS CLASSIFICATIONS

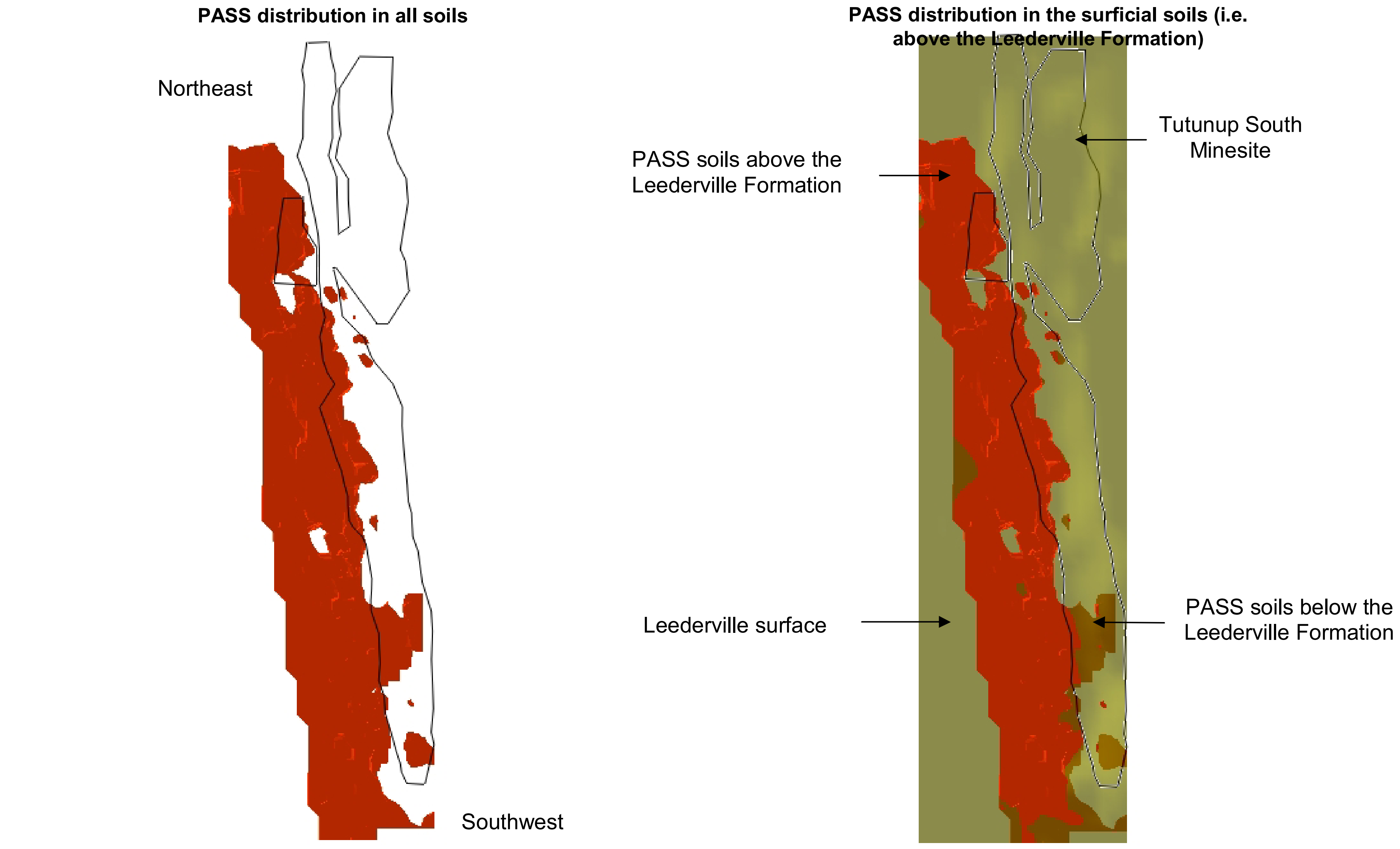
Figure 1



PN	PN0075-1-5-IR-065	
Prep by	ASP	02/05/07
Rev'd by	AJH	02/05/07
Revision No.		1

Iluka Resources Limited
TUTUNUP SOUTH MINESITE ASS SURVEY
DISTRIBUTION OF AASS IN RELATION TO GEOLOGY AND PROPOSED MINEPITS

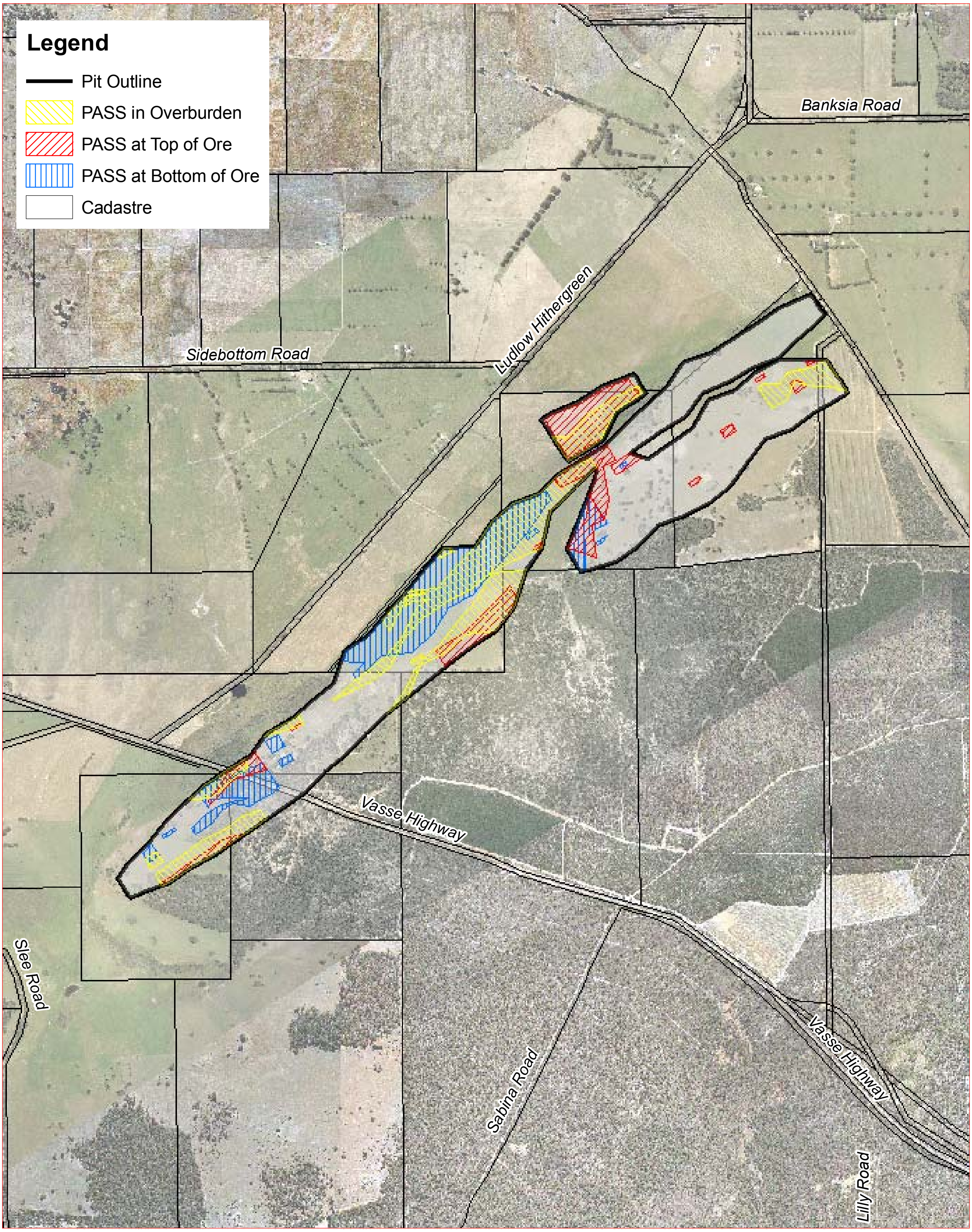
Figure 2



800 m

PN	PN0075-1-5-IR-065		Iluka Resources Limited TUTUNUP SOUTH MINESITE ASS SURVEY **DISTRIBUTION OF PASS (pHFOX < 2.67)** **PLAN VIEW**
Prep by	ASP	02/05/07	
Rev'd by	AJH	02/05/07	
Revision No.		1	

Figure 3



NOTE:
Aerial Photography dates:
Site - Nov 2005
Regional - 2001

N

0 500 1000 1500 m

MGA Coordinates, GDA94

ILUKA

TUTUNUP SOUTH

DISTRIBUTION OF PASS WITHIN MINE PITS (pH FOX <3.31)

ORIG:	S.J.
DRAWN:	D.L.S.
SCALE:	1:20,000
DATE:	Sept 2007

DWG No: 176751v00 | A4 | **FIGURE: 4**

Metal leaching

Suspension Peroxide Oxidation Combined Acidity and Sulfate (SPOCAS) analysis was conducted on soils used in the leaching investigation. Results showed that the majority of non-pyritic soils in the area have low actual (TAA) and potential (TPA) acidities (SWC, 2007). TAA values were often equal or greater than TPA values, indicating that these soils have already released all of their potential acidity. Several non-pyritic samples were found to contain significant potential acidity. This acidity was likely to be associated with either iron and aluminium oxides/oxyhydroxides or organic acids. Therefore, these samples could hydrolyse.

All soils tested in the leaching trial had very low arsenic, cadmium, nickel, zinc and mercury levels and most soils had chromium, copper and lead levels below the Ecological Investigation Level (EIL) (SWC, 2007). Only two samples had chromium levels in excess of the EIL and one sample had copper levels in excess of the EIL. It is therefore considered that the majority of soils at Tutunup South have low metal contents.

Leaching was conducted using a neutral solution and a strongly acidic solution. Leaching removed very little of the heavy metals and the leachability of the metals varied considerably. Chromium, arsenic and cadmium were held strongly (< 0.5 % leached), and copper, zinc and nickel were freely available to the leaching solution (up to 13 % leached). No significant difference was observed between the neutral solution or the acidic solution, indicating that metals were mainly removed from the exchange sites on the soils and the strongly acidic solution was unable to remove the structural metals (SWC, 2007).

Minimal release of heavy metals is expected to occur if soils hydrolyse or oxidise. There is therefore minimal risk to the environment if these soils are disturbed (SWC, 2007).

3. POTENTIAL IMPACTS

Mining within an area where ASS material exists presents the potential for acidic drainage to develop. Acidic drainage can create adverse impacts on mine-site water, infrastructure, groundwater and surface water quality, downstream beneficial uses, environmental values and post-mining rehabilitation. Potential impacts on ASS may result from either direct or indirect impacts.

At Tutunup South, the potential sources of acid drainage are the overburden, ore, HMC, oversize, clay fines, sand tails and the pit walls and floor.

During the mining process, non mineralised soils over the orebody (overburden) will be excavated and either stockpiled for later return to the mining pit or returned directly to another part of the mining void. Soils containing mineral (ore) are mined and processed to remove rock (oversize) and extract heavy mineral concentrate (HMC). Non-mineral soil components separated in this process are returned to the pit (sand tails) or solar drying dams (clay tails). Water is used in processing and is recycled through the system.

As each of the soil components are handled differently during the mining process, the potential pathways for development of acid drainage differ. These include:

- PASS:

- Overburden - Placement of PASS affected overburden in temporary stockpiles exposes the sulphides to atmospheric oxygen and may result in acid generation and acid drainage.

- Stockpiled ore and HMC - short-term stockpiling of PASS affected ore prior to processing may result in acid generation and acid drainage.

  When the ore is processed through the concentrator, sulphides are typically concentrated in the HMC. HMC may also be stockpiled on site prior to transport off site. The stockpiled HMC is also a potential source of acid generation and acid drainage.

- Process by-products including clay fines (<53µm), sand tails (>53µm, <2mm) and oversize (>2mm, recovered at the screenplant) - Sulfide concentrations in sand tails and oversize are generally significantly reduced and oxidiation within clay fines is significantly retarded, however there is some potential for acid generation and acid drainage.

- In situ pit wall and basement materials - Mining of the Tutunup South deposit will occur below the water table and dewatering will be required. Dewatering creates a cone of depression around the pit. This may lead to sulphide oxidation and acid generation within the cone of depression. Pit dewatering waters may therefore contain decreased pH or increased metals.

- AASS

  - Overburden – direct disturbance of AASS affected overburden and placement in temporary stockpiles may result in the release of acidity and mixing with non-AASS overburden resulting in its contamination.

  - Stockpiled ore and HMC - direct disturbance of ore by excavation and subsequent short-term stockpiling of ore or HMC may result in acidic runoff or leachate.

  - Process by-products including clay fines (<53µm), sand tails (>53µm, <2mm) and oversize (>2mm, recovered at the screenplant) – may contain acidity and therefore carry some potential for acid drainage.

  - In situ pit wall and basement material dewatering may result in mobilising acidity in the AASS materials.

Management of each of these potential sources is discussed in section 5.

4. PERFORMANCE INDICATORS/CRITERIA

Table 2: Performance Indicators/Criteria

Indicator No.	Subject	Indicator
1	Surface Water	Surface Waters to be discharged are within limits set in the site pollution prevention licence.
2	Groundwater	Groundwater in the vicinity of the site is within the background pH range for the piezometer, allowing for seasonal variation and regional differences.

5. MANAGEMENT

The management approaches proposed for Tutunup South are in line with those that have been developed by Iluka over the course of managing other acid sulfate soil sites in the south west. It is anticipated that changes to management may be made during the life of the Tutunup South Deposit. Review and revision of this plan will be as detailed in section 9.

The priorities for management of PASS are:

- avoid oxidation;
- minimise the rate of oxidation;
- neutralisation of acid; and
- treatment of acidic waters prior to release.

The priorities for management of AASS are:

- Reduce water infiltration into affected soils, thus reducing the potential to mobilise acidity; and
- treatment of acidic waters prior to release.

The proposed management actions for ASS affected material at Tutunup South are described below.

5.1. Overburden material (Bassendean Sand/Guildford Clay)

Approximately 4 652 000 t of overburden lies over the orebody at Tutunup South and therefore needs to be removed before the ore can be mined. The overburden is primarily pale grey sands and sandy clay soils from the depositional basin (sumpland area) on the western side of the proposed mine pit (SWC, 2007). Removed overburden will be either stockpiled on the surface or returned directly to the mine void as mining progresses.

5.1.1. AASS

There is no AASS within the overburden material and low levels of heavy metals (SWC, 2006a). No specific management is required.

5.1.2. PASS

There is estimated to be approximately 514 602 tonnes of PASS affected overburden, which is approximately 11 % of the total volume of overburden.

PASS locations identified through modelling will be incorporated into mine planning. Any PASS identified through operational monitoring will be highlighted to mine planners immediately, so that all PASS material can be separated from non-PASS overburden and managed appropriately.

The preference in managing PASS overburden is to directly return the material to the base of the mine pit (preferably under the water table). Where PASS overburden is returned directly to the pit void, once the dumping location is no longer to be used, or no dumping occurs at that location for a period of one week in summer and three weeks during winter, if PASS overburden is not submerged within one week during summer, or within three weeks during winter, it will be covered with at least 1 m of non-PASS overburden.

Where direct return is not possible, PASS overburden will be placed in a designated PASS overburden stockpile. During summer, if PASS overburden is to be stockpiled for more than one week, it will be covered with at least 2 m of non-PASS overburden. During winter, if PASS overburden is to be stockpiled for more than three weeks, it will be covered with at least 2 m of non-PASS overburden. The thicker cover of non-PASS overburden is required on stockpiles due to the greater capacity for moisture loss from stockpiled overburden. Bunding will be installed where required to control surface runoff from PASS affected overburden stockpiles. Runoff will be directed to the process water system as per all site water (see section 5.7).

Due to the high clay content and resultant low permeability of the overburden, the risk of impact to groundwater from leachate is very low; however a “guard” layer of limestone will be used as a base for PASS overburden stockpiles. The quantity of lime required per square metre of stockpile area will be based on 0.2 times the average Potential (SCR or TPA) and Existing Acidity (TAA) for every meter depth of the soil to be treated. Given the low risk of leachate being generated from the PASS overburden stockpiles it is considered unnecessary to include the safety factor of 1.5 – 2.0, as recommended in the Treatment and Management of Disturbed ASS Guideline (DoE, 2004).

On return, stockpiled PASS overburden will be placed as close to the base of the mine pit as possible.

PASS affected overburden will not be used in the construction of noise bunds.

5.2. Stockpiled Ore

Ore stockpiles will be established in the mine pits near the hopper locations to provide feed to the plant at night. Stockpiled AASS ore has the potential to leach and stockpiled PASS ore has the potential to oxidise, causing acidic leachate.

Where possible, AASS and PASS will be fed directly into the hopper, rather than being stockpiled in the pit. Should stockpiling of AASS or PASS be required, stockpiles will be sited such that drainage is toward a dewatering sump, so that any leachate from stockpiles will be captured in dewatering water and directed to the process water system, enabling treatment if required.

5.3. Oversize

Oversize makes up a small component of the ore. For Tutunup South, there is expected to be approximately 263 500 t of oversize, which is 2.5 % of the ore. Approximately 46 000 t of oversize (3.2 % of the PASS-affected ore) is predicted to be PASS affected. A very small quantity of oversize is predicted to be AASS affected.

Due to the small volumes of AASS and PASS affected oversize, no specific treatment or neutralisation is required (SWC, 2007). AASS and PASS affected oversize will be returned to the mining void at depth as soon as practically possible (within one to two weeks of stockpiling). Re-submergence will prevent oxidation of PASS from occurring (SWC, 2007).

5.4. Clay Fines

Clay fines generally contain significant quantities of pyrite. Whilst the potential for acidic material is acknowledged, the properties of the clay fines will limit the extent of oxidation and removal of oxidation products. Clay textured materials do not acidify as rapidly as sandy textured materials (Sullivan, 2007). Kinetic investigations conducted on Yoganup West clay fines material (GCA, 2005) indicate that pyrite oxidation is significantly limited by particle size and pore size, restricting water movement and retarding oxidation and the removal of products of oxidation in clay fines. SO_4 and soluble-acidity forms, are effectively trapped within micro-pores when the clayey-fines are relocated to the mine void (GCA, 2006).

When the ore is separated in the concentrator, one of the products is clay fines. These are the very fine materials that are less than 53 µm in size. Clay fines exit the process in a slurry form. This material cannot be directly returned to the pit due to the very high water content, but is first deposited into dams known as solar drying dams. The dams allow the fine materials to settle out of the slurry and for water to be decanted off the top and returned to the process water system for reuse. As noted in section 7.4, once the clay fines material is in a state where it can be handled by excavators and trucks, it is removed from the dam and returned to the mine void. Solar drying dams to be used for PASS affected clay fines will either have a clay base or will be lined with lime sand to neutralise any potentially acidic leachates.

5.5. Sand Tailing

Due to the particle characteristics of sand tails (predominantly sand grains with particle density of 2.65 g/cm³ and particle size greater than 53 µm), it contains little pyrite. However, also due to its particle characteristics, tails sand has high permeability and low water retention properties, such that it is well aerated, allowing oxidation. The poor buffering capacity of sand tails means that when PASS materials in sand tails oxidise, the pH can drop rapidly (SWC, 2007). This characteristic also means that overdosing with lime results in high pH (A Pratt pers. comm.).

Sand tails are returned directly to the mine void in slurry form. The time between excavation of material to deposition of sand tails in the mine void varies, however is estimated at approximately 2 hours. It is estimated that a total of 1000 kT of PASS sand tails is present at Tutunup South. Due to the volumes of PASS affected sand tails, and the very small quantities of lime that would be required to treat it, treatment of sand tails is likely to result in overliming. PASS affected sand tails will be treated with lime sand and deposited into the mine void at depths greater than 1 m below the final soil surface, in areas to be rehabilitated to pasture only.

5.6. Heavy Mineral Concentrate

The HMC from Tutunup South will contain significant amounts of pyrite. HMC is temporarily stockpiled on site before being transported to Capel for further processing. HMC stockpiles cannot be neutralised with limestone as calcium contaminates the HMC.

While stockpiling HMC cannot be avoided completely, where possible, stockpiling of ASS affected HMC will be scheduled to a minimum to minimise oxidation time for PASS and limit the opportunity for rainfall to cause acidic leachates from AASS and PASS materials.

The HMC stockpile pad will be located within a bunded area and will be constructed to allow capture of leachate from the stockpile.

5.7. Site Water

Water is removed from the mine pit to allow dry mining to occur. All dewatering water from the mine pit will be directed to the Process Water Dam to be used in processing. Surface runoff from disturbed areas and decant water from solar drying dams will also be directed to the process water system. Dewatering water, surface runoff and decant water from solar drying dams is preferentially used in the process over bore water to maximise water efficiency.

If site water exceeds processing requirements and storage capacities, water may be required to be discharged through a discharge point licensed by the DEC under the prescribed premise licence. Water discharge control is also detailed in the Ground and Surface Water Management Plan and Operating Strategy for Dewatering.

5.8. In situ soils

Dewatering of the mine pit causes drawdown of the water table, which has the potential to result in oxidation of pyritic soils around the pit. The degree of oxidation outside of the pit will be largely governed by the duration that such strata are locally unsaturated, and the diffusive supply of oxygen (GCA, 2006). Dewatering also has the potential to mobilise acidity from AASS material, which predominantly occurs in the northern section of the proposed mine pit.

At several locations at Tutunup South, the base of the pit is within 2 m of the upper surface of the underlying PASS material. PASS materials were also located adjacent to the western margin of the mine within the depositional basin. Groundwater dewatering may result in disturbance of this PASS, causing oxidation to occur. Cross sections of modelled PASS occurrence and modelled groundwater drawdown are shown in Figure 5.

When drawdown of the water table occurs, the soils along the pit face come into direct contact with the atmosphere.

Oxygen diffusion, and therefore oxidation, is strongly related to the water content, air filled pores and total porosity of the soil (SWC, 2006). In a saturated soil, the air-filled porosity is zero, so oxygen diffusion is minimal. As water is removed, the air-filled porosity increases and so does the oxygen diffusion rate.

The sediments within the depositional basin hold strongly onto water and therefore have a very low permeability and a high field capacity, which facilitates this material existing in a saturated or near saturated condition. At this moisture content, the air-filled porosity will be very small, resulting in reducing conditions (SWC, 2007). Dewatering during mining will only result in 'drying' of soil moisture levels to field capacity directly adjacent to the pit wall. At distances greater than 2 m from the pit wall, no appreciable change in soil moisture content is likely to occur, hence reducing conditions are likely to continue in the majority of the depositional basin during mining (SWC, 2007).

Limiting the extent of the cone of depression and the opportunity for oxidation is best achieved by minimising abstraction and backfilling the voids as quickly as possible. In the vicinity of the in-pit hopper located within PASS material, this method alone may be insufficient to prevent significant oxidation, as the hopper location will remain open for up to 3.7 years. Iluka is investigating the use of sealant products that can be applied to the pit wall in this location to form a barrier to oxygen diffusion and allow moisture retention in the material behind the pit wall. Several products are being investigated.

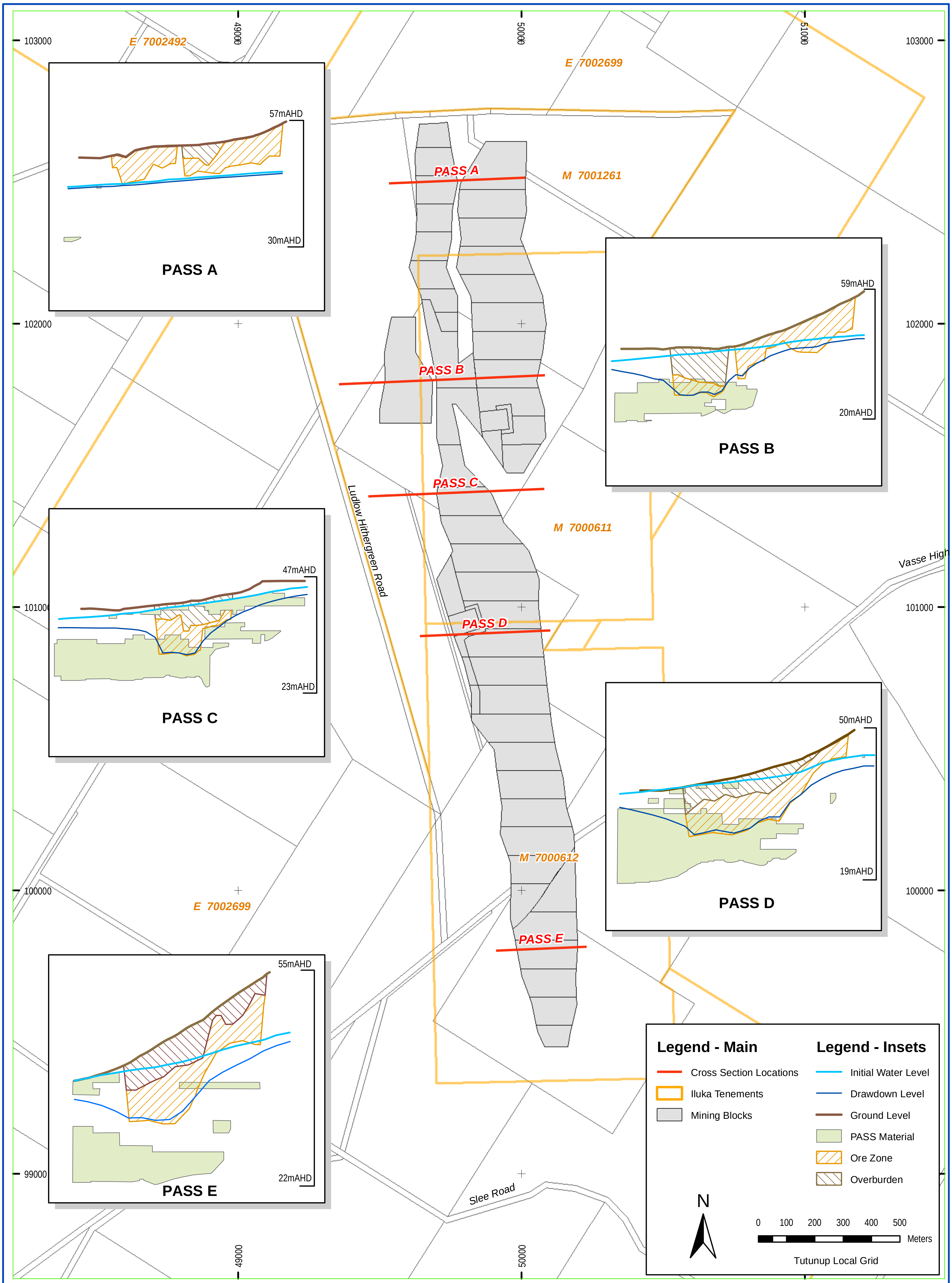
Sumps are located in the lowest areas of the mine pit so that pit water drains toward them. Three of the four sumps that will be required to operate the mine will be located within areas modelled as containing PASS. One of these three sumps is associated with an in-pit hopper. Sumps in areas of PASS can be managed to maintain moist conditions on the pit floor.

Management will include:

- Standard sump design involves digging a sump into the lowest part of the pit floor and installing a dewatering pump to remove water from the pit to allow safe working conditions for heavy equipment. At Tutunup South, for the three sumps located within PASS-affected material, dewatering will be modified to prevent PASS materials in the pit floor from becoming exposed. This will include managing sump pumping using float switches set to turn the pump off close to floor level, rather than manual operation, where there is the risk that the pump will be left running longer than necessary, which may result in exposure of PASS materials. This will ensure that the pit floor remains saturated. Maintaining high water levels may mean that scrapers cannot be used to mine the last half metre of ore. In this case, excavators or other machinery may be used to remove ore from the pit floor.

- in-pit hoppers are built on a hopper pad, consisting of a one metre thick pad of gravel and limestone. Standard practice is to dig a sump into the pit floor to collect water from the mine pit to prevent the hopper location from flooding. At Tutunup South, the depth of the sump near the PASS affected hopper location will be reduced to prevent dewatering into the PASS affected zone, with the hopper pad built up clear of water level. By doing this, water levels around the hopper can be maintained at the pit floor, so that any PASS material in the pit floor remains saturated.

- Any PASS material excavated from sumps will be handled as appropriate.



TUTUNUP SOUTH

PASS and GROUNDWATER DRAWDOWN CROSS SECTIONS

ILUKA

Ver.	ORIG	DRAWN	DATE	COMMENTS

REVISIONS

ORIG: P.French DRAWN: T.L.G SCALE: 1:12,500 (A3) DATE: 15 Feb. 2008 DWG No: 180841 ver.00

FIGURE: 5

6. MONITORING

Implementing a robust monitoring program allows for the verification of impact assessment and provides for the use of management techniques at appropriate times and in appropriate circumstances.

6.1. Overburden material (Bassendean Sand / Guildford Clay)

The presence or absence of ASS affected overburden as predicted by modelling will be verified by pH_F and pH_{FOX} monitoring and, where potential positive results are found, XRF to determine sulphur levels. Samples with sulphur levels over 0.03% will be considered to be PASS (see Table 3). Validation samples will be taken whereby all high sulphur samples will be tested for S_{CR} to ensure that assessment is appropriate.

6.2. Stockpiled Ore

All ore stockpiles are located within the pit and leachates will be collected by dewatering sumps, which are monitored (see section 6.7). Monitoring of stockpiled ore is therefore not required.

6.3. Oversize

Hard rock which cannot be easily crushed cannot be tested. However, oversize which can be easily crushed and is intended for use as road base or will not be quickly submerged will be tested for PASS.

Monitoring of oversize will aim to identify the amount of sulphur in the oversize in order to identify PASS affected oversize so that it can be appropriately treated. XRF will be used to determine sulphur levels. Samples with sulphur levels over 0.03% will be considered as PASS.

Monitoring of oversize will be conducted as per Table 3.

6.4. Clay Fines

Monitoring of clay fines will aim to identify the amount of sulphur in the clay fines in order to identify PASS affected clay fines so that they can be appropriately managed. XRF will be used to determine sulphur levels. Samples with sulphur levels over 0.03% will be managed as PASS. Validation samples will be taken whereby high sulphur fines are tested for S_{CR} to ensure that management is appropriate.

Monitoring will be conducted as per Table 3.

6.5. Sand Tailing

The use and verification of PASS modelling will enable identification of PASS affected ore such that sand tails can be directed to the appropriate location.

Monitoring of sand tails out of the concentrator will identify the amount of sulphur in the sand tails in order to identify PASS affected sand tails. XRF will be used to determine sulphur levels. Samples with sulphur levels over 0.03% will be considered PASS. This monitoring will enable operations to keep records of the locations of PASS sand tails. Monitoring of sand tails will be conducted as per Table 3.

6.6. Heavy Mineral Concentrate

HMC monitoring will aim to identify the amount of sulphur in HMC, and quantify the pH of leachate from the HMC stockpiles.

In addition, groundwaters in the vicinity of the HMC stockpiles will be monitored such that significant changes in water quality can be identified.

Monitoring will be conducted as outlined in Table 3.

6.7. Site Water

Monitoring of site water will aim to quantify the pH of site water so that this water can be appropriately managed. Site water includes in-pit dewatering sumps, decant water from solar drying dams and water dams.

Monitoring will be conducted as outlined in Table 3. At the cessation of mining, the monitoring program will be reviewed in consultation with the DEC to determine requirements for ongoing monitoring of groundwater. Site water is also considered in the Ground and Surface Water Management Plan.

6.8. In situ soils

There is an existing network of groundwater monitoring piezometers around the proposed Tutunup South site, measuring the superficial and Leederville aquifers (see Figure 6). Several piezometers are expected to be decommissioned once ground-disturbing activities commence as they are within the mine pit and associated infrastructure footprint.

Additional piezometers are planned to be installed further from the operations to assist in identifying the extent of change in piezometric head (Figure 6). These piezometers will be used as part of a monitoring program outlined in Table 3. Several piezometers are planned to be located along the western edge of the minepit in areas of both PASS and AASS. This will allow monitoring of groundwater quality in areas that have already oxidized and to assess any groundwater quality changes that may occur in PASS affected areas in response to mining-related activities. Groundwater monitoring is also considered in the Ground and Surface Water Management Plan.

The monitoring program for PASS is detailed in Table 3 below. This program will be reviewed and updated as required. Items in the monitoring table may also occur in related management plans. Where this occurs, reference is made in the table. Piezometers installed to characterise the hydrogeology of the site may occur within the disturbance area. Piezometers will be retained where possible, however several may require removal and will subsequently be removed from the Management Plan.

Table 3: Tutunup South PASS monitoring program

	Monitoring Site	Frequency	Analysis	Trigger	Action	Reference to other management plan
Piezometers	Selected piezometers: To be determined	Weekly	Field pH	>1 unit less than previous 12 months monitoring	See Figure 7	
				<4	1. NATA Accredited lab – Metals analysis for 4 weeks: Al; Cr; Cu; Fe; Mn; Mg; Ni; Zn; Cd; Se; As; Pb; Hg 2. After 4 weeks: - if pH constant/increased and no significant change in metals, return to normal monitoring; - if pH continues to decrease or significant change in metals, continue weekly analysis	
			Field EC	+/- 20 % from baseline in bore	Review all analysis	
			Field titratable acidity	+/- 20 % from baseline in bore	See Figure 7	
			$Cl:SO_4$	Change to < 4	See Figure 7	
		Monthly	SWL (mAHD)	To be determined		Ground and surface water management plan
		Quarterly	NO3; Ca, Na; K; Alkalinity; Al; Cr; Cu; Fe; Mn; Mg; Ni; Zn; Cd; Se; As; Pb; Hg			
	Superficial and Leederville piezometers: TS001, TS002, TS003S, TS003D, TS004, TS005S, TS005D, TS006, TS007, TS008S, TS008D, TS009	Monthly	SWL (mAHD)	To be determined		Ground and surface water management plan
		Quarterly	Field pH	>1 unit less than previous 12 months monitoring	See Figure 7	
				<4	Review all analysis	
			Field EC	+/- 20 % from baseline in bore	Review all analysis	
			$Cl:SO_4$	Change to < 4	See Figure 7	
			NO3; Ca, Na; K; Alkalinity; Al; Cr; Cu; Fe; Mn; Mg; Ni; Zn; Cd; Se; As; Pb; Hg			
	Regional Piezometers: To be installed	Quarterly	SWL (mAHD)	To be determined		Ground and surface water management plan
Surface Water	Process Water Dam (TSPD)	Monday to Friday	Field pH	>1 unit less than previous 4 weeks monitoring	Notify Management	
				< 5	1. Notify Management 2. Once per week for 4 weeks: Iluka lab – IC(SO4), pH, EC	

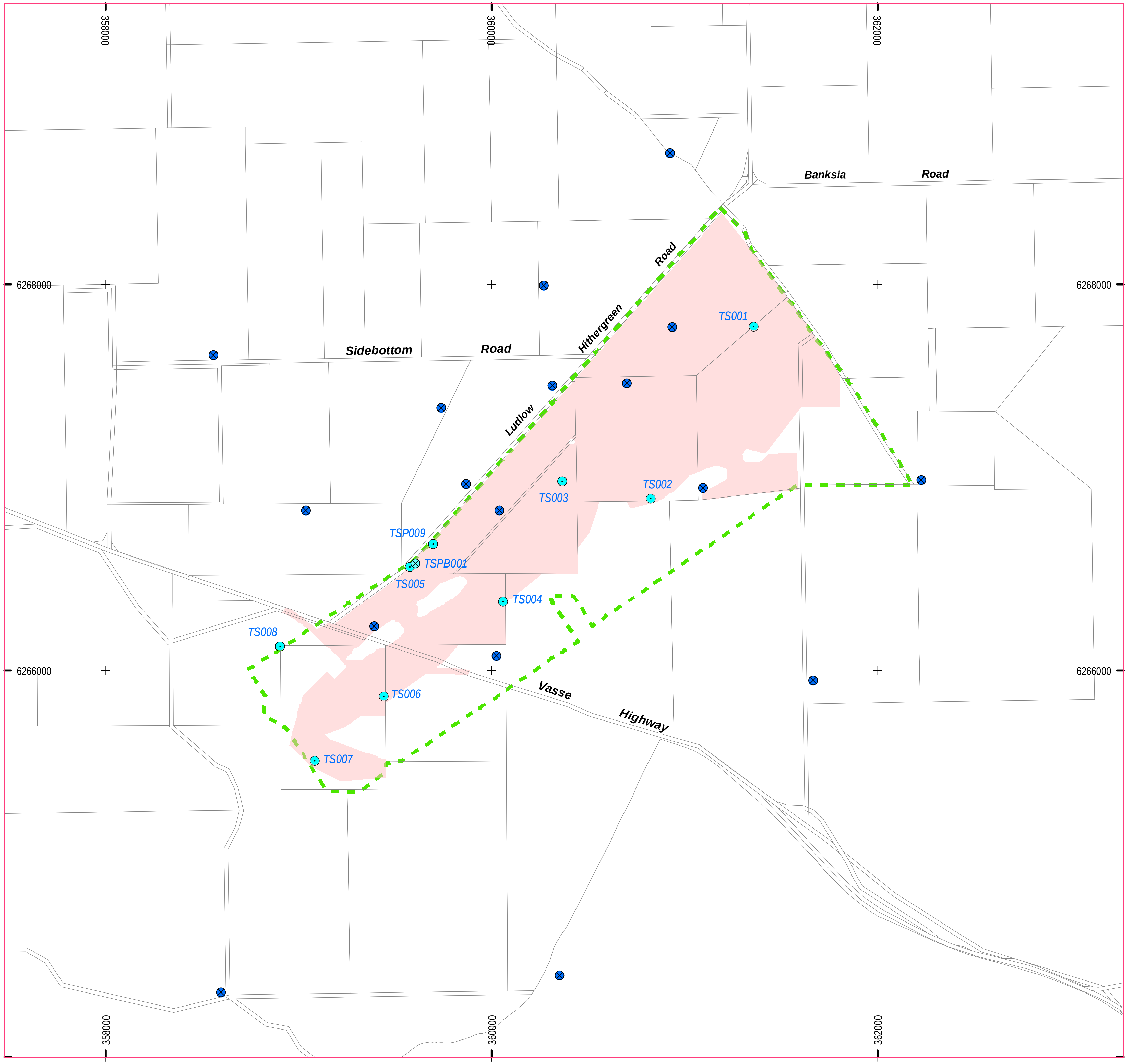
	Monitoring Site	Frequency	Analysis	Trigger	Action	Reference to other management plan
				< 4	1. Notify Management 2. Once per week for 4 weeks: Iluka lab: IC(SO4), pH, EC NATA lab: Al; Cr; Cu; Fe; Mn; Mg; Ni; Zn; Cd; Se; As; Pb; Hg; total acidity	
		Quarterly	pH EC Aluminium Calcium Manganese Iron Arsenic Cadmium Chromium Copper Lead Mercury Nickel Zinc Total Acidity Total Petroleum Hydrocarbons Total Suspended Solids	Check for increase from previous sample	Notify Management	Ground and surface water management plan
	Dewatering sumps, decant water, HMC stockpile leachate	Monday to Friday	Field pH	>1 unit less than previous 4 weeks monitoring	Notify Management	
				If changed to < 5	1. Notify Management 2. Once per week for 4 weeks: Iluka lab – IC(SO4), pH, EC	
				If changed to < 4	1. Notify Management 2. Once per week for 4 weeks: Iluka lab: IC(SO4), pH, EC NATA lab: Al; Cr; Cu; Fe; Mn; Mg; Ni; Zn; Cd; Se; As; Pb; Hg; total acidity	
			Field EC			
Soil	Overburden & in-situ ore – Pit face	Weekly	pH_F	< 4.5	Iluka lab: XRF (%SO3) >0.03 S, treat as PASS	
			pH_{FOX}	< 4; or Vigorous reaction (not organic)	Iluka lab: XRF (%SO3) >0.03 S, treat as PASS **Further Analysis for %SO3 >0.03S** NATA lab: SPOCAS +/or SCR + TAA	
			pH_{FOX} - pH_F	pH difference > 1 unit	Iluka lab: XRF (%SO3) >0.03 S, treat as PASS	
	Oversize – screen plant	Weekly	XRF (%SO_3)	> 0.03 S	Notify management – to be treated as PASS Nata lab: SPOCAS +/or SCR + TAA	
	Clay fines	Twice	XRF (%SO_3)	> 0.03 S	Notify management – to be treated as PASS	

	Monitoring Site	Frequency	Analysis	Trigger	Action	Reference to other management plan
		weekly			Nata lab: SPOCAS +/or SCR + TAA	
	Sand tails - concentrator	Twice daily	XRF (%SO_3)	> 0.03 S	Notify management – to be treated as PASS **Further Analysis for %SO3 >0.03S** Nata lab: SPOCAS +/or SCR + TAA	
	HMC - Concentrator	Twice daily	XRF (%SO_3)	> 0.03 S	Notify management – to be treated as PASS **Further Analysis for %SO3 >0.03S** Nata lab: SPOCAS +/or SCR + TAA	

*significant change defined as: 10 % higher than the highest baseline reading or over trigger level

REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S.	D.G.S.	9.08.07	Original version
01	L.S.	D.G.S.	14.09.07	Proposed piezos added



Legend

- Piezometer
- Production Bore
- Proposed Piezometer
- Mine pits and associated infrastucture
- Project area

N

0 500 1,000 m

MGA Coordinates, GDA94

ILUKA

ORIG: L.Sadler
DRAWN: D.G.S.
SCALE: 1:20,000
DATE: 14 Sept. 2007

TUTUNUP SOUTH

GROUNDWATER MONITORING LOCATIONS

DWG No: 176489 ver.01 | A3 | FIGURE: 6

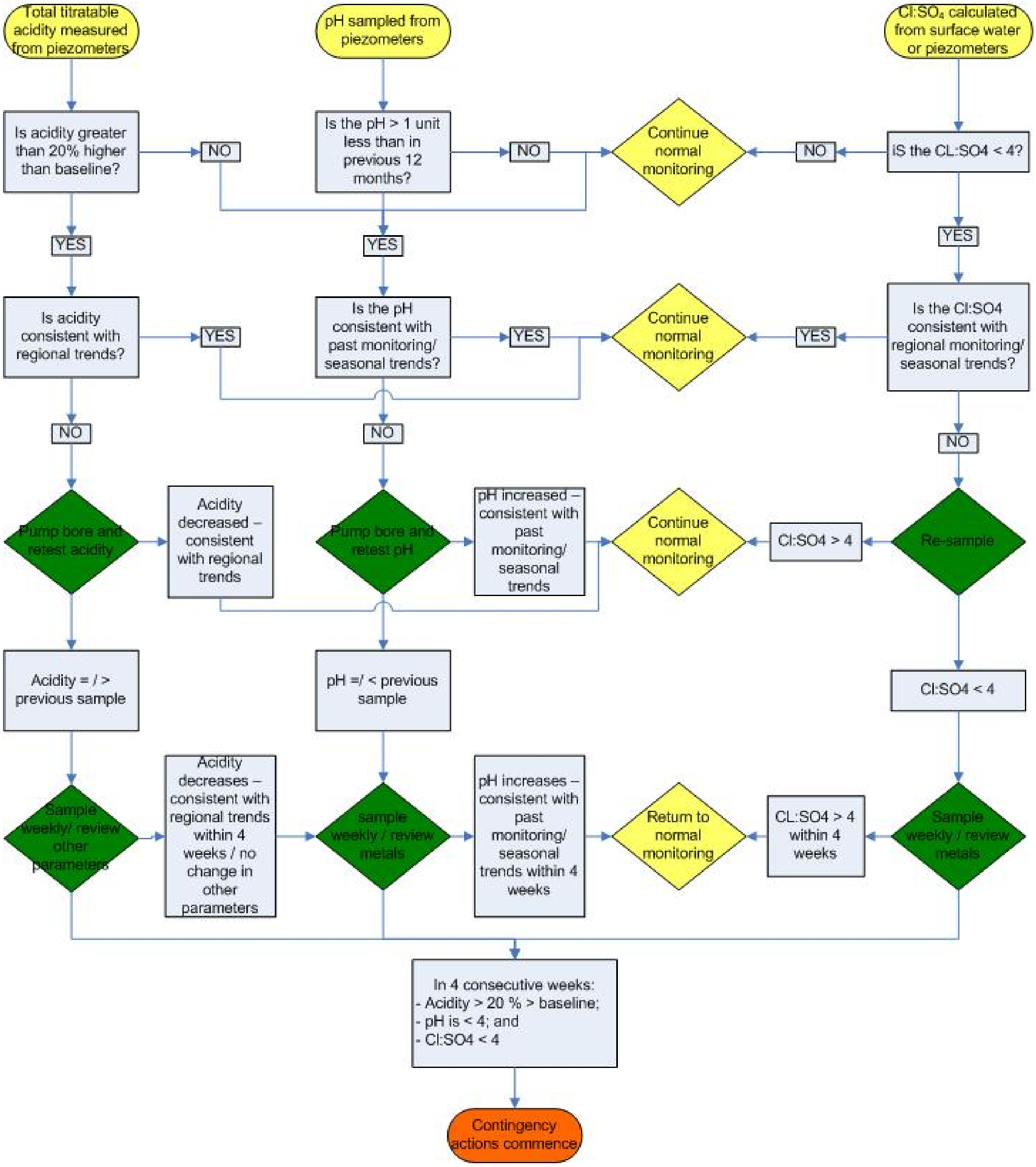


Figure 7: Action trigger flowchart for piezometer monitoring

7. CONTINGENCY

7.1. Overburden material (Bassendean Sand/Guildford Clay)

If insufficient non-PASS overburden is available to cover stockpiled PASS overburden as described in section 5.1, or it is found that oxidation has occurred, agricultural limestone aggregate (or other neutralising materials) will be co-disposed with the PASS-affected overburden at 150% of the stoichiometric requirement for neutralisation of the maximum potential acidity of the sulphidic overburden. Exact dosing requirements will be determined by monitoring.

Treated PASS affected overburden will be placed as deep within the mine void as possible.

7.2. Stockpiled Ore

No contingency required.

7.3. Oversize

In cases where oversize will not be submerged below the permanent groundwater (based on the summer minimum water table) in less than 1-2 months, the material will be sampled to determine if it is PASS affected. Any PASS affected oversize will then be mixed and co-disposed with agricultural limestone.

7.4. Clay Fines

To minimise the period of oxidation prior to being returned to the mine void, dewatered clay fines will be excavated from solar drying dams and disposed of to the mine void once the material can be handled by excavators and trucks. This material will be buried to prevent oxidation.

7.5. Sand Tailing

Where monitoring suggests that sand tails were inappropriately located i.e. PASS tails located <1m below the final surface, these tails will be moved to an appropriate location (>1 m below the final surface).

7.6. Heavy Mineral Concentrate

If monitoring shows significant adverse changes in water quality such that contingencies are required (Figure 7), actions will be determined in consultation with the DEC.

7.7. Site Water

Should accidental discharge of unsuitable water occur, the DEC will be contacted. Should remediation be required, actions will be determined in consultation with the DEC. Accidental discharge is also covered by the Ground and Surface Water Management Plan. Where these plans differ, the Ground and Surface Water Management Plan shall prevail.

7.8. In situ soils

Should monitoring of groundwater piezometers indicate that contingency actions are required, the following will occur:

1. Comprehensive groundwater quality analysis will be conducted in the affected piezometer and nearby piezometers to assist in determination of the cause and extent of impact.

2. A program of drilling and testwork will be undertaken to delineate the affected area and further assist in the determination of cause and extent of impact.

3. A remediation plan will be developed and implemented. The remediation plan may include, but will not be limited to the inclusion of:

    - continued monitoring of a low level or isolated change in water quality to identify any increase or dissipation of contamination.

    - Altering mining and backfilling to reduce impacts. Optimising of mining and backfill have been considered in project planning. However, differences between the modelled and actual environments have the potential to result in exposure of material that was not modelled as PASS, and may necessitate a change in methodology. In this case, priorities for backfill may be altered to ensure that PASS materials are backfilled into the pit (with appropriate treatments) as quickly as possible, thereby preventing further oxidation. This type of contingency may also involve the use of certain types of pit materials to cap other materials and prevent them from oxidising.

    - Re-injecting water into trenches or bores or other engineering solutions. Reinjection would require a suitable source of water to be available and a method of returning it to the ground to be determined that would be suitable for the extent, depth and location (upstream or downstream) of the observed impact. This type of technology and other engineering solutions to groundwater issues have been used previously for varying purposes and with varying degrees of success. Investigation of previous attempts would be conducted to ensure the greatest chance of success of implementation.

    The merits of contingency actions will be required to be assessed on an individual basis in regard to the observed impact, in terms of the type, scale (spatially, temporally and by level) and cause of any impact found; as well as the potential for improvement as a result of implementing that contingency, and the potential for adverse impacts associated with the contingency itself.

4. Should it be determined in consultation with the DEC that significant acid sulphate soil related impacts have occurred due to mining the Tutunup South Deposit, and that these impacts cannot be satisfactorily managed and remediated, extraction and mining will cease.

8. REPORTING

Environmental compliance reports will be submitted to the DEC annually, as an appendix to the Annual Environment Report (AER).

If monitoring triggers the need for contingency actions, the DEC will be notified within 7 days of the need becoming known.

The compliance report will be based around the items in the key management actions table and will provide evidence of compliance with the management plan, in the form of relevant monitoring data and other management records.

9. REVIEW AND REVISE

This management plan will be reviewed to assess its suitability, adequacy and effectiveness in meeting the set objectives annually, or more frequently as deemed necessary by Iluka. Where necessary, the plan will be revised and revisions will be submitted to the DEC.

10. KEY MANAGEMENT ACTIONS TABLE

Table 4: Key Management Action Table

Key Management Actions	Evidence of demonstration
Conduct monitoring as per Table 3	Monitoring data
Direct return of PASS-affected overburden where possible	PASS-affected overburden not stockpiled longer than non-PASS-affected overburden
PASS affected overburden returned to pit covered with 1 m non-PASS overburden (unless submerged within 1 week during summer or 3 weeks during winter).	Materials movement records
Stockpiled PASS affected overburden covered by 2 m non-PASS overburden after 1 week in summer and 3 weeks in winter	Materials movement records
No PASS affected overburden used in construction of noise bunds	Materials movement records
PASS affected ore stockpiles drain toward sump	Stockpile position / drainage design
PASS affected oversize material returned to mine void at depth within 1-2 weeks of stockpiling	Materials movement records
Solar drying dams either clay based or lined with lime sand	Records of construction
Clay fines excavated from Solar Drying Dams and disposed of in mine void once material can be handled	Condition of clay fines in dams
Sand tails disposed into mine void at appropriate depth	Materials movement records
HMC stockpile constructed to allow capture and treatment of leachate	Stockpile design
Dewatering water/surface runoff collected	Water system diagrams
Discharged water within licence limits	Discharge point water quality records

11. REFERENCES

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Sullivan, Prof. L. (2007) *Third-party review of acid sulfate soil assessment and management in selected mining operations in south-west Western Australia*. Unpublished report prepared for Iluka Resources Limited.

Soil Water Consultants (2006) *Theoretical assessment of the potential for pyrite oxidation adjacent to the proposed Cloverdale minesite following groundwater drawdown during mining*. Unpublished paper prepared for Iluka Resources Limited.

12. DOCUMENT CONTROL

Version	Reviews/Changes	Create Date
A	First Draft	070822
B	LS reviewed/comments incorporated	070907
C	Internal Review/comments incorporated	070910
D	Submitted to EPASU and peer review	070914
E	Revised in response to EPASU/peer review comments	080122
F	Revised in response to EPASU comments	080414

Appendix 4

Ground and Surface Water Management Plan and Operating Strategy for Dewatering

Iluka Resources Limited

Ground and Surface Water Management Plan and Operating Strategy for Dewatering

Tutunup South Mineral Sands Project

April 2008

ILUKA-TR-T15791

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1. INTRODUCTION

This plan relates to the management of ground and surface water impacts at the proposed Tutunup South mine. This plan has been developed in conjunction with the Public Environmental Review (PER) impact assessment document. Implementation of this plan and compliance during operations is a commitment of the PER document.

This plan is also designed to fulfil the requirements of an Operating Strategy to support an application to the Department of Water (DoW) for a Groundwater Well Licence for proposed dewatering at Tutunup South. The purpose of an Operating Strategy is to detail Iluka's commitments to managing the impacts of dewatering, including describing the water source(s) to be used; water abstraction regime and infrastructure, monitoring and reporting commitments; methods proposed to manage impacts on the environment and other water users, contingency plans, and water efficiency measures employed. This plan is to be in place for the duration of the Tutunup South mine.

2. ENVIRONMENTAL OBJECTIVE

The objective of this plan is to maintain, to the maximum extent practicable, the integrity, functions and environmental values of water bodies and quantity and quality of groundwater within and adjacent to the project area.

3. PRE- MINE ENVIRONMENT

The Tutunup South site is located at the foot of the Whicher Scarp on mostly agricultural land, 15 km southeast of Busselton. The project also extends into forested areas on its southeastern side which includes both private and State forest vacant crown land and a gravel reserve vested with the Shire of Busselton.

3.1. Surface Hydrology

The project is located over two catchment areas, the Vasse-Wonnerup Estuary catchment (Abba River) and the Upstream Vasse-Sabina catchment (Sabina River) (Figure 1). Despite the close proximity of the Abba River east of the project, the site drains to the north and west, reporting to the Sabina River (Figure 2 and Figure 3). The Sabina River is diverted into the Vasse Diversion Drain shortly after. Within the project area (Figure 2), are two areas of wetland that remain vegetated (all other wetland areas are cleared for agricultural purposes). These two areas are known as the 'northern' and the 'southern' wetlands. The northern wetland (aquatic survey site T1) is shown in Figure 4 and the southern wetland (aquatic survey site T2) is shown in Figure 5. A small creekline (Woddidup Creek) exists to the south-west of the disturbance area (Figure 6) and two small drainage lines (D1 and D2) cross the project (Figure 3). The northern drainage line (D1) flows from the Whicher Scarp across the project area. The southern drainage line (D2) originates within the project area. Flow from both drainage lines and Woddidup Creek is diverted into a roadside drain at Sidebottom Road (Government of Western Australia, 2002). The drains flow into the Sabina River over 6 km downstream of the project.

Approximately 200 m further downstream, flow in the Sabina River is diverted to the Vasse Diversion Drain (Government of Western Australia, 2002).

Extensive modification has occurred as a result clearing and the installation of drainage systems (Government of Western Australia, 2002).

Wetland Research and Management (WRM, 2006) surveyed Woddidup Creek (T3 on Figure 2) and found it to be slightly disturbed due to local weed infestations and cattle access. Overstorey along the creek consists of a moderately dense stand of *Eucalyptus patens*. The understorey consists of dense, tall sedges, Myrtaceaous species and bracken fern. The sedge *Lepidosperma tetraquetrum* fringes the creek. No erosion or bank slumping was evident, although sedimentation was present at cattle crossing points. Given the extensive clearing in the area, the creekline was considered by WRM (2006) to be of high conservation value. The River Action Plan for the Sabina, Abba and Ludlow Rivers (Government of Western Australia, 2002) describes this section of the creek as unfenced and grazed with a number of weeds present.

Runoff from the project is seasonal, with minor drainage lines and agricultural drains experiencing dry periods. The wetlands are also seasonal, evidenced by having reduced to small shallow pools during early summer (WRM, 2006).

There are extensive wetland areas in the region. Wetland areas can be significant at a number of levels. Wetlands of international significance are listed under the Ramsar Convention which is an international treaty that covers the conservation of wetlands of international importance. Within Western Australia twelve of these wetland systems exist. The closest to Tutunup South is the Vasse-Wonnerup Estuary system, located more than 13 km to the northwest (Figure 1). Water from the project area does not report to the Vasse-Wonnerup Estuary.

Wetlands of national significance requiring protection are listed under the Directory of Important Wetlands and/or under the Australian Heritage Commission's Register of the National Estate. The nearest wetland of national significance is McCarley's Swamp, some 14 km north of Tutunup South (ANCA 1996 in WRM 2006). This fresh wooded swamp is one of the few permanent wetlands of its type remaining in the south of the Coastal Plain (ANCA 1996, cited in WRM, 2006 as before). This wetland does not receive surface water flow from the project area and lies outside the zone of influence from mine dewatering activities (WRM 2006).

Wetlands of regional significance within the Swan Coastal Plain are protected under the *Environmental Protection (Swan Coastal Plain Lakes) Policy*. There are no gazetted EPP wetlands or Conservation Category wetlands within 1 km of the Tutunup South project area. There is a conservation category wetland 2 km east of the project, on the Abba River. This wetland is located within the Whicher Scarp at a topography well above the Tutunup South project area and thus is not hydrologically linked to the wetlands at Tutunup South (WRM 2006) (Figure 1).

The lower land within the project area contains two Multiple Use wetlands as mapped by Hill *et al* (1996). They are UFI 596, classified as floodplain, closer to the scarp and UFI 13199, classified as Palusplain wetland. The wetlands are remnants of a linear paluslope/riverine wetland system that originally ran south-west across the site prior to historical clearing for agricultural purposes. Paluslope-type wetlands are seasonally waterlogged wetlands with a gentle topographic gradient (Semeniuk and Semeniuk 2004).

There is a high degree of disturbance within the wetlands and vegetation remains only in two areas of the floodplain wetland, occurring over 1 km apart (the northern and southern wetlands). The rest of the wetlands mapped by Hill *et al* (1996) are cleared for agricultural purposes. The areas with vegetation remaining within the project area, which retain much greater wetland function than the areas actively used for agriculture are discussed as the ‘northern’ and ‘southern’ wetlands. These wetland areas (T1 and T2) are similar in vegetation and morphological characteristics, being Myrtaceous wetlands dominated by perennial waterbutton (*Cotula* sp.) and with a number of native sedges with a surrounding ring of fringing *Melaleuca* spp. The southern wetland (T2) has been previously cleared and burnt (T Woodward, pers. comm). The wetlands were rated condition 3 and 4 on the Bush Forever Condition Rating. The northern wetland (T1) is fenced to exclude active grazing by stock, whereas the southern wetland is currently grazed by stock.

A site surface water assessment has been conducted by Wetland Research and Management (WRM 2006). The survey work considered the wetlands within the project to be compatible with Resource Enhancement category wetlands. Further assessment and liaison with DEC was undertaken, though the wetland classification has remained as Multiple Use.

A further wetland review was undertaken in 2007 by Biota to consolidate existing studies on the biological aspects of the Tutunup South wetlands and to place their attributes into context with similar ecological systems in the locality (Biota 2007c). Four other wetlands were considered to be equivalents to the Tutunup South wetlands at a broad comparison level being located within the south-eastern extent of the Swan bioregion, remnant paluslope wetlands and Cartis complex vegetation. Four wetland sites were selected and the comparative measures are summarised in Table 1.

Table 1: Summary comparison of wetland attributes (Biota, 2007)

Attributes	Tutunup South Wetlands	Comparison Sites			
		Cable Sands Wetland	Gavin's Road Wetland	Yoganup Wetland	Yoganup S Wetland
Approximate extent	9.3 ha (four discontinuous units)	4.0 ha	17.7 ha	69.6 ha	8.8 ha
Location relative to Tutunup South		27km to the north east	25km to the north east	14km to the north east	12km to the north east
Geomorphology	Gentle sloping sand and clay flats, incised drainage in south-west	Gentle sloping sand and clay flats	Gentle sloping sand and clay flats	Gentle sloping sand and clay flats, mosaiced with low linear sand ridges	Gentle sloping sand and clay flats
Hydrology	Seasonal waterlogging, seasonal inundation	Seasonal water-logging	Seasonal water-logging	Seasonal water-logging	Seasonal water-logging
Wetland types	Paluslope/Palusplain	Paluslope/Palusplain	Paluslope/Palusplain	Paluslope/Palusplain	Paluslope/Palusplain
Flora diversity	101 plant taxa	No data available	No data available	No data available	300 taxa in project area (a subset occurs in the wetland)
Dominant flora taxa:					
M. preissiana	Yes	Yes	Yes	Yes	Yes
M. rhaphiophylla	Yes			Yes	Yes
T. linearifolia	Yes		Yes	Yes	Yes
A. fascicularis	Yes	Yes	Yes	Yes	
A. scoparia	Yes				Yes
C. avenacea	Yes		Yes		Yes
Vegetation Complex	Cartis complex	Cartis complex	Cartis complex	Cartis complex	Cartis complex
Mammals	6 species recorded, one Priority 4 taxon (*Isoodon obesulus fusciventer*)	4 of the Tutunup South mammal species recorded from adjacent area	4 of the Tutunup South mammal species recorded from adjacent area	No site specific data, but 3 of the Tutunup South mammal species recorded from nearby	No site specific data, but 3 of the Tutunup South mammal species recorded from nearby

Attributes	Tutunup South Wetlands	Comparison Sites			
		Cable Sands Wetland	Gavin's Road Wetland	Yoganup Wetland	Yoganup S Wetland
				Yoganup 215	Yoganup 215
Herpetofauna	9 species recorded, all common in the bioregion	6 of the Tutunup South herpetofauna species recorded from adjacent area	5 of the Tutunup South herpetofauna species recorded from adjacent area	No site specific data, but 5 of the Tutunup South herpetofauna species recorded from nearby Yoganup 215	No site specific data, but 5 of the Tutunup South herpetofauna species recorded from nearby Yoganup 215
Avifauna	35 species recorded, all common in the bioregion	19 of the Tutunup South bird species recorded from adjacent area	No data available	No data available	21 species recorded, 60% of which also occurred at Tutunup South
Aquatic Invertebrates	98 taxa recorded. Six 'rare'* species, two of which were not found in any other wetland	No data available	One 'rare' species recorded that was not found at any other wetland.	No data available – dry at time of survey in November 2007	Three 'rare' species found, two of which were also identified from Tutunup South.
Survey Effort	Site inspection Systematic fauna survey Systematic flora survey Wetland survey	Site inspection Systematic fauna survey (data from 800m outside site) Systematic flora survey Wetland survey	Site inspection Systematic fauna survey (data from 200m outside site) Wetland survey	Site inspection Wetland survey	Site inspection Systematic flora survey Wetland survey

The results of this review indicate that there are other broadly similar wetlands in the locality that clearly replicate some of the ecological attributes of the Tutunup South wetlands. This includes occurring in the same locality, within the same bioregion, the same vegetation complex and being of the same wetland type.

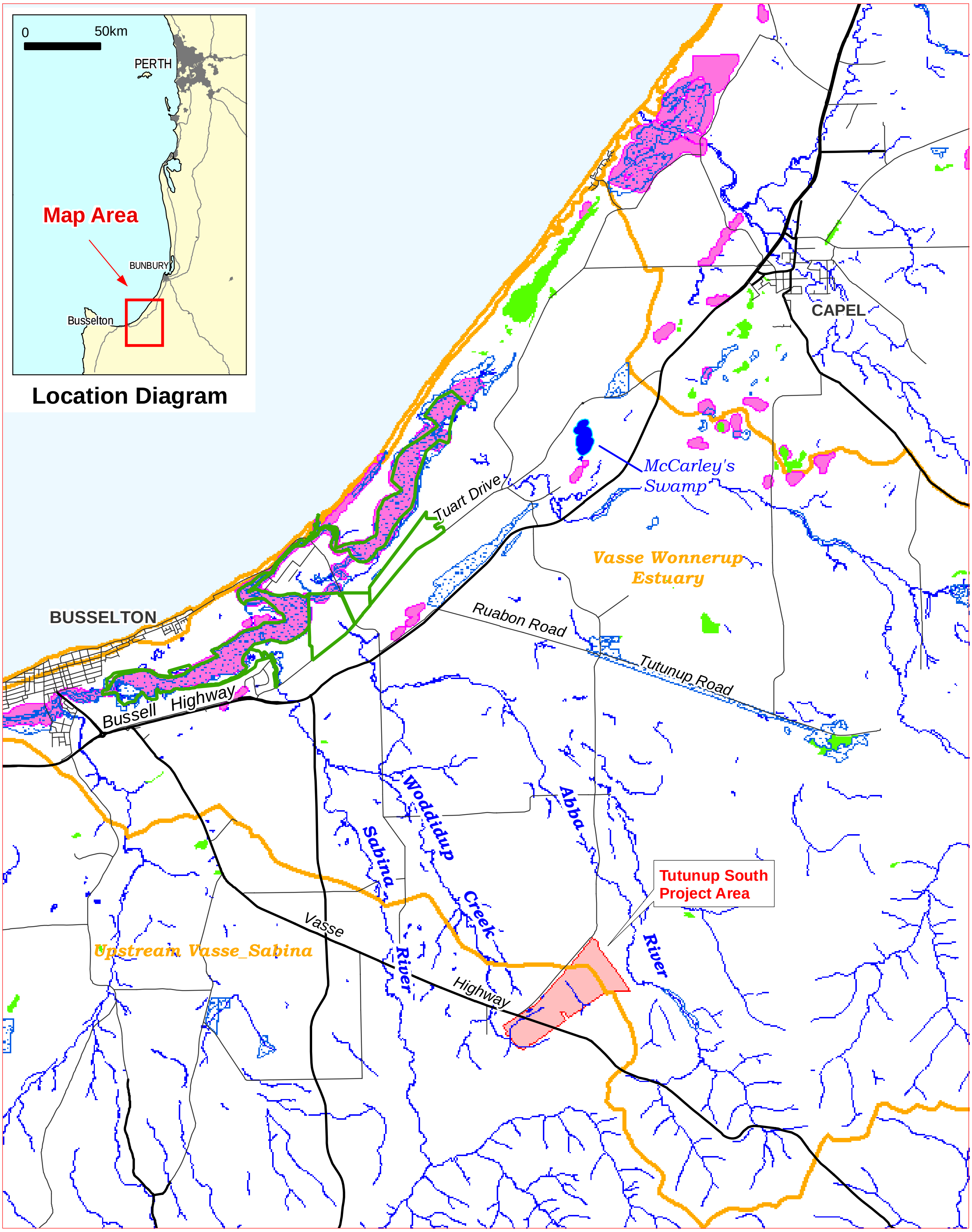
Macroinvertebrate sampling was conducted over the two wetlands and creekline, with the results included in the Native Fauna Management Plan.

3.2. Surface Water Quality

Surface water quality samples were taken from Tutunup South during the aquatic survey in November 2005. From the results obtained, all sites (two wetlands plus minor stream-flow from the seasonal creek) contained fresh water ranging from 443 uS/cm to 693 uS/cm. Water quality was also described as being acidic for all sites (4.53 to 5.98) when compared with the ANZECC/ARMCANZ (2000) trigger values. Total suspended solids (TSS) were low at all sites ranging from 2 mg/L to 11 mg/L.

In terms of eutrophic potential, all sites had a low dissolved oxygen concentration (57-59%), although only the southern wetland had nitrogen (1.5 mg/L) and phosphorous (0.06 mg/L) concentrations in excess of ANZECC/ARMCANZ (2000) trigger values for freshwater ecosystems. The northern wetland and creekline both had low concentrations of nutrients, indicating these have less exposure to agricultural influences than the southern wetland.

Using the ANZECC/ARMCANZ (2000) 95% guidelines for the protection of freshwater ecosystems aluminium and zinc were found to exceed trigger levels. The result for aluminium is not unexpected as it has been previously recorded in high concentrations during assessment for other sites and is expected to be related to the known occurrence of acid sulphate within the project area. All hydrocarbon analyses returned low concentrations.



Legend

- Wetland - Conservation category
- Wetland - Resource enhancement
- Important wetland
- Wetlands (DEP)
- Hydrographic catchments
- Drainage
- Ramsar site
- Project area

N

0 2.5 5 km

ILUKA

ORIG:	S.Edwards
DRAWN:	D.G.S.
SCALE:	1:150,000
DATE:	22 Jan. 2008

TUTUNUP SOUTH

CATCHMENT PLAN

DWG No: 178083 ver.01 | A4 | FIGURE: 1

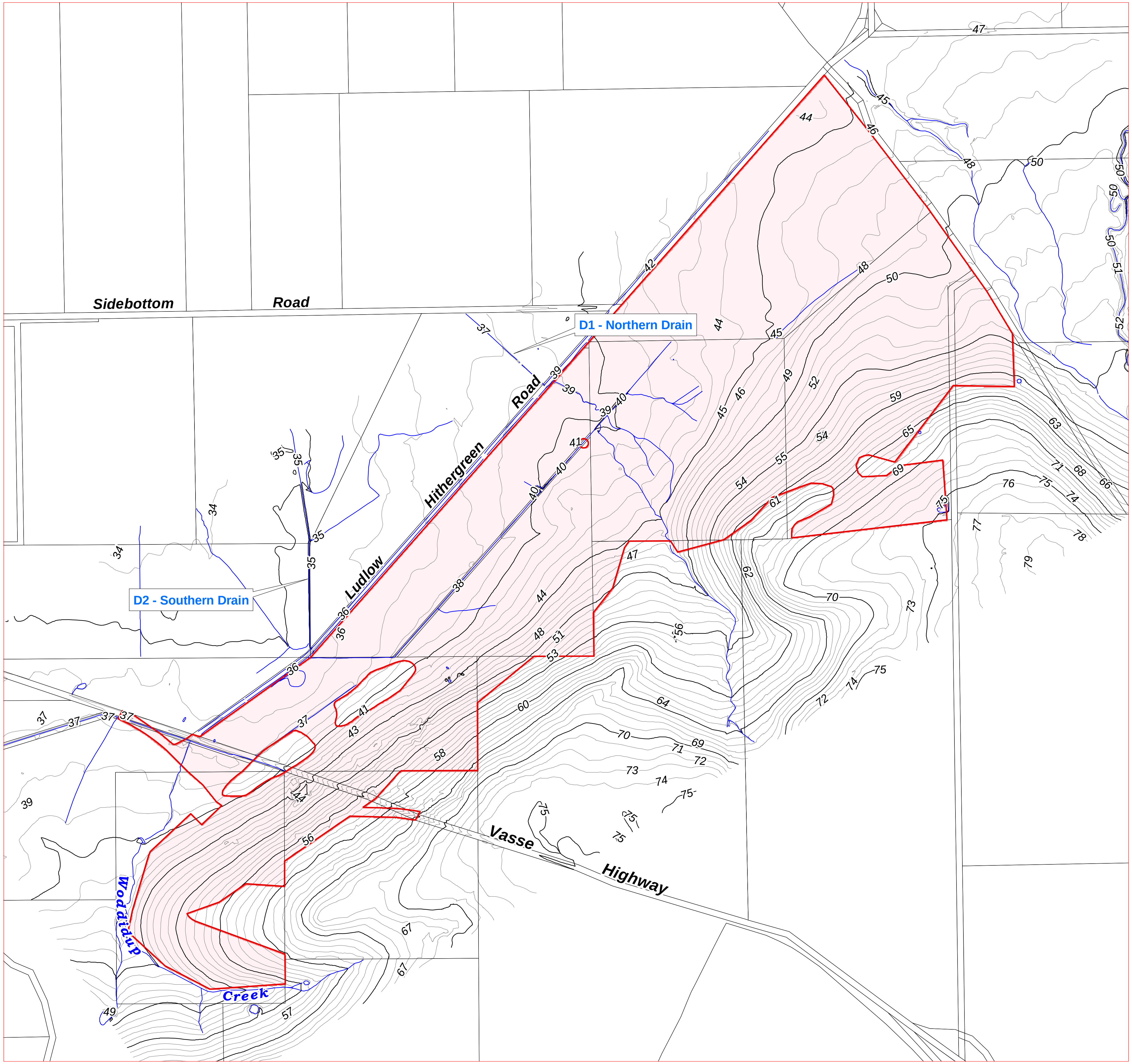
TUTUNUP SOUTH

REGIONAL DRAINAGE

ILUKA

ORIG:	S.Jones
DRAWN:	T.L.G
SCALE:	1:15,000
DATE:	8 April 2008

DWG No: 176769 ver.02 | A2 | FIGURE: 11



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	S.E	D.G.S	04.12.07	Original Design
01	S.J	T.L.G	08.04.08	Update of disturbance area

Legend

- Drainage features
- Disturbance area
- Contour (1m)
- Index contour (5m)

N

0 250 500 m

ILUKA

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:12,500
DATE: 8 April 08

TUTUNUP SOUTH

EXISTING SURFACE DRAINAGE

DWG No: 178472 ver.01 A3 FIGURE: 3

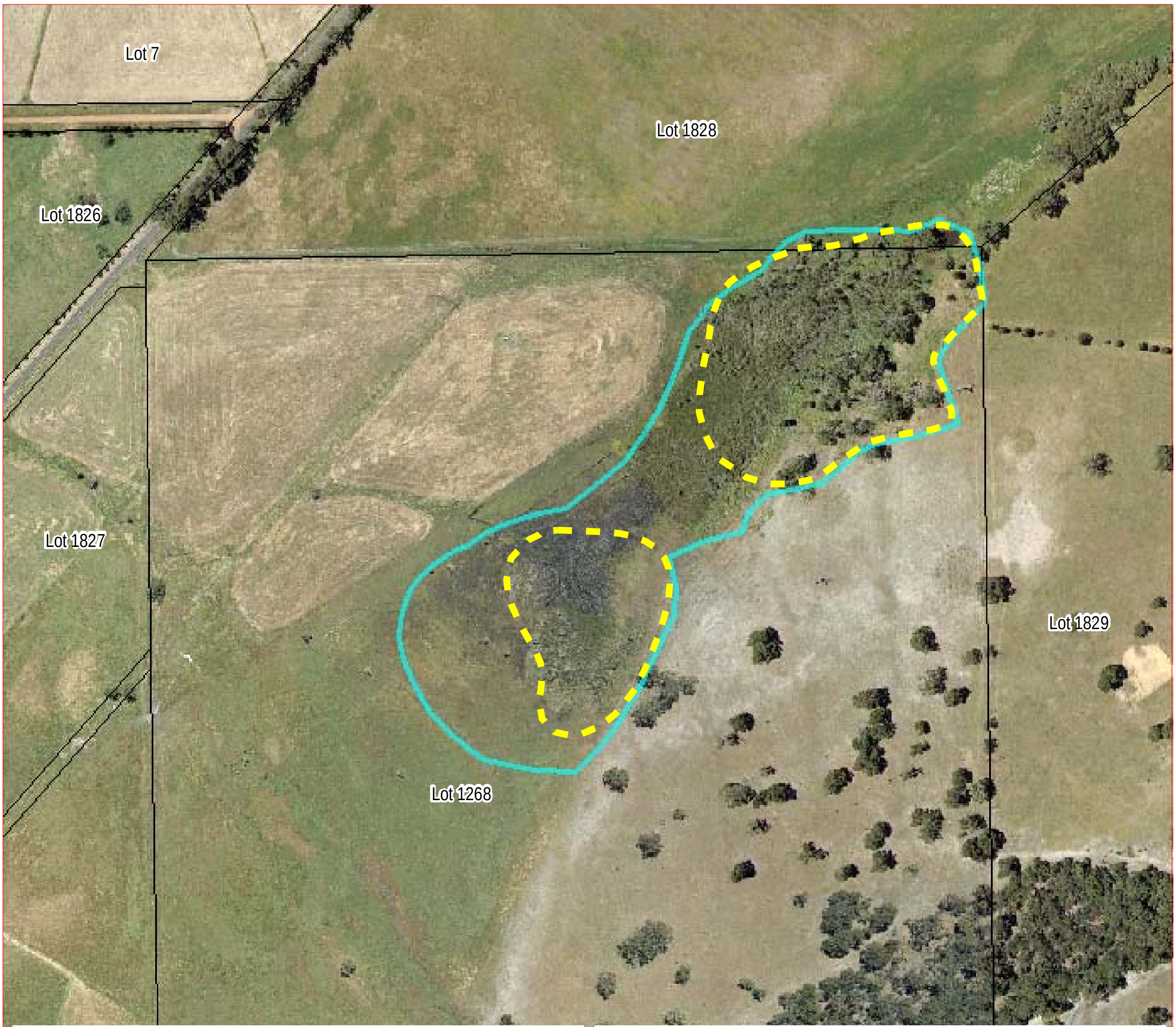


Plate 1. Site T1, showing wetland vegetation.

Plate 2. One of the tannin-stained shallow pools used for sampling at wetland site T1.

Legend

Wetland vegetation

Inundation Areas

N

Date of aerial photo; 19 Nov. 2005

0 100 200 m

ILUKA

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:5,000
DATE:	9 Aug. 2007

TUTUNUP SOUTH

NORTHERN WETLAND (Site T1)

DWG No: 176486 ver.00 A4 FIGURE: 4

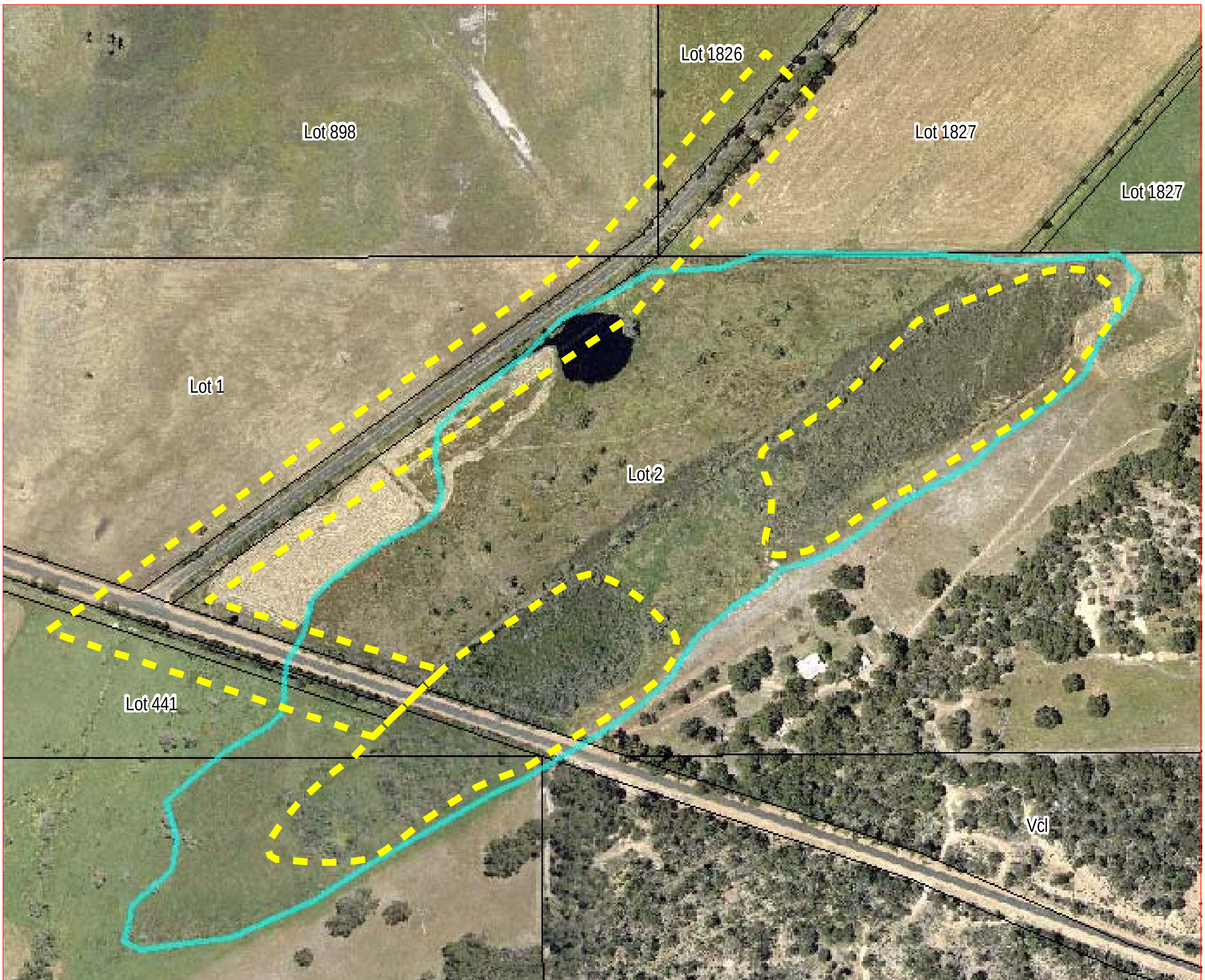


Plate 1. The wetland area at site 2, showing the major vegetation types; Melaleuca and Myrtaceae over pasture

Plate 2. One of the tannin-stained shallow pools surrounded by sedges and waterbutton at T2.

Legend

Wetland vegetation

Inundation Areas

N

Date of aerial photo. 19 Nov. 2005

0 100 200 m

ILUKA

ORIG: L.Sadler

DRAWN: D.G.S.

SCALE: 1:5,000

DATE: 9 Aug. 2007

TUTUNUP SOUTH

SOUTHERN WETLAND (Site T2)

DWG No: 176487 ver.00 | A4 | FIGURE: 5

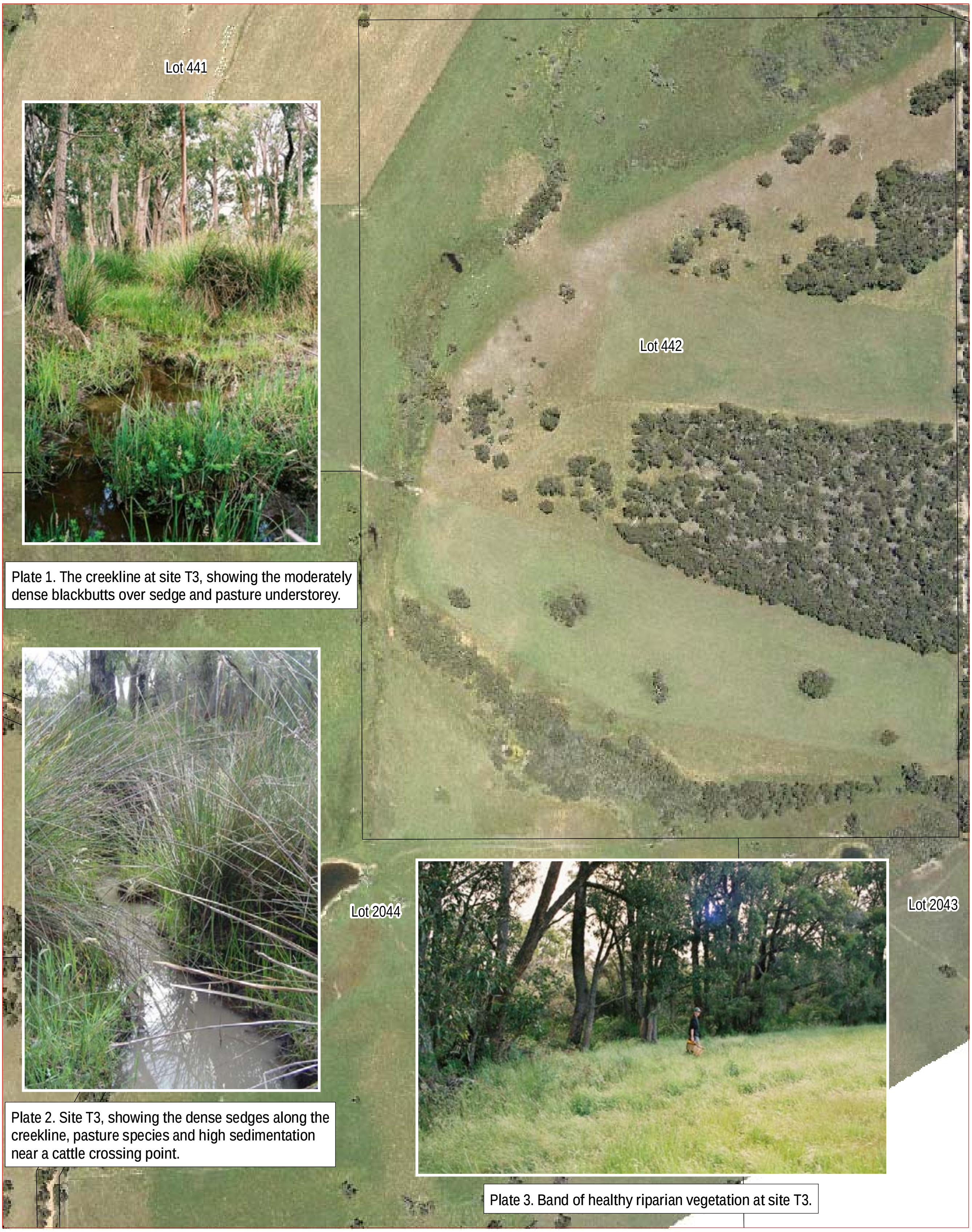


Plate 1. The creekline at site T3, showing the moderately dense blackbutts over sedge and pasture understorey.

Plate 2. Site T3, showing the dense sedges along the creekline, pasture species and high sedimentation near a cattle crossing point.

Plate 3. Band of healthy riparian vegetation at site T3.

Date of aerial photo; 19 Nov. 2005

N

0 100 200 m

ILUKA

ORIG: L.Sadler

DRAWN: D.G.S.

SCALE: 1:5,000

DATE: 9 Aug. 2007

TUTUNUP SOUTH

CREEKLINE (Site T3)

DWG No: 176488 ver.00 | A4 | FIGURE: 6

3.3. Groundwater Aquifers

3.3.1. Superficial Aquifer

The project is located at the foot of the Whicher Scarp (Figure 7) on the Swan Coastal Plain within the Southern Perth Basin. It is within the Capel subdivision of the Busselton-Capel Groundwater Area.

An unconfined groundwater lens in the Bassendean Sands is caused by low permeability clays of the Guildford Formation retarding the downward flow of groundwater. This results in perching of shallow groundwater depths, seasonal waterlogging and the expression of wetlands in local depressions. The Guildford Formation itself is described by Parsons Brinkerhoff (2006) as a discontinuous aquifer/aquitard having a low transmissivity due to its clay particle size, thus forming a hydraulic barrier below and above it.

Below the Guildford Formation lies the sandy beds of the Yoganup Formation. Test pit excavations at Tutunup South have confirmed this to be a greater yielding aquifer than those above it. The mineral sands ore zones are also within Yoganup Formation and thus are expected to be where the bulk of groundwater interception during mining will be encountered. Recharge is limited where the Guildford Formation overlies the Yoganup Formation. However, the presence of the Whicher Scarp enables recharge of the Yoganup Aquifer where the Guildford Formation is absent and from the Leederville Formation which is elevated in the Whicher Scarp, compared to the Yoganup Formation on the coastal plain (SWC 2007).

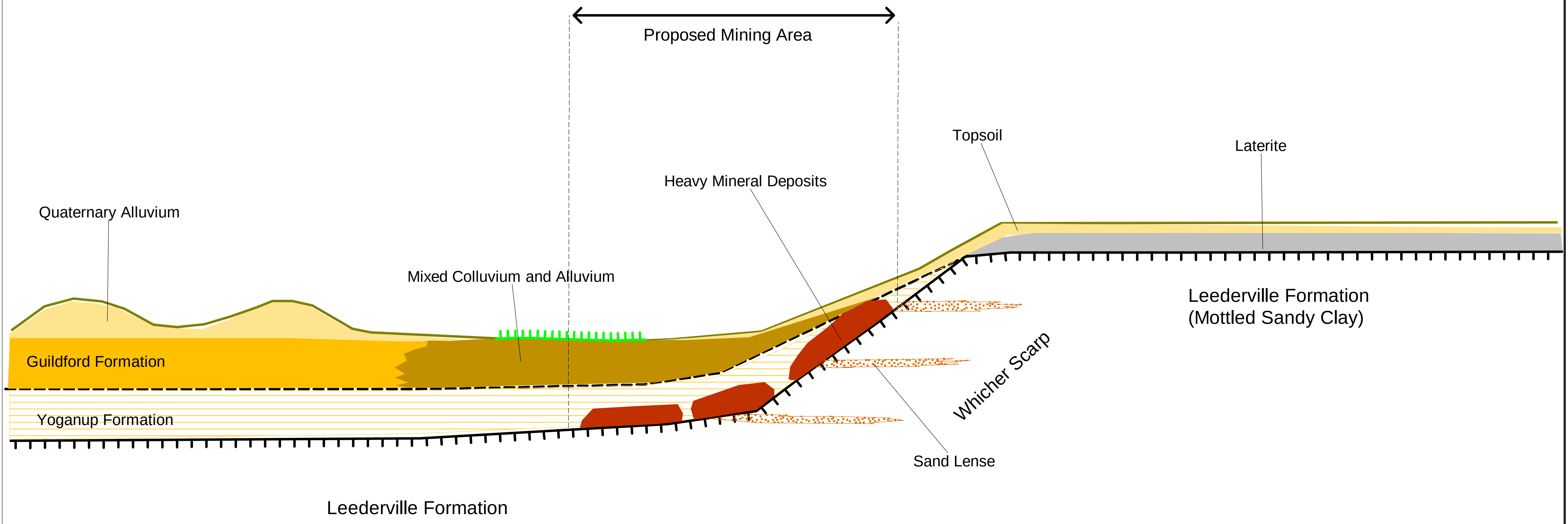
Groundwater flow is to the north-west between Capel and Donnybrook, and salinity is generally less than 500 mg/L, deteriorating with depth.

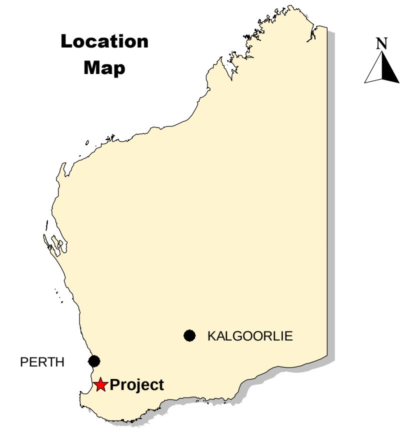
3.3.2. Leederville Aquifer

The Leederville Aquifer subcrops extensively beneath the superficial aquifer in the area and comprises inter-layered sandstones and shales of the Leederville Formation. Regional recharge is provided through infiltration of rainfall on the Blackwood Plateau to the south and by localised downward leakage from the superficial aquifer or upward leakage from the Yarragadee Formation. Where present, the Bunbury Basalts act as a strong aquiclude impeding vertical groundwater movement. Bunbury Basalts have been encountered by exploration drilling towards the northern end of the project. Groundwater flow in the Leederville Aquifer is to the northwest, discharging into the ocean via the Leschenault Inlet.

3.3.3. Yarragadee Aquifer

The Yarragadee Aquifer forms the major groundwater resource in the Bunbury-Busselton region. The aquifer is hosted by the weakly consolidated sandstone, siltstone and shales of the Yarragadee Formation. Recharge is principally achieved by leakage from superficial aquifers where the Leederville Formation and Bunbury Basalts are absent.





LEGEND

- Ground
- Sand Lenses
- Yoganup Formation
- Guildford Formation
- Quaternary Alluvium
- Mixed Colluvium and Alluvium
- Heavy Mineral Deposits
- Laterite
- Leederville Formation

Not To Scale

aquaterra

Figure 7 Geology Cross-Section

Author:	Date: 10/05/07
Drawn:GB	Revised:23/05/07
Job No: 706	Report No.:
Projection: N/A	Scale: Not to Scale

F:\jobs\F:\Jobs\706\Data\Mapinfo\Figures

3.4. Groundwater Piezometers and Bores

A series of piezometers have been installed around the site to measure groundwater before, during and after mining (Figure 8). The piezometers installed include four measuring the superficial aquifer and seven measuring the Leederville Aquifer.

Subsequent to the installation of these piezometers, a production bore was installed in the south of the project area to a depth of 250 m below ground level extending well into the Yarragadee Aquifer. A nest of three piezometers were also installed, with one measuring the Leederville Aquifer and two measuring the Yarragadee Aquifer (Parsons Brinckerhoff 2007).

The recent modelling conducted by Aquaterra (2007) has recommended the installation of additional monitoring bores to assist gauging the impact of mining operations further away from the mining area. In addition, Iluka has proposed further piezometers both inside and outside the predicted drawdown area (Figure 8).

3.5. Groundwater Quality and Quantity

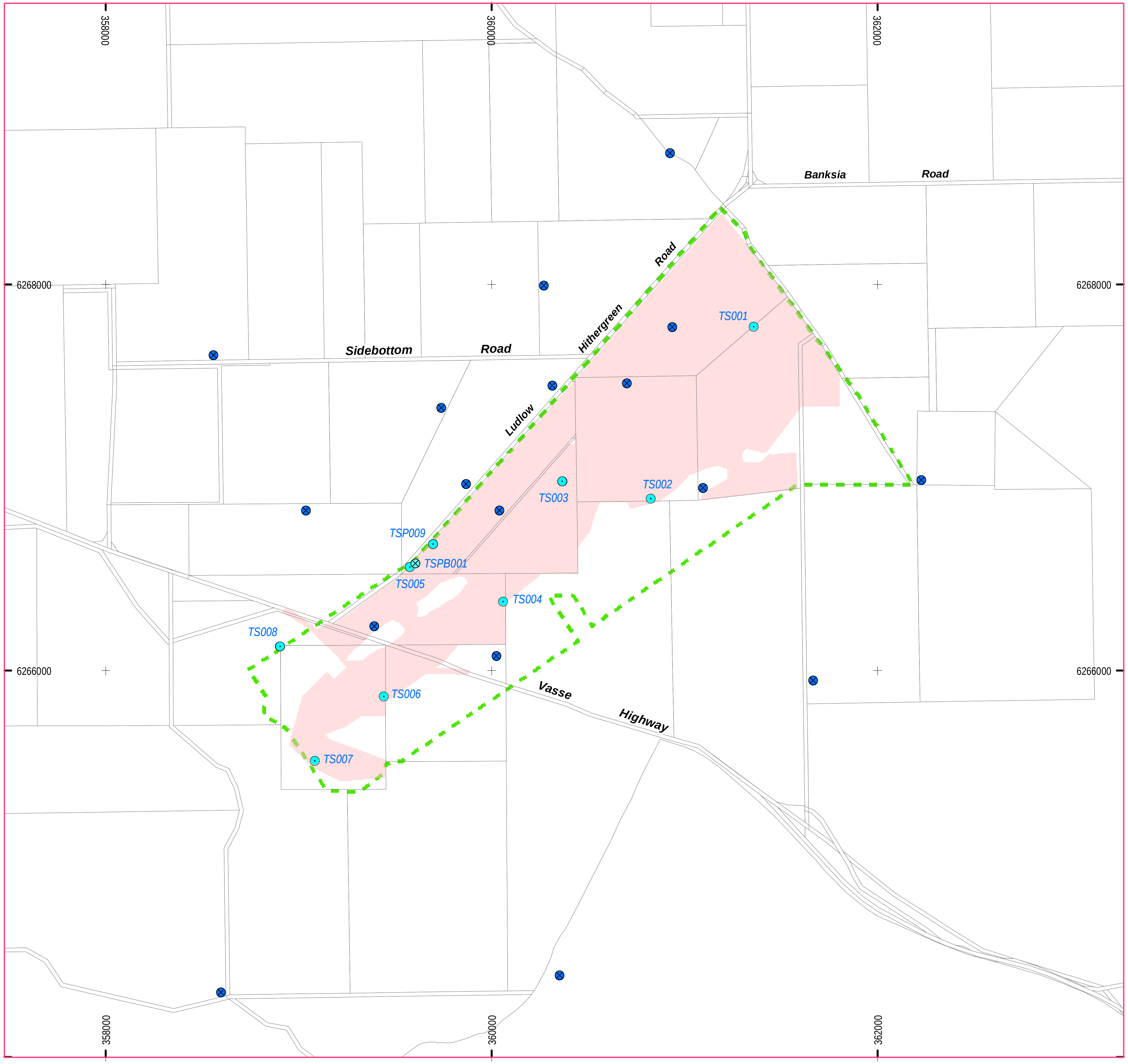
Water levels in piezometers TS001 to TS008 have been measured monthly since September 2006. The results from these measurements have defined the superficial aquifer as occurring between 0.55 and 3.63 m below ground level, with a seasonal variation of 1.70 to 2.47 m. Measurements from piezometers in the Leederville Aquifer ranged between 0 and 9.21 m below surface with a seasonal variation of 1.13 to 1.80 m. These data indicate that the Leederville Aquifer has a positive head attributed to recharge from the nearby Whicher Scarp.

The production bore and monitoring piezometers measuring the Yarragadee Aquifer ranged between 18.15 and 18.50 m below ground level, from a smaller number of measurements.

Water quality has also been measured from the piezometers and production bore, with a brief synopsis of pH and TDS results for each aquifer are presented below.

- Superficial Aquifer
  - pH 4.80 (TS003S and TS005S) to 6.69 (TS001)
  - EC 247 uS/cm (TS005S) to 1,048 uS/cm (TS001)
- Leederville Aquifer
  - pH 4.52 (TS006) to 6.01 (TS005D)
  - EC 253 uS/cm (TS003D) to 580 uS/cm (TS008D)
- Yarragadee Aquifer
  - pH 6.77 (TSPB1 single analysis only)
  - EC 430 uS/cm (TSPB1 single analysis only)

Data and graphs of data collected up to July 2007 can be located in Appendix 1 of this management plan.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S.	D.G.S.	9.08.07	Original version
01	L.S.	D.G.S.	14.09.07	Proposed piezos added

Legend

- Piezometer
- Production Bore
- Proposed Piezometer
- Disturbance area
- Project area

N

0 500 1,000 m

MGA Coordinates, GDA94

ILUKA

TUTUNUP SOUTH

GROUNDWATER MONITORING LOCATIONS

ORIG: L.Sadler
DRAWN: D.G.S.
SCALE: 1:20,000
DATE: 14 Sept. 2007

DWG No: 176489 ver.01 A3 FIGURE: 8

3.6. Groundwater Dependent Ecosystems

An assessment of groundwater dependency has been conducted identifying 11 areas of vegetation as Groundwater Dependent Ecosystems (GDEs), including the vegetation associated with Woddidup Creek immediately south of the disturbance area, the Abba River to the north of the disturbance area the southern wetland and the northern wetland. GDEs can be affected by groundwater drawdown from dewatering which is required for mining. The northern wetland is within the disturbance area and therefore not assessed further for potential impacts from drawdown. Further detail on the assessment, impacts and management of GDEs is provided in the Flora, Vegetation and Dieback Management Plan.

3.7. Acid Sulphate Soil

The soils within Tutunup South project area are known to contain both Potential Acid Sulphate Soils (PASS) and Actual Acid Sulphate Soils (AASS). In addition to excavation of these soils, there is risk that proposed dewatering activities will result in increasing the potential for oxidation of in situ PASS, releasing acidity into the environment. Whilst Acid Sulphate Soils has a significant consideration for the management of groundwater, a separate Acid Sulphate Soil Management Plan has been developed which describes the pre-mine acid sulphate soil environment, as well as the potential impacts related to mining in an area containing acid sulphate soil, management and monitoring of acid sulphate soil.

3.8. Nearby Water Users

A review of the Department of Water (DoW) groundwater bore database revealed that there are 54 bores or shallow wells within a 5 km radius of the project, although only 16 of these appear to be in use. The principal use of these bores was for stock watering. Most of the bores are shallow with only three being more than 10 m in depth. The water quality in these bores is fresh (between 200 and 500 mg/L TDS). Complementing the DoW database, Iluka completed a bore census from properties within 1 km of the Tutunup South project in 2005, and subsequently identified 21 active bores. Most of these were used for stock watering or domestic supply, with four being used for irrigation.

4. POTENTIAL IMPACTS

Mining activities at Tutunup South could have potential negative impacts on both surface and ground water quality and the ecosystems that these depend upon.

4.1. Physical/Chemical Impacts

Runoff from disturbed areas and discharge water has the potential to cause erosion and increase turbidity and suspended solids in surface water flows. Fine particles could travel some distance in surface water flows, whereas heavier particles are likely to settle close to the source of the erosion. The combined effect of discharge and runoff water may overwhelm local minor drainage features, affecting the morphology of the stream zone and if in excess of the channel size spilling outside if the stream zone affecting both native vegetation and agricultural productivity. Thus, the release of discharge water must be carefully controlled to be within the tolerances of the existing drainage system.

Potential contaminants to surface and groundwater include hydrocarbons and flocculants. Potential contamination sources include the concentrator area, screen plant, mine workshop, vehicle washdown bay, fuel bays and refuelling areas.

In addition to these anthropogenic sources of contamination, the oxidation of PASS through either exposure to air by mining, or through dewatering activities may result in the release of acidity. The impacts of acidity can include increased toxicity and bioavailability of metals, deterioration of vegetation quality and reduced soil fertility. Acid Sulphate Soils are addressed in a specific management plan for this issue.

The impacts of dewatering groundwater have been modelled by Aquaterra (2007). From this report, it is expected that dewatering rates will vary from an initial 20 ML per month, up to an average 40 ML per month, although the there is a five month period whereby dewatering peaks at 112 ML per month towards the end of the mine's life. At the conclusion of mining a 0.2 m groundwater drawdown is expected 1.5 km from the project area. Figure 9 to Figure 14 show predicted groundwater drawdown impacts over the life of mine. In areas away from the mine, groundwater recovery is delayed by a time lag of up to two years after the cessation of mining and dewatering. However the majority of groundwater levels recover to 90% of their pre-mining levels within two to three years after the completion of dewatering, with 95% recovery expected after four to five years.

4.2. Adjacent Water Users

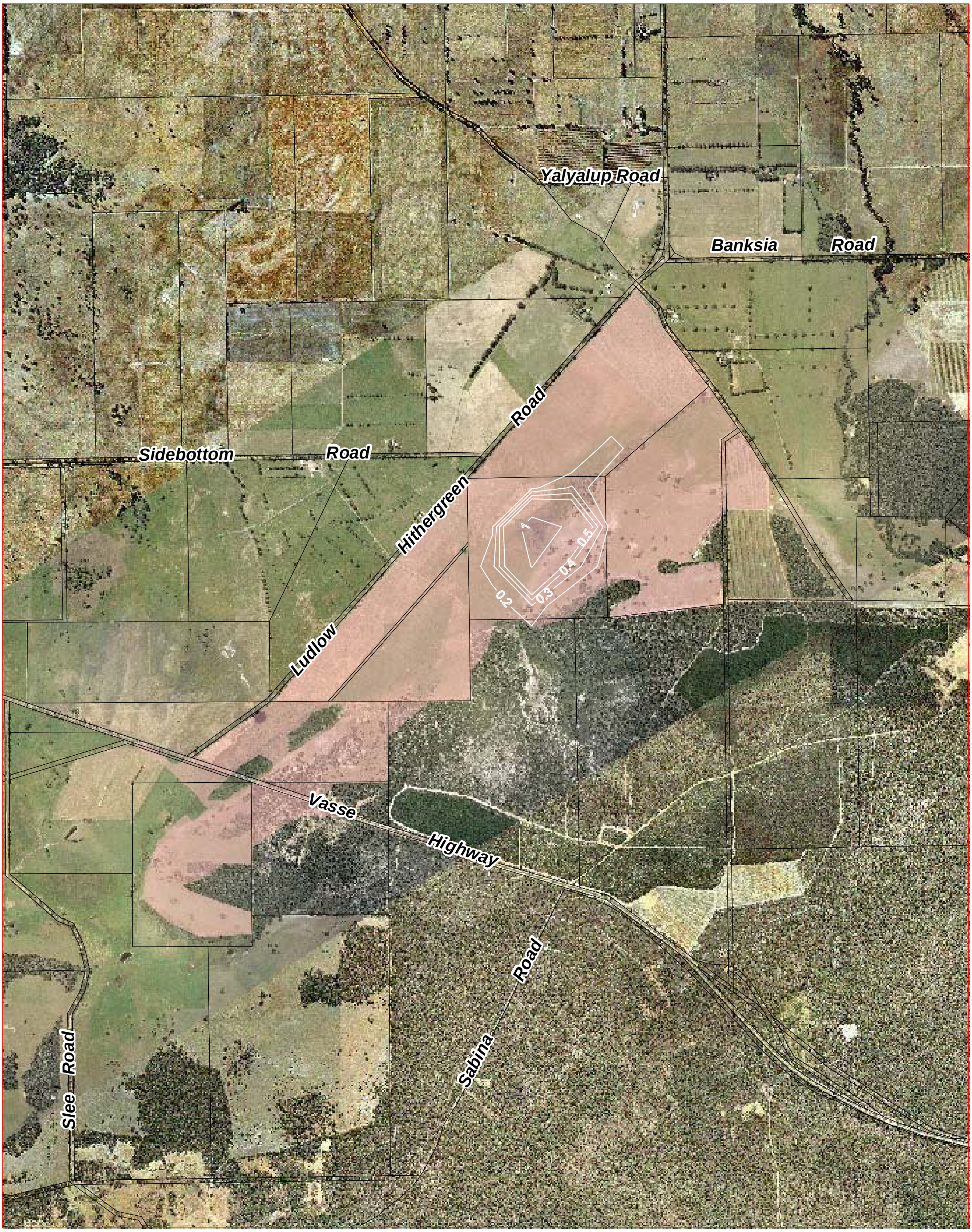
Impacts on the ability of bores to deliver water is anticipated to be restricted to shallow bores or wells where drawdown reduced the water to below the base of the bore or pump inlet. Deeper bores penetrating into the Leederville Aquifer are not expected to have their ability to supply water impacted.

Only five bores have been identified as being within the zone where maximum drawdown exceeds 0.5 m, whilst two bores are within a maximum predicted drawdown of 1 m. Thus, if these bores extend to 5 m in depth, it is unlikely that their water supply will be significantly reduced.

4.3. Groundwater Dependent Wetland ecosystems

The vegetation along Woddidup Creek assessed as being a potential GDE lies 150 m from a mine pit at its closest point. The maximum drawdown predicted under this vegetation is 0.4 m. The vegetation along the Abba River, assessed as being a potential GDE, lies outside the area of predicted groundwater drawdown. The vegetation along Ludlow-Hithergreen Road has also been assessed as being dependent on groundwater. It is predicted that the maximum groundwater drawdown will be between 0.5m and 1.0m (SWC 2007).

There are a number of vegetation communities that are present midway along the eastern boundary of the disturbance area. These vegetation communities have been assessed as being dependent on groundwater and vary from having a predicted maximum groundwater drawdown of between 0.5m and 2.5m (SWC 2007).



Legend

Predicted drawdown contour

Disturbance area

Date of aerial photography;
Inset: 19 Nov. 2005
Regional: 2001

0 500 1,000 m

N

ILUKA

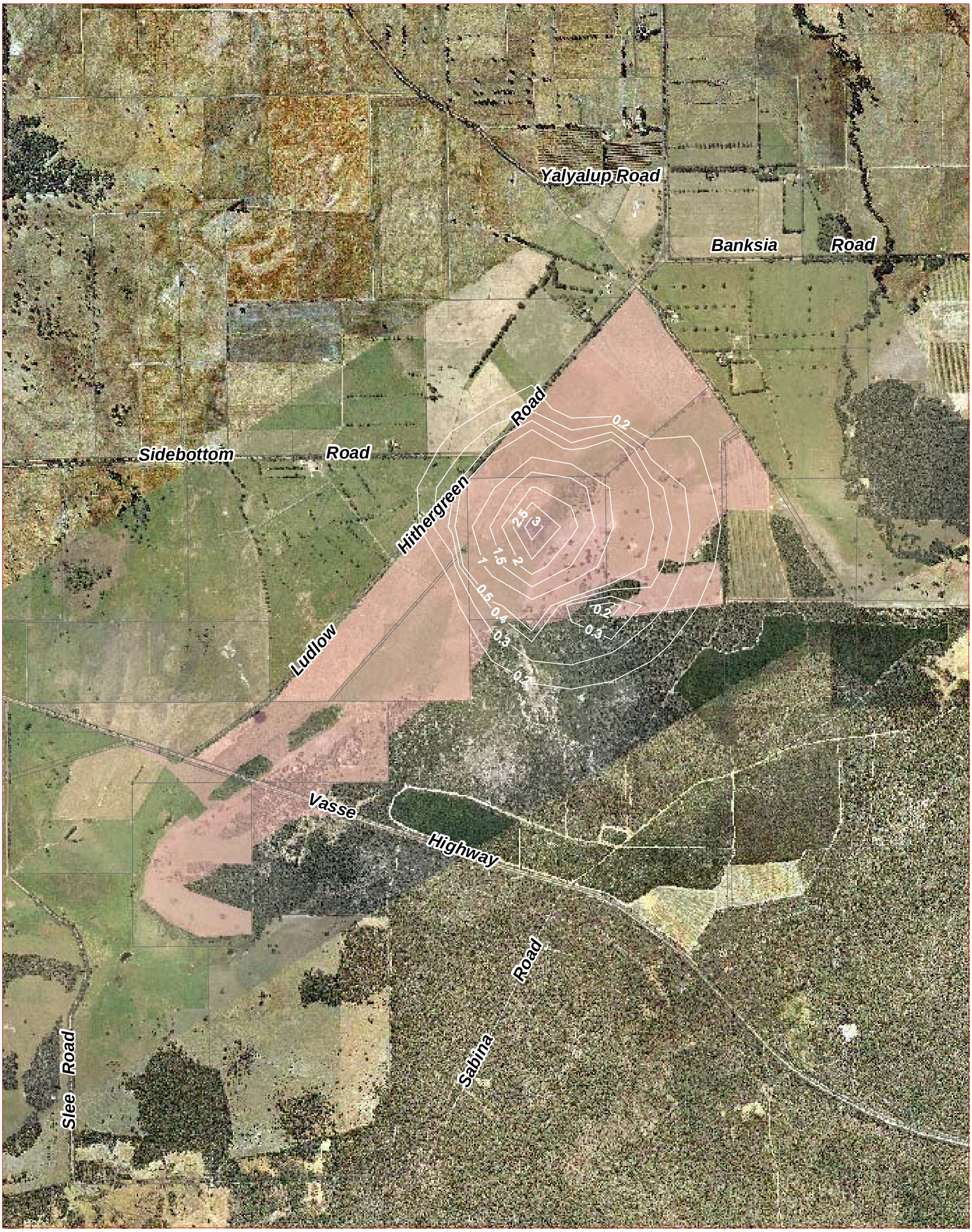
ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	9 Aug. 2007

TUTUNUP SOUTH

PREDICTED DRAWDOWN

MONTH 6

DWG No: 176490 ver.00 | A4 | FIGURE: 9



Legend

Predicted drawdown contour

Disturbance area

Date of aerial photography;
Inset: 19 Nov. 2005
Regional: 2001

0 500 1,000 m

N

ILUKA

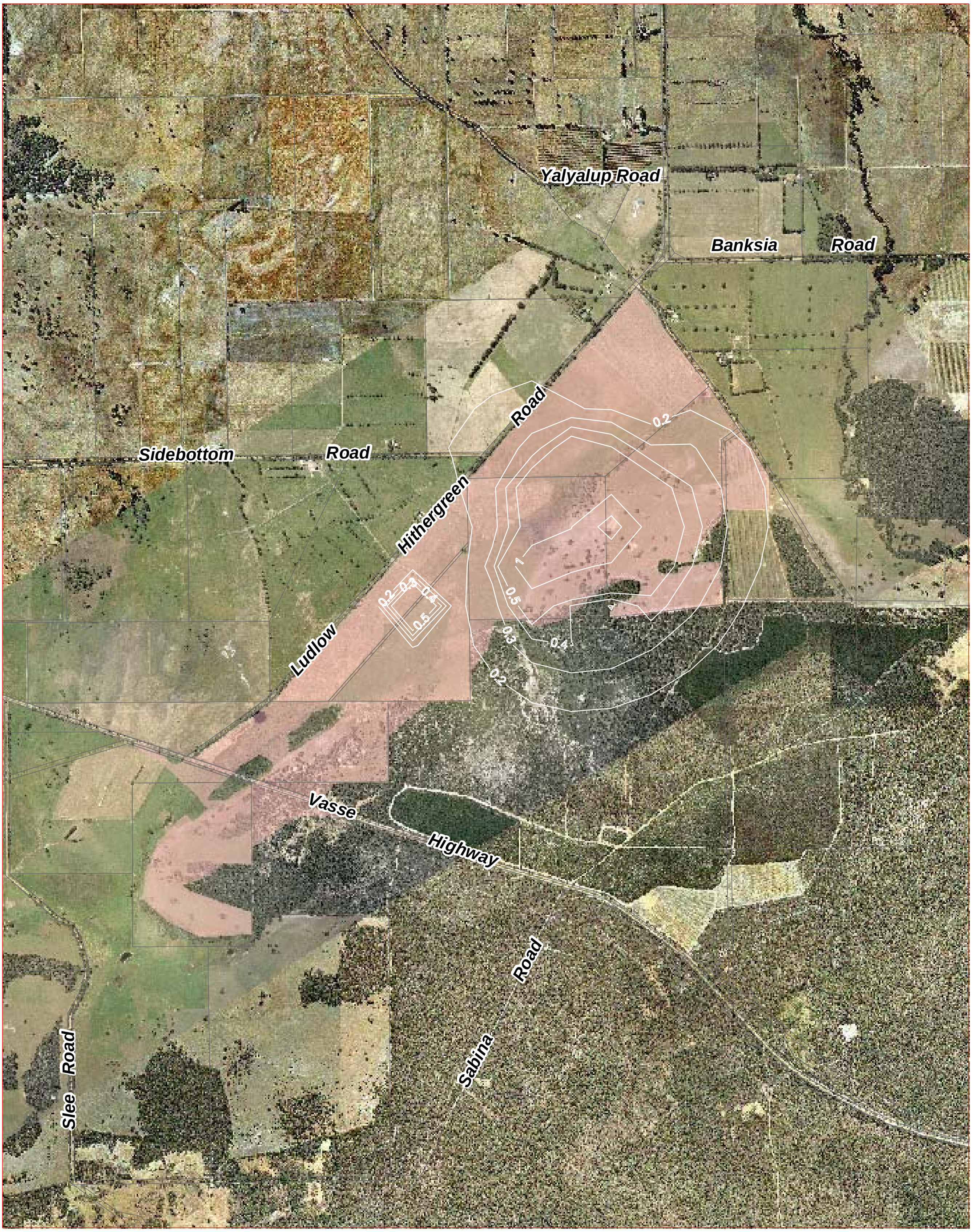
ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	9 Aug. 2007

TUTUNUP SOUTH

PREDICTED DRAWDOWN

MONTH 18

DWG No: 176491 ver.00 A4 FIGURE: 10



Legend

- Predicted drawdown contour
- Disturbance area

Date of aerial photography;
Inset: 19 Nov. 2005
Regional: 2001

0 500 1,000 m

N

ILUKA

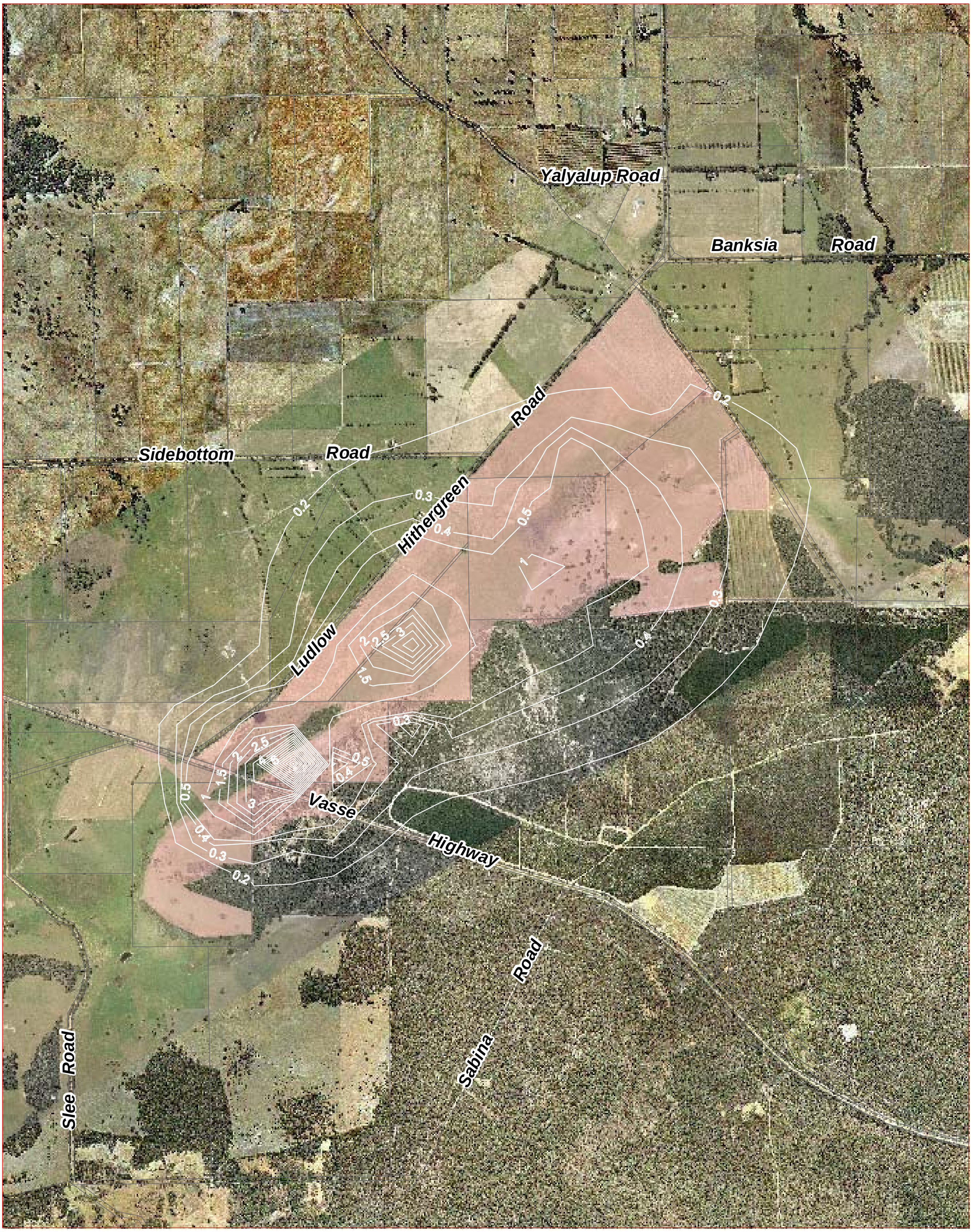
ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	9 Aug. 2007

TUTUNUP SOUTH

PREDICTED DRAWDOWN

MONTH 30

DWG No: 176492 ver.00 | A4 | FIGURE: 11



Legend

Predicted drawdown contour

Disturbance area

Date of aerial photography;
Inset: 19 Nov. 2005
Regional: 2001

0 500 1,000 m

N

ILUKA

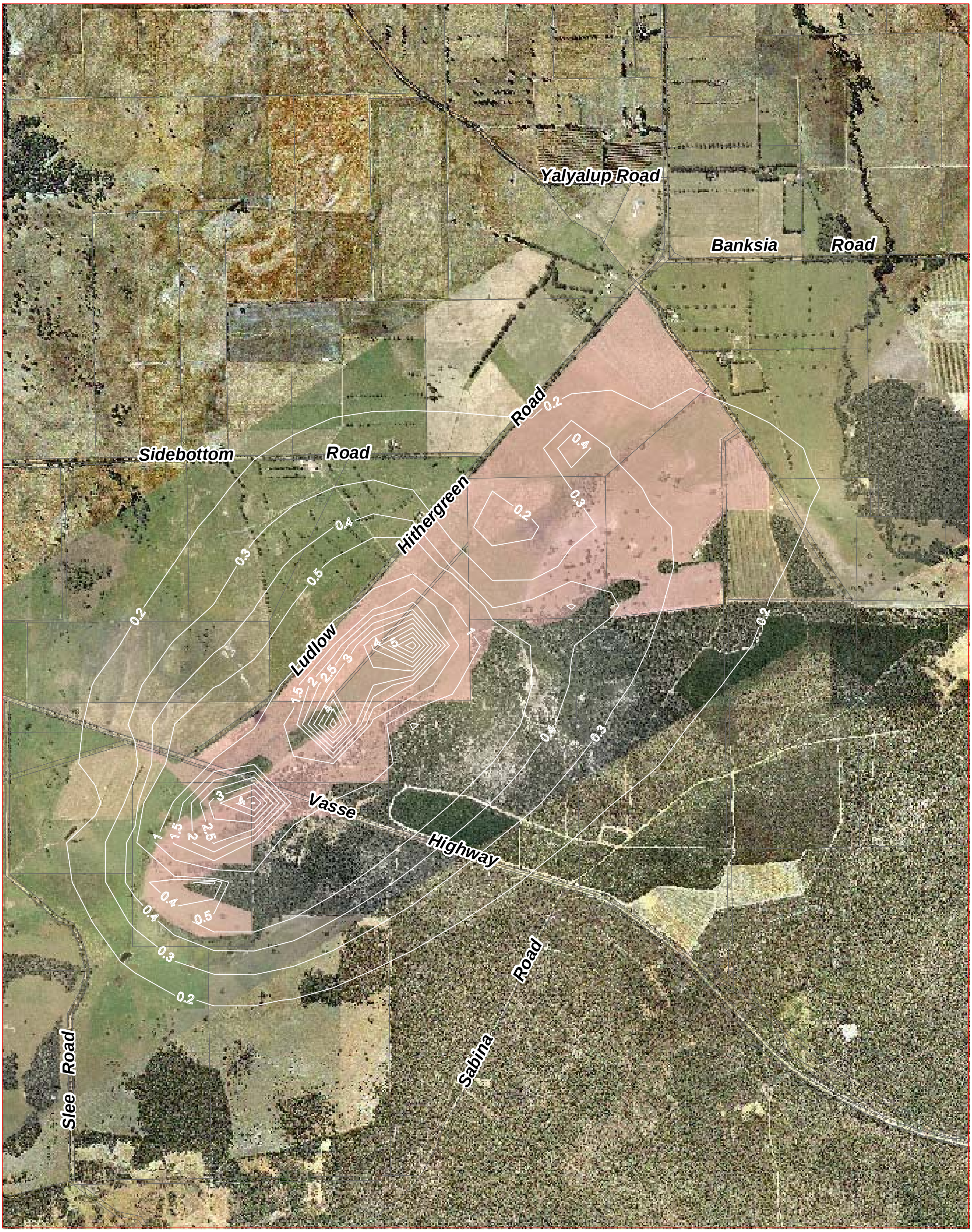
ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	9 Aug. 2007

TUTUNUP SOUTH

PREDICTED DRAWDOWN

MONTH 42

DWG No: 176493 ver.00 | A4 | FIGURE: 12



Legend

Predicted drawdown contour

Disturbance area

Date of aerial photography;
Inset: 19 Nov. 2005
Regional: 2001

0 500 1,000 m

N

ILUKA

ORIG: L.Sadler

DRAWN: D.G.S.

SCALE: 1:25,000

DATE: 9 Aug. 2007

TUTUNUP SOUTH

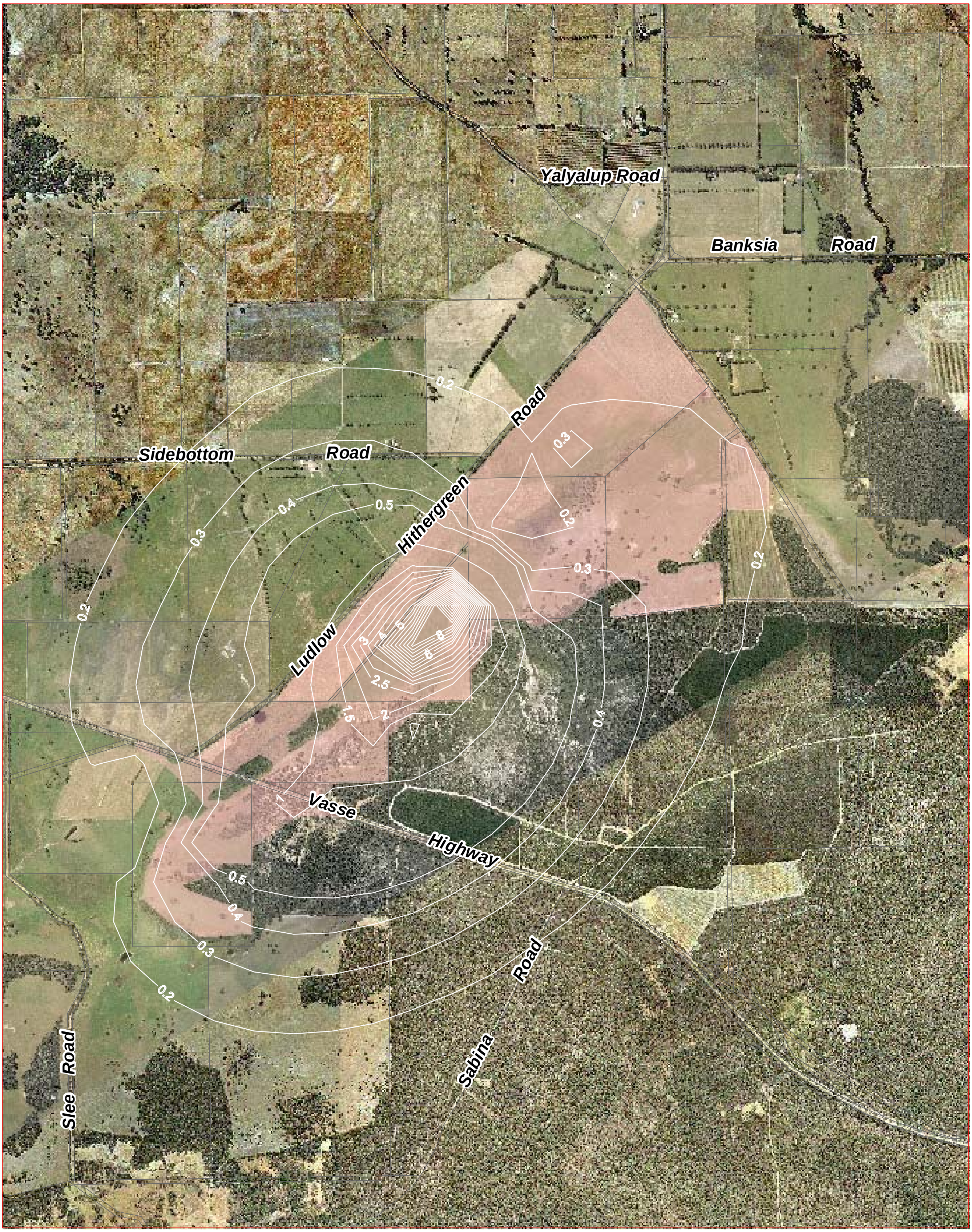
PREDICTED DRAWDOWN

MONTH 54

DWG No: 176494 ver.00

A4

FIGURE: 13



Legend

Predicted drawdown contour

Disturbance area

Date of aerial photography;
Inset: 19 Nov. 2005
Regional: 2001

0 500 1,000 m

N

ILUKA

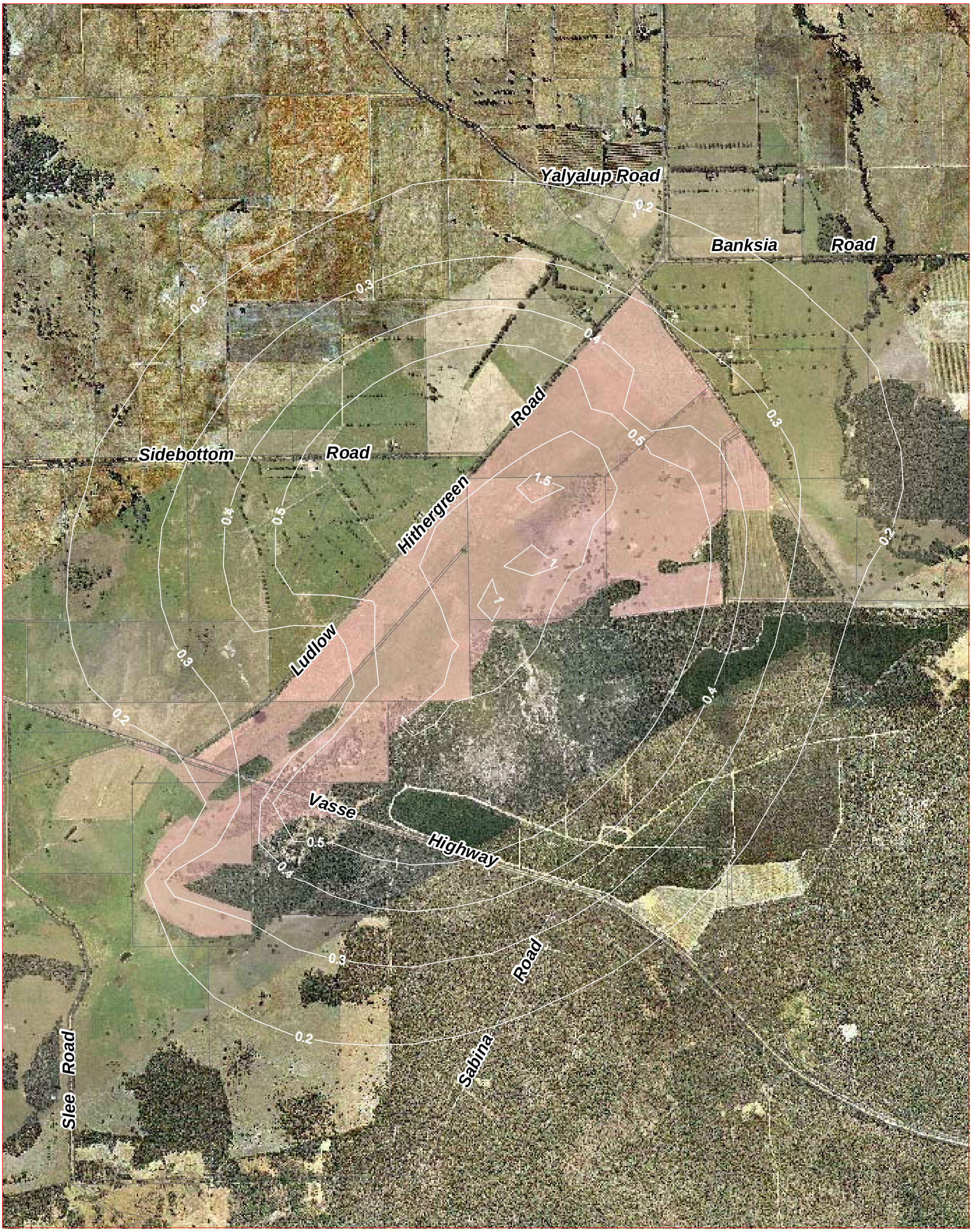
TUTUNUP SOUTH

PREDICTED DRAWDOWN

MONTH 66

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	9 Aug. 2007

DWG No: 176495 ver.00 A4 FIGURE: 14



Legend

——— Predicted drawdown contour

Disturbance area

Date of aerial photography;
Inset: 19 Nov. 2005
Regional: 2001

0 500 1,000 m

N

ILUKA

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	9 Aug. 2007

TUTUNUP SOUTH

PREDICTED DRAWDOWN 1 YEAR AFTER MINING

DWG No: 176496 ver.00 A4 FIGURE: 15

5. OPERATING RULES

The following are included in the operating rules for the Tutunup South mine:

- based on predicted inflow rates for each month of dewatering, the maximum predicted annual abstraction over the life of the mine is expected to be up to 1040 ML.
- monthly aggregate dewatering volumes are expected to range from 1 ML to 112 ML, with an average of 20 ML/month for the first 2.5 years and approximately 40 ML/month thereafter (Aquaterra, 2007)
- Dewatering water will be preferentially used for process water supply and dust suppression, vehicle washdown and rehabilitation work.
- Abstraction will take place all year.
- Water meters will be calibrated as per the manufacturer's specifications.

6. PERFORMANCE INDICATORS/CRITERIA

Table 2: Performance Indicators/Criteria

Indicator No.	Subject	Indicator
1	Drainage Controls	All water from disturbed areas is captured and directed to the pit or process water dam External catchment water shall be directed around site where possible
2	Water Release	Excess water to be released from site through a licensed discharge point within site prescribed premises licence limits
3	Water levels	Change in water levels within predicted variation Impact on vegetation beneath predicted levels
4	Water abstraction	Water abstraction within predicted volumes

7. MANAGEMENT

7.1. Groundwater Dependent Ecosystems

The potential risk to and management for each potentially impacted GDE is described in the Flora, Vegetation and Dieback Management Plan.

7.2. Drainage Controls

Topsoil stockpiles or grader banks will be utilised to direct overland paddock flow around the site and into external drainage systems. Rainfall and run-off collected on site will be collected and used for processing. Woddidup Creek (T3) will be bunded from the operations to ensure no uncontrolled drainage from the cleared areas to the creekline.

The northern drainage line (D1) will be collected in a dam and water will be directed to either the raw water dam for processing or piped across the project area and returned to the D1 drainage line on the downstream side of the project area. The northern drainage line has minimal flows with a 1 in 10 year ARI winter flow anticipated to be 252 m^3/hr. The sump at this location will be designed to accommodate and transfer these volumes.

The southern drainage line (D2) originates on site. Much of this area will be mined and internal drainage will be installed and water kept within the site.

7.3. Contaminant Control

Development of the Tutunup South project will involve the construction of a number of facilities that have the potential for hydrocarbon contamination. All hydrocarbons will be contained and managed to prevent contamination to the environment. Refuelling facilities will comprise of self-bunded tanks on imperviously lined pads reporting to an oil/water separator. Treated water from this system and runoff from the contractor area will report to the process water dam. The existing environmental incident reporting system will be utilised to report and manage any spillage of hydrocarbons.

7.4. Process Water Abstraction

Abstraction from the Yarragadee Aquifer under Iluka's Groundwater Abstraction Licence GWL 161847(2) will be required to supplement the contribution of dewatering to the process water requirements. Iluka has recently agreed to a substantial reduction in its water allocation but believes that this project can be managed within the scope of its existing allocation.

Yarragadee abstraction will be kept to a minimum with dewatering, recycled water and captured rainfall and runoff used preferentially. Yarragadee abstraction requirements are estimated to be between 1,120 and 1,500 Ml/annum.

7.5. Dewatering abstraction and ASS management

Dewatering of the superficial formation will require a new groundwater abstraction licence from the DoW under the *Rights in Water and Irrigation (RIWI) Act 1914*. Groundwater inflows are predicted to range from initially less than 20 Ml/month and increase to between 50 and 60 Ml/month by the third year of mining. Inflows are expected to peak at 112 Ml/month at the end of mining. The highest total 12 month groundwater inflows are 1,040 ML. The groundwater licence application will cover this volume.

The mine pit will be dewatered via sumps with dewater directed to the process water dam. Dewater will be used to meet processing and other site requirements, including dust suppression, vehicle washdown and rehabilitation work, in preference to abstracting water from the production bore.

The cone of depression resulting from dewatering can be minimised by backfilling mine pits to the bottom of the Guildford Formation (clay layer) as quickly as possible after the ore is removed. Backfilling to the bottom of the Guildford Formation seals the higher transmissivity Yoganup Formation below, from where water flow is greatest. Sealing off the Yoganup Aquifer as quickly as possible minimises the length of time that pits need to be dewatered and the volume of water abstracted. Monitoring and management of ASS is detailed in the Tutunup South Acid Sulfate Soil Management Plan.

To assist the continual improvement of the accuracy of groundwater modelling, Iluka will conduct a verification of the groundwater model after 6 months of operating conditions.

7.6. Water Discharge Control

At times when there is excess water for site requirements (eg construction, peak groundwater inflows and peak water flows during winter), water will be released via an open channel or pipeline into the southern drainage line (D2 in Figure 2). As a contingency, water may also be released to the northern drainage line (D1 in Figure 2). The maximum predicted discharge is 810m^3/hr during worst case winter conditions. This discharge is anticipated due to the large variation in volumes of pit dewatering predicted over the life of the mine. The drains may need to be upgraded between Ludlow-Hithergreen road and Sidebottom road to accommodate expected release volumes. This will be conducted in consultation with the landowner. An assessment of the receiving drainage channel will be conducted and findings of this assessment will be used to determine where improvements are required.

Water discharged from site will be conducted in accordance with the site's prescribed premises licence. Compliance against these criteria is expected to be reported in the site's Annual Environmental Report.

Due to the conditions that will be applied to water discharge, the existing condition of the receiving environment, the distance from the Sabina River and the diversion of flow from the Sabina River to the Vasse Diversion Drain approximately 200 m downstream from where the drain enters the River, mining will not cause a significant impact to the Sabina River.

It is possible that there may be times when excess water does not meet licence conditions. Should this occur, Iluka's preference will be to release water that meets licence conditions first, store water that does not meet licence criteria within the process water dam, then within available pits and/or solar drying dams. As a last resort Iluka may need to have a non-standard controlled release that does not meet water quality criteria. Should a non-standard controlled release be required, the following will occur:

- time permitting, contact the DEC to report the pending release and why the water is suspected to be outside of quality criteria;
- contact the adjacent landowner to advise of the non-standard release;
- monitor the drain and process water dam water quality before the release (if possible);
- monitor drain water quality during release;
- monitor water quality after the release has ceased and normal operating conditions resumed; and
- investigate impacts of the release and conduct remediation where required.

This process has been identified in the PER for Tutunup South as the site is spatially constrained, with reduced water storage and operational flexibility.

7.7. Landowner Bores

Most of the bores in close proximity to Tutunup South are either on land owned by Iluka or subject to landowner agreements. In the event a landowner notes a change in the capability of their bore to deliver water which is believed to be a consequence of Iluka's operations, a review of data from the nearest Iluka monitoring bores will be conducted. If the review indicates landowner bores have been adversely impacted by Iluka's mining activities, make up water will be provided.

8. MONITORING

8.1. Surface Water Monitoring

The surface water monitoring program for Tutunup South is outlined below. This program will be reviewed and updated as required. The results of monitoring will be reviewed on the receipt of results and any anomalous results scrutinised and resampled if necessary. The full suite of data collected will be reviewed as part of annual reporting. Items in this monitoring program may also occur in related management plans. Where this occurs, reference is made in the table.

Table 3: Surface Water Monitoring Program

Sample Point	Sample frequency	Analyte	Unit
Process Water Dam (See also Acid Sulfate Soils Management Plan (ASSMP))	Quarterly	pH	No Unit
		Electrical Conductivity	μScm^{-1}
		Aluminium	mgL^{-1}
		Calcium	mgL^{-1}
		Manganese	mgL^{-1}
		Iron	mgL^{-1}
		Arsenic	mgL^{-1}
		Cadmium	mgL^{-1}
		Chromium	mgL^{-1}
		Copper	mgL^{-1}
		Lead	mgL^{-1}
		Mercury	mgL^{-1}
		Nickel	mgL^{-1}
		Zinc	mgL^{-1}
		Total Acidity	mgL^{-1}
		Total Petroleum Hydrocarbons	mgL^{-1}
		Total Suspended Solids	mgL^{-1}
Water discharge point	Continuous	Volume	m^3
	Every Week (when flowing)	pH	No unit
		Electrical Conductivity	μScm^{-1}
		Total Suspended Solids	mgL^{-1}
	Every Month (when flowing)	Aluminium	mgL^{-1}
		Iron	mgL^{-1}
		Manganese	mgL^{-1}
		Sulphate	mgL^{-1}
		Total Acidity	mgL^{-1}

Water samples will be collected in accordance with AS5667.1:1998 and submitted to a NATA accredited laboratory for analysis, in accordance with “Standard Methods for Examination of Water and Wastewater-APHA-AWWA-WEF”.

8.2. Groundwater Monitoring

The groundwater quantity monitoring program is detailed below. This program will be reviewed and updated as required. Groundwater quality will be monitored as required by the Tutunup South prescribed premises licence and the Acid Sulphate Soils Management Plan.

There are currently 14 piezometers installed at Tutunup South monitoring the superficial, Leederville and Yarragadee aquifers. Additional monitoring bores will be installed to monitor the superficial and Leederville aquifers further from the mine pit.

The currently existing piezometers were installed to characterise the hydrogeology of the site and provide information for groundwater modelling. Of these piezometers, all except TS008S and TS008D are located within the disturbance area. Whilst every effort will be made to retain these piezometers, several may be required to be removed and will subsequently be removed from the monitoring programme.

Due to the nature of the site, some piezometers are unable or unsafe to be accessed in wet conditions. When ground conditions preclude access, these piezometers will not be monitored.

The proposed groundwater monitoring network is shown in Figure 8.

Table 4: Groundwater Monitoring Program

Sample Point	Sample Frequency	Analyte	unit
Superficial and Leederville Piezometers TS001, TS002, TS003S, TS003D, TS004, TS005S, TS005D, TS006, TS007, TS008S, TS008D, TS009 (See also ASSMP)	Monthly	SWL	mAHD
Regional Piezometers: To be installed (See also ASSMP)	Quarterly	SWL	mAHD
Yarragadee Piezometers TS009M, TS009D	6 Monthly	SWL	mAHD
Yarragadee Production Bore TSPB1	Monthly	Volume of water extracted from the bore	kL
Soil Moisture Probes	Weekly	Soil moisture	Volumetric Soil Water Content (%)
Tutunup South Raw Water Dam (inlet from mine dewatering/runoff)	Weekly	Volume of water extracted from the pit	kL

9. CONTINGENCY PLANS

Where an issue is identified, contingency plans will be put in place to address the concern. These contingency situations are described in Table 5.

Table 5: Contingencies for Unplanned Events

Trigger	**Contingency action**
Hydrocarbon spills	• Clean up using spill kits
Water quality in raw water dam not suitable for discharge	• Water treated and/or • Water is stored on site until quality is satisfactory.
Quantity of water released exceeds carrying capacity of the drain	Initial response • Reduce flow Follow-up • Conduct investigation to determine the impact, and devise appropriate remediation strategy
Non-standard but controlled release of water that may not be suitable for discharge	Initial Response • Inform DEC, and adjacent landowner • Monitor water quality in drain and raw water dam before controlled emergency release (if possible) Follow-up • Monitor discharge quality during release and after non-standard conditions have abated. • Investigate impacts of the release and conduct remediation where required.
Breach of water containment facilities causing discharge of water to the environment	Initial response • Monitor discharge quality Follow-up • Conduct investigation to determine the impact, and devise appropriate remediation strategy
Landowner concern regarding impaired ability to extract water from a bore or well.	• Review the groundwater drawdown in the affected area and any other relevant information to determine if Iluka has caused the decline in bore productivity • Devise appropriate response following outcome of the aforementioned review

10. WATER USE EFFICIENCY

It is estimated that up to 810 ML of excess water may be discharged off site in a year. This discharge is anticipated due to the large variation in volumes of pit dewater predicted over the life of the mine. There will be times when there is a water deficit and times when there is a surplus. As much water as possible will be held on site within the process water system, in order to both minimise the volume of water required to be discharge, and minimise the volume of water required to be drawn from the production bore.

The recycling and management mechanisms in place within the mineral processing facilities further reduce the requirement for drawing from the production bore. Processing is expected to require a total of approximately 12 000 ML water per annum, however approximately 85 % of the total site water requirement is expected to be sourced from recycled water sources including water decanted from clay fines and sand tails.

Some of the practices which Iluka will have in place to increase water use efficiency are:

- Using dewatered water in preference to Yarragadee bore water;
- Daily monitoring of dewatering pumps and pipeline; control of slimes dam return water and optimisation of water return on site included in outstations operator's role;
- Water balance completed at site commencement;
- Water balance completed at the start of summer to identify losses and minimise consumption from Yarragadee bore; and
- Review of water balance as part of change management strategies.

11. ADMINISTRATIVE REQUIREMENTS AND REPORTING

11.1. Contact Person

The Mine Superintendent, Tutunup South, once appointed, will be responsible for the implementation of this Operating Strategy. He/she can be contacted via the following details:

Mine Superintendent, Tutunup South
Iluka Resources Limited
PO Box 96
CAPEL WA 6271
(08) 9780 3287

11.2. Annual Monitoring Review

This version of the Operating Strategy will be current upon approval by DoW. It will form part of the conditions of the licence to dewater once issued.

An annual aquifer monitoring review is to be submitted to the DoW before 31 March of each year, summarising changes in operations, particulars and interpretation of the previous year's monitoring data to enable a regional assessment of the impacts of abstraction within the framework of groundwater management areas, sub-areas and groundwater flow systems. The reporting period (water year) is proposed to be between 1st January and 31st December.

The assessment should comment on the effects of abstraction on the local and regional resources of the superficial formations and other groundwater users. The assessments shall also investigate drawdown within the Leederville Formation which underlies the superficial formations. The assessment must include:

- Local monitoring records from piezometers;
- Observed local and regional drawdown impacts;
- Evaluation of effective aquifer parameters based on observed drawdowns;
- Relevant data on other licensed users of the superficial formation groundwater resource;
- Review of local and regional performance of the aquifer, including areas downstream of the project area;
- Comparisons between observed and predicted abstraction volumes and drawdown;
- Long-term predictions of local and regional drawdown impacts on other users and the flow system;
- A review of this plan; and
- Any breaches of GWL conditions.

The assessment shall be prepared in accordance with DoW publication *Guidelines for Hydrologeology Reports* and *Statewide Policy No.10 , Use of Operating Strategies, in the Water Licensing Process, May 2004*.

11.3. AER

Environmental compliance reports will be submitted to the DEC (Department of Environment and Conservation) annually, as an appendix to the Annual Environment Report (AER). The compliance report will be based around the items in the key management actions table and will provide evidence of compliance with the management plan, in the form of relevant monitoring data and other management records.

11.4. Incremental reporting

Should a breach of licence limits be identified, the Department of Water and/or Department of Environment and Conservation will be notified as required.

12. REVIEW AND REVISE

This management plan will be reviewed to assess its suitability, adequacy and effectiveness in meeting the set objectives annually, or more frequently as deemed necessary by Iluka. Where necessary, the plan will be revised and revisions will be submitted to the DEC.

13. KEY MANAGEMENT ACTIONS TABLE

Table 6: Key Management Actions

Key Management Actions	**Evidence of demonstration**
Install drainage line around site disturbance area	Drainage line installed
Hydrocarbons contained and managed to prevent contamination	Appropriate bunding installed
Excess water released from the nominated discharge site	Water quantity monitoring
Surface water monitoring conducted	Monitoring data
Environmental incidents reported	Incident reports
Backfill pits to bottom of Guildford Formation as quickly as possible after ore is removed	Backfill to bottom of Guildford Formation completed as soon as possible of completion of mining
Pit dewatering water used in preference over Yarragadee bore water	Water use within licence limits
Data reviewed if landowner concern raised	Record of review
After 6 months of operation the groundwater model is to be verified	Records of model verification
Superficial and Leederville Aquifer piezometers to be monitored regularly	Monitoring data
Abstraction volumes, operating hours and cumulative abstraction from in-pit sumps to be monitored monthly	Monitoring data
Yarragadee abstraction volumes monitored monthly	Monitoring data

14. SUMMARY OF LICENSEE'S COMMITMENTS

In conducting its dewatering activities, the licensee makes the following commitments:

- The mine pit will be dewatered by means of sump pumps, with dewater directed to the process water system
- Dewatering will be conducted up to 810 ML per annum
- Any excess water that cannot be contained on site will be released from a location licensed by the DEC
- Pit water abstraction will be used preferentially for processing water supply and other site functions such as dust suppression
- The monitoring program identified in section 8 will be implemented
- An annual monitoring review will be reported to the DoW before 31 March of each year for the reporting period 1 January to 31 December.

15. REFERENCES

ANZECC/ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

Aquaterra (2007) Tutunup South Groundwater Impact Assessment. Report prepared for Iluka Resources Limited.

Environmental Protection Authority (2005) *Guidance Statement No. 33: Environmental Guidance for Planning and Development*.

Parsons Brinkerhoff (2006) *Tutunup South Deposit: Hydrogeological Investigation.* Report prepared for Iluka Resources Limited.

Parsons Brinckerhoff (2007) *Completion Report for Yarragadee Bores TSPB1 and TS009, Tutunup South*. Report to Iluka Resources Ltd.

Soil Water Consultants (2007) *Groundwater Dependent Ecosystem Assessment for the Proposed Tutunup South Minesite.* Report prepared for Iluka Resources Limited.

Wetland Research and Management (2006) *Tutunup South Project Baseline Aquatic Biology and Water Quality Study.* Report prepared for Iluka Resources Limited.

16. DOCUMENT CONTROL

Revision	Reviews/Changes	Create Date
A	First Draft	30 July 2007
B	Incorporation of comments from LKS	25 August 2007
C	Incorporation of further comments from LKS	6 September 2007
D	Incorporation of comments from group review	15 September 2007
E	Incorporation of Operating Strategy specific sections	25 November 2007
F	Reviewed for re-submission	18 January 2008
G	Reviewed after EPASU review	10 April 2008

Appendix 1: Groundwater levels, pH and EC Graphs and Data to July 2007

Date	Site	Aquifer	Temp oC	pH	EC uS/cm	Depth to Water m	Groundwater Elevation mAHD
01-May-06	TS001	Superficial/Leederville				2.69	43.99
07-Sep-06	TS001	Superficial/Leederville	16.5	5.96	1012	1.16	45.52
10-Oct-06	TS001	Superficial/Leederville	16.8	5.91	992	1.41	45.27
10-Nov-06	TS001	Superficial/Leederville	17.5	6.17	978	1.75	44.93
18-Dec-06	TS001	Superficial/Leederville	18.8	6.05	1046	2.29	44.39
16-Jan-07	TS001	Superficial/Leederville	19.4	6.69	1029	2.66	44.02
15-Feb-07	TS001	Superficial/Leederville	19.7	5.96	992	3.63	43.05
08-Mar-07	TS001	Superficial/Leederville	19.6	5.97	1007	2.97	43.71
11-Apr-07	TS001	Superficial/Leederville	19.2	6.54	1048	3.11	43.57
09-May-07	TS001	Superficial/Leederville	19.5	6.33	930	2.82	43.86
13-Jun-07	TS001	Superficial/Leederville	19.2	6.12	1031	2.75	43.93
10-Jul-07	TS001	Superficial/Leederville	17.6	6.06	971	2.00	44.68
01-May-06	TS002	Leederville				DRY	
07-Sep-06	TS002	Leederville				DRY	
10-Oct-06	TS002	Leederville				DRY	
10-Nov-06	TS002	Leederville				DRY	
18-Dec-06	TS002	Leederville				DRY	
16-Jan-07	TS002	Leederville				DRY	
15-Feb-07	TS002	Leederville				DRY	
08-Mar-07	TS002	Leederville				DRY	
11-Apr-07	TS002	Leederville				DRY	
09-May-07	TS002	Leederville				DRY	
13-Jun-07	TS002	Leederville				DRY	
10-Jul-07	TS002	Leederville				DRY	
01-May-06	TS003D	Leederville				1.53	40.81
07-Sep-06	TS003D	Leederville	18.4	5.18	270	0.79	41.55
10-Oct-06	TS003D	Leederville	19.0	5.03	264	0.96	41.38
10-Nov-06	TS003D	Leederville	18.8	5.31	261	1.31	41.03
18-Dec-06	TS003D	Leederville	19.1	5.21	263	1.56	40.78
16-Jan-07	TS003D	Leederville	19.1	5.37	266	1.72	40.62
15-Feb-07	TS003D	Leederville	19.2	5.32	262	2.59	39.75
08-Mar-07	TS003D	Leederville	19.4	4.9	268	1.89	40.45
11-Apr-07	TS003D	Leederville	19	4.99	261	1.93	40.41
09-May-07	TS003D	Leederville	19.2	5.36	253	1.66	40.68
13-Jun-07	TS003D	Leederville	19.2	5.07	271	1.57	40.77
10-Jul-07	TS003D	Leederville	18.9	5.16	266	1.16	41.18
01-May-06	TS003S	Superficial				2.59	39.74
07-Sep-06	TS003S	Superficial	18.5	4.82	341	1.83	40.50
10-Oct-06	TS003S	Superficial	18.7	4.90	335	2.16	40.17
10-Nov-06	TS003S	Superficial	18.9	5.11	336	2.52	39.81
18-Dec-06	TS003S	Superficial	18.8	4.95	345	2.68	39.65
16-Jan-07	TS003S	Superficial	18.9	5.76	358	2.75	39.58
15-Feb-07	TS003S	Superficial	18.2	5.23	320	3.57	38.76
08-Mar-07	TS003S	Superficial	20.7	4.8	358	2.84	39.49
11-Apr-07	TS003S	Superficial	19.7	4.98	332	2.88	39.45
09-May-07	TS003S	Superficial	21	5.7	323	2.55	39.78
13-Jun-07	TS003S	Superficial	19.7	4.86	339	2.58	39.75
10-Jul-07	TS003S	Superficial	18.9	4.99	339	1.94	40.39

Date	Site	Aquifer	Temp oC	pH	EC uS/cm	Depth to Water m	Groundwater Elevation mAHD
01-May-06	TS004	Leederville				7.96	45.43
07-Sep-06	TS004	Leederville	19.0	5.11	279	7.62	45.77
10-Oct-06	TS004	Leederville	19.1	4.90	274	7.68	45.71
10-Nov-06	TS004	Leederville	18.7	5.23	279	7.82	45.57
18-Dec-06	TS004	Leederville	19.8	5.22	285	7.97	45.42
16-Jan-07	TS004	Leederville	19.1	5.74	279	8.16	45.23
15-Feb-07	TS004	Leederville	19.3	5.27	274	9.01	44.38
08-Mar-07	TS004	Leederville	20.9	4.9	285	8.37	45.02
11-Apr-07	TS004	Leederville	19.6	5.32	271	8.48	44.91
09-May-07	TS004	Leederville	19.7	5.25	263	8.43	44.96
13-Jun-07	TS004	Leederville	19.7	5.08	283	8.43	44.96
10-Jul-07	TS004	Leederville	20.2	5.22	282	8.20	45.19
01-May-06	TS005D	Leederville				0.54	35.78
07-Sep-06	TS005D	Leederville	17.7	5.37	369	0.00	36.32
10-Oct-06	TS005D	Leederville	18.9	5.38	358	0.05	36.27
10-Nov-06	TS005D	Leederville	18.8	5.57	359	0.28	36.04
18-Dec-06	TS005D	Leederville	19.1	5.66	364	0.61	35.71
16-Jan-07	TS005D	Leederville	19	6.01	367	0.80	35.52
15-Feb-07	TS005D	Leederville	18	5.61	359	1.79	34.53
08-Mar-07	TS005D	Leederville	19.2	5.3	364	1.00	35.32
11-Apr-07	TS005D	Leederville	19	5.41	361	1.12	35.20
09-May-07	TS005D	Leederville	19	5.62	347	0.97	35.35
13-Jun-07	TS005D	Leederville	19.2	5.50	367	0.84	35.48
10-Jul-07	TS005D	Leederville	18.8	5.57	372	0.77	35.55
01-May-06	TS005S	Superficial				1.59	34.76
07-Sep-06	TS005S	Superficial				0.87	35.48
10-Oct-06	TS005S	Superficial	17.7	5.02	281	1.27	35.08
10-Nov-06	TS005S	Superficial	17.8	5.22	249	1.44	34.91
18-Dec-06	TS005S	Superficial	18.3	5.14	250	1.81	34.54
16-Jan-07	TS005S	Superficial	18.4	5.47	250	1.97	34.38
15-Feb-07	TS005S	Superficial	18.5	5.27	247	2.85	33.50
08-Mar-07	TS005S	Superficial	19.5	*4.8*	256	2.12	34.23
11-Apr-07	TS005S	Superficial	19.6	5.30	373	1.79	34.56
09-May-07	TS005S	Superficial	19.2	5.23	272	1.50	34.85
13-Jun-07	TS005S	Superficial	19.1	5.00	258	1.43	34.92
10-Jul-07	TS005S	Superficial	17.7	5.10	331	0.55	35.80
01-May-06	TS006	Leederville				8.27	47.91
07-Sep-06	TS006	Leederville	20.1	4.65	315	8.10	48.08
10-Oct-06	TS006	Leederville	20.1	4.52	307	8.08	48.10
10-Nov-06	TS006	Leederville	20.1	5.14	314	8.18	48.00
18-Dec-06	TS006	Leederville	22.3	4.99	331	8.28	47.90
16-Jan-07	TS006	Leederville	20.7	5.24	321	8.39	47.79
15-Feb-07	TS006	Leederville	21.2	5.20	317	9.21	46.97
08-Mar-07	TS006	Leederville	22.8	4.9	322	8.54	47.64
11-Apr-07	TS006	Leederville	20.6	4.59	307	8.64	47.54
09-May-07	TS006	Leederville	21.5	5.28	304	8.69	47.49
13-Jun-07	TS006	Leederville	20.3	4.74	317	8.73	47.45
10-Jul-07	TS006	Leederville	21.4	4.85	311	8.72	47.46

Date	Site	Aquifer	Temp oC	pH	EC uS/cm	Depth to Water m	Groundwater Elevation mAHD
01-May-06	TS007	Leederville				1.96	46.38
07-Sep-06	TS007	Leederville	18.9	4.91	531	1.57	46.77
10-Oct-06	TS007	Leederville	19.2	4.95	504	1.88	46.46
10-Nov-06	TS007	Leederville	19.1	5.29	523	2.01	46.33
18-Dec-06	TS007	Leederville	19.9	5.27	503	2.20	46.14
16-Jan-07	TS007	Leederville	20.6	5.29	506	2.26	46.08
15-Feb-07	TS007	Leederville	21.5	5.23	505	3.02	45.32
08-Mar-07	TS007	Leederville	22.4	4.9	503	2.32	46.02
11-Apr-07	TS007	Leederville	22.1	4.95	511	2.28	46.06
09-May-07	TS007	Leederville	22	5.33	474	2.15	46.19
13-Jun-07	TS007	Leederville	21.1	5.02	526	2.14	46.20
10-Jul-07	TS007	Leederville	20.9	5.08	530	1.71	46.63
01-May-06	TS008D	Leederville				2.17	36.27
07-Sep-06	TS008D	Leederville	19.2	5.24	456	1.41	37.03
10-Oct-06	TS008D	Leederville	19.4	5.31	445	1.68	36.76
10-Nov-06	TS008D	Leederville	19.3	5.66	448	1.97	36.47
18-Dec-06	TS008D	Leederville	19.6	5.46	450	2.19	36.25
16-Jan-07	TS008D	Leederville	19.5	5.74	453	2.32	36.12
15-Feb-07	TS008D	Leederville	19.7	5.58	447	3.19	35.25
08-Mar-07	TS008D	Leederville	19.7	5.2	449	2.49	35.95
11-Apr-07	TS008D	Leederville	19.5	5.24	443	2.57	35.87
09-May-07	TS008D	Leederville	19.5	5.50	431	2.35	36.09
13-Jun-07	TS008D	Leederville	19.6	5.37	580	2.30	36.14
10-Jul-07	TS008D	Leederville	19.5	5.37	457	1.78	36.66
01-May-06	TS008S	Superficial				1.77	36.72
07-Sep-06	TS008S	Superficial	18.8	4.96	439	1.06	37.43
10-Oct-06	TS008S	Superficial	18.7	4.88	427	1.35	37.14
10-Nov-06	TS008S	Superficial	18.7	5.26	455	1.59	36.90
18-Dec-06	TS008S	Superficial	19.1	5.11	433	1.84	36.65
16-Jan-07	TS008S	Superficial	19.1	5.42	434	1.94	36.55
15-Feb-07	TS008S	Superficial	19.1	5.22	427	2.76	35.73
08-Mar-07	TS008S	Superficial	19.4	4.9	432	2.05	36.44
11-Apr-07	TS008S	Superficial	19.4	5.17	429	2.12	36.37
09-May-07	TS008S	Superficial	19.5	5.36	415	1.85	36.64
13-Jun-07	TS008S	Superficial	19.2	5.14	456	1.84	36.65
10-Jul-07	TS008S	Superficial	19.4	5.10	439	1.25	37.24
Multipiezometer							
23-Apr-07	TS009D	Yarragadee				18.49	18.37
13-Jun-07	TS009D	Yarragadee				18.50	18.36
10-Jul-07	TS009D	Yarragadee				18.15	18.71
23-Apr-07	TS009M	Yarragadee				18.46	18.40
13-Jun-07	TS009M	Yarragadee				18.46	18.40
10-Jul-07	TS009M	Yarragadee				18.18	18.68
23-Apr-07	TS009S	Leederville				1.37	35.49
13-Jun-07	TS009S	Leederville				1.99	34.87
10-Jul-07	TS009S	Leederville				1.67	35.19
Production Bore							
12-Apr-07	TSPB1	Yarragadee				18.46	18.15
13-Jun-07	TSPB1	Yarragadee				17.45	19.41
10-Jul-07	TSPB1	Yarragadee				17.11	19.75

Appendix 5

Noise Management Plan

Iluka Resources Limited

Noise Management Plan

Tutunup South Mineral Sands Project

April 2008

ILUKA-TR-T15789

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1. INTRODUCTION

This plan relates to noise from the Tutunup South mine site. This plan has been developed in conjunction with the Public Environmental Review (PER) impact assessment document. Implementation of this plan and compliance during operations is a commitment of the PER document.

2. ENVIRONMENTAL OBJECTIVE

The objective of this plan is to protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring the noise levels meet statutory requirements and acceptable standards.

3. PRE- MINE ENVIRONMENT

The Tutunup South site is located at the foot of the Whicher Scarp on mostly agricultural land. The project also extends into forested areas on its south-eastern side which includes both private and State forest and a gravel reserve vested with the Shire of Busselton.

15 houses, including both landowners and neighbours, have been identified in the vicinity of the Tutunup South project. The definition of landowners is used to define residences which Iluka has agreement to mine on their property. Neighbours are residences adjacent to the Iluka operations (Figure 1).

4. POTENTIAL IMPACTS

The project will generate noise from construction, mining and processing activities. The main source of noise will be mobile earth-moving equipment and fixed plant, including roadside pumps.

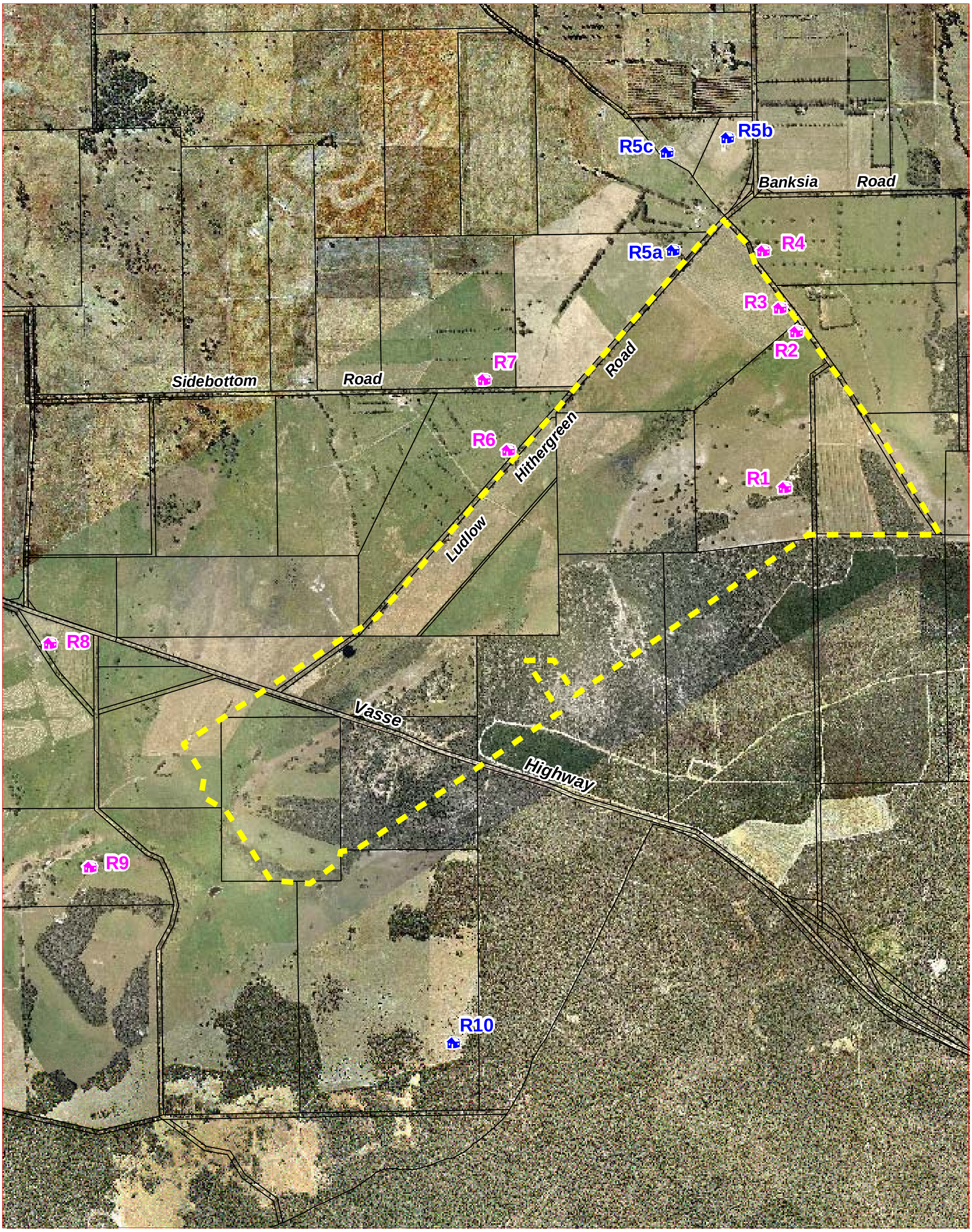
4.1. Noise regulations

Noise levels from the operations are controlled by implementation of the *Environmental Protection (Noise) Regulations (1997)*, which stipulates noise levels at receiving locations. As an industrial zoning, the Tutunup South mine will have allowances for influencing factors on noise limits applicable at nearby residences. Influencing factors are noise allowances for certain land uses and surrounding activities for use when applying the limits prescribed in the Noise Regulations. In the case of Tutunup South, the influencing factor for each residence is dependent on the distance of the residence from the mine. The relevant influencing factor for each residence is presented in Table 1.

Under regulation 13, the noise levels in Table 1 do not apply to construction noise from Monday to Saturday between 7am and 7pm, when construction work is conducted in accordance with the control of environmental noise practices set out in section 6 of *AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites* and the equipment used is the quietest reasonably available.

Table 1: Assigned Noise Limits Including Influencing Factors at Receiving Locations

Closest Residences	Influencing Factor in dB	Assigned Noise Limits (LA10) in dB(A)		
		Day	Evening	Night
R1	9	54	49	44
R2	5	50	45	40
R3	3	48	43	38
R4 (2 houses)	0	45	40	35
R5 (3 houses)	1	46	41	36
R6	7	52	47	42
R7	1	46	41	36
R8	0	45	40	35
R9 (3 houses)	0	45	40	35
R10	0	45	40	35



Legend

Landowners

Neighbours

Project area

Photography dates:
Inset: 19 Nov. 2005, Regional: 2001

0 500 1,000 1,500 m

N

ILUKA

TUTUNUP SOUTH

RESIDENCES

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:25,000
DATE:	6 Aug. 2007

DWG No: 176474 ver.00 | A4 | FIGURE: 1

4.2. Noise Modelling

To predict the noise that may be created by the proposed mining operation, a model was developed (SVT, 2008). Noise levels emitted from the mining equipment (fixed and mobile) have been calculated from existing mine sites and data from manufacturers. The equipment has been modelled without any noise attenuation. This data, together with local weather data, ground topographical data and receiver locations, was used to predict noise levels at ten residences (R1-10) which represent 15 houses in the vicinity of the Tutunup South site under worst case conditions. A tonality assessment was included as part of the modelling and a 5dB(A) penalty added to the noise emitted if tonality was considered likely to be present.

Worst case predictions were applied to the following scenarios (or stages) of the mining operation:

- Scenario 1 – Construction day operations;
- Scenario 2 – Mining between March 2009 and October 2009;
- Scenario 3 – Mining between November 2009 and March 2011;
- Scenario 4 – Mining between September 2012 and December 2012; and
- Scenario 5 – Mining between December 2013 and June 2014.

From the modelling, eight residences are likely to experience exceedances during the day under unfavourable conditions. These are residences R1 to R7 and R9. At night, six residences (R1, R5, R6, R7, R9 and R10) are predicted to exceed the prescribed limits (Table 2). Conditions that result in non-compliance with the *Environmental Protection (Noise) Regulations* are presented in Table 3.

Table 2: Worst Case Noise Levels for Ten Residences Surrounding Tutunup South

Closest Residence	Adjusted worst-case day and night noise levels in dB(A)								
	Scenario 1	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	Day	Day	Night	Day	Night	Day	Night	Day	Night
R1	58.5	**50.6**	**45.1**	**59.1**	**45.1**	41.2	32.5	**48.3**	**38.0**
R2	53.9	**52.2**	33.4	**64.3**	33.0	**46.1**	29.0	39.9	**34.0**
R3	53.5	**51.3**	32.7	**61.9**	32.3	**46.3**	28.6	39.7	**33.9**
R4	51.6	**47.0**	**34.6**	**55.6**	**34.4**	**44.6**	27.4	38.2	24.3
R5	53.2	**46.7**	**37.7**	**54.3**	**37.5**	**47.2**	29.2	39.4	24.4
R6	65.2	46.0	**50.0**	**53.7**	**50.0**	**54.5**	**49.9**	**55.3**	**47.3**
R7	59.1	42.2	**45.4**	**51.2**	**45.4**	45.4	**43.9**	**51.4**	**44.2**
R8	46.0	29.2	27.6	30.9	**32.6**	44.4	28.8	36.1	28.3
R9	44.1	31.1	30.8	31.9	**35.8**	**51.8**	31.2	35.9	**36.0**
R10	44.8	29.3	27.7	31.3	27.7	40.1	31.9	37.2	**36.7**

Table 3: Compliance Assessments for Worst Case Day and Night Operations

Residence	Adjusted Assigned Noise Levels dB(A)	Scenario 2		Scenario 3		Scenario 4		Scenario 5	
		Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions	Compliance	Non-compliance wind directions
R1 Day	54	Yes		No	SW-NE	Yes		Yes	
R1 Night	44	No	S-NW	No	S-NW	Yes		Yes	
R2 Day	50	No	S-W	No	ALL	Yes		Yes	
R2 Night	40	Yes		Yes		Yes		Yes	
R3 Day	48	No	SE-W	No	ALL	Yes		Yes	
R3 Night	38	Yes		Yes		Yes		Yes	
R4 Day	45	**No**	SE-W	No	ALL	Yes		Yes	
R4 Night	35	Yes		Yes		Yes		Yes	
R5 Day	46	**No**	SE-W	No	NE-W	No	SE-SW	Yes	
R5 Night	36	**No**	SE-W	**No**	SE-W	Yes		Yes	
R6 Day	52	Yes		**No**	NE-SE	**No**	SE-W	No	E-SW
R6 Night	42	No	All	No	All	No	All	No	E-NW
R7 Day	46	Yes		No	NE-S	Yes		No	SE-S
R7 Night	36	No	All	No	All	No	All	No	All
R8 Day	45	Yes		Yes		Yes		Yes	
R8 Night	35	Yes		Yes		Yes		Yes	
R9 Day	45	Yes		Yes		No	N-SE	Yes	
R9 Night	35	Yes		No	N-SE	Yes		No	N-SE
R10 Day	45	Yes		Yes		Yes		Yes	
R10 Night	35	Yes		Yes		Yes		No	NW-E

Eight of the 10 residences are landowners and noise factors will be addressed in the landowner agreement to allow access to property for mining. R1 and R6 will be vacant during mining. The remaining 2 residences modelled are neighbours, modelled as R5 and R10. R5 represents 3 houses, R5a, R5b and R5c. The modelled R5 is R5a, which is the closest of the 3 houses.

Day-time noise is over the adjusted assigned level of 46 dB(A) at R5 during daytime mining by up to 3.3 dB(A). Night-time noise is modelled to exceed the assigned level of 36 dB(A) by up to 1.7 d(BA). Iluka proposes to develop neighbour agreements with R5a, R5b and R5c.

Night-time noise is over the assigned level of 35 dB(A) at R10 during night-time by 1.7 dB(A) under one of the scenarios modelled. This includes a 5 dB(A) penalty for tonality. Iluka proposes to develop neighbour agreements with R10.

5. MANAGEMENT

5.1. Site Design

Noise bunds have been integrated into the mine design as needed to minimise noise emissions. These noise bunds will be constructed from earthen material as appropriate material becomes available. Specifically:

- a noise bund 10 m high will be installed adjacent to the concentrator;
- the screening plant will be placed in the pit, 4 m below surface and surrounded by 10 m noise bunds; and
- ore mining at night in pit 2 will be conducted behind the ore stockpile.

The in-pit hopper, screen plant and concentrator locations were selected to be as far away from receiving residences as possible. Conveyors will be used to transport ore from the in-pit hopper to the screen plant. The conveyors emit lower noise levels than mobile equipment. From the screen plant, the ore will be pumped via a pipeline to the wet concentrator. Pumps will be installed in enclosures to suppress noise and contained behind stockpiles where possible.

The proposed site layout with noise control features highlighted is shown in Figure 2.

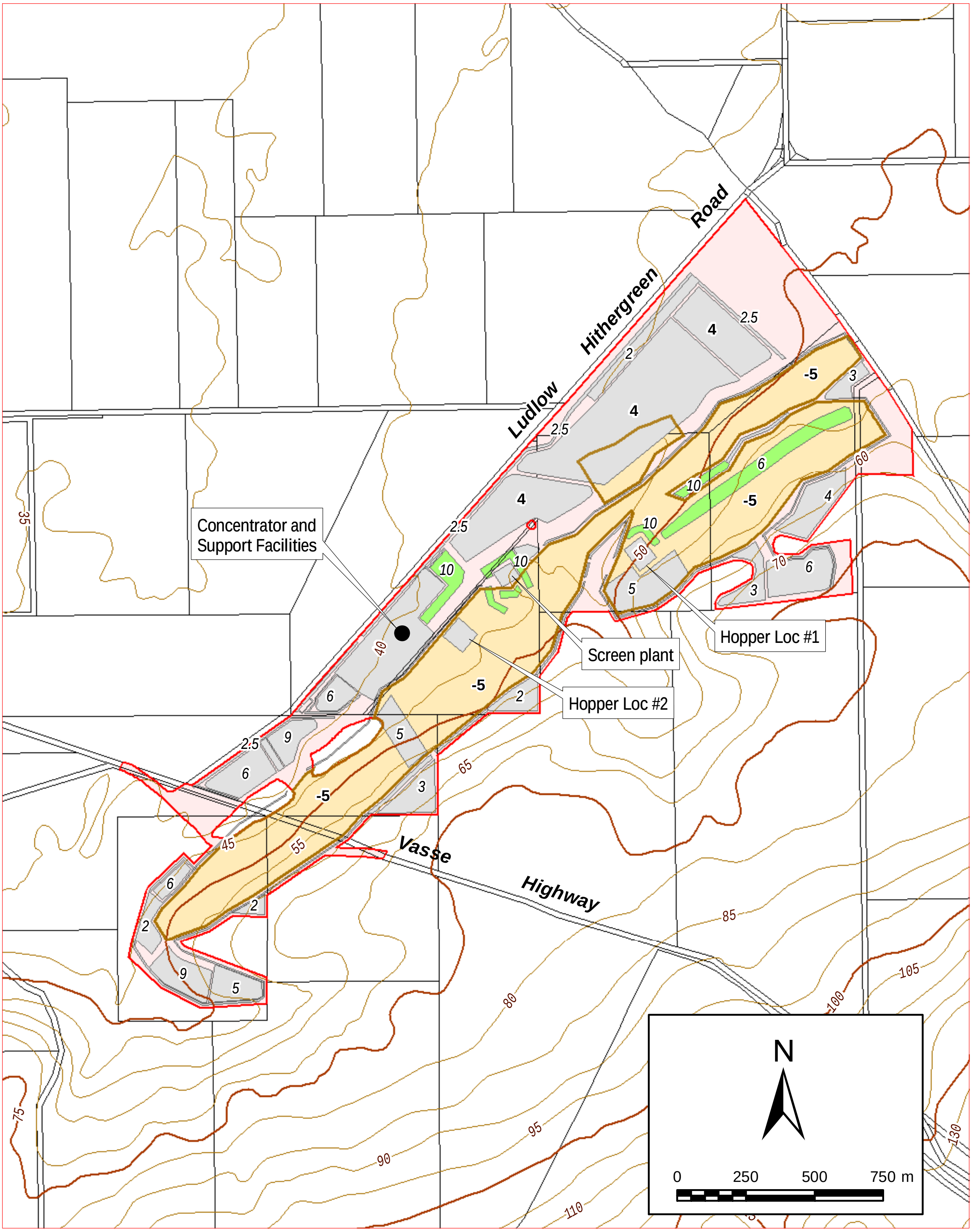
5.2. Construction

Construction activities will be conducted in accordance with Regulation 13 (Construction Sites) of the *Environmental Protection (Noise) Regulations 1997*.

Heavy vehicle operation during construction will be restricted to daytime hours. Heavy vehicle operation outside these hours will be limited to dust suppression where necessary. Low noise activities such as light vehicle movements, surveying, fencing, installation of fixed plant may be conducted outside the above hours provided they meet noise limits.

During construction, there will be exceedances to the noise regulations during daytime operations. This is allowed for under section 13 of the noise regulations, with the provision that construction work is carried out in accordance with the control of environmental noise practices set out in section 6 of *AS 2436-1981 Guide to Noise Control and Construction Maintenance and Demolition Sites*. These practices include:

- Control of noise at source, by substitution, modification, use and siting of equipment and/or regular and effective maintenance.
- Controlling the spread of noise, by distance and/or screening.



Legend

- Noise Control
- Infrastructure
- Mine pit
- Disturbance area
- 6 Height of feature above surface (metres)
- -5 Pit depth below surface (metres)

ILUKA

ORIG: S.Jones

DRAWN: T.L.G

SCALE: 1:20,000

DATE: 8 April 2008

TUTUNUP SOUTH

NOISE CONTROLS AS MODELLED

DWG No: 176657 ver.02 | A4 | FIGURE: 4

Managing mobile equipment to ensure efficient operations allowing maximum material movement whist minimising noise emissions is essential. The following practices will be implemented at Tutunup South:

- minimising the number of equipment operating in the same area at once;
- minimising number of machines starting up at once;
- ensuring the mobile machinery parking area (go-line) is as far from residences as possible and noise bunds are constructed around the go-line as early as possible; and
- equipment will be subject to regular maintenance.

Recent experience at other sites has been directed to reducing the intermittent noises from the operation. These intermittent noises have been recognised as having a high level of annoyance. All mobile machinery at the Tutunup South site will be required to have directional broadband white noise alarms rather than standard reversing beepers. The use of alarms instead of horns as an alert system has also been introduced at Iluka sites with good feedback received.

5.3. Operations

During operations, topsoil and subsoil stripping, general maintenance activities and overburden movement will be restricted to daytime hours, whilst mining and processing of ore will occur continuously 24 hours per day.

The same practices outlined for construction of controlling noise at source and controlling the spread of noise apply during operations.

6. MONITORING

Noise monitoring will be conducted both on a regular basis and as required.

6.1. Monitoring pre and during construction

Monitoring will be conducted at selected residences before construction commences and during construction, with a portable sound logger and a handheld sound level meter. The logger will be set out at residences for periods of 1-2 days, to capture a range of times and conditions prior to work commencing. During construction, the logger will be set out for a period of 1-2 days at least twice at residences R2, R5a, R7 and R9 with the aim of capturing noise measurements over a range of construction and weather conditions. These residences were chosen as they are close to the operation and span impacts from different wind directions.

6.2. Monitoring during operations

Noise levels shall be monitored at selected residences at least every 6 months. The first operational monitoring will occur within the first month of operations.

Noise monitoring will be conducted on an as needs basis in response to operational changes and landowner queries.

7. COMMUNITY LIAISON

7.1. Community consultation

Iluka engages in a continuous consultation process for neighbours and the locally elected representatives and executives of the Shires in which it operates. This includes providing regular briefings, site tours, letters and newsletters on an ongoing and as required basis in order for these important stakeholders to be kept informed and for feedback on the operations to be sought.

Iluka regularly conducts detailed briefings with NGO groups on an operational and project level, and Tutunup South will be included as part of these briefings.

Iluka will share information regarding the mine with the wider community via Iluka's website and regular newsletters.

7.2. Complaints Procedure

Iluka has a well established community comment and complaints procedure, which is recognised by the community as being thorough and responsive.

Neighbours of the mine site will be provided with 24 hour contact cards providing the phone numbers of key Iluka operational personnel for Tutunup South.

All complaints are responded to in a timely manner, and it is aimed to resolve complaints where practical within three days.

Mine site operators and key Iluka staff have been trained in Iluka's comprehensive community complaints strategy.

8. CONTINGENCY PLANS

Where a noise issue is identified, contingency plans will be put in place to address the concern. These contingency actions and the triggers are outlined in Table 4.

Table 4: Trigger and Contingency Action

Trigger	**Contingency action**
Monitoring identifies noise in excess of acceptable levels at a residence	• Undertake review of the dominant noise sources causing an issue at that residence. • Discuss with the resident. • Investigate management options.
Resident identifies noise in excess of acceptable levels at a residence	Initial response: • discussion with the resident to aid in identifying the source of the noise; • if required and if the noise is continuing at the time Iluka is alerted, visit residence to identify the source of the noise; and • where the noise source can be identified, modify operational activities to reduce the noise if practicable. Follow-up: • Undertake review of the dominant noise sources causing an issue at that residence • Investigate management options
Employee or contractor identifies equipment that is noisier than usual	• Report through Iluka's incident reporting system • Investigate cause of excessive noise and implement any remedial actions identified
Any person identifies works being conducted which is not compliant with management action in section 5.1, which lead to unacceptable noise levels	• Report through Iluka's incident reporting system • Complete actions generated

Management options for reducing noise depend on the exact nature and impact of the noise, however may include:

- moving equipment to another area;
- changing to less noisy equipment if available and practicable;
- maintenance to reduce unusual noise;
- other engineering solutions; or
- cease problematic activity until weather conditions improve.

9. KEY MANAGEMENT ACTIONS

Table 5: Key management actions

Key Management Actions	Performance indicator
Manage mobile machinery equipment start-up, movement and operation to minimise noise impacts	Logbook
Equipment will be regularly maintained	Maintenance records
Directional broadband white noise alarms on all mobile machinery	Logbook
All pumps will be installed in enclosures	Enclosures fitted
Construct noise bunds as planned	Noise bunds in place
Site screenplant within pit	Screenplant in place
Conveyors will be used during operations for transport of ore from the in-pit hopper to the screen plant	Conveyors constructed and operational
A pipeline will be used to transport ore from the screen plant to the concentrator	Pipeline installed and operational
Noise monitoring will be conducted before and during construction.	Records of monitoring before and during construction
Noise will be monitored every 6 months	Records of 6 monthly noise monitoring
Noise will be monitored in response to operational changes and landowner queries	Records of 'as required' monitoring

Where performance indicators are not being met, action will be immediately undertaken to ensure the objective is met. These actions will include management response to ensure logbooks and maintenance records are completed, prioritise work directions to ensure bunds are constructed and not commence operations until agreements are finalised.

10. REPORTING

A noise summary will be provided in the Annual Environmental Report (AER).

11. REVIEW AND REVISE

This management plan will be reviewed to assess its suitability, adequacy and effectiveness in meeting the set objectives annually or as required. Where necessary, the plan will be revised and revisions will be submitted to the DEC for approval.

12. REFERENCES

SVT (2008) *Environmental noise assessment of the Tutunup South mine site*. Unpublished report prepared for Iluka Resources Limited.

13. DOCUMENT CONTROL

Revision	Reviews/Changes	Create Date
A	Initiation of First Draft	16 July 2007
B	Comments from LKS and updated formatting and cross-referencing	6 September 2007
C	Comments from MR, FD and SS	9 September 2007
D	Comments from internal draft review	14 September 2007
E	Incorporating comments from external review	16 January 2008
F	Revised after EPASU comment	17 March 2008

Appendix 6

Preliminary Closure and Rehabilitation Plan

ILUKA

Iluka Resources Limited

Preliminary Closure and Rehabilitation Plan

Tutunup South Mineral Sands Project

April 2008

ILUKA-TR-T15793

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1. INTRODUCTION

1.1. Background

The Tutunup South project is located approximately 15 km southeast of Busselton on mining tenements M70/611, M70/612, M70/1261 and E70/2699. It is anticipated that the extent of mining will occupy approximately 230 ha of which approximately 6 ha is isolated trees in cleared agricultural land and 25.6 ha is native vegetation for which condition and community could be assessed. The mine will consist of pits, stockpiles, plant and infrastructure, a process water dam, and solar drying dams.

This plan relates to the closure and rehabilitation of the Tutunup South mine site. This plan has been developed in conjunction with the Public Environmental Review (PER) impact assessment document. Implementation of this plan and compliance during operations is a commitment of the PER document. This document has been developed in accordance with EPA Guidance Statement no. 6.

1.2. Purpose and Objectives

The purpose of this plan is to define an acceptable rehabilitation objective, provide preliminary information on the approach that will be taken by Iluka to reach the objective and present monitoring options for determining the progress towards the objective and compliance with the agreed approach. More specifically this plan has been developed to achieve the following objectives:

- identify the legislative guidance influencing closure and rehabilitation of the Tutunup South mine;
- summarise baseline conditions and land capability prior to mining;
- communicate the conceptual rehabilitated landscape at Tutunup South;
- identify the likely structures that will need to be removed and or rehabilitated at closure;
- assess the risks confronting rehabilitation; and
- identify rehabilitation completion criteria for agreement as a mechanism for the relinquishment of bonds.

1.3. Legislative and Regulatory Framework

The following Acts currently apply to mining activities at all of Iluka's Western Australian mine sites and will continue to apply during rehabilitation at Tutunup South until the tenement is relinquished:

- *Environmental Protection Act 1986 (as amended)*
- *Rights in Water and Irrigation Act 1914*
- *Conservation and Land Management Act 1984*
- *Bush Fires Act 1954-1977*
- *Soil and Land Conservation Act 1945*

- *Radiation Safety Act 1975*
- *Mining Act 1978*
- *Mine Safety and Inspection Act 1995*
- *Explosives and Dangerous Goods Act 1961*
- *Wildlife Conservation Act 1950*
- *Agriculture and Related Resources Protection Act 1976*
- *Contaminated Sites Act 2003*

Any conditions that are placed on Tutunup South under Part IV of the Environmental *Protection Act* and Iluka policy and standards will also be adhered to.

1.3.1. Tenement conditions

Closure and rehabilitation of Tutunup South will be conducted in accordance with tenement conditions of Mining Leases 70/611, 70/612 and 70/1261 that relate to rehabilitation (Table 1).

Table 1: Mining leases 70/611, 70/612, 70/1261 conditions that relate to rehabilitation

No.	Condition
6	Unless the written approval of the Environmental Officer, DoIR is first obtained, the use of scrapers, graders, bulldozers, backhoes or other mechanised equipment for surface disturbance or the excavation of costeans is prohibited. Following approval, all topsoil being removed ahead of mining operations and separately stockpiled for replacement after backfilling and/or completion of operations.
10	Tailings dams, disposal areas and dumps being sited so as to pose no threat to water course stability or to groundwater and surface water quality, and being constructed so as to be stable on decommissioning.
20	The lessee at his expense carrying out all necessary measures to prevent the spread of the forests disease Phytophthora cinnamomi (or Jarrah Dieback) on the area of the lease and liaising with the District Manager CALM before commencing exploratory work outside areas being mined.
21	Lessee taking all such necessary precautions as may be indicated by the District Manager CALM to prevent the occurrence or spread of any fire within or adjacent to the leased area.
22	The lessee at his expense rehabilitating all areas affected by mining or operations associated with mining conducted during the term of the lease, including the rehabilitation enrichment of dieback or other forest disease affected areas, resulting from the lessees mining or operations associated with mining. Rehabilitation being to the satisfaction of the Regional Mining Engineer and in agreement with the Regional Manager CALM.
25	The lessee designating to the Regional Manager, CALM a responsible officer to direct and control the rehabilitation programme.

1.3.2. EPA Guidance Statement No. 6

The preparation and inclusion of this plan is consistent with EPA Guidance Statement No. 6 "Rehabilitation of Terrestrial Ecosystems" (EPA 2006). The EPA advises that the anticipation of satisfactory rehabilitation outcomes is an integral part of the environmental impact assessment process for projects involving substantial clearing of native vegetation, and it recommends that more precise information on environmental impacts and the expected outcomes of rehabilitation attempts be presented during the assessment stages of the project (EPA 2006).

In its guidance, the EPA states that its primary objective for rehabilitation is to minimise environmental impacts resulting from permanent change to ecosystems. This requires the return of rehabilitated areas to self-sustaining and functional ecosystems comprised of local provenance species. The EPA requires that rehabilitation plans are based on clear objectives and targets which can be effectively monitored and audited to confirm objectives are achieved.

For the purposes of environmental impact assessment, the EPA expects proponents to:

- assess the environmental significance of the land;
- identify major limitations to rehabilitation;
- set rehabilitation objectives and definitions, prepared in consultation with key stakeholders; and
- design offset packages, if relevant.

The EPA states that, wherever feasible, comprehensive rehabilitation plans should be made available and assessed during the main proposal approval stage of the EIA process. The environmental impacts of projects which involve rehabilitation of ecosystems are determined from:

- the environmental significance of the ecosystem;
- the demonstrated capacity of the proponent to rehabilitate equivalent environments; and
- the magnitude and significance of factors constraining favourable outcomes.

The information provided by Iluka to facilitate assessment of these factors is provided in this management plan and relevant sections of the PER.

2. BASELINE ENVIRONMENT

2.1. Geology and Landforms

The Southern Perth Basin lies between the Darling Scarp and the Leeuwin-Naturaliste Ridge and comprises of the Blackwood Plateau and the Swan and Scott Coastal Plains. Tutunup South is situated between the Blackwood Plateau and Swan Coastal Plain, on the Whicher Scarp that forms the incline separating these landform units (Webb *et al* 2006). The Whicher Scarp is orientated parallel to the present day coastline extending from Burekup to Dunsborough and comprises soils of dominated by sand and laterite (Hirschberg, 1989; cited in SWC (2007a)) (Table 2).

The Tutunup South disturbance area covers parts of the Yoganup Formation and younger littoral and marginal marine units deposited on the Western Australian continental shelf during the Pliocene and Pleistocene periods (Table 2). The Whicher Scarp forms the limit of numerous Tertiary marine transgressions. Palaeo-shorelines along this part of the scarp are collectively referred to as the Yoganup Shorelines. The Yoganup Formation is partly buried by estuarine and fluvial clays of the Guildford Formation and by later alluvial fan deposits and thin aeolian quartz dunes of the Bassendean dune systems. There have been numerous phases of heavy mineral accumulation in the Tutunup South deposit, which occur from 28 to 47 m above sea level, and each concentration itself is a result of numerous individual accumulation events. Subsequent to deposition, the deposit has been subject to topographic deflation, erosion by drainage channels off the scarp, induration through lateritisation and ironstone development, and alteration of the mineral constituents.

The surface elevation of the site varies from 40 m above sea level on the western side of the disturbance area to 60 m above sea level on the eastern side. The dominant aspect is to the northwest.

Table 2: Stratigraphic sequence in the southern Perth Basin (Hirschberg, 1989; cited in SWC (2007))

Age	Formation	Maximum Thickness (m)	Lithology
Quaternary Pleistocene	Bassendean Sand	15	Dunal Sand
	Guildford Formation	18	Clay, minor sand
Tertiary – Quaternary Pleistocene – Pliocene	Yoganup Formation	15	Sand, conglomerate
Mesozioc Early Cretaceous	Leederville Formation	500	Sand, siltstone, shale
	Bunbury Basalt	85	Basalt
Middle – Late Jurassic	Yarragadee Formation	1,400	Sandstone, minor shale
Early Jurassic	Cockleshell Gully Formation	1,500	Sandstone, shale
Paleozoic Permian	Sue Coal Measure	1,838	Sandstone, shale, coal

2.2. SOILS

2.2.1. Regional Survey

The soils of the Tutunup South area have been mapped at a regional scale by McArthur and Bettenay (1958) and the Department of Agriculture (Tille and Lantzke, 1990; cited in SWC, 2007). The proposed Tutunup South mine occurs at the junction of the Abba Plain and Whicher Scarp. Subsequently, the soils on the western side of the disturbance area represent the low-lying, seasonally inundated soils of the Abba Plain, whilst on the eastern side the soils are well drained with deep sandy and gravelly duplex soils corresponding to the Yelverton Land Unit.

The soils in the Abba Plain typically consist of sandy grey-brown duplex (Abba Soil Series) and gradational (Busselton Soil Series) soils overlying the heavy clay subsoils of the Guildford Formation. The thickness of the surface sands in the Abba Series are typically < 1 m, however deeper sands do occur with a well-defined organic stained ferricrete (i.e. coffee-rock layer) occurring at the duplex boundary. In low-lying areas which experience prolonged inundation (Abba Very Wet Saline Flats) the surface sandy soils often become saline during the summer months due to surface evaporation and accumulation of soluble salts. In contrast to the inundated soils of the Abba Plain, the soils of the Yelverton Shelf are well drained and experience prolonged oxidised conditions. Consequently, the surface soils often contain abundant gravels (Forest Grove Soil Series) or deep yellow sands (Yelverton Deep Sandy Flats). On the western side of the Whicher Scarp, and along the broad U-shaped drainage lines, the surface soils experience seasonal inundation resulting in mottled pale grey appearance (Mungite Soil Series) (Table 3).

Table 3: Description of the regionally mapped soil types in the Tutunup South mine site area (Tille and Lantzke, 1990; cited in SWC, 2007).

Land Unit	Soil type description
Abba Plain Land System	
Abba Flats (213Ab_A)	Flats and low rises with sandy grey-brown duplex (Abba) and gradational (Busselton) soils.
Abba Wet Flats (213_Ab_Aw)	Winter wet flats and slight depressions with sandy grey-brown duplex (Abba) and gradational (Busselton) soils.
Abba Very Wet Saline Flats (213Ab_Awy)	Poorly drained depressions containing shallow sands over clay subsoils. Soils typically become saline during summer.
Abba Fertile Flats (213Jd_Af)	Well drained flats containing deep red-brown sands, loams and light clays (Marybrook soils)
Yelverton Shelf Land System	
Yelverton Flats (252WsYL)	Gravelly duplex (Forest Grove soils), mottled pale grey (Mungite soils) and yellow sandy soils occurring on flat land surfaces (gradients 0 – 2%). These soils are typically well drained.
Yelverton Deep Sandy Flats (252WsYLd)	Deep bleached and yellow sands occurring on flat land surfaces (gradients 0 – 2%). These soils are very well drained.
Yelverton Wet Valleys (252WsYLvw)	Mottled pale grey soils (Mungite) occurring in broad U-shaped drainage depressions with swampy floors.
Treeton Hills Land System	Deep gravely and lateritic soils of the Blackwood Plateau.

2.2.2. Land capability

The land capability of land units occurring within the Tutunup South Project area is summarised in Table 4. To simplify interpretation of the data, land capability classes are grouped as per the recommendation by van Gool *et al.* (1999).

Table 4: Land capability of soil types occurring with the Tutunup South mine site area (Data source: Tille and Lantzke, 1990)

Land Unit	Grazing	Annual horticulture	Perennial horticulture	Vines	Cropping
Ab_AB1	High	Fair	Low	Fair	Fair
Ab_Aw	Low	Low	Low	Low	Low
Ab_Awy	Low	Low	Low	Low	Low
YL2	High	Fair	Fair	High	Fair
Yld	Low	Fair	Fair	Fair	Low
Ylvw	Fair	Low	Low	Low	Low

Notes:

- High: 50%+ of land = class 1 or 2
- Fair: 50%+ of land = class 1, 2 or 3
- Low: 50%+ of land = class 4 or 5

Abba flats have a high capability for grazing, but low capability for perennial horticulture due to seasonal waterlogging. Abba wet flats and very wet saline flats have low land capability for all land uses due to limitations of waterlogging, low trafficability and salinity. Land use for Yelverton flats and deep sandy flats is the low water holding capacity of their sandy soils. Yelverton wet valleys have low land capability for all land uses except grazing due to waterlogging, low trafficability and flooding risk.

The dominant land use within the Tutunup South Project area is for grazing. Figure 1 demonstrates the spatial variation in land capability for this land use.

2.2.3. Site Soil Surveys

The soils of the Tutunup South project vary from exposed laterite to gravelly duplex soils along the Whicher Scarp to deep pale grey sands within the low-lying sumplands of the Abba Plain. Detailed soil surveys by Soil Water Consultants (2007a, b) have determined that there are five distinct soil mapping units over the disturbance area (Figure 2 and Figure 3).

- SMU 1: Exposed Laterite

Exposed laterite occurs on the eastern side of the project. The absence of soil cover over the laterite indicates this area is subject to erosive influences. Any soil development from weathering or breakdown of laterite is rapidly transported downslope. This SMU will not be disturbed by mining.

- SMU 2: Gravelly Duplex Soil

  Gravelly duplex soils existing downslope of the exposed laterite, formed by deposition of gravels from the exposed laterites. The soil profile consists of a dark brown loamy sand of approximately 15 cm depth overlying yellow sand gravel up to 1 m deep. Beneath the gravel is a horizon of mottled clayey sand to sandy loam of the Yoganup Formation to 4.5 m below ground level before transitioning into blue grey sandy clay.

The width of this SMU varies from 20 m to the north of the project to 100 m to 450 m at the southern end of the project. The increased width at the southern end of the project is believed to be due to the presence of remnant scarp which has experienced less erosion and deposition than the northern end of the project. This proposition is supported by drilling data (SWC 2007a).

- SMU 3: Deep Yellow Sandy Duplex

  SMU 3 is downslope of SMU 2, formed by the deposition of yellow sands from the upslope laterites of the Whicher Scarp onto sandy clays. The soil profile consists of a topsoil of dark brown loamy sand overlying 6 m of yellow sand (Yoganup Formation). Pale grey clayey sand/sandy loam lies beneath the yellow sand. Beneath the yellow sand is a 1 m partially consolidated laterite layer overlying pale grey clayey sand.

  SMU 3 dominates the northern end of the project having a width of up to 400 m, whilst at the southern end of the project the width varies from less than 20 m to 150 m.

- SMU 4: Deep Pale Grey Sandy Duplex

  The deep pale grey sandy duplex is further downslope of SMU 3 representing soils under permanent reducing conditions characterised by shallow groundwater levels and subject to seasonal inundation. The soil profile is comprised of dark brown loamy sand overlying approximately 3.5 m of pale grey sand (Bassendean Sands). Below this is the pale grey clayey sand/sandy loam of the Yoganup Formation.

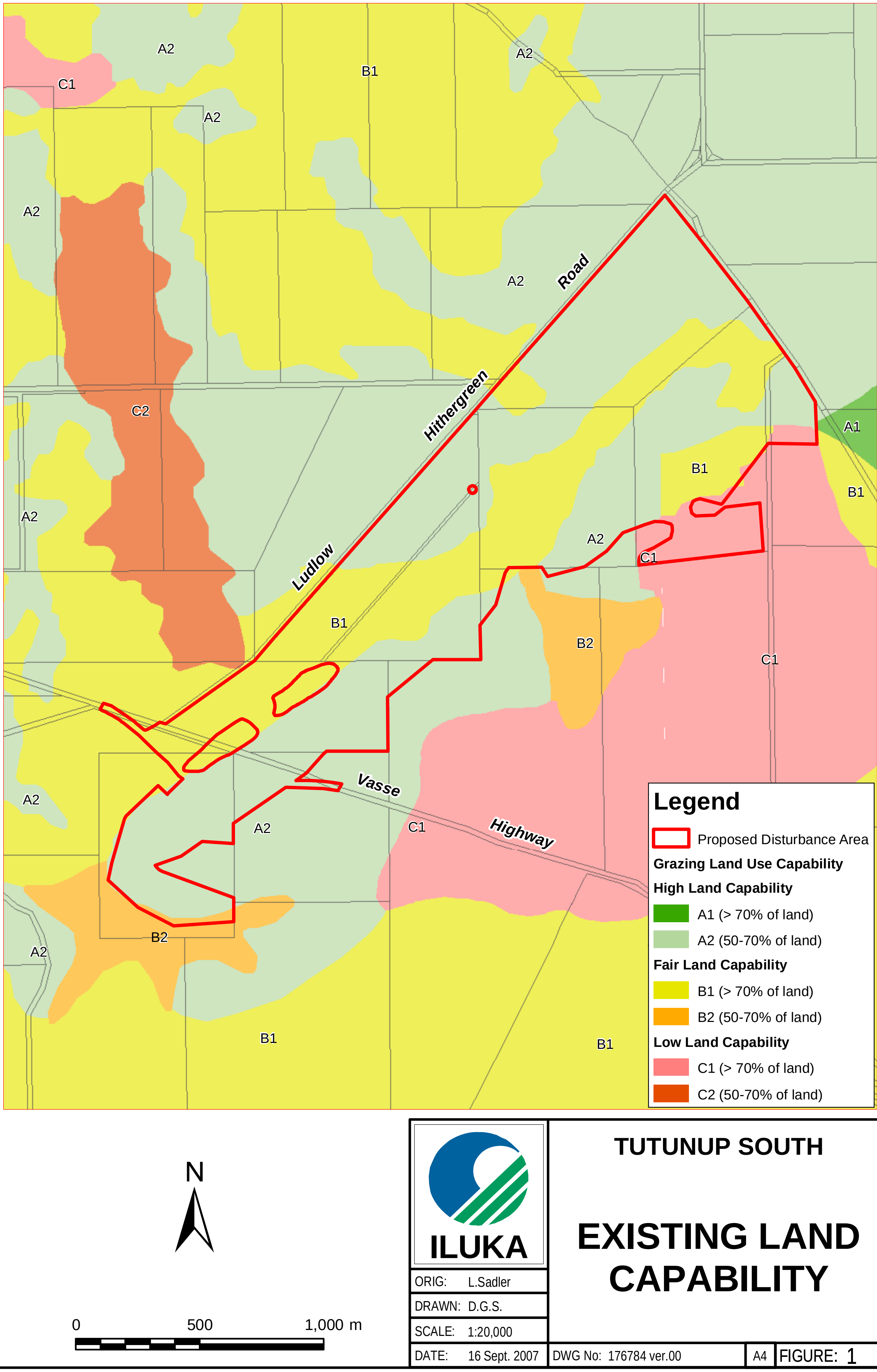
  These soils exist over the western half of the orezone extending beyond the northwestern boundary of the project, except where SMU 5 occurs (at the northern corner of the project).

- SMU 5: Shallow Pale Grey Sandy Duplex

  The shallow pale grey sandy duplex represents a relatively minor (by area) soil type at the northern end of the project. It is comprised of a dark brown sandy loam overlying approximately 1 m of pale grey sand. Below the sand is a blue grey sandy clay representing the Guildford Formation.

Through the course of mining, it is anticipated that the SMUs 3 and 4 will be the most frequently disturbed soils. SWC (2007a) made the following recommendations for soil handling to maximise the value of soils for rehabilitation:

- The topsoils from SMUs 2 and 3 should be stockpiled separately from SMUs 4 and 5.
- Similarly, the higher iron oxide content of the yellow and gravelly sands below the topsoils in SMUs 2 and 3 have a greater nutrient holding capacity and should therefore be stockpiled separately to the pale grey sands of SMUs 4 and 5.



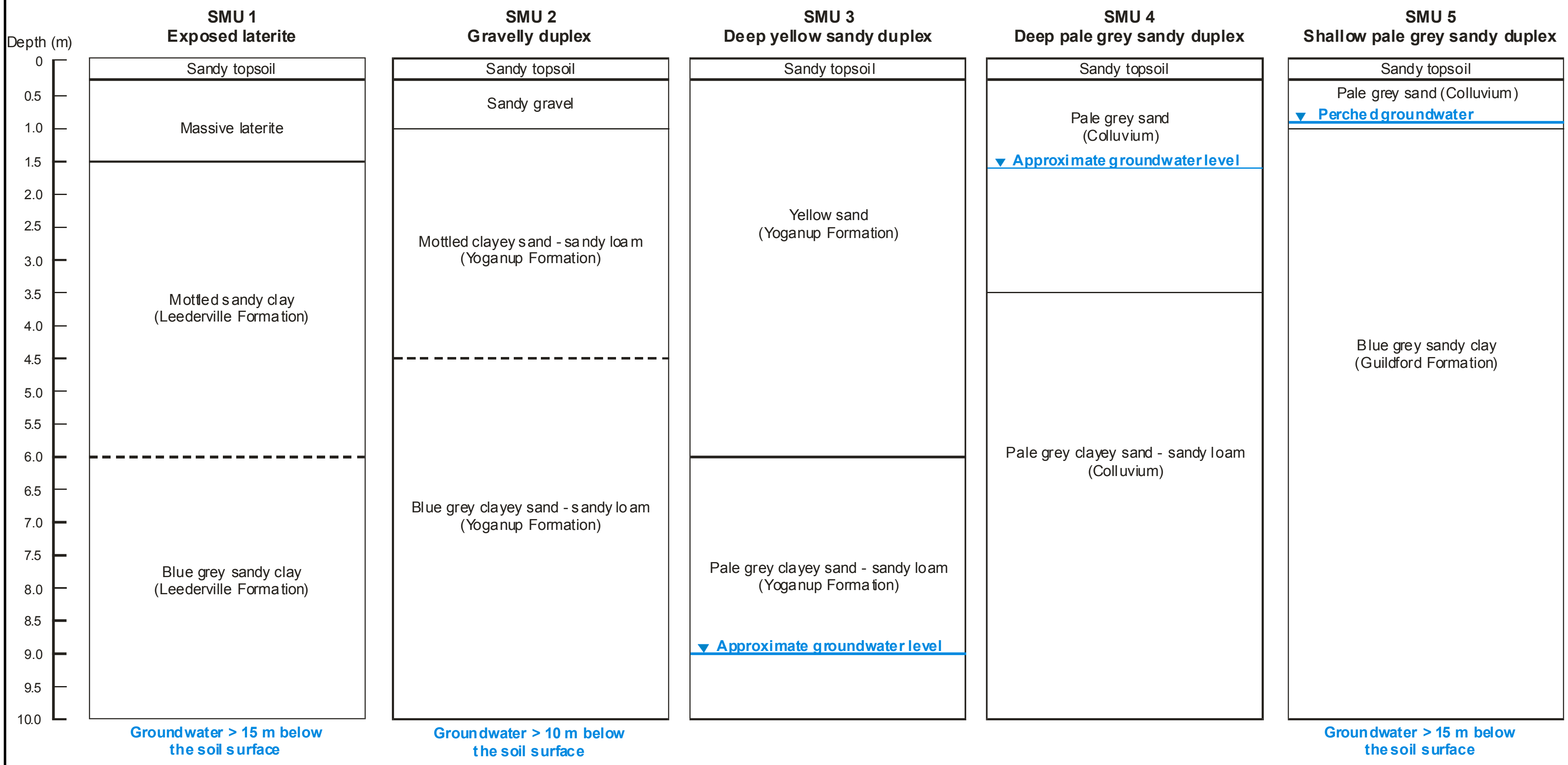
ILUKA

TUTUNUP SOUTH

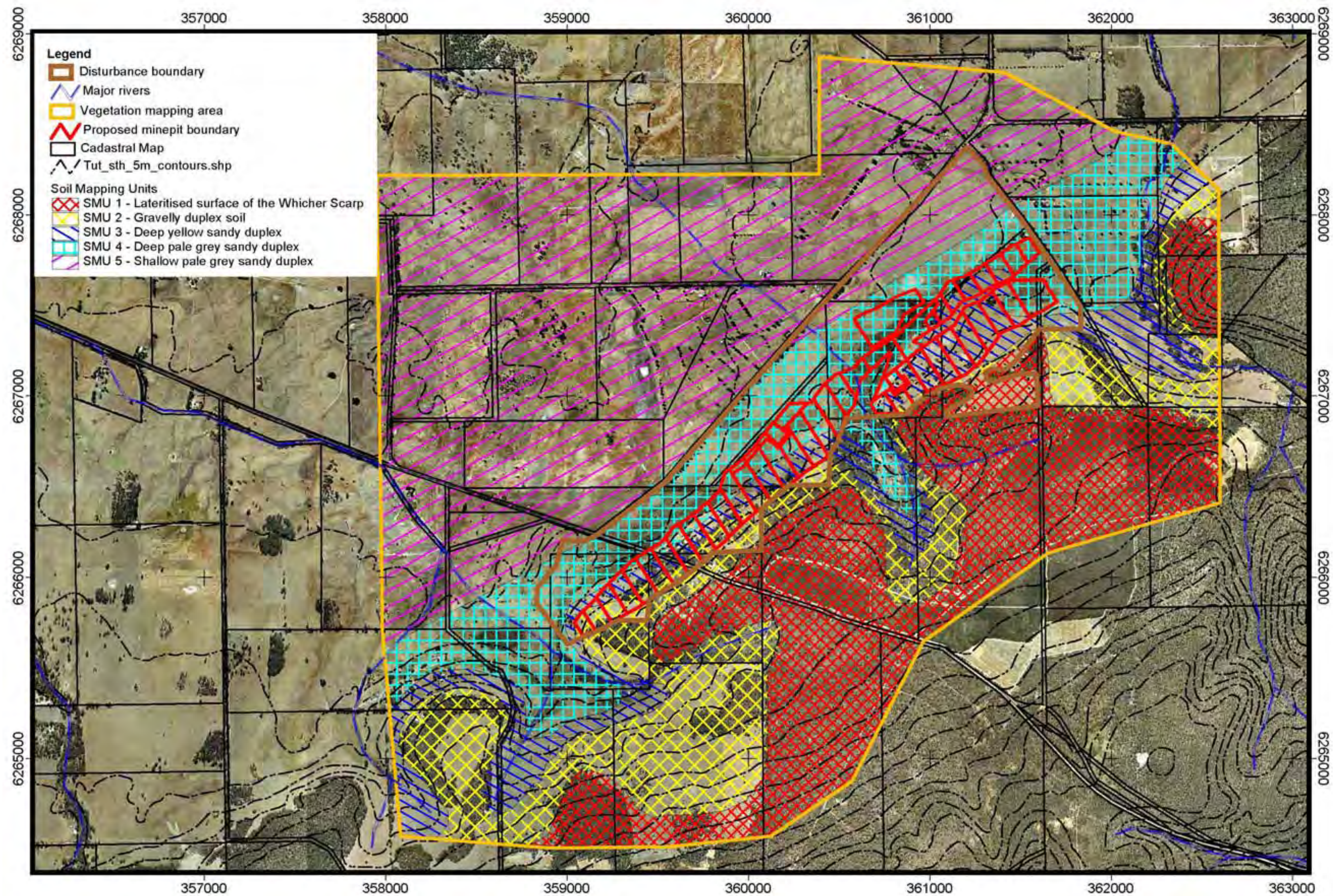
EXISTING LAND CAPABILITY

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:20,000
DATE:	16 Sept. 2007

DWG No: 176784 ver.00 | A4 | FIGURE: 1



PN	PN0094-1-1-IR-069		Iluka Resources Limited TUTUNUP SOUTH **TYPICAL SMU PROFILES**	**Figure 2**
Prep by	ASP	29/05/07		SWC
Rev'd by	AJH	29/05/07		
Revision No.		0		



PN	PN0095-1-1-IR-074		Iluka Resources Limited TUTUNUP SOUTH GDE ASSESSMENT **SOIL DISTRIBUTION (SWC, 2007)**	**Figure 3**
Prep by	ASP	29/05/07		
Rev'd by	AJH	29/05/07		
Revision No.		0		

2.2.4. Acid Sulphate Soils

The Tutunup South project is in an area where acid sulphate soils are prevalent. Investigations conducted by SWC (2007c) have found that 1,698 m^3 of acid sulphate soils will be mined as overburden during the life of the project, and 255,156 m^3 mined as ore. A separate Acid Sulphate Soils Management Plan has been prepared to ensure this material is placed appropriately during operations and does not affect successful rehabilitation.

2.3. Surface Hydrology

The project is located over two catchment areas, the Vasse-Wonnerup Estuary catchment (Abba River) and the Upstream Vasse-Sabina catchment (Sabina River). Despite the close proximity of the Abba River east of the project, the site drains to the north and west ultimately reporting to the Sabina River). Within the project area are two vegetated areas of multiple use wetlands. A small creek exists to the south-east of the disturbance area and two small drainage lines cross the project. Both drainage lines report to the Sabina River, then to the Vasse Diversion Drain. The northern drainage line flows from the Whicher Scarp across the project area. The southern drainage line originates within the project area.

Runoff from the project is seasonal, with minor drainage lines and agricultural drains experiencing dry periods. The wetlands are also seasonal, evidenced by having reduced to small shallow pools during early summer (WRM 2006).

A separate Ground and Surface Water Management Plan and Operating Strategy for Dewatering has been developed and outlines the surface hydrology features in further detail.

2.4. Groundwater

A comprehensive analysis of the groundwater environment has been compiled by Aquaterra (2007). A Ground and Surface Water Management Plan and Operating Strategy has also been developed.

The structure of the groundwater aquifers is strongly influenced by the underlying geological units. From the stratigraphy described in Section 2.1, the main groundwater aquifers are within the following formations:

- Quaternary Bassendean Sands;
- Yoganup Formation;
- Leederville Formation; and
- Yarragadee Formation.

An unconfined groundwater lens in the Bassendean Sands is caused by low permeability clays of the Guildford Formation retarding the downward flow of groundwater. This results in perching of shallow groundwater depths, seasonal waterlogging and the expression of wetlands in local depressions. The Guildford Formation itself is described by Parsons Brinkerhoff (2006) as a discontinuous aquifer/aquitard having a low transmissivity due to its clay particle size, thus forming a hydraulic barrier below and above it.

Below the Guildford Formation lies the sandy beds of the Yoganup Formation. Test pit excavations at Tutunup South have confirmed this to be a greater yielding aquifer than those above it. The mineral sands ore zones are also within Yoganup Formation and thus are expected to be where the bulk of groundwater interception during mining will be encountered. Recharge is limited where the Guildford Formation overlies the Yoganup Formation. However, the presence of the Whicher Scarp enables recharge of the Yoganup Aquifer where the Guildford Formation is absent and from the Leederville Formation which is elevated in the Whicher Scarp, compared to the Yoganup Formation on the coastal plain.

The Leederville Formation contains a larger aquifer than the aforementioned superficial aquifers and sits below the ore zones. This formation is between 22 and 24 m thick at the Tutunup South site. It is the uppermost major confined aquifer of the region. Water may move between the Yoganup and Leederville aquifers due to the Leederville Formation extending up the Whicher Scarp, and the existence of upwards pressure heads reported from the more sandy layers within the Leederville Formation. Recharge is sourced from rainfall on the Blackwood plateau, whilst groundwater flow is to the northwest between Capel and Donnybrook.

The weakly consolidated sandstone siltstone and shales of the Yarragadee Formation, forms the major groundwater resource in the Bunbury-Busselton region (the Yarragadee Aquifer). Recharge is principally achieved by leakage from the Bassendean Sands and Yoganup Formation where the Leederville Formation and Bunbury Basalts are absent. However, where the Bunbury Basalts are present, they form a strong aquiclude and have been encountered by exploration drilling to the north of the Tutunup South project.

2.5. Flora and Vegetation

Most of the disturbance area consists of cleared agricultural land covered by a variety of agricultural grasses. Mattiske Consulting Pty Ltd (2005, 2007) has assessed the vegetation over the disturbance area and surrounding areas, defining 12 native vegetation communities (Figure 4). This included three communities dominated by E*ucalyptus marginata* or *Eucalyptus patens*, three dominated by *Corymbia calophylla*, two *Melaleuca* woodlands, one *Banksia attenuata* woodland, two Myrtaceous shrublands and a pine plantation (Mattiske Consulting, 2007).

Of these communities, the M1 (Melaleuca woodlands), E2 (open Jarrah/Marri forest) and S2 (tall shrubland) communities are expected to receive clearing impacts, along with 2.9 ha of degraded land (no community type ascribed) and 6 ha of isolated trees in paddocks resulting in a total clearing footprint of 31.6 ha (Table 5).

Table 5: Disturbance to Native Vegetation at Tutunup South

Vegetation Community	Bush Forever Condition	Vegetation Identification	Area in hectares
E2	2	62	0.1
E2	4	8, 10, 11, 13, 14, 32,60, 64	14.9
S2	5	9	0.8
M1	3	5	3
M1	4	4	1.4

Vegetation Community	**Bush Forever Condition**	**Vegetation Identification**	**Area in hectares**
M1	5	3	2.5
D	5	12	2.9
		Total	25.6
Isolated trees in agricultural paddocks	NA	NA	6
		Total	31.6

Whilst no Declared Rare Flora are within the disturbance area, the three priority flora (*Gratiola pedunculata* (P2), *Aotus cordifolia* (P3) and *Loxocarya magna* (P3)) are likely to be disturbed by mining.

The flora and vegetation survey included the establishment of 14 permanent survey plots. These were located in all habitats, including wetlands. Floristic, environmental and location data were collected for the permanent monitoring locations and this information will be used for rehabilitation purposes and specifically in vegetation community design.

2.6. Weeds

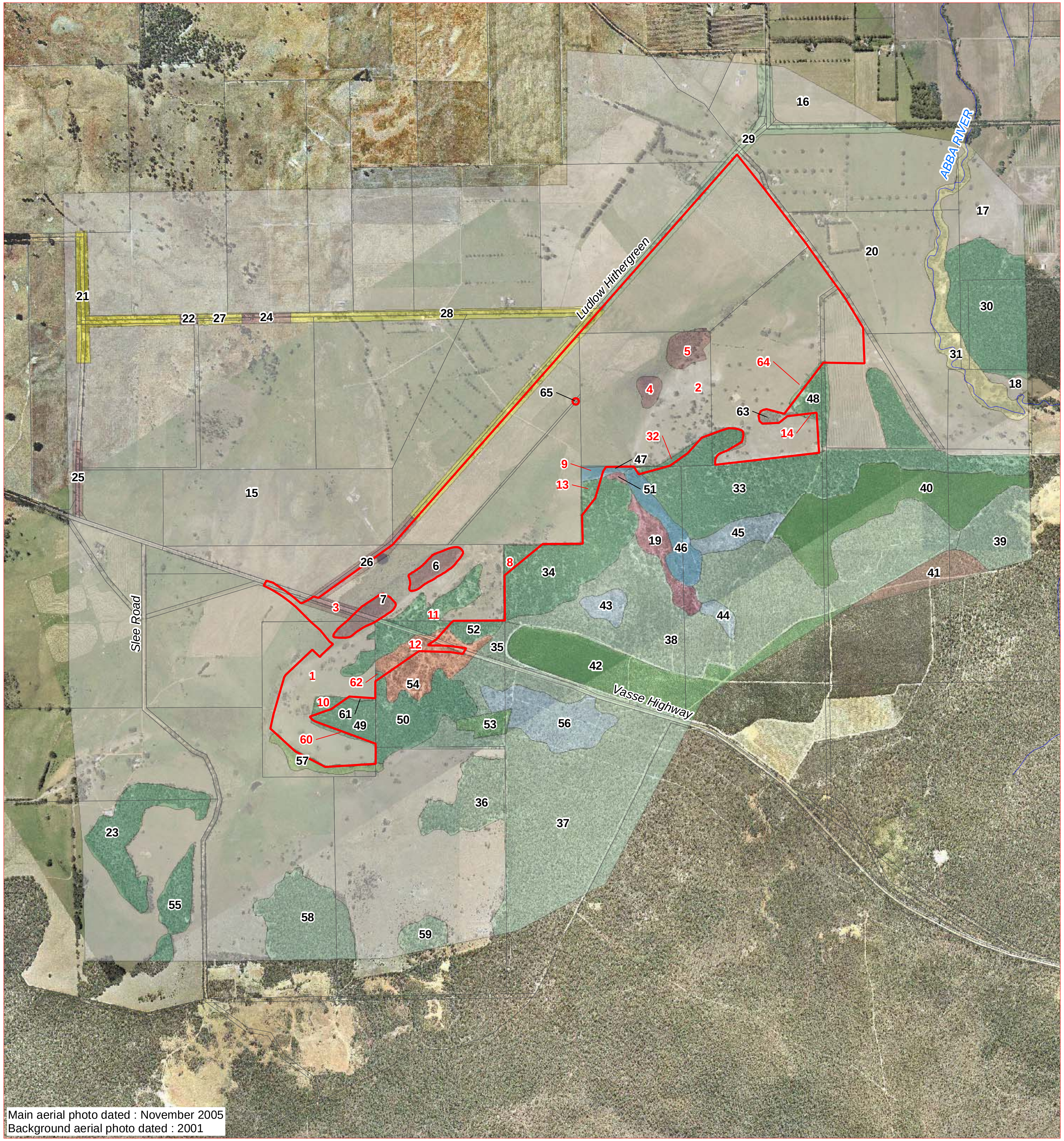
Fifty-six introduced (weed) taxa were recorded during the Mattiske Consulting surveys. Two of these, the Arum Lily (*Zantedeschia aethiopica*) and Cape Tulip (*Moraea flaccida*) being Declared Plants pursuant to Section 37 of the *Agriculture and Related Resources Protection Act*. Both the Arum Lily and Cape Tulip have P1 and P4 classifications, prohibiting the movement of contaminated machinery, plants and seeds from the property, and obliging the landowner to treat to destroy Declared Plants (Mattiske Consulting Pty Ltd 2007).

2.7. Dieback

A dieback survey of the disturbance and surrounding area was undertaken by DEC, Forest Management Branch in February 2007 (DEC, 2007). This survey determined that the majority of the disturbance area was uninterpretable which will be managed as unprotectable/infested (Figure 5). Parts of the State Forest to the east of the disturbance area were classified as protectable/uninfested. The Flora, Vegetation and Dieback Management Plan for Tutunup South describes dieback mitigation and management strategies.

2.8. Fauna

A level 1 fauna survey was undertaken by Ninox Consulting in 2006. A more detailed level 2 fauna survey was undertaken by Biota in February 2007. The most significant fauna present in the Tutunup South area is considered to be the Carnaby's and Baudin's Black Cockatoos and the Forest Red-tailed Black Cockatoo. A separate Native Fauna Management Plan has been prepared for Tutunup South and describes baseline environment, potential impact and mitigation and management strategies for fauna.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
05	L.S.	D.G.S.	16.09,07	Numbering of veg polygons changed
06	P.F.	D.G.S.	7.02.08	Permanent Veg Monitoring Locations
07	S.J	T.L.G	8.04.08	Update Disturbance Area
08	S.J	T.L.G	10.04.08	Remove veg monitoringlocations

Legend

Disturbance Area

Tutunup South Existing Vegetation

Vegetation Code

- B1 Woodland of Banksia attenuata over Beaufortia squarrosa, Adenanthos meisneri , Melaleuca thymoides , Stirlingia latifolia and Melaleuca trichophylla on sandy soils. - Site 41
- C1 Open Forest of Corymbia calophylla over Taxandria lineariifolia (ms) and Astartea scoparia over mixed sedges on flowlines. - Site 31
- C2 Woodland of Corymbia calophylla over Xanthorrhoea preissii and Kingia australis on loam soils. - Site 21
- C3 Woodland of Corymbia calophylla over pasture on loam soils. - Sites 27,28
- E1 Open Forest of Eucalyptus marginata subsp. marginata Corymbia haematoxylon with Banksia grandis and Banksia attenuata over Xanthorrhoea preissii , Podocarpus drouynianus , Stirlingia latifolia , Melaleuca thymoides and Dasypogon hookeri over Anarthria scabra and Phlebocarya ciliata on gravelly sandy loams on middle to upper slopes of the Whicher Range escarpment. Sites 29,35,36,37,38,39,58,59
- E2 Open Forest of Eucalyptus marginata subsp. marginata Corymbia calophylla with Banksia grandis and Xanthorrhoea preissii over Hibbertia hypericoides on gravelly sandy loams on lower slopes of the Whicher Range escarpment. Sites 8, 10, 11, 13, 14, 23, 30, 32, 33, 34, 48, 49, 50, 52, 55, 60, 62, 64
- E3 Woodland of Eucalyptus patens, Taxandria linearifolia (ms) and Astartea scoparia over Gahnia decomposita, Lepidosperma tetraquetrum and Cyathochaeta avenacea on loam soils. Site 57
- M1 Woodland of Melaleuca rhaphiophylla and Melaleuca preissiana with Taxandria lineariifolia (ms), Astartea scoparia and Acacia divergens over Cyathochaeta avenacea and mixed sedges and rushes on clay-loam soils. Sites 3, 4, 5, 6, 7, 22, 24, 25, 26
- M2 Open Woodland of Melaleuca preissiana with Kunzea ericifolia , Xanthorrhoea preissii and Baxteria australis on sandy-loam soils - Sites 19, 51
- S1 Low Shrubland of Melaleuca thymoides and Beaufortia squarrosa over Kunzea micrantha subsp. micrantha, Stirlingia latifolia, Dasypogon bromeliifolius with emergent Allocasuarina fraseriana, Nuytsia floribunda, Banksia attenuata and Xanthorrhoea preissii on sandy loam soils. Sites 43, 44, 45, 56
- S2 Tall Shrubland of Taxandria linearifolia (ms), Taxandria fragrans (ms), Astartea scoparia, Kunzea recurva, Pericalymma spongiocaule over Cyathochaeta avenacea on sandy-loam soils. Sites 9, 46, 47
- CL Cleared - Sites 1, 2, 15, 16, 17, 18, 20, 61, 63, 65
- PL Plantation - Sites 40, 42, 53
- D Degraded - Sites 12, 54

Survey conducted November 2005 by Mattiske Consulting PTY LTD

N

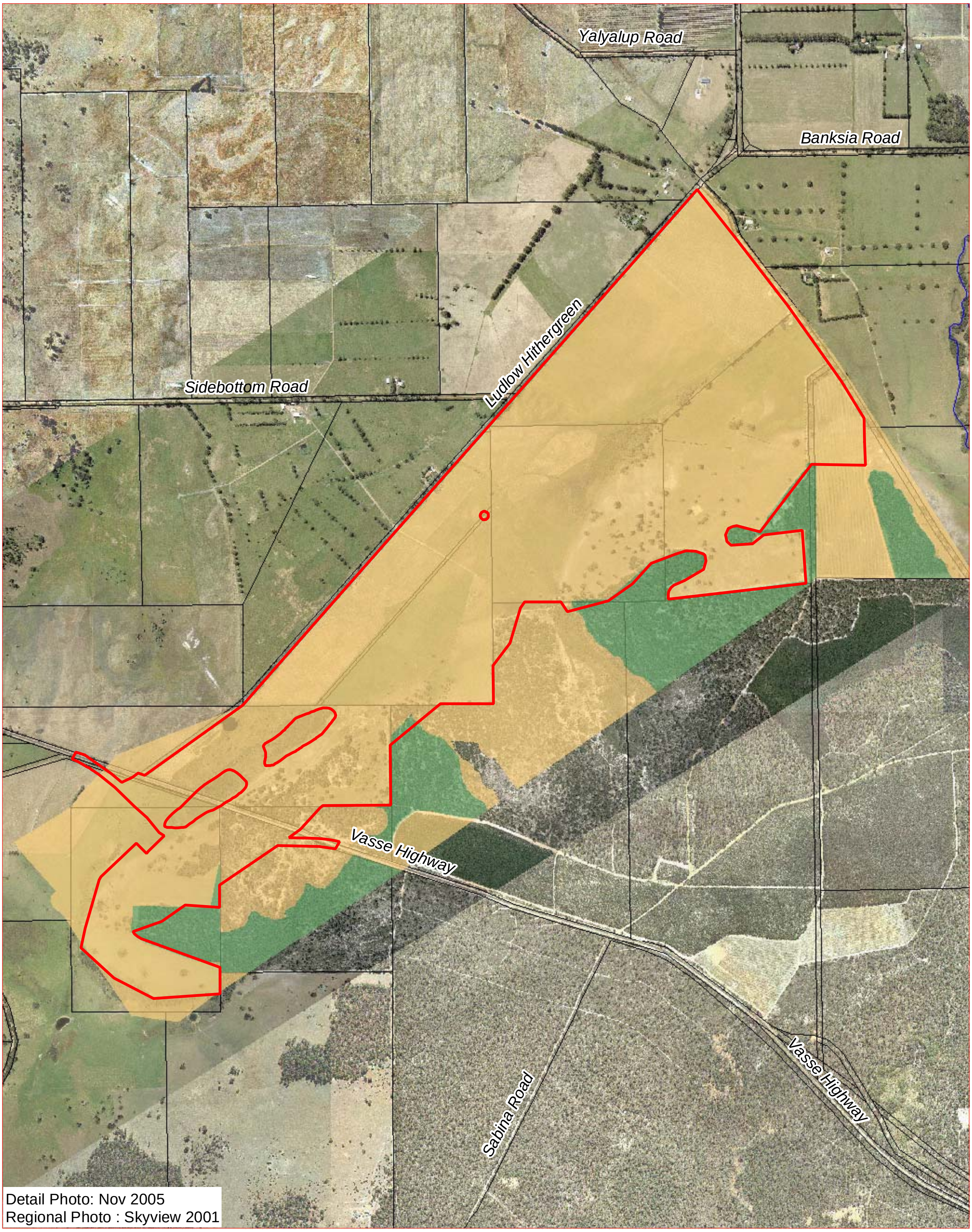
0 500 1,000 m

ILUKA

TUTUNUP SOUTH

VEGETATION AREAS

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:20,000
DATE: 10 Apr. 2008
DWG No: 168824 ver.07
A3
FIGURE: 4



Legend

Disturbance Area

Dieback Areas

Infested / unprotectable

Uninfested / protectable

N

0 500 1,000 m

ILUKA

TUTUNUP SOUTH

DIEBACK MAP

ORIG:	L.Sadler
DRAWN:	D.G.S.
SCALE:	1:20,000
DATE:	14 Sept. 2007

DWG No: 171042 ver.01 | A4 | FIGURE: 5

3. CLOSURE OBJECTIVES AND VISION

The primary objective of closure of the disturbed area is 'In consultation with relevant landholders, return the land profile consistent with the surrounding topography and establish either productive agricultural land or native vegetation considering past land uses'.

Standard objectives for rehabilitation as defined by the EPA (2006) and adopted by Iluka are:

- Safe, stable and resilient landforms and soils.
- Appropriate hydrology to support rehabilitated habitats.
- Providing visual amenity, retaining heritage values and being suitable for agreed land use.
- Resilient and self sustaining vegetation comprised of local provenance species.
- Reaching agreed numeric targets for vegetation recovery.
- Comprising habitats capable of supporting all types of biodiversity.

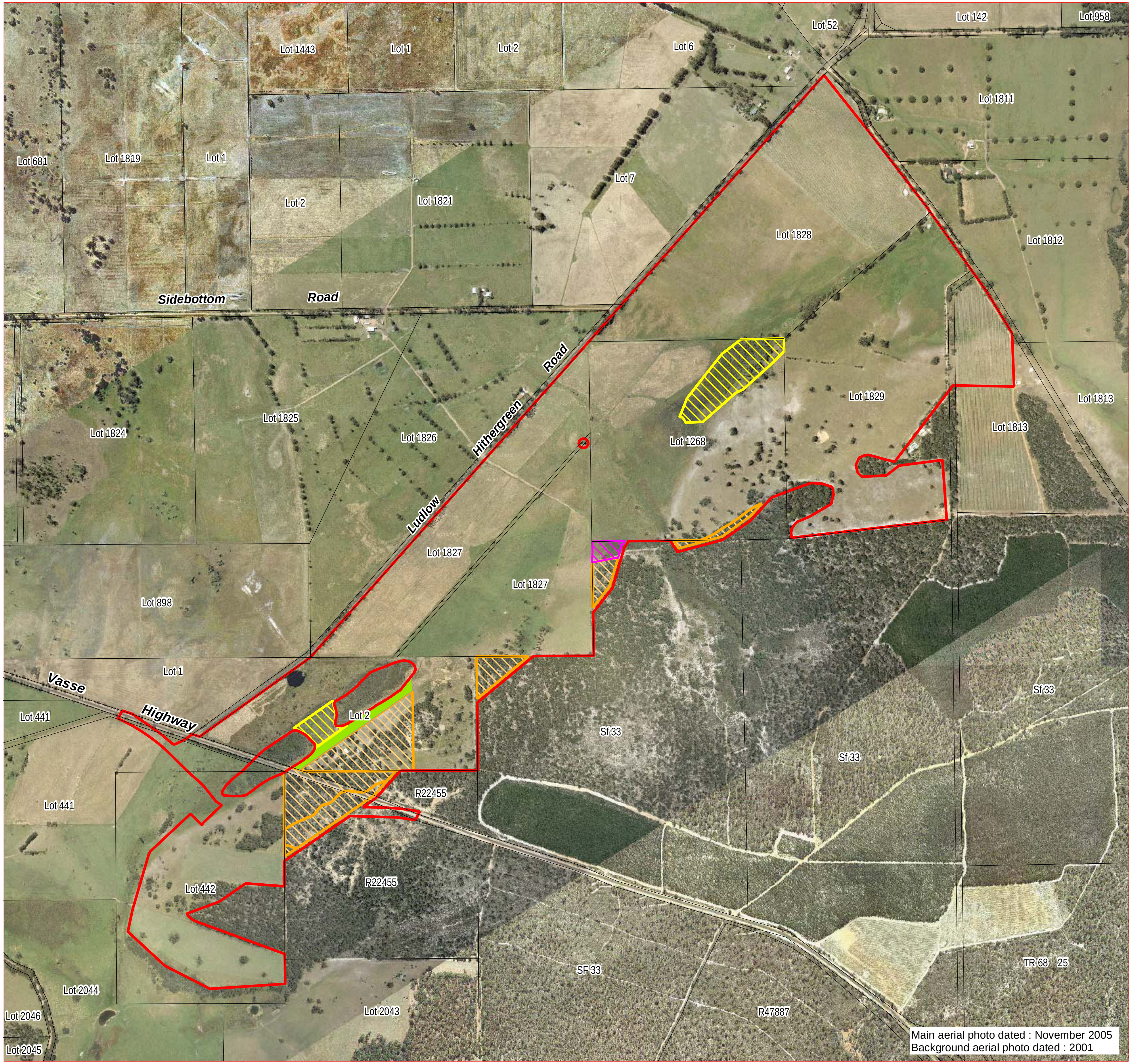
For Tutunup South, Iluka plans to return the disturbance area to an agricultural system with at least a comparable agricultural value to that before mining, and at least 25.6 ha of native vegetation rehabilitated to compensate the clearing of native vegetation. In essence the disturbance area will comprise of a flat to shallow sloped area providing an effective integration of the Whicher Scarp with the Abba Plain. Most of area will be suitable for a variety of agricultural purposes, although with an emphasis on sustainability in landform design and practices.

Within the agricultural area of the project will be the southern wetland (avoided by mining) and a new northern wetland that replaces the wetland cleared by mining. Whilst the southern wetland is currently in a reasonably poor state (although still of conservation value), Iluka will conduct restoration activities over this wetland to improve its structure and ultimately habitat value. The new northern wetland will be designed to replicate an M1 vegetation community (which was previously present). The value of the southern wetland will be enhanced by developing a native vegetative corridor linking the wetland to the State forest, improving the linkage and value of the wetland community (Figure 6).

The post-mining landform will be designed to re-establish the hydrological regime necessary to support the habitat areas. This design will be of particular importance to the success of the rehabilitation plan.

The areas of State forest and gravel reserve required for clearing will be rehabilitated with native vegetation. Rehabilitation will focus on returning species reflecting vegetation communities affected by clearing.

The Vasse Highway which requires diversion for mining will be re-diverted back to its original alignment prior to closure.



REVISIONS

Ver.	ORIG	DESIGN	DATE	COMMENTS
00	L.S	T.L.G	16.09.07	Original Design
01	S.J.	T.L.G	10.04.08	Added Cadastre layer

Legend

Disturbance Area

Target Vegetation Communities

- M1
- C1
- E2
- S2

N

0 250 500 m

ILUKA

ORIG: S.Jones
DRAWN: T.L.G
SCALE: 1:12,500
DATE: 10 April 2008

TUTUNUP SOUTH

REHABILITATION AREAS

DWG No: 176777 ver.01 | A3 | FIGURE: 6

4. DECOMMISSIONING

During the course of mining, there are a number of structures developed that will need to be removed or otherwise rehabilitated to implement an effective closure including:

- Topsoil, overburden and subsoil stockpiles
- Noise bunds
- Pumping infrastructure and pipelines
- Conveyors
- In-pit hopper
- Screenplant
- Concentrator
- Workshops, fuel facility, contractor laydowns and offices
- Process water dam
- Internal powerlines
- Pits
- Solar drying dams

As part of Iluka's continuing operations, much of the infrastructure used for mining is relocated to the next project for mine development. From the above list, this means that shortly after closure, a large proportion of the site infrastructure will be removed or dismantled and removed. Once items for re-use have been relocated, recyclable infrastructure will be removed by a salvage contractor leaving a landscape dominated by foundations and open areas.

Inert or structural waste that cannot be recycled will be excavated and placed in the base of the remaining open pit.

The foundations around workshops, refuelling areas, laydown areas and below fixed plant will be investigated for the potential of contamination. Where contaminated material is encountered, it will be excavated for remediation.

Internal (Iluka owned) powerlines will be removed.

Material stored within the solar drying dams and any remaining overburden stockpiled or as part of noise bunds will be transferred into the remaining open pit, effectively removing the solar drying dams as structures in the landscape.

After completion of decommissioning infrastructure, the site will be ready to commence rehabilitation on the remaining open area.

5. REHABILITATION RISK ASSESSMENT

5.1. Significant Limitations to Rehabilitation

A ranking of anticipated limitations to rehabilitation, are outlined in Table 6. This table is adopted from the EPA's Guidance Statement No. 6, (2006) and is used to highlight major issues relevant to rehabilitation.

Table 6: Ranking of Significant Limitations to Rehabilitation at Tutunup South

Criteria	Score					
	1	**2**	**3**	**4**	**5**	**Ranking**
Land clearing scale	a few m^2	a few ha	many ha	a few km^2	many km^2	3
Drought/rainfall unpredictability	very low risk, or not relevant	low risk, but of some relevance	moderate risk, some problems are expected	substantial problems are expected	major problems are expected	3
Temperature harshness and unpredictability						2
Diseases and pests (especially dieback)						3
Environmental weeds						2
Seed germination/ availability						3
Soil/landform stability						3
Soil structure and chemistry	unaltered	minor/ temporary impacts	some long-term impacts on vegetation expected	substantial impacts on vegetation expected	unlikely to support original vegetation	2
Hydrology						2
Landform structure						2
Connectivity for seed dispersal etc.	continuous	some cleared land	good linkages	poor linkages	fully isolated	2
Ecosystem resilience (capacity to withstand fire, weeds etc.)	highly resilient	resilient	fairly resilient	susceptible	highly susceptible	2

The main limitations to the success of rehabilitation of disturbed land back to productive pasture at Tutunup South are considered to be:

- Changed soils and soil profile
- Landform stability
- Changed hydrology
- Climatic unpredictability

The main limitations to the success of native vegetation rehabilitation of wetlands and scarp vegetation at Tutunup South are considered to be:

- Changed hydrology
- Changed biota and ecosystems

- Environmental weeds
- Grazing by pests or livestock
- Climatic unpredictability

5.2. Pasture Rehabilitation: Potential Risks and Management

5.2.1. Changes to Soils and Soil Profile

Potential Risks:

Changed soils or soil profiles may alter the capability of the rehabilitated land to support agricultural pastures. This may then affect the quantity and seasonal distribution of pasture production. However, assessments of pasture productivity need to be considered in the context of the prevailing management regime.

Management strategy:

The management strategy for soil profile reconstruction in agricultural areas will rely primarily on the identification and retention of specific soil materials (including topsoil) identified in the soil survey as being important to pasture productivity (see section 2.2). Given appropriate management, the preservation and subsequent return of these soil materials to the same position in the profile, will reinstate the potential for productive agricultural pastures.

The management strategy for soil profile reconstruction in pastured areas will rely primarily on the identification and retention of specific soil materials (including topsoil) identified in the soil survey as being important to pasture productivity.

5.2.2. Landform Stability

Potential Risks:

Until the restored landform is revegetated with pasture species, the returned soils will be vulnerable to erosion by wind or water.

Management Strategy:

The risk of erosion from water will be relatively low due to the low relief of the land and the sandy nature of the soils. Early rains tend to infiltrate into the soils rather then create surface runoff. By the time surface runoff can be expected, topsoils will stabilised by emergent pasture species.

Erosion of soils by wind during and after the completion of the landform restoration process is an important issue requiring management at all of Iluka's mine sites. A water cart is used to suppress dust in active working areas. A small amount of clay slurry is added to the water cart to provide longer lasting (several months) stabilisation in areas where soil return is complete.

5.2.3. Changes to Hydrology

Potential Risks:

Changes to hydrology may affect downstream users by either increasing or reducing the volume of flow.

Management Strategy:

The pre-mining drainage network consists of agricultural farm drains which all flow into the Sabina River. During mining and early rehabilitation, the site will have isolated drainage with a controlled release point into an agricultural drain. Drainage will be re-instated comparable to pre-mining conditions once rehabilitation is at an advanced stage.

5.2.4. Climate unpredictability

Potential Risk:

Climate unpredictability may impact on the rehabilitation of pasture due to either excessive or inadequate rainfall at certain times of the year.

Excessive rainfall will reduce the trafficability of soils requiring handling, thus causing delays to rehabilitation.

Inadequate rainfall will allow soil return to be completed; however subsequent seeding with pasture may then fail. This is an ongoing risk experienced by most graziers.

Management Strategy:

Where excessive rainfall is experienced, a delay to rehabilitation may be unavoidable. If necessary, the rehabilitation area would be seeded the following year.

Where inadequate rainfall is experienced, pasture establishment will unavoidably be poor. The rehabilitated area will be stabilised with clay slurry if necessary and reseeded the following year.

5.3. Native Vegetation Rehabilitation: Potential Risks and Management

5.3.1. Changes to hydrology

Potential Risks:

The native vegetation to be established during rehabilitation within the Tutunup South disturbance area may be impacted by changes to the texture and structure of soils as they will be altered during the mining and processing of the ore. Backfilling of the pit with altered or different soils may result in floristic composition change in response to new edaphic conditions.

The significance of this change in floristic composition will tend to be proportional to the change in the backfilled soils relative to the existing conditions. Where changes to the soils are slight, then the vegetation type may change slightly, but the same range of species is still expected to be represented across the disturbance area. By contrast, significant adverse alteration of the soil profile could result in vegetation stress due to restricted root access into the underlying mottled sandy clay.

Management strategy:

Reinstate surface and subsurface drainage characteristics. In upper slopes native vegetation (i.e. E2), the primary importance of the backfill strategy is to ensure that the roots of the vegetation are able to freely proliferate into the deeper soils. Therefore these areas will not be backfilled with impeding layers of clay.

Wetland areas (i.e. M1) are reliant on water supply from underlying aquifers (SWC, 2007b), therefore in these areas, hydraulic connectivity from the Yoganup and Leederville aquifers to the wetland vegetation will need to be maintained.

Key aspects of the management strategy for soil profile reconstruction in native vegetation areas include:

- double stripping of topsoil and direct return wherever possible;
- retention of the existing subsoil layer; and
- selection of backfill materials with similar physical and chemical properties to the existing sandy soils and no adverse properties.

5.3.2. Changes to biota and ecosystems

Potential Risks:

There is the potential that recruitment of species in rehabilitation is unable to achieve target species densities and composition.

Management strategy:

Identify species required in rehabilitation areas and define recruitment strategy for each species.

5.3.3. Environmental Weeds

Potential Risks:

Several parts of the disturbance area, including native vegetation areas, have an existing high weed load, however additional weeds could be introduced if incorrect species were planted. Machinery and equipment carrying foreign soil could also introduce weeds into the area.

Management Strategy:

Ensure that all machinery and equipment used for native vegetation rehabilitation is in a clean condition. Control emergent weeds before topsoil stripping, in stockpiles and in rehabilitation as required. The Arum Lily and Cape Tulip populations will be controlled prior to mining. Any occurrence of this or other declared weed species during rehabilitation will be controlled as required.

5.3.4. Grazing by pests or livestock

Potential impacts:

Livestock and pests (i.e. rabbits) entering the native vegetation rehabilitation may damage planted seedlings by trampling or grazing.

Management Strategy:

The native vegetation areas will be fenced to ensure the exclusion of pests and livestock.

If inspections of the rehabilitation identify problem pests are prevalent, then a suitable control programme will be developed (e.g. 1080 baiting for rabbit control).

5.3.5. Climate unpredictability

Potential Risks:

Climate unpredictability may impact on the success of rehabilitation due to either excessive or inadequate rainfall at certain times of the year.

Excessive rainfall may cause flood events which could damage planted seedlings.

Inadequate rainfall, or drought, may result in high mortality rates in planted seedlings due to moisture stress.

Management Strategy:

Both flooding and drought are natural phenomena, which can not be controlled by Iluka. If high mortalities are experienced due to climatic conditions, then the losses will be replaced by infill planting the following year.

6. SITE DEVELOPMENT

This section describes the activities to be undertaken during the site development phase in order to ensure effective conservation and management of the sites agricultural and natural resources such that they can provide optimal benefit to the landform restoration and revegetation phases.

6.1. Seed Collection

Seed collection will be undertaken where possible by an experienced contractor within and adjacent to the Tutunup South disturbance area prior to any ground disturbing activities. As the disturbance area contains relatively little native vegetation, the primary focus will be on collecting seed from the surrounding State Forest. Provenance seed may also be collected from surrounding areas should insufficient seed be available from the site. All seed collected from the site will be temporarily stored.

6.2. Infrastructure

All farm infrastructure such as fences and livestock water supplies within the disturbance area shall be decommissioned prior topsoil stripping. To facilitate its correct reinstatement, the position of this infrastructure will be surveyed prior to its removal.

6.3. Vegetation Clearing

Demarcation

25.6 ha of native vegetation will be cleared to allow mining at Tutunup South. Only those areas essential for mining operations will be cleared. Prior to clearing any vegetation a physical barrier will be erected to demarcate the boundary and deter any accidental movement into surrounding non-mining areas by machinery operators.

Habitat timber

Following harvesting of commercially valuable timber, the remaining vegetation will be cleared and stockpiled for later use as mulch or habitat. Excess timber to site requirements will be burnt.

Sedge harvesting

Sedges that occur in the wetlands are known to be hard to regenerate from seed. Where possible, sedge species will be salvaged from the wetland areas, maintained in a site nursery and transplanted during rehabilitation. Target areas for transplanting will be identified prior to commencement of timber harvesting.

6.4. Soil Removal

Effective soil management is imperative to the success of native vegetation rehabilitation, with the following forming part of this management:

- Native vegetation soils will be removed in the dry summer months where possible to minimise the loss of soil propagules.
- Topsoil will be handled so that any dieback uninfested soils remains separate.
- Topsoil shall be double-stripped to ensure optimal preservation of the soil seed bank.
- Subsoil shall then be stripped and stockpiled separately.

6.5. Stockpiling

All soil materials removed are stockpiled separately to facilitate subsequent landform reestablishment. Native topsoil will be located as far as possible from pasture areas to limit build up of pasture seed. The maximum height of native vegetation topsoil stockpiles is 2 m and the maximum height of agricultural topsoil stockpiles is 3 m. A cover will be established on topsoil stockpiles to protect against erosion.

Subsoils and overburden will be stockpiled separately.

All machinery will be cleaned down prior to commencing work on topsoil or subsoil during construction, mining and rehabilitation activities to minimise the risk of dieback spread and/or weed introduction from agricultural areas.

7. LANDFORM RESTORATION

Iluka's goals for the final restored landform will be to:

- achieve a post mining landform similar to the pre mining condition and acceptable to the landowners;
- achieve soil profile, structure and infiltration characteristics which enable the land to be returned to its pre-mining land capability;
- reinstate surface drainage; and
- keep erosion to acceptable levels.

Final volumes of topsoil, subsoils and overburden materials will be calculated following site development and regularly reviewed over the life of mine.

The overburden design surface will depend on the final amounts of material mined, returned to the void as sand and clay tails and overburden. The material volumes and balances will be regularly reviewed to ensure an appropriate final design surface.

Topsoil and subsoil replacement depths are currently estimated from pre-mining test pits. Exact volumes and depths replaced will be dependent upon amounts removed during site establishment. The topsoil and subsoil balances will be regularly reviewed to ensure appropriate final topsoil and subsoil replacement depths.

The final surface design and drainage layout will be similar to the pre-mining surface design with minor variations to balance materials removed and replaced.

It is preferable to utilise carry-graders for topsoil and subsoil replacement as they allow a more accurate final land surface.

To control surface water runoff on agricultural land, grade banks will be installed as per Iluka's usual practice. The banks are constructed approximately every 2m drop in elevation at grades between 1:100 to 1:400, with the variation allowed to accommodate a safe discharge point.

Ripping of rehabilitated land lowers soil compaction and bulk density and increases water infiltration. This is beneficial in the control of erosion as increased infiltration subsequently reduces the intensity of any surface water runoff.

To alleviate any compaction caused by the movement of heavy machinery, all mined areas will be ripped. Ripping requirements will be tailored to suit specific rehabilitation areas. In native rehabilitation areas, deep ripping to 1m depth may be required. In some pastured rehabilitation areas, less aggressive ripping may be prescribed to avoid adversely impacting the final land surface or the soil profile.

In areas of native vegetation rehabilitation, the timing of deep ripping can influence seedling regeneration. Ward and Koch (1999) observed that deep ripping after topsoil spreading could reduce plant densities by 40-60% due to burial effects. Therefore deep ripping will be implemented after the replacement of subsoil, but prior to replacement of the topsoil.

8. PASTURE REHABILTIATION

The Tutunup South mine site will be rehabilitated using similar methods to other operations in the south west. Where practicable, rehabilitation will be undertaken progressively during operations. Pasture rehabilitation will be conducted over areas shown in Figure 6.

8.1. Pasture Establishment

Iluka has extensive experience in rehabilitating farmland on the Swan Coastal Plain. Procedures for re-establishment of agricultural land at Tutunup South will follow those currently used at other southwest mine sites. Subject to landowner agreements and agronomic advice, a clover-ryegrass mixture will be sown and fertilised in autumn to ensure a vigorous re-establishment of the pasture.

The methodology is summarised broadly below:

- application of lime at a rate determined via soil testing and agronomic advice;
- stickpicking to remove excessive quantities of large sticks in the returned topsoil;
- seedbed preparation using a combination of secondary tillage implements (e.g. offset discs, scarifier, drag and harrows);
- application of fertiliser, for which the type, rate and number of applications will be determined via soil testing and agronomic advice;
- application of seed mix consisting of sub clover and ryegrass varieties; and
- the area is rolled to provide a firm seed bed for pasture establishment.

8.2. Pasture Management and Maintenance

After pastures are established, they will be continually managed by Iluka's rehabilitation personnel. The primary aspects requiring management are: grazing, weed and pest control, and fertiliser inputs.

8.2.1. Grazing

In the first spring after sowing, the primary objective is to develop a stable, productive soil profile by encouraging proliferation of pasture roots and soil biota. Pasture will be grazed lightly to promote tillering of the ryegrass, a healthy component of clover, and to discourage pasture weeds (e.g. Capeweed) from attaining dominance.

In subsequent years, it will be necessary to demonstrate that the pre-mining land capability (established by independent agricultural assessment (John Wise Consultancy, 2005)) has been restored and that with appropriate management pasture productivity typical of the locality can be achieved. Consequently, grazing intensity will be gradually increased to levels considered appropriate for the district and the seasonal conditions.

8.2.2. Weed and pest control

Weed control will primarily be achieved by ensuring pastures are appropriately grazed such that they out-compete pasture weeds. Pastures will be monitored for problem weeds and pests. Where warranted, weeds will be controlled via herbicide application. Similarly, where warranted, pests such as red-legged earth mite will be controlled via insecticide application.

Invasive or Declared Weeds such as Apple of Sodum, Arum Lilies, Cape Tulip and Double Gees, will require spot spraying with a suitable herbicide.

Weed control procedures will follow normal agricultural practices, with agronomic advice sought where necessary.

8.2.3. Fertiliser

Pastures will be fertilised annually as part of an ongoing maintenance programme. The type, rate and number of fertiliser applications will be determined via soil testing and agronomic advice.

8.3. Farm infrastructure

As a minimum, the pre-mining farm infrastructure will be reinstated. Inclusion of additional infrastructure will be a commercial negotiation between the landowners and Iluka.

A farm layout will be developed in consultation with the landowners that indicates the surface design, fence, drain locations, stock water supplies, shelterbelts and farm roads required by the landowner.

9. NATIVE VEGETATION REHABILITATION

The native rehabilitation program will revegetate areas cleared of native vegetation to native vegetation (Figure 6). Iluka will strive to improve on the condition of native vegetation areas from pre-mining condition. The disturbance area will be revegetated predominantly from the topsoil seed store with the remainder comprised of planted seedlings, direct seeding and transplanting. In addition vegetation corridors will be established over areas as shown in Figure 6 to link the southern wetland to the State forest.

9.1. Native vegetation rehabilitation experience

Iluka will draw on a range of skills and experiences to facilitate native vegetation rehabilitation at Tutunup South.

9.1.1. Professional services

During the planning and implementation of the programme for native vegetation rehabilitation at Tutunup South, Iluka will utilise the services of a number of qualified professionals with experience relevant to the restoration of native ecosystems. Examples of these professionals are provided below, however Iluka may choose to utilise consultants or contractors other than those listed.

- Mattiske Consulting Pty Ltd: This botanical consultancy undertook baseline surveys of the project area. These botanists (or other suitably experienced botanists) will be utilised to implement monitoring of vegetation within the rehabilitated mine site.
- Soil Water Consultants Pty Ltd: This consultancy undertook the pre-mine soil assessment for the project and completed a study identifying suitable soil materials for use in the rehabilitated soil profile.
- South Western Native Seed Supplies Pty Ltd: This professional seed collecting business has an extensive record of collection local provenance seed for mining companies in the south west of WA.
- Kings Park Botanical Gardens (KPBG): This organisation is well known for its research into native seed dormancy mechanisms. Iluka will draw on KPBG's knowledge to ensure recruitment of recalcitrant species is maximised.
- Johnstone, Johnstone and Kirkby: This group has extensive knowledge of cockatoo habitat and Iluka will draw on their expertise in regard to the provision of cockatoo hollows

9.1.2. Personnel

Iluka has a dedicated rehabilitation team of 7 staff in the South West, all with experience in rehabilitating native vegetation. These staff will implement and/or supervise the range of tasks necessary to conduct planned native vegetation rehabilitation at Tutunup South.

Mine sites for which Iluka's current rehabilitation staff has direct experience in native vegetation rehabilitation include:

- Yoganup Extended Mine, Boyanup, WA (Iluka)
- Yoganup West Mine, Capel, WA (Iluka)
- Eneabba Mine, Eneabba, WA (Iluka)
- Stratham West Mine, Stratham, WA (Iluka)
- Yarloop Mine, Yarloop, WA (Cable Sands)
- Jangardup Mine, Pemberton, WA (Cable Sands)
- Ludlow Mine, Capel, WA (Cable Sands)

Learnings gained from these experiences will be applied to rehabilitation works at Tutunup South.

Earthmoving operations will be performed by mine site operators with experience and skill in the operation of scrapers, bulldozers and other heavy earthmoving machinery.

Ongoing supervision is provided by a site coordinator to ensure the correct implementation of tasks. Additional supervision is provided by Rehabilitation staff by providing specific advice on acceptable standards for tasks described within this document.

9.1.3. Mining Industry Experience and knowledge

Rehabilitation of native vegetation is undertaken at a wide range of mine sites throughout Australia. The mining industry therefore provides a considerable resource base for native vegetation rehabilitation. Sharing of mining industry experience with native vegetation rehabilitation occurs formally through workshops set up by the Australian Centre for Mining Environmental Research (ACMER), and informally via mine-site field trips when required.

Mine-sites for which Iluka's current rehabilitation staff have visited and reviewed native vegetation rehabilitation practices include:

- North Stradbroke Mine, Stradbroke Island, QLD (CRL)
- Cooljarloo Mine, WA (Tiwest)
- Tomago Wetlands, Newcastle, NSW (RZM)
- Macquarie Lakes, NSW (RZM)
- Boddington Bauxite Mine, Boddington, WA (Worsley Alumina)
- Beenup Mine, Augusta, WA (BHP)
- Huntley Mine, Wagerup, WA (Alcoa Australia)

9.2. Mulching

In areas of native vegetation rehabilitation, spreading of timber mulch will follow the spreading and ripping of topsoil.

Mulching of native vegetation will include the spreading of crushed or chipped timber across the entire native vegetation rehabilitation area. This mulch is beneficial in reducing wind erosion and providing habitat and protection for small mammals and invertebrates.

Subject to availability of material, the mulch will be spread thick enough to provide the desired benefits, but not so thick as to inhibit germination of seed.

9.3. Direct Seeding

Revegetation of the site will include those species that were recorded in baseline surveys. To improve on pre-mining condition it may be beneficial to expand the pre-mining species list to include other species that would generally be found in the affected vegetation communities. Should other species be added, Iluka will consult with the regional branch of the DEC to ensure that the additional species proposed are suitable for the location.

Prior to direct seeding, seed shall undergo the appropriate treatments required to break dormancy and improve germination rates. The treatments could include smoking, freezing, boiling or scarifying.

To ensure an even coverage, the seed will be combined with vermiculate and then spread by machine across the site.

9.4. Seedling Planting

Seedlings shall be propagated from seed, cuttings or tissue culture. Excluding recalcitrant flora the species to be planted as seedlings are likely to be predominantly overstorey or keystone species.

Seedlings will be largely propagated in a Nursery Industry Accreditation Scheme Australia (NIASA) accredited nursery; however it is possible that some seedlings could be produced in a tissue culture laboratory.

9.5. Transplanting

Sedge species and priority flora salvaged prior to mining will be stored in a nursery and then transplanted at suitable locations in the winter following topsoil return.

9.6. Fertiliser

The soils within the project area are predominantly sandy, thus many of the native plants are psammophilous and are adapted to conditions of low nutrient availability. In such conditions these species may grow more competitively than weeds from adjacent agricultural areas that are adapted to a more nutrient rich environment. To avoid encouraging weed proliferation, granular fertilisers will only be spread at low rates.

Slow release fertiliser tablets will be applied with planted seedlings. To reduce their access by weeds, these tablets will be inserted below the soil surface adjacent to the seedlings.

9.7. Fauna Habitat

Stockpiled timber and rocks will be utilised to develop fauna habitat piles.

9.8. Fencing

The areas of revegetation will be fenced before seeding to provide protection for young plants from rabbits and kangaroos. The fence shall be a minimum height of 1.5m with a skirt of 30cm rabbit netting attached to the foot of the fence to prevent rabbits and/or kangaroos from pushing under the fence.

9.9. Fire Management

Developing vegetation within the revegetation areas will not be able to withstand fire for many years. Prior to completion of mining Iluka will consult with DEC to ensure appropriate fire control strategies are developed.

9.10. Maintenance

Maintenance of the rehabilitated areas will be required until relinquishment of the mining tenement to ensure the continued performance towards the objective. This will predominantly consist of weed control and pest control, the latter involving maintenance of the perimeter fencing and/or baiting.

10. KEY REHABILITATION ACTION SUMMARY

The key rehabilitation actions described in sections 6, 7, 8 and 9 are summarised in Table 7.

Table 7: Key Rehabilitation Action Summary

Phase/Factor	Action	Timing	Performance criteria	Evidence
Pre-mining				
Seed Collection	Collect local provenance seed from disturbance area and adjacent areas.	Prior to and during Mining	Local provenance seed collected	Records of seed collected
Landform	Detailed topographic survey to be undertaken	Prior to Mining	Completed topographic survey	Survey
Dieback	Dieback survey updated	Prior to Mining	Completed dieback survey	Report
Site Development				
Vegetation clearing	Max 25.6 ha will be cleared	Prior to and during Mining	No more than 25.6 ha cleared	Survey; aerial photography
Vegetation clearing	Salvage as much timber as possible	Prior to and during Mining	Landowner satisfied with extent of salvage	Landowner advice
Vegetation clearing	Collect sedges and priority species from wetland areas to be cleared.	Prior to and during Mining	Sedges and priority species collected and used in rehabilitation	Records of sedge collection and use
Soil removal	Remove and stockpile topsoil, subsoils and overburden separately	Prior to and during Mining	Soil materials in separate stockpiles	Visual assessment
Stockpiling	Stockpile topsoil to max 2 m	Prior to and during Mining	Topsoil stockpiles max 2m	Surveyed height of topsoil stockpiles
Mining and Landform Restoration				
Planning	Survey final stockpile volumes	Prior to landform restoration	Landform meets design profile	Survey files
Backfill	Return overburden to design levels	During landform restoration	Backfill meets design profile	Survey/ test pits
Soil profile return	Return subsoils to design levels	During landform restoration	Subsoils meet design profile	Survey/ test pits
Surface earthworks	Additional treatments (e.g. Ripping)	During landform restoration	Additional treatments conducted	Contractor log books
Surface earthworks	Reinstate drainage	After landform restoration	Additional treatments conducted	Photo
Pasture rehabilitation				

Phase / Factor	Action	Timing	Performance criteria	Evidence
Planning	Develop final farm layout in consultation with the landowners.	Prior to rehabilitation	Final farm layout acceptable to landowners	Final farm layout signed by landowners
Pasture establishment	Apply lime as per agricultural advice	During rehabilitation (autumn)	Application as per agronomic advice	Documentation of advice and materials invoice
Pasture establishment	Prepare seedbed	During rehabilitation (autumn)	Implementation of normal agricultural practices	Photo
Pasture establishment	Clover-ryegrass mixture sown and fertilised as per agricultural advice	During rehabilitation (autumn)	Application as per agronomic advice	Documentation of advice and materials invoice
Monitoring	Monitor pasture production	For approximately 3 years after mining	Monthly monitoring	Pasture monitoring records
Grazing	Pasture will be grazed lightly	First spring after sowing	Healthy clover component and low level of pasture weeds	Pasture monitoring records
Grazing	Gradually increase grazing intensity to levels considered appropriate for the district and the seasonal conditions	For approximately 3 years after mining	Pasture productivity typical of the locality	Pasture monitoring records
Weed control	Ensure pastures appropriately grazed	For approximately 3 years after mining	Low level pasture weeds	Pasture monitoring records
Weed control	Control problem weeds via herbicide application where warranted	For approximately 3 years after mining	Low level pasture weeds and declared weeds	Pasture monitoring records
Pest control	Control pests via insecticide application where warranted	For approximately 3 years after mining	Low level pests	Pasture monitoring records
Fertiliser	Fertiliser applied as per agricultural advice	For approximately 3 years after mining	Applied as per agronomic advice	Documentation of advice and materials invoice
Native Vegetation Rehabilitation				
Seeding and Planting	Seed and plant species that reflect the pre-disturbance vegetation communities	During Rehabilitation	Appropriate species in rehabilitation	Visual assessment/photos
Weed and pest control	Control weeds and pests as required	Prior to and during Rehabilitation	Reduction in weed and pest abundance	Visual assessment/photos

Phase/Factor	Action	Timing	Performance criteria	Evidence
Maintenance	Infill plant where required	For approximately 3 years after mining	Areas of poor vegetation ameliorated	Visual assessment/photos
Maintenance	Maintain fences	For approximately 3 years after mining	Fences in serviceable condition	Visual assessment
Monitoring	Monitor species recruitment	For approximately 3 years after mining	Annual monitoring	Rehabilitation monitoring reports
Monitoring	Monitor species recruitment	After 3 years post mining	Monitoring requirements reviewed in consultation with DEC	Rehabilitation monitoring reports

11. MONITORING METHODOLOGY

11.1. Pasture Rehabilitation

When Iluka considers that the pasture rehabilitation is complete, an independent agricultural consultant will be engaged to develop a post-mining agricultural productivity report. This report will integrate the results of monitoring for aspects described below and will verify whether pre-mining productivity levels have been met and are considered sustainable.

11.1.1. Landform

During landform restoration, visual inspections of work in progress will be conducted routinely by rehabilitation staff to ensure the correct procedures are being implemented.

After restoration of the landform, the disturbed area will be surveyed and a map produced showing 0.5m contour intervals. Monitoring points will also be established to enable the assessment of land stability three years after completion.

11.1.2. Soil

During landform restoration, visual inspections of work in progress will be conducted routinely by rehabilitation staff to ensure that soil materials are returned to the correct position.

In the first year of rehabilitation, preliminary soil pits may be excavated to allow early confirmation of the soil profile and identification of any limiting factors such as compaction. Early identification of such factors then allows remedial activities such as ripping to be performed in a timely manner.

The final post-mining assessment of the rehabilitated soil profile will be performed by a suitably experienced soil scientist. This assessment will not be performed until approximately 3 years after pasture establishment, so that pasture root distribution through the profile may be assessed.

Assessment of the post-mining soil profile will utilise similar methods to the pre-mining soil survey. Pit excavations will be excavated to a depth of 2m. The soil profile within the pit will be recorded, with all soil horizons described and their location within the profile measured. Similar physical and chemical parameters assessed in the pre-mining survey will be reassessed within each soil horizon.

The results of the soils assessment will be presented to the DoIR and DEC in a final Post-Mining Soils Assessment Report.

11.1.3. Pasture productivity

While rehabilitated land is being maintained by Iluka, visual inspections of pasture growth will be conducted routinely by rehabilitation staff to ensure appropriate management of factors discussed in Section 7.2.

Pasture productivity monitoring will be conducted monthly during the growing season to measure total dry matter pasture production and the distribution of pasture and weed species. Methods currently used by Iluka for monitoring of existing rehabilitated sites will be extended to the Tutunup South site. These methods include a combination of pasture cuts, rising plate meter measurements, and ground cover scores.

The results of pasture monitoring will be presented to the government agencies annually as part of Iluka's Annual Environmental Report.

11.2. Native Vegetation

Visual inspections of the native vegetation rehabilitation will be conducted routinely by rehabilitation staff to gauge the success of rehabilitation and determine when maintenance activities are required.

In addition, fixed photographic monitoring sites will be established within the area to provide documentary evidence of the outcomes of rehabilitation. These sites will be established prior to disturbance, so that evidence of the baseline condition of the area is obtained.

Photographic monitoring will be conducted annually during spring and will include the recording of native and introduced species present within the photo frame. Evidence of damage by pests will also be recorded.

Plot-based density counts by species will be conducted at the same time as photographic monitoring to quantify species abundance and richness.

Annual monitoring will occur in the first three years of rehabilitation when the majority of works are undertaken. Following this, monitoring is likely to be decreased to intervals of 2-3 years or more in consultation with the DEC.

12. REHABILITATION COMPLETION CRITERIA

Completion criteria need to be developed to determine when rehabilitation of the disturbance area at Tutunup South can be agreed to be complete. An approved set of completion criteria will be used as a basis for assessing this completion. Iluka will be required to be in compliance with these criteria before bonds and mining tenements can be relinquished by the State.

Completion criteria are indicated in Table 8. These criteria reflect current technology and best practice rehabilitation methods, but will be subject to periodic review in consultation with relevant stakeholders. Amendments to the criteria will be subject to regulatory approval.

Table 8: Completion Criteria for Tutunup South

CRITERIA	MEASURE/ TARGET	EVIDENCE	CORRECTIVE ACTION
Pasture Rehabilitation			
Restore landform as soon as practicable	Soil profile restored within 1 year post mining	Annual inspection by government agencies	Restore soil profile as soon as is practicable
Restore vegetative cover as soon as practicable	Pasture re-established within 1 year after completion of backfill	Annual inspection by government agencies	Re-establish pasture as soon as is practicable
Mined land will be returned to the pre-mining agricultural productivity	Pre-mining productivity levels achieved and considered sustainable (by independent assessment)	Post-mining Agricultural Productivity Report	Review requirements for remedial action in consultation with regulatory agencies
Native Vegetation Rehabilitation			
Achieve a stable, non-eroding landform that can support native vegetation	Soil profile design achieved and after 3 years no significant limitations to native vegetation occur that were not present pre-mining	Final Post-Mining Soils Assessment Report	Review requirements for remedial action in consultation with regulatory agencies
The species diversity of native vegetation is comparable with pre-mining levels	Quantitative targets to be set in Final Closure and Rehabilitation Plan	Photographic monitoring, plot monitoring	Infill plant further species as required
Livestock excluded from the vegetation improvement area	Fencing restricts stock access to access points	Annual inspection by government agencies	Maintain fences

13. REVIEW AND REVISION

This management plan is a live document that will be subject to continual review and improvement.

Initially, this management plan will be submitted as a preliminary plan with the PER. This provides preliminary information on Iluka's approach to rehabilitation of the proposed disturbance area.

Following the process of EIA, the management plan will be updated to the satisfaction of the EPA. The management plan shall then be reviewed on an annual basis, to account for progress or changes that may be required to achieve the designated performance targets.

14. REPORTING

Reporting of activities, rehabilitation planning and monitoring results will be through the existing annual environmental reporting process to the DEC and DoIR.

15. REFERENCES

Biota (2007) Tutunup *South Fauna Habitats and Fauna Assemblage Survey*. Report prepared for Iluka Resources Limited.

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Soil Water Consultants (2007b) Groundwater *Dependent Ecosystem Assessment for the Proposed Tutunup South Minesite*. Report Prepared for Iluka Resources Limited.

Tille PJ and Lantzke NC (1990) Busselton – *Augusta – Margaret River Land Capability Study*. Land Resource Series No 5. Department of Agriculture, Perth van Gool, D, Tille P and Moore, G (1999) Land *Evaluation Standards for Land Resource Mapping*, Third Edition, Draft technical Report (updates 181), Agriculture Western Australia

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16. DOCUMENT CONTROL

Revision	Reviews/Changes	Create Date
A	Revised Draft by LS	23 August 2007
B	Comments from SJ, PMc inserted	26 August 2007
C	Comments from RB, NMc inserted	9 September 2007
D	Comments from group review	15 September 2007
E	Revised following external comments	19 November 2007
F	Revised following EPASU review	3 April 2008

Appendix 7
Offsets Table

Tutunup South Mineral Sands Project
Environmental Offsets Table

A The Proposal	**B Key Information Used to Develop Offsets**
Iluka Resources Tutunup South Mineral Sands Project Mining and production of heavy mineral concentrate	Vegetation Report Groundwater Report Fauna Report

C Potential Environmental impacts, on site management measures and residual environmental impacts					
Potential Impacts on Environment	**High Value/Critical Assets Involved**	**Proposed on-site management**	**Alternative Measures**	**Potential Residual Environmental Impacts**	**Offsets Proposed**
Clearing of vegetation	SCP02 (S2) is listed by DEC as an endangered TEC	Areas of native vegetation have been avoided where possible. Rehabilitation to pre-impact condition following mining.	None	Short term loss of vegetation communities. Clearing of 25.6 ha of vegetation including • 15 ha of E2 (SCP01a) • 6.9 ha of M2 (SCP09) • 0.8 ha of S2 (SCP02) • 2.9 ha of disturbed vegetation	Y
Clearing of fauna habitat	Carnaby's Cockatoo Baudin's Cockatoo	Avoid 5 potential cockatoo nest hollows. Rehabilitation to pre-impact condition following mining.	None	Medium term loss of fauna habitat Clearing of 3 potential nest hollows	Y
Groundwater drawdown impacts on Groundwater Dependent Ecosystem (GDE) vegetation	SCP02 (S2) is listed by DEC as an endangered TEC	Avoid or minimise impact by maintaining vegetation through recharge. Rectify impacts by infill planting if vegetation loss occurs.	None	Reduction in vegetation health due to drawdown impacts including • High risk of impact to 6.4 ha of vegetation, including 1.1 ha of S2 and 5 ha of M1 • Moderate-High risk of impact to 3.5 ha • Low-Moderate risk of impact to 1.58 ha	Y

<table>
<tr><th colspan="3">D What offsets are proposed?</th></tr>
<tr><th>Potential residual environmental impact</th><th>Environmental offsets</th><th>Direct or Contributing Offset</th></tr>
<tr><td>Short term loss of vegetation communities.

Clearing of 25.6 ha of vegetation including
• 15 ha of E2 (SCP01a)
• 6.9 ha of M2 (SCP09)
• 0.8 ha of S2 (SCP02)
• 2.9 ha of disturbed vegetation</td><td>Offset 1: Improve condition of vegetation cleared during rehabilitation including fencing of areas from stock, re-establishment of native vegetation corridors between State Forest and southern wetland. Conservation covenants to be placed over all revegetated areas.

Offset 3: Protection of native vegetation block, comprising 92 ha near Yoganup minesite, through conservation covenant. Commitment to re-establishment of a 7 ha native vegetation corridor between State Forest and vegetation block.</td><td>Direct

Direct</td></tr>
<tr><td>Medium term loss of fauna habitat

Clearing of 3 potential nest hollows</td><td>Offset 2: Install nest boxes for cockatoos in State Forest surrounding Project Area</td><td>Direct</td></tr>
<tr><td>Reduction in vegetation health due to drawdown impacts including
• High risk of impact to 6.4 ha of vegetation, including 1.1 ha of S2 and 5 ha of M1
• Moderate-High risk of impact to 3.5 ha
• Low-Moderate risk of impact to 1.58 ha</td><td>Incorporated in offsets above</td><td></td></tr>
</table>

E Robustness of offsets package								
Offset	**Net Environmental Benefit**	**Approvals needed**	**Ongoing Management & Responsibility**	**Timeframe to meet offset objectives**	**Risk to implementation**	**Consultation**	**Advice**	**Other Comments**
Offset 1	Enhanced quality of vegetation. Links from wetland to scarp.	Landowner consent to fencing areas from stock & placing conservation covenants.	Landowner responsible for maintaining fences.	3 years following mining	Rehabilitation success	DEC Landowner	DEC Landowner	
Offset 2	Install nest boxes for cockatoos	DEC	Iluka responsible for life of mine and rehabilitation period	1 year after mining commences	None	DEC Consultant	DEC Consultant	
Offset 3	Conservation and protection of Roberts Block.	None.	Landowner responsible for maintaining fences.	3 years following mining	None	DEC	DEC	