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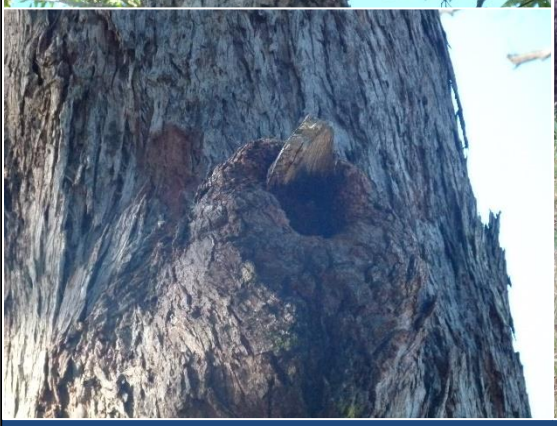
Flora and Fauna Management Plan



Lot 172 // DP 755923 & Lot 823 DP // 247285 Berringer Road, Cunjurong Point Road and Sunset Strip, Manyana, NSW

Residential subdivision

Prepared for Ozy Homes Pty Ltd

28 December 2023

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Glossary and abbreviations

ABBR./TERM	DESCRIPTION
APZ	Asset Protection Zone
BC Act	NSW *Biodiversity Conservation Act 2017*
DA	Development Application
DAWE	Commonwealth Department of Agriculture, Water and the Environment
EEC	Endangered Ecological Community
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
FFMP	Flora and Fauna Management Plan
ha	Hectares
HBT	Hollow-bearing Tree
LEP	Local Environmental Plan 2014
LGA	Local Government Area
Mm/cm/m/km	Millimetres/centimetres/metres/kilometres
PCT	Plant Community Type
PFC	Projected Foliage Cover
TEC	Threatened ecological community, listed as vulnerable, endangered or critically endangered under either the TSC Act (now repealed by BC Act) or EPBC Act
TSC Act	NSW *Threatened Species Conservation Act 1995*
WoNS	Weeds of National Significance
*	Denotes exotic species

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1. Introduction

1.1 Description of project and purpose of Flora and Fauna Management Plan

Ecoplanning were commissioned by Precise Planning Pty Ltd to prepare a Flora and Fauna Management Plan (FFMP) relating to the residential subdivision of Lot 172 // DP 755923 & Lot 823 // DP 247285 Berringer Road, Cunjurong Point Road and Sunset Strip, Manyana, NSW, 2539 (hereafter referred to as the '**study area'**) (**Figure 1.1**). The lots are situated on land that is currently zoned R2 – Low Density Residential under the Shoalhaven Local Environmental Plan 2014 (LEP). At present, the two lots have approval to be sub-divided into one hundred and eighty-two (182) residential allotments. The subdivision will be implemented over 6 stages, with each stage including the addition of approximately 30 lots. An area of vegetation mapped as an Endangered Ecological Community (EEC) under the *Threatened Species Conservation Act 1995* (TSC Act), a buffer around the EEC and a bushland reserve are hereafter referred to as the '**subject site**'.

This FFMP has been prepared in accordance with the Determination of Major Project No. 05-0059 (File No. 904674) (8 July 2008) and fulfils the following consent conditions:

- B8 – Vegetation Management Plan for each stage of the development,
- B9 – Vegetation Management Plan – EEC,
- D9 – Protocols for Trees with Hollows, and
- E16 – Dedication of Land

The primary objectives of this FFMP include:

- The identification of all hollow-bearing trees (HBTs) within the impact area, which will be offset within the retained vegetation in the subject site by the installation of nest boxes,
- The implementation of a monitoring program for the nest boxes, conducted every 6 months until all construction works are completed and in accordance with Condition E16,
- The protection of fauna both prior to, during and following the construction works,
- The management and protection of important fauna habitat within retained vegetation and within the development site,
- Management and monitoring activities to reduce the impacts on the EEC and all other ecological values of the subject site,
- Protective measures during the construction phase, consideration of the potential impacts of the adjoining residential development, means of weed control, revegetation, threatened species protection, habitat creation, propagation and translocation, and
- Maintaining and monitoring of the EEC for 3 years post the land being dedicated to Council.

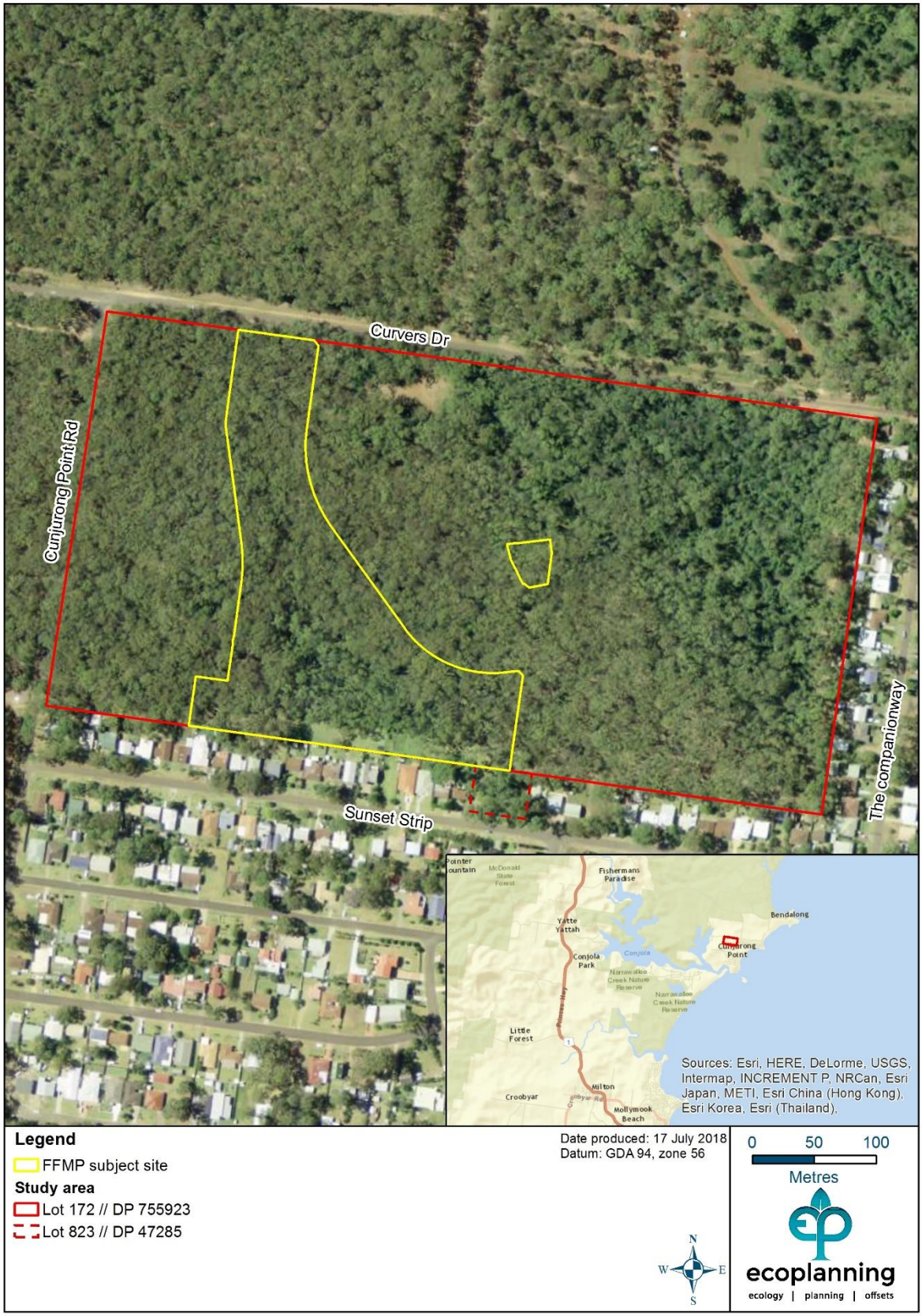

Figure 1.1: The study area and FFMP subject site.

1.2 Site description

The ***study area*** is situated in Shoalhaven Local Government Area (LGA) and includes all land contained within Lot // 172 DP 755923 & Lot 823 // DP 247285 Berringer Road and Cunjurong Point Road, Manyana, NSW, 2539. The surrounding lots are zoned RU2 – Rural Landscape, E2 – Environmental Conservation and R2 – Low Density Residential under the Shoalhaven LEP (2014). The suburb of Manyana is surrounded by a large intact expanse of bushland, which includes Conjola National Park to the north. The nearest major town is Ulladulla, which is located to the south, approximately 35 km by road. Lake Conjola is situated approximately 500 m from the western boundary of the study area and Inyadda Point is located approximately 1.2 km to the east.

The ***subject site*** includes important habitat trees to be retained within residential subdivision Stages 2, 4, 5, and 6 during the clearing of prior subdivision stages as well as all of the vegetation mapped as Bangalay Paperbark Woodland (Thomas et al. 2000).

The important habitat trees to be retained include *Syncarpia glomulifera* (Turpentine) and *Banksia integrifolia* (Coast Banksia) in Stage 2, *Eucalyptus paniculata* (Grey Ironbark) and *Syncarpia glomulifera* in Stage 4, and *Syncarpia glomulifera* only in Stage 5 and Stage 6. These trees are to be retained on site while earlier stages are developed and will be retained and protected where they occur within temporary Asset Protection Zones (APZs).

The subject site includes the retained reserve area containing a canopy of *Eucalyptus botryoides* (Bangalay) and a midstorey of small trees and shrubs, including *Callicoma serratifolia* (Black Wattle), *Leptospermum polygalifolium* subsp. *polygalifolium* (Tantoon), *Melaleuca ericifolia* (Swamp Paperbark), *Melaleuca linariifolia* (Flax-leaved Paperbark) and *Myrsine variabilis*. The groundlayer consists of sedges, ferns, forbs and grasses including *Blechnum nudum* (Fishbone Water Fern), *Gahnia radula, Imperata cylindrica* (Blady Grass), *Oplismenus aemulus* (Australian Basket Grass) and *Pteridium esculentum* (Common Bracken). Bangalay Paperbark Woodland is consistent with the EEC *Swamp sclerophyll forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions*. The remaining vegetation in the subject site has been mapped as Northern Coastal Sands Shrub/Fern Forest (Thomas et al. 2000).

The subject site also incorporates a 25 m buffer around the EEC. A relatively small area of this buffer will be directly impacted by the proposed basin batters in the east of the subject site (**Figure 1.2**). The subject site currently retains good connectivity with the large expanse of bushland to the north, south and west of the site (**Figure 1.3**). The inclusion of a bushland reserve in the subject site will facilitate connectivity between the EEC and Lots 6 and 108 // DP755923 to the north. These lots are currently vegetated and are well connected to surrounding vegetation, including Conjola National Park.

Northern Coastal Sands Shrub/Fern Forest also occurs over most of the study area. This community consists of an established open forest dominated by *Eucalyptus pilularis* (Blackbutt), *Eucalyptus piperita* (Sydney Peppermint), *Corymbia gummifera* (Red Bloodwood) and *Eucalyptus eugenioides* (Thin-leaved Stringybark). The north-eastern corner of the study area has been mapped as Bangalay Moist Woodland Open Forest. Further information regarding the vegetation communities in the study area is provided in **Section 2.2.1**.

Figure 1.2: EEC area, 25 m buffer, Bushland Reserve, basins and the proposed development.

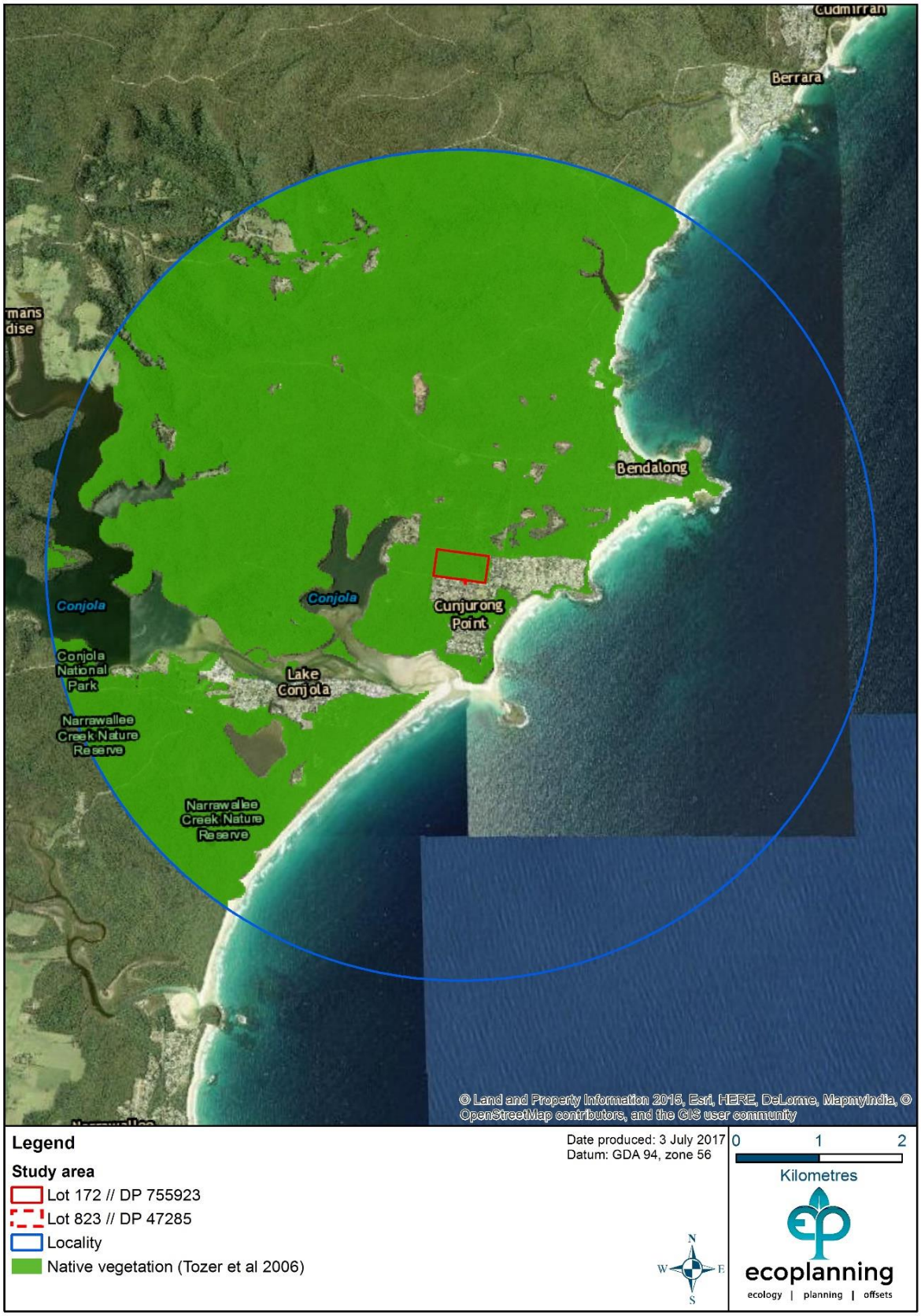

Figure 1.3: Locality of the FFMP subject site and connectivity to surrounding native vegetation (Tozer et al. 2006).

2. Site assessment

2.1 Methods

A field survey was undertaken on 14 June 2017 by Thomas Hickman (Ecologist, Ecoplanning) and Kieren Northam (Graduate Ecologist, Ecoplanning) to identify vegetation condition and management requirements and identify HBTs in the study area. The study area and subject site were traversed by foot and the weather conditions on the day were cool to warm with clear skies (**Table 2.1**).

Table 2.1. Daily weather observation at Ulladulla (AWS) – station 069138 (14 km south west of the development site)

Date	Temp (°C)		Rainfall (mm)[1]	Max wind	
	Min	Max		Direction	Speed (km/h)
26/05	10.4°C	18.8°C	0mm[1]	N	30

The current health of the vegetation in the subject site was inspected. This included assessment of the resilience of the subject site, thus its capacity to respond to the potential impacts of the proposed residential development. The site was surveyed to identify any problematic exotic species, particularly all priority weeds and Weeds of National Significance (WoNS). Notes regarding appropriate site-specific weed control techniques for the dominant exotic species were taken during the site inspection.

2.1.1 Hollow bearing tree assessment

The field assessment aimed to locate all HBTs within the study area. This was undertaken by traversing the study area on foot whilst actively looking for trees containing hollows. The location of each of the HBTs was marked using a hand-held GPS and trees were tagged with the letter H to indicate the presence of hollows. Additional information was taken for each HBT, including the number of hollows, the dimension of the hollows, their height from the ground and recent signs of use (i.e., observed presence of fauna, scratch marks around the hollows entrance and any other signs of use). Trees containing nests were also mapped and observed for any signs of recent activity.

2.2 Results

2.2.1 Plant communities

Regional vegetation mapping of Tozer et al. (2006) has mapped the vegetation in the study area as Coastal Sand Forest (DSF p64) (**Figure 2.1**). Tozer et al. (2010) describes this community as a eucalypt forest with a mixed understorey of sclerophyll shrubs, ferns, grasses and forbs. Field assessment of the study area by BES (2006) was conducted prior to the wider scale regional vegetation mapping by Tozer et al. (2006) and related the vegetation to mapping undertaken Thomas et al. (2000).

Field assessment determined the vegetation mapping conducted by BES (2006) to be consistent with the composition of flora species within the study area (**Figure 2.2**). The

vegetation communities identified in the study area (including comparisons to the equivalent TEC) is provided in **Table 2.2**.

Table 2.2: Vegetation community nomenclature

Vegetation communities (Thomas et al. 2000)	Threatened Ecological Communities	TSC Act	EPBC Act
Bangalay Paperbark Woodland	Swamp sclerophyll forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions	E	-
Northern Coastal Sands Shrub/Fern Forest	-	-	-
Bangalay Moist Woodland Open Forest	-	-	-

E = Endangered

It is noted that the vegetation community Bangalay Paperbark Woodland is a component of the EEC *Swamp sclerophyll forest on the coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions* listed under the TSC Act. Northern Coastal Sands Shrub/Fern Forest and Bangalay-Moist Woodland Open Forest are not consistent with any TECs listed under the TSC Act or EPBC Act.

2.2.2 Bangalay Paperbark Woodland

This vegetation community has been mapped along and in proximity to the drainage line that runs through the centre of the subject site. The canopy is dominated by *E. botryoides*, with a height of 22 m and a projected foliage cover (PFC) of approximately 25%. *Eucalyptus botryoides* (Bangalay), which is usually a component of similar vegetation communities described by Mills (1993) and Thomas et al. (2000), was not recorded in the canopy within this vegetation community. A sub-canopy is present and is dominated by *E. botryoides* to a height of 12 m with a PFC of 20-30%. The sub-canopy includes other species such as *Callicoma serratifolia, Melaleuca linariifolia, Myrsine variabilis* and occasionally *Allocasuarina littoralis* (Black She-Oak). The groundlayer consists of sedges, ferns, forbs and grasses, including *Blechnum nudum*, *Oplismenus aemulus, Gahnia radula*, *Imperata cylindrica* and *Pteridium esculentum*.

2.2.3 Northern Coastal Sands Shrub/Fern Forest

Northern Coastal Sands Shrub/Fern Forest is described by Thomas et al. (2000) and has been mapped in the north-eastern corner of the study area (**Figure 2.3**). This vegetation community has been mapped across a majority of the study area and is also located within the subject site. The community consists of an open forest dominated by *E. piperita*, *E. pilularis* and *C. gummifera*, however also includes additional canopy species that occur less frequently, such as *E. eugenioides, Eucalyptus globoidea* (White Stringybark), *Eucalyptus paniculata* (Grey Ironbark) and *E. botryoides. Syncarpia glomulifera* (Turpentine) occurs through the vegetation zone, as a canopy – sub canopy species, and in some places occurs as the dominant canopy species. The understorey is comprised of shrubs, including *Acacia terminalis* (Sunshine Wattle), *Acacia ulicifolia* (Prickly Mosses) *Dodonaea triquetra* (Large-leaf Hop-Bush), *Platylobium formosum* (Handsome Flat Pea) and *Persoonia linearis* (Narrow-leaved Geebung).

2.2.4 Bangalay Moist Woodland Open Forest

This vegetation community occurs in the north eastern/eastern portion of the study area and has been separated from the Northern Coastal Sands Shrub/Fern Forest based on a higher abundance and cover of mesic shrubs and increased incidence of *E. botryoides* (**Figure 2.4**). It is likely that the rainforest elements in this community are the result of a reduced frequency of fires. The dominant canopy species in this vegetation community include, *Angophora floribunda* (Rough-barked Apple), *E. botryoides, E. eugenioides,* and *E. paniculata*. The midstorey consists of mesic shrub species, including *Acmena smithii* (Lilly Pilly), *Clerodendrum tomentosum* (Hairy Clerodendrum), *Elaeocarpus reticulatus* (Blueberry Ash)*, Pittosporum undulatum* (Sweet Pittosporum) and *Synoum glandulosum* (Scentless Rosewood). In the far eastern corner this community comprises a small patch of vegetation with a closed sub-canopy dominated by *Acmena smithii*. The understorey and groundlayer is sparse in this area and consists of *Lomandra longifolia* (Spiny-headed Mat-rush), *Notelaea* spp., *Psychotria loniceroides* (Hairy Psychotria), *S. glandulosum* and *Stenocarpus salignus* (Scrub Beefwood).

2.2.5 Site resilience

Field assessment determined that the majority of the vegetation in the subject site and in the study area has high resilience. This was gauged by the general lack of exotic species, which only occur sporadically through the study area (<1% cover). Of the 184 flora species identified during field survey only 20 of these species were exotic. The low cover of exotic species suggests that the study area has been exposed to minimal disturbances, such as soil modification and nutrient enrichment. Native vegetation in the subject site is present in all stratums, with large *Eucalyptus* spp. occurring through most of the study area. Whilst the study area is relatively undisturbed and intact, it is likely that it may have been subject to selective logging, wildfire and/or prescribed burns.

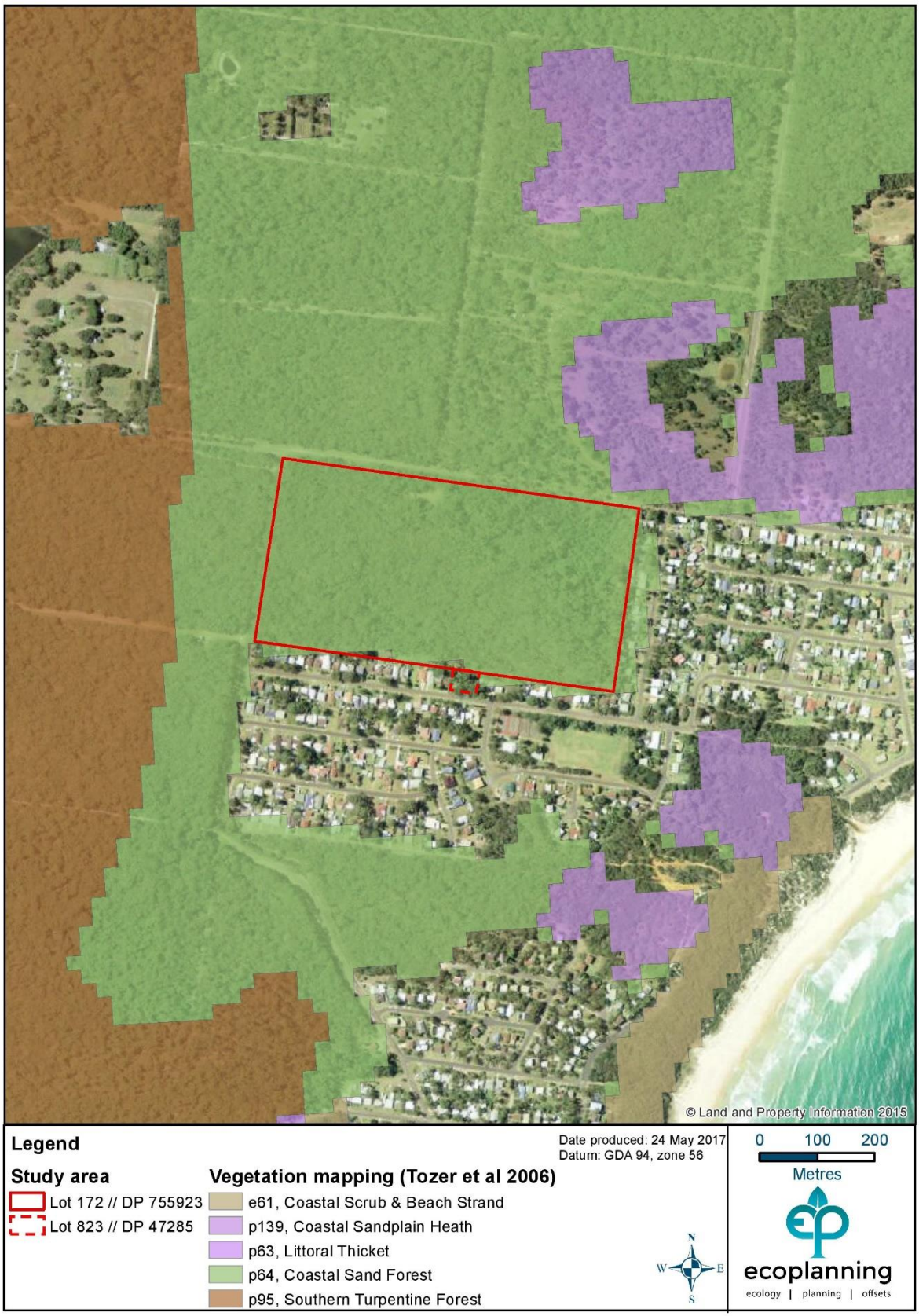

Figure 2.1: Regional vegetation mapping of the study area (Tozer et al. 2006).

Figure 2.2: Vegetation within the study area BES (2006).

Figure 2.3: Northern Coastal Sands Shrub/Fern Forest.

Figure 2.4: Bangalay-Moist Woodland Open Forest.

2.2.6 Flora species

A total of 184 flora species were identified within the study area, of which 20 are exotic and 164 are native (**Appendix A**). Two species listed under the NSW *Biosecurity Act 2015* in accordance with the Shoalhaven LGA are known within the study area (**Table 2.3**). Both of these species are Weeds of National Significance WoNS.

Table 2.3. Priority weeds and Weeds of National Significance (WoNS).

Common name	Scientific name	WoNS	Duty
Bridal creeper	*Asparagus asparagoides*	Y	**Mandatory Measure** *Must not be imported into the State or sold*
Ground Asparagus	*Asparagus aethiopicus*	Y	**Regional Recommended Measure** Exclusion zone: whole region except the core infestation area of Wingecarribee, Wollongong, Kiama, Shellharbour, Shoalhaven, Eurobodalla and Bega *Whole region: Land managers should mitigate the risk of new weeds being introduced to their land. Exclusion zone: The plant should be eradicated from the land and the land kept free of the plant.*

No threatened flora species listed under the TSC Act or EPBC Act were recorded in the study area or subject site during field survey for this report, or during previous assessment of the study area (BES 2006).

2.2.7 Fauna habitat

A total of 51 HBTs were identified within the study area, of which 36 are proposed for removal and 15 are proposed for retention, five of which are situated in the subject site (**Table 2.4** and **Figure 2.5**). An additional 3 habitat trees containing nests ranging from 0.8 – 1 m in diameter will require removal. The nests were constructed from twigs and sticks of small - moderate lengths and positioned in the crown of large *Eucalyptus* spp. The size of the nests suggests that they have been constructed by a moderate – large raptor species. The Square-tailed Kite has been recorded in the study area (BES 2006 and OEH 2017), although this species was not recorded during field survey.

Table 2.4: Number of trees impacted by the proposal

Tree	Impact	Number of trees
Hollow Bearing Tree	Removed	36
	Retained	15
	Total	51
Nest Tree	Removed	3
	Total	54

Square-tailed Kites construct large stick platforms in living trees, in open forest or woodland, often along or close to watercourses (OEH 2016). The habitat in the study area is consistent with this description, as is the construction of the nest. However, it is unclear whether the nests

are currently in use by Square-tailed Kite, another raptor or are currently unoccupied. It is noted that no fauna activity was observed in proximity of the nests during field assessment. All trees containing nest will be subject to the same pre-clearance protocols as the hollowing bearing trees (see **Section 5.1.1**).

2.2.8 *Glossopsitta pusilla* (Little Lorikeet)

A mixed flock of Little Lorikeet and *Glossopsitta concinna* (Musk Lorikeet) was observed in the north east of the study area during field assessment on the 26 May 2017. The flock was observed for approximately 20 minutes, and was mostly seen foraging on flowering *Eucalyptus* spp. Four observations of the Little Lorikeet have been recorded in the locality over the past 8 years. This includes a record on the 1 March 2016, which was reported in the north eastern boundary of the study area at 1 The Companion Way, Manyana (OEH 2017).

Little Lorikeet were not observed utilising the HBTs in the study area. However, appropriate measures will be implemented to avoid impact on this species during vegetation clearing.

2.2.9 *Callocephalon fimbriatum* (Gang-gang Cockatoo)

Two pairs of Gang-gang Cockatoo were observed foraging in Blackbutt trees on the site in May 2020. Gang-gang Cockatoos were not observed utilising HBTs in the study area. However, appropriate measures will be implemented to avoid impact on this species during vegetation clearing.

2.2.10 *Pteropus poliocephalus* (Grey-headed Flying-fox)

GHFF food trees will be clearly marked by an Ecologist. An arborist will be engaged to identify Tree Protection Zones (TPZ) surrounding each GHFF food tree. Prior to commencement of tree clearing, TPZ fencing will be established at the perimeter surrounding each tree as identified by the arborist. The Landscape Plan – Stage 1; LD03 (HLS 2021) includes proposed street tree planting which are also winter flowering species, comprising 77 *Banksia integrifolia* subsp. *integrifolia* (Coast Banksia), eight *Eucalyptus paniculata* subsp. *paniculata* (Grey Ironbark) and 11 *Eucalyptus robusta* (Swamp Mahogany).

Any excavation required within TPZs must be supervised by an arborist.

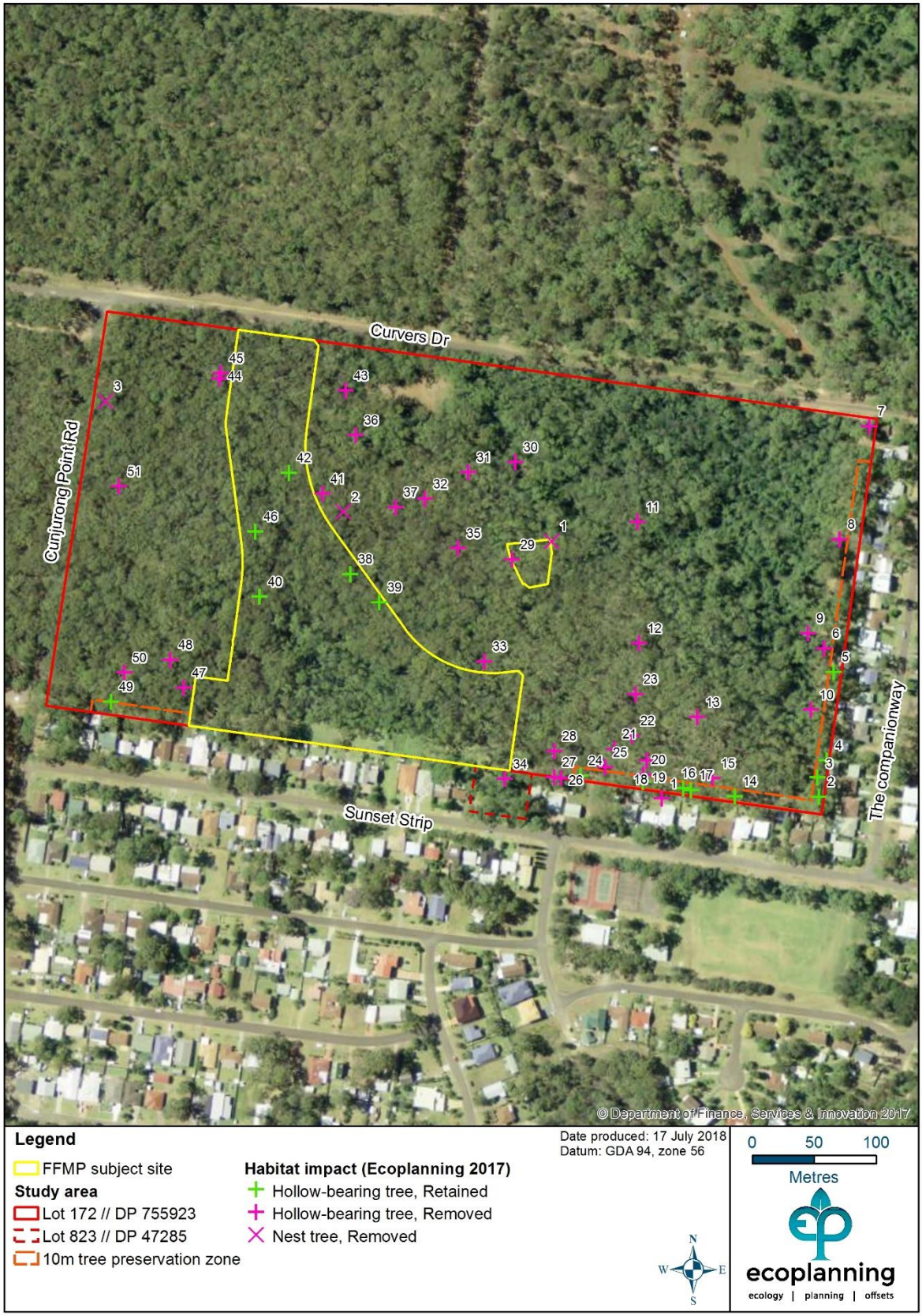

Figure 2.5: Hollow bearing trees and nest trees within the subject site and study area.

3. Impacts to EEC, protective measures and monitoring

This section outlines potential impacts of the development and the measures for the protection and long-term monitoring of the EEC during the construction and post-construction phases as required under Consent Condition B9 – Vegetation Management Plan – EEC.

A number of factors have the potential to impact on the resilience and health of the vegetation within the EEC, buffer zones and habitat corridor within the subject site. The following section outlines these factors, with particular focus on the potential impacts on the TSC Act listed EEC *Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions*.

3.1.1 Hydrology

Potential impacts posed by alterations to the hydrology in the study area were considered during field assessment and reviewed in the report prepared by Storm Consulting Pty Ltd (2007). The potential impacts to the EEC and the buffer habitat corridor, include:

- An increase in the annual volume of runoff,
- The potential for the flow from the water quality facility to contain nutrients, such as nitrogen or phosphorus, which may reduce the fitness of the EEC in the subject site, or promote the establishment of exotic species, and
- The potential for flow containing increased nutrients or weed propagules to enter the EEC along the western and eastern boundaries.

The development will include the installation of three water quality facilities within the subject site, which will consist of open wetlands with the following key features:

1. Open water inlet area to collect sediment,
2. Maintenance access to allow for collection of accumulated sediment,
3. Shallow water reed bed area to provide surface area for pollutant filtration, and
4. Water level control at the outlet.

The facilities are situated in the south western and south eastern corner of the subject site, with the third facility situated in the south of the park (**Figure 3.1**). The positioning of the western basin requires discharge to enter the Bangalay Paperbark Woodland, which will then flow in an easterly direction into the larger water quality facility in the south eastern corner of the subject site.

3.1.2 Fire regime

This section outlines criteria for monitoring changes to the fire regime and impacts on the EEC to inform necessary changes to the FFMP over time in order to better managed these impacts. Appropriate fire regimes can play an important role in the long-term management of the EEC, buffers and habitat corridor.

Bangalay Paperbark Woodland

Minimal research has been conducted on the impacts of fire on swamp sclerophyll forest. However, the domain of acceptable fire intervals is known to be from 7 to 35 years, with some

intervals greater than 20 years desirable (Kenny et al 2004). Fires applied more frequently than 7 years are likely to lead to a decline of species within the EEC that do not tolerate regular burning. Some vegetation in the study area exhibits evidence of frequent fire (BES 2006), particularly portions of the Northern Coastal Sands Shrub/Fern Forest. However, the date of the most recent fire in the EEC is not known.

Northern Coastal Sands Shrub/Fern Forest

The vegetation mapped as Northern Coastal Sands Shrub/Fern Forest falls into the vegetation formation dry sclerophyll shrub forest (Kenny et al. 2004). The domain of acceptable fire intervals for this vegetation formation is 7 to 30 years, with some intervals greater than 25 years desirable. Portions of this vegetation community show signs of past burning (>15 – 20 years ago).

Monitoring criteria

The recommended fire interval for Swamp Sclerophyll Forest is between 7 to 35 years and for Northern Coastal Sands Shrub/Fern Forest it is 7 to 30 years. The number of fires that occur in the subject site should be monitored. As a precaution, it is assumed that the most recent fire was at least 5 years ago (but it is unlikely to be more than 30 years ago) as the structural formation of the forest appears to be mature, with well-developed understorey layers.

Therefore, the site should be protected from fire for at least the next two years and residents should be educated about the risk of fire as per the *Bush Fire Risk Management Plan* (Shoalhaven Bush Fire Management Committee). Any fires (controlled burn or wildfires) should conform to the inter-fire intervals of between 7 and 30-35 years.

Should a fire occur within the next two years then the FFMP should be reviewed to include additional measures to protect the EEC from inappropriate fire regimes. Such measures should be in accordance with the Bush Fire Risk Management Plan (Shoalhaven City Council 2010) and could include the following:

- No fires to be lit within the EEC, buffers and corridor other than for the purposes of ecological burning,
- A record should be kept of all fires within the EEC, buffers and corridor, including:
    - the year the last fire went through, the type of fire and the extent of the fire and location, where known
    - response of the EEC to ecological burns

3.1.3 Exotic species

This section outlines protective measures and monitoring criteria with regards to impacts from weeds and weed control and removal.

The subject site currently contains few exotic species and has a low cover of exotic species (<1%). Dumping of garden refuse is the most likely means by which weed seed and vegetative material would be introduced into the subject site. Additional factors that may facilitate the growth of exotic species is an increase in edge effects, which will change the microclimatic conditions of the vegetation on its edges and provide suitable conditions for exotic species. Disturbances associated with edge effects, such as increased soil moisture and nutrients, will be mitigated and have been considered in the hydrological report by Storm Consulting Pty Ltd (2007). Appropriate signage (see **Section 4.1**) and regular monitoring of illegal dumping of

garden materials will reduce the likelihood of exotic species from becoming established in the subject site.

The implementation of batters around basin A, B and C will require soil modification to achieve a batter slope that facilitates the construction of the basins. If sourced offsite (see **Section 3.1.4**) the soil material has the potential to contain weed propagules, which if left unmanaged, weeds will become established and could spread into the remainder of the subject site. A maintenance regime will include regular sweeps of the basin batters for establishing herbaceous weeds and grasses, which will be treated prior to establishment and seeding (see **Section 4.3** and **Appendix C**).

Monitoring of exotic species will be addressed in monthly and annual reports conducted by the bush regeneration contractors and will be measured quantitatively both spatially and temporarily across the two BioMetric plots (see **Section 3.1.6**, **Section 6.2** and **Table 6.2**).

3.1.4 Soil disturbance

The project will result in the alteration of the soil profiles around basin A, B and C where batters will be constructed to facilitate drainage. All existing midstorey and canopy vegetation will require removal to achieve the desired basin batter width. As such, it is recommended that the topsoil within the proposed batter zone is removed and translocated on top of the batter fill. This approach will be beneficial for multiple reasons, including:

- The utilisation of the soil stored native seedbank in the subject site, thus ensuring seed of local provenance,
- Reduced ongoing weed management costs, and
- Reduced cost of revegetation, which may still be necessary depending on the success of the translocation.

Appropriate sedimentation controls will be necessary, which will remain in place and maintained until the basin batters are vegetated, curb and guttering is sufficiently channelling stormwater containing sediments into the wetlands, and all construction works are complete. Ample time should be allowed to determine the capacity for the batters to regenerate naturally following the translocation of topsoil. Revegetation should be conducted approximately 2 years following each topsoil translocation stage, with densities based on infill planting, as opposed to complete revegetation of the basin batters (see **Section 4.4**). If the topsoil translocation is successful, then revegetation will not be necessary along the basin batter. In this scenario, the proposed cost of revegetation can be used for other management activities, such as weeding, or revegetation in other areas of the site.

3.1.5 Pedestrians access

Given the substantial size of the proposed development (182 lots), there is potential for impacts to inadvertently occur to the EEC as a result of pedestrian access. Therefore, the perimeter of the subject site should be fenced with post and cable fencing to prevent vehicular access and discourage access by the general public. Fencing will direct foot traffic to dedicated pedestrian walkways. This will prevent disturbances associated with increased pedestrian traffic, such as soil compaction, soil erosion and transportation of weed seed propagules into the subject site. Fencing should be in accordance with the recommendations in **Section 4.1.2**.

3.1.6 Boardwalk

A boardwalk is proposed to traverse through the Bushland Reserve in the north of the subject site (**Figure 3.2**). The boardwalk will be 2 m wide to allow for pedestrian and cyclist access. The platform of the boardwalk will be constructed from fibreglass reinforced plastic, with a steel frame and foundation posts. The boardwalk from Garrads Reserve, Narrawallee (**Figure 3.3**) should be used as an example for the boardwalk in the subject site.

The boardwalk will require the removal of five canopy trees and modification to the native midstorey and groundlayer. The trees proposed for removal are in either poor or declining health or are structurally dangerous. Impacts from installation of the proposed boardwalk will be restricted to the 2 m footprint of the boardwalk, and only minimal impacts would occur to surrounding vegetation during construction. This will be achieved by implementing the following mitigation measures:

- A 2 m wide access trail will be established by brush cutting native midstorey and groundlayer species to approximately 5 cm above ground level (conducted by the bush regeneration contractors).
- The five canopy trees proposed for removal will be clearly marked and felled with a chainsaw (conducted by the bush regeneration contractors).
- Where possible, the trees proposed for removal will be felled at an angle so that they fall within the 2 m wide boardwalk footprint area. This will prevent surrounding vegetation from being crushed and damaged during the tree removal process.
- The canopy trees should be gradually lowered to the ground to reduce impacts to surrounding vegetation, cut into manageable lengths and distributed throughout the buffer area to provide refuge/habitat. The cut vegetation will not be stacked.
- Access to the area will be limited to the 2 m footprint for the boardwalk and no additional trails or tracks to access the area will be established.
- The construction of the boardwalk will be done systematically in an east-west, or west-east direction, which will avoid the trampling of surrounding native vegetation.
- Soil disturbance will be limited to the digging required to install the steel foundation posts.
- Excess soil generated from the construction of the boardwalk will be removed from the site and not stored within the Bushland Reserve.
- No heavy machinery will be utilised for the clearing of the vegetation and installation of the boardwalk.

The implementation of the above mitigation measures will minimise impacts to areas of vegetation surrounding the proposed boardwalk. As such, it will not be necessary for revegetation works to be conducted in the area. Assisted natural regeneration will be the primary method of restoring any areas adjacent to the boardwalk if necessary, following installation and the stabilisation of the area.

3.1.7 Headwall

A headwall is proposed for installation which will direct flow under Curvers Drive and into the established drainage line in the north of the subject site. Additional works are required, including the installation of a concrete kerb and batter along the northern perimeter of the site. Reconstruction of the area will be achieved using translocated topsoil (see **Section 4.5**). Revegetation of the area may be necessary, depending on the success of the soil translocation and the recruitment of native species. It is recommended that the success of topsoil

translocation is assessed after two years, and is deemed unsuccessful, then revegetation should be used to augment the area to achieve desired covers.

3.1.8 Monitoring

Annual monitoring of the vegetation in the subject site should be conducted to quantitatively measure:

- potential impacts as a result of the project, including changes to hydrology and nutrient loads, which may result in exotic species abundance/cover,
- The success of the translocated soil on the basin batters, and
- the success of ongoing management actions in accordance with this FFMP.

A total of two plots will be established through the subject site, which will correspond to the site management zones 1 and 2 (see **Section 4.3**), comprising one in the EEC and one in the 25 m buffer zone/habitat corridor (**Figure 3.4**). GPS coordinates of floristic plots will be recorded and included in monitoring reports to facilitate consistent monitoring. Plot and transect surveys will be conducted in accordance with the BioBanking Assessment Methodology (BBAM 2014). This will include 20 x 20m floristic plots, which can be modified where necessary to reflect a total area of 0.4 ha.

It will be necessary to gather baseline data prior to the initiation of the proposal to capture natural variability of the vegetation over time. Ideally, baseline data will be collected over two – three years prior to development. However, the collection of only one year of baseline data is considered feasible, as the timing of Stage 1 of the development may not allow for multiple years of baseline data collection. Control plots should be established in vegetation proximal to the study area within the same Plant Community Type (PCT). This will include a control plot in vegetation consistent with *Swamp Sclerophyll Forest on Coastal Floodplains* and Northern Coastal Sands Shrub/Fern Forest. Annual monitoring will continue for 3 years after dedication of the land to Council.

The vegetation in the subject site is currently in an intact condition, with minimal disturbance and weed occurrence. The primary aim of conducting management and monitoring works in accordance with this FFMP is to ensure that the retained vegetation stays largely intact and unmodified. Should the vegetation remain in an unchanged state it will be a reasonable indication that either the management actions outlined in this report are successful, or the surrounding development has not altered the vegetation in the subject site substantially. Statistical analysis of parameters collected using the BBAM (2014) will be used to determine the success of restoration works and the potential impacts of the project. Criteria which could change as a result of the development include:

- Weed cover, abundance and species richness (EPC)
- Native plant species richness (NPS)
- Native mid-storey cover (NMS)
- Native over-storey cover (NOS)
- Native ground cover

Monitoring will also include the collection of water samples, which will be tested for the presence of nutrients, including phosphorus and nitrogen. Water samples will be compared to plot data to determine if changes in nutrient levels are comparable to an increase in exotic species cover/abundance, reduced NPS etc. These factors are of most relevance to the EEC,

given its proximity to the watercourse and its susceptibility to increased nutrient levels. Samples will be taken at four separate locations within the subject site (**Figure 3.1**), including:

1. Where the watercourse enters the subject site northern boundary,
2. The discharge exciting the wetland in the west of the subject site,
3. The confluence where the existing watercourse and the discharge from the western wetland coincide, and
4. The discharge from the large wetland in the south east of the subject site.

3.1.9 Criteria to trigger adaptive management

The collection of baseline data prior to the initiation of Stage 1 will provide a benchmark for the condition of the vegetation in the EEC and the buffer zone/habitat corridor. As previously mentioned, statistical analysis of parameters collected using the BBAM (2014) will be conducted. A negative change to one, or several of these parameters would trigger a review by an ecologist to determine the need for adaptive management and a review of the management actions in this FFMP. However, the vegetation in the subject site is resilient and has been subject to minimal disturbances in the past. As such, disturbance effects are likely to be gradual and may require several years of annual monitoring before a negative change in vegetation quality is detected.

The most likely disturbances to the vegetation would be a result of changes in the hydrological regime, or an increase in nutrients, which would favour the growth of exotic species and reduce the health of native shrub and canopy species. However, these disturbance factors are likely to lead to a slow and gradual reduction in the quality and resilience of the vegetation in the subject site, as opposed to an immediate impact that could be ameliorated. Readily detectable impacts, such as a rapid influx of sediments, for example due to poor sedimentation controls, would require immediate attention and would also trigger adaptive management to ensure that additional resources are allocated to prevent further degradation in these areas.

Figure 3.1: Watercourses in the study area and proposed water sampling locations.

Figure 3.2: The six development stages and a proposed boardwalk.

Figure 3.3: An example of a boardwalk at Garrads Reserve, Narrawallee

Figure 3.4: Transect start and end points and photo monitoring points.

4. Weed management and revegetation

This section outlines weed management and revegetation measures in accordance with Section B9 of the consent conditions.

Vegetation management works outlined below will be implemented for the subject site. Weed management will begin upon the initiation of works proposed under the Development Application (DA). A suitably qualified and experienced bush regeneration contractor as per **Section 6.3** must be engaged to carry out vegetation management works. It will be necessary for the bush regenerator to be engaged before the commencement of the proposed works to enable establishment of baseline data, photo points and other identified baselines.

4.1 Preliminary works

4.1.1 Seed collection

Seed collection will be required to ensure indigenous species are available for revegetation works; species identified for revegetation are outlined in **Appendix C**. All plantings should be of local provenance, collected from adjacent patches of vegetation. However, nurseries that supply indigenous seedling stock, (not horticultural varieties), may also be used to supplement the plantings.

Seed collection zones can extend within a radius of 3 km for groundcover, shrubs and trees and up to 10 km for grasses. The collection site should reflect the natural conditions that exist for the area being regenerated.

Record keeping of seed collection and planting locations is to be as per the Flora Bank guidelines (Mortlock 2000), the bush regeneration contractor is responsible for recording this information. A Section 132C licence under the NSW *National Parks and Wildlife Act 1974* will be required to undertake seed collection works.

4.1.2 Fencing

Exclusion fencing will be erected prior to commencement of any clearing work and will protect the Bushland Reserve throughout the entire construction process. The exclusion fencing will have signs attached every 20 m stating 'Environmental Protection Area' to reinforce the importance of the bushland excluded from the development site. The exclusion fencing will be regularly monitored and maintained to ensure that it is effectively preventing access to the Bushland Reserve. Following the completion of the construction works the full perimeter of the FFMP subject site will be fenced in accordance with the fencing masterplan provided in the landscaping designs. This will include post and cable fencing, which will prevent car access, and discourage pedestrian access.

Sedimentation fencing will be installed at the interface between the basin batters and the EEC buffer zone and Bushland Reserve. The purpose of the fencing will be to prevent the translocated soil on the basin batters from washing off into the EEC, buffer zone and Bushland Reserve. The translocated soil will retain a substantial O horizon (topsoil layer containing a high proportion of organic material) with an accumulation of leaf litter, which will reduce the potential of the material to erode. However, it is possible that the material will remain slightly unstable for several years following the topsoil translocation. The sediment fence should be

regularly monitored for damaged sections, which will be replaced promptly. The sedimentation fencing can be removed when the translocated topsoil is sufficiently stabilised.

4.1.3 Signage

Appropriate interpretative signage will be installed along the perimeter of the subject site to help reduce impacts. The signs will inform residents of the environmental value of the subject site and ways they can reduce impacts to vegetation. "No dumping" signs should be installed along the perimeter of the subject site to deter residents from dumping grass clippings, cuttings and various other garden wastes. Signage around the perimeter of the subject site should also inform residents and other pedestrians that disturbance to the area, including collection of firewood, is prohibited. Interpretive signage is to be developed in consultation with the Natural Resources & Floodplain Unit of Council, Natural Areas Operations Officer.

4.2 Weed management techniques

Weed management will mostly consist of maintenance works and a small amount of primary and secondary weed control. Weed control will include mechanical removal techniques and herbicide application. Disturbance of the soil during the weed management process should be minimised at all times (Buchanan 1989, Bradley 2002). Any herbicide use is to be undertaken in accordance with the relevant herbicide label and/or Australian Pesticides and Veterinary Medicines Authority (APVMA) off-label permits. No herbicide spraying is to be undertaken over or immediately adjacent to water-bodies, or sensitive vegetation. Weed control objectives and treatment techniques are outlined below (**Appendix B**) in accordance with weed type.

4.2.1 Primary Weed Control

Primary weed control is the initial removal of weed species. Mechanical removal techniques relevant to the weed being removed (Buchanan 1989; Bradley 2002; DPI 2015) should be used for all woody weeds and herbaceous plants. Herbicide application, such as backpack spraying, should be avoided where loss of native species is likely to occur, which is the majority of the subject site.

4.2.2 Secondary Weed Control

Secondary weed control involves follow-up weed control to remove seedlings that have emerged after primary control and treatment of any existing plants that reshoot. Any new weed infestation areas identified will also be treated.

4.2.3 Maintenance

Maintenance is the long-term management of a site to prevent weeds from becoming re-established after primary and secondary work. Substantial effort will be focussed on reducing the weed seed bank, eradicating problematic weeds and supporting the growth of native vegetation. Maintenance works will include regular sweeps through the site to remove all exotic species prior to seeding and to prevent the establishment of any exotic species not previously identified in the site.

4.2.4 Weed Disposal

All seeding herbaceous/grass material and tubers will be bagged and removed from site. Woody weeds will be de-seeded, neatly piled, removed from site and disposed of at a licenced green waste facility.

4.3 Vegetation Management Zones

The subject site has been classified into five management zones (MZs) (**Figure 4.1** and **Appendix B**). The management actions are generally consistent between zones, particularly for MZ1 and MZ2. However, MZ3 will require slightly different management to MZ1 and MZ2, as this zone relates to an area of translocated topsoil, which may require supplementary planting, increased weed maintenance and sedimentation controls. MZ5 is specific to a strip of lawn grass in the south of the subject site, which requires revegetation. MZ4 includes the area within the basin, which will require revegetation and ongoing maintenance work to prevent the establishment of exotic species.

4.3.1 Management Zone 1 and 2 – Weed maintenance

The management of MZ1 is synonymous with MZ2. These two MZs have been separated for reporting purposes to determine when managements actions are conducted within the EEC.

MZ1 encompasses all areas within the subject site that have been mapped as the EEC Bangalay Swamp Woodland. MZ1 is mostly confined to the southern portion of the subject site, particularly in poorly drained sections. Exotic species occur in a low abundance and cover (<1%), as past disturbance of the vegetation has been minimal. Given MZ1's close proximity to the watercourse, aquatic weeds have the potential to become an issue. As such, regular sweeps will be conducted to prevent the establishment of all exotic species prior to establishment and seeding. Given that the study area is part of a contiguous expanse of intact native vegetation, it is unlikely that woody weeds, such as *Ligustrum lucidum** (Large-leaved Privet) and *Ligustrum sinense** (Small-leafed Privet) will become established in MZ1 and MZ2, particularly as they occur in low cover within the surrounding locality. Woody weeds, such as *Senna pendula* var. *glabrata** and *Senna septemtrionalis** (Arsenic Bush) were recorded within the study area, although they were observed infrequently in the subject site.

Weed treatment within MZ1 will consist of hand weeding for herbaceous weeds and exotic grasses. Spraying is not permitted in the either of the MZs, given the high resilience of the vegetation and the potential damage that could occur to native species. The removal of herbaceous weeds will be conducted prior to seeding where possible, and all weed material will be bagged and removed from site. Sweeps will be regularly conducted for aquatic species, such as *Ageratina adenophora* (Crofton Weed) and *Ageratina riparia** (Mist Flower), which have potential to spread in the altered conditions, such as increased nutrients and water influxes. *Lonicera japonica** (Japanese Honeysuckle) was recorded in low abundance and cover in the study area and is another species which will be regularly targeted in these zones.

4.3.2 Management Zone 3 – Soil translocation and supplementary revegetation

This MZ applies to the batters surrounding basins A, B and C (see **Figure 4.1**). The batters will consist of a sloped embankment and will be constructed utilising soil available onsite where possible. A topsoil profile of approximately 10 cm will be gathered from a 'donor site' within the subject site where direct impacts will occur, and subsequently applied to the top of the basin batters (see **Section 4.5**). Mixing of the soil profile should be avoided where possible,

as this may reduce the capacity for the native seed bank to germinate. The soil utilised for translocation should be directly applied to the batter.

It is anticipated that the topsoil used for translocation is unlikely to contain a large weed seed bank, particularly as few exotic species are currently established throughout the study area. As such, maintenance work in this MZ is likely to be minimal and will mostly consist of sweeps conducted every several months. However, restoration efforts should be increased in spring and summer months when the rate of growth and establishment of herbaceous weeds and exotic grasses is likely to be greater. This will ensure that exotic species are treated prior to seeding and becoming established in this zone. Where possible, maintenance work can be achieved through visual inspections for establishing weed species from outside the zone. This will prevent germinating native species within the zone from being trampled and will avoid unnecessary compaction of the translocated topsoil.

4.3.3 Management Zone 4 – Revegetation and maintenance

This MZ includes the area within basins A, B and C. Following the construction of the basins the MZ will be revegetated with a native sedges, rush and grass species. Regular maintenance work will be conducted in the MZ to prevent the establishment of exotic species, particularly herbaceous weeds and exotic grasses. It will be necessary to remove any shrub and canopy species that become established in the basins, as they have the potential to shade out aquatic species and increase the amount of detritus within the basins. Shrub and canopy species will be treated by hand removal prior to establishment.

4.3.4 Management Zone 5 – Revegetation and maintenance

This MZ corresponds to a strip of lawn grass in the south of the subject site. The area within 10 m of the rear of the properties along Sunset Strip will be managed as an Asset Protection Zone (APZ). As such, this area will remain in its current condition and will continue to be mown to keep lawn grasses at low levels. A pedestrian path will be situated along the northern perimeter of the APZ. All exotic grasses and herbaceous weeds will be treated to the north of the pedestrian path, mulched and subsequently revegetated with native groundlayer species.

Primary and secondary treatment of exotic grasses and herbaceous weeds will be achieved in the first 6 months of the contract period. Exotic species in the MZ will be blanket sprayed using 1% Roundup Biactive®, or a higher solution if necessary to successfully treat the target species. This area should be treated an additional 2 – 3 times prior to mulching and revegetating. This will ensure that all difficult to treat grass species are eradicated and the weed seed bank will have been sufficiently suppressed in preparation for mulching. Secondary and maintenance work in this zone will consist of regular hand weeding and careful spot spraying around planted vegetation with 1% Roundup Biactive®.

Note: Boundaries of MZ2 - MZ5 are indicative only. Refer to Landscape Plan for precise locations of revegetation categories.

Figure 4.1: Management zones within the FFMP subject site.

4.4 Revegetation

The restoration of MZ3 will primarily be achieved using topsoil translocation. Should this have mixed success, it will be necessary to install additional grasses and groundcovers to achieve a density of 4 plants per m^2 across the zone. Revegetation costings for MZ3 are based on the low germination rate of native grasses and groundcovers within the translocated topsoil, therefore, their installation at a density of 4 plants per m^2. However, it may not be necessary to revegetate MZ3, depending on the success of the soil translocation and the recruitment of native grasses. In this instance, the allocated revegetation costs should be amalgamated into other management activities onsite, such as bush regeneration maintenance works.

Revegetation will be necessary in the northern portion of MZ5, which currently consists of mown lawn grass. This zone will be mulched and revegetated with low lying groundcover species. The natural recruitment of native midstorey and canopy tubestock will be regulated, although should be limited to the removal of species required for maintaining sight-lines along roads, and the maintenance of fence lines, pedestrian paths and access easements. Revegetation will not be necessary in MZ1 and MZ2, as they are resilient areas of well vegetated bushland.

Revegetation will be necessary in MZ4 within basins A, B and C to provide stability to the basins and assist in the removal and assimilation of excess nutrients. Native sedges, rush and grass species that are indigenous to the area and suitable for installation will be planted at a density of 4 plants per m^2. Planting will be conducted as soon as the basins are constructed and will utilise the species listed in **Appendix C**.

Staging and logic

Sufficient time will be allowed following the translocation of topsoil onto the basin batters. If succession of native species is successful at densities of 4 plants per m^2, then supplementary revegetation will not be necessary. Revegetation of MZ5 will be conducted within the first 6 months of contract, following primary weed control and mulching of the land to the north of the pedestrian footpath. Revegetation of MZ4 will be conducted following the construction of basins A, B and C, which corresponds with Stages 6, 4 and 1 of the development. Replacement and maintenance are to be undertaken to ensure a survival rate of at least 90 % after 12 months of installation and each subsequent reporting period.

Planting densities and species

Species representative of the vegetation community Northern Coastal Sands Shrub/Fern Forest will be used for MZ3, whereas MZ5 will be consistent with Bangalay Paperbark Woodland (see **Appendix C**). The main difference being the addition of rushes, sedges and ferns in MZ5 to make the revegetation more consistent with Bangalay Paperbark Woodland. A species list has been provided with suitable species, including sedges, rushes and grasses for installation within basins A, B and C. It is noted that the species list is not exhaustive, and thus could be supplemented with indigenous species that are adapted to damp environments and will assist in the filtration and nutrient removal process in the basins. The planting densities for MZ3, MZ4 and MZ5 are as follows:

- 4 groundcover species per m^2 (grass, forb, sedge or rush)

The exact number of plantings required in MZ3 and MZ4 have not been calculated, as the boundaries between these two zones are subject to change. Furthermore, MZ3 is likely to contain large areas of turf grass, which will not require revegetation with native species. As

such, the calculation of plants required for installation in these areas would be incorrect. Similarly, the areas required for revegetation in MZ5 are dependent on how the pedestrian path traverses through the zone. The Landscape Masterplan will specify the total number of plants required in MZ3, MZ4 and MZ5 once the boundaries and total areas of these zones area confirmed.

Minimum planting diversity

A diverse range of species will be selected for the revegetation of MZ4 and MZ5 to avoid the over-use of readily available species. A total of 36 species have been recommended for installation into MZ4 in accordance with the vegetation community Bangalay Paperbark Woodland (**Appendix C**). It is advised that at least 15 of the 36 species should be selected for revegetation and the proportion of each of these species should be no less than 5% and no greater than 10% of the total number of plants proposed for installation.

A total of 22 species have been recommended for installation into MZ5 within basins A, B and C. Species diversity is less integral in the basins, as the main role of the vegetation is to filtrate sediments and assimilate excess nutrients. Nevertheless, it is recommended that at least ten of the 22 species should be selected for the revegetation of MZ5 and the proportion of each species should represent no less than 5% and no greater than 15% of the total number of plants proposed for installation.

MZ3 will be reconstructed using translocated topsoil, which will have an intact diverse native soil seedbank. As such, establishing a minimum diversity for revegetation in this MZ is not necessary. The main aim of revegetation in this zone will be to augment areas of the reconstructed batters to fill in gaps where plants did not establish, or where additional soil stability is required. In this instance, easily accessible, plants in accordance with Northern Coastal Sands Shrub Forest (**Appendix C)** that can establish quickly is favourable.

Equipment, installation and timing

Plantings will be planned for autumn, post rain when growth conditions are ideal. Planting of tube-stock (tree and shrub species) and Hiko or Viro cells (grasses and other groundcover species) is favoured over broad scale seed application, such as direct seeding or brush matting.

A water-retaining and fertilising product (e.g., Terraform™) should be applied to each tube-stock hole, to assist in the establishment of the plants. Each plant should be sufficiently watered on the same day as installation and regular (fortnightly) watering should continue *in lieu* of rainfall for a period of 6 weeks, or until plantings have taken.

Plant Biosecurity – Myrtle rust

See fact sheet at **Appendix D** for factsheet on biosecurity best management practice to avoid the spread of the fungal disease Myrtle Rust (*Puccinia psidii*).

4.5 Topsoil Translocation

Topsoil translocation will be utilised for the reconstruction of the basin batters. The benefits of using this method as opposed to revegetation include:

- Reduced, or eliminated need to revegetate the basin batters,
- The utilisation of seed of known provenance, which would otherwise be disposed of,

- Reduced likelihood of imported fill containing potential weed seed from entering and becoming established in the subject site,
- The retention of the topsoil's abiotic and biotic components, and
- Reduced ongoing weed maintenance costs, given that the extant soil profile contains minimal weed seed.

Protocols

Topsoil will be sourced from any area of the study area mapped as Northern Coastal Sands Shrub/Fern Forest (the 'donor site'). However, for time and cost efficiency it is recommended that the topsoil is sourced from the area being directly impacted by the batters within the subject site. The topsoil will be removed, retained and reapplied to the surface of the batters (the 'recipient site'). The topsoil will be obtained by removing the top 10 cm of the soil profile. Removal of more than 10 cm of soil has the potential to reduce the success of seedling recruitment and prevent some species from germinating altogether (Rokich et al. 2000). Care should be taken to avoid the mixing of topsoil and subsoil substrates, as this will dilute the native seedbank and reduce germination rates.

The topsoil will be removed in slabs that are as large as possible and that are practical to transport. The topsoil will be removed from the donor site and immediately applied to the recipient site. It is necessary that the slabs are only removed when the soil is moist, to maximise the likelihood of the slabs staying intact during transport and laying. The stockpiling of topsoil will not occur, as this is known to lead to a reduction in species richness and diversity (Tacey and Glossop 1980). Receiving sites will be lightly raked/ripped to create roughness to improve the union between the topsoil or slabs.

The vegetation to be used in the rehabilitation should be slashed on multiple occasions several months prior to the slabs being removed. This will remove taller shrubs and other vegetation that may otherwise make the transportation more difficult. Slashing may also help to encourage grasses and groundcovers to thicken up and develop more extensive root systems, which will help bind the soil slabs. Soil compaction and damage by heavy machinery will be avoided in the donor site. The weather should be closely monitored for up to three months following the topsoil translocation, during which time if no rain occurs, then the recipient site should be regularly (fortnightly) watered to maximise successful establishment of the translocated vegetation. Once moved, the soil or slabs should be lightly watered in.

The topsoil translocation will be conducted by a professional revegetation expert with proven experience in soil translocation, or an understanding of how the process should be conducted. The reconstruction of the batters will correspond with the six stages of the proposed development (**Figure 3.2**). Stages one, five and six specifically include development at the interface of the habitat corridor and the 25 m EEC buffer zone. An approximate cost of soil translocation has been factored into the costings for these three stages.

4.6 Scrub Turpentine

The proponent is to contact the Botanic Gardens, Booderee National Park prior to vegetation clearing and notify botanic gardens staff of the presence of EPBC Act listed Critically Endangered *Rhodamnia rubescens* (Scrub Turpentine). The proponent will allow botanic gardens staff to access the site to collect specimens for ex-situ conservation, if requested.

4.7 Concurrent Works

Vegetation management works will be initiated upon the start of stage 1 of the proposed works and will continue concurrently with civil construction works. Therefore, planning between the bush regeneration contractor and civil works supervisor will be undertaken in particular with reference to the construction of the basin batters and the translocation of the topsoil.

The civil works team will install environmental management controls across the site including exclusion zone fencing and erosion and sediment control. The bush regeneration contractor is to be present to supervise, check and repair any damage throughout the installation of environmental management controls across the site. It is essential that appropriate sedimentation controls are implemented around the perimeter of the subject, to ensure that sediment does not enter the EEC or buffer areas.

4.8 Maintenance

Due to the minimal amount of exotic species in the study area, the majority of the restoration work in the subject site consists of maintenance works, with no defined primary or secondary work stages. The maintenance phase must continue for a period of 3 years following the dedication of the EEC to Council. Informal inspections of site condition will be conducted by the contracted bush regenerators, including general site monitoring for potential new infestation areas and subsequent weed control of any identified weed species.

Weed maintenance works will include:

- Removal of all exotic species prior to establishment and seeding, and
- Regular sweeps to monitor for new weed infestation, particularly species that were not previously identified in the subject site.

Revegetation maintenance works will include:

- Replacement of poorly growing or diseased individuals consistent with prescribed planting,
- Management of insect damage, if necessary,
- Watering during dry periods, and
- Augmenting past planting areas where attenuation has occurred.

4.9 Cost of implementation

The costing for the FFMP has been calculated over a six-year period and is estimated at a total of $65,040 (**Table 4.1**). The contract period has been based on each of the six development stages taking approximately 6 months to be completed, with an additional three years of funding once dedicated to Council. The costs have been calculated based on the employment of trained bush regenerators at a rate of $480 pp/day ($60 pp/hr for an 8-hour working day), which covers crew and supervisor wages, equipment, herbicides, and all other associated business costs.

The costing indicates how many crew members are required to attend monthly visits over the six-year contract, based on the size of the site, extent of weed infestation and anticipated weed issues that may become apparent following disturbance to the broader study area. The costs are indicative of commercial bush regeneration charge out rates, and some variation is

excepted depending on the bush regeneration company used and their associated charge out rates.

The costings below have taken into consideration the cost of monthly and annual reports by the bush regeneration contractors and the costs of annual vegetation monitoring. Additional costs associated with the project, including sediment fencing, soil translocation, revegetation and infill plantings have not been calculated. These calculations are subject to change and can be calculated once boundaries and areas are confirmed for those areas requiring revegetation and topsoil translocation. The cost of ecological burns and fencing installation have not been included.

Table 4.1: Indicative cost of weed control and monitoring over a 6-year period.

Task	Timing									Total
	Year 1		Year 2		Year 3		Year 4	Year 5	Year 6	
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6				
Weed control										
Maintenance (@ $60 pp/hour)	$11,520		$11,520		$11,520		$5,760	$5,760	$5,760	$51,840
Assosciated costs										
Monthly reporting	$1,200		$1,200		$1,200		$1,200	$1,200	$1,200	$7,200
Annual reporting	$1,000		$1,000		$1,000		$1,000	$1,000	$1,000	$6,000
BioMetric plot monitoring	$1,920		$1,920		$1,920		$1,920	$1,920	$1,920	$11,520
Total	$15,640		$15,640		$15,640		$7,960	$7,960	$7,960	$65,040

5. Fauna habitat management

5.1.1 Nest box installation

Nest boxes will be installed within the subject site approximately three months prior to the initiation of the Stage 1 subdivision. The number of nest boxes has been determined based on the number of all HBTs proposed for removal in the study area. A total of 51 HBTs were identified within the study area, of which 36 require removal (**Figure 2.5**). HBTs are recommended for replacement at a ratio of 1:3 nest boxes for every hollow-bearing tree proposed for removal (Consent condition B9(h)). Therefore, the installation of up 108 nest boxes will include a variety of sizes to cater for various arboreal species, avifauna and microbats, based on the dimensions of the hollows being removed. The nest boxes should be distributed relatively evenly across the selected area.

Following comments received from Council (5 July 2019, Scott Haylett, Senior Engineer, email correspondence), and subsequent consultation (Lucas McKinnon, Principal Ecologist, 24 July 2019, telephone correspondence), it was determined that it was impractical to place 108 nest boxes in the Bushland Reserve (EEC and Buffer Zone). It was recommended that a maximum of 30-40 boxes would be more practical, with the final location of the remainder to be determined in consultation with Council prior to the placement of the nest boxes. Additional specification regarding fitting height and aspect were provided by Council and have been incorporated into

Table 5.1.

Three main nest box design types that will be included are:

- Microchiropteran Bat Box: These boxes are designed specifically for microchiropteran bats, but other arboreal marsupials have been known to use them. They have a small opening slit at the bottom of the box and parallel internal compartments. These boxes should be mounted 4 m from the base of the tree and positioned on the trees north-eastern aspect.
- Small to Medium Sized Arboreal Mammal Box: These boxes have been designed to accommodate small to medium sized arboreal mammals such as possums and gliders. These boxes should have entrance diameters of approximately 3 cm and be positioned 2-6 m from the base of the tree (Beyer and Goldingay 2006). It is also recommended that these boxes have rear-entries as studies have shown that native birds are less likely to take up residency when the entries are positioned as such (Beyer 2003).
- Small - Large Avifauna Box: These boxes are designed specifically for the use of birds. Nest boxes that are suitable for use by large forest owls (i.e., Powerful Owl) should be installed to offset the removal of large hollows within the subject site.

Table 5.1: Number of nest boxes required and costings of each box.

Hollow Size	HBT removed	Nest Boxes	Fitting height	Aspect	Type	Cost per box[1]	Total Cost
S (<0.2m)	28	84	At least 4 m	NE	Double chamber microbat, tree/bridge mount	$165.00	$13,860.00
M (0.2 < 0.4m)	6	18	2-6 m	S to NE	Brushtail/ringtail possum, greater glider rear entry	$213.84	$3,849.12
L (>0.5 m)	2	6	At least 4 m	S to NE	Large Owl	$462.00	$2,772.00
Total	**36**	**108**			**-**	**-**	**$20,481.12**

1. price based upon Hollow Log Homes – CYPLAS Range, website. https://www.hollowloghomes.com/cyplas-range. Prices correct as of June 2018.

Measures should also be taken to reduce the likelihood of feral competitors moving into the nest boxes. For feral bees, carpet can be attached to the underside of the box lid to prevent them forming a hive. Conditions should also be imposed on future residents in regard to owning a cat, either prohibiting the action or requiring responsible ownership measures.

5.1.2 Monitoring

The nest boxes will be monitored every 6 months and will include inspections of the nest boxes for their functionality (i.e., presence of pests such as bees/wasps and vertebrate pests) and examination for evidence of use or habitation by native fauna. Monitoring will be conducted during construction works until all works are completed and in accordance with Condition E16. Additional monitoring will continue for three years following the dedication of the land to Council and will include the replacement of nest boxes, where damage or substantial deterioration has occurred. Nest boxes should be kept free of vertebrate and invertebrate pest species at all times.

5.1.3 Pre-clearance Protocols

To protect the significant environmental features on the site, prior to the issuing of a construction certificate the applicant shall provide written evidence to Shoalhaven City Council that a suitably qualified environmental consultant has been engaged to supervise the clearing works and that an appropriate release location for any rescued fauna has been identified. Pre-clearance surveys of trees with hollows will be conducted in accordance with consent condition, which is replicated here below. In addition to prescribed protocols, the engaged

ecologist / fauna specialist must undertake inspection of previously identified large nest trees (potentially Square-tailed Kite) to ensure they are not currently in use and determine the appropriate timing for felling these trees. Trees with hollows to be felled during the construction phase will be felled in accordance with the following procedures:

- Felling will be supervised by a fauna specialist appropriately licensed under the NSW National Parks and Wildlife Act, for the purpose of rescuing displaced fauna;
- The fauna specialist will be suitably attired with protective clothing and have suitable equipment to undertake the work. A "Green Card" from an Occupational Health and Safety Induction Training Course for Construction Work will also be held by the fauna specialist, who may also need to be suitably vaccinated (especially if there is potential for handling bats);
- An appropriately skilled local wildlife carer must be notified at least 24 hours prior to the tree felling, that animals may be captured and that these animals may need care;
- GHFF food trees will be clearly marked by an Ecologist;
- An arborist will be engaged to identify Tree Protection Zones surrounding each GHFF food tree;
- Prior to commencement of tree clearing, TPZ fencing will be established at the perimeter surrounding each tree as identified by the arborist;
- Any excavation required within TPZs must be supervised by an arborist;
- Any non-hollow bearing trees around those with tree hollows to be felled will be removed first. At least 1 day will be left between clearing of the non-hollow-bearing trees and the hollow bearing trees to allow fauna time to vacate the trees;
- Prior to felling of the identified and marked hollow-bearing trees, the trees will be shaken or nudged by tree felling equipment to encourage any fauna to vacate the trees;
- If no animals emerge from the hollows after shaking or nudging, then the tree will be felled and lowered to the ground if possible;
- If an animal emerges from a hollow following shaking or nudging of the tree, then at least 30 minutes will be allowed for the animal to leave the tree. If the animal comes to the ground, or when it is on the lower trunk, attempts will be made to capture the animal using a net. Captured animals will be immediately transferred to a suitably sized cotton bag and checked for obvious injury during the transfer process;
- Captured animals will be placed in individual bags unless they are a family group to which separation would risk the survival of the young (i.e., lactating female with young);
- Once the tree has been felled, a search will be made of the branches around the tree for any fleeing fauna and hollows should be inspected with a torch for the presence of any animals. Attempts will be made to capture any fleeing fauna with a net, and animals inside hollows should be extracted by hand. Captured animals will be immediately transferred to a suitably sized cotton bag and checked for obvious injury during the transfer process;
- Injured, shocked or immature captured animals will be placed in a cotton bag secured at the top. Bags will be wrapped in appropriate insulating material such as blankets and placed in a quiet, warm and preferably dark place until the wildlife carer can collect them. Details on the location of the capture and proposed release areas will be provided to the wildlife carer;

- Uninjured animals will be released in appropriate habitat as soon as practicable (at night for nocturnal species); and,
- The environmental consultant must provide a written report to Shoalhaven City Council (email to Council's Threatened Species Officer acceptable) detailing any fauna detected as a result of the clearing works.

Note: Any clearing to be undertaken as part of this approval in Stages 2, 3 or 4 or affecting the Bangalay Moist Woodland/Open Forest will be preceded by a bird census surveys with survey effort sufficient to determine presence/ absence in accordance with guidelines published by DAWE. If Black-faced Monarch or Rufous Fantail are detected within the Bangalay Moist Woodland/Open Forest, then clearing may not be undertaken between the beginning of October and end of February to minimise potential impacts on breeding by the migratory species Black-faced Monarch and Rufous Fantail.

6. Performance criteria and weed monitoring

6.1 Performance criteria

The progress and compliance with the FFMP will be monitored and reviewed annually. This process will involve the bush regeneration contractor and land manager. The performance criteria listed in **Table 6.1** below are considered to be best practice and are not linked with any specific legislation. The bush regeneration contractor, in consultation with Shoalhaven City Council can adapt these criteria as required in response to the success of restoration works. Based on the success of the management works, further performance criteria may need to be developed for the maintenance phase.

Table 6.1. Performance monitoring criteria.

Management measure	Management Actions	Timing and Responsibility	Key Performance Indicator (KPI)
Engagement of bush regeneration contractors	Establishment of baseline vegetation monitoring data in accordance with **Section 3.1.8**, including: • Two BAM plot/transects in the subject site • Two control plots in an adjoining area of similar vegetation	**Bush Regenerator, Ecologist and Hydrologist** One year prior to initiation of Stage 1 of the development	A suitably qualified and experienced bush regeneration company will have been engaged to conduct the works under this FFMP (see **Section 4**). Baseline data collected for monitoring of the vegetation in the subject site in accordance with **Section 3.1.8**. One vegetation plot/transect will have been established in MZ1 and another in MZ2 in the locations indicated in **Figure 3.4**. Start and end point of the transect will be marked with hardwood stakes and GPS coordinates will be recorded. Control plots will have been established in vegetation near to the study area in the vegetation communities *Swamp Sclerophyll Forest on Coastal Floodplains* and Northern Coastal Sands Shrub/Fern Forest.
	Establishment of water monitoring locations.		Water samples will have been successful collected at the locations indicated in **Figure 3.1** and analysed in accordance with the recommendations in **Section 3.1.8**. The location of each water monitoring point will be marked with a hardwood stake and GPS coordinates will be recorded.
	Establishment of photo monitoring points in accordance with **Figure 3.4**.		Photo monitoring point will have been established at the start and end point of the two transects and the additional points indicated in **Figure 3.4**. The location of the photo monitoring points will be numbered, marked with a hardwood stake and GPS coordinates will be recorded.

Management measure	Management Actions	Timing and Responsibility	Key Performance Indicator (KPI)
Vegetation monitoring	Ongoing plot and transect surveys	**Ecologist** Yearly following the initiation of Stage 1 of the development.	Annual collection of plot and transect data in accordance in accordance with **Section 3.1.8** in the locations indicated in **Figure 3.4**. Statistical analysis of parameters collected using the BBAM (OEH 2014) will be performed annually in accordance with **Section 3.1.8** and detailed in a short report. Annual vegetation monitoring will continue for three years after dedication of the land to Council.
Nest Box installation and monitoring	Installation of nest boxes into the subject site, or other selected areas (to be confirmed by Shoalhaven Council)	**Ecologist** Three months prior to the initiation of Stage 1 subdivision	The installation of 108 nest boxes to offset the loss of 36 hollow bearing trees (replaced at a ratio of 1:3). Council request 30-40 be emplaced in the Bushland Reserve on site 1, and location of the remainder are located offsite in consultation with Council. The onsite boxes should include a suitable mix of Large, Small and Microbat boxes, with the final number determined following emplacement, but will be at least 30 and not more than 40.
	Nest box monitoring	**Ecologist** Every six months following the installation of the nest boxes	Monitoring will include inspections of the nest boxes for the habitation of native fauna, which will be documented in a brief letter report. Monitoring will continue until all construction works are completed in accordance with Condition E16. Additional monitoring will continue three years following the dedication of the land to Council. Any damaged nest boxes will be replaced. The boxes will be kept free of invertebrate pests at all times.

Management measure	Management Actions	Timing and Responsibility	Key Performance Indicator (KPI)
			Nest box monitoring should also be conducted simultaneously with fauna survey designed to monitor diversity and population sizes of fauna residents within the subject site.
Installation of fencing	-	**Civil Works Supervisor** Exclusion fencing to be erected prior to the commencement of any clearing works Post and cable fencing to be installed following the completion of construction works.	Fencing is to be in accordance with the fencing masterplan provided in the landscaping designs and the recommendations made in Section **4.1.2** The exclusion fencing, and the post and cable fencing will surround the full perimeter of the subject site. The exclusion fencing is to have signs attached every 20 m stating 'Environmental Protection Area' to reinforce the importance of the bushland excluded from development at the site The fencing will be regularly monitored (monthly) and maintained to ensure that it is effectively preventing access to the Bushland Reserve. Post and cable fencing will prevent car access and discourage pedestrian access.
Installation of signage	Interpretative signage will be installed around the perimeter of the subject site.	**Civil Works Supervisor** In association with each of the six stages.	Interpretative signage is successfully deterring residents from dumping garden refuse in the subject site and collecting firewood. Interpretive signage is to be developed in consultation with the Natural Resources & Floodplain Unit of Council, Natural Areas Operations Officer Interpretative signage is effective at informing the residents of the sensitivity of the subject site and reducing pedestrian disturbance in the area.
Weed control	Primary and secondary weed management	**Bush Regenerator**	Primary and secondary treatment of exotic grasses and herbaceous weeds in MZ5 is successfully completed.

Management measure	Management Actions	Timing and Responsibility	Key Performance Indicator (KPI)
		First six months of the contract	
	Maintenance weed management	**Bush Regenerator** Years one - six	Exotic grasses and herbaceous weeds maintained at low cover (<1%) throughout the contract in all management zones. *Lonicera japonica* maintained at low cover (<1%) throughout the contract in all management zones. Woody weeds maintained at low cover (<1%) throughout the contract in all management zones. Eradication of all introduced woody weed species prior to establishment (no individuals >5 cm high) in all management zones. Frequency of maintenance works is to have been conducted in accordance with the costings and spread throughout the year. Years 1-3 should consist of monthly visits of a team of two bush regenerators, and years 4-6 will consists of visits every two months with a team of two bush regenerators. Maintenance work will have successfully prevented the establishment of new weed populations in the subject site.
Water quality monitoring	-	**Hydrologist** Yearly following the initiation of Stage 1 of the development.	Annual collection of water samples from the locations indicated in **Figure 3.1**. Comparisons will be made between the condition of the vegetation based on the plots and transect data and water quality.

Management measure	Management Actions	Timing and Responsibility	Key Performance Indicator (KPI)
			Comparison between water quality and vegetation condition will be detailed in a short annual report in combination with the results of the plot/transect data.
Soil Translocation	Topsoil translocation onto the batters of basin C	**Civil Works Supervisor and Bush Regenerator** Stage 1	Topsoil translocation will be conducted in accordance with **Section 4.5**. The basin batters will be constructed and immediately applied with topsoil sourced from any area of the study area mapped as Northern Coastal Sands Shrub/Fern Forest (the 'donor site'). The success of the translocated topsoil will be assessed and included in the annual bush regeneration reports. The translocated topsoil will be monitored for two years, and should the translocation be unsuccessful (or partially successful) then revegetation should be conducted following the advice below.
	Topsoil translocation onto the batters of basin B	**Civil Works Supervisor and Bush Regenerator** Stage 4	
	Topsoil translocation onto the batters of basin A	**Civil Works Supervisor and Bush Regenerator** Stage 5	
Revegetation	Mulching and revegetation of MZ5 with low lying groundcover species.	**Bush Regenerator** First six months of the contract	MZ5 will be mulched and revegetated following the successful primary treatment of exotic grasses and herbaceous weeds in the zone. Grasses and groundcovers will be installed at a density of 4 plants per m^2 across MZ4. Replacement and maintenance are to be undertaken to ensure a survival rate of at least 90% after 12 months of installation.
	Revegetation of basin C in the event that the translocated topsoil does not achieve desired covers on the basin.	**Bush Regenerator** Start of year three (Approximately two years following the translocation of topsoil during Stage 1)	Revegetation of the basin batters after two years of each topsoil translocation event. The batters will be revegetated to achieve a density of 4 grasses or groundcovers per m^2 across the zones. Replacement and maintenance are to be undertaken to ensure a survival rate of at least 90% after 12 months of installation.
	Revegetation of basin B in the event that the translocated topsoil	**Bush Regenerator** Mid-way through year four (Approximately two years	

Management measure	Management Actions	Timing and Responsibility	Key Performance Indicator (KPI)
	does not achieve desired covers on the basin.	following the translocation of topsoil during Stage 4)	
	Revegetation of basin A in the event that the translocated topsoil does not achieve desired covers on the basin.	**Bush Regenerator** Start of year five (Approximately two years following the translocation of topsoil during Stage 4)	
Seed collection and propagation	Collection and propagation of native seed in preparation for revegetation of MZ5 and MZ4	**Bush Regenerator** Evidence of planning 8 months – one year prior to revegetation	Seed collection to be in accordance with **Section 4.1.1**. A Section 132C licence under the NSW *National Parks and Wildlife Act 1974* will be required to undertake seed collection works.
Bush regenerator reporting	Monthly reports will be documented and compiled into an annual report	**Bush Regenerator** Years one - six	Monthly reports will be produced in accordance with **Section 6.2** and should take into consideration the example report provided in **Table 6.2**. Monthly reports will be compiled into an annual report. which will compare the management activities conducted onsite to the relevant management actions and their associated KPI for the given year of the contract. Management measures should be adapted in response to findings of floristic monitoring and the addition of new management issues onsite.

6.2 Monitoring reports

The bush regeneration contractor and the land manager will monitor the vegetation for changes over time. The objective of the monitoring and reporting program is to record changes to the vegetation as a result of vegetation management works. Monitoring works will require liaison with the land manager, the bush regeneration contractor and Shoalhaven Council.

Monthly monitoring and reporting must be documented and compiled into an annual report to determine the effectiveness of the works undertaken. Site conditions should be recorded on the work plan template at the beginning and end of on-ground works. This data should be included in the annual report. The required monitoring period following the dedication of the land to council is three years.

Monitoring photo points will be established at five permanent reference points in the subject site. The photo monitoring points will be additional to the photo monitoring points established at the start and end points of the two vegetation transects (see **Figure 3.4**). Photo monitoring points will be positioned at basins A, B and C, along the boardwalk and adjacent to the proposed headwall in the north of the subject site where disturbances are likely to be centralised. Photo points must be marked (e.g., with hardwood stakes) and GPS coordinates recorded for consistency of pictures and taken in a westerly (270°) direction.

An example report is detailed in **Table 6.2**, the report should include:

- Works carried out, including weed species targeted and their location
- An approximation of the time spent on each task
- Any observations, such as the occurrence of new weed species
- Rates of regeneration of native species
- A description of any problems encountered and how they were overcome
- A summary of how the site-specific objectives have been met (or not)
- Herbicide and other chemicals used, including quantity, dilution rate and other relevant information
- Weed control mechanisms used during the period
- Climatic conditions which may have influenced weed germination and growth
- Performance criteria and success; and
- If required, maps of weed distribution and density.

6.3 Bush regeneration contractors

Suitably qualified and experienced bush regeneration contractors that are members of the Australian Association of Bush Regenerators or fulfil the membership criteria must undertake all vegetation management works. In addition to this, team leaders should hold a Certificate III in Conservation & Land Management or possess equivalent field experience and certification. The contractor should carry out best practice bush regeneration techniques as described by Buchanan (1989). Engagement of the bush regeneration contractor must be at or before commencement of project to enable establishment of baseline data, photo points, etc.

Table 6.2. Monitoring report template example.

Date			
Name of Contractor:			
Hours worked on site since last monitoring report:			
Site Condition:	Zone		
	Weed cover %		
	Seedling survival %		
	Planting numbers		
	Herbicide used (in Litres)		
	Other		
Describe relevant weed management techniques:			
Describe problems; e.g., weed invasions, damage to planted material, etc.:			
Photographic evidence:			
Planned work before next monitoring report:			

References

Bradley, J. (2002) *Bringing back the bush. The Bradley Method of Bush Regeneration*. New Holland Publishers, Sydney.

Buchanan R.A (1989) Bush regeneration: recovering Australian landscapes. 2nd edn, TAFE NSW, Sydney.

Bushfire + Environmental Services (BES) (2006). Flora and Fauna Assessment Report Proposed Residential Subdivision – Lot 172 DP 755923 and Lot 823 DP 247285 Berringer Road and Cunjurong Point Road and Sunset Strip, Manyana (Ref: 04383) prepared by BES, September 2006.

HLS (2021). Manyana Residential Subdivision, Berringer Road and Cunjarong Point Road Manyana, for Ozy Homes P/L. Landscape Plans – Stage 1, LD03E, issued: 22 April 2021.

Kenny, B, Sutherland, E, Tasker, E and Bradstock, R (2004) Guidelines for Ecologically Sustainable Fire Management NSW Biodiversity Strategy. NSW National Parks and Wildlife Service, Hurstville.

Mills, K. 1993, The Natural Vegetation of the Jervis Bay Region of New South Wales. The National Estates Grant Scheme 1990/91, The NSW Heritage Assistance Program. The University of Wollongong, January. Includes maps at a scale of 1:25,000 for the whole region.

NSW Office of Environment and Heritage (OEH) (2016). Square Tailed Kite – profile. Accessed at: http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10495

Mortlock, W. (2000) The Hawkesbury-Nepean Catchment Management Authority (2000) Florabank Guideline 10: Seed collection ranges for revegetation. http://www.florabank.org.au/ Florabank, Yarralumla, ACT [20 August 2001].

NSW Dept. of Planning and Environment (DPE) (2017) NSW Planning Viewer Beta. NSW Government. Accessed at: https://maps.planningportal.nsw.gov.au/Terms.

Rokich, D.P., Dixon, K.W., Sivasithamparam, K. and Meney, K.A. (2000). Topsoil Handling and Storage Effects on Woodland Restoration in Western Australia. *Restoration Ecology* 8(2): 196-208.

Tacey, W.H., Glossop, B.L. (1980). Assessment of topsoil handline techniques for rehabilitation of sites mined for Bauxite within the Jarrah Forest of Western Australia. *Journal of Applied Ecology* 17: 195-201.

Thomas, V., Gellie, N. and Harrison, T (2000) Forest Ecosystem Classification and Mapping for the Southern CRA Region. Volume II Appendices. NSW National Parks and Wildlife Service Southern Directorate.

Tozer, M.G., Turner, K., Simpson, C., Keith, D.A., Beukers, P., MacKenzie, B., Tindall, D. & Pennay, C. (2006). Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. NSW Department of Environment and Conservation & NSW Department of Natural Resources.

Tozer, M.G., Turner, K., Keith, D.A., Tindall, D., Pennay, C., Simpson, C., MacKenzie, B., Beukers, P. and Cox, S. (2010). Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. *Cunninghamia* 11(3): 359–406 [plus Appendices

Water Cycle Management Report for Proposed Subdivision Lot 172 DP 755923 and Lot 823 DP 247285 at Berringer Road and Cunjurong Point Road Manyana (Project No. 555) prepared by Storm Consulting, October 2007.

Appendix A: Flora inventory

Family	Genus	Species	Common name	Native/Exotic
Acanthaceae	*Brunoniella*	*pumilio*	Dwarf Blue Trumpet	Native
Acanthaceae	*Pseuderanthemum*	*variabile*	Pastel Flower	Native
Adoxaceae	*Sambucus*	*nigra*	Elderberry	Exotic
Anthericaceae	*Arthropodium*	*milleflorum*	Pale Vanilla Lily	Native
Anthericaceae	*Thysanotus*	*tuberosus*	Common Fringe Lily	Native
Apiaceae	*Centella*	*asiatica*	Indian Pennywort	Native
Apocynaceae	*Marsdenia*	*rostrata*	Milk Vine	Native
Apocynaceae	*Marsdenia*	*suaveolens*	Scented Marsdenia	Native
Apocynaceae	*Parsonsia*	*straminea*	Common Silkpod	Native
Apocynaceae	*Tylophora*	*barbata*	Bearded Tylophora	Native
Araliaceae	*Hydrocotyle*	*sibthorpioides*		Native
Arecaceae	*Livistona*	*australis*	Cabbage Palm	Native
Asparagaceae	*Asparagus*	*asparagoides*	Bridal Creeper	Exotic
Asparagaceae	*Asparagus*	*aethiopicus*	Asparagus Fern	Exotic
Asteraceae	*Bidens*	*pilosa*	Cobblers Pegs	Exotic
Asteraceae	*Hypochaeris*	*radicata*	Catsear	Exotic
Asteraceae	*Sonchus*	*oleraceus*	Sowthistle	Exotic
Asteraceae	*Taraxacum*	*officinale*	Dandelion	Exotic
Asteraceae	*Cassinia*	*aculeata*	Dolly Bush	Native
Asteraceae	*Lagenifera*	*gracilis*	Slender Lagenophora	Native
Asteraceae	*Olearia*	*viscidula*	Wallaby Weed	Native

Family	Genus	Species	Common name	Native/Exotic
Asteraceae	*Ozothamnus*	*diosmifolius*	Rice Flower	Native
Asteraceae	*Senecio*	*hispidulus*	Hill Fireweed	Native
Asteraceae	*Vernonia*	*cinerea* var. *cinerea*		Native
Balsaminaceae	*Impatiens*	*balsamina*		Exotic
Bignoniaceae	*Pandorea*	*pandorana*	Wonga Wonga Vine	Native
Blechnaceae	*Blechnum*	*camfieldii*	Eared Swamp Fern	Native
Blechnaceae	*Blechnum*	*cartilagineum*	Gristle Fern	Native
Blechnaceae	*Blechnum*	*nudum*	Fishbone Water Fern	Native
Blechnaceae	*Doodia*	*aspera*	Prickly Rasp Fern	Native
Caprifoliaceae	*Lonicera*	*japonica*	Japanese Honeysuckle	Exotic
Casuarinaceae	*Allocasuarina*	*littoralis*	Black She-oak	Native
Convolvulaceae	*Dichondra*	*repens*	Kidney Weed	Native
Convolvulaceae	*Polymeria*	*calycina*	Polymeria	Native
Crassulaceae	*Crassula*	*multicava*		Exotic
Cunoniaceae	*Callicoma*	*serratifolia*	Black Wattle	Native
Cyatheaceae	*Cyathea*	*australis*	Rough Tree-fern	Native
Cyperaceae	*Carex*	*longebrachiata*		Native
Cyperaceae	*Gahnia*	*clarkei*	Tall Saw-sedge	Native
Cyperaceae	*Gahnia*	*melanocarpa*	Black-fruit Saw-sedge	Native
Cyperaceae	*Gahnia*	*radula*		Native
Cyperaceae	*Gahnia*	*sieberana*	Red-fruit Saw-sedge	Native
Cyperaceae	*Lepidosperma*	*laterale*		Native
Cyperaceae	*Lepidosperma*	*neesii*		Native
Cyperaceae	*Schoenus*	*melanostachys*	Black Bog-rush	Native

Family	Genus	Species	Common name	Native/Exotic
Dennstaedtiaceae	*Pteridium*	*esculentum*	Common Bracken	Native
Dicksoniaceae	*Calochlaena*	*dubia*	Rainbow Fern	Native
Dilleniaceae	*Hibbertia*	*scandens*	Climbing Guinea Flower	Native
Dilleniaceae	*Hibbertia*	*aspera*	Rough Guinea Flower	Native
Dilleniaceae	*Hibbertia*	*linearis*		Native
Elaeocarpaceae	*Elaeocarpus*	*reticulatus*	Blueberry Ash	Native
Elaeocarpaceae	*Tetratheca*	*thymifolia*	Black-eyed Susan	Native
Epacridaceae	*Epacris*	*pulchella*	Wallum Heath	Native
Epacridaceae	*Leucopogon*	*juniperinus*	Prickly Beard-heath	Native
Epacridaceae	*Leucopogon*	*lanceolatus* var. *lanceolatus*	Lance Beard-heath	Native
Ericaceae - Epacridoideae	*Monotoca*	*elliptica*	Tree Broom-heath	Native
Euphorbiaceae	*Amperea*	*xiphoclada* var. *xiphoclada*		Native
Euphorbiaceae	*Breynia*	*oblongifolia*	Coffee Bush	Native
Fabaceae - Caesalpinioideae	*Senna*	*septemtrionalis*	Arsenic Bush	Exotic
Fabaceae - Caesalpinioideae	*Senna*	*pendula* var. *glabrata*		Exotic
Fabaceae - Faboideae	*Desmodium*	*rhytidophyllum*		Native
Fabaceae - Faboideae	*Desmodium*	*varians*	Slender Tick-trefoil	Native
Fabaceae - Faboideae	*Glycine*	*clandestina*		Native
Fabaceae - Faboideae	*Gompholobium*	*latifolium*	Golden Glory Pea	Native
Fabaceae - Faboideae	*Hardenbergia*	*violacea*	Purple Coral Pea	Native
Fabaceae - Faboideae	*Indigofera*	*australis*	Australian Indigo	Native
Fabaceae - Faboideae	*Kennedia*	*rubicunda*	Dusky Coral Pea	Native
Fabaceae - Faboideae	*Platylobium*	*formosum*	Handsome Flat Pea	Native
Fabaceae - Faboideae	*Podolobium*	*ilicifolium*	Prickly Shaggy Pea	Native

Family	Genus	Species	Common name	Native/Exotic
Fabaceae - Faboideae	*Pultenaea*	*daphnoides*	Large-leaf Bush-pea	Native
Fabaceae - Faboideae	*Pultenaea*	*linophylla*		Native
Fabaceae - Faboideae	*Pultenaea*	*retusa*	Notched Bush-pea	Native
Fabaceae - Mimosoideae	*Acacia*	*binervata*	Two-veined Hickory	Native
Fabaceae - Mimosoideae	*Acacia*	*elata*	Mountain Cedar Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*implexa*	Hickory Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*longifolia* subsp. *longifolia*	Sydney Golden Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*mearnsii*	Black Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*parramattensis*	Parramatta Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*longifolia* subsp. *sophorae*	Coastal Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*suaveolens*	Sweet Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*terminalis*	Sunshine Wattle	Native
Fabaceae - Mimosoideae	*Acacia*	*ulicifolia*	Prickly Moses	Native
Gleicheniaceae	*Gleichenia*	*dicarpa*	Pouched Coral-fern	Native
Goodeniaceae	*Goodenia*	*bellidifolia* subsp. *bellidifolia*	Daisy-leaved Goodenia	Native
Goodeniaceae	*Scaevola*	*ramosissima*	Purple Fan-flower	Native
Haloragaceae	*Gonocarpus*	*teucrioides*	Raspwort	Native
Hypericaceae	*Hypericum*	*gramineum*	Small St John's Wort	Native
Hypoxidaceae	*Hypoxis*	*hygrometrica*	Golden Weather-grass	Native
Iridaceae	*Watsonia*	*meriana*		Exotic
Iridaceae	*Patersonia*	*glabrata*	Leafy Purple-flag	Native
Lamiaceae	*Clerodendrum*	*tomentosum*	Hairy Clerodendrum	Native
Lazuriagaceae	*Eustrephus*	*latifolius*	Wombat Berry	Native
Liliaceae	*Lilium*	*formosanum*	Formosan Lily	Exotic

Family	Genus	Species	Common name	Native/Exotic
Lobeliaceae	*Lobelia*	*anceps*		Native
Lobeliaceae	*Pratia*	*purpurascens*	Whiteroot	Native
Lomandraceae	*Lomandra*	*longifolia*	Spiny-headed Mat-rush	Native
Lomariopsidaceae	*Nephrolepis*	*cordifolia*	Fishbone Fern	Exotic
Luzuriagaceae	*Geitonoplesium*	*cymosum*	Scrambling Lily	Native
Meliaceae	*Synoum*	*glandulosum* subsp. *glandulosum*	Scentless Rosewood	Native
Menispermaceae	*Stephania*	*japonica*	Snake Vine	Native
Myrtaceae	*Acmena*	*smithii*	Lilly Pilly	Native
Myrtaceae	*Angophora*	*floribunda*	Rough-barked Apple	Native
Myrtaceae	*Corymbia*	*gummifera*	Red Bloodwood	Native
Myrtaceae	*Eucalyptus*	*botryoides*	Bangalay	Native
Myrtaceae	*Eucalyptus*	*eugenioides*	Thin-leaved Stringybark	Native
Myrtaceae	*Eucalyptus*	*globoidea*	White Stringybark	Native
Myrtaceae	*Eucalyptus*	*paniculata*	Grey Ironbark	Native
Myrtaceae	*Eucalyptus*	*pilularis*	Blackbutt	Native
Myrtaceae	*Eucalyptus*	*piperita*	Sydney Peppermint	Native
Myrtaceae	*Eucalyptus*	*sclerophylla*	Hard-leaved Scribbly Gum	Native
Myrtaceae	*Kunzea*	*ambigua*	Tick Bush	Native
Myrtaceae	*Leptospermum*	*polygalifolium* subsp. *polygalifolium*	Tantoon	Native
Myrtaceae	*Melaleuca*	*ericifolia*	Swamp Paperbark	Native
Myrtaceae	*Melaleuca*	*linariifolia*	Flax-leaved Paperbark	Native
Myrtaceae	*Rhodamnia*	*rubescens*	Scrub Turpentine	Native
Myrtaceae	*Syncarpia*	*glomulifera* subsp. *glomulifera*	Turpentine	Native
Oleaceae	*Notelaea*	*longifolia*	Large Mock-olive	Native

Family	Genus	Species	Common name	Native/Exotic
Oleaceae	*Notelaea*	*venosa*	Veined Mock-olive	Native
Orchidaceae	*Calanthe*	*triplicata*	Christmas Orchid	Native
Orchidaceae	*Cryptostylis*	*erecta*	Bonnet Orchid	Native
Orchidaceae	*Cryptostylis*	*subulata*	Large Tongue Orchid	Native
Orchidaceae	*Cymbidium*	*suave*	Snake Flower	Native
Orchidaceae	*Dipodium*	*variegatum*		Native
Orchidaceae	*Microtis*	*parviflora*	Slender Onion Orchid	Native
Orchidaceae	*Thelymitra*	sp.		Native
Oxalidaceae	*Oxalis*	*exilis*		Native
Phormiaceae	*Dianella*	*caerulea* var. *caerulea*	Blue Flax-lily	Native
Phormiaceae	*Dianella*	*caerulea* var. *producta*		Native
Phyllanthaceae	*Glochidion*	*ferdinandi*	Cheese Tree	Native
Pittosporaceae	*Billardiera*	*scandens*	Hairy Apple Berry	Native
Pittosporaceae	*Pittosporum*	*revolutum*	Wild Yellow Jasmine	Native
Pittosporaceae	*Pittosporum*	*undulatum*	Sweet Pittosporum	Native
Poaceae	*Cenchrus*	*clandestinus*	Kikuyu	Exotic
Poaceae	*Holcus*	*lanatus*	Yorkshire Fog	Exotic
Poaceae	*Stenotaphrum*	*secundatum*	Buffalo Grass	Exotic
Poaceae	*Austrostipa*	*pubescens*		Native
Poaceae	*Dichanthium*	*sericeum*	Queensland Bluegrass	Native
Poaceae	*Echinopogon*	*caespitosus* var. *caespitosus*	Tufted Hedgehog Grass	Native
Poaceae	*Entolasia*	*marginata*	Bordered Panic	Native
Poaceae	*Entolasia*	*stricta*	Wiry Panic	Native
Poaceae	*Imperata*	*cylindrica*	Blady Grass	Native

Family	Genus	Species	Common name	Native/Exotic
Poaceae	*Microlaena*	*stipoides*	Weeping Grass	Native
Poaceae	*Oplismenus*	*aemulus*	Australian Basket Grass	Native
Poaceae	*Oplismenus*	*imbecillis*	Creeping Beard Grass	Native
Poaceae	*Panicum*	*simile*	Two-colour Panic	Native
Poaceae	*Poa*	*labillardieri* var. *labillardieri*	Tussock	Native
Poaceae	*Rytidosperma*	*fulvum*	Wallaby Grass	Native
Poaceae	*Themeda*	*triandra*	Kangaroo Grass	Native
Polygalaceae	*Comesperma*	*ericinum*	Pyramid Flower	Native
Primulaceae	*Rapanea*	*variabilis*	Mutton Wood	Native
Proteaceae	*Banksia*	*integrifolia* subsp. *integrifolia*	Coast Banksia	Native
Proteaceae	*Banksia*	*serrata*	Saw Banksia	Native
Proteaceae	*Banksia*	*spinulosa* var. *spinulosa*	Hair-pin Banksia	Native
Proteaceae	*Hakea*	*salicifolia*	Willow-leaved Hakea	Native
Proteaceae	*Lomatia*	*ilicifolia*	Holly Lomatia	Native
Proteaceae	*Persoonia*	*linearis*	Narrow-leaved Geebung	Native
Proteaceae	*Persoonia*	*mollis* subsp. *caleyi*		Native
Proteaceae	*Petrophile*	*pedunculata*	Conesticks	Native
Proteaceae	*Stenocarpus*	*salignus*	Scrub Beefwood	Native
Pteridaceae	*Adiantum*	*aethiopicum*	Common Maidenhair	Native
Phyllanthaceae	*Phyllanthus*	*hirtellus*	Thyme Spurge	Native
Ranunculaceae	*Clematis*	*aristata*	Old Man's Beard	Native
Restionaceae	*Leptocarpus*	*tenax*		Native
Rhamnaceae	*Alphitonia*	*excelsa*	Red Ash	Native
Rosaceae	*Rubus*	*ulmifolius*	Blackberry	Exotic

Family	Genus	Species	Common name	Native/Exotic
Rosaceae	*Rubus*	*moluccanus* var. *trilobus*	Molucca Bramble	Native
Rosaceae	*Rubus*	*parvifolius*	Native Raspberry	Native
Rubiaceae	*Gynochthodes*	*jasminoides*	Sweet Morinda	Native
Rubiaceae	*Opercularia*	*aspera*	Coarse Stinkweed	Native
Rubiaceae	*Opercularia*	*varia*	Variable Stinkweed	Native
Rubiaceae	*Psychotria*	*loniceroides*	Hairy Psychotria	Native
Rutaceae	*Boronia*	*polygalifolia*	Dwarf Boronia	Native
Santalaceae	*Exocarpos*	*cupressiformis*	Cherry Ballart	Native
Santalaceae	*Leptomeria*	*acida*	Native Currant	Native
Santalaceae	*Santalum*	*obtusifolium*	Blunt Sandalwood	Native
Sapindaceae	*Dodonaea*	*triquetra*	Large-leaf Hop-Bush	Native
Smilacaceae	*Smilax*	*glyciphylla*	Sweet Sarsaparilla	Native
Thymelaeaceae	*Pimelea*	*linifolia subsp. linifolia*	Slender Rice Flower	Native
Ulmaceae	*Trema*	*aspera*	Native Peach	Native
Uvulariaceae	*Schelhammera*	*undulata*		Native
Violaceae	*Viola*	*hederacea*	Ivy-leaved Violet	Native
Vitaceae	*Cissus*	*hypoglauca*	Water Vine	Native
Xanthorrhoeaceae	*Xanthorrhoea*	sp.		Native
Zingiberaceae	*Hedychium*	*gardnerianum*	Ginger Lily	Exotic

Appendix B: Weed treatment methods

Zone	Objective	Main Weeds	Method	Key Performance Indicators (KPI)
All	Eradicate all exotic grasses and herbaceous weeds.	*Asparagus aethiopicus, Asparagus asparagoides, Bidens pilosa, Sonchus oleraceus, Lilium formosanum* and *Hedychium gardnerianum*	• Regular sweeps will be conducted to prevent the establishment of herbaceous weeds. At present herbaceous weeds constitute a very low cover (<1%). • Herbaceous weeds will be hand pulled prior to establishment and seeding. • Spraying of herbaceous weeds should be avoided in all MZs, with the exception for the of revegetation in MZ4. • *Asparagus aethiopicus* will be crowned to ensure removal of woody rhizome. All underground tubers of *Asparagus asparagoides* will be removed.	• Exotic grasses and herbaceous weeds maintained at low cover (<1%) throughout the contract.
	Prevent the establishment of exotic vine species.	*Lonicera japonica*	• Regular sweeps will be conducted to prevent the establishment of *Lonicera japonica*. • *Lonicera japonica* will be treated by hand removal, however large bases should be scrapped and painted with neat Roundup Biactive® where too large to remove by hand.	• *Lonicera japonica* maintained at low cover (<1%) throughout the contract.
	Treatment of all woody weeds.	*Sambucus nigra, Senna pendula var. glabrata* and *Senna septemtrionalis.*	• Regular sweeps will be conducted to prevent the establishment of woody weeds. At present woody weeds constitute a very low cover (<1%). Woody weeds will be hand pulled prior to establishment and cut/scraped and painted with neat Roundup Biactive® where too large to remove by hand. • Woody weeds will be removed prior to establishment (i.e., no individuals >5 cm high) and prior to seeding. All woody weed material will be bagged, or stockpiled, removed from site and disposed of at a licenced green waste facility. • As few woody weed species occur onsite particular focus should be paid to the introduction and establishment of woody weeds that were not recorded in the study area, or	• Woody weeds maintained at low cover (<1%) throughout the contract. • Eradication of all introduced woody weed species prior to establishment (no individuals >5 cm high).

Zone	Objective	Main Weeds	Method	Key Performance Indicators (KPI)
			the immediate surrounds prior to initiation of construction works. Preventing the establishment of additional woody weed species is a high priority.	

Appendix C: Planting palettes

Northern Coastal Sands Shrub/Fern Forest

Planting palette for the vegetation community Northern Coastal Sands Shrub/Fern Forest, as described by Thomas et al. (2000).

Scientific Name	Common Name
Grasses	
Austrostipa pubescens	
Echinopogon caespitosus var. *caespitosus*	Tufted Hedgehog Grass
Entolasia marginata	Bordered Panic
Entolasia stricta	Wiry Panic
Imperata cylindrica	Blady Grass
Microlaena stipoides	Weeping Grass
Oplismenus aemulus	Australian Basket Grass
Oplismenus imbecillis	Creeping Beard Grass
Panicum simile	Two-colour Panic
Poa labillardieri var. *labillardieri*	Tussock
Rytidosperma fulvum	Wallaby Grass
Themeda triandra	Kangaroo Grass
Groundcovers, forbs and scramblers	
Centella asiatica	Indian Pennywort
Tylophora barbata	Bearded Tylophora
Hydrocotyle sibthorpioides	
Lagenifera gracilis	Slender Lagenophora
Vernonia cinerea var. *cinerea*	
Dichondra repens	Kidney Weed
Hibbertia scandens	Climbing Guinea Flower
Hibbertia aspera	Rough Guinea Flower
Desmodium varians	Slender Tick-trefoil
Glycine clandestina	
Hardenbergia violacea	Purple Coral Pea
Goodenia bellidifolia subsp. *bellidifolia*	Daisy-leaved Goodenia
Scaevola ramosissima	Purple Fan-flower
Gonocarpus teucrioides	Raspwort
Hypericum gramineum	Small St John's Wort
Hypoxis hygrometrica	Golden Weather-grass
Lobelia anceps	
Pratia purpurascens	Whiteroot
Lomandra longifolia	Spiny-headed Mat-rush

Scientific Name	Common Name
Dianella caerulea var. *caerulea*	Blue Flax-lily
Dianella caerulea var. *producta*	
Billardiera scandens	Hairy Apple Berry
Adiantum aethiopicum	Common Maidenhair
Phyllanthus hirtellus	Thyme Spurge
Schelhammera undulata	
Viola hederacea	Ivy-leaved Violet
Brunoniella pumilio	Dwarf Blue Trumpet
Pseuderanthemum variabile	Pastel Flower
Arthropodium milleflorum	Pale Vanilla Lily

Bangalay Paperbark Woodland

Planting palette for the vegetation community Bangalay Paperbark Woodland, as described by Thomas et al. (2000).

Scientific Name	Common Name
Grasses	
Echinopogon caespitosus var. caespitosus	Tufted Hedgehog Grass
Entolasia marginata	Bordered Panic
Entolasia stricta	Wiry Panic
Imperata cylindrica	Blady Grass
Microlaena stipoides	Weeping Grass
Oplismenus aemulus	Australian Basket Grass
Oplismenus imbecillis	Creeping Beard Grass
Panicum simile	Two-colour Panic
Themeda triandra	Kangaroo Grass
Groundcovers, forbs and scramblers	
Centella asiatica	Indian Pennywort
Tylophora barbata	Bearded Tylophora
Hydrocotyle sibthorpioides	
Dichondra repens	Kidney Weed
Goodenia bellidifolia subsp. *bellidifolia*	Daisy-leaved Goodenia
Pratia purpurascens	Whiteroot
Lomandra longifolia	Spiny-headed Mat-rush
Dianella caerulea var. *caerulea*	Blue Flax-lily
Dianella caerulea var. *producta*	
Adiantum aethiopicum	Common Maidenhair
Schelhammera undulata	
Viola hederacea	Ivy-leaved Violet
Brunoniella pumilio	Dwarf Blue Trumpet

Scientific Name	Common Name
Pseuderanthemum variabile	Pastel Flower
Sedges, rushes and ferns	
Blechnum camfieldii	Eared Swamp Fern
Blechnum cartilagineum	Gristle Fern
Blechnum nudum	Fishbone Water Fern
Calochlaena dubia	Rainbow Fern
Doodia aspera	Prickly Rasp Fern
Gahnia clarkei	Tall Saw-sedge
Gahnia melanocarpa	Black-fruit Saw-sedge
Gahnia radula	
Gahnia sieberana	Red-fruit Saw-sedge
Lepidosperma laterale	
Lepidosperma neesii	
Pteridium esculentum	Common Bracken
Schoenus melanostachys	Black Bog-rush

Sediment Basin Revegetation

A majority of the species below have been identified within the study area and are suitable for installation in the basins. Additional species have been added to the list that have not been recorded onsite but are indigenous to the area.

Scientific Name	Common Name
Grasses	
Dicanthium sericeum	Queensland Bluegrass
Echinopogon caespitosus var. *caespitosus*	Tufted-Hedgehog Grass
Imperata cylindrica	Blady Grass
Isachne globosa	Swamp Millet
Poa labillardieri var. *labillardieri*	Tussock
Rytidosperma fulvum	Wallaby Grass
Themeda triandra	Kangaroo Grass
Groundcovers, forbs and scramblers	
Centella asiatica	Indian Pennywort
Dichondra repens	Kidney Weed
Lomandra longifolia	Spiny-headed Mat-rush
Sedges, rushes and ferns	
Baumea articulata	Jointed Twig-rush
Baumea juncea	
Carex appressa	Tall Sedge
Carex longebrachiata	
Ficinia nodosa	Knobbly Club-rush

Scientific Name	Common Name
Gahnia clarkei	Tall Saw-sedge
Gahnia melanocarpa	Black-fruit Saw-sedge
Gahnia radula	
Gahnia sieberana	Red-fruit Saw-sedge
Lepidosperma neesii	
Leptocarpus tenax	
Schoenus melanostachys	Black Bog-rush

Appendix D: Myrtle Rust (*Puccinia psidii*) factsheet

NSW GOVERNMENT Department of Primary Industries

primefact

Myrtle rust

July 2015 Primefact 1417 First edition
Plant Biosecurity & Product Integrity, Orange

Myrtle rust in Australia

Myrtle rust (*Puccinia psidii*) is a fungal disease which infects plants in the Myrtaceae family. Common Australian Myrtaceae species include eucalyptus, willow myrtle, turpentine, bottlebrush, paperbark, tea tree and lilly pilly.

Since myrtle rust was first detected in NSW in April 2010 it has spread across the eastern Australian landscape in bushland reserves, home gardens, commercial operations and amenity settings such as parks and street plantings.

Myrtle rust can now be found in New South Wales, Victoria, Queensland, Tasmania and on the Tiwi Islands in the Northern Territory.

Figure 1 Severe myrtle rust infection on narrow-leaved malletwood (*Rhodamnia angustifolia*)

Figure 2 Myrtle rust spores on clothing

Figure 3 Myrtle rust infecting flowers and stems of Geraldton wax (*Chamelaucium uncinatum*)

Background

When myrtle rust was first detected, a response was initiated to eradicate myrtle rust. The response was unsuccessful because myrtle rust spores are very easily dispersed by wind.

In December 2010 eradication efforts were abandoned and transitioned to management.

Manage risk

Precautions to limit the spread of myrtle rust should be taken by people carrying out activities where there is potential to spread myrtle rust to vulnerable species or plant communities.

People engaged in activities associated with plants known to have, or likely to have myrtle rust should ask themselves:

- Will my actions spread myrtle rust to new areas?
- Will my actions spread myrtle rust to a vulnerable and important plant species or plant community?
- What can I do and how can I change my actions so that I do not spread myrtle rust?

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Description

Myrtle rust is a fungal disease which attacks soft, actively growing leaves, shoot tips and young stems. Severity of infection and symptoms vary with different host species.

Myrtle rust may also attack flowers and fruit of certain hosts (Figures 3 & 4).

Generally myrtle rust starts as small purple spots on leaves (Figure 5). Bright yellow spores form in pustules (Figure 6) within these purple spots. Pustules fade to dull yellow and then grey as the infection ages (Figure 7). In severe infections, spots enlarge and merge, often causing leaf distortion (Figure 8).

Heavy infection can result in the death of soft plant material. Whole plant death may occur in highly susceptible hosts.

Plants with dark purple leaves such as willow myrtle 'Afterdark' (*Agonis flexuosa* cv 'Afterdark') do not display obvious symptoms of early infection. Disease becomes apparent once the bright yellow pustules form on both surfaces of the infected leaf (Figure 9).

On turpentine (*Syncarpia glomulifera*), initial symptoms appear as small purple flecks on young leaves then yellow pustules form on the lower surface (Figure 10).

Disease cycle

The visible yellow pustules of myrtle rust are made up of millions of powdery yellow spores. Spores are spread by wind to other host plants. Spores germinate and the myrtle rust fungus grows, piercing plant cells to obtain nutrients from the plant.

Myrtle rust spores require darkness, moisture and temperatures of 15–25°C to germinate. The first symptoms become visible within 3–5 days of initial infection. The new pustules can mature to release spores in 10–12 days. Spores can remain viable for up to three months.

Spread

Myrtle rust spreads naturally by wind, water, insects and animals. Spread can occur rapidly. Rust spores can travel very long distances and may infect susceptible plants many kilometres from the initial site of infection.

Myrtle rust spores can spread over long distances carried on infected plant material, contaminated equipment, vehicles and clothing (Figure 2).

Figure 4 Myrtle rust infecting fruit of cedar bay cherry (*Eugenia reinwardtiana*)

Figure 5 Early stages of myrtle rust on willow myrtle 'Afterdark' (*Agonis flexuosa* cv 'Afterdark')

Figure 6 Myrtle rust pustules on broad-leaved paperbark (*Melaleuca quinquenervia*)

Figure 7 Older lesions of Myrtle rust on willow myrtle 'Afterdark' (*Agonis flexuosa* cv 'Afterdark')

Hosts

Myrtle rust infects plants in the family Myrtaceae.

Common plants that are susceptible to myrtle rust include:

- *Eucalyptus* species
- willow myrtle (*Agonis flexuosa*)
- turpentine (*Syncarpia glomulifera*)
- bottlebrush (*Callistemon* species)
- paperbark (*Melaleuca* species)
- water gum (*Tristanis neriifolia*)
- tea tree (*Leptospermum* species)
- lilly pilly (*Syzygium wilsonii*)

New host species in Australia are continuously being discovered. To date, over 300 hosts have been recorded and can be found in the Australian Network for Plant Conservation host list.

Impact

The Australian environment

The plant family Myrtaceae dominates many major Australian ecosystems.

The short term impact of myrtle rust on mature trees is minimal.

Continued infection of new seedlings and young trees over time may hinder the regeneration of susceptible species in natural forests. This may alter species balance and modify currently stable environments.

Genetic diversity in highly susceptible species could be greatly reduced and the structure and function of certain ecosystems could be adversely affected in the long term.

Commercial operations

Myrtle rust is a problem for commercial operations such as timber plantations and nurseries. Myrtle rust can lead to seedling death and increases costs of managing disease outbreaks.

The movement of Myrtaceae plant material is regulated in some states and trade can be impacted. At the time of writing Tasmania, Western Australia, Northern Territory and South Australia have quarantine restrictions in place for the importation of products of the Myrtaceae family from states known to have myrtle rust.

Distribution in Australia

Myrtle rust is widespread along the east coast of Australia from southern New South Wales to far north Queensland. In Victoria myrtle rust is found mainly in production nurseries around Melbourne.

Figure 8 Older lesions of myrtle rust on turpentine (*Syncarpia glomulifera*) leaves

Figure 9 Myrtle rust pustules on leaves of willow myrtle 'Afterdark' (*Agonis flexuosa* cv 'Afterdark')

Figure 10 Myrtle rust on turpentine (*Syncarpia glomulifera*)

In Tasmania myrtle rust is found on properties on the north-west coast. Myrtle rust has been found on the Tiwi Islands off the coast of the Northern Territory.

Favourable conditions for the continued spread of myrtle rust include all coastal areas of Australia and inland areas with required humidity levels and susceptible hosts.

Myrtle rust is unlikely to establish in arid regions as dry conditions do not support disease growth and spread.

Prevention

Preventative measures can be taken to reduce the chance of myrtle rust being introduced onto properties, into unaffected plant communities or even in backyards. General measures include:

- Familiarise yourself with signs of myrtle rust
- Do not move plants known to be infected with myrtle rust
- In home gardens, remove healthy plants susceptible to myrtle rust before they become infected
- Launder clothing, hats and gloves worn during activities in high risk areas before using them in other areas

In commercial operations

- Check plants often for signs of myrtle rust
- Keep records of inspections and plant movements
- Advise all visitors and workers of biosecurity measures in place
- Disinfect equipment and personal effects such as glasses and mobile phones
- When purchasing new plants or cuttings ensure they are free from myrtle rust
- Keep new plants separate from existing plants until disease freedom can be assured or until treated with an appropriate fungicide

In the bush

- Always start jobs with clean equipment and clean vehicles
- Relocate planned activities from known or likely infected areas to another place if possible
- Comply with risk management and mitigation measures that business enterprises and sites of vulnerable plants and plant communities have in place

Management

Chemical treatment for infected plants

There are a number of fungicides available for the control of myrtle rust. Refer to the Australian Pesticides and Veterinary Medicines Authority permit (PER12156) or consult your local garden centre for a list of approved products.

Highly susceptible host plants are likely to become reinfected unless regularly treated. Rotation of fungicides containing different active ingredients is recommended to ensure fungicide applications remain effective.

Figure 11 Scrub turpentine (*Rhodamnia rubescens*) infected with myrtle rust

Figure 12 Be mindful of spreading myrtle rust when carrying out activities in high risk areas

Removal of infected parts or whole plants

Removing plants infected with myrtle rust, or pruning infected plant parts, can help reduce disease spread and minimise chance of future infection. Affected plants should be removed and disposed of appropriately to minimise the spread of myrtle rust:

- Spray infected and nearby plants with a fungicide to kill spores 3-4 days prior to removal
- Before being removed, smaller plants and plant parts should be enclosed in a plastic bag
- Larger plants that do not fit in bags can be cut into smaller pieces and covered with black plastic for 3-4 weeks in a sunny spot. This process is called solarisation and kills remaining spores
- When disposing of plants, small plants enclosed in plastic bags can be put in a normal waste bin - NOT the green waste bin. Larger plants can be taken to the tip - NOT the green waste section

Arrangements for interstate trade

An Interstate Certification Assurance (ICA) arrangement, ICA-42 Production Nursery freedom, treatment and inspection for myrtle rust is in place to assist businesses trading in myrtle rust host plants to comply with interstate quarantine requirements.

As market access requirements may be subject to change, the requirements for all States and Territories should be checked prior to export. Please visit the NSW DPI website for further information.

Further reading

Arrive Clean, Leave Clean, Commonwealth of Australia 2015

Myrtle Rust Biosecurity Fact Sheet, DPIPWE Tasmania 2015

Myrtle rust information page, DEPI Victoria

Acknowledgments

Figures 1 and 2 courtesy of Fiona Giblin, University of the Sunshine Coast, QLD

Figure 3 courtesy of Dr Geoff Pegg, QDAF

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Figure 10 courtesy of R.O. Makinson, Royal Botanic Gardens, Sydney

Figures 11 and 12 courtesy of NSW DPI

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NSW I&I Fact sheet: Myrtle rust in my backyard, 2010. ISSN 1832-6668

NSW I&I Fact sheet: Preventing spread of Myrtle Rust in bushland, 2010. ISSN 1832-6668

NSW I&I ID Sheet: Identification of Myrtle Rust (*Uredo rangelii*), 2010

NSW I&I Primefact 1017: Myrtle rust – *Uredo rangelii* (Second edition), 2010

NSW DPI Primefact 1104: Myrtle rust – everyday management, 2011

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