EXTRACTIVE INDUSTRIES LICENCE APPLICATION

Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury

EXTRACTIVE INDUSTRIES LICENCE APPLICATION

Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury

Prepared by:

RPS

38 Station Street, SUBIACO WA 6008
PO Box 465, SUBIACO WA 6904

T: 618 9211 1111
F: 618 9211 1122
E: environment@rpsgroup.com.au
W: rpsgroup.com.au

Prepared for:

ROCLA QUARRY PRODUCTS

130 Fauntleroy Avenue

REDCLIFFE WA 6104

Report No: L07396:2
Version/Date: Rev 2, July 2013

Document Status

Version	Purpose of Document	Orig	Review	Review Date	Format Review	RPS Release Approval	Issue Date
Draft A	Draft for Client Review	JesO'Ha	JohHal	08.01.08	VF 14.01.09		
Draft B	Further Draft for Client Review	JilAbe	JohHal	21.04.09	SN 28.04.09		
Draft C	Further Draft for Client Review	CatWill	JohHal	21.10.09	SN 26.10.09		
Rev 0	Final for Issue	JohHal	KriBen	11.12.09	SN 21.12.09	B. Hollyock	21.12.09
Rev 1	Final for Issue		JohHal	14.02.12	SN 22.02.12	J. Halleen	23.02.12
Rev 2	Final for Issue		JohHal	02.07.13	SN 15.07.13	J. Halleen	15.07.13

Disclaimer

SUMMARY

This Extractive Industry Licence (EIL) Application report supports an application for:

- an EIL under the Shire of Serpentine–Jarrahdale *Extractive Industries Local Law* made on 20 December 1999 pursuant to the *Local Government Act 1995* (WA)

- development application planning approval both under the Metropolitan Region Scheme (MRS) and the Shire of Serpentine–Jarrahdale Town Planning Scheme (TPS) No. 2.

in connection with Rocla Quarry Products' (Rocla) proposed sand mining activities on Lot 6 Banksia Road, and Lots 300 and Lot 301 Boomerang Road, Oldbury (Oldbury site).

Table 1: Project Summary

Project Component	Proposal Characteristic
Excavation	
Total area of project site (Lots 6, 300 and 301)	32.32 ha
Total area of mining footprint	15.2 ha
Total disturbance area	15.2 ha (11.2 ha has remnant vegetation)
Life of the project	Approximately 10 years
Dewatering requirements	Nil
Maximum depth of excavation	18 metres AHD
Processing	
Sand	Dry screening of sand only
Water requirements	Nil
Infrastructure	
Fuel storage	5,000 Litre above ground (self-bunded) tank
Transport	
Truck movements	Variable but approximately 2–4 per hour
Workforce	
Hours of operation	7.00 am to 5.00 pm Monday–Saturday. Some operations may occur on a Sunday for major infrastructure project(s) if required by project demand

This page is intentionally blank.

TABLE OF CONTENTS

Page

TABLES

(contained within report text) **Page**

FIGURES

(contained within report text) **Page**

(compiled at rear of report)

APPENDICES

1.0 INTRODUCTION

1.1 Overview

Rocla was established in Western Australia in the early 1980s and is Perth's major supplier of processed sand products.

With the continued growth in Perth's south-east corridor, there is an increasing demand for sand resources for construction purposes. The sand resource at the Oldbury site is unique medium–fine grained Bassendean sand, which is in high demand by local concrete manufacturing operators located in the southern and eastern metropolitan area.

The Oldbury site totals 32.32 hectares (ha) with the proposed excavation area comprising of 15.2 ha, which will support mining of sand for 5–8 years depending upon market demands for the product. The excavation will be staged and where practical native vegetation (*Banksia spp – Eucalyptus marginata* woodlands) restoration will commence upon the completion of mining in each stage.

It is proposed that the excavation area will be restored back to *Banksia spp – Eucalyptus marginata* woodlands utilising the eighteen years of Banksia restoration research conducted by the Botanical Parks and Gardens Authority (BPGA) to maximise the regeneration of natural bushland, subject to the site zoning of "Rural" under the Metropolitan Region Scheme (MRS) and the Shire of Serpentine Jarrahdale Town Planning Scheme (TPS) remaining unamended in the long-term.

1.2 Site Location

The proposed sand mining site is located in the Shire of Serpentine Jarrahdale and covers an area of approximately 15.2 ha (Figure 1).

The land subject to the EIL application consists of three privately owned lots:

- Lot 6 Banksia Road, Oldbury
- Lot 300 Boomerang Road, Oldbury
- Lot 301 Boomerang Road, Oldbury.

The site is bound by Boomerang Road and Banksia Road to the north and the Mundijong–Kwinana railway to the south. It is located approximately three kilometres (km) to the east of the Kwinana Freeway (Figure 2). The entire site, incorporating Lots 6, 300 and 301 is 32.32 ha, of which only 15.2 ha is proposed for sand extraction. Approximately 4 ha of the proposed sand mining area has previously been cleared for hobby farming and a motorbike track.

1.3 Applicant and Owner Details

Rocla is the proponent for this EIL Application.

Rocla owns Lot 6 Banksia Road, Oldbury. Ownership of the two remaining lots (that form this EIL Application) is as follows:

- Lot 300, Boomerang Road, Oldbury is owned by Raymond Tilbury
- Lot 301, Boomerang Road, Oldbury is owned by Kenneth and Cecil Ditchfield.

Rocla has entered into an agreement with each of the above landowners in connection with the extraction of the sand resource from these lots. In accordance with the Section 2.3(1)(h) of the Extractive Industries Local Law written consent and support of the application from the landowners of the excavation site has been provided in the development application.

The key Rocla contact is detailed below:

Contact Person:	Vern Newton
Position:	Resource Development Manager
Phone:	(08) 9475 2500
Fax:	(08) 9477 2633

1.4 Proposed Operations

Sand is proposed to be extracted from 15.2 ha within Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road. The proposed sand mining operation will occur on a staged basis with a subsequent native vegetation restoration program. It is estimated that, depending upon demand, the sand resource will support mining for five to eight years.

1.5 Significance of the Site

The Oldbury site contains substantial deposits of medium to fine grain silica sand with physical characteristics suitable for a wide range of uses, including concrete production and engineering fill.

The amount of sand required for the metropolitan area has been steadily increasing over recent years due to the increase in housing estates and land development within the metropolitan area.

The establishment of this sand mine site in Oldbury will create a southern Perth operation servicing the urban and industrial areas in the Canning Vale, Kwinana, Armadale and Byford regions, and facilitate the long-term supply of high quality sand for Perth's southern corridor and construction industries.

Sand deposits of the Oldbury site's quality near the Perth Metropolitan area are not typically common; as a result, the Oldbury site presents a unique resource. The significance of the Oldbury sand deposit has been recognised by the Department of Mining and Petroleum and the Department of Planning (Appendix 1).

1.6 Extractive Industries Local Law

As Rocla's proposed excavation is permissible with the grant of planning approval under TPS No. 2, the Shire of Serpentine Jarrahdale may (under clause 3.1(1) of the Extractive Industries Local Law) grant an extractive industries licence following the grant of planning approval.

Pursuant to clause 1.2(1) of the Shire of Serpentine–Jarrahdale Extractive Industries Local Law, Rocla's proposed excavation of the site will be subject to the Extractive Industries Local Law. The information contained in this report and the Development Application report (Roberts Day 2013) addresses the requirements in section 2.3 of the Extractive Industries Local Law.

1.6.1 Planning Context

Rocla's proposed activity is subject to and complies with the following planning framework:

- MRS
- Shire of Serpentine–Jarrahdale TPS (No. 2).

In addition, the following State Planning Policies are relevant to Rocla's proposed activity:

- State Planning Policy 1 – State Planning Framework Policy
- State Planning Policy 2.4 – Basic Raw Materials
- State Planning Policy 2.5 – The Peel Harvey Coastal Plain Catchment.

1.6.2 Permissibility

1.6.2.1 Metropolitan Region Scheme Zoning

Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road are zoned "Rural" under the MRS (refer to the Development Application report).

1.6.2.2 Shire of Serpentine Jarrahdale's TPS No. 2

Consistent with the MRS the subject land is zoned "Rural" under the Shire of Serpentine Jarrahdale's TPS No. 2. The proposal is considered to represent development for the purpose of "Extractive Industry", noting Industry – Extractive is classified as an "AA" use

in "Rural" zoned areas. The classification of "AA" under TPS No. 2 contemplates that the Shire of Serpentine Jarrahdale Council may, at its discretion permit this use. (refer to the Development Application report)

The Development Application planning application and report (Roberts Day 2013) provides a detailed explanation on the planning context inclusive of compliance with the relevant state planning policies.

1.6.3 Environmental Assessment History

In 2007, the Environmental Protection Authority (EPA) assessed the previous proposal for sand mining on Lot 6 Banksia Road pursuant to Section 38 of the *Environmental Protection Act 1986*. The EPA set the level of assessment for the project as "Advice Only" i.e. the proposal was not subject to a formal environmental impact assessment. In its advice statement, the EPA identified the following key environmental issues:

- vegetation
  - establishing an ecological linkage along the western boundary of Lot 6 between the wetland and Lot 53 Banksia Road
  - establishing and managing a wetland buffer
  - restoration program utilising indigenous vegetation
- surface water management
- groundwater contamination
- noise and dust management.

The previous advice from the EPA is addressed in this proposal. Section 4 of this report outlines specific mitigation/management measures with respect to the identified environmental factors.

As part of the assessment process (for this proposal) Rocla has undertaken the following:

- met with the Department for Environment and Conservation (DEC) – Native Vegetation Conservation Branch on four occasions
- Level 1 Spring 2008 flora and vegetation survey
- surface and groundwater assessment and modelling

- referred the proposal to the Department of Environment and Conservation (DEC) for a "purpose permit" clearing application (in progress)

- a referral to the Department for Sustainability, Environment, Water, Population and Communities (DSEWPC) in accordance with the *Environmental Protection and Biodiversity Act 1999* (EPBC) was undertaken in 2011 (in progress).

This page is intentionally blank.

2.0 EXISTING ENVIRONMENT

2.1 Topography

The site has a ridge line located in the central to northern portions of Lots 6, 300 and 301 that runs east to west with a maximum elevation of 39 metres Australian Height Datum (mAHD) (Figure 3). The land falls in a south-west direction towards the wetlands (abutting the southern boundary) to a height of approximately 11 mAHD (Department of Water 2009).

The proposed sand extraction area has a topographic range of approximately 18 mAHD to 39 mAHD (Figure 3).

2.2 Soils and Geology

Geology mapping indicates that the project site consists: "Bassendean Sand – white and grey quartz sand" (GSWA 1978 Pinjarra Sheet) (Figure 4). Geotechnical investigations undertaken by Rocla confirmed the sand on site comprises light grey to white, and light yellow medium grained quartz sand consistent with the Bassendean Sand unit geology.

2.3 Acid Sulfate Soils

2.3.1 Overview

Acid Sulfate Soils (ASS) are formed naturally under waterlogged, iron and sulfate rich conditions. These conditions are typical of coastal lowlands where the land has been subject to inundation by sea water. These soils contain iron sulfide minerals (most commonly pyrite) or their oxidation products. They remain stable under anaerobic conditions but exposure to air can lead to their oxidation resulting in the formation of sulfuric acid and the release of iron, aluminium and other heavy metals and nutrients from soils into surface water bodies and groundwater.

2.3.2 Western Australian Planning Commission (WAPC) ASS Mapping

The WAPC has mapped the risk of ASS occurrence throughout parts of Western Australia including the Serpentine area (WAPC 2003). The majority of the site is mapped as having a low to moderate risk of ASS occurring within 3 m of natural soil surface (or deeper). The wetland area (located south-west portion of the project site), is mapped as having a "high to moderate risk" of ASS occurring within 3 m of natural soil surface (Figure 5), which is external to the extraction area and will not be impacted upon.

2.3.3 Geotechnical Testing

Rocla undertook geotechnical investigations including soil analysis of the site in 2006 using six test pits. The test pits where installed to a depth of approximately 5 m below ground level (bgl). Geotechnical investigations undertaken included test pit excavations and did not identify the existence of ASS material within the proposed excavation area. The sand encountered was documented as being, "very clean with little silt and clay present (generally less that 1%). The sand was dry and appeared to have good drainage properties as no water ponding was observed" (GHD 2006).

The proposed excavation area is set within an area described as having a "low to moderate risk" of ASS occurrence (as outlined in Section 2.3.2) given the predominantly aeolian origins of the geological units and the landform formation conditions. The potential presence of any ASS materials is expected to be limited to the low-lying alluvial wetland area excluded from the extraction area.

2.3.4 Key Outcomes

As the soil extraction operations are not proposed to breach a 2 m vertical buffer between excavations and the water table, and no dewatering is proposed, the oxidative effects of groundwater level modification can be discounted, and the risk of acid generation would hence be considered low, as all soils above the water table would potentially already have been exposed to oxidative effects.

Based on the available information, including test pitting, and the WAPC ASS risk mapping, there appears to be a low risk of ASS in the soil extraction area. In recognition of this uncertainty, a DEC ASS Site Self Assessment Form was completed, using existing knowledge of the site. In accordance with the self-assessment forms no further investigation is required for the following reason:

1. The soil extraction operations will specifically avoid encroaching into the wetland located to the south-western corner of Lot 6 and part Lot 300 through the provision of a minimum 60 m buffer zone.

2.4 Hydrology

2.4.1 Wetlands

A search of DEC's Geomorphic Wetlands Database (Landgate 2009) indicates that the majority of the site is not classified as a wetland. However, a small portion of land located in the south-west corner of Lot 6 and part Lot 300 is categorised as a Resource Enhancement Wetland (REW: UFI14705). Also, a portion of a Multiple Use (MUW: UFI 14409) categorised wetland extends into the lower corner of Lots 300 and 301 (Figure 6).

Table 2: DEC Wetland Management Categories

Management Category	General Description	Management Objectives	Number of Wetlands for this site
Conservation	Wetlands support a high level of ecological attributes and functions.	Highest priority wetlands. Objective is preservation of wetland attributes and functions through various mechanisms including: ▪ reservation in national parks, Crown reserves and state-owned land ▪ protection under Environmental Protection Policies ▪ wetland covenanting by landowners. These are the most valuable wetlands and WRC will oppose any activity that may lead to further loss or degradation. No development.	0
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions.	Priority wetlands. Ultimate objective is for management, restoration and protection towards improving their conservation value. These wetlands have the potential to be restored to conservation category. This can be achieved by restoring wetland structure, function and biodiversity. Protection is recommended through a number of mechanisms.	1 (UFI 14705)
Multiple Use	Wetlands with few important ecological attributes and functions remaining.	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through land care. Should be considered in strategic planning (e.g. drainage, town/land use planning).	1 (UFI 14409)

Source: adapted from Water and Rivers Commission now DoW, 2001

It is acknowledged in the Guideline for the Determination of Wetland Buffer Requirements (WAPC 2005) that separation distances for both Resource Enhancement Wetlands and Multiple Use Wetlands and management measures are recommended on the basis of potential threats in order to mitigate likely impacts of the surrounding land use. Separation measures are required to mitigate only those threats that are present.

The proposed area for sand extraction will be located outside the minimum required 50 m buffer from both the REW and the MUW (Figure 6). The proposed sand extraction area is located over 60 m from the REW.

2.4.2 Groundwater

According to Davidson (1995), the site is located on the Jandakot Mound. An analysis of the local groundwater contours (at maximum winter levels) indicates that groundwater beneath the site migrates in a south to south-westerly direction under a hydraulic gradient of approximately 0.004 (Figure 7). Groundwater elevation at the site ranges from approximately 14 m to 16.5 mAHD (DoW 2009).

The groundwater level determined from a bore at the northern part of the site and a test pit at the south-western part of the site were both measured at approximately 16 mAHD (GHD 2006). This groundwater elevation is in close proximity to the DoE Atlas (2007).

2.4.2.1 Groundwater Separation

It is proposed to set an interim conservative mine floor level which provides five metres of clearance to the "future maximum water table" (FMWT), which is a term specified in WRC (1999). In light of the declining trend in groundwater levels and the likely overestimation of the FMWT resulting from this trend, the interim 5 m buffer is considered to be sufficiently conservative to prevent any impacts from excavation activities to the groundwater resource.

After two winters of monitoring and the FMWT is finalised, the 2 m separation can be adopted. This is as per Rocla's recently endorsed management plan with the Department of Water (DoW) for Priority 1 water on the Gnangara Mound. This approach is preferable to be conservative while further water monitoring occurs, rather than undertaking monitoring upfront. This approach was discussed between Rocla and DEC as agreed way forward.

The basis of the 2 m separation distance is premised upon DoW policy application of 2 m of undisturbed profile between the likely future maximum water table and the proposed surface level within Priority 2 and 3 Public Drinking Water Source Areas (Water and Rivers Commission 2000). It should be noted that while this sand extraction proposal is outside the Jandakot Groundwater Protection Policy Area (WAPC State Planning Policy 2.3 2003) it still meets the DoW policy standard for sand mining in Public Drinking Water Source Area.

Rocla has extensive experience mining in Priority Groundwater Protection Areas with major sand extraction sites located in Gnangara (Priority 1 Source Protection Area) and Banjup (Priority 2 Source Protection Area).

The DEC annually audits operations at the Gnangara site and no groundwater related issues have been identified. Rocla will take all precautions necessary to ensure groundwater is not adversely impacted by extraction operations.

Rocla are committed to the following:

- survey control of quarry floor to ensure accurate recording of separation distance
- monthly monitoring of the groundwater via piezometer
- staged restoration program.

These key commitments are characteristic of the DEC reporting requirements for Rocla's sand extraction operations within Priority Water Source Protection areas.

2.4.3 Surface Drainage

The nearest weather station to the site is the Medina Research Centre, located approximately 12 km to the north. The average annual rainfall since 1983 (when the weather station began operating) is 780 millimetres.

Drainage on the site is towards the REW and MUW in the south-west of the site. A drainage line is also located in the south-west corner of Lot 6 (Figures 2 and 6).

Water run-off from incident rainfall percolates through the highly permeable sandy soils within the site. No direct drainage to the southern wetlands will occur by way of a defined channel.

Recognising the potential impacts on surface and groundwater additional investigation and modelling was undertaken by RPS. RPS has finalised a hydrology assessment to estimate the potential impacts of the proposed quarry on the hydrology of a REW to the south. This wetland is alleged to have characteristics of Organic Mound (Tumulus) Springs, which is classified by the DEC as a Threatened Ecological Community (TEC). The key outcomes from the investigation include:

- Groundwater modelling predicts the average annual maximum increase in groundwater levels at the L120 Wetland of about 0.15 m to occur after a 10 year period. This equates to about 1.5 cm per year, which is less than the generic Ecological Water Requirements "low impact" water level change for wetlands provided by Froend and Loomes (2004). After 10 years of excavation with revegetation, the groundwater level is predicted to decrease and result in no net change in levels at the wetland after another 10 years. As such, the water level changes are predicted to be temporary. This prediction is conservative as it does not include the controlling effects of open drains in the area.

- The investigations indicate the hydrology in the area of the wetland is significantly controlled by anthropogenic factors including a railway embankment and open drains that intercept groundwater and are at a lower elevation than the L120 Wetland. These factors are expected to minimise and control any groundwater level increases in the vicinity of the wetlands that are associated with the proposed excavation. This is particularly the case in the winter months when the drains remove water away from the system to the east and control groundwater levels.

- A species-specific risk analysis of groundwater dependent vegetation in the L120 Wetland calculated an acceptable risk of impact to the L120 Wetland from sand quarrying activities. This is the lowest of the five possible risk categories, namely: acceptable, low, moderate, high and extreme.

- Despite the conclusions of the modelling and the on-site investigations, several contingency measures have been established should the water level in the L120 Wetland be considered unacceptably high in the future. These include

- ensuring open drains in the immediate vicinity are not blocked and allow free transmission of water, by contacting Water Corporation as the regulatory agency responsible for drain performance

- the planting of phreatophytes

- the abstraction of groundwater at the site.

2.5 Vegetation and Flora

GHD was commissioned in 2005 to conduct a flora and vegetation survey of Lot 6 Boomerang Road, Oldbury (GHD 2006). Rocla commissioned RPS to conduct a Level 1 flora and vegetation survey (incorporated a targeted search for declare rare and priority flora) during spring 2008. The spring Level 1 Flora and Vegetation Survey was the agreed level of investigation by the DEC Native Vegetation Conservation Branch in its assessment of the Purpose Permit clearing application. The Level 1 Flora and Vegetation Survey included the following:

- vegetation mapping
- conformation of vegetation complexes present
- vegetation condition mapping
- identification and assessment of conservation significance.

The additional vegetation and flora work was undertaken to supplement the survey work completed by GHD in 2005 and to extend the study area to include Lots 300 and 301, thereby encompassing the entire sand extraction area. The vegetation complexes are defined in Figure 8.

2.5.1 Field Survey Methodology

A botanist surveyed the Oldbury project area in 2012 to verify the accuracy of the Heddle mapping and to map the condition of the native vegetation in areas previously excluding from flora and vegetation assessment.

The boundaries of the Heddle vegetation complexes were redefined and mapped by RPS by method of direct field observation based on floristic community composition, dominant taxa and landform/topography. The survey results were presented to the DEC Native Vegetation Conservation Branch in September 2012. The DEC Native Vegetation Conservation Branch has accepted the conclusions of the revised Heddle mapping.

Vegetation condition was recorded using the vegetation condition rating scale developed by Keighery (1994) that recognises the intactness of vegetation, defined by:

- completeness of structural levels, extent of weed invasion, historical disturbance and the potential for natural or assisted regeneration.

2.5.2 Vegetation Complexes Overview

According to mapping by Heddle et al. (1980) the vegetation within the revised clearing area is representative of two vegetation complexes:

- Bassendean Complex – Central and South – Woodland of *Eucalyptus marginata – Allocasuarina fraseriana* – Banksia spp. to Low Woodland of Melaleuca spp. and Sedgelands on moister sites

- Serpentine River Complex – Closed Scrub of Melaleuca spp. and fringing Woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* along streams.

2.5.3 Bassendean Complex – Central and South and Serpentine River Complex Representation

The following section defines in tables the vegetation extents of the Bassendean Complex–Central and Serpentine River Complex within the project area and the remaining percentage of vegetation in this complex within the Swan Coastal Plain, Bush Forever Sites within the Perth Metropolitan Region and within the City of Serpentine – Jarrahdale local government area (Del Marco et al. 2004).

Table 3: Representation of Bassendean Complex – Central and South and Serpentine River Complex circa 1997 Remnant Vegetation Extent on the Swan Coastal Plain

Vegetation Complex	Pre-European Extent (ha)	Present Extent (ha) Remaining	% of Present Extent Remaining	% of Present Extent In Secure Tenure #
Bassendean Complex – Central and South	87 626	23 635	27*	0.7
Serpentine River Complex	19 855	2 103	10.6**	2.8

(Del Marco et al. 2004)

* Equivalent to < = 30% in 2004 based on the limitations of these statistics
** Equivalent to < = 10% in 2004 based on the limitations of these statistics
# refers to National Parks, Nature Reserves, Conservation Parks and Reserves from DEC Managed Lands 2002 GIS database. Swan Coastal Plain- Moore River to Dunsborough

Table 4: Representation of Bassendean Complex – Central and South and Serpentine River Complex circa 1997 Remnant Vegetation Extent in Bush Forever Study Areas on the Swan Coastal Plain of the Perth Metropolitan Region

Vegetation Complex	Pre-European Extent (ha)	Present Extent (ha) Remaining	% of Present Extent Remaining	% of Complex Proposed for Protection within Bush Forever Areas
Bassendean Complex – Central and South	46 220	10 919	24	13
Serpentine River Complex	4 445	398	9	4

(Del Marco et al. 2004)

Table 5: Representation of Bassendean Complex – Central and South, and Serpentine River Complex within the City of Serpentine – Jarrahdale Local Government Area

Community	Pre European (ha)	Remaining Extent of Pre-European as of 2001	
		ha	%
Bassendean Complex – Central and South	9854	3011	31
Serpentine River Complex	783	51	7

(Del Marco et al. 2004)

2.5.4 Vegetation Complex Survey Results

Heddle vegetation complexes of the Swan Coastal Plain were originally delineated and mapped at a scale of 1: 250,000. The reliability of the Heddle mapping varies across map series. Vegetation complexes were either determined from ground-truth, aerial photography or by vehicle/road traverses. The reliability of each map series or geographical area varies and is expressed as a reliability diagram which details the techniques utilised to map vegetation complexes (and boundaries) for a particular area. The project area is contained within the Pinjarra Sheet. Vegetation complexes mapped by Heddle et al. (1980) for this map series were inferred based on aerial photography and road traverses by vehicle. Subsequently, the reliability of the vegetation mapped within the site is considered low.

Recent interpretation by RPS of aerial photography over the project area suggested the Heddle mapping did not accurately reflect the composition of the vegetation complexes present within the site. This was confirmed during the field survey and RPS concludes that the current Heddle vegetation complex mapping within the project area is incorrect. The Serpentine River Complex mapped by Heddle et al. (1980) is reported to extend over the eastern portion of the project area. The vegetation in the majority of this area consists of "Banksia Low Woodland" which has no affiliation to the floristic assemblage of the Serpentine River Complex.

RPS subsequently re-mapped the boundaries of the vegetation complexes in the project area (Figure 9). The figure indicates that the Serpentine River Complex is restricted to the southern portions of Lot 6, Banksia Road and Lot 300, Boomerang Road.

Approximately 0.01 ha of this vegetation complex occurs within the proposed clearing area. The majority of the Serpentine Vegetation Complex is contained within the ecological corridor proposed by Rocla and will be formally protected by means of a conservation covenant (as described in Part B of this report). The representation of vegetation complexes within the project area, inside and outside of the proposed disturbance footprint (as determined by the DEC and by RPS) is presented below in Table 6.

Table 6: Lots 6, 300 and 301 Revised Vegetation Complex (Heddle) Assessment

Vegetation Complex	Oldbury Project Area (Lots 6, 300 and 301) (ha)	Within Proposed Clearing Application Area (excludes Existing Cleared Areas) (ha and %)	Within Proposed Ecological Corridor (ha and %)
Bassendean Complex – Central and South	25.3	11.6 (45%)	10 (39.5%)
Serpentine River Complex	7.4	0.01 (0.13%)	7.39 (99.8%)

2.5.5 Local and Regional Analysis

Rocla intend to undertake a Banksia woodland restoration program post-sand mining extraction. The vegetation of the area proposed for clearing is representative of the Bassendean Complex – Central and South. This complex is classified as "Vulnerable" in terms of extent of vegetation, with 27% remaining compared to pre-European extents. If a clearing application is granted approximately 11.6 ha or 0.05% of the present regional extent remaining of this vegetation complex will be temporarily lost.

There is approximately 31% or 3,011 ha of the pre-European extent of the Bassendean Complex – Central and South within the City of Serpentine – Jarrahdale Local Government Area (Del Marco et al. 2004). Clearing of vegetation in the proposed clearing application area will result in the temporary loss of 0.11% of the Bassendean Complex – Central and South at a local scale.

At a regional scale the total aggregate area of Bush Forever sites, National Parks and Conservation Areas within a 20 km buffer of the project area is 25,093.2 ha. The clearing of remnant vegetation represents a temporary loss of 0.05% of the 25,093.2 ha currently under formal protection.

In regards to the Serpentine River Complex the inclusion of the ecological corridor into a formal conservation protection status will significantly increase the percentage of pre-European extent remaining of this complex. RPS has calculated that formal protection of the Serpentine River Complex in the project area will increase the present extent in secure tenure on the Swan Coastal Plain by 12.65%, the percentage proposed for protection within Bush Forever in the Perth Metropolitan Region from 15.92 ha to 23.37 ha (46.8% increase).

At a local scale protection of the Serpentine River Complex within the project area will increase the pre-European extent remaining by 14.6% to 58.45 ha.

2.5.6 Flora Species Richness

A total of 232 plant taxa have been recorded by GHD (2006) and RPS (2008) within Lot 6, Banksia Road, Lot 300 and Lot 301 Boomerang Road, Oldbury. This total consists of 172 native taxa and 60 introduced species represented by 56 families (15 introduced).

RPS investigated the richness of flora species occurring in Bush Forever sites located within seven kilometres of the project area (Government of Western Australia 2000). The results of this review are provided below in Table 6.

Table 7: Flora Species Richness in Bush Forever Sites Located within 7 km of the Project Area

Bush Forever Site No.	Total Flora Species Recorded	Limitations	Comments
269	104	Estimated >75% of taxa	Low diversity
270	250	Estimated <70% of total flora	High diversity
273	104	>50% of expected flora	Plot based assessment only
348	197	Estimated <80% of expected flora	High diversity
349	129	>60% of flora	Plot-based assessment only
353	150	Estimated >75% of expected flora	Moderate diversity. Similar size to proposed clearing application area

*Note: It is not stated whether total flora species counts include introduced (weed) species.

The diversity of the vegetation of the project area can be considered to be of moderate diversity in comparison to the Bush Forever sites listed above in Table 7. Therefore, the proposed clearing is unlikely to have any significant impact on biodiversity in the region or of the local area. Furthermore, the sand mining and the subsequent elimination of weed species during the restoration phase may potentially minimise and even reduce the introduction of weed species or rate of weed incursion into surrounding bushland.

2.6 Vegetation Condition

Vegetation condition mapping of the majority of the project area was previously completed by GHD (2006) and RPS (2008). Vegetation condition mapping was not undertaken in the southern portion of the project area. The purpose of the recent field survey conducted by RPS was to extend previous condition mapping for the project area.

The vegetation within the southern portion of the project area has been subject to moderate to high degrees of disturbance over time. Disturbance factors include fire, severe weed incursions by aggressive species and previous clearing for the purpose of fire breaks and access track establishment. The density of some exotic grass species such as *Ehrharta calycina* and *Avena barbata* was observed to be very high and *Zantedeschia aethiopica* or arum lily was located at several locations.

The condition of the vegetation in the project area ranges from Very Good to Completely Degraded however approximately 69% of the vegetation was rated Good–Degraded to Completely Degraded. The condition of the vegetation in the area proposed for clearing ranges from Very Good to Completely Degraded however less than 50% of the vegetation was rated Good or better (Figure 10).

2.6.1 Declared Rare and Priority Flora

Declare Rare Flora (DRF) are species that have been adequately surveyed and are considered to be in danger of extinction, rare or otherwise in need of special protection within Western Australia. DRF are protected under the *Wildlife Conservation Act 1950*.

Additionally, in Western Australia there are four types of Priority Flora whose conservation status warrants some protection, (but is not specifically covered under current legislation). Priority 1–3 is allocated to species that are poorly known. These require more information to be assessed for inclusion as DRF. The categories are arranged to give an indication of the priority for undertaking further surveys (based on known sites and degree of threat). A fourth category, Priority 4 is included for those species that have been adequately surveyed and are considered to be rare but not currently threatened.

The DEC databases for threatened flora (Declared Rare Flora) and the Western Australian Herbarium (WAH) Specimen and DRF were searched for known records within a 5 km radius of the site. There were eighteen conservation significant species recorded within a 5 km radius of the site of which six are DRF.

No Priority or Declared Rare Flora where observed / recorded within the site during a botanical survey in spring 2008. Similarly, no Threatened Ecological Communities were recorded from the site.

2.6.2 Conclusions

The findings of the flora and vegetation assessments completed for the project area are summarised below:

- The vegetation community in the area proposed for clearing is 99.87% representative of the Bassendean Complex – Central and South community (the remaining 0.13% of the proposed clearing area comprises vegetation characterised as Serpentine River Complex).

- Within the City of Serpentine – Jarrahdale Local Government Area there is 31% of the Bassendean Complex – Central and South within Bush Forever and other designated Reserves.

- 7.39 ha of the ecological corridor (conservation area) comprises Serpentine River Complex. RPS has calculated that formal protection of 7.39 ha of the Serpentine River Complex in the project area will increase the present percentage proposed for protection of that vegetation type within Bush Forever in the Perth Metropolitan Region from 15.92 ha to 23.37 ha (a 46.8% increase).

- Approximately 232 plant taxa have been recorded within Lot 6, Banksia Road, Lot 300 and Lot 301 Boomerang Road, Oldbury. This total consists of 172 native taxa and 60 introduced species.

- RPS considers the vegetation of the project area to be of "moderate diversity".

- No Threatened Rare or Priority Flora known to occur in the proposed clearing application area.

- No Threatened or Priority Ecological Communities (TECs, PECs) occur in the proposed clearing application area.

- There are no wetlands or watercourses in the proposed clearing application area.

2.7 Tumulus Springs (Organic Mound Springs) Threatened Ecological Community (TEC)

RPS understands that as part of the DEC's assessment of Rocla's purpose permit clearing application, the DEC has characterised the L120 Resource Enhancement Wetland, to the south of the clearing application on Lot 7, as a Tumulus or Mound Spring. Tumulus Springs (organic mound springs) on the Swan Coastal Plain are classified as a Critically Endangered Threatened Ecological Community (TEC).

The habitat of the Tumulus Springs community is characterised by continuous discharge of groundwater in raised areas of peat. The peat and surrounds provide a stable, permanently moist series of microhabitats. Hydrogeologically tumulus springs are described as permanent groundwater discharges from raised areas of peat, commonly with preferred pathways which carry sand and silt to the surface, contributing further to mound formation.
It is understood the TEC classification was based on a site survey assessment by the DEC botanical expert Val English.

The Tumulus Springs community is located at its closest point approximately 80 m from the boundary of the proposed clearing area. The location of the proposed sand quarry and its vicinity to the L120 Wetland is shown on Figure 6.

RPS has undertaken a hydrological study of the site and assessed the potential impacts of a proposed sand quarry based on several site visits and groundwater modelling. The report identifies operational drains on the south and south-east side of the L120 Wetland, which limit any potential rise in water level within the wetland. Water is contributed to the wetland, not only by direct groundwater seepage and spring flow, but also via a drain which intersects the water table along the southern side of the railway line which forms the northern boundary of the wetland.

A summary of the existing human impacts is provided in Figure A.

Figure A: Summary of L120 Wetland Impacts

2.8 Peer Review

JDA Consultant Hydrologists (JDA) were commissioned in September 2012 to undertake a professional review of the Hydrology Assessment, Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury report (RPS 2012).

The aim of the review is to provide independent advice on the conclusions of the RPS report, namely that:

> The proposed quarry is not expected to decrease water levels in the wetland, while any increase in groundwater and wetland levels are expected to be controlled by the drains in the immediate vicinity. In relation to present conditions, the proposed quarry's predicted impact to the quality and quantity of the L120 Wetland is expected to be significantly overshadowed by the anthropogenic impacts that already exist.
>
> (JDA 2012)

The peer review also assessed the allegation by the DEC that the L120 Wetland is a Tumulus or Mound Spring. The JDA review included a site visit by Principal Hydrogeologist John Barnett and Environmental Hydrologist Chiquita Burges on 4 October 2012. Ted Love, the local farmer who owns the Lot 7 property surrounding the L120 Wetland, was met during the site visit, and provided useful information about local drains, springs and changes of land use in the area.

JDA also discussed the TEC characterisation of L120 Wetland with Val English and Hydrogeologist Jasmine Rutherford of the DEC.

2.8.1 JDA Conclusions

JDA endorses the general conclusion of the RPS report, namely that:

> The proposed quarry is not expected to decrease water levels in the wetland, while any increase in groundwater and wetland levels are expected to be controlled by the drains in the immediate vicinity. In relation to present conditions, the proposed quarry's impact to the quality and quantity of the L120 Wetland is expected to be significantly overshadowed by the anthropogenic impacts that already exist.
>
> (JDA 2012)

2.8.1.1 Hydrology Assessment of the Tumulus Spring L120 Wetland

In relation to L120 wetland JDA hydrologist concluded:

- The L120 Wetland is one of a discontinuous linear series of springs, swamps and wetlands along the boundary of the Jandakot Mound, where the Bassendean Sand abuts the much less permeable Guildford Formation.

- The L120 Wetland has been identified by DEC as a Tumulus or Mound Spring on the basis of the associated suite of plants. The wetland does not conform to the hydrogeological definition of a Tumulus or Mound Spring, in that it is located in a local topographic depression with no evidence of peat or sand mounding. There is also no sign of coarse material having been brought to the surface by groundwater discharge via preferred pathways.

2.8.1.2 Predicted Outcomes to the Flora Species with L120 Wetland

Groundwater modelling indicates the average annual maximum increase in groundwater levels at the wetland of about 0.15 m occurred after a 10 year period. This equates to about 1.5 cm per year, which is less than the generic Ecological Water Requirements "low impact" change provided by Froend and Loomes (2004). After 10 years of excavation with revegetation, the groundwater level is predicted to decrease and result in no net change in levels at the wetland after another 10 years. As such, the water level changes are predicted to be temporary. This prediction is conservative as it does not include the controlling effects of the drains in the area.

The proposed sand quarry is not expected to impact on the groundwater quality in the region, while any changes to groundwater levels are predicted to result in slightly higher levels at the L120 Wetland. This is important because the flora species typically found within Tumulus Springs are likely to be more prone to impacts from lower groundwater levels (i.e. dewatering), as some flora and fauna are reliant on a permanent supply of freshwater and permanent moisture. Thus the proposed sand excavation is not expected to decrease water levels in the wetland, while any increases in groundwater and wetland levels are expected to be controlled by the drains in the immediate vicinity. In relation to present conditions, the proposed quarry's predicted impact to the quality and quantity of the L120 Wetland is expected to be significantly overshadowed by the anthropogenic impacts that already exist.

Further, JDA also concluded the maximum rise of 0.17 m at the L120 Wetland forecast by the RPS computer model would be beneficial rather than otherwise, being superimposed on regionally declining water-levels in the general range of 1.0–1.5 m since the mid-1980s.

Despite the conclusions of the modelling and the on-site investigations, several contingency measures have been established should the water level in the wetland be considered unacceptably high in the future. These include accelerated revegetation, the planting of phreatophytes and the abstraction of groundwater at the site.

2.9 Cultural Heritage

2.9.1 European Cultural Heritage

A search of the Heritage Council of Western Australia's Places Database was conducted in April 2009. There are no places registered on the State Register of Heritage Places in the suburb of Oldbury.

2.9.2 Indigenous Cultural Heritage

The Department of Indigenous Affairs Register of Aboriginal Sites database was searched (August 2008) for Registered Aboriginal Sites. No Aboriginal sites have been registered within this site (Appendix 2).

3.0 EXCAVATION MANAGEMENT

3.1 General

The site contains deposits of Bassendean Sand which is suitable for use as construction and fill sand. Extraction of sand at this site will facilitate the continued supply of specialised sand for concrete products and engineering fill for projects in Perth's southern corridor. It is estimated that there is approximately two million tonnes of sand available for excavation within the 15.2 ha excavation area (Figure 11) which will support mining for an estimated five to eight years.

Land based sand extraction involves a sequence of operations as follows:

1. Vegetation clearing.
2. Topsoil removal.
3. Extraction operations.
4. Distribution.
5. Restoration of native vegetation.

3.2 Project Description

3.2.1 Pre-excavation Works (Staged Extraction and Restoration Plan)

Native vegetation clearing and topsoil removal will be conducted in stages as the excavation progresses (Figure 12). It is estimated that 4 to 6 ha will be cleared initially with 3 to 5 ha cleared annually thereafter depending upon the demand for the sand resource.

All clearing will be conducted using a rake and wheeled loader. The topsoil removed from cleared areas will be retained for use in the restoration program. The topsoil will be stockpiled in an appropriate area on site or and then directly transferred to the completed excavation stage as part of the *Banksia spp – Eucalyptus marginata* woodlands restoration works. The first section of topsoil will be recovered allowing for the best seed retention at a later date. This technique will utilise the best available research into *Banksia* re-establishment that Rocla has been conducting in partnership with the (Kings Park) BGPA over the past eighteen years (Appendix 3).

3.2.2 Excavation Method

Sand will be mined from the excavation area in a staged program with mining proposed to commence in the last quarter of 2012. The excavation process will be undertaken on a staged basis with restoration of *Banksia spp – Eucalyptus marginata* woodlands (restoration) commencing post-completion of each stage which reduces the exposed

areas and minimises any areas where water may potentially pond. The extraction pit will be designed to maintain a buffer of greater than 2 m between the maximum depth of extraction and the maximum height of the water table. The open extent will be restricted to the staged area anticipated to be mined over the next twelve months, which is estimated to be approximately 3 to 5 ha. Following extraction in one stage, the next mined stage will be cleared and the previous cell rehabilitated back to *Banksia spp – Eucalyptus marginata* woodlands. At this rate, it is estimated that the site will support mining for an estimated five to eight years (Figure 11).

The sequence in the extraction of sand from the site is outlined below:

1. Excavation will commence on the south-eastern edge of the ridge (mid-Lot 301) and move westwards on a staged basis.

2. Prior to excavation, vegetation will be cleared, topsoil will be removed and stored for use in restoration.

3. Overburden will be removed and stored for future land restoration through backfill and placement.

4. The sand resource is typically screened using a portable screening plant to remove any organic material and stockpiled prior to tipping directly into road trucks for transportation to stockpile areas.

5. Reforming of the land is normally carried out using a bulldozer or loader to push the topsoil and overburden.

6. On completion, the land surface will be graded to ensure the final slopes will not exceed one in three vertical to horizontal in accordance with Shire of Serpentine Jarrahdale Extractive Industries Local Law 1999.

7. Restoration will progressively follow each excavation stage wherever possible.

3.2.3 Finished Levels

Excavation proposes to lower natural surface topography following the east–west ridgeline by between 20 m to 2 m to a finished floor level of approximately 18 mAHD. The floor level is above the 2 m separation required between the finished levels and the average annual maximum water table (AAMGL). The excavation will continue to the bottom of the resource which is at an average floor level of approximately 18 mAHD. To achieve the proposed excavation levels each stage will require a sufficiently large footprint to enable internal roads at suitable grades to ensure an efficient and safe excavation operation.

In accordance with the *Mines Safety and Inspection Act 1994* the final profile of the batters/faces used to integrate mined surfaces with the natural remaining topography of the site, equates to the final batters being one in three vertical to horizontal or less which also meets the Shire of Serpentine / Jarrahdale's Extractive Industry Local Law 1999 requirements.

Working batters on the sand excavation/quarry face will be left in a slumped condition at the end of each day and over weekends for safety.

3.2.4 Hours of Operation

Hours of operation will be from 7.00 am to 5.00 pm, Monday to Saturday inclusive.

The flexibility of a six-day week operation is necessary to maintain efficiency because not all parts of the site can be excavated at all times of the year. Although the sand will be transported throughout the year, excavation will be discontinuous and dependent upon the demand for this particular sand type and requirement to avoid very wet conditions. It is more efficient to excavate sand material and produce on-site stockpiles from which sand can be transported in the intervening times, as this maximises the use of mobile plant equipment.

3.3 Infrastructure and Access

3.3.1 Site Access

A bitumen entrance road located off Boomerang Road (entering mid-Lot 6) and cross-over will be constructed by Rocla prior to operations commencing.

Vehicle access to the site will be via Banksia and Boomerang Roads and for authorised personal only. Overnight and on weekends, vehicles will be kept within locked premises.

Perimeter fencing will be maintained along the boundaries of the property. Property gates will be locked outside operating hours.

3.3.2 Haulage

The number of trucks entering the site will vary throughout the year depending upon the demand for the sand resource. However, it is anticipated that between two to four trucks per hour will access the site per day. Truck payload size will vary depending whether they are semitrailers or rigid wheeler trucks. Trucks will only be entering and exiting the site between the hours of 7.00 am and 5.00 pm.

The main haulage route is anticipated to be along Banksia Road onto Lyndon Road, Coyle Road and then King Road (which provides access to Thomas Road and the Kwinana Freeway). King Road is listed as a heavy vehicle route, with a maximum load of 87.5 tonnes and a maximum length of vehicle of 27.5 m.

3.3.3 Site Infrastructure

Site infrastructure for the Oldbury proposed sand extraction site will consist of the following:

- transportable site office
- vehicle/equipment compound
- toilet
- refuelling facility (5000 litre (maximum) self-bunded diesel above ground tank).

All site infrastructure will be located in the northern portion of Lot 6. A self-bunded fuel tank or an earth wall bund will be constructed around the designated refuelling facility in accordance with Water Quality Protection Note 56: Tanks for Elevated Storage (DoW 2006). Specific measures in regards to the above ground fuel tank include:

- The total tank storage volume shall not exceed 5,000 litres.

- There will be no underground pipework carrying fuel from the tank to facilities outside the compound. The storage tank will be self-bunded and located within a compound that effectively capture and contain any chemical spills.

- Minimum storage tanks and associated spill containment compounds will comply with the current Australian Standard 1940, the *Explosive and Dangerous Goods Act 1961* and any associated regulations.

3.4 Safety

3.4.1 Operations

All excavation, mining practices and operations procedures will comply with the following legislation:

- *Mines Safety and Inspection Act 1994*
- Mines Safety and Inspections Regulations 1995
- *Occupational Health and Safety Act 1984*
- Occupational Health and Safety Regulations 1996
- Shire of Serpentine–Jarrahdale Extractive Industry Local Law 1999.

Rocla has developed procedures and work practices to manage safety, environmental impact, site management and restoration. All personnel are trained to industry standards. All personnel are provided with site induction, safety and environmental awareness training. All workers are required to wear full-time protective safety and high visibility work gear when on site.

3.4.2 Signage

In accordance with clause 6.2 of the Shire of Jarrahdale–Serpentine's Extractive Industry Local Law 1999 Rocla will place a sign not less than 1.8 m high and not less than 1 m wide which states "Danger Excavations Keep Out".

The signs will also indicate operation hours and contact details of the site manager.

This page is intentionally blank.

4.0 POTENTIAL ENVIRONMENTAL IMPACT AND MANAGEMENT

4.1 Introduction

This section details the potential environmental impacts and how these will be managed. Each environmental topic is addressed in the same format using a series of sub-headings as follows:

- Background: the environmental topic is placed in context for the Oldbury site
- Policy and Guidelines: outlines the relevant government policy or guidelines applied to noise, dust and visual amenity
- Potential Impacts: describes the identified potential dust, noise and visual environmental impact that might arise from the proposed sand mining
- Management Response: proposed management responses are detailed.

4.2 Vegetation Clearing

4.2.1 Background

Rocla proposes to extract sand from Lot 6 Banksia Road, and Lots 300 and 301 Boomerang Road. The total site is comprised of 32.32 ha with an extraction area of 15.2 ha. In order to facilitate sand extraction, 11.2 ha will require clearing. The resource will be extracted through a staged mining process. Following each stage, the area will be rehabilitated back to *Banksia* spp and *Eucalyptus marginata* woodland.

Both the RPS and GHD spring flora and vegetation surveys identified that the condition of the remnant vegetation across the proposed sand extraction area varies depending on disturbance and weeds. All three lots support portions of predominantly *Banksia* (*Banksia attenuata* and *Banksia menziesii* woodland) vegetation in Good condition surrounded by degraded vegetation due to weed invasion and land use disturbances.

As noted, the DEC – Native Vegetation Conservation Branch is responsible for determining the "purpose permit" clearing application for the proposed sand extraction area (which is in progress) and the proposed excavation cannot be undertaken prior to a "purpose permit" being granted. The DEC's assessment of the excavation area will include a review of the following:

- vegetation unit mapping

- confirmation of vegetation complexes present
- vegetation condition mapping
- identification and assessment of the potential impact on flora of conservation significance
- impacts of hydrology and the southern wetland.

4.2.2 Legislation, Policy and Guidelines

In 2007, the EPA provided advice on a previous sand extraction application for Lot 6 Banksia Road. The EPA advised (in accordance with the EPA Guidance Statement No 33) that restoration should focus on indigenous vegetation and particular emphasis should be placed on the rapid reinstatement of an ecological linkage along the western boundary of Lot 6 between the wetland (in the southern portion of the lots) and Lot 53 Banksia Road.

The EPA also recommended the establishment of visual screen planting in the northern portion of Lot 6 to prevent any loss in view shed amenity for surrounding neighbours.

Relevant legislation, policy and guidelines for vegetation and flora include:

- Guidance Statement for Rehabilitation of Terrestrial Ecosystems Final Guidance Statement No. 6 (EPA 2006)
- Level of Assessment for Proposals Affecting Natural Areas within the System 6 Region and Swan Coastal Plain Portion of the System 1 Region Final Guidance Statement No 10 (EPA 2006)
- Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia Final Guidance Statement No. 49 (EPA 2006)
- Serpentine–Jarrahdale Shire Local Biodiversity Strategy (Ironbark 2007)

4.2.3 Potential Impacts

The important factors associated with the clearing of native vegetation include:

- loss of biodiversity (species and species assemblage)
- sedimentation and increased turbidity of local wetlands
- soil erosion
- reduced habitat for native fauna
- spread of weeds
- impacts on lifestyle opportunities.

4.2.4 Management Response

Rocla has committed to the following measures to protect and restore key native vegetation and flora (in accordance with the 2007 EPA advice):

- staged clearing of the site, through the stage mining process to allow for fauna movement away from proposed mining operations and clearing
- maintaining a vegetated buffer through avoiding disturbance of native vegetation outside of the sand extraction area. The excavation areas will be clearly defined through site surveys and marked out on ground at each stage
- provision of a minimum 60 m buffer from the extraction zone to the on-site wetland areas in accordance with EPA Guidance Statement No. 33 (EPA 2005)
- provision of a minimum 60 m north–south ecological corridor link along the boundaries of Lot 6 and Lot 300 (Figure 11), linking the south-western wetland to Lot 53 Banksia Road (old rifle range north-west of the proposed site). The total size of the ecological corridor is 11.6 ha
- stockpiling of topsoil for use in regeneration of *Banksia* woodlands
- staged restoration of the site in collaboration with BGPA to utilise over eighteen years of research into *Banksia* woodland restoration
- provision of the site to be used in future *Banksia* woodlands restoration research trials by BGPA
- dieback prevention measures in accordance with DEC protocols
- weed control measures during and post-sand mining.

4.3 Fauna

The DEC and DSEWPC identified the following key fauna species which may be impacted as a result of clearing 11.6 ha:

4.3.1 Birds

- Carnaby's Black-Cockatoo (Rare and Endangered)
- red-tailed black cockatoo (Rare and Vulnerable)
- rainbow bee-eater (Migratory).

4.3.2 Mammals

- western brush wallaby (Priority 4)
- quenda (Priority 4).

4.3.2.1 Black Cockatoos

The proposed area contains suitable foraging habitat for Carnaby's and red-tailed black cockatoos. Rocla and Kings Park Botanic Gardens and Parks Authority intend to undertake staged Banksia woodland restoration in cleared areas. Clearing of Banksia woodlands will result in a temporary reduction in available foraging habitat for the Carnaby's and red-tailed black cockatoos, however, restoration of the site post-mining will result in a net increase Banksia woodland species density and increase future foraging habitat within the local area.

4.3.2.2 Rainbow Bee-eater

Rainbow bee-eaters are common throughout most of Australia and are highly migratory, wintering in the north of Australia, and offshore islands, including New Guinea. This species is not restricted for nesting habitat in the Perth region, as they will build nesting tunnels in sandy slopes in a variety of areas, including disturbed sites.

This species is more likely to utilise the vegetation associated with nearby wetland areas. This area is within the proposed 11.6 ha ecological corridor which is proposed to be protected via conservation covenant by Rocla.

4.3.2.3 Quenda

It is possible the quenda may utilise the Banksia woodlands in the proposed clearing application area however this species is more likely to utilise the riparian and wetland vegetation in the southern portion of the project area. Quenda's prefer dense scrubby, often swampy, vegetation with dense cover up to one metre high. Quendas will thrive in more open habitat subject to exotic predator control. On the Swan Coastal Plain, quendas are more often associated with wetland area. The Oldbury sand extraction site proposes to protect the preferred quenda habitat (if present) in the ecological corridor area.

The southern portion of the site which totals 11.6 ha will be reserved as an ecological corridor.

4.3.2.4 Western Brush Wallaby

The western brush wallaby, a medium sized macropod, is a grazer found primarily in open forest and woodland. While no western brush wallaby were observed in Lots 6, 300 and 301 it may potentially use or transition through the project area.

Western brush wallaby is not protected under legislation but is listed as a Priority 4 species by the DEC, which means it is a species in need of monitoring.

Clearing and restoration of Banksia woodland vegetation will occur on a staged basis. The aim of the restoration program is to have a net increase in Banksia woodland species density and increase future fauna habitat within the local area.

4.3.3 Legislation, Policy and Guidelines

Rocla's management response to potential impacts has been developed in consideration of the following relevant legislation, policy and guidelines concerning fauna and fauna management:

- protection of Specially Protected Fauna managed by the DEC under the *Wildlife Conservation Act 1950*
- potential impacts on species / communities listed as nationally threatened under the Commonwealth's EPBC Act 1999 are subject to the Commonwealth DSEWPC environmental assessment process.

4.3.4 Potential Impacts

The important factors associated with the clearing of native vegetation include

- reduced habitat for native fauna.

4.3.5 Management Response

Rocla have committed to the staged restoration (to *Banksia spp – Eucalyptus marginata* woodland) in collaboration with the BPGA of the site post-extraction works (Appendix 3).

This will include the restoration and re-establishment of a north-west ecological corridor linking the southern wetland area to Lot 53 Banksia Road (Section 5.3). The site will also be utilised for further research into regeneration of *Banksia* woodland by BGPA (Appendix 4).

Based on the proposal, Rocla will implement the following general measures to avoid or reduce impacts to species listed under the EPBC Act that may occur in the project area, including the black-cockatoos

- staged restoration of the site in collaboration with BGPA to utilise over eighteen years of research into Banksia woodland restoration

- provision of the site to be used in future *Banksia* Woodland restoration research trials by BGPA
- avoid damage to any habitat outside of the prescribed clearing area
- staged clearing of the site, through the stage mining process to allow for fauna movement away from proposed mining operations and clearing
- provision of a minimum 60 m buffer from the extraction zone to the on-site wetland areas in accordance with EPA Guidance Statement No. 33 (EPA 2005)
- provision of a 11.6 ha ecological corridor link along the boundaries of Lot 6 and Lot 300, linking the south-western wetland to Lot 53 Banksia Road (old rifle range north-west of the proposed site).

4.4 *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999* Referral

In May 2009 Rocla initiated discussions with the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) as part of a pre-referral consultation for the proposed sand extraction area. A formal referral in accordance with the *Environmental Protection and Biodiversity Act* (EPBC) *1999* was made on 24 August 2010. The proposal was determined to be a controlled action on 21 September 2010. The determination will be made on "preliminary documentation" and is pending.

4.5 Surface and Groundwater Protection

4.5.1 Background

RPS finalised a three-dimensional numerical groundwater model to estimate the potential increase in water levels due to clearing of vegetation at the proposed sand quarry within Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury. The specific purpose of the model is to investigate the impact of clearing vegetation upon the hydrogeology of the wetlands including increase in recharge and water logging.

The groundwater model predicts that staged clearing of the vegetation at the site will result in a groundwater increase of up to 0.25 m at the site, and up to 0.14 m at the REW and MUW located 60 m south of the excavation area.

Due to the high porosity of the sandy soils at the site, run-off from the excavation areas is not anticipated and infiltration will remain the predominant drainage process. As the base of the excavation will be 2 m above the maximum water table, no dewatering will be required.

Water infiltrating within the quarry will be by direct rainfall run-off and is not expected to contain any potential contaminants. Further, vehicle refuelling will be conducted at the vehicle compound by hand. The fuel tank will be self-bunded and be lined to prevent any contamination in the unlikely event of a spill (Section 4.6.2).

4.5.2 Legislation, Policy and Guidelines

The proposed measures to ensure surface and groundwater protection in the implementation of Rocla's activity have been developed in consideration of the following legislation, policy and guidelines:

- the *Environmental Protection Act 1986* as a legislative tool for achieving environmental resource protection and implementing the National Water Quality Management Strategy and State Water Quality Management Strategy in Western Australia

- water allocation decisions and regulations on the use of water by the DoW through the powers assigned to it under the *Rights in Water and Irrigation Act 1914*.

4.5.3 Potential Impacts

Potential impacts upon surface and groundwater as a result of sand mining include:

- removal of the native vegetation in the proposed sand mining area can potentially increase the amount of groundwater recharge in these areas, resulting in rising groundwater levels which in turn can cause waterlogging or increase discharge of groundwater into the REW and MUW

- the contamination of surface / groundwater resources from "point sources" such as fuel spills.

4.5.4 Proposed Management

As a precaution, the refuelling station will be located towards the northern end of the excavation area which constitutes a 200 m separation distance away from the wetlands in the south-western area of the site. Given the separation distances, and that the risk of contaminant generation is low, water quality impacts on the wetlands and are not anticipated.

While water quality impacts are not anticipated, in order to reduce the potential for water quality impacts to occur Rocla proposes that the following management measures be undertaken:

4.5.5 Surface Water

- delineate and maintaining a minimum 60 m buffer to the REW and MUW.

- minimum 80 m buffer from the DEC inferred Tumulus Springs wetland
- stage clearing of the site in accordance with Figure 11 therefore minimising the exposed areas at any one time (and reducing opportunities for erosion from surface water flow)
- commence restoration works at the completion of each mining stage in collaboration with BGPA
- maintain all plant equipment in good condition
- maintain all haul road and hardstand surfaces in good condition and with suitable grades.

Due to the nature of the soils at the site, run-off from the excavation areas is not anticipated rather, infiltration will remain the predominant drainage process.

4.5.6 Groundwater

Rocla will monitor groundwater levels at the southern edge of the site for the duration of the clearing program. Groundwater trigger levels have been determined (at 0.5 m above the model simulated groundwater increase of 0.21 m) and if exceeded for a period of more than two months consecutively, management strategies will be immediately implemented. The management strategies include:

- ensuring open drains in the immediate vicinity are not blocked and allow free transmission of water, by contacting Water Corporation as the regulatory agency responsible for drain performance
- accelerated planting of cleared stages where applicable
- planting of phreatophytes (deep-rooted plants) along the southern boundary of the site to increase water uptake
- groundwater abstraction bores can be installed along the southern boundary to decrease groundwater levels, if required. The water could be used in dust suppression or to accelerate plant growth in rehabilitated areas.

As the base of the excavation will be at a minimum 2 m above the FMWT, no dewatering will be required. The final finished levels / land surface will have a minimum separation distance of 2 m to the FMWT based on site monitoring results.

4.6 Accidental Spillage

4.6.1 Background

In the unlikely event of a spill occurring during refuelling of either vehicles or the screening plant, impacted soil will be immediately excavated to prevent any contamination of the underlying groundwater.

If any spillage of any material occurs within the excavation area or the haul routes the incident will be reported to the site manager for appropriate action. The site manager is responsible for immediately employing the necessary resources (labour, machinery and material) to clean the spill and recording and reporting of the incident (if applicable to the DEC and the Shire of Serpentine Jarrahdale).

4.6.2 Proposed Management

The above ground fuel storage tank will be self-bunded to prevent any accidental loss of diesel fuel to the environment. The refuelling area will be located towards the north-west end of Lot 6 excavation area which is over 200 m from the wetlands. Given these separation distances, and that the risk of contaminant generation is low, water quality impacts on the wetlands are not anticipated.

It should be noted that DoW's policy position of a 2 m vertical separation distance from the water table was substantiated upon simulated diesel spill scenarios which modelled a range of situations from large and extensive spills to smaller release over a longer period of time. In considering the results of the study, the DoW considered that the 2 m vertical separation distance of undisturbed sand profile is appropriate. This buffer minimises the risk of contamination of groundwater and allows time for remediation / mitigation measures to take place.

Rocla will strictly adhere to the FMWT separation buffer and undertake monthly groundwater monitoring and survey controls to ensure separation distances are controlled.

4.7 Separation Distances and Surrounding land Uses

4.7.1 Background

There are two land uses adjacent to the project site; residential and rural. Mining activities on the project site will need to ensure that these land uses are not impacted. This requires sufficient buffers to be provided between the surrounding land use and the mine site.

The determination of an appropriate buffer distance is a combination of separation distance and the protection measures to prevent impacts on adjoining land users. This applies primarily to noise, dust and visual impact, however, as outlined in this EIL report, Rocla will be proactively monitoring in particular for dust during the excavation phase. Site specific buffer determination will need to take into account the scale of operations, plant processes, storage of raw sand material, wind patterns, topography and protection measures to prevent impacts on adjoining land users.

The EPA Guidance Statement: Separation Distance between Industrial and Sensitive Land Uses (EPA 2005) states the generic buffer distance for sand and limestone pits as 300–500 m. A generic buffer relates to the distance at which it is unlikely to be any problems without further investigation and does not mean that smaller buffers are not acceptable. There are many examples within the Perth metropolitan region where extractive industries operate compatibly within 300 m of residential or industrial land uses. This outcome is in part due to the low key nature of the sand extraction works and also the on-site management of issues such as dust and noise.

The sand excavation proposal at the Oldbury site proposes no blasting or processing of the sand, other than separating organic matter from the sand on site. The sand is relatively soft and the proposed excavation area is largely surrounded by native vegetation on the eastern boundary and wetlands to the immediate south. Rocla has committed to maintaining a minimum 60 m vegetation buffer from the REW and MUW wetlands and a minimum 60 m buffer as part of an 11.6 ha ecological corridor along the boundary of Lot 6 (Figure 11).

The majority of the surrounding sensitive premises to the proposed extraction area are located in excess of 300 m away to the north-west and east which complies with the recommended setback presented in EPA Guidance Statement 3 (300–500 m for extractive industries, sand and limestone extraction) (EPA 2005).

The exceptions are the location of the following dwellings:

4.7.1.1 Within Approximately 300 m of the Proposed Excavation Area

- Lot 36 Banksia Road – the dwelling which is located approximately 110 m west from the excavation boundary within Lot 6
- Lot 30 Boomerang Road – the dwelling is located approximately 120 m north-east from the boundary of Lot 301
- Lot 1121 Boomerang Road – the dwelling is located approximately 280 m north-east from the boundary of Lot 301.

There is a surrounding dwelling in close proximity to the 300 m setback. The location of this dwelling is noted below:

4.7.1.2 Outside 300 m of the Proposed Excavation Area:

- Lot 33 Boomerang Road – the dwelling is located approximately 300 m to the east of from the boundary of Lot 300.

As the dwellings are either located within or close to 300 m of the proposed mine site, Rocla has committed to further environmental management actions to ensure that these surrounding land uses are not impacted.

4.7.2 Legislation, Policy and Guidelines

Rocla has considered a number of policies and guidelines regarding buffers, air quality, noise and visual amenity in connection with its proposed activity, including:

- WAPC – State Planning Policy 4.1: State Industrial Buffer Policy discusses the need to consider adjoining land uses when locating buffers and applies the buffers for sand extraction operations contained within EPA Guidance Statement 3
- EPA – Guidance Statement No. 3: Separation Distances between Industrial and sensitive land uses
- *Environmental Protection (Noise) Regulations 1997*
- EPA Guidance Statement No. 8: Environmental Noise (draft) (2007)
- EPA Guidance Statement No. 18: Prevention of Air Quality Impacts from Land Development Sites 2000
- National Environment Protection Measure (Ambient Air Quality) Measure (NEPM)
- Draft State Environmental (Ambient Air) Policy 2009 (which applies the NEPM)
- Occupational Safety Regulations 1996.

4.7.2.1 Potential Impacts

Potential impacts relating to separation distances include:

- human health and amenity
- natural environment
- social pursuits.

4.7.3 Proposed Management

The environmental impacts and general management measures pertaining to dust, noise and visual impacts are presented below. Appropriate and specific management for the immediate landowners located within Lots 36 Banksia Road and Lots 30, 1121 and 33 Boomerang Road is detailed in Section 5.0.

4.8 Dust Management

All proposed sand excavation works will be set back a minimum 20 m from the boundary of Lots 6, 300 and 301. Further, a 150 m buffer will be established from the dwelling located within Lot 36.

Dust levels throughout the sand extraction process will be compliant with NEPM under expected wind conditions. Sand extractions operations will cease in adverse wind conditions or exceedance of National Environmental Protection (Ambient Air Quality) Measure (NEPM) levels.

4.8.1 Background

Dust can be generated when the wind velocity and frequency is sufficiently strong enough to lift sand particles from the ground surface. The susceptibility of the soil particles to lift is a function of how exposed the ground surface is which includes whether there is any ground cover, level of compaction and the moisture content of the soil. Dust is measured as Total Suspended Particles (TSP) which refers to particles that can remain suspended in the atmosphere but not necessarily inhaled. The potential for dust generation may occur during topsoil stripping, sand extraction, stockpiling and sand transport.

4.8.2 Potential Impacts

Dust resulting from operations has the potential to affect:

- human health and amenity
- natural environment
- social pursuits.

The potential for dust generation may occur during topsoil stripping, sand extraction, stockpiling and sand transport. Dust can originate from a number of operations and may impact on the on-site workers or travel off site.

4.8.3 Policies and Guidelines

The proposed measures to control dust during the proposed excavation works has been undertaken in consideration the following applicable guidelines for air quality:

- National Environmental Protection (Ambient Air Quality) Measure (NEPM)
- EPA Guidance Statement 18 – Prevention of Air Quality Impacts From Land Development Sites (March 2000).

4.8.4 Proposed Management

There are a number of management actions that can be taken to minimise dust generation or travel and these will be used whenever possible.

4.8.4.1 Dust Monitoring

The TSP and the PM_{10} fractions are the important considerations when measuring dust levels. Rocla commits to a dust monitoring program as outlined below:

1. It is proposed that Rocla monitors dust using a peak monitoring station within the operational area at the commencement of Stage 1 and establish a neighbourhood monitoring station along the north-western boundary of the excavation area (closest to Lot 30). The monitors will measure levels of suspended particulates for the source and near the closest receptor (Lot 30) for an initial three month period to determine the actual nature of the dust impact (if any).

2. After the three month monitoring period Rocla will undertake an assessment of the dust information, compare the data to the NEPM criteria and determine if further monitoring requirements and dust management practices on site is required.

Further, contingency monitoring and management measures identified in the context of the proposed sand excavation area and surrounding dwellings are outlined in Section 5.

Additional key dust management measures are detailed below:

4.8.4.2 Dust from Traffic on Unsealed Roads

- Minimise the width and length of internal roads.
- Restrict vehicle movements to defined roads and operational areas.
- Avoiding disturbance of non-operational areas of the site.
- Use of water as appropriate to wet down roads and trafficked areas.
- Use of dust suppressants where appropriate (either mixed with water to enhance dust suppression and vegetation cover, or applied periodically to specific areas).
- Limit the speed of vehicles on the site.

- Maintain haul road surface in a good condition and with suitable grades.
- Ensure all sand transport vehicles leaving the site have covered loads.

4.8.4.3 Dust from Operational and Non-operational Areas of the Site

- Locate stockpiles as far away from the boundary of Lots 301 and 6 as possible.
- Dust control on stockpiles will be controlled using water sprays, drift fencing and daily inspections.
- Wind fencing along the boundary with Lot 23 to reduce wind flow from the excavation works. The windscreen will be constructed of shade cloth or hessian on an approximately 1.8 m high-fence.
- Use of water carts to dampen dust prone areas.
- Establish screening vegetation and/or ground cover on non-operational areas and finished sand extraction stages as soon as practicable.
- Apply surface treatments (e.g. mulch, ground cover) to stabilise any bare areas which might be prone to wind erosion.
- Minimise the area disturbed or open at any one time, as far as practicable.
- Define "no-go" buffer areas on the site to avoid any unnecessary disturbance of stabilised surfaces or vehicle traffic.
- Cease operational activities until conditions improve and compliance can be achieved.
- Push overburden dumps into positions where they can form screening barriers (i.e. bunds) and at specific locations screening trees will be planted.
- Use screening fencing along Lots 6, 300 and 301 boundary if required.

4.9 Noise Management

4.9.1 Background

Noise can originate from a number of operations and impact on external sensitive premises. Noise impacts are addressed by reducing the noise generated from the sand excavation and processing operations. The closest noise sensitive premises are the dwellings located approximately 110 m to the west of the excavation site.

Lloyd George acoustics were commissioned to assess and predict the likely noise impacts from the proposed sand mining and compare the results against the Environmental Protection (Noise) Regulations 1997 (Appendix 5).

The acoustic assessment was inclusive of the following key assumptions:

- The quarry plant will consist of a mobile screen and front-end loader.
- Trucks will arrive on site via Boomerang Road and will be loaded with sand.
- The quarry floor will be at an RL (finished ground level) of 18 mAHD and will start from the south-east corner of the site working towards the north-west corner. Three phases have been assessed. These being
  - Phase 1 – quarry face in south-east corner
  - Phase 2 – quarry face at middle of site
  - Phase 3 – quarry face at north-west of site (final).

4.9.2 Potential Impacts

Excessive exposure to noise can negatively impact upon people's health, amenity and the natural environment, in particular native fauna.

4.9.3 Legislation, Policies and Guidelines

Off-site noise is governed by the Environmental Protection (Noise) Regulations 1997, and the EPA Guidance for the Assessment of Environmental Factors provides guidelines on noise from developments and other activities. Rocla has had regard to these regulations and guidelines in considering noise management issues associated with its proposed activities at the Oldbury site.

4.9.4 Proposed Management

The key conclusions from the Lloyd George acoustic assessment include:

- During the initial phase of the operations (Phase 1), the operations are far enough away for the noise sensitive receivers to achieve compliance with the Regulations during the daytime period.
- The critical time is during the middle of the pit life (Stages 3 and 5). At this stage, assuming the quarry face runs straight across the site, the barrier effect from the quarry walls is insufficient to achieve compliance with the Regulations and an exceedance of up to 5 dB is likely during downwind conditions.
- As the quarry moves into the final phases (Stages 6 and 7), the walls of the quarry are high enough for the barrier effect to achieve compliance with the Regulations during the daytime period.

To comply with the Noise Regulations during the daytime period, a 5 dB reduction is required to the overall noise level in particular when the project reaches the middle Stages 3 and 5.

To achieve this, Rocla is committed to constructing a temporary east–west earth bund wall at an average of RL of 25 m at the top of the bund for the middle Stages 3 and 5. The profile of the wall will be enclosed on three sides congruent with the recommendations from Lloyd George acoustic assessment.

There are a number of further management actions that will be undertaken to minimise noise generation. The general management actions are summarised below.

- Comply with the Environmental Protection (Noise) Regulations 1997.
- Retain and establish vegetation between the mine site and the adjacent land holdings to provide a physical separation barrier between mine site activities and adjacent noise sensitive premises.
- Maintain a minimum 150 m separation barrier between the excavation area within Lot 6 and the dwelling within Lot 36, and excavation works in Lot 301 and the dwellings within Lot 30.
- Design the excavation to provide enhanced landform and constructed noise screening (i.e. bunds). This would include constructing an east–west earth bund wall along at an average of RL of 25 m for the middle stage 3 and 5.
- Maintain noise suppression devices in good condition on all operational machinery.
- Shut down equipment when not in use.
- Operate machinery within the designated hours of operation, 7.00 am to 5.00 pm, Monday to Saturday. Some operations may occur on a Sunday for major infrastructure project(s) if required by project demand.
- Schedule activities to minimise the likelihood of noise nuisance.
- Use the dedicated transport route.
- Record and follow up any complaints received regarding noise disturbance immediately to minimise the cause, to the greatest possible extent.

4.10 Site Finished Level and View Analysis

A site finished floor level and view analysis is provided in the Oldbury Development Approval application report (Roberts Day 2013).

4.10.1 Proposed Management

There are a number of management actions that can be done to minimise the visual impact of sand extraction. The following management actions, as summarised below, will be utilised across the site:

- Stage workings and progressive restoration to provide visual protection of later excavations.
- Minimise the amount of open ground at any one time.
- Wind fencing along the boundary of Lot 36 to reduce wind flow from the excavation works. The windscreen will be constructed of shade cloth or hessian on an approximately 1.8 m high-fence. This will also act as a visual screen to the sand excavation works.
- Plant screening trees at appropriate locations.
- Maintain a minimum 30 m vegetation buffer from Boomerang and Banksia Roads to the north and north-west of the excavation area.
- While not anticipated due to the existing natural topography and pit design Rocla will position overburden dumps so they form screening barriers if required.

Rocla will undertake of planting screening vegetation along the Lot 36 and Lot 6 boundary (buffer area) to improve the visual amenity and along the boundary of Lot 6 (and create an ecological corridor) prior to the commencement of any excavation works. However, in line with the staging plan the proposed sand extraction area closest to Lot 36 will be the last area mined. This approach will maximise the time for the vegetation to be established as a screen.

Intermittent views into the excavation area may be possible particularly from Lots 30 Boomerang Road (north of the excavation area) and Lot 36 Banksia Road immediately west of the site, as portions of these boundaries have no remnant vegetation. Rocla has committed to maintaining the existing vegetation within 20 m from the boundary and planting additional screening vegetation.

Final levels and view analysis maps post-staged mining works with Banksia woodlands restoration is illustrated in Figures 12 to 15.

4.11 Dieback and Weed Management

4.11.1 Background

The proposal creates a potential risk for the introduction or spread of weeds and / or dieback (*Phytophthora cinnamomi*).

4.11.1.1 Weeds

A weed survey was undertaken as part of the Level 1 vegetation and flora survey in spring 2008 (RPS 2008). Eighteen introduced flora (weeds) were recorded with the majority of introduced flora from the *Poaceae* (grass) and *Asteraceae* (daisy) families. *Ehrharta calycina* and *Avena barbata* was observed to be very high.

There were two weed species found within the study area that is listed as a Declared Plant for the whole of the state: *Zantedeschia aethiopica* (arum lilly) and *Argemone ochroleuca* (Mexican poppy).

4.11.1.2 Dieback

Dieback is a plant disease caused by the introduced soil-borne pathogen *Phytophthora*, which is a water mould spread by the movement of soil. There are several species of *Phytophthora* present in native vegetation but by far the most widespread and destructive is *Phytophthora cinnamomi* (CALM 2003).

Evidence of dieback (*Phytophthora cinnamomi*) was not witnessed during the Level 1 flora and vegetation survey or by BGPA site review of the *Banksia* Woodlands.

4.11.2 Legislation, Policy and Guidelines

Rocla has considered the following relevant legislation, policy and guidelines in considering the potential impacts of its proposed activities at the Oldbury site, and proposed management measures:

- *Agriculture and Related Resources Protection Act 1976* – declared weed control
- best practice guidelines for management of *Phytophthora* have been published by the Dieback Working Group.

4.11.3 Potential Impacts

Potential impacts as a result of sand mining include:

- spread of dieback due to sand mining activities which contributes to the reduction of flora and vegetation biodiversity and fauna habitats

- the spread and / or introduction of weeds during or post-sand mining which contributes to the loss of biodiversity.

4.11.4 Proposed Management

The proposed management of weeds and dieback *(Phytophthora cinnamomi)* is detailed below:

4.11.4.1 Prevention

Undertake a baseline weed status survey prior to excavation works.

Implement a weed control program which includes spraying during the spring flowering season and ongoing monitoring.

If required, intra-project hygiene boundaries will be established to prevent the spread of weeds and dieback within the project area. These boundaries will be clearly demarcated on site and equipped with clean down facilities.

Sand excavation equipment will be cleaned to remove soil, vegetation, rock and debris prior to arrival at site.

4.11.4.2 Mobilisation Hygiene Certificate

Internal approval for earth moving equipment to mobilise to site will be dependent on completion of hygiene requirements i.e. dieback-free.

Any equipment or vehicle considered to have been working in a weed or dieback risk area will be cleaned down before remobilising.

Key Rocla and site personnel (e.g. site manager) will be made aware of dieback issues, identification of weed species / reporting of infestations and hygiene procedures. These key personnel will be responsible for the implementation of the weed control program and dieback management.

4.11.4.3 Weed Control

A weed control program will be implemented for project areas where introduced species are present. Where required, infestations will be controlled by spot spraying or manual removal.

4.11.4.4 Monitoring

Weed infestation status inspections will be conducted by the Site Manager as part of regular site inspections.

A targeted weed survey will be conducted at the completion of each sand extraction stage area (prior to restoration works commencing) and repeated again within twelve months.

4.11.4.5 Contingencies

Any new weed populations that arise in the project area as a result of the construction works will be removed.

Incidents relating to a failure in hygiene processes will be reported investigated and rectified to prevent recurrence.

5.0 MANAGEMENT ACTIONS FOR SURROUNDING SENSITIVE PREMISES AND WETLANDS

The proposed sand extraction operation has the potential to affect immediate landowners located within Lots 36 Banksia Road and Lots 30 and 1121 Boomerang Road. Consequently, appropriate and specific management actions are required to ensure that the environmental risk associated with sand extraction works adjacent to noise and dust sensitive dwellings is undertaken to minimise potential detrimental impacts (Sections 5.1–5.5).

5.1 Maintaining Adequate Buffers to Sensitive Premises

The sensitivity of the area in which the proposed sand excavation area is situated requires consideration. Based upon the nature of fine particulates that will be produced as a result of the excavation, along with generation of dust during vehicle movements, it is plausible that it may impact on the surrounding dwellings (in particular Lot 36 Banksia Road and Lot 30 Boomerang Road) during periods of strong winds.

5.1.1 Lot 30, 1121 and 33 Boomerang Road

Initially a 50 m buffer will be maintained from the sand excavation area in the northern portion of Lots 6, 300 and Lot 301. This also incorporates the Shire of Serpentine Jarrahdale's provisions of a minimum 20 m mining buffer from the boundary of the proposed mining lot. This would facilitate the planting and establishment of screening vegetation and maintain a buffer of approximately 150–280 m from the existing dwellings in Lots 30, 1121 and 33.

A three month dust monitoring program incorporating dust readings from the operational source (peak monitoring station) and nearest to Lot 30 (i.e. along the north-western boundary of Lot 301) will be carried out at the commencement of Stage 1. These monitoring stations will monitor potential dust travelling north to Lot 30 and 1121 Boomerang Road.

It is noted that Lot 33 has significant existing vegetation extending westward (approximately 200 m) from the dwellings to the boundary of Lot 301.

5.1.2 Lot 36 Banksia Road

A minimum 150 m buffer will be delineated as a "no go area" and maintained throughout the sand excavation works from the dwelling located within Lot 36.

If the findings of the Stage 1 three month dust monitoring program demonstrate that dust emanating from the operational area is an issue, Rocla will, at the commencement of Stage 3 excavation works, position a peak air quality monitoring station within the

operational area and a neighbourhood monitoring station located at the north-western boundary of the excavation area. The monitoring stations will measure levels of suspended particulates for a three month period to determine the actual nature of the dust impact (if any), based on changes made post sand extraction (from Stages 1 and 2) and monitoring outcomes from these Stages through measuring dust levels upon the receptor within Lot 36 Banksia Road.

Wind fencing on the boundary of Lot 36 will be undertaken to reduce wind flow from the excavation works. The wind fence will also act as a visual screen to the sand excavation works.

5.2 Dust Emissions Monitoring

At the commencement of Stage 1, (as described in Section 4.7) monitoring of air quality at the operational source (peak monitoring station) and along the western boundary closest to Lot 30 Boomerang Road (neighbourhood monitoring station) will commence. Air quality monitoring will be undertaken for an initial three month period to provide an indication of the levels of airborne particulate matter from the operational area and nearest to sensitive receptors.

Table 8 summarises the air quality assessment criteria. The air quality criteria relates to the total dust concentration in the air (in recognition of the surrounding land uses i.e. market gardens) and not just the dust generated from the proposed sand extraction area. In other words consideration of background levels needs to be made when using these criteria to assess impacts.

Table 8: Air Quality Assessment Criteria

Pollutant	Criteria	Averaging Period
Total suspended particulate (TSP)	90 µg/m^3	Annual mean
Fine particulate matter (PM_{10})	50 µg/m^3	24 hour maximum
	30 µg/m^3	Annual mean

5.2.1 Dust Suppression

When required a water cart or other similar alternatives (i.e. sprinklers, dust suppressants) will be utilised for the wetting down of operational areas to prevent the generation of dust as much as possible.

During dry periods, operational areas and if appropriate sand stockpiles, will be wet down during excavation activities to minimise the migration of dust from the base of the pit. The routine wetting of the operational area will mitigate potential dust generation from the site.

5.2.2 Ceasing Operational Activities

During the sand extraction operations the generation of dust will be monitored to determine whether operation conditions are within acceptable limits.

The NEPM value is a 24 hour average where instantaneous levels can be considerably higher than the limit. Should the 24 hour maximum PM_{10} average be exceeded then the contingency actions as detailed in Section 5.2.3 will be implemented.

5.2.3 Contingency Response

Should air quality monitoring show that dust emissions exceed the air quality criteria, dust management practices will be immediately reviewed and corrective action taken to improve air quality.

The corrective action taken will typically comprise the following sequence of actions:

- Check all trucks are appropriately covered and that earthmoving machinery is operating in wetted down areas.
- Increase the water application rates over all exposed excavation areas and internal roads.
- Reduce the level of earthmoving activity if evaporation rates are drying the fill quicker than watering can be applied.
- Apply a suitable physical dust suppressant to any inactive areas.
- Cease all work if extreme weather conditions are the prime reason for excessive dust levels and dust suppression techniques have been ineffective in controlling the dust.

5.3 Re-vegetation

5.3.1 Plant Screening Barriers with Trees

In addition to the wind fence Rocla will commit to the planting of trees and / or screening barriers (i.e. bund) along the buffer boundary between Lot 6 and Lot 36 prior to the commencement of excavation works. The planting of trees will help reduce the migration of dust emanating from the staged excavation areas and improve the visual amenity.

It is noted that Lot 33 has significant existing vegetation extending westward from the dwellings to the boundary of Lot 301.

5.3.2 Restoration Works

Rocla is committed to the re-vegetation, at the completion of each stage, of the site back to the pre-excavation indigenous *Banksia spp – Eucalyptus marginata* woodlands.

Rocla formed a partnership with the BGPA in 1995, with the aim of researching the restoration of *Banksia* woodlands to ensure their long-term conservation and restoration.

As a result of this partnership, Rocla has achieved one of the highest levels of species and plant reinstatements (in particular for *Banksia* communities) per unit area of post-mined restoration in the resource sector.

Restoration plans are currently being drafted for the Oldbury site in conjunction with the BGPA with the following research / management strategies to be undertaken as part of the re-vegetation of the Oldbury site:

- An inventory of the topsoil seed bank will be conducted to determine the topsoil's potential as a source of native plant replacement.
- Determine strategies for managing weed emergence.
- Investigate the potential of dry storing the topsoil seed bank as a means of seed conservation.
- Investigate the potential to connect the upper-lying *Banksia* woodland with the lower lying wetland community.

5.3.3 Restoration Success

The restored area will be monitored by a botanist to allow early detection of locations requiring additional attention. Yearly monitoring reports will be developed to assess the success of the restoration program by a botanist as part of the research being undertaken.

Typically three quadrats will be established within the restored area which will be monitored by a qualified botanist during spring. Monitoring will include assessment of:

- species present
- percentages of vegetation cover both native species and weeds
- plant survival rates.

Quadrat sizes will be 10 m × 10 m plots for floristic assessment (native and weed species presence) and 2 m × 2 m plots for native species and weed cover percentage.

General inspections of the restored area will also be made at the same time as monitoring quadrat sampling is undertaken to identify signs of vegetation and landform disturbance and vegetation deaths. Should any of these occurrences be detected additional restoration work would be undertaken in these areas to rectify the situation.

5.4 Communication Procedures

Rocla will inform the residences of Lot 36 and Lot 30 regarding the sand excavation proposal and provide the contact details of the site manager who would act as the primary point of contact in regards to any concerns about dust or noise.

5.4.1 Reporting

Rocla will meet with Shire Serpentine Jarrahdale after the three month dust monitoring period and present a summary of the results and proposed amendments where appropriate to dust and/or noise management.

This page is intentionally blank.

6.0 NATIVE VEGETATION RESTORATION AND DECOMMISSIONING

Rocla have committed to, subject to the land use zoning remaining "Rural" under the MRS and Shire of Serpentine Jarrahdale TPS, the staged restoration (to *Banksia* spp and *Eucalyptus marginata* woodland) in collaboration with the BGPA to maximise the regeneration of natural bushland. This will include the rehabilitation and re-establishment of a north-west ecological corridor linking the southern wetland area to Lot 53 Banksia Road (Figure 11).

6.1 Decommissioning

Upon final completion of the sand extraction all site facilities and equipment will be removed from the site.

Removal of the fuel tank will adhere to all safety practices to minimise the risk of contamination or spills. Remaining fuel will be emptied prior to moving.

Access track removal will be dependent on their usefulness for future uses of the site. Some areas may require retention of access tracks while other areas may require removal.

6.2 Restoration

Native vegetation restoration will commence with the establishment of topographic contours. The final contours are anticipated to be visually compatible with other parts of the local landscape. A commitment will be made to ensure that the final slopes are similar to those in the local area and that the excavation will be left in a safe manner in conformity with the *Mines Safety and Inspection Act 1994*.

The main objective for the restoration of the site is to restore native *Banksia* woodland to the site. The methodology adopted for the restoration is based on eighteen years of experience at other Rocla sand extraction sites and restoration (as well as research conducted into the ecology) of native *Banksia* woodland areas. The restoration completion criteria are as follows:

- a landform compatible with the surrounding contours
- a self-sustaining cover of native vegetation
- weed species at levels not likely to threaten the native species.

In 1995 Rocla approached the BGPA with the aim of returning post-sand extraction mine sites back into former *Banksia* woodland. Rocla sought the assistance of the Science Directorate at BGPA to undertake research into the ecology and restoration of

Banksia woodland and have now subsequently built a long-term scientific relationship. This research resulted in Rocla and BGPA being awarded the Golden Gecko environmental award by the Department of Mines and Petroleum in 2008, the most prestigious environmental award in the state.

As a result of this partnership Rocla has successfully restored over eight former sand extraction sites back to *Banksia* woodland on the Swan Coastal Plain.

The objectives of the Oldbury site restoration program are to:

- undertake progressive native vegetation restoration to minimise the open excavation area at any one time
- stabilise the surface sands against erosion
- establish a southern and north-west ecological corridor.

The proposed restoration program will consist of application of topsoil and overburden to a depth of approximately 10 cm to the restoration areas and seeding with native species. Topsoil is proposed to be directly transferred from the cleared areas to the restoration sites with clearing and restoration preparation occurring simultaneously on an annual basis, after the first year. Topsoil will also be managed and protected to maximise regeneration.

The EPA (2007) in its consideration of the use of Lot 6 Banksia Road for sand extraction stated that native vegetation restoration should focus on indigenous vegetation and particular emphasis should be placed on the rapid re-establishment of an ecological linkage along the southern and western boundary of the lot between the wetland and Lot 53 Banksia Road.

The proposed restoration plan is consistent with the previous EPA assessment and advice.

Clearing and commencement of restoration is proposed to occur in autumn each year. It is anticipated that approximately 3 to 5 ha will be mined per year, therefore restoration is proposed to commence in Year Two and continue at a rate of approximately 3 ha per year until excavation is complete and the quarry fully rehabilitated.

Brushing with larger logs (remaining following regrowth clearing) will occur on the perimeter of restoration sites to decrease the potential for erosion and vehicle movement.

6.2.1 Restoration Stages

The stages involved in the site restoration program are summarised as follows:

- Clearing and commencement of native vegetation restoration is proposed to occur in autumn each year.

- Establishing a north-west ecological corridor (Figure 11) along the boundary of Lot 6 is a priority restoration task. Rocla has commenced the establishment of the north-west ecological corridor with the planting of *Eucalyptus marginata* in July 2009.

- The proposed restoration program will consist of application of topsoil to a depth of approximately ten centimetres to the restoration areas and seeding. Where possible, topsoil and overburden will be directly transferred from an area being cleared to an area to be restored. Where this is not possible, the topsoil and overburden will be stored in low piles for future use in restoration works.

- The levelled topsoil will be cross-ripped to a depth of 50 to 80 cm with wing-shaped tynes. This is intended to eliminate the compaction created in the soil profile during the excavation process.

- A supplementary seed mix containing species which do not regenerate readily from the replaced topsoil will be distributed over the restoration area by hand.

- Slopes are shaped and battered with retained topsoil. These will then be spread with vegetative debris, which acts as a barrier to wind erosion and maximises microhabitats.

- Assessment of the success of the native vegetation restoration works will be undertaken annually with additional supplementary seeding, planting or re-broadcasting of seed applied in the subsequent winter if considered necessary by the BGPA and Rocla.

- Brushing with larger logs (remaining following regrowth clearing) will occur on the perimeter of restoration sites to decrease the potential for erosion and vehicle movement.

Rocla will undertake, manage and fund the native vegetation restoration program until the completion criteria outlined below are met. Table 9 presents a provisional schedule of all programmed monitoring activities.

Table 9: Monitoring Schedule

Issue	Parameter	Frequency	Time Frame	Responsibility
Restoration Program	Finalise topography levels	Once	Prior to site works	Rocla
	Finalise native species list for re-vegetation	Once	Prior to the commencement of restoration works	Rocla (in collaboration with BGPA)
	Undertake topsoil replacement	Once a year for life of mine	Every year for the duration of mining	Rocla
	Undertake supplementary seed planting	Once a year (if required)	Post-application of topsoil	BGPA
	Undertake planting (if required)	Once a year	Post-application of topsoil	BGPA
	Weed Control Weeds sprayed with an appropriate herbicide or weeded by hand in accordance with the DoW's Herbicide use in Wetlands (WRC 2001)	As required	Two years from initial planting	Rocla and: BGPA
	Establish two quadrats plots	Once	When first year of restoration has been completed	Rocla
	Survey quadrats	Annually (spring)	Five years	Rocla
	Assess the success of the re-establishment of vegetation planted	Annually	Five years	Rocla

7.0 CONCLUSIONS

The site is located at Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury and extends over a total area of 32.32 ha. Sand is proposed to be extracted from 15.2 ha of the site. The operations will include simple excavation, temporary stockpiling and loading onto transport trucks.

The environmental management actions are outlined in Table 10.

Table 10: Management Actions

Environmental Factor	Management Action
Buffer	Trees and vegetation will be planted to provide a buffer and screening along the north and western border of the site.
Topsoil	Topsoil removal will be conducted in stages and stored for restoration purposes.
Vegetation Clearing	Restoration and re-establishment of a north-west ecological corridor.
	Staged restoration of entire site to *Banksia* woodland using practices developed in conjunction with BGPA. Additional research into *Banksia* regeneration is to be conducted on the site
Water Quality	Refuelling tank will be self-bunded in case of accidental spillage.
	Delineate and maintain adequate buffers to the Resource Enhancement and Multiple Use category wetland.
	Maintain the final land surface with a separation distance of 2 m to the FMWT.
	Maintain all plant equipment in good condition to prevent spills.
Groundwater levels	Accelerated plantings of phreatophytes (deep rooted plants)
	Monthly monitoring of groundwater levels, throughout the mining operation.
Spillage	Fuel storage tank will be located within earth bund walls.
	Maintain 2 m vertical separation distance from the water table at all times
Surrounding land uses	Buffer of approximately 200 m between sand quarry operations and surrounding land use.
	Maintaining a minimum 50 m vegetation buffer from the RE and MU wetlands
	Priority planting screening vegetation
Dust	Monitor dust within the operations area and at the north-western boundary.
	Minimise the width and length of internal roads and restrict vehicle movements to defined roads and operational areas.
	Avoid disturbance of non-operational areas of the site.
	Use of water carts to dampen dust prone areas.
	Limiting the speed of vehicles on the site.
	All vehicles leaving the site are required to have covered loads.
	Application of surface treatments (e.g. mulch, ground cover) to stabilise any bare areas which might be prone to wind erosion.
	Maintain haul road surface in a good condition and with suitable grades.

Environmental Factor	Management Action
	Define “no-go” buffer areas of the site to avoid any unnecessary disturbance of stabilised surfaces or vehicle traffic.
Noise	Retain and establish vegetation between the mine site and the adjacent land uses to act as a buffer.
	Noise suppression devices will be maintained in good condition on all operational machinery.
	Shut down equipment when not in use.
	Machinery will only operate within the designated hours of operation, 7.00 am to 5.00 pm, Monday to Saturday. Some operations may occur on a Sunday for major infrastructure project(s) if required by project demand.
	Use the dedicated transport route to avoid unnecessary noise disturbance.
Visual Impacts	Establish a minimum 30 m vegetation buffer from Boomerang and Banksia Roads to the north and north-west of the excavation area.

8.0 REFERENCES

Archer, R.H., Biggs, E.R. and Rexilius, J.P. 1975. *Mooore River – Cape Leschnault Urban Geology. 1935 II – 2035 III*. Western Australian Urban Geology Series. Perth, Western Australia.

Department of Environment and Conservation. 1980. Perth Groundwater *Atlas*, Perth, Western Australia.

Department of Environment and Conservation. 2003–2004. *Acid Sulfate Soils Guideline Series.* Department of Environment. Perth, Western Australia.

Department of Environment and Conservation. 2008. Department of Environment and Conservation. Contaminated Sites Database. Perth, Western Australia.

Department of Minerals and Energy. 2000. Geological Survey of Western Australia. Perth, Western Australia.

Department of Water. 2009. *Perth Groundwater Atlas.* Department of Water, Perth.

Environmental Protection Authority. 1993. *Red Book Status Report 1993. Conservation Reserves for Western Australia.* Environmental Protection Authority. Perth, Western Australia.

Environmental Protection Authority. 2005. *Guidance on the Assessment of Environmental Factors – Separation Distances between Industrial and Sensitive Land Uses. Guidance Statement 3*. Environmental Protection Authority. Perth, Western Australia.

Environmental Protection Authority. 2006. *Guidance on the Assessment of Environmental Factors – Level of Assessment for Proposals affecting Natural Areas within the System 6 Region and Swan Coastal Plain portion of the System 1 Region. Guidance Statement No 10*. Environmental Protection Authority. Perth, Western Australia.

Environmental Protection Authority. 2007. *Guidance on the Assessment of Environmental Factors – Environmental Guidance for Planning and Development. Guidance Statement No 33*. Environmental Protection Authority. Perth, Western Australia.

Geological Survey of WA. 1978. *Geological Survey of WA: Pinjarra.* Geological Survey of WA, Perth.

Heddle, E.M., Loneragan, O.W. and Havell, J.J. 1980. *Vegetation Complexes of the Darling System Western Australia. In Atlas of Natural Resources Darling System Western Australia.* Department of Conservation and Environment. Perth, Western Australia.

Water and Rivers Commission. 2000. Water Quality Protection Note, *Extractive Industries within Public Drinking Water Source Areas*. Perth, Western Australia.

Water and Rivers Commission. 2001. Position Statement: *Wetlands*. Perth, Western Australia.

Western Australian Planning Commission. 2000. *Bush Forever.* Perth, Western Australia.

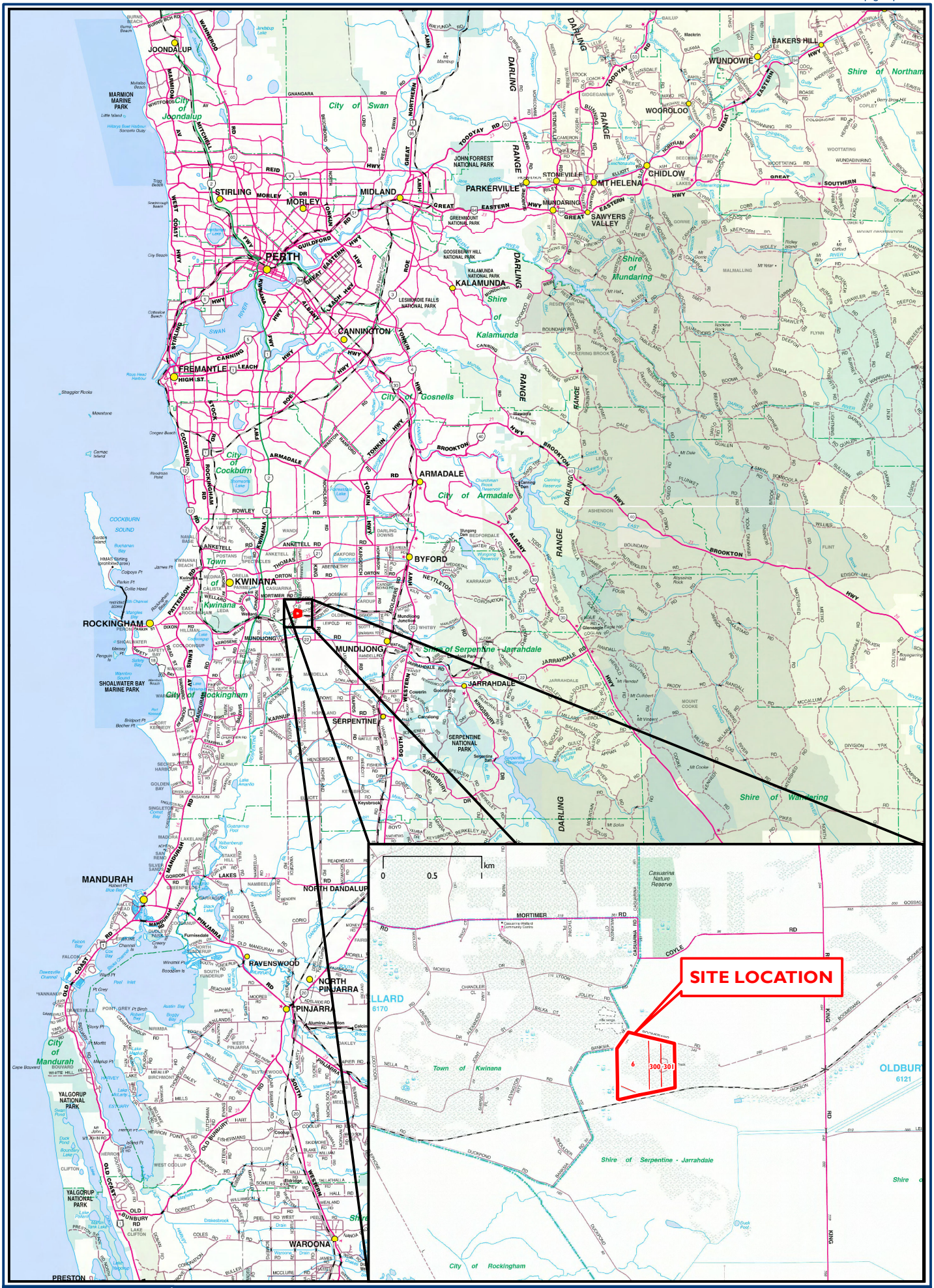
Western Australian Planning Commission. 2000. *State Planning Policy No. 2.4 Basic Raw Materials*. Perth, Western Australia.

Western Australian Planning Commission. 2002. *State Planning Policy 2.5 – Agricultural and Rural Land Use Planning*. Perth, Western Australia.

Western Australian Planning Commission. 2003. Planning Bulletin No. 64, *Acid Sulfate Soils*. Perth, Western Australia.

FIGURES

290 Churchhill Ave Subiaco | T +61 8 93824744 | F +61 8 93821177 | www.rpsgroup.com.au



RPS

Job Number: L07396 Extractive Industry Licence
Date: 08.07.13
Revision: A
Scale: 1:500000 @ A4
Drafted by: SC
Source: Landgate, 2008

Figure 1

Lots 6, 300 and 301 Oldbury - Site Location

290 Churchhill Ave Subiaco | T +61 8 93824744 | F +61 8 93821177 | www.rpsgroup.com.au

LEGEND
- Site Boundary
- Proposed Sand Extraction Area
- Cadastre
- Drain Reserve

Lot 53
Lot 28
Lot 29
Lot 30
Lot 1121
Lot 31
BOOMERANG RD
NAME UNIDENTIFIED
Lot 6
Lot 300
Lot 301
Lot 33
Lot 32
Lot 36
BRADDOCK RD
Lot 6
Lot 1
RAILWAY
Lot 7
Lot 7
GARRICK RD
Lot 2
Lot 38
Lot 39

RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 002
Date: 08.07.13
Scale: 1:5000 @ A3
Drafted by: MA
Source: Aerial photograph - Landgate, 2012.

0 25 50 100 150 200 metres

Figure 2

Site Location - Local

290 Churchhill Ave Subiaco | T +61 8 93824744 | F +61 8 93821177 | www.rpsgroup.com.au

RPS

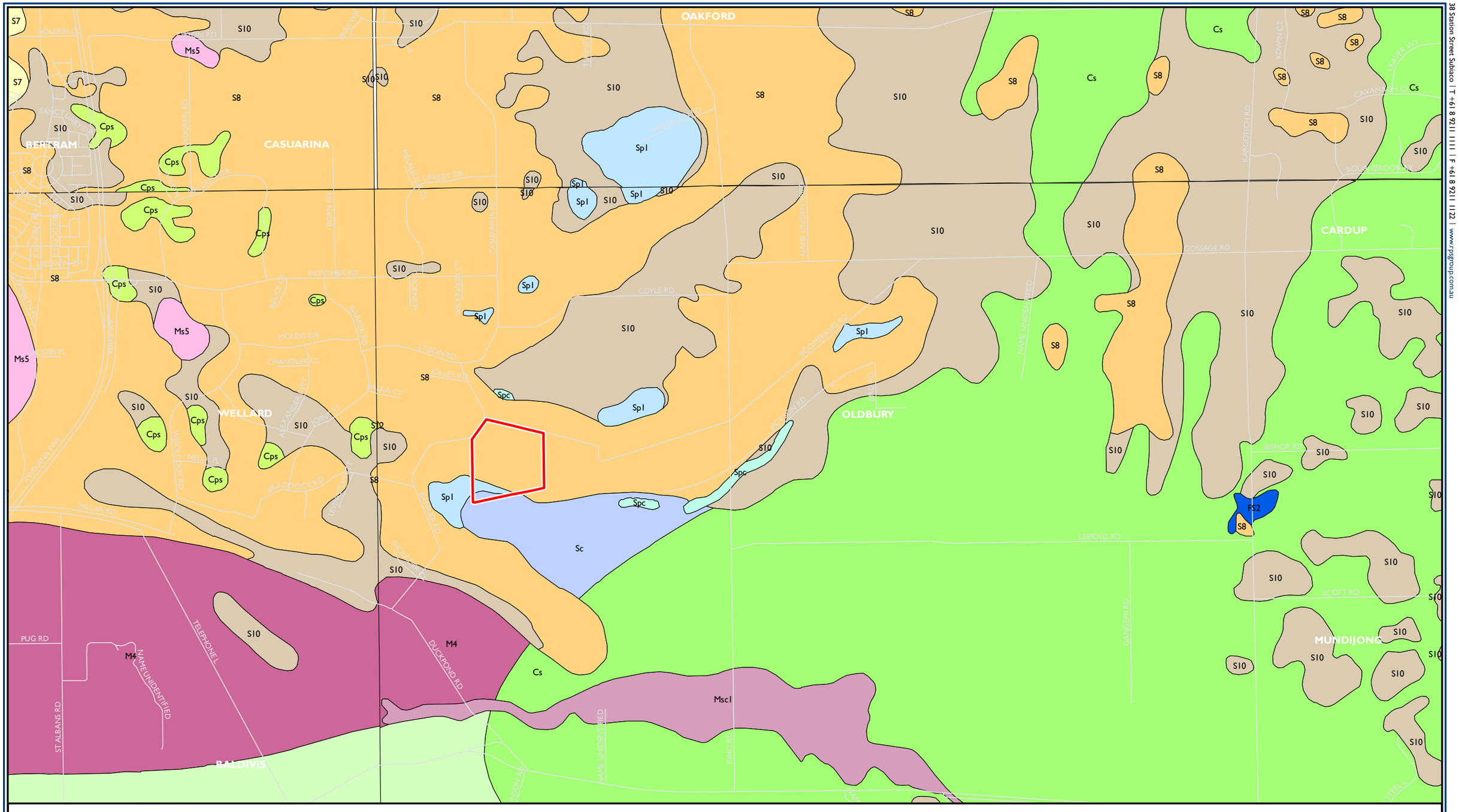
Job Number: L07396 Extractive Industry Licence
Doc Number: 003
Date: 08.07.13
Scale: 1:3000 @ A3
Drafted by: MA
Source: Aerial photograph - Landgate, 2012. Topography - Ion Services (licenced surveyors)

0 25 50 100 150 200 metres

Figure 3

Topography

38 Station Street Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au



LEGEND

Site Boundary

Surficial Geology

- C2 - CLAY - strong brown and dark grey clay, plastic in places, soft when wet, variable silt content in mastrix, of alluvial origin
- Cps - PEATY CLAY - dark grey and black, soft, variable organic content, some quartz sand in places, of lacustrine origin
- Cs - SANDY CLAY - white-grey to brown, fine to coarse-grained, subangular to rounded sand, clay of moderate plasticity gravel and silt layers near scarp
- FS2 - IRONSTONE - red-brown, grading from coffee rock through sandy, vuggy and pisolitic to massive, of alluvial origin
- M4 - SILT - very pale brown silt, soft when moist, firm when dry, low clay content, of alluvial origin
- Ms5 - SANDY SILT - dark brownish grey silt, with disseminated fine-grained quartz sand, firm, variable clay content, of lacustrine origin
- Msc1 - CLAYEY SANDY SILT - pale brown, sand angular to rounded, low cohesion, of alluvial origin
- S7 - SAND - pale yellowish brown, medium to coarse-grained sub-angular quartz, trace of feldspar, moderately sorted, of residual origin
- S8 - SAND - white to pale grey at surface, yellow at depth; fine to medium-grained, moderately sorted sub-angular to sub-rounded minor heavy minerals, of eolian origin
- S10 - SAND - as S8 over sandy clay to clayey sand of the Guildford Formation, of eolian origin
- S12 - SAND - structureless yellow, fine sub-angular and medium to coarse sub-rounded to rounded quartz, feldspar and heavy minerals common, minor silt and clay, of colluvial origin
- Sc - CLAYEY SAND - silty in part, pale grey-brown, medium to coarse, poorly sorted, sub-angular to rounded, frequent heavy minerals, rare feldspar, of alluvial origin
- Sp1 - PEATY SAND - grey to black, fine to medium-grained moderately sorted quartz sand, slightly peaty, of lacustrine origin
- Spc - CLAYEY PEATY SAND - grey to black, quartz sand with variable organic content; minor clays, of lacustrine origin

RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 004
Date: 08.07.13
Scale: 1:30000 @ A3
Drafted by: SC
Source: Environmental Geology - DoIR, 1999.

0 125 250 500 750 1,000 metres

Figure 4

Geology

290 Churchhill Ave Subiaco | T +61 8 93824744 | F +61 8 93821177 | www.rpsgroup.com.au

LEGEND

- Proposed Sand Extraction Area
- Site Boundary
- Cadastre
- Drain reserve

ASS RISK MAPPING

- High to moderate risk of ASS occuring within 3m of natural soil surface
- Moderate to low risk of ASS occuring within 3m of natural soil surface

Lot 28 · Lot 29 · Lot 30 · Lot 1121 · Lot 53 · Lot 6 · Lot 300 · Lot 301 · Lot 33 · Lot 36 · Lot 1 · Lot 7

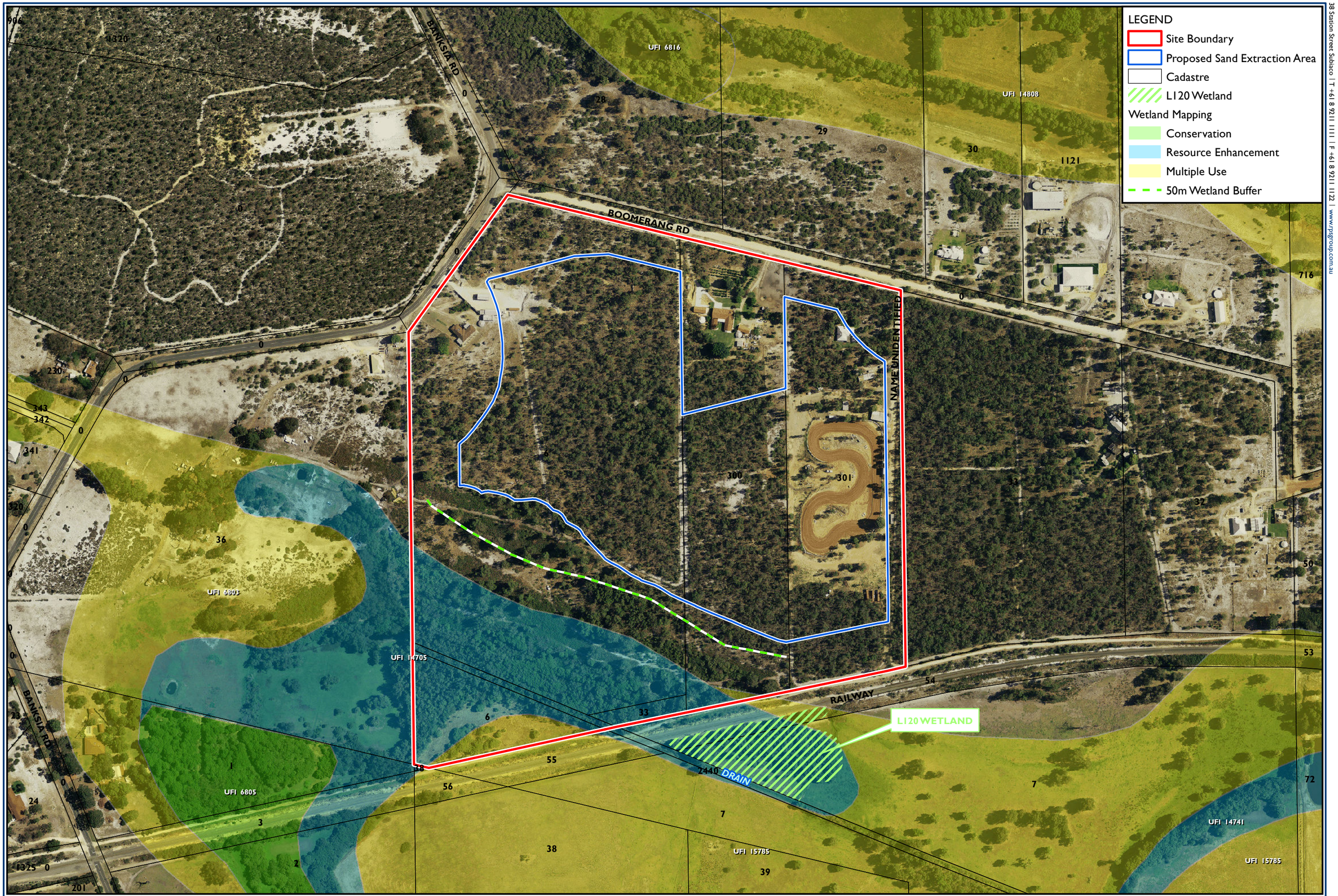
BOOMERANG RD · BANKSIA RD · NAME UNIDENTIFIED · RAILWAY

Job Number: L07396 Extractive Industry Licence
Doc Number: 005
Date: 08.07.13
Scale: 1:3000 @ A3
Drafted by: MA
Source: ASS Risk Mapping - DEC, 31st July 2008. Aerial photograph - Landgate, 2003.

0 25 50 100 150 200 metres

Figure 5

Acid Sulfate Soils



RPS

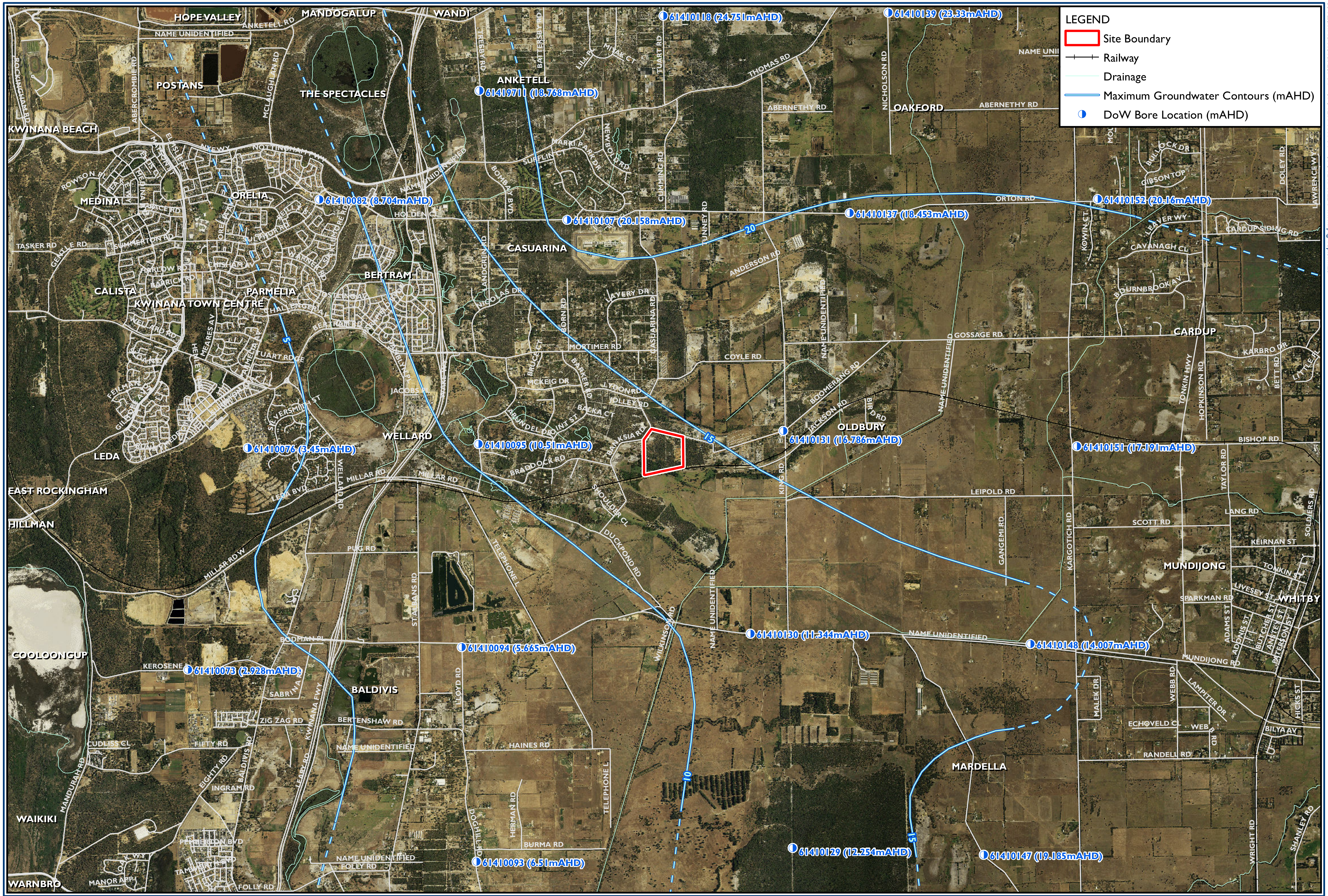
Job Number: L07396 Extractive Industry Licence
Doc Number: 006
Date: 08.07.13
Scale: 1:4000 @ A3
Drafted by: MA
Source: Orthophoto - Landgate, 2012 Wetland Mapping - DEC, 18.10.12

0 25 50 100 150 200 metres

Figure 6

Wetland Locations

38 Station Street Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au



RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 007
Date: 08.07.13
Scale: 1:50000 @ A3
Created by: SC
Source: Orthophoto - Landgate, 2012 Topo - Geoscience Australia Bores - DoW, 2013

0 0.375 0.75 1.5 2.25 3 km

Figure 7

Maximum Groundwater Contours

38 Station Street Subiaco | T +61 8 9211 1111 | F +61 8 9211 1122 | www.rpsgroup.com.au

290 Churchhill Ave Subiaco | T +61 8 93824744 | F +61 8 93821177 | www.rpsgroup.com.au

LEGEND
- Cadastre
- Site Boundary
- Drain Reserve

BaBm

EmAf

AfBaBm

LOT 6

LOT 300

LOT 301

Vegetation Units

BaBm - Scattered *Allocasuarina fraseriana* over Low Woodland of *Banksia attenuata* and *Banksia menziesii* over Tall Open Shrubland *Jacksonia furcellata* over an Open Shrubland of *Macrozamia fraseri* over a Sedgeland of *Lyginia barbata* and *Desmocladus flexuosus* with an Open Herbland of *Burchardia congesta* and *Dasypogon bromeliifolius.*

AfBaBm - Low Woodland of *Allocasuarina fraseriana, Banksia attenuata* and *Banksia menziesii* over Tall Open Shrubland of *Kunzea glabrescens* over Low Shrubland of *Hibbertia hypericoides, Macrozamia fraseri* and *Xanthorrhoea preissii* over Herbland of *Burchardia congesta* over Very Open Sedgeland of *Mesomelaena pseudostygia* and *Desmocladus flexuosus.*

EmAf - Open Woodland of *Eucalyptus marginata* and *Allocasuarina fraseriana* over Low Open Woodland of *Banksia ilicifolia* over Tall Open Shrubland of *Kunzea glabrescens* over Low Shrubland of *Pteridium esculentum* and weeds.

RPS

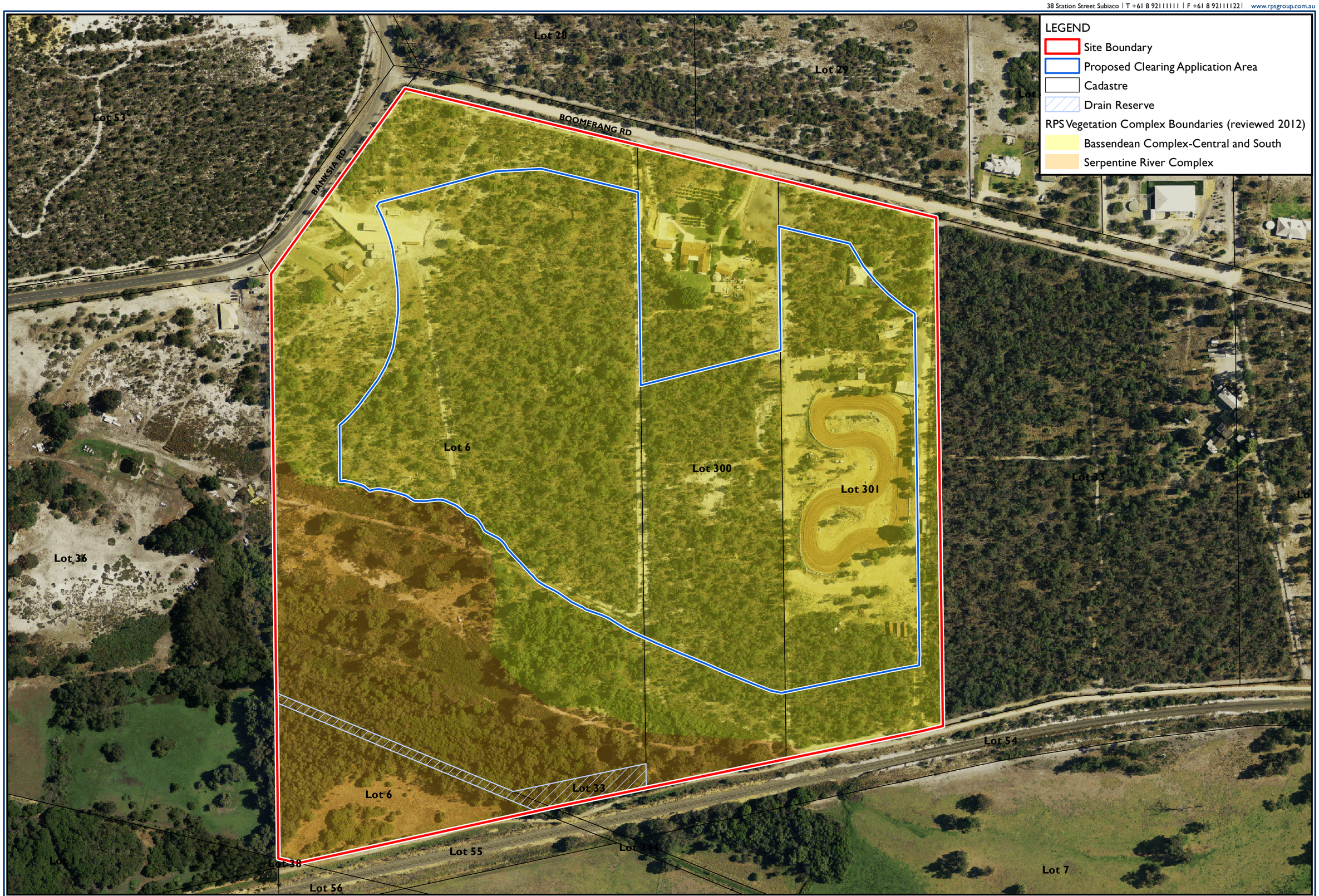
Job Number: L07396 Extractive Industry Licence
Doc Number: 008
Date: 08.07.13
Scale: 1:2500 @ A3
Drafted by: MA
Source: Aerial photograph, Cadastre - Landgate, 2012.

0 10 20 40 60 80 metres

Figure 8

Vegetation Units

38 Station Street Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au



RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 009
Date: 09.07.13
Scale: 1:3000 @ A3
Drafted by: MA
Source: Orthophoto and Cadastre - Landgate, 2012

0 12.5 25 50 75 100 metres

Figure 9

Vegetation Complex (Heddle) Mapping

290 Churchhill Ave Subiaco | T +61 8 93824744 | F +61 8 93821177 | www.rpsgroup.com.au

LEGEND

- Project Area
- Proposed Sand Extraction Area
- Cadastre

Vegetation Condition

- Very Good
- Good
- Good to Degraded
- Degraded
- Degraded to Completely Degraded
- Completely Degraded
- Not Assessed

BOOMERANG RD

BANKSIA RD

CD
G-D
D-CD
VG
G
D
NA

RPS

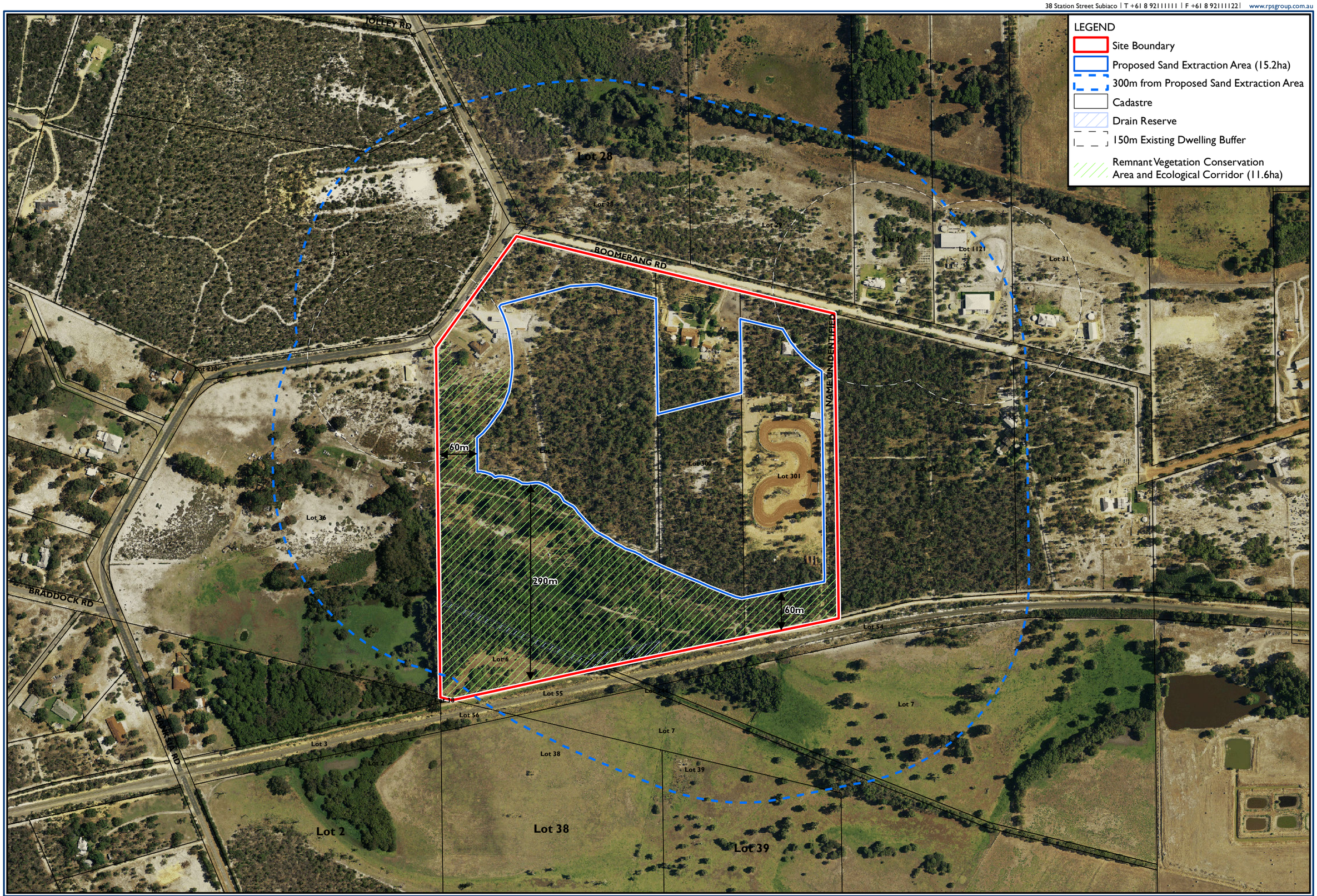
Job Number: L07396 Extractive Industry Licence
Doc Number: 010
Date: 08.07.13
Scale: 1: 3000 @ A3
Created by: MA
Source: Orthophoto - Landgate 2012. Cadastre - Landgate, 2011.

0 12.5 25 50 75 100 metres

Figure 10

Vegetation Condition Mapping

38 Station Street Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au



RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 011
Date: 08.07.13
Scale: 1:5000 @ A3
Drafted by: MA
Source: Orthophoto, Cadastre - Landgate, 2012 Wetlands - DEC, 13.10.11

0 40 80 160 240 320 metres

Figure 11

Excavation Areas, Proposed Buffers and Ecological Corridor

38 Station Street Subiaco | T +61 8 92111111 | F +61 8 92111122 | www.rpsgroup.com.au

LEGEND
- Site Boundary
- Proposed Sand Extraction Area (15.2ha)
- Staging Program
- Cadastre
- Drain Reserve
- 50m Wetland Buffer

Lot 28
Lot 29
Lot 30
Lot 53
BOOMERANG RD
BANKSIA RD
5
6
2
Lot 6
4
Lot 300
1
Lot 301
3
Lot 33
Lot 36
2
Lot 54
Lot 6
Lot 55
Lot 244
Lot 38
Lot 1
Lot 56
Lot 7

RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 012
Date: 08.07.13
Scale: 1:3000 @ A3
Drafted by: MA
Source: Orthophoto - Landgate, August 2012 Wetlands - DEC, 13.10.11

0 20 40 80 120 160 metres

Figure 12

Staged Excavation Plan

38 Station St Subiaco | T +61 9 9211 1111 | F +61 8 9221 1122 | www.rpsgroup.com.au

banksia road

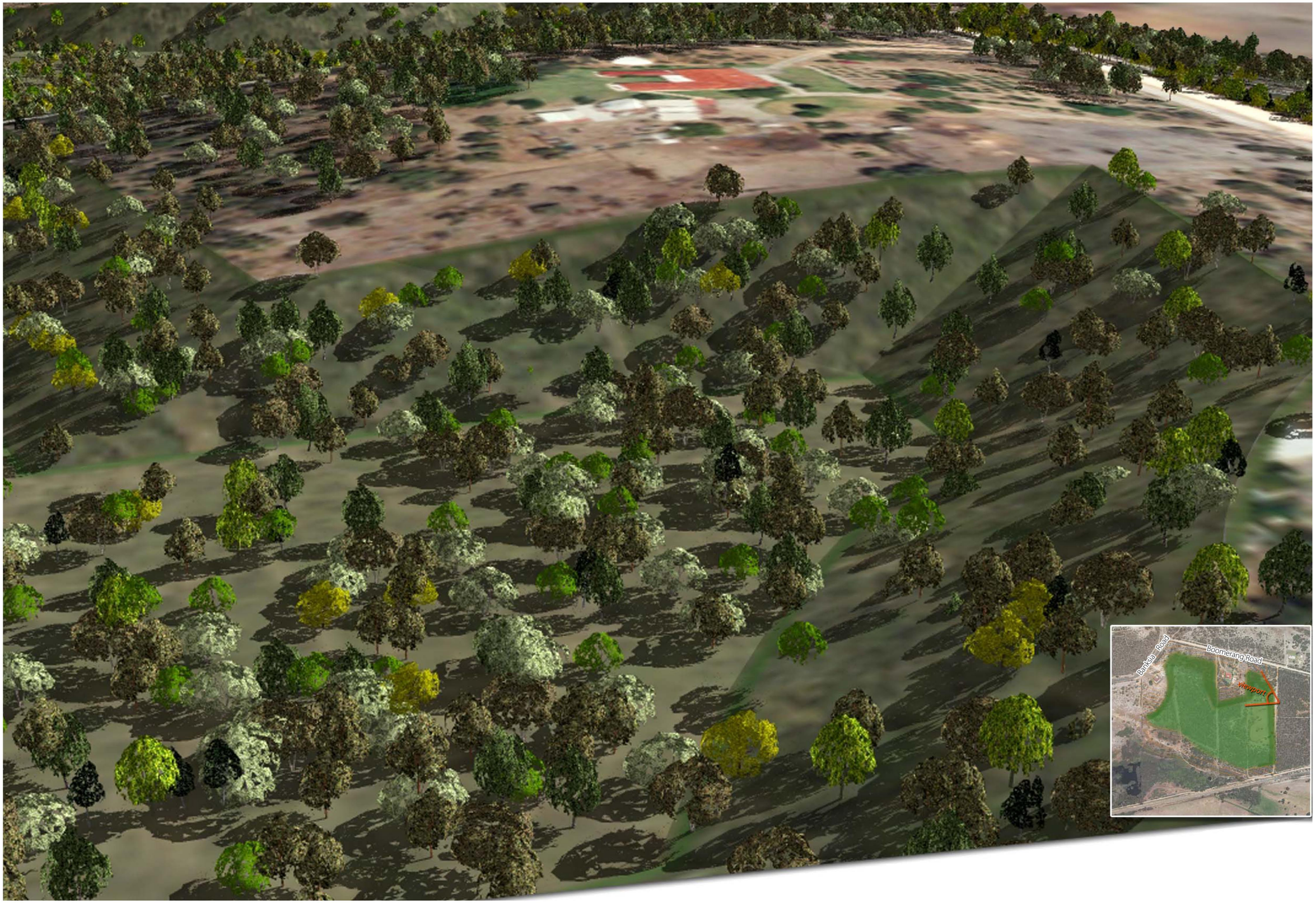
RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 013
Date: 08.07.13
Page: A3
Drafted by: SC
Source: Rocla - 11.12.09

Figure 13

Proposed Excavation Area Post Rehabilitation: Looking East

38 Station St Subiaco | T +61 9 9211 1111 | F +61 8 9221 1122 | www.rpsgroup.com.au



RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 014
Date: 08.07.13
Page: A3
Drafted by: SC
Source: Rocla - 22.10.09

Figure 14

Proposed Excavation Area Post Rehabilitation Looking North West

38 Station St Subiaco | T +61 9 9211 1111 | F +61 8 9221 1122 | www.rpsgroup.com.au

RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 015
Date: 08.07.13
Page: A3
Drafted by: SC
Source: Rocla - 22.10.09

Figure 15

Proposed Excavation Area Post Rehabilitation: Looking North East 1

38 Station St Subiaco | T +61 9 9211 1111 | F +61 8 9221 1122 | www.rpsgroup.com.au

RPS

Job Number: L07396 Extractive Industry Licence
Doc Number: 016
Date: 08.07.13
Page: A3
Drafted by: SC
Source: Rocla - 22.10.09

Figure 16

Proposed Excavation Area Post Rehabilitation: Looking North East 2

APPENDIX I

Department of Mining and Petroleum and Department of Planning Letters

Rocla
QUARRY PRODUCTS

MEMO

DATE: ***December 29, 2011***

TO: ***Heather Tolley and John Halleen***

FROM: Vern Newton

SUBJECT: DMP- Regionally Significant Basic Raw Materials

Heather and John

Please find attached a letter dated, 22 December 2011, and maps from the Department of Mines and Petroleum (DMP) highlighting significant resources that are required to secure long term supplies for future growth of the Perth Region. These maps were produced to assist government with future planning.

These maps show Rocla's Gingin, Neerabup and Oldbury sites as significant resources to meet future requirements. To meet the strategic requirements a number of criria needed to be met, which all of these resources have met.

Additionally it is important to note the very limited resource available to meet the southern Perth and Mandurah demand. The Oldbury resource is therefore very important particularly for concrete production

Similary the Gingin resources (Lennards Road and Creighton Road) are also very important as this area (as highlighted on the maps) is the only resource of its type that has white quartz sand suitable for roof tile, concrete paver and high strength concrete suitable for dam construction. Manufacturing production plants for these products have been built around the specification of the white quartz sand.

Vern Newton
Resource and Development Manager

Government of **Western Australia**
Department of **Mines and Petroleum**

Your ref:
Our ref: A1436/201101
Enquiries: Colin Strickland - Ph 9222 3139 Fax 9222 3633
Email: colin.strickland@dmp.wa.gov.au

Mr Vern Newton
Resource and Development Manager
Rocla Pty Ltd
130 Fauntleroy Avenue
REDCLIFF WA 6104

Dear Sir

REGIONALLY SIGNIFICANT BASIC RAW MATERIALS - SWAN COASTAL PLAIN AND ADJOINING AREAS

The Geological Survey of Western Australia will be publishing a series of maps in 2012 showing regionally significant basic raw materials, along the Swan Coastal Plain and adjoining areas. This mapping is intended to assist government in future planning to ensure that wherever possible access will be maintained to long term supplies of the basic raw materials needed for the future growth of Perth and the South West.

Please find attached the first three draft maps in PDF format for the Perth region along with documentation on the methodology used in construction of the maps.
Note that these maps are not intended to identify all sources of basic raw materials, but rather focus primarily upon those larger potential resource areas, and to a lesser extent upon those smaller deposits that have special properties that will be needed for long term supply purposes. As an important stakeholder, we seek your technical comments on the mapping as it may apply to your area of detailed knowledge. All technical comments will be considered before final publication.

Note that this mapping cannot be taken as government endorsement of approval or priority to mining in these areas and that further considerations such as environmental constraints will need to be taken into account before it can be used for planning purposes.

I would appreciate if you could forward your comments to Colin Strickland, Senior Geologist, Land Use Geoscience, telephone 08 9222 3139 or colin.strickland@dmp.wa.gov.au by 13 February 2012.

Yours sincerely

Rick Rogerson
Executive Director
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

22 December 2011

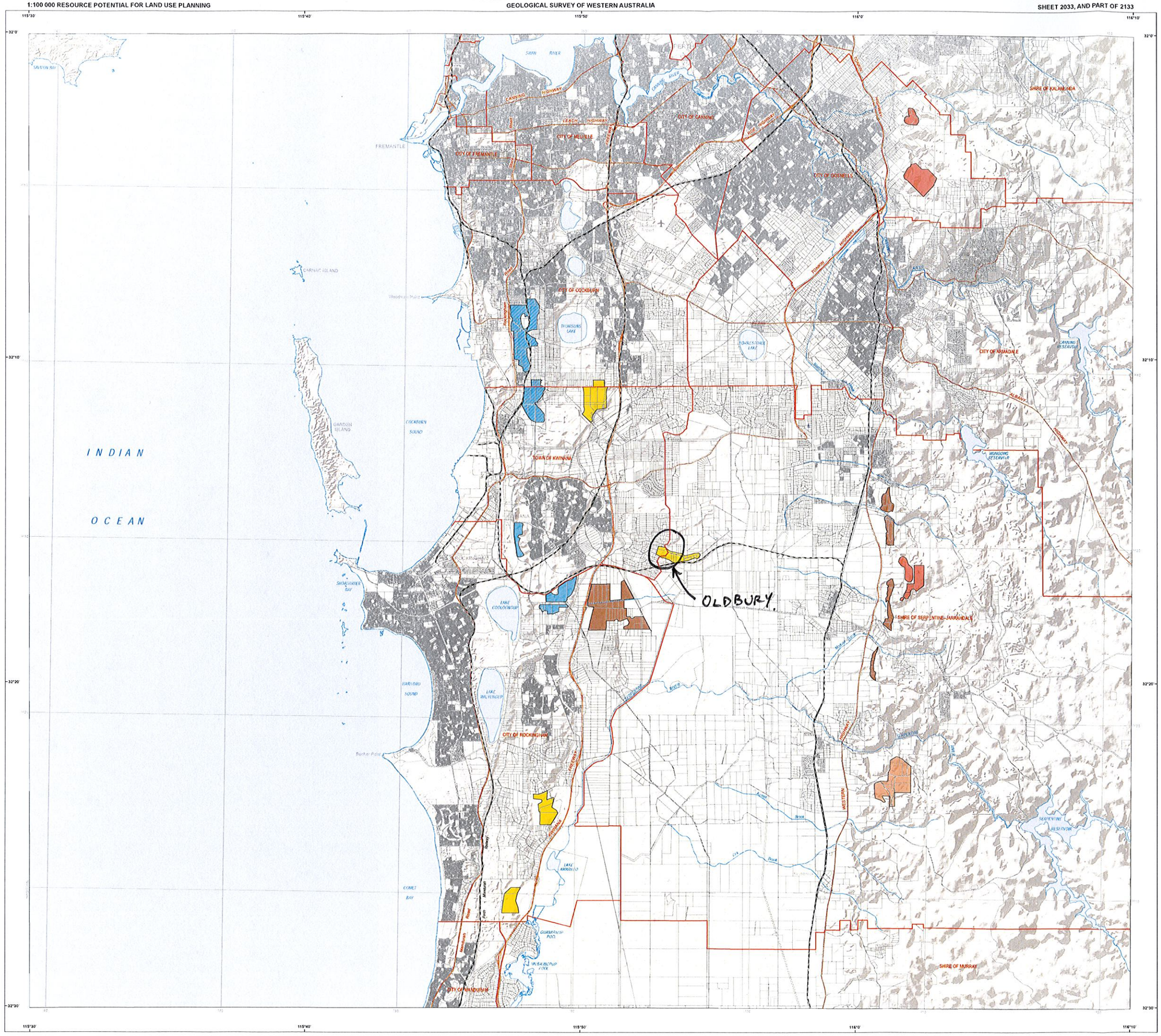
Mineral House 100 Plain Street East Perth Western Australia 6004
Telephone +61 8 9222 3333 Facsimile +61 8 9222 3862
www.dmp.wa.gov.au
www.wa.gov.au
ABN 69 410 335 356

REGIONALLY SIGNIFICANT BASIC RAW MATERIALS
1:100 000 RESOURCE POTENTIAL FOR LAND USE PLANNING

FREMANTLE–JARRAHDALE

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET 2033, AND PART OF 2133

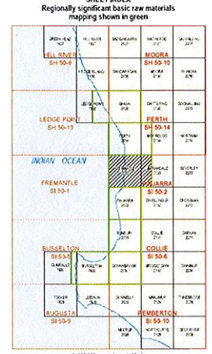


Clay
Gravel
Limestone / limestone high grade
Rock aggregate
Sand

Land title boundary, simplified
Highway / major road
Rail
Airfield
Local government area boundary
Drainage

NOTE: Regionally significant basic raw materials have been compiled from previous geological mapping using various thresholds to identify those areas that have the potential to provide a long-term supply of these materials. Thus, these areas are primarily those with the largest potentially extractable quantities taking depth to water table into account where appropriate. A range of practical high-level planning and mining constraints were applied, but these do not take into account any constraints imposed by State and Commonwealth environmental or heritage legislation. This mapping was compiled to assist government and community decision-making, but cannot be taken as a government endorsement of approval or priority to mining in these areas.

SHEET INDEX
Regionally significant basic raw materials mapping shown in green



1: 100 000 maps shown in black
1: 250 000 maps shown in brown
Search for GSWA map products online at <http://www.dmp.wa.gov.au/GSWApublications>

DATA DIRECTORY

Theme	Data Currency	Organization[1]
Cadastre	APR 2011	Landgate
Regionally significant basic raw materials*	DEC 2011	Geological Survey of Western Australia, Department of Mines and Petroleum
Topographic nomenclature	2009	Landgate
Topography	2009	Landgate

* DMP data can be viewed interactively via GeoVIEW.WA <http://www.dmp.wa.gov.au/geoview>, and related datasets can be downloaded from the GSWA Data and Software Centre <http://www.dmp.wa.gov.au/dataservices>
[1] WA State Government unless otherwise indicated

Compiled by CD Strickland 2012
Cartography by AK Jones
Edited by XX Xxxx
Published by the Geological Survey of Western Australia
This map is published in digital format (PDF) and is available online at <http://www.dmp.wa.gov.au/GSWApublications>.
Copies of this map are available from the Information Centre, Department of Mines and Petroleum,
100 Plain Street, East Perth, WA 6004
Phone (08) 9222 3459 Fax (08) 9222 3444
Website <http://www.dmp.wa.gov.au/gswa> Email geological.survey@dmp.wa.gov.au
The recommended reference for this map is: Strickland, CD 2012, Regionally significant basic raw materials, Fremantle–Jarrahdale, Resource potential for land use planning [1:100 000 scale], Geological Survey of Western Australia.

Government of Western Australia
Department of Mines and Petroleum
HON. NORMAN MOORE, M.L.C.
MINISTER FOR MINES AND PETROLEUM

Geological Survey of Western Australia
RICK ROGERSON
EXECUTIVE DIRECTOR

Scale 1:100 000
1000 0 1 2 3 4 5 6 7 8 9 10
Metres Kilometres

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: GEOCENTRIC DATUM OF AUSTRALIA 1994
Grid lines indicate 10 000 metre interval of the Map Grid Australia Zone 50

GDA The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94). GDA94 positions are compatible within one metre of the datum WGS84 positions

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

RESOURCE POTENTIAL FOR LAND USE PLANNING

REGIONALLY SIGNIFICANT BASIC RAW MATERIALS

FREMANTLE–JARRAHDALE

SHEET 2033, AND PART OF 2133 FIRST EDITION 2012

Version 1.0 – Jan 2012

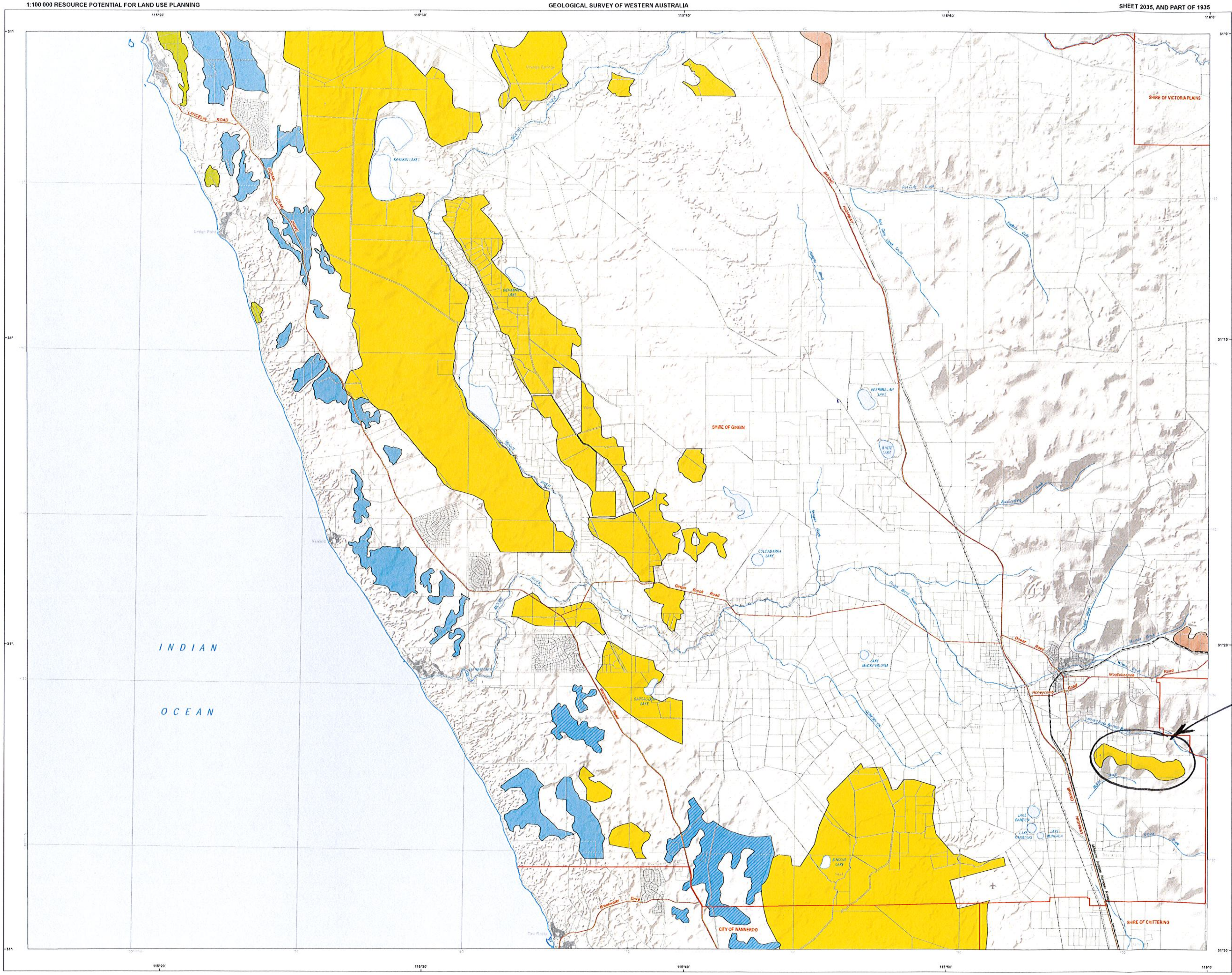
DRAFT

REGIONALLY SIGNIFICANT BASIC RAW MATERIALS
1:100 000 RESOURCE POTENTIAL FOR LAND USE PLANNING

GINGIN–LEDGE POINT

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

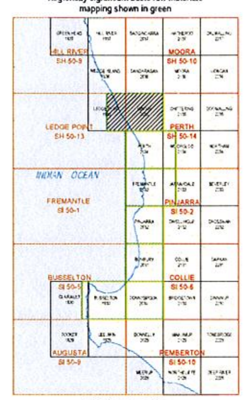
SHEET 2035, AND PART OF 1935



- Gravel
- Sand
- Limestone / limestone high grade
- Limesand
- Land title boundary, simplified
- Highway / major road
- Rail
- Airfield
- Local government area boundary
- Drainage

NOTE Regionally significant basic raw materials have been compiled from previous geological mapping using various thresholds to identify those areas that have the potential to provide a long-term supply of these materials. Thus, these areas are primarily those with the largest potentially extractable quantities taking depth to water table into account where appropriate. A range of practical high-level planning and mining constraints were applied, but these do not take into account any constraints imposed by State and Commonwealth environmental or heritage legislation. This mapping was compiled to assist government and community decision-making, but cannot be taken as a government endorsement of approval or priority to mining in these areas.

SHEET INDEX
Regionally significant basic raw materials mapping shown in green



1:100 000 maps shown in black
1:250 000 maps shown in brown
Search for GSWA map products online at <http://www.dmp.wa.gov.au/GSWApublications>

DATA DIRECTORY

Theme	Data Currency	Organization[†]
Cadastre	APR 2011	Landgate
Regionally significant basic raw materials*	DEC 2011	Geological Survey of Western Australia, Department of Mines and Petroleum
Topographic nomenclature	2009	Landgate
Topography	2009	Landgate

* DMP data can be viewed interactively via GeoVIEW.WA <http://www.dmp.wa.gov.au/geoview>, and related datasets can be downloaded from the GSWA Data and Software Centre <http://www.dmp.wa.gov.au/datacentre>

† WA State Government unless otherwise indicated

Compiled by CD Strickland 2012
Cartography by AK Jones
Edited by XX Xxxx
Published by the Geological Survey of Western Australia
This map is published in digital format (PDF) and is available online at <http://www.dmp.wa.gov.au/GSWApublications>.
Copies of this map are available from the Information Centre, Department of Mines and Petroleum,
100 Plain Street, East Perth, WA 6004.
Phone (08) 9222 3459 Fax (08) 9222 3444
Website <http://www.dmp.wa.gov.au/gswa> Email geological.survey@dmp.wa.gov.au
The recommended reference for this map is: Strickland, CD 2012, Regionally significant basic raw materials, Gingin–Ledge Point, Resource potential for land use planning (1:100 000 scale): Geological Survey of Western Australia.

CREIGHTON & LENNARDS RD
GINGIN

Government of Western Australia
Department of Mines and Petroleum

Geological Survey of Western Australia

HON. NORMAN MOORE, MLC.
MINISTER FOR MINES AND PETROLEUM

RICK ROGERSON
EXECUTIVE DIRECTOR

Scale 1:100 000

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: GEOCENTRIC DATUM OF AUSTRALIA 1994
Grid lines indicate 10 000 metre interval of the Map Grid Australia Zone 50

GDA The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94). GDA94 positions are compatible within one metre of the datum WGS84 positions

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA
RESOURCE POTENTIAL FOR LAND USE PLANNING
REGIONALLY SIGNIFICANT BASIC RAW MATERIALS

GINGIN–LEDGE POINT

SHEET 2035, AND PART OF 1935 FIRST EDITION 2012
Version 1.0 – Jan 2012

DRAFT

REGIONALLY SIGNIFICANT BASIC RAW MATERIALS
1:100 000 RESOURCE POTENTIAL FOR LAND USE PLANNING

PERTH–WOOROLOO

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET 2034, AND PART OF 2134

NEERABUP

INDIAN OCEAN

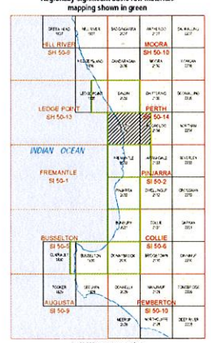
SHIRE OF CHITTERING
CITY OF WANNEROO
CITY OF SWAN
CITY OF JOONDALUP
CITY OF STIRLING
CITY OF BELMONT
SHIRE OF MUNDARING
SHIRE OF KALAMUNDA

Gravel
Sand
Limestone / limestone high grade
Clay
Rock aggregate

Land title boundary, simplified
Highway / major road
Rail
Airfield
Local government area boundary
Drainage

NOTE: Regionally significant basic raw materials have been compiled from previous geological mapping using various thresholds to identify those areas that have the potential to provide a long-term supply of these materials. Thus, these areas are primarily those with the largest potentially extractable quantities taking depth to water table into account where appropriate. A range of practical high-level planning and mining constraints were applied, but these do not take into account any constraints imposed by State and Commonwealth environmental or heritage legislation. This mapping was compiled to assist government and community decision-making, but cannot be taken as a government endorsement of approval or priority to mining in these areas.

SHEET INDEX
Regionally significant basic raw materials mapping shown in green



1:100 000 maps shown in black
1:250 000 maps shown in brown
Search for GSWA map products online at <http://www.dmp.wa.gov.au/GSWApublications>

DATA DIRECTORY

Theme	Data Currency	Organization†
Cadastre	APR 2011	Landgate
Regionally significant basic raw materials*	DEC 2011	Geological Survey of Western Australia, Department of Mines and Petroleum
Topographic nomenclature	2009	Landgate
Topography	2009	Landgate

* DMP data can be viewed interactively via GeoVIEW.WA <http://www.dmp.wa.gov.au/geoview> and related datasets can be downloaded from the GSWA Data and Software Centre <http://www.dmp.wa.gov.au/dasc/center>
† WA State Government unless otherwise indicated

Compiled by CD Strickland 2012
Cartography by AK Jones
Edited by XX Xxxx
Published by the Geological Survey of Western Australia
This map is published in digital format (PDF) and is available online at <http://www.dmp.wa.gov.au/GSWApublications>.
Copies of this map are available from the Information Centre, Department of Mines and Petroleum,
100 Plain Street, East Perth, WA 6004.
Phone (08) 9222 3459 Fax (08) 9222 3444
Website <http://www.dmp.wa.gov.au/gswa> Email geological.survey@dmp.wa.gov.au
The recommended reference for this map is: Strickland, CD 2012, Regionally significant basic raw materials, Perth–Wooroloo, Resource potential for land use planning (1:100 000 scale), Geological Survey of Western Australia.

Government of Western Australia
Department of Mines and Petroleum
HON. NORMAN MOORE MLC
MINISTER FOR MINES AND PETROLEUM

Geological Survey of Western Australia
RICK ROGERSON
EXECUTIVE DIRECTOR

Scale 1:100 000

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: GEOCENTRIC DATUM OF AUSTRALIA 1994
Grid lines indicate 10 000 metre interval of the Map Grid Australia Zone 50

The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94); GDA94 positions are compatible within one metre of the datum WGS84 positions

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

RESOURCE POTENTIAL FOR LAND USE PLANNING

REGIONALLY SIGNIFICANT BASIC RAW MATERIALS

PERTH–WOOROLOO

SHEET 2034, AND PART OF 2134 FIRST EDITION 2012
Version 1.0 – Jan 2012

DRAFT

PRINCIPLES FOR THE SELECTION OF REGIONALLY SIGNIFICANT BASIC RAW MATERIALS

Regionally significant basic raw materials have been compiled from previous geological mapping using various thresholds to identify those areas that have the potential to provide a long-term (50 years) supply of these materials. Thus, these areas are primarily those with the largest potentially extractable quantities taking depth to water table into account where appropriate. A range of practical high-level planning and mining constraints were applied, but these do not take into account any constraints imposed by State and Commonwealth environmental or heritage legislation. This mapping was compiled to inform government and community decision-making, but cannot be taken as a government endorsement of approval or priority to mining in these areas.

1. Selection principles for all basic raw materials

- Define areas based upon geological boundaries wherever possible.
- Take into account current and past extraction operations, Crown reserves, recommendations of the Chamber of Commerce and Industry and Landvision study of basic raw materials in the South West.
- Minimise the potential for future land use conflict by selecting areas that are more than the maximum recommended EPA separation distance from current and planned residential and rural residential areas, except for where there are already operating quarries or for where sequential land use may be appropriate.
- Sites must not be constrained by statutory access impediments such as some Class 'A' Reserves and State Agreements.
- Avoid conflict with other higher-value resources and capital-intensive infrastructure.

2. For Sand

- Maximize the potential size and hence period of supply. This is achieved by selecting the largest geological areas with the highest nominal thicknesses.

- Avoid potential conflict with current and future titanium-zircon mining operations.

3. For Limestone

- Maximize the potential size and hence period of supply. This is achieved by selecting the largest geological areas with the highest nominal thicknesses.

- In areas where quarrying is already taking place less than 2 m above water table, accept thinner high grade limestone.

4. For Limesand

- Maximize the potential size and hence period of supply. This is achieved by selecting the largest geological areas with the highest nominal thicknesses.

5. For Clay

- Where potential host geological units are larger than the area needed for future extraction, select the area based upon current extraction operations, land holdings of the operator (for future operations) and contiguous geological areas.

- Where there are current extraction operations in smaller geological units, select the entire associated geological area that may be suitable for future extraction.

- Select larger geological units that have known high potential for clay extraction but no current extraction operations (based upon test data, correlation with geological units with known suitability, and proximity to processing sites).

6. For Rock

6.1 *Bunbury Basalt*

- As the Bunbury Basalt is mainly buried, minimize the depth of overburden.

- Apply planning criteria of the current Greater Bunbury Region Scheme 'basalt extraction area' and the nominated buffer distance for the Gelorup quarries.

- Identify other exploration areas that potentially have a minimal overburden.

6.2 *Yilgarn Craton*

- Use ultimate quarry boundaries or the extent of tenure for current or planned quarry operations.

- Identify undeveloped and substantially unconstrained areas identified in the recommendations of the Darling Escarpment Aggregate Resources (DEAR) Committee.

- Identify strategically located unconstrained and undeveloped sites that lie outside the area examined by the DEAR committee.

7. For Gravel

- Maximize the potential size and hence period of supply from areas with demonstrated suitability for extraction. This is achieved selecting the largest geological areas with:
  - substantial current extraction operations, or
  - at least one current extractive industry licence (or granted mining tenement) and one Crown reserve for gravel and one operating pit within either, or
  - Large Crown reserves for gravel.

8. Constraints for all regionally significant basic raw materials

The following are deemed to 'sterilize' basic raw material (BRM) areas, and hence are fundamental constraints on determining significant geological supply areas:

- Residential or small scale (intensive) rural-residential development (definitely for blocks less than 2000 square metres).
- Areas with approved zoning for residential (urban, urban deferred), industrial, rural-residential development. (but may be suitable for sequential development).
- Areas with existing capital development that are deemed to be too costly to remove or relocate with respect to the value of the resource e.g. railways, main roads, main gas pipelines, and public infrastructure such as hospitals and schools etc.
- National Parks and Class 'A' Nature Reserves.
- Any other Class 'A' Reserve in the South West Land Division and Esperance and Ravensthorpe Shires, except for State Forests and Timber Reserves in the South West Mineral Field.
- Other higher-value resources that could be diminished if BRM extraction took place.
- The above constraints do not take into account any of those imposed by State and Commonwealth environmental or heritage legislation. For mining proposals, these constraints are normally assessed on a case by case basis with reference to the appropriate legislation e.g. Environmental Protection (Clearing of Native Vegetation) Regulations 2004.

9. Selection procedure for regionally significant basic raw materials

1. Sand

1.1 *Swan Coastal Plain*

- Produce detailed mapping of the geological units that contain the potential resource.

- Use detailed topographic elevation data and borehole data to define potential resource units that are more than 2 m above the water table, and meet the following thickness thresholds (over and above the 2 m above the water table):
  - Plus 2 m
  - Plus 5 m
  - Plus 10 m
  - Plus 15 m.

- Define the major constraints on potential resource extraction areas.

- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) sand pits.

- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with sand extraction.

- Identify all Crown reserves that are wholly or partly intended for sand extraction.

- Identify the largest unconstrained areas with the greatest sand thicknesses by outlining mainly contiguous 'Plus 10 m' areas that cover more than 100 ha. These are given a rank of '1'. Avoid areas that are within 500 m of existing or planned residential or rural residential development, or adjacent to a Strategic Mineral Resource Protection Area (SMRPA) for titanium-zircon mineralization. These areas do not necessarily have existing mining operations or tenure.

- Identify unconstrained areas that have a combination of mainly contiguous 'Plus 10 m' and 'Plus 5 m' thicknesses, cover more than 100 ha, and have an operating pit, extractive industry licence or granted mining tenement (to a BRM operator). These are given a rank of '2'. Can be located adjacent to a SMRPA if a quick review of exploration reports shows the area to have been adequately tested and found to have low potential for titanium-zircon mineralization. May be

less than 500 m from existing residential or rural residential development if already operating in this situation.

- Identify unconstrained areas that have mainly contiguous 'Plus 10 m' (minimum of 25%) and 'Plus 5 m' thicknesses, and cover more than 100 ha. Must be more than 500 m from existing or planned residential or rural residential development as these areas do not have existing mining operations or tenure These are given a rank of '3'.

- Calculate nominal thickness from visual surface proportions of the appropriate polygons.

- Do a quick audit for each area to:
  - confirm low potential for other (more valuable) mineralization – silica sand is permitted.
  - check that the nominal thicknesses are reasonable.
  - compare with proposed Priority Resource Locations and Key Extraction Areas.

- Calculate nominal volume and tonnages.

- Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.

1.2 *Outside Swan Coastal Plain*

- Compile mapping of the geological units that contain the potential resource.

- Define the major constraints on potential resource extraction areas.

- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) sand pits.

- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with sand extraction.

- Identify all Crown reserves that are wholly or partly intended for sand extraction.

- Identify unconstrained areas that cover more than 100 ha, and have an operating pit, extractive industry licence or granted mining tenement (to a BRM operator). Where necessary, refine mapping using all available information including a digital elevation model and orthophotography. Estimate thickness above bedrock. These are given a rank

of '2'. Can be located adjacent to a SMRPA if a quick review of exploration reports shows the area to have been adequately tested and found to have low potential for titanium-zircon mineralization. May be less than 500 m from existing residential or rural residential development if already operating in this situation.

- Estimate nominal thickness above bedrock from available information including surface elevations.

- Do a quick audit for each area to:
  - confirm low potential for other (more valuable) mineralization – silica sand is permitted.
  - check that the nominal thicknesses are reasonable.
  - compare with proposed Priority Resource Locations and Key Extraction Areas.
  - Calculate nominal volume and tonnages.

  - Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.

2. Limestone

2.1 Swan Coastal Plain

- Produce detailed mapping of the geological units that contain the potential resource, and of the areas known from sampling to contain high grade limestone.

- Use detailed topographic elevation data and borehole data to define potential resource units that are more than 2 m above the water table, and meet the following thickness thresholds (over and above the 2 m above the water table):
  - Plus 2 m
  - Plus 5 m
  - Plus 10 m
  - Plus 15 m.

- Define the major constraints on potential resource extraction areas.

- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) limestone pits.

- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with limestone extraction.

- Identify all Crown reserves that are wholly or partly intended for limestone extraction.

- Identify the largest unconstrained areas with the greatest limestone thicknesses by outlining mainly contiguous 'Plus 10 m' areas that cover more than 100 ha. These are given a rank of '1'. Include fringing areas of 'Plus 5 m' limestone. Avoid areas that are within 500 m of existing or planned residential or rural residential development. These areas do not necessarily have existing mining operations or tenure.

- Identify unconstrained areas that have a combination of mainly contiguous 'Plus 10 m' and 'Plus 5 m' thicknesses, and adjoining thinner high grade limestone that are more than 100 ha, and have an operating pit, extractive industry licence or granted mining tenement (to a BRM operator). These are given a rank of '2'. May be less than 500 m from existing residential or rural residential development if already operating in this situation.

- Identify unconstrained areas that have mainly contiguous 'Plus 5 m' thicknesses and adjoining thinner high grade limestone that cover more than 50 ha. These areas do not necessarily have existing mining operations or tenure, and are given a rank of '3'. If no existing mining operations, must be more than 500 m from existing or planned residential or rural residential development.

- Calculate nominal thickness from visual surface proportions of the appropriate polygons and surface contours within the area.

- Do a quick audit for each area to check that the nominal thicknesses are reasonable. Also, compare with proposed Priority Resource Locations and Key Extraction Areas.

- Calculate nominal volume and tonnages.

- Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.

2.2 Leeuwin-Naturaliste Ridge

- Compile existing mapping of the geological units that contain the potential resource.

- Define the major constraints on potential resource extraction areas. Include the 'Principal Ridge Protection Area' as a constraint.

- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) limestone pits.

- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with limestone extraction.

- Identify all Crown reserves that are wholly or partly intended for limestone extraction.

- Identify unconstrained areas that cover more than 50 ha. These areas do not necessarily have existing mining operations or tenure, and are given a rank of '3'. If no existing mining operations, must be more than 500 m from existing or planned residential or rural residential development.

- Estimate nominal thickness above bedrock from available information including surface elevations.

- Do a quick audit for each area to check that the nominal thicknesses are reasonable. Also, compare with proposed Priority Resource Locations and Key Extraction Areas.

- Calculate nominal volume and tonnages.

- Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.

3. Limesand

- Produce detailed mapping of the geological units that contain the potential resource.

- Use detailed topographic elevation data and orthophotography to identify potential resource units within mobile (non-vegetated) sand dunes and estimate average elevation above ground level.

- Define the major constraints on potential resource extraction areas.

- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) limesand pits.

- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with limesand extraction.

- Identify all Crown reserves that are wholly or partly intended for limesand extraction.

- Identify the largest unconstrained areas with the greatest limesand thicknesses by outlining mainly contiguous areas that have an average height greater than or equal to 10 m above ground level and cover more than 100 ha. These are given a rank of '1'. Avoid areas that are within 500 m of existing or planned residential or rural residential development, or adjacent to a Strategic Mineral Resource Protection Area (for titanium-zircon mineralization). These areas do not necessarily have existing mining operations or tenure.

- Identify unconstrained areas that have an average height of 5 to 10 m above ground level, cover more than 100 ha and have an operating pit, extractive industry licence or granted mining tenement (to a BRM operator). These are given a rank of '2'. Can be located adjacent to a SMRPA if a quick review of exploration reports shows the area to have been adequately tested and found to have low potential for titanium-zircon mineralization. May be less than 500 m from existing residential or rural residential development (because already operating in this situation).

- Identify unconstrained areas that have an average height greater than or equal to 5 m above ground level and cover more than 50 ha. These areas do not necessarily have existing mining operations or tenure, and are given a rank of '3'. If no existing mining operations, must be more than 500 m from existing or planned residential or rural residential development.

- Calculate nominal thickness from average height estimate.

- Do a quick audit for each area to check that the nominal thicknesses are reasonable. Also, compare with proposed Priority Resource Locations and Key Extraction Areas.

- Calculate nominal volume and tonnages.

- Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.

4. Clay

- Compile mapping of the geological units that contain the potential resource.
- Define the major constraints on potential resource extraction areas.
- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) clay pits, and clay mineral occurrences.
- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with clay extraction.
- Identify all Crown reserves that are wholly or partly intended for clay extraction.
- Identify current clay/shale extraction operations and associated tenure (extractive industry licences and mining tenements) in geological units that are much larger than the area that will be needed for future extraction (e.g. the Guildford Formation). Select unconstrained areas that cover both current tenure and possible future tenure requirements. This may include adjacent land owned by the current tenure holders. Trim areas to geological boundaries where appropriate. May be less than 500 m if already operating in this situation. These are given a rank of '1'.
- Identify entire unconstrained geological units that may be required for future extraction, and have current clay/shale extraction operations and associated tenure (extractive industry licences and mining tenements). These are given a rank of '2'.
- Identify unconstrained geological areas that cover more than 25 ha, have no current clay/shale extraction operations, but are known to have high potential for future clay extraction due to the known suitability of the material and proximity to current or planned processing sites. Avoid areas that are within 500 m of existing or planned residential or rural residential development. These are given a rank of '3'.
- Estimate nominal thickness.
- Do a quick audit for each area to check that the nominal thicknesses are reasonable. Also, compare with proposed Priority Resource Locations and Key Extraction Areas.

- Calculate nominal volume and tonnages.

- Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.

5. Rock

- Compile mapping of the geological units that contain the potential resource.

- Define the major constraints on potential resource extraction areas.

- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) rock quarries.

- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with rock quarrying.

- Identify all Crown reserves that are wholly or partly intended for rock quarrying.

5.1 *Bunbury Basalt*

- Identify areas with less than 20 m of overburden.

- Identify unconstrained lots that have current or previous rock quarrying operations and lie entirely within the current GBRS basalt extraction area. These are given a rank of '1'.

- Identify unconstrained areas that lie adjacent to the rank '1' lots, but are over 700 m from urban or urban deferred areas in the GBRS. These are given a rank of '2'.

- Identify unconstrained areas with less than 20 m of overburden that lie more than 700 m from planned residential or rural residential development. These areas can include titanium-zircon SMRPAs. These are given a rank of '3'.

5.2 *Yilgarn Craton*

- Identify current or proposed quarrying operations, and associated extractive industry licences, or mining tenements or Crown reserves for rock quarrying. These may include intermittently operating sites. Outline the extent of long-term quarry (pit) boundaries where known. Otherwise outline the extent of tenure, constrained by geology and viewshed where appropriate. These are given a rank of '1'.

- Identify undeveloped and substantially unconstrained areas (use 1000 m separation distance from residential or rural residential areas) identified in the Report of the Darling Escarpment Aggregate Resources (DEAR) Committee that either adjoin current operations or are separated from current operations by at least 10 km by road. Areas can be modified taking into account new information including detailed topographic data. These are given a rank of '2'.

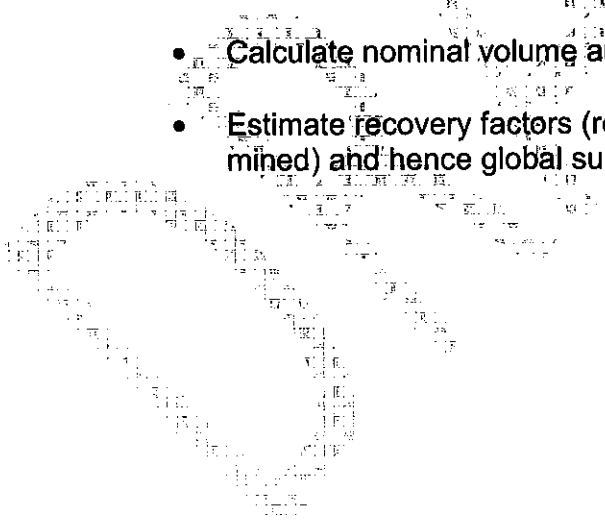
- Select unconstrained (use 1000 m separation distance from residential or rural residential areas) undeveloped sites outside the area covered by the DEAR report using similar considerations to those employed by DEAR Committee that require further investigation for suitability for future quarrying. These are strategically located with respect to transport routes and future growth areas. These are given a rank of '3'.

- Estimate nominal thickness.

- Do a quick audit for each area to check that the nominal thicknesses are reasonable. Also compare with proposed Priority Resource Locations and Key Extraction Areas.

- Calculate nominal volume and tonnages.

- Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.



6. Gravel

- Compile mapping of the geological units that contain the potential resource.

- Define the major constraints on potential resource extraction areas. For gravel, State Agreement areas for bauxite are considered an additional constraint. For the Alcoa State Agreement area, exclude State Forest areas only.

- Identify all known existing and planned, operating and non-operating (shutdown, care and maintenance and abandoned) gravel pits.

- Identify all known extractive industry licences and mining tenements (both applications and granted) that are or may be associated with gravel extraction.

- Identify all Crown reserves that are wholly or partly intended for gravel extraction.

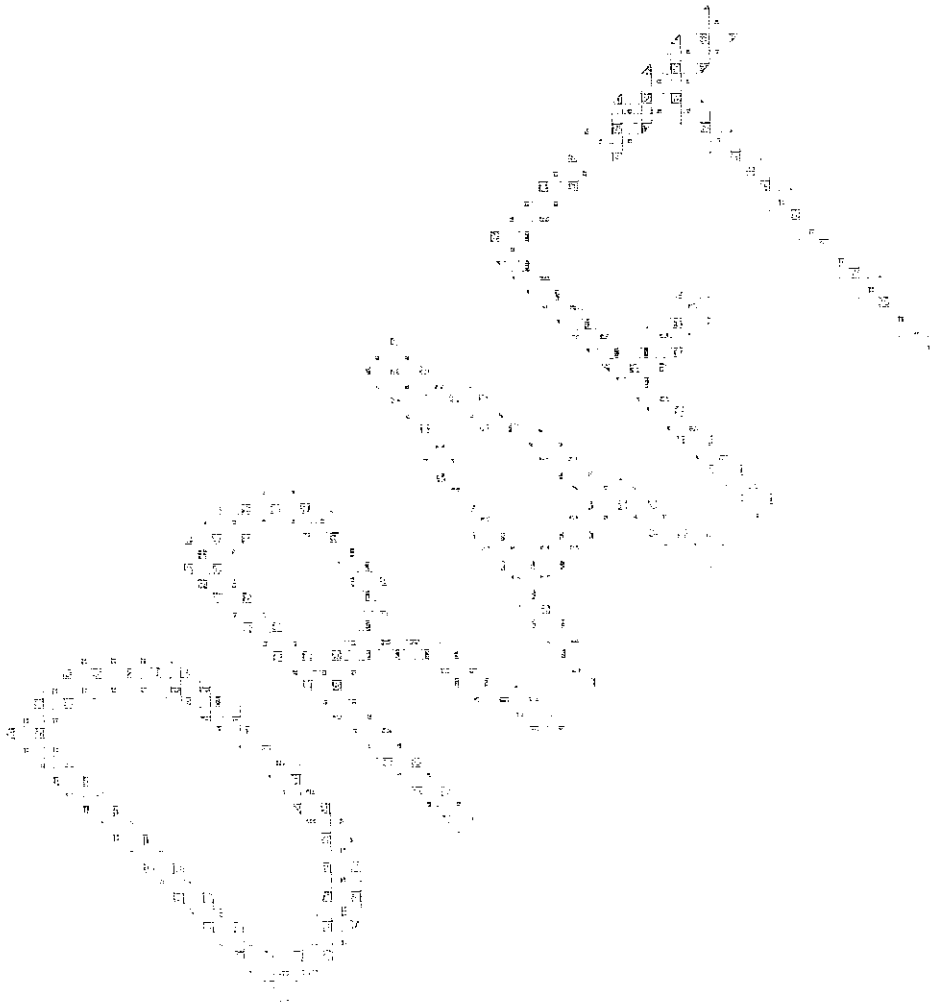
- Identify unconstrained geological areas that cover more than 100 ha and have at least one substantial operating gravel pit within a current extractive industry licence or granted mining tenement. There must be significant potential for further gravel extraction within the current tenement(s). Must be more than 500 m from existing or planned residential or rural residential development unless already operating in this situation. These are given a rank of '1'.

- Identify unconstrained geological areas that cover more than 100 ha and have at least one current extractive industry licence or granted mining tenement and one Crown reserve wholly or partly for gravel. There must be at least one operating gravel pit within the licence, tenement or reserve. Must be more than 500 m from existing or planned residential or rural residential development unless already operating in this situation. These are given a rank of '2'.

- Identify unconstrained geological areas that cover more than 100 ha and have one or more Crown reserves with a combined area of at least 50 ha wholly or partly for gravel. There must be evidence of substantial current or past gravel extraction from within the geological area. Must be more than 500 m from existing or planned residential or rural residential development unless already operating in this situation. These are given a rank of '3'.

- Estimate nominal thickness.

- Do a quick audit for each area to check that the nominal thicknesses are reasonable.
- Calculate nominal volume and tonnages.
- Estimate recovery factors (realistic proportion that may be mined) and hence global supply estimates.



Government of **Western Australia**
Department of **Planning**

Your ref: 16/8/11
Our ref: DPI/09/00957/1
Enquiries: G Findlay
Telephone: (08) 6551902

Mr V Newton
Resource Development Manager
Rocla Quarry Products
PO Box 469
CLOVERDALE WA 6895

Dear Mr Newton

RE: OLDBURY SITE – SAND RESOURCE

The Department of Planning (DoP) in conjunction with the Department of Mines and Petroleum (DMP) is currently reviewing the mapping that will support the State Planning Policy 2.4- Basic Raw Materials (SPP2.4) and to update the current areas of significant basic raw materials (BRM) around Perth.

The existing SPP 2.4 mapping is over 10 years old and Perth's development frontier has expanded resulting in previously identified supplies of BRM being either exhausted or sterilised.

As confirmed by the DMP the subject sites at Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury contain high quality concrete sands of strategic regional significance. Although not shown on current SPP 2.4 as a Priority Resource Site the DoP defers to the DMP assessment of the sand resource, as per its letter to you of 8 January 2011.

The DoP promotes the utilisation of land that allows a sequential development process providing for the extraction of BRM and the return of the land to a land use compatible with its future long-term role.

Should you require any further information on this issue, please contact Geoff Findlay of this office on 65519092.

Yours sincerely

Martin Mileham
Executive Director
Strategy, Policy and Projects

06/09/2011

Postal address: Locked Bag 2506 Perth WA 6001 / Street address: 140 William Street Perth WA 6000
Tel: (08) 6551 9000 / Fax: (08) 6551 9001 / corporate@planning.wa.gov.au / www.planning.wa.gov.au
ABN 79 051 750 680
wa.gov.au

APPENDIX 2

DIA Aboriginal Heritage Site Search

Search Criteria

0 sites in a search box. The box is formed by these diagonally opposed corner points:

GDA94	
Latitude	Longitude
-32° 15' 56"	115° 53' 3"
-32° 16' 19"	115° 53' 26"

Disclaimer

Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist. Consultation with Aboriginal communities is on-going to identify additional sites. The AHA protects all Aboriginal sites in Western Australia whether or not they are registered.

Copyright

Legend

Restriction

N	No restriction
M	Male access only
F	Female access

Access

C	Closed
O	Open
V	Vulnerable

Coordinate Accuracy

Accuracy is shown as a code in brackets following the site coordinates.

[Reliable]	The spatial information recorded in the site file is deemed to be reliable, due to methods of capture.
[Unreliable	The spatial information recorded in the site file is deemed to be unreliable due to errors of spatial data capture and/or quality of spatial information reported.

Status

L	Lodged	IR	Insufficient Information (as assessed by Site Assessment Group)
I	Insufficient Information	PR	Permanent register (as assessed by Site Assessment Group)
P	Permanent register	SR	Stored data (as assessed by Site Assessment Group)
S	Stored data		

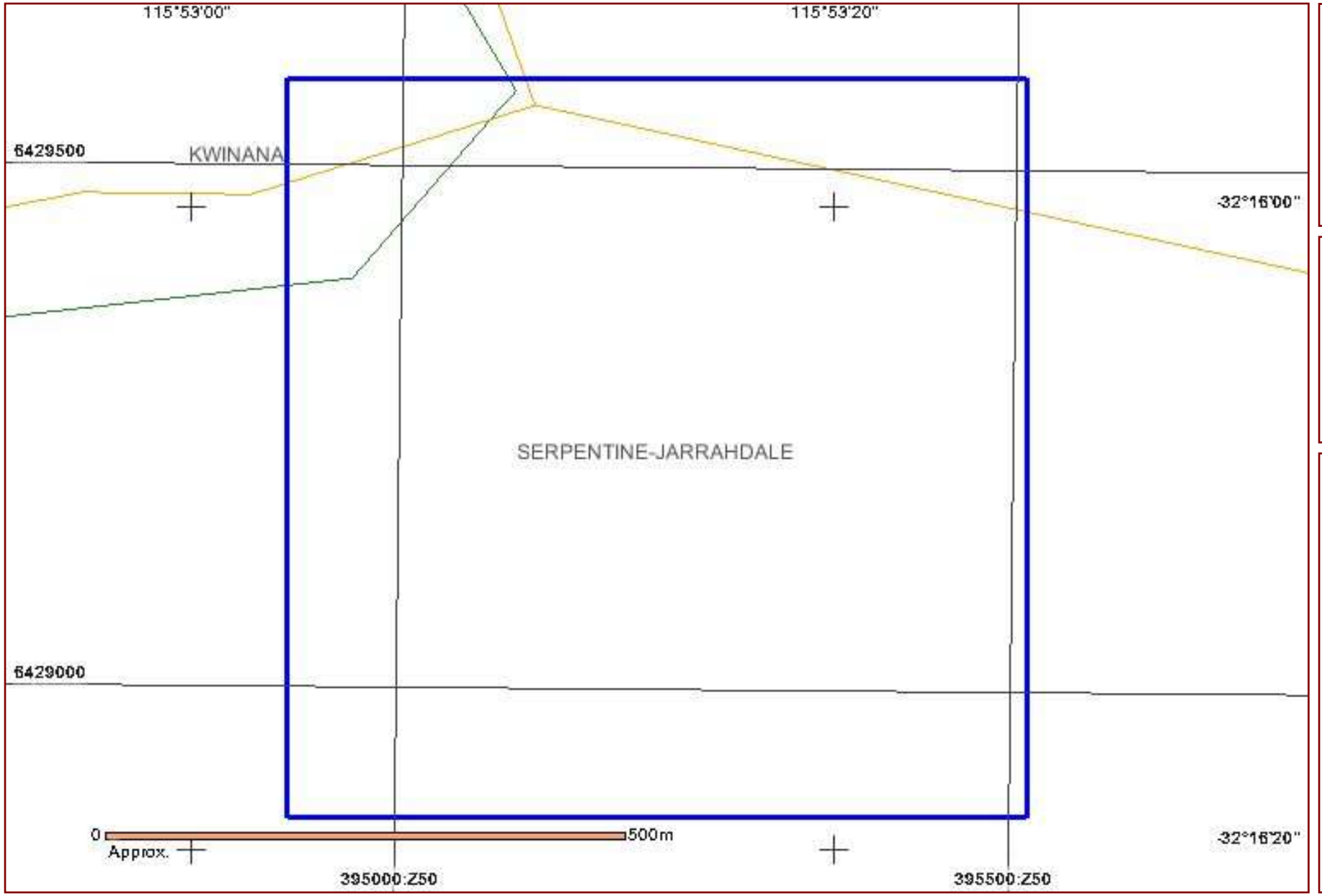
Site Assessment Group (SAG)

Sites lodged with the Department are assessed under the direction of the Registrar of Aboriginal Sites. These are not to be considered the final assessment.

Final assessment will be determined by the Aboriginal Cultural Material Committee (ACMC).

Spatial Accuracy

Index coordinates are indicative locations and may not necessarily represent the centre of sites, especially for sites with an access code “closed” or “vulnerable”. Map coordinates (Lat/Long) and (Easting/Northing) are based on the GDA 94 datum. The Easting / Northing map grid can be across one or more zones. The zone is indicated for each Easting on the map, i.e. '5000000:Z50' means Easting=5000000, Zone=50.



Legend

- Highlighted Area
- Town
- Map Area
- Search Area

APPENDIX 3

Botanic Garden and Parks Authority Confirmation Letter

BOTANIC GARDENS & PARKS AUTHORITY

KINGS PARK AND BOTANIC GARDEN • BOLD PARK

ABN 30 706 225 320

Reply to: Kingsley Dixon
Directorate: Science
Telephone: 61 8 9480 3614
Facsimile: 61 8 9480 3641

20 April 2009

Mr Vern Newton
Resource and Development Manager
Rocla Quarry Products
PO Box 469
CLOVERDALE WA 6009

Dear Vern

RESTORATION COMMITMENT OF ROCLA QUARRY PRODUCTS FOR LOTS 300, 301 AND 6 BOOMERANG ROAD, OLDBURY.

This letter illustrates a 13-year restoration and research partnership forged between Rocla Quarry Products (RQP) and the Botanic Gardens and Parks Authority (BGPA) to tackle the complex environmental and biodiversity issues associated with post-sand extraction restoration of the iconic *Banksia* woodland communities on the Swan Coastal Plain. It highlights the long-term and genuine restoration commitment of RQP to re-instate post-sand extracted plant communities, and the crucial role that the company has played in research focused on developing the restoration science underpinning the long-term conservation, restoration and ecological enhancement of *Banksia* woodland communities.

Since 1995, RQP has been committed to restoring post-sand extracted *Banksia* woodland sites with an ecosystem closely resembling the pre-sand extracted native species composition. At the commencement of the RQP-BGPA restoration research partnership, the diversity and sustainability of post-sand extracted vegetation was extremely limited. An understanding of how *Banksia* woodland ecosystems function and the restoration ecology and biology of constituent species has been essential to plan management strategies for the successful restoration of *Banksia* woodland sites disturbed through RQP's sand extraction activities. As a result, RQP in collaboration with the BGPA has been undertaking research into many facets of *Banksia* woodland ecosystem restoration - seed ecology, the regenerative potential of the soil seed bank, detailed methods of topsoil handling and storage, seed pre-treatments (eg. smoke), greenstock treatments (eg. tree-guards, anti-transpirants) site treatments (eg. mulching, irrigation and soil ripping practices and application of soil stabilizers), autecology of several of the dominant local weeds, plant and soil water relations, and a few other topics have been the primary foci of research.

Through the research findings of the research partnership, RQP and the BGPA have begun to understand the critical path of restoring *Banksia* woodland vegetation. Today, as a result, RQP boasts one of the highest levels of species and plant reinstatement per unit area of post-mined restoration in the resources sector (>100 plants/5m^2), which is double the standard achieved by the industry leader, Alcoa Alumina, and testimony to the outstanding level of environmental stewardship and excellence arising from the research partnership and commitment.

The ongoing high-level restoration commitment by RQP can be illustrated through site-specific research and subsequent restoration undertaken at all sites that are subject (or will be subject) to post-sand extraction activities by RQP. One such area includes Lots 300, 301 and 6 Boomerang Road, Oldbury, whereby site management plans are currently being developed by RQP, and consultation with the BGPA is being undertaken to ensure that 'site-specific' and 'best practice' restoration are implemented, thereby aligning with the restoration philosophy of RQP and the BGPA.

To demonstrate, currently, the *Banksia* woodland community (on Lots 300, 301 and 6 Boomerang Road, Oldbury), in some parts, is heavily invaded by weed species, and separated from the low-lying wetland. Critical objectives of restoration research activities, to be undertaken by RQP and BGPA, are to firstly conduct an analysis/inventory of the topsoil seedbank to determine its potential as a source of native plant replacement; secondly, tackle weed seedling emergence (given the pre-existing invasion of exotic species); thirdly, investigate the potential to dry store the topsoil seedbank as a means of seed conservation (given the potentially high quality topsoil that may be present within certain areas); and fourthly, investigate the potential to connect the upper lying *Banksia* woodland with the lower lying wetland community. To tackle immediate restoration research needs, the BGPA has begun sourcing Honours program students to inventorise the topsoil seedbank (of both native and weed species) and to investigate the potential to dry store the topsoil seedbank (to maintain high species germinability). To begin linking the upper lying *Banksia* woodland to the lower lying wetland community, a planting program is currently being planned for 2010.

All research activities on Lots 300, 301 and 6 Boomerang Road, Oldbury will be managed by BGPA personnel, whilst restoration activities will be managed by RQP personnel in direct consultation with BGPA personnel, thereby ensuring "best practice" restoration is maintained.

Yours sincerely

Professor Kingsley Dixon
Director, Science
Kings Park and Botanic Garden

Permanent Visiting Professor, School of Plant Biology
Faculty of Natural and Agricultural Science
The University of Western Australia

RPS

APPENDIX 4

Botanic Garden and Parks Authority Partnership Letter

BOTANIC GARDENS & PARKS AUTHORITY

KINGS PARK AND BOTANIC GARDEN • BOLD PARK

ABN 30 706 225 320

RECEIVED 07 APR 2008

Reply to: Kingsley Dixon
Directorate: Science
Telephone: 61 8 9480 3614
Facsimile: 61 8 9480 3641

1 April 2009

Mr Vern Newton
Resource and Development Manager
Rocla Quarry Products
PO Box 469
CLOVERDALE WA 6009

Dear Vern

A RESEARCH PARTNERSHIP BETWEEN ROCLA QUARRY PRODUCTS AND THE SCIENCE DIRECTORATE AT KINGS PARK AND BOTANIC GARDEN

This letter summarises a 13-year research partnership forged between Rocla Quarry Products and the Science Directorate at Kings Park and Botanic Garden (an adjunct department of the UWA) to tackle the complex environmental and biodiversity issues associated with post-mining restoration of the iconic *Banksia* woodland communities on the Swan Coastal Plain. It highlights the crucial role that Rocla Quarry Products have played in research and (the UWA) student programs focused on developing the restoration science underpinning conservation and ecological enhancement of *Banksia* woodland communities.

In 1995, Rocla approached Kings Park with a highly ambitious plan to return post-sand extracted sites to an ecosystem closely resembling the pre-sand extracted species composition of *Banksia* woodland. At the time, this ambition was well beyond the statutory compliance environmental requirements for the sand extraction industry. Despite this, Rocla sought the assistance of the Science Directorate at Kings Park to undertake research into the ecology and restoration of the *Banksia* woodland and subsequently built a long-term scientific partnership.

In the absence of any prior knowledge on *Banksia* woodland ecology, management and restoration, the research partnership embarked on a unique and completely novel approach to test ecological restoration theory based on melding the principles of adaptive management (decisions made on the basis of lessons learned) with integrated restoration science (linking core restoration disciplines). The vision of the project was to develop international leading practice for the integrated restoration of post-mined sites, and improve the States understanding of *Banksia* woodland ecology. Such an approach had not been attempted previously for a highly biodiverse ecosystem.

The research excelled in taking restoration of a biodiverse plant community to levels not often achieved on a global scale by other mining activities. Today, as a result of the research partnership, Rocla boasts one of the highest levels of species and plant reinstatement per unit area of post-mined restoration in the resources sector (>100 plants/5m^2), which is double the standard achieved by the industry leader, Alcoa Alumina, and testimony to the outstanding level of environmental stewardship and excellence arising from the research partnership and commitment.

Indeed, in October 2008, the success of the research partnership culminated in the awarding of the Golden Gecko award to Rocla and Kings Park for environmental excellence, with particular recognition given to the unique research partnership. Further testimony to Rocla's commitment to environmental research is the continued support into *Banksia* woodland ecology research with Kings Park, including restoration of native woodland within post-pine removal sites on the Gnangara Water Mound, thereby providing direct benefit to the State.

The ongoing research commitment by Rocla to the restoration of biodiverse *Banksia* woodland plant communities can be summarised and illustrated through the support, to date, of:

- ***Seven scientific journal publications*** (including two currently in preparation) co-addressed with The University of Western Australia.
- ***Five honours/independent level*** (UWA) students completed.
- ***Three Phd level*** (UWA) students and their respective programs (one completed, two commencing).
- ***Two ARC Linkage Grants*** through the UWA.
- ***A half-time senior scientist*** dedicated to the restoration ecophysiology of *Banskia* woodland communities.
- ***Four international scientific conferences*** (co-hosted by Kings Park and the UWA) related to mediterranean ecosystems, seed science, orchid biology and restoration ecology.
- ***Restoration of post-pine plantations*** that will assist the State program related to restoration of 20,000 ha post-pine removal (Gnangara Park), through in-kind and cash support to a UWA student.
- ***Restoration programs in Kings Park, through sponsorship.***
- ***Educational tours for students.***

Rocla's future commitments and research with Kings Park and the UWA includes:

- Investigating the potential to develop a seed orchard of *Banksia* woodland species to commence banking the significant seed source that will be required for the States' various restoration programs in the future.
- Salary maintenance of a 0.5FTE dedicated to the restoration ecophysiology of *Banskia* woodland communities for another three years (as part of a five-year commitment).
- A 3-year program investigating the restoration of post-pine plantations that will assist the State program related to restoration of 20,000 ha post-pine removal (Gnangara Park).

Outcomes of the Rocla/Kings Park research partnership have resulted in outstanding long-term community benefits – including improved understanding of

restoration of urban *Banksia* woodland remnants, e.g. the high profile bushlands at Kings Park and Bold Park. Without the commitment by Rocla, there would be limited understanding of *Banksia* woodland ecology, management and restoration. The partnership is an inspiration to industry and academia, demonstrating that restoration and knowledge-building of biodiverse ecosystems within a biodiversity hotspot is possible through dedicated, long-term environmental research excellence, leadership and partnership. '

For any questions, please do not hesitate to email kingsley.dixon@bgpa.wa.gov.au or deanna.rokich@bgpa.wa.gov.au, or telephone (08) 9480 3614.

Yours sincerely

Professor Kingsley Dixon
Director, Science
Kings Park and Botanic Garden

Permanent Visiting Professor, School of Plant Biology
Faculty of Natural and Agricultural Science
The University of Western Australia

Journal Articles

Rokich DP, Dixon KW, Sivasithamparam K. and Meney KA. (2000) Topsoil Handling and Storage Effects on Woodland Restoration in Western Australia. ***Restoration Ecology***. 8: 196-208.

Rokich DP, Meney KA, Dixon KW and Sivasithamparam K. (2001) The Impacts of Soil Disturbance on Plant Growth in *Banksia* Woodland Communities in the Southwest of Western Australia. ***Australian Journal of Botany***. 49: 169-183.

Rokich DP, Dixon KW, Sivasithamparam K and Meney KA. (2002) Smoke, Mulch and Seed Broadcasting Effects on Woodland Restoration in Western Australia. ***Restoration Ecology***. 10: 185-194

Turner SR, Pearce B, Rokich DP, Dunn RR, Merritt DJ, Majer JD and Dixon KW. (2006) Influence of Polymer Seed Coatings, Soil Raking, and Time of Sowing on Seedling Performance in Post Mining Restoration. ***Restoration Ecology***. 14: 267-277.

Rokich DP and Dixon KW. (2007) Recent Advances in Restoration Ecology, with a particular focus on the *Banksia* woodland and the smoke germination tool. ***Australian Journal of Botany*** 55:375-389.

Golos P, Rokich DP, Grierson P, Stevens JA. To plant or to sow: Returning *Banksia* species to post-mining restoration sites. (in prep for ***Plant and Soil).***

Ord R, Rokich, DP, Turner S, and Plummer JA. Wind erosion, and to a lesser extent invertebrate activity, play roles in seed displacement in woodland restoration (in prep for ***Journal of Applied Ecology***).

Book Chapters

Rokich DP. (2006) Achieving success in mine reclamation. Essay 15.2, Chapter 15. In: Principles of Conservation Biology - 3rd Edition (2006). Editors: Groom MJ, Meffe GK, Carroll CR. Sinauer Associates, Inc, USA.

Conference Proceedings

Rokich DP. (2000) Manipulation of Soil Seed-Banks for Mine-Site Restoration in Western Australia: A Case Study of a Sand Quarry within *Banksia* woodland. Proceedings of the third Australian Workshop on Native Seed Biology for Revegetation, ACMER.

Ord R, Rokich, DP, Turner S, and Plummer JA. (2007) Wind erosion and invertebrate activity on broadcast seed removal in *Banksia* woodland restoration. In Proceedings of the MEDECOS XI 2007 Conference, 2-5 September, Perth, Australia". Eds D Rokich, G Wardell-Johnson, C Yates, J Stevens, K Dixon, R McLellan and G Mos. pp: 183-184 Kings Park and Botanic Garden, Perth, Australia.

Student Theses (Phd)

Rokich DP. (2000) *Banksia* woodland restoration, University of Western Australia.

Ord R. (current) Post removal of *Pinus pinaster* plantations in Western Australia: Implications for reinstatement of Banksia woodland, a historical ecosystem assemblage, University of Western Australia.

G01151 (Disk 24)

Benigno S. (current) Interaction of drought and soil compaction stresses on the ecophysiological adaptation of keystone *Banksia* woodland species subject to minesite restoration, University of Western Australia.

Student Theses (Honours)

Pearce B (2004) Influence of Polymer Seed Coatings, Soil Raking, and Time of Sowing on Seedling Performance in Post Mining Restoration. Curtin University

Tuckett RE. (2005) Pre-treating broadcast seeds increases seedling emergence and survival for *Banksia* woodland restoration, University of Western Australia

Golos P. (2006) Returning *Banksia attenuata* and *B. menziesii* to sand mine restoration sites, University of Western Australia.

Ord R. (2007) Assessing the effects of wind erosion and invertebrate activity on broadcast seed removal in *Banksia* woodland restoration, University of Western Australia.

Student Independent Research Project

Whyte C. (2008) Seed displacement from an ecological and restoration perspective in rehabilitated *Banksia* woodland in Gnangara, Western Australia, University of Western Australia.

APPENDIX 5

LGA Quarry Noise Assessment

Noise Impact Assessment

Proposed Quarry at Lots 300 & 301 Boomerang Rd and Lot 6 Banksia Rd Oldbury

Prepared For

Rocla®

July 2009

LLOYD GEORGE Acoustics

Reference: 9061279-01 draft

Report: 9061279-01 draft

Lloyd George Acoustics Pty Ltd

ABN: 79 125 812 544

PO Box 717
Hillarys WA 6923

Offices:	Ocean Reef	Padbury	Scarborough	Waterford
Phone:	9300 4188	9401 7770	9245 3223	9313 3655
Fax:	9300 4199	9401 7770	9300 4199	9300 4199
Email:	daniel@lgacoustics.com.au	terry@lgacoustics.com.au	mike@lgacoustics.com.au	rebecca@lgacoustics.com.au
Mobile:	0439 032 844	0400 414 197	0438 201 071	0427 388 876

Member of the Association of Australian Acoustical Consultants – (AAAC)

Approved for Issue:	Daniel Lloyd 
Position:	Project Director
Verified	Terry George 
Date:	27 July 2009

CONTENTS

APPENDICES

1 INTRODUCTION

Rocla Quarry Products is proposing to develop a sand extraction pit on Lots 300 &301 Boomerang Road and Lot 6 Banksia Road, Oldbury, Western Australia. The location and outline of the project is shown in *Figures 1.1 and 1.2*.

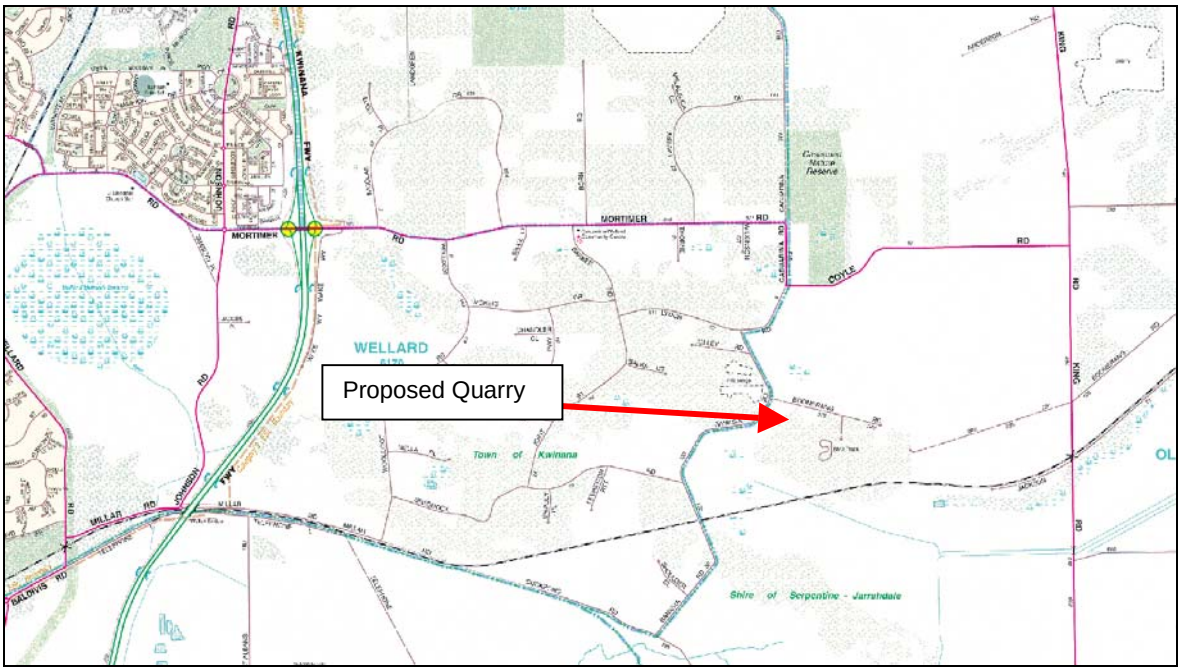


Figure 1.1 Proposed Quarry Locality

Figure 1.2 Proposed Quarry Extents

This assessment predicts the likely noise impacts from the quarry and compares the results against the *Environmental Protection (Noise) Regulations 1997*.

The quarry plant will consist of a mobile screen and front-end loader. Trucks will arrive on site via Boomerang Road and will be loaded with sand. It is expected that between two and four trucks per hour will access the quarry.

The quarry floor will be at an RL (ground level) of 18.0 metres and will start from the southeast corner of the site working towards the northwest corner. Three phases have been assessed. These being:

- Phase 1 - Quarry face in southeast corner;
- Phase 2 - Quarry face at middle of site; and
- Phase 3 - Quarry face at northwest of site (Final).

Appendix A contains a description of some of the terminology used throughout this report.

2 CRITERIA

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 7 defines the prescribed standard for noise emissions as follows:

"7. (1) Noise emitted from any premises or public place when received at other premises –

(a) Must not cause or *significantly contribute to*, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) Must be free of –

i. Tonality;

ii. Impulsiveness; and

iii. Modulation".

A "…noise emission is taken to *significantly contribute to* a level of noise if the noise emission exceeds a value which is 5dB below the assigned level…"

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

(a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) The noise emission complies with the standard after the adjustments of *Table 2.1* are made to the noise emission as measured at the point of reception.

Table 2.1 – Adjustments For Intrusive Characteristics

Tonality	Modulation	Impulsiveness
+ 5dB	+ 5dB	+ 10dB

Note: The above are cumulative to a maximum of 15dB.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown below in *Table 2.2*.

Table 2.2 – Baseline Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise Sensitive[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise Sensitive[2]	All hours	60	75	80
Commercial	All hours	60	75	80
Industrial	All hours	65	80	90

1. Applies within 15metres of a building associated with a noise sensitive use, as defined in Schedule 1, Part C.
2. Applies at a noise sensitive premises greater than 15metres from a building associated with a noise sensitive use.

As there are no major or secondary roads, or commercial/industrial land uses adjacent to the noise sensitive premises surrounding the proposed quarry, the influencing factor has been calculated as 0 dB. Therefore the baseline assigned levels would be used in this assessment.

In addition, as there are no other industries in the immediate vicinity, the noise from the proposed quarry would not be considered to '*significantly contribute'* to the existing noise environment.

3 ASSESSMENT METHODOLOGY

Computer modelling has been used to predict the noise from the proposed quarry operations. The software used is *SoundPLAN 6.5* with the CONCAWE algorithms selected. These algorithms have been selected as they are one of the few that include the influence of wind and atmospheric stability. Input data required in the model are:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.

3.1.1 Meteorological Information

Meteorological information utilised is based on that specified in EPA *Guidance for the Assessment of Environmental Factors No.8 Environmental Noise draft*, and are shown below in *Table 3.1*.

Table 3.1 –Modelling Meteorological Conditions

Parameter	Night (1900-0700)	Day (0700-1900)
Temperature (^{o}C)	15	20
Humidity (%)	50	50
Wind Speed (m/s)	3	4
Wind Direction*	All & Prevailing	All & Prevailing
Pasquil Stability Factor	F	E

* Note that the modelling package used allows for all wind directions to be modelled simultaneously.

Note that the above conditions approximate the typical worst-case for enhancement of sound propagation. The EPA policy is that compliance with the assigned noise levels needs to be demonstrated for 98% of the time, during the day and night periods, for the month of the year in which the worst-case weather conditions prevail. In most cases, the above conditions occur for more than 2% of the time and therefore must be satisfied.

At wind speeds greater than those shown above, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

3.1.2 Topographical Data

Topographical data was based on that provided by Rocla Quarry Products, which is from the Department of Land Information (DLI). The contours are in 1-metre intervals and cover the noise sensitive premises of concern.

Buildings have also been included as these can provide barrier attenuation when located between a source and receiver, much the same as a hill.

Additional topography was also included to represent the pit or stockpiles etc.

3.1.3 Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). As this is a rural setting, a value of 1.0 has been used for the study area.

3.1.4 Source Sound Levels

Table 3.2 shows the sound power levels used in the modelling.

Table 3.2 – Source Sound Power Levels, dB(A)

Description	One-third or Centre Octave Band Frequency (Hz)								Overall
	63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	
Front-end Loader	86	97	101	105	105	101	95	85	**110**
Mobile screen	69	76	79	86	95	97	94	88	**106**
	82	85	80	91	97	96	92	85	
	80	77	84	92	99	96	91	81	
Truck	93	90	93	92	96	94	84	70	**106**
	89	92	90	90	94	96	91	79	
	94	91	92	93	95	95	87	76	

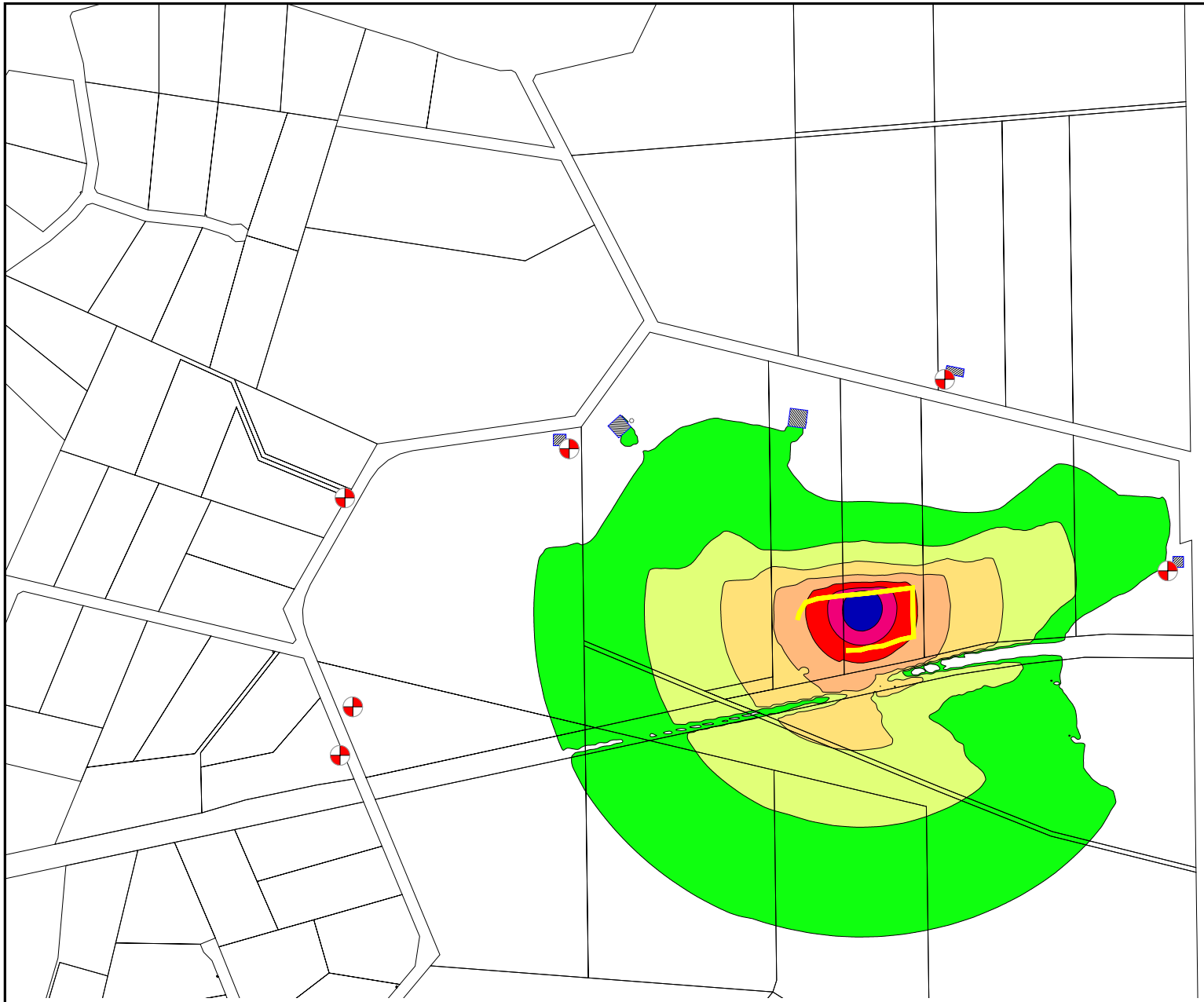
With regards to the above, please note the following:

- Source of data was from measurements undertaken at a similar sized Rocla Quarry Products operation;
- The front-end loader and screen will be operating for more than 10% of the time and represents the L_{A10} noise level. The truck movements will be present for less than 10% of the time and represents the L_{A1} noise level; and
- Location of screen and loader is at the quarry face as shown in the noise contour maps.

4 RESULTS

The results of the noise modelling are presented in *Figures 4.1 to 4.4.*

Figure 4.1



Noise level
L_{A10} dB

<= 45	Compliant With Regulations
<= 50	Exceeds Regulations
<= 55	
<= 60	
<= 65	
<= 70	
<= 75	
> 75	

Signs and symbols

- Property Boundaries
- Point source
- Buildings
- Quarry edge
- Point receiver

N

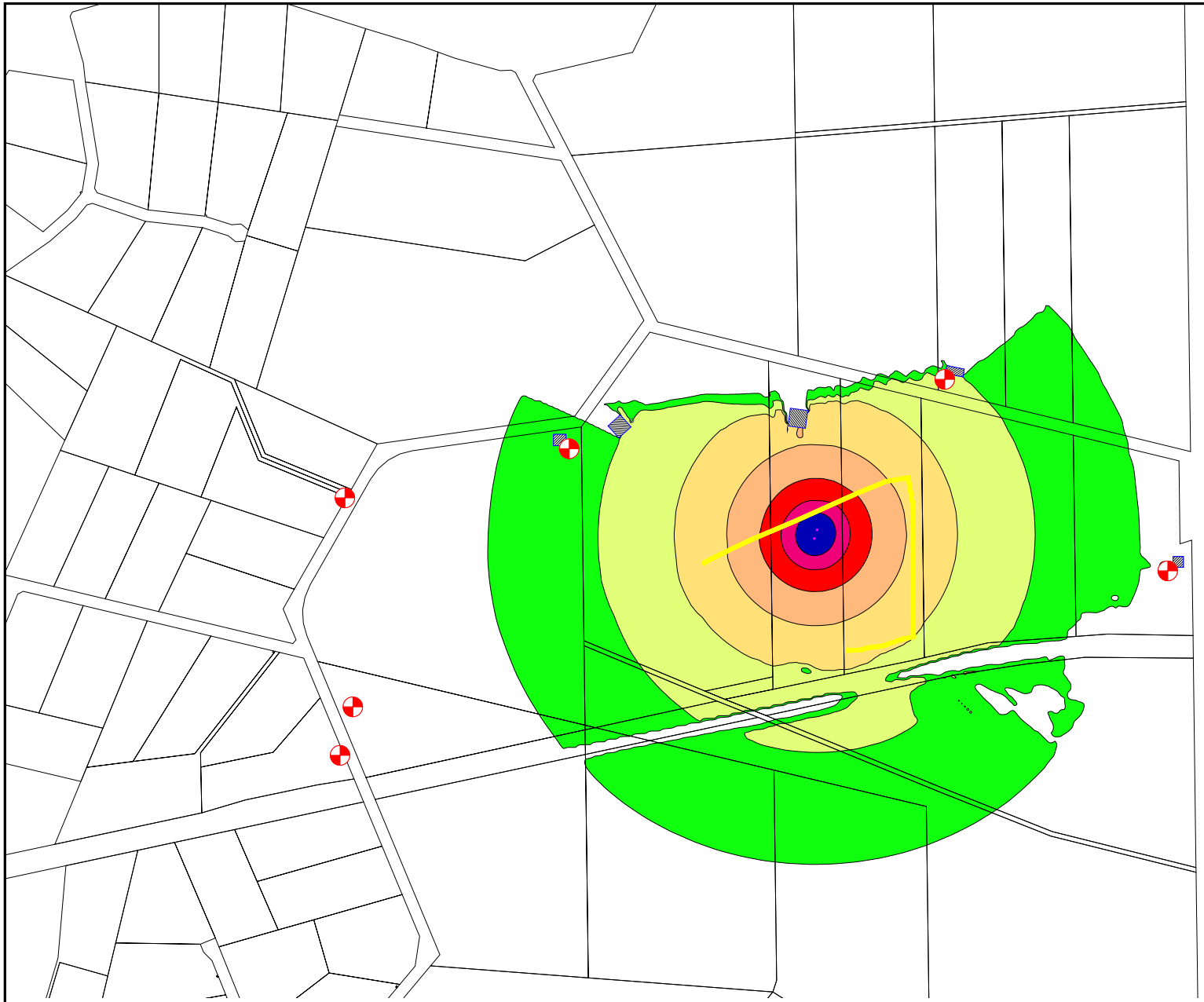
Length Scale

0 50 100 200 300 400 m

Rocla Quarry Products - Proposed Quarry at Lots 300 & 301 Boomerang Rd and Lot 6 Banksia Rd, Oldbury
Phase 1 - Predicted L_{A10} Noise Level Contours (Adjusted by +5 dB for Tonality) - Wind From All Directions

Lloyd George Acoustics
by Daniel Lloyd
daniel@lgacoustics.com.au
(08) 9300 4188

Figure 4.2



Noise level
L_{A10} dB

	<= 45	Compliant With Regulations
	<= 50	Exceeds Regulations
	<= 55	
	<= 60	
	<= 65	
	<= 70	
	<= 75	
	> 75	

Signs and symbols

- Property Boundaries
- Point source
- Buildings
- Quarry edge
- Point receiver

N

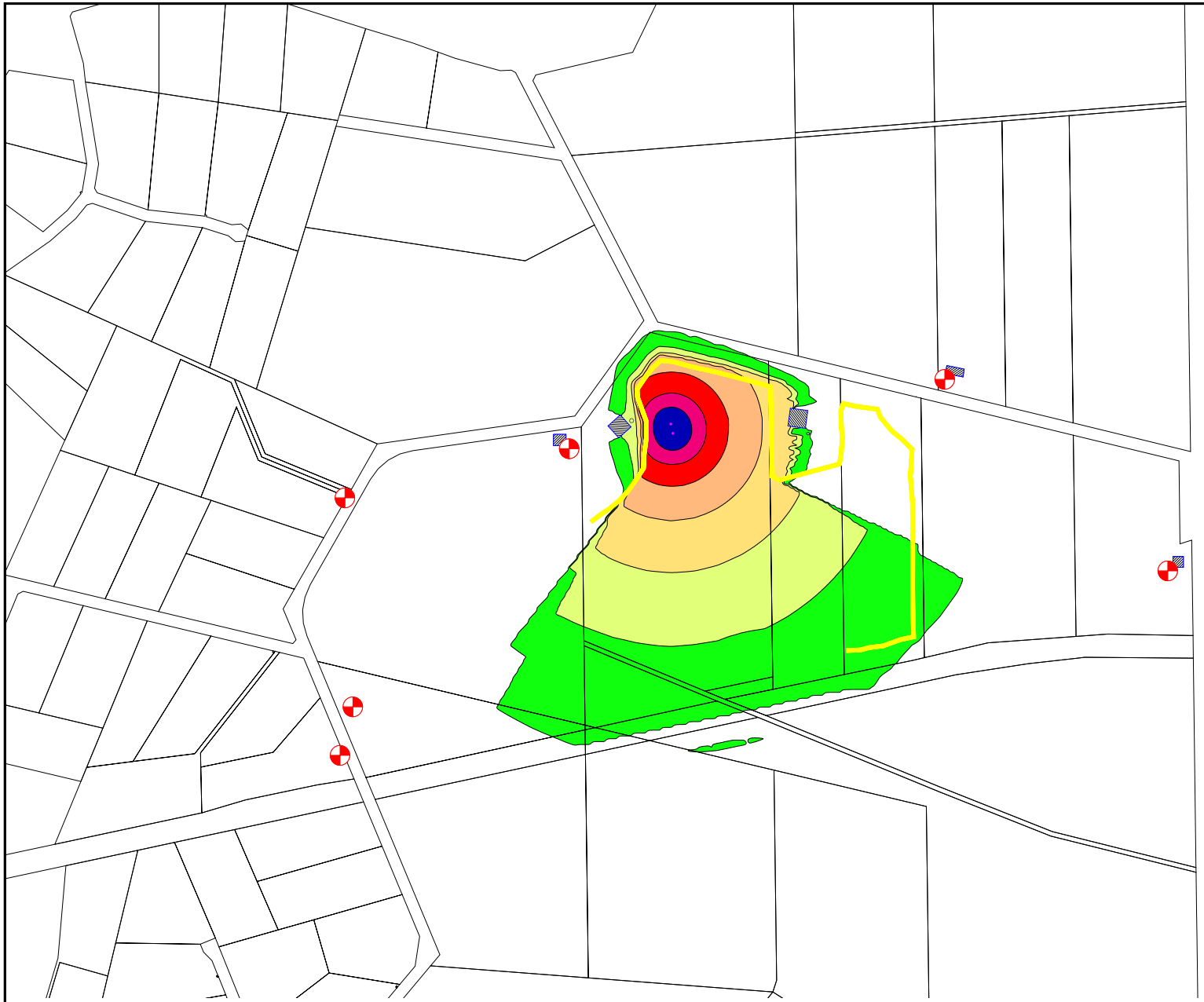
Length Scale

0 50 100 200 300 400 m

Rocla Quarry Products - Proposed Quarry at Lots 300 & 301 Boomerang Rd and Lot 6 Banksia Rd, Oldbury
Phase 2 - Predicted L_{A10} Noise Level Contours (Adjusted by +5 dB for Tonality) - Wind From All Directions

Lloyd George Acoustics
by Daniel Lloyd
daniel@lgacoustics.com.au
(08) 9300 4188

Figure 4.3



Noise level
L_{A10} dB

<=	45	Compliant With Regulations
<=	50	Exceeds Regulations
<=	55	
<=	60	
<=	65	
<=	70	
<=	75	
>	75	

Signs and symbols

- Property Boundaries
- Point source
- Buildings
- Quarry edge
- Point receiver

N

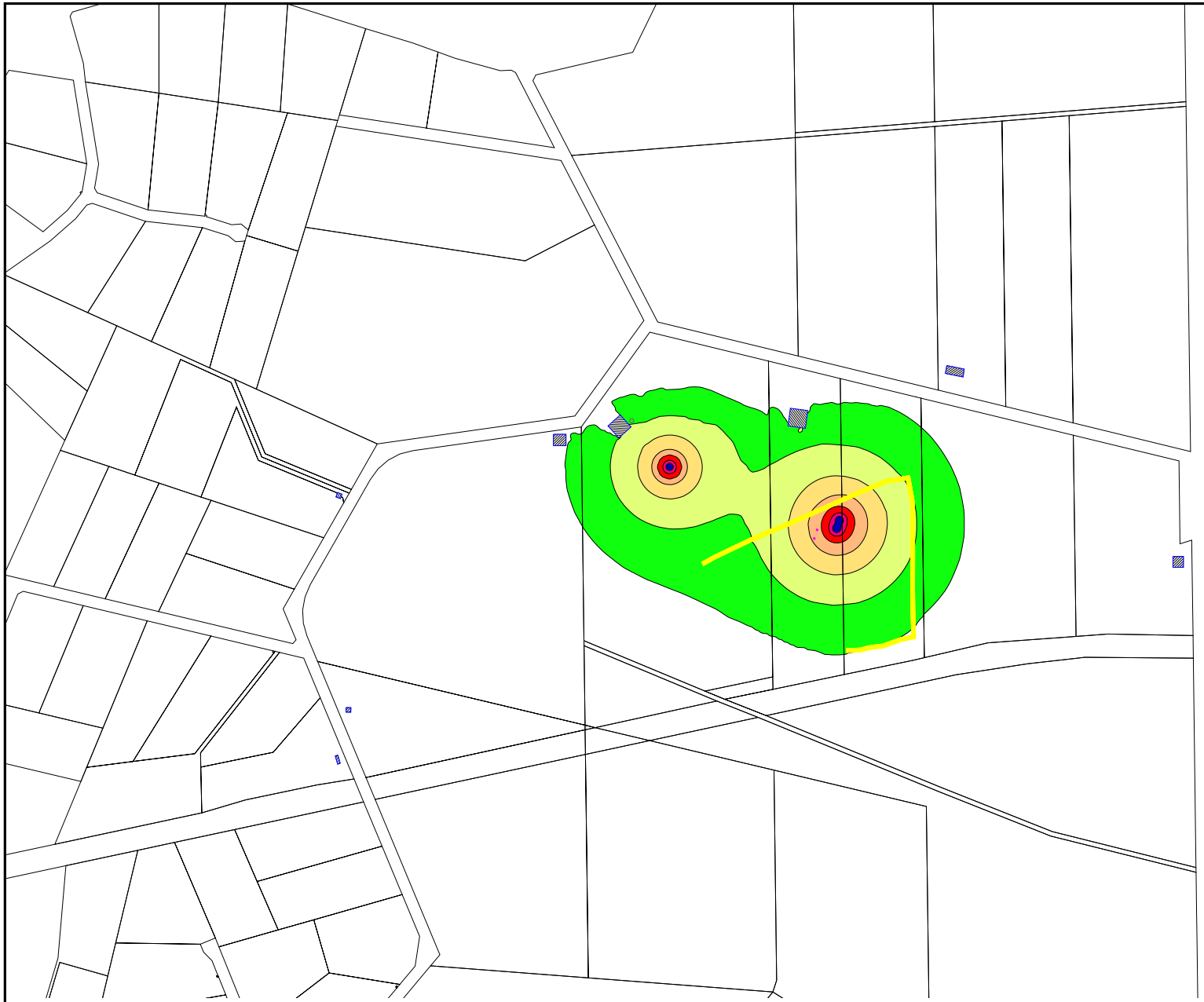
Length Scale

0 50 100 200 300 400 m

Rocla Quarry Products - Proposed Quarry at Lots 300 & 301 Boomerang Rd and Lot 6 Banksia Rd, Oldbury
Phase 3 - Predicted L_{A10} Noise Level Contours (Adjusted by +5 dB for Tonality) - Wind From All Directions

Lloyd George Acoustics
by Daniel Lloyd
daniel@lgacoustics.com.au
(08) 9300 4188

Figure 4.4



Noise level
L_{A1} dB

	<= 50	Compliant With Regulations
	<= 55	Exceeds Regulations
	<= 60	
	<= 65	
	<= 70	
	<= 75	
	<= 80	
	> 80	

Signs and symbols

- Property Boundaries
- Point source
- Buildings
- Quarry edge

N

Length Scale

0 50 100 200 300 400 m

Rocla Quarry Products - Proposed Quarry at Lots 300 & 301 Boomerang Rd and Lot 6 Banksia Rd, Oldbury
Phase 2 - Predicted L_{A1} Noise Level Contours - Wind From All Directions

Lloyd George Acoustics
by Daniel Lloyd
daniel@lgacoustics.com.au
(08) 9300 4188

5 ASSESSMENT

There were no noise sources that are considered to be modulating or impulsive, however tonality is likely to be present. It is considered that the tonality cannot be practicably removed and as such, the predicted L_{A10} noise levels in *Figures 4.1 to 4.3* have been adjusted by + 5 dB in accordance with *Table 2.1*.

During the initial phase of the operations (phase 1), the operations are far enough away for the noise sensitive receivers to achieve compliance with the Regulations during the daytime period.

The critical time is during the middle of the pit life (phase 2) when the quarry is moving closer to the residences located to the north. At this stage, assuming the quarry face runs straight across the site, the barrier effect from the quarry walls is insufficient to achieve compliance with the Regulations and an exceedance of up to 5 dB is likely during downwind conditions.

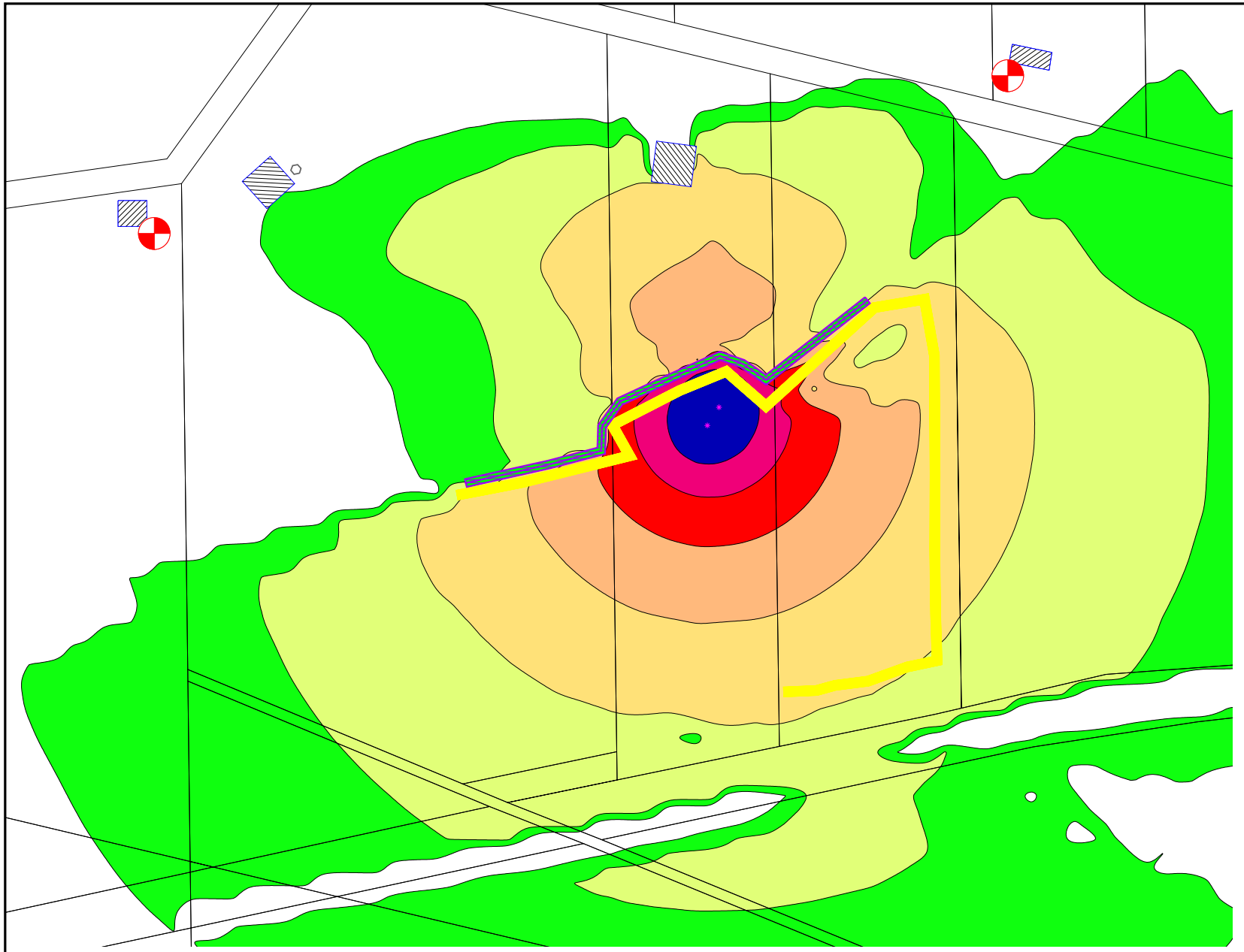
As the quarry moves into the final phases (phase 3), the walls of the quarry are high enough for the barrier effect to achieve compliance with the Regulations during the daytime period.

The L_{A1} noise levels, shown in *Figure 4.4*, are from the truck movements. This shows compliance with the assigned levels during the daytime period, when the truck is at the closest point to the nearest noise sensitive receiver. In reality, as the truck is moving, the noise will diminish quickly as the truck moves further away from the receiver.

6 RECOMMENDATIONS

To comply with the Regulations during the daytime period, a 5 dB reduction is required to the overall L_{A10} noise level when the project reaches phase 2. To achieve this, the barrier effect of the quarry walls needs to be increased and it is recommended to construct a bund along the quarry wall with an RL of 25.0 metres at the top of the bund. In addition, the profile of the quarry wall should be such that the screen is enclosed on three sides. The effect of these noise control measures is presented in *Figure 6.1*.

Figure 6.1



Noise level
L_{A10} dB

<= 45	Compliant With Regulations
<= 50	Exceeds Regulations
<= 55	
<= 60	
<= 65	
<= 70	
<= 75	
> 75	

Signs and symbols

- Property Boundaries
- Point source
- Buildings
- Quarry edge
- Noise Bund
- Point receiver

N

Length Scale

0 20 40 80 120 160 m

Rocla Quarry Products - Proposed Quarry at Lots 300 & 301 Boomerang Rd and Lot 6 Banksia Rd, Oldbury
Phase 2 with RL 25m Bund - Predicted L_{A10} Noise Level Contours (Adjusted by +5 dB for Tonality)
Wind From All Directions

Lloyd George Acoustics
by Daniel Lloyd
daniel@lgacoustics.com.au
(08) 9300 4188

APPENDIX A

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)

The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

Sound Power Level (L_w)

Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure levels at known distances. Noise modelling incorporates source sound power levels as part of the input data.

Sound Pressure Level (L_p)

The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

L_{ASlow}

This is the noise level in decibels, obtained using the A frequency weighting and the S time weighting as specified in AS1259.1-1990. Unless assessing modulation, all measurements use the slow time weighting characteristic.

L_{AFast}

This is the noise level in decibels, obtained using the A frequency weighting and the F time weighting as specified in AS1259.1-1990. This is used when assessing the presence of modulation only.

L_{APeak}

This is the maximum reading in decibels using the A frequency weighting and P time weighting AS1259.1-1990.

L_{Amax}

An L_{Amax} level is the maximum A-weighted noise level during a particular measurement.

L_{A1}

An L_{A1} level is the A-weighted noise level which is exceeded for one percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{A10}

An L_{A10} level is the A-weighted noise level which is exceeded for 10 percent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{Aeq}

The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

L_{A90}

An L_{A90} level is the A-weighted noise level which is exceeded for 90 percent of the measurement period and is considered to represent the "*background*" noise level.

One-Third-Octave Band

Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20 000 Hz inclusive.

L_{Amax} assigned level

Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded at any time.

L_{A1} assigned level

Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 1% of the representative assessment period.

L_{A10} assigned level

Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 10% of the representative assessment period.

Tonal Noise

A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

the presence in the noise emission of tonal characteristics where the difference between —

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

Modulating Noise

A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of tonality is:

> a variation in the emission of noise that —
>
> (a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;
>
> (b) is present for at least 10% of the representative

Impulsive Noise

An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of tonality is:

> a variation in the emission of a noise where the difference between $L_{A\ peak}$ and $L_{A\ Max\ slow}$ is more than 15 dB when determined for a single representative event;

Major Road

Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

Secondary / Minor Road

Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

Influencing factor

$$= \frac{1}{10}(\%\ \text{Type A}_{100} + \%\ \text{Type A}_{450}) + \frac{1}{20}(\%\ \text{Type B}_{100} + \%\ \text{Type B}_{450})$$

where:

$\%\ \text{Type A}_{100}$ = the percentage of industrial land within a100m radius of the premises receiving the noise

$\%\text{TypeA}_{450}$ = the percentage of industrial land within a 450m radius of the premises receiving the noise

$\%\ \text{Type B}_{100}$ = the percentage of commercial land within a100m radius of the premises receiving the noise

$\%\text{TypeB}_{450}$ = the percentage of commercial land within a 450m radius of the premises receiving the noise

+ Traffic Factor (maximum of 6 dB)

= 2 for each secondary road within 100m

= 2 for each major road within 450m

= 6 for each major road within 100m

Representative Assessment Period

Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

Background Noise

Background noise or residual noise is the noise level from sources other than the source of concern. When measuring environmental noise, residual sound is often a problem. One reason is that regulations often require that the noise from different types of sources be dealt with separately. This separation, e.g. of traffic noise from industrial noise, is often difficult to accomplish in practice. Another reason is that the measurements are normally carried out outdoors. Wind-induced noise, directly on the microphone and indirectly on trees, buildings, etc., may also affect the result. The character of these noise sources can make it difficult or even impossible to carry out any corrections.

Ambient Noise

Means the level of noise from all sources, including background noise from near and far and the source of interest.

Specific Noise

Relates to the component of the ambient noise that is of interest. This can be referred to as the noise of concern or the noise of interest.

Satisfactory Design Sound Level

The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

Maximum Design Sound Level

The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Reverberation Time

Of an enclosure, for a sound of a given frequency or frequency band, the time that would be required for the reverberantly decaying sound pressure level in the enclosure to decrease by 60 decibels.

RMS

The root mean square level. This is used to represent the average level of a wave form such as vibration.

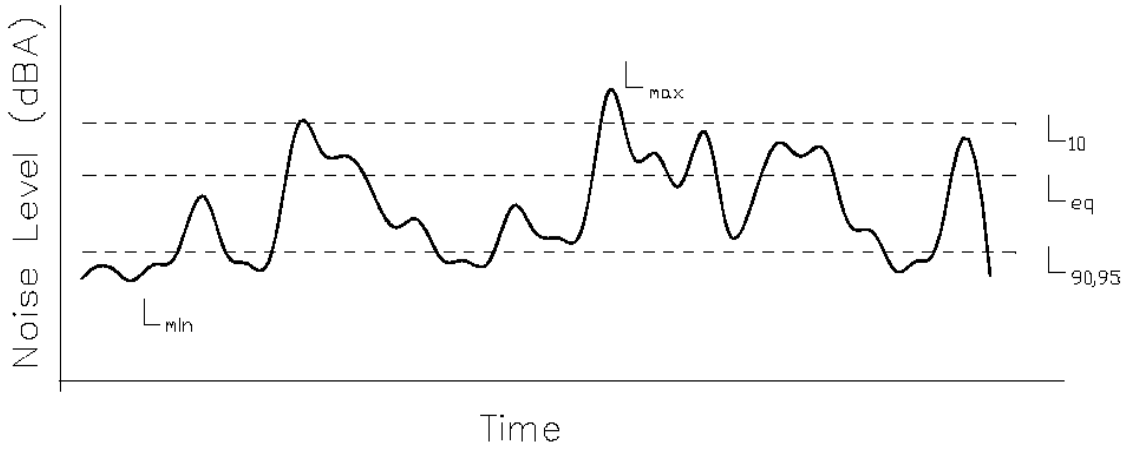
Vibration Velocity Level

The RMS velocity of a vibration source over a specified time period. Units are mm/s.

Peak Velocity

Level of vibration velocity measured as a non root mean square (r.m.s.) quantity in millimetres per second (mm/s).

Chart of Noise Level Descriptors



Typical Noise Levels