Paperbark Closed Forest

This community occurs in the central northern portion of the subject land (Figure 5), and is associated with a small drainage swale at this location. Soils in the upper part of the swale are peaty and shallow. Once the drainage line begins to descend over exposed sandstone (below the Paperbark Closed Forest), it becomes more incised.

The upper stratum is dominated by Snow-in-Summer with a foliage cover of 50-75% and heights of 8-12m. The mid-stratum is variable based on available light levels associated with the upper stratum cover, with the main species being Prickly Tea-tree, Lemon-scented Tea-tree, Cheese Tree, Nowra Heath-myrtle, Sydney Golden Wattle, Narrow-leaved Geebung and Mock Olive.

The lower stratum consists of a diverse range of grasses, herbs, sedges and ferns including Tall Saw-sedge, Bracken, *Oplismenus aemulus*, Mat Rush, Blady Grass, Bordered Panic, Common Silkpod, Sweet Morindia, False Braken Fern, Common Couch, Pennywort and Climbing Guinea Flower.

The Paperbark Closed Forest community was not mapped elsewhere within the urban release area addressed by BES (2004). Nevertheless, this plant community is widely distributed in the Shoalhaven LGA (*pers obs*), and is regularly recorded in relatively small patches along drainage lines where soil moisture levels are high.

This is not a listed "*threatened ecological community*" (TSC Act or EPBC Act - see Chapter 4.3).

Photo 4 Paperbark Closed Forest along drainage swale

Regrowth Woodland and Scattered Trees

Around the periphery of the cleared agricultural land, and along existing fence lines, there are scattered stands and individuals of native trees and shrubs, many of which are relatively young regrowth.

These areas of vegetation, including the narrow band of trees and shrubs along the fence line dividing the two existing lots (Figure 5), are of extremely limited ecological value, although they would be used by birds such as the Willie Wagtail, Grey Fantail and Rosellas which utilise perches adjacent to cleared grassland for foraging and shelter purposes.

The species present are a mix of the native plant species found in adjoining areas of native vegetation, as well as a number of introduced species including noxious weeds. In some places, a modest heath understorey of Tick Bush *Kunzea ambigua* is present, although few of these areas are located in areas of impeded drainage or high soil moisture.

This vegetation type does not constitute a "*threatened ecological community*" (TSC Act or EPBC Act), and is not regarded as of any particular conservation value or significance.

Photo 5 Regrowth Woodland and Scattered Trees

Kunzea Shrubland/Heathland

This vegetation type is restricted to three patches in the northeastern and central eastern portions of the subject land (Figure 5), associated with areas of exposed sandstone and shallow skeletal soils.

These communities are relatively treeless, although a small number of scattered Grey Gum, Red Bloodwood and Blue-leaved Stringybark are present, with a foliage canopy cover of less than 5%. The shrub stratum is dominated by White Kunzea, Needlebush, Nowra Tea-tree, *Epacris microphylla*, Dagger Hakea, Stiff Bottlebrush, Hairpin Banksia, Bushy Parrot-pea and *Acacia subtilinervis*.

The lower stratum exhibits a variable foliage cover ranging from 30-65%. Dominant species include Scale Rush, Wiry Panic, Three-awn Spear Grass, Oats Spear Grass, Prickly Moses, Nowra Heath-myrtle, Mat Rush, Slender Rice-flower, Two-colour Panic, *Melaleuca thymifolia*, and Silky Purple-Flag.

The Kunzea Shrubland/Heathland community is present only in small patches on the subject land at Mundamia. It occurs in various sized patches in the immediate vicinity and general locality, and is widely distributed throughout the Shoalhaven LGA.

There are scattered specimens of the Nowra Heath-myrtle in this community, and it constitutes potential habitat for the "*endangered*" Spring Tiny Greenhood orchid. However, no specimens of this species have been recorded on the subject site (see Chapter 4.4.1).

This vegetation type is not a listed "*threatened ecological community*" (TSC Act or EPBC Act).

Photo 6 Kunzea Shrubland/Heathland

In some places, where there is exposed bedrock adjacent to the Kunzea Shrubland, small 'moss gardens' are present. These appear to be sustained, to some extent at least, by groundwater discharges along the top of the sub-surface bedrock, but are not strictly part of the Kunzea Shrubland community (although they are often, but not exclusively, located amongst or at the upper extremities of stands of Kunzea).

These small 'moss gardens' are the typical habitat of the endangered Spring Tiny Greenhood orchid. Dedicated surveys for this species by Shoalhaven City Council (SCC) and Environmental InSites in 2010 and 2011 identified populations of this species in 'moss gardens' to the south, west and northwest of the subject land.

However, none of the investigations by either Council or Environmental InSites recorded any specimens of the Spring Tiny Greenhood orchid on the subject land at Mundamia.

Photo 7 Exposed bedrock with 'moss gardens'

Pasture

Detailed systematic botanical surveys were not conducted within this community, due to the scarcity of native plant species and dominance of exotic pasture grass species.

The agricultural (pasture) areas of the subject land, occupying the western half approximately of the land (Figures 2 and 5), have been cleared of most native vegetation. They now consist predominantly of pasture grasses and herbs, and an array of weed species. Native species are uncommon, with some scattered shrub regrowth and narrow bands of trees and tall shrubs along fence lines.

This vegetation is not a listed "*threatened ecological community*" (TSC Act or EPBC Act).

Photo 8 Cleared pasture

4.2 Vegetation to be Removed

Of the total area proposed for residential development of the subject land at Mundamia (occupying a total of 31.03ha, or 71.68% of the land), the majority (21.41ha or 69%) is land which has already been substantially modified, cleared or highly distributed for agricultural purposes (Table 2). A further 0.67ha consists of regrowth and scattered trees.

The land was previously identified in the *Nowra-Bomaderry Structure Plan* (see Chapter 16) as an appropriate location for future residential development activities around the Nowra-Bomaderry area, given that there is a requirement for further residential land to be made available. Similarly, the subject land is identified as appropriate for rezoning for those purposes in SLEP 2009, and in the *South Coast Regional Strategy* (DoP 2006).

In addition to development of the grazing lands, small areas of several native plant communities are also to be removed for the proposed development (Figure 7; Table 2). None of those vegetation types, however, are "*threatened ecological communities*" listed in either the TSC Act or the EPBC Act (see Chapter 4.4). Further, all of those communities are well represented in the immediate vicinity and general locality, including in the extensive conservation reserves in the vicinity and elsewhere within the Shoalhaven LGA.

Table 2 Areas of the various vegetation types to be removed in the development area

Community	Ha	%	Comments
Grey Gum – Blue-leaved Stringybark Forest/Woodland #	6.84	39.5	Extensive areas to be retained in *Conservation Area* and nearby
Spotted Gum - Blackbutt Open Forest	-	0	Widely distributed and common in vicinity and locality
Scribbly Gum – Bloodwood Forest	0.41	100	Widely distributed and common in vicinity and locality; highly degraded on site
Paperbark Closed Forest	0.71	89	Scattered and widely distributed in vicinity and locality
Kunzea Shrubland / Heathland	0.92	100	Scattered patches throughout vicinity and locality; widespread; common
Regrowth Woodland and Scattered Trees	0.65	76.1	Widespread and of extremely limited ecological value
Pasture	21.41	95.8	Widely distributed and of no ecological value

Includes Highly Disturbed Grey Gum – Stringybark Woodland.
% Percentage of the community present on the subject land.

4.3 Plant Species

A total of 269 plant species have been recorded within the *Nowra-Bomaderry Structure Plan Study Area 5, Mundamia, West Nowra* (BES 2004), of which the subject land is a part (Appendix E). Systematic botanical surveys conducted as part of this *Report* have recorded a further 22 native plant species in addition to those recorded by BES (2004).

One threatened flora species, the Nowra Heath-myrtle *Triplarina nowraensis* (which is listed as "*endangered*" in Part 1 of Schedule 1 of the TSC Act, and also as "*endangered*" in the EPBC Act), was recorded on the subject land (as discussed in Chapter 4.4 of this *Report*).

Three *Rare Or Threatened Australian Plants* (ROTAP) have been recorded on the subject land - *Acacia subtilinervis* (3RCa), *Leptospermum epacridoideum (*2RC) and *Leptospermum sejunctum (*2K). One species of regional significance within the Shoalhaven LGA (*Acacia hispidula*) has also been recorded from the subject land (see BES map in Appendix B). However, none of these species have any statutory protection, pursuant to either NSW or federal legislation.

Whilst individuals of some of these species, and habitat of known or potential relevance, is to be removed for the proposed residential development on the subject land at Mundamia, the *Conservation Area* proposed on the subject land will also contain individuals and/or suitable habitat for those species. The vegetation to be removed along the eastern and northeastern parts of the subject land for the proposed residential development is the same as that to its immediate east, northeast and north, and there are further substantial areas of similar habitats in the immediate vicinity and general locality.

Given those circumstances, it is not likely that these species will be significantly adversely affected by the proposed development. As noted above, these species are not of particular biodiversity conservation concern.

4.4 Threatened Biota

4.4.1 Threatened Species

Only one threatened plant species listed in the TSC Act has been recorded on the subject land at Mundamia to date.

The Nowra Heath-myrtle *Triplarina nowraensis* is listed as "*endangered*" in Part 1 of Schedule 1 of the TSC Act, and as "*endangered*" in the EPBC Act.

This species is a small erect shrub (to 3.5m in height) with creamy-white tea-tree flowers. The Nowra Heath-myrtle is currently only known from five populations, three of which are located west of Nowra in the vicinity of the subject land. The other two populations are southwest of Nowra in the Boolijong Creek Valley, and on the plateau above Bundanon north of the Shoalhaven River (DECC 2008).

Habitat for the Nowra Heath-myrtle has been described as vegetation types that exhibit either a very open tree canopy or are treeless. Whilst the species occurs in areas of impeded drainage, it is not confined to such areas. And also occurs in drier woodland and shrubland communities..

The greatest stand of the Nowra Heath-myrtle on the subject land is located in the northern part of the subject site, on a quite xeric slope. Whilst the DECC (2008) suggest that this species is generally located along drainage channels or on poorly drained flat to gently sloping sandstones of the Nowra group, the populations on the subject site are not confined to such areas.

Within the subject land, a large number of specimens of the Nowra Heath-myrtle have been recorded scattered across the Grey Gum – Blue-leaved Stringybark Forest/Woodland, Paperbark Closed Forest and Kunzea Shrubland/Heathland vegetation types. The largest patches of the Nowra Heath-myrtle were observed in disturbed areas of Grey Gum – Blue-leaved Stringybark Forest/Woodland in the northern portion of the land (Figure 8), which had been slashed a few years previously. It appears that this species favours disturbed areas with increased available light levels, and its apparent ability to resprout from lignotubers means it can benefit from the slashing of vegetation (*eg* for the provision of APZs).

The vast majority of specimens of and habitat for the Nowra Heath-myrtle will be retained as part of this proposal in the proposed *E2 – Environmental Conservation Zone* (Figure 8). The northern boundary of the residential area has been re-designed (in response to recommendations provided by the principal author of this *Report*) to substantially increase the retention of the Nowra Heath-myrtle, including all of the main northern patch of this species.

In addition to retaining approximately 95% of the Nowra Heath-myrtle population on the subject land, the ongoing management of the bushfire *Asset Protection Zones* and parts of the *Conservation Area* will be directed towards the protection and enhancement of this species. The experience in the northern part of the land where the slashing had occurred (see photograph below), indicates that relevant parts of the *Conservation Area* should be managed using that technique. The proposal has also been designed to maintain the pre-development hydrological regimes immediately adjacent to the proposed development (Storm Consulting 2012), particularly with respect to soil moisture levels.

Photo 9 Stand of regrowth Nowra Heath-myrtle in north of subject site

4.4.2 Endangered Populations

No "*endangered population*" of any flora species has been recorded as part of this study, or during any previous investigations within the subject land (BES 2004).

4.4.3 Threatened ecological Communities

No "*threatened ecological communities*" have been recorded within the subject land.

The Paperbark Closed Forest vegetation on the subject land is not an example of the Swamp Sclerophyll Forest on Coastal Floodplains community, because the land is neither on nor is "*associated with*" a "*coastal floodplain*". Any "*coastal floodplain*" in the vicinity would be confined to the immediate floodplain of the Shoalhaven River and the lower parts of Flat Rock Creek. The subject land is not "*associated with*" those landscape features in any relevant way.

4.5 Groundwater Dependent Ecosystems

The *NSW State Groundwater Dependent Ecosystems Policy* (GDE Policy) identifies 'Groundwater Dependent Ecosystems' (GDEs) as *"ecosystems which have their species composition and their natural ecological processes determined by groundwater".* Of the vegetation types and ecosystems present on the subject land at Mundamia, only two are considered possible or likely to be dependent, in part at least, on groundwater discharges.

The nature of the subject land (as detailed in the *Hydrogeological Assessment Report* by Martens – February 2011) creates a close connection between surface waters and groundwater, because of the thin soils present and the relatively impervious sandstone bedrock (which is located generally less than 0.5m below the soil surface). Given that circumstance, much of the groundwater which could potentially traverse the subject land would be intercepted by plant roots, and would be transpired.

Of the two potential GDEs present on the subject land (the Swamp Paperbark Forest and the 'moss gardens'), only the latter is likely to be particularly dependent upon groundwater flows. However, given the interaction between surface flows and groundwater, even that 'dependence' is arguable. The Swamp Paperbark community (in the northeastern part of the subject site) is located at a low point along a drainage swale in this part of the land, and is likely to depend more on overland flows and incipient rainfall than on groundwater flows *per se*.

The 'moss gardens', by contrast, are located at the periphery of areas of soil where the sandstone bedrock is exposed (generally in large flat sheets). 'Moss gardens' constitute a narrow layer of thin moss vegetation sitting directly on top of the bedrock (see page 18), and it is assumed that at least some of the moisture required to maintain the 'moss gardens' is derived from groundwater flows which express themselves on top of the bedrock, where the surface soil ceases.

The 'moss gardens' tend to be located in the vicinity of stands of Kunzea Shrubland, but the Kunzea itself is not typically associated with areas of groundwater expressions. The Tick Bush *Kunzea ambigua* typically occurs on ridge tops and rock outcrops, and is not located in areas where the soil is permanently moist. Thus, it is not the Kunzea Shrubland that would constitute a GDE, but rather the 'moss gardens' which are in places coincident with Kunzea Shrublands.

The proposed development will remove some of the 'moss gardens' along the eastern boundary of the development, but will retain others. It is likely that additional areas of 'moss gardens' will develop naturally as a result of the bioretention swales along the eastern boundary of the development.

5 FAUNA AND FAUNA HABITATS

5.1 Fauna Habitats

Vegetation on the subject land at Mundamia (as described above) consists in part of open farmland with scattered trees and in part of open forest and woodland with a generally dense shrubby understorey.

The open farmland is structurally simple and provides only very limited habitat opportunities for native fauna. Mammals (such as the Eastern Grey Kangaroo) and birds (such as the Australian Magpie Lark, Masked Lapwing, Willie Wagtail and Australian Magpie) which can use disturbed and/or more open environments were frequently observed in this part of the subject land, along with a number of introduced species (including the Red Fox and European Rabbit). Two small farm dams are also present within the open farmland, as well as a large 'sediment dam' in the southern part of the land, (a legacy of previous quarry operations (SLR consulting 2012). These provide habitat for amphibian species which can use artificial environments (such as Haswell's Frog, the Striped Marsh Frog and Common Eastern Froglet).

The open forest within the northern and eastern parts of the subject land is structurally complex, and provides a diversity of habitat niches for forest-dependent native fauna, including threatened species such as the Yellow-bellied Glider. This vegetation has distinctive lower, middle and upper strata, and consequently there are abundant and varied foraging resources and shelter, nesting or roosting opportunities for a wide diversity of native fauna. There is a moderate number of tree-hollows of varying sizes, and an expansive sandstone outcrop area along the eastern boundary of the subject land and beyond (to the east), containing numerous small caves and rock overhangs.

5.2 Hollow-bearing Trees

The positions of all hollow-bearing trees within the development area and the immediately adjacent *Asset Protection Zone* (APZ) were mapped in the field with a PDA/GPS running the ArcPad GIS software package (Figure 6). It is to be noted, however, that not all of the hollow-bearing trees on the land have been identified, and that the proposed *Conservation Area*, and adjoining lands to the east and north, support abundant tree-hollows.

The information collected (Table 3; Appendix F) includes:

- tree species;
- tree height (m);
- Diameter at Breast Height Over Bark (DBHOB);
- the number and size of visible hollows;
    - Small large enough for a small arboreal species (up to a Sugar Glider);
    - Medium large enough for a medium arboreal species (up a Squirrel Glider);
    - Large large enough for a large arboreal species (up to a Brush-tailed Possum);
    - Owl suitable for a large forest owl;
- type of hollow (spout, stem, trunk, base, fissure); and
- geographical location (Easting and Northing - GDA 1994; AMG Zone 56).