14898

AREA 14 STAGE 1B

Ecological Assessment

Lot 1 DP374315 and Lot 4 DP615261

Final report prepared

for

Port Macquarie Hastings Council

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1.0 Introduction

The Hastings Urban Growth Strategy identified land between Lake Cathie and Bonny Hills (Area 14) as one of the major urban growth areas in the Hastings Valley. On this basis, Port Macquarie Hastings Council coordinated preparation of an Urban Design Master Plan for Area 14 which was adopted in February 2004. Council is now proceeding with the preparation of LEP amendments for Area 14, including zoning changes to enable development to proceed in accordance with the adopted Master Plan. This process is expected to include an amendment to Hastings LEP 2001 in relation to Lot 1 DP374315 and adjoining Lot 4 DP615261, both of which are located within the Area 14 planning area and notable because they include a relatively large area of littoral rainforest.

Littoral rainforest is a distinctive coastal sub-formation of rainforest that is the least extensive of all NSW rainforest types. Littoral rainforest combines characteristics from subtropical and/or warm temperate and/or dry rainforest sub-forms, generally with a wind-sheared upper canopy that exhibits some tolerance to salt spray; it occurs on coastal headlands on soils derived from substrates such as slate or basalt and/or nutrient-enriched dune sands (Harden *et al.* 2006).

Although widespread along the east coast, littoral rainforest is restricted to approximately 1,300 ha within NSW. Small patch sizes and high levels of fragmentation pose problems for long-term conservation of this community. Littoral rainforest patches occupy sites that are subject to persistent wind and salt spray, the specific composition of the community dictated by the environmental conditions. The floristic composition is distinctive with canopy species characteristically dominated by members of plant families such as Sapindaceae, Myrtaceae, Euphorbiaceae, Rutaceae and Moraceae. Stands are often stratified into an upper canopy, a lower tree layer, shrub and/or herb layers, together with numerous climbers (Adam 1987).

In relatively sheltered sites littoral rainforest may form a low forest from 10-20m high, but in more exposed localities it is generally reduced to dense wind-sheared thickets (Adam 1987). Trees that would typically grow to taller than 10m may be reduced to less than 1m (Buchanan 1989); stands may have narrow transitional zones or abrupt boundaries with adjacent communities (Adam 1987). Threats to littoral rainforest communities include invasion by weed species, clearing or disturbance to stand margins resulting in loss of canopy integrity with increased salt or wind damage, understorey disturbance associated with firewood collection, grazing, human visitation and rubbish dumping; collection of epiphytes, impacts on transitional zones from fire, the introduction of pathogens and predation of fauna by feral animals.

In 1988, the NSW State Government moved to protect remaining stands of littoral rainforest by enactment of *State Environmental Planning Policy No 26 - Littoral Rainforests* (hereafter referred to as SEPP 26).

SEPP 26 applies to:
"(a) land enclosed by the outer edge of the heavy black line on the series of maps held in the Department and marked "*State Environmental Planning Policy No 26 - Littoral Rainforests (Amendment No 2)*", and

(b) land not so enclosed but within a distance of 100 metres from the outer edge of that heavy black line except residential land and land to which *State Environmental Planning Policy No 14 - Coastal Wetlands* applies."

With regard to land use within the 100m distance identified in part (b) above, and amongst other things, SEPP 26 states that:

"(2) *A person shall not, without the consent of the Council, on land described in clause 4(1)(b), erect a building, disturb or change or alter any landform or disturb, remove, damage or destroy any native flora, or dispose of or dump any liquid, gaseous or solid matter.*"

Subclause (6) of SEPP 26 states that "*The Council shall not consent to an application made under subclause (1) or (2) unless it is satisfied, if the application is to erect a building, carry out a work, use land for any purpose or dispose of or dump any liquid, gaseous or solid matter, that there is no place outside the area to which this Policy applies on which the development might suitably be located or occur.*"

Lot 1 DP374315 and adjoining Lot 4 DP615261 are captured by the maps referred to in a) above and are thus subject to the provisions of SEPP 26.

In 2002 Council agreed to preparation of a rezoning application by consultants acting on behalf of the owners of the above lots subject to an independent review by Council or their appointees prior to completion of a Local Environmental Study (LES). An initial review undertaken in 2006 on behalf of Council by Gutteridge Haskins Davey (GHD) suggested that the littoral rainforest "buffer" proposed by the owners should be revised to take into account edge effects upon the rainforest, particularly those associated with urban stormwater and the interaction between groundwater and vegetation. Council subsequently engaged Martens & Associates Consulting Engineers to undertake detailed groundwater investigations for the site. The GHD report also recommended that any proposed revegetation plan should be revised to include greater detail on the program and restoration targets.

Further to the above, biolink were appointed by Council in December 2006 to compile an up-to-date ecological assessment of the Lot 1 DP374315 and Lot 4 DP615261. Amongst other things the assessment was required to incorporate a review of earlier reports (listed below in chronological order) prepared by consultants on behalf of the property owners including:

- Flora and Fauna Survey report prepared by Peter Parker Environmental Consultants completed in May 2002.
- Stormwater Quality Management report by Jelliffe Environmental Pty Ltd

(June 2002).

- The rezoning application (draft LES), associated Revegetation Plan and proposed Planning Agreement prepared by King & Campbell Pty Ltd (March 2006).
- Supplementary comments by Peter Parker dated 6 March 2006.
- Supplementary comments by Dr Peter Brennan dated 21 March 2006.

In addition, the assessment was required to:

- Update the threatened species records for the site to include any species and/or community listings under either the *Threatened Species Conservation Act 1995* or the *Environment Protection and Biodiversity Conservation Act 1992* since the work of Parker (2002).
- Review preliminary outcomes of the groundwater monitoring and modelling study of the site by Martens & Associates.
- Determine necessary environmental setbacks and make recommendations with regard to land use in the vicinity of the Littoral Rainforest, consistent with the provisions of SEPP 26.
- Update the Revegetation Plan.

This report details our response to the study brief. Preparation of the report has been assisted by our familiarity with the area in question, but has additionally involved a site inspection with Council officers and land owner representatives in addition to a subsequent meeting in Sydney with landowners, their consultants and officers of the NSW Department of Planning.

2.0 Review of documentation

This section provides a summary of the reports that were provided by Council, together with review comments. In undertaking the review we have drawn on the results of other surveys and information from other studies as required, with particular emphasis on matters pertaining to knowledge about the littoral rainforest community *per se*, edge effects and buffer design.

2.1 Flora and Fauna Survey Report prepared by Peter Parker Environmental Consultants (May 2002).

This report involved preparation of a vegetation map and flora/fauna inventory. Vegetation work involved use of 1:5000 aerial photography supported by a number of "meandering" transects and opportunistic observations, while the fauna work employed cage and elliot traps, pit-falling, call-playback, Anabat, mist net and harp trapping, hair tubes, scat analysis, spotlighting and opportunistic observations. A total of 133 native plant species from 56 Families were recorded, including the threatened Rough-shelled Bush Nut *Macadamia tetraphylla*. Vegetation mapping recognised 8 distinct communities, the most common of which was a generic category of littoral rainforest. Of the fauna, a total of 69 native species from 39 Families were recorded, including the threatened Eastern Blossom Bat *Syconycteris australis*, Grey-headed Flying-fox *Pteropus poliocephalus* and Little Bent-wing Bat *Miniopteris australis*; eight-part tests for each of the threatened species were included in the report, each of which concluded that there would not be significant impact.

The report concluded with a discussion of edge effects and buffer design that resulted in a number of recommendations relating to future management of the littoral rainforest community and any adjoining development. The recommendations can be summarised as follows:

- the need for a vegetated strip 10 – 40m wide to both buffer the adjoining littoral rainforest area and to increase overall patch size by reducing the edge to area ratio,

- the need for a 1.2 m high fence to restrict access by humans and domestic animals, supported by a "hedge" of thorny and/or spiny shrubs,
- use of a perimeter road adjoining a grassed swale, the latter to facilitate stormwater infiltration and provide a food resource for macropods,
- signposting,
- subdivision design (houses to face buffer),
- street lighting (directed away from forest edge),
- the need for a vegetated east-west corridor to connect the littoral rainforest area with riparian habitat to west,
- the need for an elevated, fenced walkway through the littoral rainforest to the beach; and
- the need for a stormwater management system.

Review Comments:

The vegetation mapping and flora inventory are adequate to address the broad issue being considered, although it is likely that the patch of littoral rainforest in question comprises at least two of the sub-alliances identified by Floyd (1990). A small patch of littoral rainforest in the south western corner of Lot 1 DP 374315 mapped by biolink (2004) also appears to have been mis-typed as a "Water gum, blackwood, swamp fern low to mid-high open forest" (Figure 1). This particular outlier, additional to isolated specimens of Strangler Fig and Brush Box that occur within the two central catchments, attest to a formerly more extensive coverage of littoral rainforest over the site such that it would likely have reached its maximum development in the southernmost area of (now) Swamp Forest mapped by Parker (2002). Restoration and/or rehabilitation of this particular area in order for such potential to be realized should be a key outcome of any Revegetation Management Plan for the site (see Appendix II).

While the report recorded the threatened plant *Macadamia tetraphylla*, it argued for a discounting of the species' presence based on the premise it was most likely introduced (orchard planting), an assertion supported by its presence in a exposed situation and that it is also well outside the species' known distribution.

Figure 1. View towards the southwestern corner of Lot 1 DP 374315. The circled area is the small patch of littoral rainforest mapped by biolink (2004).

An arguable limitation of the fauna survey work is the lack of seasonal sampling. Regardless, the report confirmed that at least 3 threatened fauna species – the Grey-headed Flying Fox, Eastern Blossom Bat and Little Bent-wing Bat occur in the area. The issue of seasonal sampling can also be discounted given that at least one other survey has been undertaken in the general area. In a survey of the adjoining Middle Rock Reserve undertaken later in the same year Darkheart Eco-consultancy (2002) recorded the endangered plant *Cynachnum elegans* and also reported the presence of a similar suite of fauna species, including the native Bush Rat *Rattus fuscipes*. While not a threatened species, the presence of the *R. fuscipes* is important as it indirectly infers a high biodiversity potential for the site generally, this species being especially vulnerable to habitat fragmentation to the extent that populations are noticeably absent from small to medium sized habitat patches elsewhere throughout its range in south-eastern Australia (Cox *et al* 2004).

2.2 Updating of Threatened Species information.

a) Threatened species

This section addresses issues of relevance to the site that arise from both the *Threatened Species Conservation Act 1995* (hereafter referred to as the TSC Act) and the Commonwealth's *Environmental Protection and Biodiversity Conservation Act 1999* (hereafter referred to as the EPBC Act). To assist this process we undertook a database search of the NSW National Parks and Wildlife Service's Wildlife Atlas database for terrestrial threatened species records within a 5km radius of the site. This process returned records for 23

species of flora and fauna, each of which were then cross-checked with the EPBC Act listings in order to derive the list presented in Table 1.

Table 1. Terrestrial threatened flora and fauna species recorded within a 5km radius of the study site. 1=species listed as Endangered on Schedule 1 of the TSC Act (1995), 2=species listed as Vulnerable on Schedule 2 of the TSC Act (1995), E=species listed as Endangered (EPBC Act 1999), V=species listed as Vulnerable (EPBC Act 1999).

Family	Species	Common Name	Status
FLORA			
Asclepidaceae	*Cynanchum elegans*	White-flowered Wax Plant	1,E
FAUNA			
Myobatrachidae	*Crinia tinnula*	Wallum Froglet	2
Accipitridae	*Lophoictinia isura*	Square-tailed Kite	2
	Pandion haliaetus	Osprey	2
Cacatuidae	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	2
Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	1
Columbidae	*Ptilinopus magnificus*	Wompoo Fruit-Dove	2
Haematopodidae	*Haematopus longirostris*	Pied Oystercatcher	2
Laridae	*Sterna albifrons*	Little Tern	1
Psittacidae	*Lathamus discolor*	Swift Parrot	1,E
Strigidae	*Ninox strenua*	Powerful Owl	2
Tytonidae	*Tyto capensis*	Grass Owl	2
Dasyuridae	*Phascogale tapoatafa*	Brush-tailed Phascogale	2
	Planigale maculata	Coastal Planigale	2
Muridae	*Pseudomys gracilicaudatus*	Eastern Chestnut Mouse	2
Petauridae	*Petaurus australis*	Yellow-bellied Glider	2
	Petaurus norfolcensis	Squirrel Glider	2
Phascolarctidae	*Phascolarctos cinereus*	Koala	2
Pteropodidae	*Pteropus poliocephalus*	Grey-headed Flying-fox	2,V
Vespertilionidae	*Miniopterus australis*	Little Bentwing-bat	2

b) Endangered Ecological Communities

Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions was listed as an endangered ecological community in Part 3, Schedule 1 of the TSC Act by way of a final determination by the NSW Scientific Committee in June, 2004.

c) Assessments of Significance

Changes to Sec. 5a of the *Environmental Planning and Assessment Act 1979* were enacted by the *Threatened Species Conservation Amendment Act 2002* such that the 8-part test normally associated with any Assessment of

Significance has now been replaced by the need for a 7-part test in order to supposedly place greater emphasis on the consideration of impacts on a local rather than regional scale. Further information is provided in Appendix I.

2.3 Stormwater Quality Management report by Jelliffe Environmental (June 2002).

Outcomes from the Jelliffe Report are discussed in the more recent report by Martens & Associates (2007) and hence there is little need for reiteration.

2.4 Draft Local Environmental Study prepared by King & Campbell (March 2006).

This report is an application for rezoning presented in the form of a draft LES. Accordingly, the report details background consultations with Council, Government Agencies and other stakeholders in addition to providing an overview of the planning context and existing environment. The report concludes by detailing the extent to which issues raised by stakeholders have been met before proposing amendments to Hastings Local Environmental Plan 2000 in order that development can proceed while also advocating establishment of a planning agreement (to be implemented at rezoning) to facilitate:

a) revegetation and fencing works along the western edge of the existing littoral rainforest area,
b) a commitment to weed removal and additional rainforest rehabilitation work along the eastern (seaward) fringe, and
c) consolidation of access through the littoral rainforest community to the beach by way of an elevated pedestrian access way.

The report also argues for a merits-based approach to buffer design for the SEPP 26 area. In this context, the majority of recommendations contained in the report by Parker (2002) were reiterated and/or elaborated upon. Departures from the initial recommendations made by Parker (2002) include a proposed increase in the recommended buffer width from 10 – 40m to 40 – 60m, an increase in height of the proposed fencing from 1.2m to 2.0m and provision for a 30m (instead of the required 20m) Asset Protection Zone

(APZ). However, there is no mention of the need for an east-west corridor as proposed by Parker (2002). The need for measures relating to stormwater and water table management were also recognised.

A 4 page Revegetation Management Plan (RMP) was appended in support of the rezoning proposal. The RMP provided some basic objectives and a cursory list of plant species to be used with revegetation works proposed to be undertaken over a 6 year timeframe, ideally using plants that for the most part had been germinated from seed collected on site.

The report was also appended with two separate items of correspondence from Peter Parker and Dr. Peter Brennan respectively.

Review Comments

a) *The Draft LES*

The document presents a concise history of the planning background and the issues to be considered. In the context of edge effects and buffer zones it is apparent that the recommendations of the respective consultants have been exceeded, although it is not clear why. There is no mention of the east-west corridor recommended by Parker (2002). We also suspect that concurrence from the Dept. of Natural Resources (?) will be required in order for access to be provided to the beach but note that no evidence of consultation to this end and/or "support in principle" for this proposal from the relevant agency has been provided.

b) *The RMP*

The RMP is an important document upon which much of the planning outcome is based. While the objectives are soundly based, we consider that the RMP lacks necessary detail and moreover, has tended to over-simplify the task at hand. In support of this assertion we submit that the site exhibits variation in topography and hydrology and that consideration of these variables will be required in order to best inform design of the proposed replanting/regeneration program, as might knowledge of the juxtaposition of littoral rainforest sub-alliances referred to in 2.1 above. There is also a need

for the RMP to address required modifications to existing restoration works, particularly in the central catchment area, the floristic structure of which currently poses an ongoing fire risk to the western edge of the existing littoral rainforest area.

c) *Supplementary comments by Peter Parker and Dr. Peter Brennan*
These items of correspondence simply support the planning outcome proposed by the draft LES and offer no new information for consideration.

2.5 Preliminary Area 14, Stage 1b Groundwater Study by Martens & Associates (2007).

This report presents an analysis of groundwater quality and water movement through the eastern part of the study area based on site-specific data and hydrological modeling, the former collected from a series of boreholes and associated peiozometers. Aspects of the modeling rely upon a number of deducted assumptions and data from the scientific literature. As required by the project brief, the latter section of the report focuses on the interaction of the proposed (re-)vegetation buffer within each of 4 sub-catchments and for the site as a whole, examining this in the context of varying degrees of imperviousness that could arise as a consequence of any development.

Outcomes from the report are as follows:
a) broad concurrence with results obtained and/or inferred by the work of Jelliffe Environmental (2002),
b) the groundwater is slightly acidic and brackish to saline but with otherwise low pollutant levels,
b) there appears to be a time lag of approximately 2 months before water from upper reaches of the catchments moves to an otherwise perched groundwater reservoir,
c) low-lying areas of the site have a propensity to become waterlogged, presumably due to higher surface runoff coefficients than were present in past (i.e. vegetated) landscapes.

In the context of buffer zones and the groundwater recharge regime, the report broadly concurred with the proposals put forward by the draft LES, based on an assumed requirement of no net change (to groundwater recharge rates). On a catchment by catchment basis however, there was some evidence that the size (width) of the proposed vegetation buffer in two instances (sub-catchments C1 & C4) was likely to result in a reduction in groundwater recharge through increased evapotranspiration (ET) rates. Modeling also indicated a tendency for the perched water table in sub-catchments C2 & C3 to regularly mound once urban impervious percentages approached 70%.

To assist groundwater recharge, the report further advocated use of deep stormwater infiltration trenches rather than natural absorption, and the use of on-site stormwater detention devices (OSDs) to assist in longer-term water management.

Review Comment

The report provides a comprehensive assessment of groundwater dynamics that has directly addressed many of the issues and/or recommendations arising from the previous studies. Indirectly, the report raises a number of other issues that potentially warrant further consideration. In particular:

As recognized on page 29 of the report, the degree of imperviousness associated with urban development clearly has the potential to increase runoff potential. In theory, this must also lower the threshold amount of precipitation that is otherwise required to constitute an extreme rainfall event. Should this be the case, then we would be concerned about any increase in the frequency of perched water tables occurring, particularly in sub-catchments C2 and C3, an outcome that we consider will need to be avoided.

We note that modeling of the interaction between varying degrees of imperviousness and buffer width has been based on a premise of no net change to groundwater recharge regime. As discussed in more detail below, we consider that there is likely to be a future need for the recharge rate to be

capable of being increased. While we surmise from Table 14 in the report that this could theoretically be achieved by simply increasing the extent of imperviousness of any associated development, we also note that the supporting outcomes relating to such an increase indicate greater variability and hence less predictability in terms of managing the required outcomes. Given increasing uncertainty about future climatic trends, we have thus remained cautious about accepting and/or advocating a simple solution to what is otherwise a complex phenomenon.

Further outcomes from the report are discussed in the following section.

2.6 Other Issues.

Climate Change

As illustrated in Fig. 2, current analysis of rainfall trends in eastern Australia over the last 50 years suggests a longitudinal shift in continental rainfall patterns, the consequences of which are currently manifesting in a trend along the eastern seaboard towards a significant decline in mean annual rainfall over the summer months to the extent of at least 500mm/100 years. Coupled with this are further trends that suggest increases in both the mean maximum and mean minimum temperatures in the order of 0.5°C – 1°C along the eastern seaboard, the consequences of which will invariably result in increased ET rates for plant communities so affected.

Modeling in the report by Martens & Associates (2007) considered a mean ET rate of 5.88mm H_2O/day as best approximating that which applies to the littoral rainforest community. By extrapolation using monthly ET data, this establishes a water budget need of ~ 1964mm of water/annum. Given the current mean annual rainfall of ~ 1540mm for the study area, the resulting deficit required to meet annual ET output of the littoral rainforest community must therefore be obtained from perched water table and soil moisture reserves. (Note: we are uneasy using approximations here, but perhaps in the grand scheme of things they are best interpreted as indicative anyway.) Suffice to say that ~ 424mm currently appears to be the minimum amount of additional water required at this point in time. However, when given the

combined considerations of predicted declines in summer rainfall and increased ambient temperatures, it must also be recognized that reliance upon groundwater reserves by the littoral rainforest community can only be expected to increase over the next 50 – 100 years, possibly to somewhere in the vicinity of 774 – 924mm/annum respectively.

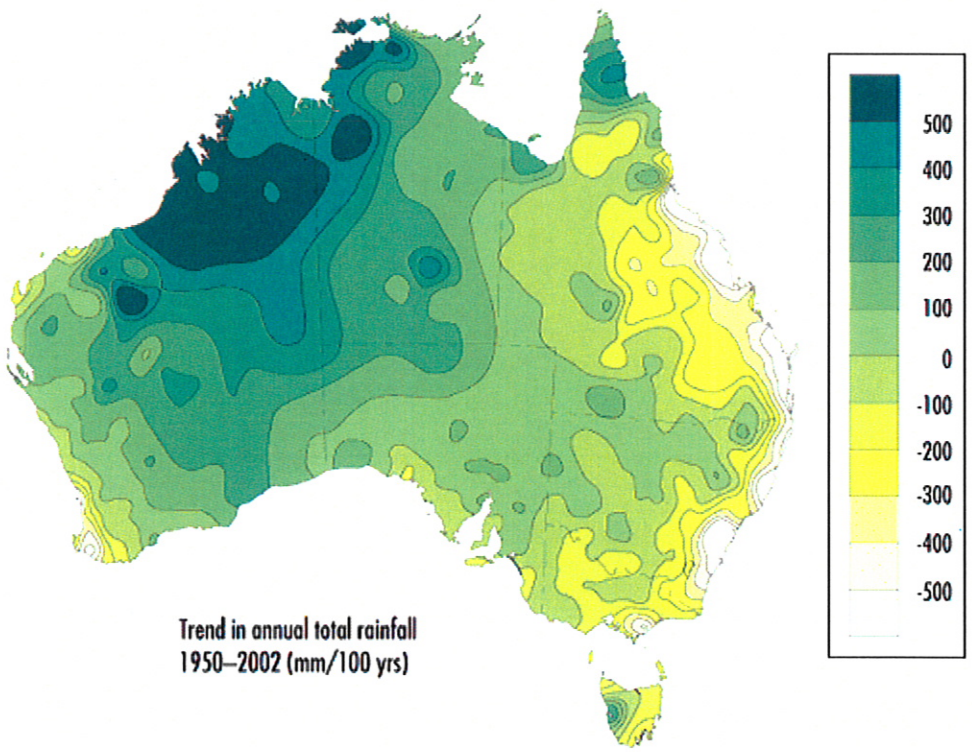

Figure 2. Changing trends in the distribution of total annual rainfall patterns in Australia as a consequence of climate change, notable amongst which is an overall decline along the eastern seaboard of Australia (source: Intergovernmental Panel on Climate Change - *Greenhouse Effects and Climate Change*).

Implications

The issue of making provision for the future impacts of climate change potentially creates a planning conundrum given both the time scales involved and the mathematical uncertainty inherent in current models. Given the information in the preceding paragraph and in terms of a worst case scenario however, it would not be unreasonable to predict a gradual contraction of the existing littoral rainforest community over the next several decades or, at the

very least, an increased predominance of the more xeric-adapted plant species.

In our opinion, the preceding considerations mandate that the combined buffer zone (i.e. revegetated area + APZ) along with any adjoining urban development within the 4 sub-catchments that support the SEPP 26 community must be capable of meeting what will be an increased demand on groundwater reserves over the long-term; it follows that suitable mechanisms must exist that can respond to the need for tweaking the system over time; including what may appear to be diametrically opposed needs to offer both the potential for rapid recharge of groundwater reserves and/or – in the case of lowered extreme rainfall event thresholds – to physically impede the run off rate in order to best manage the frequency of mounding events. To this end, regular and ongoing monitoring of water behavior on the site will be required.

To reiterate, major issues arising from the preceding discussion include:
- The potential for an increase in the frequency of temporary flooding and perched water table events in sub-catchments C2 & C3 in response to both an increase in extreme rainfall events and a lowering of expected extreme rainfall event thresholds brought about by increased surface runoff volumes from impervious areas within any adjoining development.

- As a direct consequence of climate change, the littoral rainforest patch will become increasingly reliant on groundwater reserves and hence effective recharge rates for meeting its high water budget needs over time, more so given that the major downward trend in mean annual rainfall data occurs during the summer period when ET rates will be at their highest.

These considerations imply that any development within the four catchments may need to contain special design features that can be enacted and/or called upon to assist water management. Accordingly and in collaboration with Dr. Martens we have reached consensus that any ability to do this is likely to be best met by a reduction in the extent (width) of that area proposed for revegetation more than any other factor. Such a reduction offers two primary

advantages, the first being a reduction in the amount of water nominally lost through ET and hence available to the system as a whole; the second being the ability to site the proposed storm-water infiltration trenches closer to the groundwater reservoir.

Summary & Resolution of issues

Following on from the above we have attempted below to provide a brief overview of key outcomes along with associated recommendations. In order to assist this process we have categorized the various issues into four broad themes – biodiversity, water management, re-vegetation and the urban environment.

Biodiversity

The SEPP 26 site is important at local, regional and statewide levels. The site maintains some important biodiversity indicators that suggest core ecological processes are intact. A number of threatened species of flora and fauna are known to occur, while others can reasonably be expected to occur over time.

The littoral rainforest is also an endangered ecological community for purposes of the TSC Act. Accordingly and in the context of supporting any proposed development of the adjoining lands, assessments of significance (7 part tests) will be required to address the eec listing in addition to those species of flora and fauna detailed in Appendix I.

A key element of longer-term management must be to allow ongoing processes of recruitment and dispersal to occur, particularly for less vagile terrestrial species of invertebrates, amphibians, reptiles and mammals. Hence we consider the need for some form of east-west habitat linkage as originally recommended by Parker (2002) to be validated. In this regard we note that the current Area 14 Structure Plan makes provision for a substantive east – west corridor extending from the vicinity of the Sewage Treatment Plant immediately to the south of the study area, to the vicinity of the Bonnyview Ridge Road intersection and associated forested areas to the west.

Water Management

Note: the measures below have arisen as a consequence of ongoing discussions and collaboration between the author of this report (Dr. Stephen Phillips) and Dr. Daniel Martens (Martens and Associates). Accordingly, both acknowledge that some of the measures proposed represent novel responses to the uncertainty of the extent of the threat posed by climate change and the underlying ecological needs of the littoral rainforest community; thus we reserve the right to further refine such measures in response to additional modeling and as additional information becomes available. On this basis:-

(a) we recommend reducing the width of the vegetated component of the proposed buffer by a mean distance of ~ 10m (maximized in sub-catchments C1, C3 (part) & C4, minimized in sub-catchment C2 & C3 (part)) in order to maximize groundwater management options;

(b) we propose riffling at ~1.0m contour intervals within both the "APZ" buffer and "revegetation" areas of sub-catchments C2 and C3 in order to impede stormwater run-off in extreme rainfall events (herein considered to be those emanating from the reduced rainfall threshold created by the extent of imperviousness in any adjoining development);

(c) subject to detailed design we advocate a staggered siting of the proposed deep, groundwater infiltration trenches whilst also ensuring that some are located hard up against both existing vegetation boundary and the western edge of the (re)vegetated buffer;

(d) as an option for consideration, we also identify the likely need for an above ground, dedicated storm water reservoir within the "APZ" buffer area (or perhaps within the reveg area) to be located at the boundary of catchments C2 & C3 and which offers the potential for direct feed into the proposed deep groundwater infiltration trenches; and

(e) we propose that further and ongoing monitoring will be required to inform long-term water management needs and strategies, including collection of

data to clarify the relationship between imperviousness, antecedent rainfall and the frequency of soil saturation and/or mounding events, in addition to the establishment of monitoring points within the current littoral rainforest stand.

Revegetation

Revegetation in this instance offers the primary advantage of increasing patch size by virtue of an increase in the overall area of native vegetation which in turn increases the extent of the core area within which ecological processes remain relatively intact. We contend that revegetation *per se* will not substantively assist longer-term water management needs apart from assisting in the maintenance of water quality and a reduction in ponding frequency in the long term, mindful that ET rates within the revegetated area will eventually reach the same levels as those in the adjoining littoral rainforest community.

Necessary changes and/or amendments to the structure and content of the proposed RMP are detailed in Appendix II.

The Urban Precinct

On the issue of pedestrian access through the littoral rainforest we generally support the recommendations promulgated in the rezoning application/draft LES. In particular we endorse the proposal to minimize the potential for incursions by way of a 2m fence along the western edge of the vegetated buffer, with no more than 2 formal access points provided. In this regard and bearing in mind future development of the site, we consider that a further formal access point to the south should also be considered at this point in time, rather than later when catchment-based population pressure will be greatest.

Access through the forest should be via an elevated (i.e. sufficient height to allow the passage of animals such as Swamp Wallabies) steel and timber boardwalk with chain-wire mesh sides, entrances to which from the west should be through spring-gated (self closing) access points.

In accord with the recommendations in the report by Martens and Associates, we support installation of OSD devices within the urban precinct, the detail of which to be resolved at DA stage

Further to the above we would also recommend that landscaping needs within each of the four sub-catchments be restricted to endemic littoral rainforest species and that interpretive signposting be utilized to reinforce issues of conservation significance, water management and public access.

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Appendix I

Assessments of Significance for Threatened Species and Endangered Ecological Communities.

The majority of threatened species listed in Table 1 do not have a primary ecological association with rainforest. Of those that remain, we consider that Assessments of Significance for the following suite of threatened species will be the minimum required in addition to that necessitated by the EEC listing.

Flora

White-flowered Wax Plant *Cynachnum elegans*

Justification: listed as Endangered for purposes of the TSC Act 1995 and EPBC Act 1999; known to occur on site; vulnerable to disturbance, particularly regeneration/rehabilitation works.

Fauna

Wompoo Fruit Dove *Ptilinopus magnificus*

Justification: Listed as Vulnerable for purposes of Schedule 2 of the TSC Act 1995; recorded within a 5km radius of the site; known rainforest specialist; vulnerable to window strike and predation by cats/foxes.

Rose-crowned Fruit Dove *P. regina*

Justification: Listed as Vulnerable for purposes of Schedule 2 of the TSC Act 1995; recorded within a 10km radius of the site; known rainforest specialist; vulnerable to window strike and predation by cats/foxes.

Barred Cuckoo-shrike *Coracina lineata*

Justification: Listed as Vulnerable for purposes of Schedule 2 of the TSC Act 1995; recorded within a 10km radius of the site; known rainforest specialist; vulnerable to window strike and predation by cats/foxes.

Grey-headed Flying Fox *Pteropus poliocephalus*

Justification: Listed as Vulnerable for purposes of Schedule 2 of the TSC Act 1995 and the EPBC Act 1999; known to utilize the site for feeding purposes; vulnerable to predation by foxes.

Eastern Blossom Bat *Syconycteris australis*

Justification: Listed as Vulnerable for purposes of Schedule 2 of the TSC Act 1995; known to occur on site; roosting habitat present; vulnerable to predation by cats/foxes.

Little Bent-wing Bat *Miniopteris australis*

Justification: Listed as Vulnerable for purposes of Schedule 2 of the TSC Act 1995; known to utilize the site for feeding and (possibly) roosting purposes.

Appendix II
The Revegetation Management Plan

In order for the proposed RMP to offer the maximum benefit for planning and conservation purposes, we consider the following changes to be necessary:

(i) re-mapping of the littoral rainforest community in terms of the sub alliances described by Floyd (1990) in order to both better inform species selection and ensure maximum conformity of the regenerated areas with adjoining vegetation,

(ii) more detail on the proposed planting regime that reflects the outcomes of (i) above in addition to other edaphic considerations such as elevation and hydrology,

(iii) detailed proposals for ongoing rehabilitation works along the eastern (seaward) fringe, weed control generally and the replanting/rehabilitation of the existing regeneration area in sub-catchment C3, and

(iv) a plant-out design for the proposed APZ buffer area.

The flora surveys of Parker (2002) and Darkheart Eco-consultancy (2002) collectively reported over 40 species of introduced plants from the littoral rainforest community and adjoining lands. Some of these plants are highly pervasive, with invasion by at least one species (Bitou Bush) recognized as a key threatening process for purposes of the TSC Act. For these reasons, we consider that the rehabilitation component of the RMP should also identify a priority list of weed species to be targeted, in addition to detailing the actions and measures that will be taken to assist their eradication; performance indicators and proposed monitoring standards should also be developed.

Notwithstanding a perception that the need for revegetation and rehabilitation works is a necessary offset in terms of longer-term development expectations, there is some danger in focusing on only that part of the site that adjoins the area proposed for development. To this end we consider that there would be some merit in developing a management plan for the whole of the littoral

rainforest community, rather than part thereof, thus increasing the efficacy of necessary rehabilitation works. Such an approach would also enable further funding to be obtained over time.

Regardless of the above, we consider that a RMP approved by DoP should be required as a condition of development consent.