2.8 Vegetation

2.8.1 Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road Vegetation Survey

The findings of the Level 1 Flora and Vegetation Survey (requested by the DER to be undertaken) conducted in October 2008 of Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury (RPS 2012c), can be summarised as follows:

- Botanists recorded 122 taxa from 38 plant families across the site; 18 of these taxa are exotic species that are naturalised weeds.

- No Declared Rare Flora (DRF) species, as listed under subsection (2) of Section 23F of the Western Australian Wildlife Conservation Act 1950 or Priority Flora species as listed by the Department of Environment and Conservation (Atkins 2008) were located within the study area. No species governed by the Environment Protection and Biodiversity Conservation Act 1999 were located within the study area.

- No other flora species of other conservation significance as stated in Guidance Statement 51 (EPA 2004) or as listed in Bush Forever (Western Australian Planning Commission 2000) were recorded within the study area.

- Three vegetation units were mapped for the study area. The vegetation units of the study area are inferred to represent Floristic Community Type (FCT) 21a Central Banksia attenuata – Eucalyptus marginata woodlands. This community type is centred on, but not exclusive to the Bassendean Dunes system. This community type is considered to be Well Reserved and Low Risk (Gibson et al. 1994).

- The vegetation condition of the study area ranged from Very Good to Completely Degraded (Figure 7).

- The south-eastern portion of the survey area has been mapped by Heddle et al. (1980) as part of the Serpentine River Complex (Figure 8). This complex has less than 10% remaining in the Perth Metropolitan Region of the Swan Coastal Plain (SCP), which makes it regionally significant under the Bush Forever criteria. However, the vegetation on site is not representative of the “typical” Serpentine River Complex; instead it is more similar to the Bassendean Complex, or may be a “transition area” between the two. Also, the vegetation within the mapped Serpentine River Complex that is of Good or better condition is small and surrounded by many disturbance factors that make it unlikely to be viable in the long-term. This was confirmed by detailed mapping of the boundary in 2012.

- FCTs and therefore potential TECs or other conservation significant plant communities cannot be positively confirmed without conducting a statistical analysis of plot-based data.
2.8.2 **L120 Wetland Vegetation Assessment**

Mattiske Consulting (2012) assessed the vegetation type at the L120 Wetland and the wetland area to the north of the railway line. It should be noted that the survey at the L120 Wetland was based on visual observation outside the site boundary due to access issues at the site.

The observed vegetation includes:

- **Upperstorey** – Closed woodland to woodland of *Melaleuca preissiana* with emergent *Eucalyptus rudis* Endl
- **Mid to lower storey** – *Taxandria linearifolia*, *Astartea fascicularis*, *Gastrolobium ebracteolatum* and *Pteridium esculentum*
- **Lower to ground storey** – *Juncus holoschoenus*, *Centella asiatica*, *Cycnogeton lineare* and *Cyclosorus interruptus*
- **Exotics** – *Zantedeschia aethiopica*, *Ehrharta longifolia*, *Sonchus oleraceus*, *Arctotheca calendula*, *Solanum nigrum*, *Gomphocarpus fruticosus* and *Carpobrotus sp.*

The outcomes of the vegetation assessment include:

- The preliminary assessment and comparison of vegetation within the L120 Wetland and the adjacent wetland to the north of the railway line (within Lots 6 and 300) suggests that these areas were once part of a larger contiguous wetland system that has been disconnected by railway construction.

- Wetland L120 and the wetland north of the railway line both comprise typical Serpentine River Complex associations, with species and structure conforming to those detailed within Supergroup 2: Seasonal Wetlands (Bassendean landform types).

The Mattiske Consulting (2012) report is provided within the Hydrology Assessment in Appendix 1.

2.9 **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 2000).

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1Fern previously mapped as *Cyclosorus interruptus* is most likely *Histiopteris incise* (Mattiske Consulting 2012).
Evidence of Dieback (*Phytophthora cinnamomi*) was not witnessed during the Level 1 Flora and Vegetation Survey or by the Kings Park Botanical Gardens Park Authority site review of the Banksia Woodlands (RPS 2013c).

### 2.10 Weeds

#### 2.10.1 Presence

**2.10.1.1 Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road**

Weeds were one of the determining factors influencing the vegetation condition categorisation and mapping in accordance with the Keighery (1994) Bushland Condition Rating Scale. The 2008 flora and vegetation survey recorded 18 weeds or 15% of the total flora recorded. The majority of introduced flora was from the Poaceae (grass) and Asteraceae (daisy) families.

Subsequently an RPS botanist reviewed Lots 6, 300 and 301 in 2012 as part of the vegetation complex assessment. It was noted in the assessment there was an extensive distribution of weed in and surrounding the disturbed areas, for example adjacent to fire breaks, around the houses and in the western and southern portion of Lot 6. The key weed species identified are outlined below:

- *Ehrharta calycina*
- *Ehrharta longifolia*
- *Avena barbata*
- *Briza maxima*
- *Hypochaeris glabra*
- *Zantedeschia aethiopica.*

The Environmental Weeds Strategy for WA (EWSWA) (CALM 1999), rated all the weeds known for Western Australia at the time of publication, according to invasiveness, distribution and environmental impact. The above listed weeds were rated as being high or moderate in relation to their invasiveness.

It is considered more than likely since spring 2008 the density and distribution of the weed species has significantly increased particularly adjacent to cleared areas. It is anticipated as a result there is now an increased weed load. This weed load if left unmanaged, would likely be a contribution towards the further deterioration of the vegetation condition within the remnant vegetation present within Lots 6, 300 and 301.

**2.10.1.2 L120 Wetland**

Weed species visually encountered at the L120 Wetland are:

- *Arctotheca calendula*
2.10.2  **Weed and Dieback Monitoring**

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

- 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 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.

2.11  **Acid Sulfate Soil Risk Potential**

2.11.1  **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 proposed excavation clearing area is mapped as having a low to moderate risk of ASS occurring within 3 m of natural soil surface (or deeper).

2.11.2  **Geotechnical Testing**

Roca undertook geotechnical investigations including soil analysis of the site in 2006 using six test pits. The test pits were installed to a depth of approximately 5 m below ground level (bgl). Geotechnical investigations 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 given the predominantly Aeolian origin 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 wetland area excluded from the extraction area.

2.11.3 **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, an ASS Site Self-assessment Form was completed, using existing knowledge of the site. In accordance with the self-assessment form no further investigation is required for the following reasons:

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 buffer zone at least 60 m wide.

2.12 **Contaminated Site Potential**

The Contaminates Sites Database (DER 2013) does not indicate the site is contaminated. There are no known potentially contaminating activities that have occurred at the site.
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3.0 THREATENED ECOLOGICAL COMMUNITY

3.1 Description

3.1.1 Overview

This section provides information on Tumulus Springs and is a summary of relevant sections from CALM (2006). The protection area of the Tumulus Spring covers a total area of 0.7 ha. It is separated from the extraction area by a railway line and embankment and is at its closest point 80 m from the sand extraction boundary.

3.1.2 Hydrology of Tumulus Springs

“Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain” (Tumulus Springs) have historically occurred where the sands of the Bassendean Sand meet with the lower permeability Guildford Formation clays. Continuous discharge of groundwater in raised areas of peat results in permanently moist peat and some springs are associated with permanent pools and surface water. Some flora and fauna are reliant on a permanent supply of freshwater, with some reliant on permanent moisture.

The springs are believed to be fed by a complicated network of conduits. Where water finds a “preferred pathway” or conduit through the soil, water movement is much faster than normal groundwater flow. Such conduit pipes may carry sand and silt to the surface, where it is deposited as a “collar” of increasing height, so enhancing the formation of mounds. Water continues to penetrate the increasingly elevated peat layers due to the pressure created by local and regional hydrological forces.

Evidence for the underground flow being in confined conduits is provided by large pieces of material, for example the carapaces of crustaceans that bubble up in the spring waters. Also, the pressure required to push water through the peat mounds could presumably only originate from confined flow and not from diffuse groundwater sources. Anecdotal information indicates that during excavation of one spring area, the earthworks exposed “rabbit burrow-like” conduits carrying loose sand and water within the Guildford Clay layer.

3.2 Conservation Status

“Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain” were listed under the EPBC Act as an endangered TEC on 16 July 2000 (DSEWPaC 2013).
3.3 Hydrological Requirements

As detailed in Section 3.1, some flora and fauna are reliant on a permanent supply of freshwater, with some reliant on permanent moisture.

3.4 Drainage in Preservation Area

Drainage at the L120 Wetland has been significantly impacted by anthropogenic drainage features. These include:

- groundwater drainage flowing into the wetland from the east
- the groundwater drain at the south-eastern corner of the wetland
- the groundwater drain directly south and west
- the railway embankment, tracks, paths and culvert.

The Mundijong Drainage District was officially gazetted as a drainage area in 1950 (then amended in 1958) to remove water from the area and assist with agriculture. Hence the open drains in the area are expected to have been functioning for more than 50 years.

Further details are provided in Section 2.7 and Appendix 1.
4.0 PROPOSED MODIFICATIONS

4.1 Target Requirements

Roclá proposes to clear 11.6 ha of native vegetation within Lots 6, 300 and 301 Oldbury (the project area) for the purpose of sand extraction. The proposed clearing area is illustrated in Figure 2.

DER on advice from DPaW requested further investigation regarding hydrological connection between the site and the L120 Wetland, and potential impacts to the hydrology of the L120 Wetland associated with sand extraction. For example in 2008, DER specifically requested further information relating to water management as outlined below:

Clearing of vegetation from a sandy rise adjacent to wetlands could impact the hydrogeology of the wetland including increase in recharge, water logging and more extreme fluctuations in water levels.

In 2012 in discussion between Rocla and the DER, this HMSP was agreed to be prepared to address this issue.

4.2 Proposed Design and Drainage Modifications

The primary means of drainage modification at the site is an expected increase in groundwater recharge rates associated with vegetation removal. Groundwater modelling conducted over the region 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. 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 modelling prediction is conservative as it does not include the controlling effects of open drains in the area. Details of groundwater modelling are provided in Appendix 1.
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5.0 RESULTS OF HYDROLOGICAL INVESTIGATIONS

5.1 Purpose of Review

A hydrological assessment related to the proposed sand quarry has been undertaken. The purpose of the hydrology assessment was to estimate the potential impacts of the proposed quarry on the hydrology of the L120 Wetland to the south. The location of the L120 Wetland is provided on Figure 3. Full details of the hydrology assessment are provided in Appendix 1.

5.2 Summary of Findings

The investigations have included:

- groundwater modelling to estimate the potential for water level changes in the wetland associated with the sand quarry
- three field assessments (and reporting) to investigate site specific hydrology
- elevation surveying to assess the impact of anthropogenic features (open drains and railway embankment) on the hydrology of the wetland
- an expert peer review of the RPS hydrology assessment by JDA Consultant Hydrologists
- a vegetation assessment by Mattiske Consulting
- a site specific risk analysis of sand quarrying impacts on groundwater dependent vegetation within the L120 Wetland.

The outcomes of the hydrology investigations are summarised as follows:

- 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. 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.

A risk analysis of impacts associated with the predicted water level changes can be provided by comparison with generic Ecological Water Requirements (EWRs) established by the Department of Water for the Swan Coastal Plain and Blackwood region (Hyde 2006). These generic EWRs relate to maximum drawdown limits and
rate of change limits for wetlands and phreatophytic vegetation. The DoW document includes “risk of impact” categories for wetlands that were developed by Froend and Loomes (2004).

As stated in Hyde (2006), the categories were developed based on the results of research into the response of vegetation to groundwater decline. The cumulative rate and magnitude of the predicted groundwater drawdown is defined and the possible ecological responses to the varying degrees of drawdown are described broadly as either low, moderate, high or severe in terms of probability of noticeable impact to groundwater change. The risk categories for wetlands are shown on Graph 8.

Graph 8: Risk of Impact for Wetland Vegetation based on Magnitude of Groundwater Level Change

This criterion indicates a maximum drawdown of 0.3 m at a rate of less than 0.1 m/yr is required to maintain wetland vegetation at a low level of risk. The predicted long-term maximum increase at the L120 Wetland (0.15 m) is less than the generic EWR “low impact” change provided by the DoW.

In its hydrology study, RPS (2012b) noted that increases in wetland water levels are expected to be controlled by anthropogenic factors such as drains, and that any slight increases in levels may be beneficial. JDA (2012) confirmed this view, and stated that the slight increase in water levels predicted by the computer model may be beneficial due to declining groundwater trends in the region, and that any increases in water levels are likely to be controlled by open drains in the immediate vicinity.
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.

5.3 Review Recommendations

Modelling and on-site investigations indicate little risk, additional management contingency measures are to be adopted should the water level in the L120 Wetland rise to an unacceptably high level in the future, which is deemed to be the level at which environmental impacts are considered likely to occur to the L120 Wetland. These include:

- an ongoing groundwater monitoring program at the southern boundary of the site, between the sand extraction area and L120 Wetland
- accelerated revegetation to minimise groundwater recharge
- the planting of phreatophytes to increase groundwater uptake via transpiration
- managed abstraction of groundwater at the site
- 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.

5.4 Actions Undertaken to Date

In March 2012, Rocla submitted a purpose permit clearing application to clear native vegetation at the site to the DER Native Vegetation Branch. There were significant amendments to the clearing areas from the original 2009 application as a result of discussions with the DER and the Appeals Convenor. Table 2 below illustrates the previous revisions to the clearing areas.
The proposed purpose permit clearing area boundary is 15.2 ha. The actual remnant native vegetation clearing area is 11.6 ha. This represents a 3.3 ha reduction in the clearing area from the 2010 revised area which was reviewed by the Appeals Convenor and the Minister for the Environment. Further, Rocla proposed to rehabilitate 4 ha of existing cleared land within the mining footprint and a further 0.4 ha outside of the mining footprint. Additionally, the ecological corridor width was increased by a minimum of 60 m.

To minimise risk to the L120 wetland Rocla agreed with the DER to undertake a hydrological study of the site and assessed the potential impacts of a proposed sand quarry on the L120 Wetland based on several site visits, groundwater modelling and a groundwater dependent ecosystem (GDE) risk assessment. The assessment identified operational drains on the south and southeast side of the L120 Wetland, which would 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. This HMSP is the culmination of all the works completed to an agreed template between the DER and Rocla.

<table>
<thead>
<tr>
<th>Site</th>
<th>Clearing Area (ha)</th>
<th>Reduction of Clearing Area (%) – from the Original</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial Purpose Permit Application (ha)</td>
<td>2010 Revised Clearing Area (ha)</td>
</tr>
<tr>
<td>Oldbury</td>
<td>24.78</td>
<td>14.90</td>
</tr>
</tbody>
</table>
6.0 IMPLEMENTATION OF PLAN

Details provided in this section are summarised from ENV (2011).

6.1 Roles and Responsibilities

All personnel associated with the proposed sand extraction activities must comply with all relevant environmental regulations, standards and legislation. In addition, Rocla is to ensure personnel comply with all conditions of relevant licences, permits, consents and approvals related to the project.

The environmental responsibilities of key project personnel are outlined in the following sections.

6.1.1 Superintendent

Pursuant to this management plan, the Rocla Superintendent is responsible for:

- assessing, reviewing and auditing construction activities to ensure they follow the objectives defined in this management plan
- the review and endorsement of all Environmental Management Non-Conformance Reports
- the review of construction and environmental management plans and method statements to verify that adequate environmental management measures have been incorporated into the planning of particular construction processes.

6.1.2 Supervisory Personnel – Project Engineers and Supervisors

Pursuant to this management plan, all Supervisory Personnel will be responsible for:

- complying with relevant Acts, Regulations, Codes of Practice and Standards and the Environmental Policy and Procedures
- ensuring requirements of this management plan are fully implemented and, in particular, that environmental management requirements are not subordinated by other construction requirements
- undertake inspections to check compliance with requirements of control plans, method statements, and inspection and test plans
- preparation of reporting documents
ensuring all permanent works incorporate all relevant requirements stemming from this management plan

establishment and maintenance of this management plan in accordance with the requirements of the contract such that it complies with all applicable environmental regulations

provision of all necessary environmental training, including induction of project personnel on project environmental matters

reporting to the Superintendent on environmental issues and non-conformances, etc.

ensuring all project staff have a clear understanding of environmental management obligations and their responsibilities within their areas/scope of work

preparation, review, endorsement and maintenance of a register of all environmental management related documents

initiation of remedial action to resolve non-conformances

ensuring all subcontractors comply with the relevant legislation and this management plan

prompt reporting to management of any non-conformances and/or breaches of systems.

6.2 Induction and Training

All employees shall receive suitable environmental training to ensure they are aware of their responsibilities and are competent to carry out their work in an environmentally acceptable manner. Environmental requirements shall be explained to employees during a site induction. Ongoing training shall be provided via toolbox meetings and the like. All inductions and ongoing training shall be recorded.

All employees (including subcontractors) shall receive awareness training in the following areas:

- environmental policies

- this management plan and related documents

- site environmental objectives and targets
understanding the regulatory requirements applying to the project and their consequent responsibilities as a member of the project team

potential consequences of departure from procedures

emergency procedures and responses

identification of their legal obligations.

Personnel performing tasks that may cause significant environmental impacts must be certified as having completed relevant induction and training processes, and / or as having gained appropriate experience, before undertaking such tasks.

### 6.3 Communication

Internal and external communication mechanisms, such as the following, will be established to ensure that all employees, senior management and other interested parties are appropriately informed on project related environmental issues.

#### 6.3.1 Internal Communication

Internal communication methods will include the following, as appropriate:

- meetings
- project reports
- performance assessments
- audits and non-conformance reports
- notice boards
- employee inductions, training and toolbox sessions (as required)
- subcontractor coordination meetings.

#### 6.3.2 External Communication

External communication methods will include the following, as appropriate:

- public notices and announcements
- meeting and correspondence with regulatory authorities
- handling of and responding to community complaints.

### 6.4 Reporting

Performance reporting is required to provide systematic, comprehensive and informative documentation of the environmental performance management and monitoring during the project.
The following will be undertaken:

- fortnightly site inspections to ensure all personnel comply with this management plan
- fortnightly Incident Report summarising any incidents occurring in the period, including comments on response procedures and preventative actions. This report will also include any actions required in response to adverse monitoring results and contingency actions implemented.

6.5 Complaints

In the event of a public complaint, the Rocla complaints handling procedure will be applied.
7.0 POTENTIAL ENVIRONMENTAL IMPACTS

7.1 Stormwater (Surface Water) Impacts

7.1.1 Surface Water Catchments

The site is underlain by Bassendean Sand, which is known to have a high rainfall infiltration rate. Consequently surface run-off from the sand excavation area to the L120 Wetland is not expected.

7.1.2 Pollution of Preservation Area

The L120 Wetland has the potential to be impacted via the contamination of surface / groundwater resources from “point sources” such as fuel spills.

7.1.3 Erosion and Siltation

Erosion and sedimentation of waterways are strongly linked with the loss of fringing vegetation, catchment clearing and flood plain degradation. Erosion and sedimentation are caused by changes in flow regimes and channel accommodation changes.

7.1.4 Dieback and Weed Dispersal

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 after sand mining which contributes to the loss of biodiversity.

7.2 Groundwater Impacts

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 L120 Wetland.
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8.0 WATER MANAGEMENT OBJECTIVES AND CRITERIA

8.1 Key Objectives

In line with the National Water Quality Management Strategy (ARMCANZ/ANZECC 2000) and the Stormwater Management Manual for Western Australia (DoW 2004-2007), the key objectives of this HMSP are:

- **Water Quality.** To maintain or improve surface and groundwater quality, compared with pre-development conditions and ensure no significant water quality impacts at the L120 Wetland.

- **Water Quantity.** To manage the total water cycle to ensure no significant water level impacts at the L120 Wetland.

- **Ecosystem Health.** To ensure no significant ecological impacts at the L120 Wetland.

The stormwater management hierarchy to determine the most appropriate approach to achieve these objectives is (modified from ENV 2011):

1. Retain and restore natural drainage lines, retain and restore existing valuable elements of the natural hydrological system.

2. Implement non-structural controls, minimise pollutant inputs principally via planning, organisational and behavioural means to minimise pollution entering the hydrological system.

3. Minimise run-off, infiltrate or reuse rainfall as high in the catchment as possible. Install structural controls at or near the source to minimise pollutant inputs and the volume of stormwater.

4. Use in-system management measures, including vegetative measures, such as swales and riparian zones, and structural quality improvement devices such as gross pollutant traps.

8.2 Stormwater (Surface Water) Management

General stormwater management objectives and criteria for the L120 Wetland includes (modified from ENV 2011):
- the maintenance of the current hydrological regime during and following sand extraction

- the continued prevention, reduction and protection of the L120 Wetland from potential contamination, erosion, siltation, weeds and Dieback dispersal caused by surface water flows.

These objectives will be achieved by implementation of source control techniques and best management practices (BMPs).

### 8.3 Groundwater Management

The general groundwater management objective during and following implementation of the proposed sand extraction is to maintain the groundwater regime to pre-extraction conditions.

This will be achieved by implementation of source control techniques and BMPs.

### 8.4 Water Quality Management

The general water quality management objective is to maintain (and where possible improve) water quality at the L120 Wetland.

Water quality management within the L120 Wetland is to be achieved by:

- establishing groundwater quality targets at the southern end of the Rocla site, between the excavation and the L120 Wetland. The targets will be based on pre-development groundwater quality and relevant ANZECC (2000) water quality guidelines

- implementation of source control techniques and BMPs

- establishment of a groundwater monitoring program to assess post-extraction impacts.
9.0 WATER MANAGEMENT STRATEGIES

9.1 Stormwater (Surface Water) Management Strategies

9.1.1 Water Discharge

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 above the maximum water table, no dewatering will be required.

9.1.2 Pollution of Sensitive Areas

Water infiltrating within the quarry will be by direct rainfall 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.

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 are not anticipated.

9.1.3 Protection During Clearing Activities

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
- encourage the spread of weeds
- impacts on lifestyle opportunities.

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 which exceeds the EPA Guidance Statement No. 33 (EPA 2005)

- provision of a minimum 60 m north-south ecological corridor link along the boundary of Lot 6 and Lot 300 (Figure 9), 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 rehabilitation of the site in collaboration with BGPA to utilise over fourteen years of research into Banksia Woodland restoration

- provision of the site to be used in future Banksia Woodlands rehabilitation research trials by BGPA

- Dieback prevention measures in accordance with Rocla protocols

- weed control measures during and after sand mining.

9.1.4 Erosion and Siltation

Impacts by erosion and siltation will be managed by:

- stage clearing of the site in accordance with Figure 10 therefore minimising the exposed areas at any one time

- commence rehabilitation works at the completion of each mining stage in collaboration with BGPA

- maintain all haul road and hardstand surfaces in good condition and with suitable grades.

9.1.5 Dieback and Weed Dispersal

The proposed management of weeds and Dieback (Phytophthora cinnamomi) is detailed below.

9.1.5.1 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.

9.1.5.2  **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.

9.1.5.3  **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.

9.1.5.4  **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 rehabilitation works commencing) and repeated again within twelve months.

9.1.5.5  **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.
9.2 **Groundwater Management Strategies**

9.2.1 **Diversion of Shallow Groundwater Flows**

Sand extraction activities will not intersect the water table, hence no groundwater flow diversion will occur.

In accordance with Statewide Policy No. 1 (WRC 1999), sufficient clearance above the water table will be maintained to ensure:

- Accidental fuel spills can be contained in the unsaturated zone for a reasonable period of time.
- Evaporation losses during mining and evapotranspiration losses after mine closure are minimised.

Due to the absence of on-site groundwater elevation data, 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 over-estimation 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. Further details of the FMWT determination are provided in Appendix 2.

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 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 DER as a way forward.

9.2.2 **Groundwater Recharge and Infiltration**

The sand extraction activities and vegetation clearing have the potential to increase groundwater recharge rates and consequently groundwater levels in the L120 Wetland.

Rocla will monitor groundwater levels at a number of monitoring bores across the site and L120 Wetland for the duration of the clearing and revegetation program. Monitoring locations are provided in Section 10.

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.
9.2.3 Dewatering

As the base of the excavation will be above the maximum water table, no dewatering will be required.

9.2.4 Abstraction

No abstraction at the site will be undertaken other than for potential contingency measures as detailed in Section 9.4.

9.2.5 Revegetation

Groundwater level monitoring will continue for the duration of the excavation activities to ensure re-vegetation is not resulting in groundwater to be lower than pre-excavation levels.

9.2.6 Groundwater Pollution

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 DER).

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.

Due to the absence of on-site groundwater elevation data, it is proposed to set an interim mine floor level which provides five metres of clearance to the FMWT.
Rocla will strictly adhere to this groundwater separation buffer and undertake monthly groundwater monitoring and survey control to ensure separation distances are controlled.

### 9.3 Water Quality Management

#### 9.3.1 Water Quality Management Strategies

Potential impacts to the water quality of the L120 Wetland include:

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

The likelihood of water quality impacts are expected to be minor due to:

- Water infiltrating within the quarry will be from direct rainfall and is not expected to contain any potential contaminants.

- 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.

- 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, and > 200 m to the L120 Wetland.

- 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.

- Maintain an interim buffer of 5 m to the FMWT.

- Commence vegetation rehabilitation works at the completion of each mining stage.

- Maintain all plant equipment in good condition.

- Maintain all haul road and hardstand surfaces in good condition and with suitable grades.

Full details of water quality management associated with the proposed sand quarry are provided in the Extractive Industries Licence Application (RPS 2012a).
9.4 Contingency Actions

9.4.1 Groundwater Level Increase

Rocla will monitor groundwater levels at the site and in the vicinity of the L120 Wetland for the duration of the clearing and revegetation program. Details of monitoring locations are provided in Section 10.

Groundwater trigger levels have been determined (at 0.5 m above the model simulated groundwater increase of 0.21 m) and if exceeded at the bores directly upgradient of the L120 Wetland, for a period of more than two sampling events consecutively, contingency measures will be immediately implemented. The trigger was selected to take into account groundwater variability due to higher than average rainfall periods. The first contingency measure would be:

- Assess whether long-term average increase exceeds 0.3 m (after Froend and Loomes 2004).

- If long-term average increase is less than 0.3 m, continue existing monitoring program.

- If long-term average increase exceeds 0.3 m, assess in conjunction with the appropriate regulator, whether the increase is due to regional groundwater variation (e.g. due to climate factors)
  - if increase is deemed due to natural regional variability, continue existing monitoring program
  - if increase is deemed due to sand extraction, it is proposed that contingency measures be undertaken, including
    - 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
    - installation of groundwater abstraction bores 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.
9.4.2 **Groundwater Level Decrease**

During revegetation, a groundwater level decline of 0.3 m or more below pre-development groundwater levels at the southern edge of the site (taking into account long-term regional groundwater level trends) for a period of more than two months consecutively, will trigger contingency measures including:

- If decrease exceeds 0.3 m, assess in conjunction with the appropriate regulator, whether the decrease is due to regional groundwater variation (e.g. due to climate factors)
  - If decrease is deemed due to natural regional variability, continue existing monitoring program.
  - If decrease is deemed due to sand extraction, it is proposed that contingency measures be undertaken, including
    - decelerated planting of cleared stages where applicable
    - planting of shallow rooted, low water use plants
    - diversion of rainfall to the southern area of the site to increase water levels between the site and L120 Wetland.

9.4.3 **Vegetation Restoration**

Rocla as part of the DER Purpose Permit clearing approval will be required to prepare and implement a site specific native vegetation restoration plan. Rocla has agreed to the following conditions:

- The Restoration Plan will be submitted to the Chief Executive Officer (CEO) of the DER and outline: restoration methodology and criteria; staging; and response to local water balance, with input from an ecophysiologist with experience in the Swan Coastal Plain

- The Restoration Plan will be approved by the CEO prior to commencement of any restoration

- A site specific contingency plan, consistent with the methodology in the approved site specific restoration plan, will be submitted to the CEO within six months of determining that the CEO approved criteria have not been met

- The site specific contingency plan, consistent with the methodology in the approved Restoration Plan, will be approved by the CEO prior to commencing the contingency plan.
10.0 TEC PRESERVATION AREA MONITORING

10.1 Monitoring Program

10.1.1 Monitoring Locations

It is proposed to monitor groundwater at nine locations (OMB1 to OMB9) to accurately measure on-site groundwater levels and potential impacts to the L120 Wetland. The proposed monitoring locations have been selected in order to:

- Provide information on the groundwater gradient and flow direction.
- Provide information on seasonal water level dynamics.
- Include monitoring both up gradient and down gradient of the L120 Wetland to provide information on wetland inflows and outflows.
- Include monitoring along topographic gradients.
- Provide information on the lithology at the bore locations.
- Utilise data loggers to monitor short-term groundwater level response to rainfall events.
- Include monthly manual water level readings to validate logger results, for comparison with model results and trigger levels, and to provide information on long-term groundwater trends.
- Enable calculation of groundwater flow direction.
- Monitor impacts of excavation on the L120 Wetland.

Regional DoW bores will not be monitored as the nearest is located 1.7 km to the east, however ongoing DoW monitoring data may be utilised if assessment of regional groundwater conditions is required.

Figure 11 shows the locations of the bores overlain on topography. These locations include:

- two bores (OMB1 and OMB4) located up gradient (north) of the excavation to monitor background groundwater conditions
- two bores (OMB2 and OMB5) located within the Rocla site to monitor groundwater conditions in the vicinity of the excavation areas
four bores (OMB3, OMB6, OMB7, OMB8) between the excavation and the wetlands to the south. This includes two monitoring bores (OMB3 and OMB8) between the excavation areas and the L120 Wetland

- one bore down gradient of the L120 Wetland (OB9).

Monitoring bores OMB1 to OMB3 were installed several years ago and bore logs are not available. Bores OMB4 to OMB8 were installed in May 2013. These bores encountered white/cream sand to the water table in the northern bores (OMB4 depth to water 17 m and OMB5 depth to water 4 m). Brown sand was encountered in the southern bores (OMB6 to OMB8) to the water table at depths ranging from 2 to 4.5 m. OMB9 has not been installed to date due to access issues to the south of Wetland L120.

Bores OMB4 to OMB8 were installed with an auger rig. The bore construction utilises 3 m of 50 mm slotted PVC screen at depths ranging between approximately 1 m above to 2 m below the water table that was encountered during drilling. The screen was surrounded with gravel pack and a minimum 0.5 m of bentonite pellets were installed to minimise the potential for water ingress from the ground surface to impact groundwater quality.

It is proposed to install Bore OMB9 with a hand auger due to limited access down gradient of the L120 Wetland. This bore will be constructed with 50 mm PVC pipe as were Bores OMB4 to OMB8.

The top of all bore casings will be surveyed by a licensed surveyor to Australian Height Datum (AHD).

10.1.2 Groundwater Levels

It is proposed that groundwater levels be collected during sand extraction and revegetation periods from all nine monitoring bores.

Groundwater levels will be collected monthly from the data loggers (that are corrected to barometric pressure) to ensure there are no significant time periods of logger malfunction. Concurrently, water levels in the bore will be measured monthly using an electronic dip meter.

The manual and logger levels will be compared to validate accuracy of the data. Differences of more than 0.05 m between logger and manual data will trigger an investigation into potential causes. Potential contingencies may include replacement or repair of loggers and/or dip meters and supervision of monitoring by different personnel.
10.1.3 **Groundwater Quality**

It is proposed that groundwater quality monitoring will be conducted twice per year (groundwater high and low) from the nine bores. The analytes will include field parameters and correspond to the potential source, namely hydrocarbon (diesel) spills/leaks:

- field parameters (pH, EC) – all nine monitoring bores
- total petroleum hydrocarbons (TPH) – four southern monitoring bores.

Monitoring results will be compared with pre-excavation water quality and ANZECC (2000) guidelines for wetland ecosystems in south-west Australia.

Monitoring will be undertaken using dedicated bailers with at least four bore volumes removed from the bore prior to sampling. Appropriate QA/QC procedures will be undertaken in accordance with DER guidance. Full details of monitoring methodology and QA/QC procedures are provided in Appendix 3.

10.1.4 **Vegetation Condition**

Vegetation at the wetland areas to the south of the excavation will be visually monitored for stress indicators throughout the extraction and revegetation periods. The following triggers will result in contingency measures:

- a decline in plant health including live foliage cover
- groundwater level triggers as described in Section 9.4.

Details of a site specific Vegetation Restoration Plan are provided in Section 9.4.

10.1.5 **Monitoring Duration**

The monitoring will be conducted throughout the duration of the extraction and rehabilitation periods.

10.2 **Contingency Actions**

10.2.1 **Water Levels**

If the trigger level is breached during monthly manual water level monitoring, monitoring will continue to determine the length of time the groundwater level exceeds the trigger value. If the trigger is exceeded for a period of more than two monthly sampling events, the following contingency action will be considered in consultation with the relevant authority:
investigation to assess whether water level change is a result of the excavation activities or other regional factors such as changing land use and climate. If the review indicates the excavation activities are not significantly contributing to the water level change, no further action will be taken.

If the above investigation deems the excavation activities to be significantly impacting water levels at the L120 Wetland, the following contingency measures will be implemented in consultation with the relevant authority:

- 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
- assessment of re-vegetation program. The modelling prediction that groundwater will return to pre-development levels is based on healthy re-vegetation of bushland species. The re-vegetation program will be assessed and accelerated or decelerated if required to decrease or increase groundwater levels
- groundwater abstraction. A groundwater abstraction bore(s) installed along the southern boundary will decrease groundwater levels in this area. The groundwater from this bore could potentially be used for dust suppression or to accelerate re-vegetation of bushland
- tree planting. Planting of trees along the southern boundary of the site, between the excavation and wetlands. These trees would be phreatophytes (obtain water from the saturated aquifer) and have high transpiration rates (such as pines) to reduce water levels
- planting of shallow rooted, low water use plants
- diversion of rainfall to the southern area of the site to increase water levels between the site and L120 Wetland.

10.2.2 Water Quality

In conjunction with the water level monitoring, it is proposed to monitor baseline groundwater quality. The future groundwater quality resulting from the excavation works can then be compared with the baseline data to assess any impacts associated with the site activities. It is proposed that the following trigger levels be applied:

- TPH and salinity levels exceeding 50% of baseline levels over at least two successive monitoring events and/or exceedence of ANZECC (2000) guideline where relevant.

The following contingency measures will be applied should water quality triggers be exceeded:
- Conduct an assessment as to source of spill and/or salinity increase and remediate/modify if required in conjunction with the relevant authority.

10.2.3 Vegetation Restoration

Rocla as part of the DER Purpose Permit clearing approval will be required to prepare and implement a site specific native vegetation restoration plan which will include a site specific contingency plan consistent with details provided in Section 9.4.3.

10.3 Reporting Requirements

All monitoring data will be consolidated into a single spreadsheet within two weeks of monitoring to ensure long term trends and variations can be readily discerned.

DER and DoW will be advised of any breaches of water level and or quality triggers within two weeks of Rocla obtaining the information. DER and DoW will also be consulted in relation to any contingency measures required.

An annual monitoring report will be provided to DER that includes:

- details of the monitoring undertaken including methodology and QA/QC procedures
- analysis of results and comparison with relevant guidelines
- assessment of potential impacts to the L120 Wetland
- potential modifications to existing monitoring program
- any exceedences of triggers and contingency actions undertaken.
11.0 CONCLUSIONS AND SUMMARY

In March 2012, Rocla submitted a “Purpose Permit” clearing application to clear 11.6 ha within Lots 6, 300 and 301 Oldbury to the DER Native Vegetation Branch. Rocla and the DER Native Vegetation Branch met on 21 August 2012. At this meeting Rocla was requested to review a Hydrology Management Strategy reported by ENV (2011) and see if it could be adopted by Rocla to allow access to a sand resource while protecting the potential Tumulus Spring 80 m at its nearest point to the proposed extraction area.

This HMSP has been completed in agreement with the DER to provide information and management actions to ensure minimal impact to the hydrology of the surrounding the L120 Wetland. The objectives of this HMSP are:

- Identify potential changes to L120 Wetland hydrology associated with clearing and sand extraction.
- Maintain the existing hydrology at the L120 Wetland.
- Provide monitoring, management and contingency measures to ensure the existing hydrological regime is maintained at the L120 Wetland.

A hydrology study was conducted at the site with outcomes including:

- 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.
11.1 Summary of Management Measures

Despite the conclusions of the hydrology investigations, Rocla agreed to provide a HMSP with management and contingency measures to be adopted should the water level in the L120 Wetland be considered to change unacceptably in the future. These are shown in Table 3.

Table 3: Summary of Management Measures

<table>
<thead>
<tr>
<th>Potential Impact</th>
<th>Management Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater level changes</td>
<td>Adhering to an interim excavation depth of 5 m above the Maximum Groundwater Level (MGL)</td>
</tr>
<tr>
<td>Groundwater level and quality changes</td>
<td>Installation and monitoring of nine groundwater monitoring bores for groundwater levels and quality (field parameters and total petroleum hydrocarbons at selected bores)</td>
</tr>
<tr>
<td>Groundwater level and quality changes</td>
<td>Provision of water level and quality trigger values that would result in contingency measures</td>
</tr>
<tr>
<td>Groundwater level and quality changes</td>
<td>Contingency measures including: ensuring open drains allow ready transmission of water (via Water Corporation), altering revegetation rates; the planting of phreatophytes or low water using plants; diversion of rainfall to the southern area of the site; and/or the abstraction of groundwater.</td>
</tr>
<tr>
<td>Vegetation Restoration</td>
<td>Implement site specific native vegetation restoration plan with input from an ecophysiologist and to the satisfaction of the DER</td>
</tr>
</tbody>
</table>
12.0 REFERENCES


Environmental Protection Authority. 1999. Environmental Protection and Biodiversity Act 1999.


Hingston, F.J. and Gailitis, V. 1976. The geographic variation of salt precipitated over Western Australia. CSIRO: Division of Land Resources Management. Western Australia.


RPS. 2012a. Extractive Industries License Application. Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury.

RPS. 2012b. Hydrology Assessment. Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury. Revision 3.

RPS. 2012c. Level 1 Flora and Vegetation Survey. Lot 6 Banksia Road and Lots 300 and 301 Boomerang Road, Oldbury.


Figure 1

Lots 6, 300 and 301 Oldbury - Site Location
Figure 3

Wetland Locations

LEGEND
- Site Boundary
- Cadastre
- Proposed Clearing Application Area
- Location of Predicted Groundwater Change
- L120 Wetland
- Wetland Mapping
  - Conservation
  - Resource Enhancement
  - Multiple Use
  - 50m Wetland Buffer