



AMENDMENT TO APPROVAL CONDITION FOR COBAKI LAKES: SWAMP SCLEROPHYLL FOREST ON FLOODPLAIN EEC

Cobaki Lakes Estate

**A Report Prepared for
Leda Manorstead Pty Ltd**

June 2014

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1 INTRODUCTION

1.1 Background

JWA Pty Ltd has been engaged by Leda Manorstead Pty Ltd (Leda) to complete a submission to the NSW Office of Environment and Heritage (OEH). The submission seeks to have a requirement for offsetting a loss of 3.8 hectares of Swamp Sclerophyll Forest removed from the consent conditions.

An initial concept plan for the proposed Cobaki Lakes Estate was approved in 2010 by NSW Department of Planning and Environment (06_0316). In 2013 a successful Modification was lodged to remove the condition requiring the use of Central Open Space for the regeneration of Freshwater Wetland and Swamp Sclerophyll Forest (06_0316 Mod 1). As a result of this Modification, offsite offsets are now required for the Swamp Sclerophyll Forest (SSF) Endangered Ecological Community (EEC) which occurs on the site. This offset is required for the 3.8 ha of *Eucalyptus robusta* open woodland to be impacted by the proposed development. A review of the Scientific Determination for the Swamp Sclerophyll forest on Floodplain EEC now indicates that the *E. robusta* woodland on site does not meet all of the criteria for EEC classification determined by the NSW Scientific Committee. JWA wrote to OEH in 12 May 2014 raising the issue of non-compliance with EEC criteria. OEH wrote back to JWA on 22 May 2014 and requested further information to validate the submission (**APPENDIX 1**). The following report describes the site characteristics of the *E. robusta* community on the Cobaki site and the compliance or otherwise with the published criteria in the Scientific Determination.

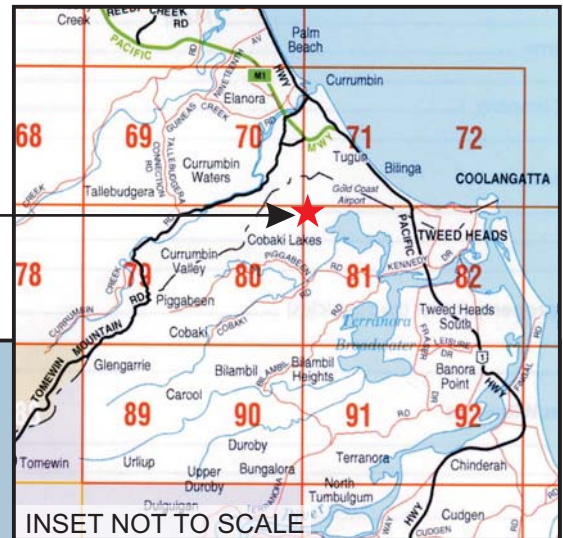
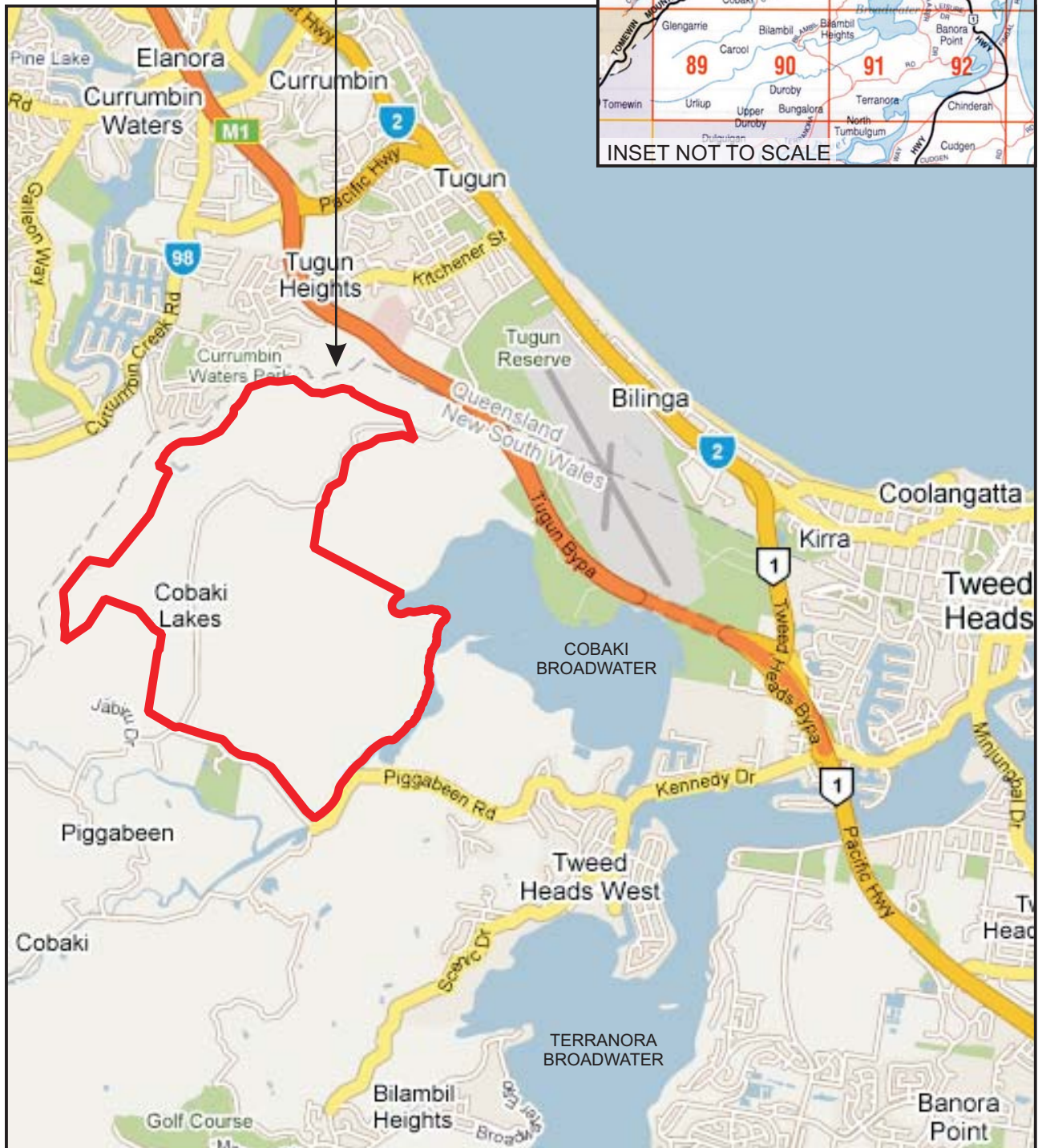
1.2 Subject Site

The Subject Site consists of land described as Lot 1 DP 570076, Lot 2 DP 566529, Lot 1 DP 562222, Lot 1 DP 570077, Lot 1 823679, Lots 46, 54, 55, 199, 200, 201, 202, 205, 206, 209, 228 & 305 DP 755740 Piggabean Road, Tweed Heads. The site covers an area of approximately 605 hectares and is shown in **FIGURE 1**.

The site lies adjacent to private landholdings to the north-west and south-east, and comprises a large portion of land cleared for agricultural purposes (i.e. grazing) throughout which a number of vegetation communities occur. Extensive clearing and subsequent slashing over the drainage basin has resulted in recruitment of a combination of native and introduced grass species in place of native plants. Forested Crown lands which form the NSW-QLD border also form the northern and western boundary of the Cobaki Estate site.



SUBJECT SITE



0 1.5km

SOURCE: Google Maps

SCALE: 1 : 50 000 @ A4

JWA PTY LTD
Ecological Consultants

CLIENT
Leda Developments Pty Ltd
PROJECT
Amendment to Approval Condition: Swamp
Sclerophyll Forest on Floodplain EEC
Cobaki Lakes, Cobaki, NSW
Shire of Tweed

FIGURE 1

PREPARED: BW
DATE: 19 June 2014
FILE: 97038_SSF_Locality.cdr

TITLE

LOCALITY PLAN

2 METHODS

In order to assess the condition of *E. robusta* woodland on site against the criteria outlined in the NSW Scientific Committee determination, previous reports were utilised, as well as additional surveys and technical reports. These include:

- Flora survey (JWA 2014);
- Revised Ecological Assessment (JWA 2013);
- Response to the Director General's environmental assessment requirements: Volume 2 - Appendices to the Ecological Assessment (JWA 2008);
- Tweed Vegetation Management Strategy (2004a) Volume 2 Technical Report - Map 2 Vegetation Types;
- Tweed Vegetation Management Strategy (2004b) Volume 3 Appendices - Appendix 6 - Vegetation Type Descriptions;
- Soils (G&S Soils Map 2013);
- Soil Characteristics in mapped Swamp Sclerophyll Forest, Cobaki Estate (G & S 2014a); and
- Hydrological Assessment & Flooding, Cobaki Estate, NSW (G & S 2014b).

JWA completed a site inspection of the *E. robusta* community in June 2014. The aim of the assessment was to compile a plant species list (**APPENDIX 2**) within the boundaries of the community as shown in **FIGURE 2**.

Leda commissioned two reports by G & S:



1. Soil Characteristics in mapped Swamp Sclerophyll Forest (**APPENDIX 3**). G & S completed a soil map for the Cobaki Estate site in 2013 (**APPENDIX 4**). This map was also assessed; and
2. Hydrological Assessment & Flooding (2014) (**APPENDIX 5**). This report focused on whether the *E. robusta* plant community occurred above or below the 1 in 100 year flood recurrence area.

A number of ecological assessments completed by JWA in 2008 and 2013 were reviewed. Of relevance to this submission, **FIGURE 3** shows the distribution of vegetation on the Cobaki Estate site.

Ecological, soil and flooding characteristics from the *E. robusta* plant community on the site were compared with the EEC criteria contained in the Scientific Determination (**APPENDIX 6**).



LEGEND

-  *Eucalyptus robusta* community
-  Site Outline

SOURCE:
Vegetation - James Warren & Associates Pty Ltd
July/Sept 2007 & May 2008
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

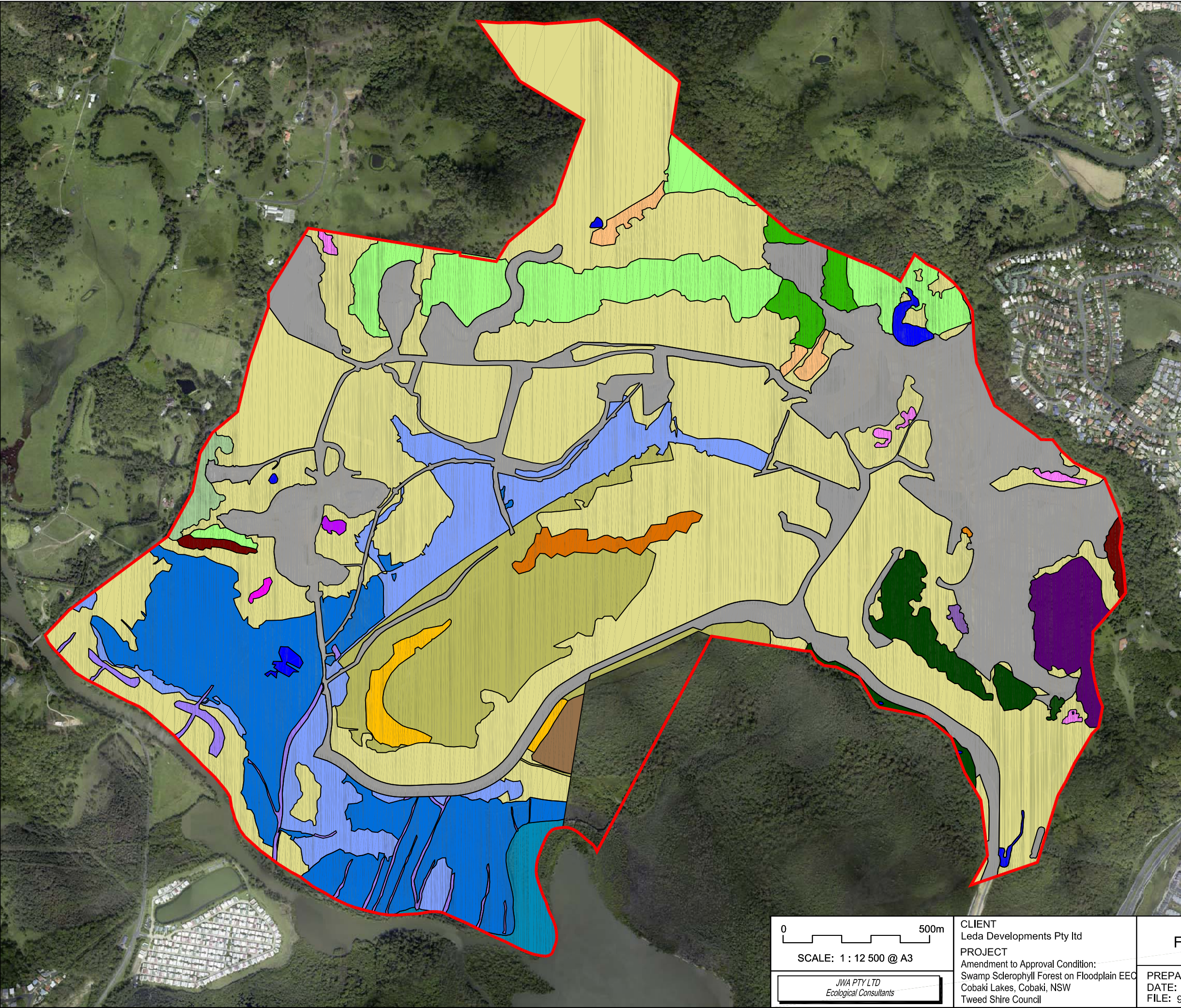
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Amendment to Approval Condition:
Swamp Sclerophyll Forest on Floodplain EEC
Cobaki Lakes, Cobaki, NSW
Tweed Shire Council

FIGURE 2
PREPARED: BW
DATE: 19 June 2014
FILE: 97038_SSF_Base.dwg

TITLE
EUCALYPTUS
ROBUSTA
COMMUNITY



LEGEND

- Community 1 - Dry sclerophyll communities
- Community 1a - Very tall open/closed sclerophyll forest (*Eucalyptus pilularis* +/- *E. microcorys* +/- *E. propinqua* +/- *Corymbia intermedia*)
 - Community 1b - Tall open/closed sclerophyll forest (*E. propinqua*)
 - Community 1c - Tall open sclerophyll woodland (*E. pilularis*)
 - Community 1d - Tall open sclerophyll forest (*E. pilularis* +/- *E. siderophloia* +/- *E. tereticornis*)
- Community 2 - Rainforest communities
- Community 2a - Tall closed forest (*Lophostemon confertus* +/- *Araucaria cunninghamii*)
 - Community 2b - Tall open forest (*Archontophoenix cunninghamiana*)
 - Community 2c - Very tall closed forest (*A. cunninghamii*)
 - Community 2d - Mid-high open/closed forest (Riparian species +/- Mixed species)
 - Community 3 - Tall/very tall open/closed forest (*L. confertus* +/- Mixed rainforest species)
 - Community 4 - Low closed forest (Heathland)
 - Community 5 - Mid-high open woodland (Mixed rainforest species)
 - Community 6 - Mid-high open woodland (*E. robusta*)
 - Community 7 - Mid-high open woodland (*E. racemosa*)
 - Community 8 - Mid-high open woodland (*E. siderophloia*)
 - Community 9 - Low closed forest (Revegetation areas +/- Mixed *Eucalyptus* species)
 - Community 10 - Low closed grassland with scattered trees (Pastoral grassess +/- Mixed species)
 - Community 11 - Low closed grassland (*Sporobolus virginicus*, *Triglochin striata* +/- *Casuarina glauca*)
 - Community 12 - Rushland/sedgeland/ grassland (Mixed aquatic species)
 - Community 13 - Low to mid-high open mangrove forest (*Avicennia marina* var *australasica* / *Aegiceras corniculatum* +/- *Casuarina glauca*)
 - Community 14 - Dams & drainage lines (Mixed aquatic species)
 - Community 15 - Low open forest/woodland (*Casuarina glauca* +/- Mixed species)
 - Community 16 - Slashed grassland/ heathland/sedgeland (Mixed Species)
 - Unvegetated land
 - Site Outline

SOURCE:
Vegetation - James Warren & Associates Pty Ltd
July/Sept 2007 & May 2008
Aerial - Michel Group Services (Ref: 6400-197.dwg)
- photo taken March 2010

0 500m
SCALE: 1 : 12 500 @ A3

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Amendment to Approval Condition:
Swamp Sclerophyll Forest on Floodplain EEC
Cobaki Lakes, Cobaki, NSW
Tweed Shire Council

FIGURE 3
PREPARED: BW
DATE: 19 June 2014
FILE: 97038_SSF_Base.dwg

TITLE
VEGETATION
COMMUNITIES

3 RESULTS

The results of the comparison of the criteria contained in the Determination with the on-site conditions are included in **TABLE 1**.

TABLE 1
COMPARISON OF SWAMP SCLEROPHYLL FOREST ON COASTAL FLOODPLAIN EEC
DETERMINATION CRITERIA AND ON-SITE CONDITIONS

Characteristic criteria of Swamp Sclerophyll Forest on Coastal Floodplains as determined by NSW Scientific Committee	Characteristics of <i>Eucalyptus robusta</i> woodland on site	Criteria satisfaction
Humic grey loams and sandy loams and/or; Soils are waterlogged, stained black or grey with humus.	Podosol (G & S 2013 and G & S 2014a)	No
Waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains and/or; Generally occupies small alluvial flats and peripheral parts of floodplains where they adjoin lithic substrates or coastal sand plains; and/or Occurs on small floodplains or where larger floodplains adjoin lithic substrates or coastal sandplains.	Site is not on an alluvial flat. Site would not be inundated by the ARI 100 year flood event; not a floodplain (G & S 2014b).	No
Generally occurs below 20 m (though sometimes up to 50 m) elevation.	Occurs at 7metres elevation (N. Zurig pers. comm. June 2014).	Yes
NSW North Coast, Sydney Basin, and South East Corner bioregions.	NSW North Coast.	Yes
Open forest to scrub, including fernland and sedgeland.	Open woodland.	Yes
Typically form mosaic with other floodplain forest communities and wetlands.	Isolated by cleared and grazed grassland; and grassland/heathland/sedgeland. Not associated with other forest communities (FIGURE 2). TVMS (2004a) does not map the <i>E. robusta</i> community or any surrounding areas.	No
Often fringing treeless floodplain lagoons or wetlands with semi-permanent standing water.	Not fringing any wetland area (FIGURE 3). TVMS (2004a) does not map the <i>E. robusta</i> community or any surrounding areas.	No
On the Tweed lowlands, this community includes 'Eucalyptus robusta mid-high to very tall closed forest' (F7).	Includes <i>Eucalyptus robusta</i> mid-high to very tall closed forest (F7). TVMS (2004a) does not map the <i>E. robusta</i> community or any surrounding areas.	Yes
Characteristic plant species shown in the Determination (APPENDIX 6).	Charactersitic plants on site include <i>Blenchum indicum</i> , <i>Dianella caerulea</i> , <i>Imperata cylindrica</i> , <i>Lomandra longifolia</i> , <i>Pteridium esculentum</i> and <i>Eucalyptus robusta</i> .	Yes

Characteristic criteria of Swamp Sclerophyll Forest on Coastal Floodplains as determined by NSW Scientific Committee	Characteristics of <i>Eucalyptus robusta</i> woodland on site	Criteria satisfaction
At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers.	Some species may not be visible due to the impacts of grazing.	Yes
Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, Lake Macquarie, Wyong, Gosford, Hornsby, Pittwater, Warringah, Manly, Liverpool, Rockdale, Botany Bay, Randwick, Sutherland, Wollongong, Shellharbour, Kiama and Shoalhaven.	Tweed.	Yes
Open to dense tree layer of eucalypts and paperbarks, which may exceed 25 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality.	Open tree layer of eucalypts but paperbarks not present.	No
Includes vegetation community Swamp mahogany on coastal alluvium.	Dominated by Swamp mahogany but not on coastal alluvium.	No
Other trees may be scattered at low abundance including <i>Callistemon salignus</i> , <i>Casuarina glauca</i> and <i>Eucalyptus resinifera</i> subsp. <i>hemilampra</i> , <i>Livistona australis</i> and <i>Lophostemon suaveolens</i> .	Other trees absent.	No
A layer of small trees may be present, including <i>Acacia irrorata</i> (green wattle), <i>Acmena smithii</i> (lilly pilly), <i>Elaeocarpus reticulatus</i> (blueberry ash), <i>Glochidion ferdinandi</i> (cheese tree), <i>Melaleuca linariifolia</i> and <i>M. styphelioides</i> (paperbarks).	Small trees absent.	No
Shrubs include <i>Acacia longifolia</i> (Sydney golden wattle), <i>Dodonaea triquetra</i> (a hopbush), <i>Ficus coronata</i> (sandpaper fig), <i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i> (lemon-scented tea tree) and <i>Melaleuca</i> spp. (paperbarks).	Shrubs absent.	No
Occasional vines include <i>Parsonsia straminea</i> (common silkpod), <i>Morinda jasminoides</i> and <i>Stephania japonica</i> var. <i>discolor</i> (snake vine).	Vines generally absent. One vine present (<i>Kennedia rubicunda</i>).	No
The groundcover is composed of abundant sedges, ferns, forbs, and grasses including <i>Gahnia clarkei</i> , <i>Pteridium esculentum</i> (bracken), <i>Hypolepis muelleri</i> (batwing fern), <i>Calochlaena dubia</i> (false bracken), <i>Dianella caerulea</i> (blue flax lily), <i>Viola hederacea</i> , <i>Lomandra longifolia</i> (spiny-headed mat-rush) and <i>Entolasia marginata</i> (bordered panic) and <i>Imperata cylindrica</i> var. <i>major</i> (blady grass).	Ground cover includes sedges, ferns, and introduced grasses including <i>Pteridium esculatum</i> , <i>Dianella caerulea</i> , <i>Lomandra longifolia</i> and <i>Imperata cylindrica</i> .	Yes
The endangered swamp orchids <i>Phaius australis</i> and <i>P. tankervillei</i> are found in this community.	These species are absent.	No

Characteristic criteria of Swamp Sclerophyll Forest on Coastal Floodplains as determined by NSW Scientific Committee	Characteristics of <i>Eucalyptus robusta</i> woodland on site	Criteria satisfaction
On sites downslope of lithic substrates or with soils of clay-loam texture, species such as <i>Allocasuarina littoralis</i> (black she-oak), <i>Banksia oblongifolia</i> , <i>B. spinulosa</i> (var. <i>collina</i> or var. <i>spinulosa</i>) (hairpin banksia), <i>Ptilothrix deusta</i> and <i>Themeda australis</i> (kangaroo grass), may also be present in the understorey.	These species are absent.	No
The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.	Historical land use (sugarcane and grazing) has impacted the understorey and introduced weed species.	Yes
Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law <i>et al.</i> 2000). The blossoms of <i>Eucalyptus robusta</i> and <i>Melaleuca quinquenervia</i> are also an important food source for the Grey-headed Flying Fox (<i>Pteropus poliocephalus</i>) and Common Blossom Bat (<i>Sycoancterus australis</i>) (Law 1994), as well as the Yellow-bellied Glider (<i>Petaurus australis</i>), Sugar Glider (<i>Petaurus breviceps</i>), Regent Honeyeater (<i>Xanthomyza phrygia</i>) and Swift Parrot (<i>Lathamus discolor</i>). Other animals found in this community include the Osprey (<i>Pandion haliaetus</i>), Australasian Bittern (<i>Botaurus poiciloptilus</i>), Large-footed myotis (<i>Myotis adversus</i>), <i>Litoria olongburensis</i> and Wallum Froglet (<i>Crinia tinnula</i>).	The Grey-headed flying fox (<i>Pteropus poliocephalus</i>) and the Wallum froglet (<i>Crinia tinnula</i>) are known to occur on the site. None of the other species noted as potentially occurring have been recorded.	No
Infrequent occurrence of <i>Casuarina glauca</i> and/or <i>Lophostemon suaveolens</i> .	Absent.	No
Occasional rainforest species of trees and understorey plants.	Absent.	No
Large sedge and ferns in groundcover.	Ground cover includes Swamp selaginella (<i>Selaginella uliginosa</i>), Bracken fern (<i>Pteridium esculentum</i>), Curly sedge (<i>Caustis recurvata</i>), Foxtails (<i>Caustis blakei</i>), Sawsedge (<i>Gahnia aspera</i>) and various regenerating heath species.	Yes
Shows little influence of saline groundwater.	Not affected by salinity.	Yes
May adjoin or intergrade with other EECs including Lowland Rainforest on Floodplain, River-Flat Eucalypt Forest on Coastal Floodplain, Subtropical Floodplain Forest, Swamp Oak Floodplain Forest and Freshwater Wetlands on Coastal Floodplains.	Does not adjoin or intergrade with any other EEC's (FIGURE 3). TVMS (2004a) does not map the <i>E. robusta</i> community or any surrounding areas.	No

4 DISCUSSION

JWA have presented an analysis of ecological, soil and flooding data relating to a small (3.8 hectare) patch of Swamp mahogany (*E. robusta*) vegetation occurring on the Cobaki Estate site. JWA contend that this small patch of vegetation has been, erroneously, described as an Endangered Ecological Community (EEC).

Review of the relevant reports and supporting documents indicate that the *E. robusta* community would have originally been an ecotonal community occurring between a Paperbark (*Melaleuca quinquenervia*) Swamp Sclerophyll Forest community on the adjacent lower lying floodplain and a more elevated Scribbly gum (*E. racemosa*) Sclerophyll Forest (TVMS 2004b). The plant species occurring in the *E. robusta* community are typical of an ecotonal community in that they are characterised by a mix of Swamp Sclerophyll and Dry Sclerophyll species.

The *E. robusta* woodland occurring on the Cobaki Estate site does not conform to the definition of a Swamp Sclerophyll Forest on coastal Floodplain Endangered Ecological Community as the critical criteria are not met i.e.

1. The soils present in the area mapped as Swamp Sclerophyll EEC are not humic clay loams nor sandy loams;
2. The Swamp Sclerophyll vegetation does not occur within the extent of the pre-developed 100 year average recurrence interval (ARI) flood event;
3. A range of drier heath species occur in association with the community indicating its ecotonal nature; and
4. The surrounding plant communities have been extensively cleared, effectively isolating the *E. robusta* trees.

5 CONCLUSION

This analysis has shown that the small stand of vegetation does not comply with a number of the 'significant' criteria contained in the Scientific Determination which would otherwise enable it to be classified as an Endangered Ecological Community (EEC).

JWA submit that any offsetting requirement for the 3.8 hectare patch of *E. robusta* vegetation be removed from the conditions of consent.

REFERENCES

Gilbert & Sutherland (2014) Soil Characteristics in mapped Swamp Sclerophyll Forest, Cobaki Estate. Report prepared for Leda Manorstead Pty Ltd.

Gilbert & Sutherland (2014) Hydrological Assessment & Flooding, Cobaki Estate, NSW. Report prepared for Leda Manorstead Pty Ltd.

James Warren & Associates (2008) Response to the Director General's environmental assessment requirements: Volume 2 - Appendices to the Ecological Assessment. Report prepared for Leda Manorstead Pty Ltd.

JWA (2013) Revised Ecological Assessment. Report prepared for Leda Manorstead Pty Ltd.

Tweed Vegetation Management Strategy (August 2004) Volume 2 of 3 Technical Report

Tweed Vegetation Management Strategy (August 2004) Volume 3 of 3 Appendices

NSW Department of Environment & Heritage (2004): Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological listing

[HTTP://WWW.ENVIRONMENT.NSW.GOV.AU/DETERMINATIONS/SWAMPSCHLEROPHYLLENDSP LISTING.HTM](http://www.environment.nsw.gov.au/determinations/swampschlerophyllendsplisting.htm)

APPENDIX 1 - OEH LETTER



Office of
Environment
& Heritage

RECEIVED
26/5/14

Your reference: Email 12 May 2014
Our reference: DOC14/67386
Contact: Krister Waern (02) 6640 2503

Mr James Warren
Managing Director
James Warren & Associates
PO Box 1465,
Ballina NSW 2478

Dear Mr Warren

Re: Cobaki Estate - Swamp Sclerophyll Forest on Floodplain EEC.

Thank you for your email of 12 May 2014 requesting advice from the Office of Environment and Heritage (OEH) regarding the identification of an Endangered Ecological Community (EEC) at Cobaki Estate. I appreciate the opportunity to provide input.

I understand that you have spoken to Senior Operations Officer, Mr Krister Waern, in my team in relation to the matter. I am advised that at this stage the applicant has not lodged an amendment to the conditions of approval with the Department of Planning and Environment (DPE), and the purpose of your request is to obtain initial advice from OEH to enable the applicant to determine if an amendment to the conditions should be lodged with DPE.

In formulating such initial advice OEH has briefly considered the Gilbert & Sutherland report dated 27 March 2014 that you attached to your email. However if an application for amending the conditions of approval is subsequently lodged, OEH will provide a more detailed assessment to DPE at that stage.

The Gilbert & Sutherland report appears to indicate that the area of vegetation in question would not be inundated by the average recurrence interval (ARI) 100 year flood event, and as such the vegetated area does not accord with the final determination of the NSW Scientific Committee for the Swamp Sclerophyll Forests on Coastal Floodplains EEC. In making such a judgement all aspects set out in the final determination would need to be considered including:

- the floristic assemblage of the vegetated area;
- the soil profile of the area;
- whether the area is associated with a floodplain;
- the elevation of the area; and,
- any other attribute associated with the scientific determination.

At this stage with the limited information supplied about one aspect of the scientific determination, it is not possible for OEH to draw the conclusion that this vegetated area is not an EEC. I understand that this area has been considered an EEC by all involved with the proposal since the early stages of the development assessment process for the site.

If the proponent is having difficulty addressing the conditions of approval in relation to the EEC, OEH would be willing to discuss the requirements and assist the applicant to meet their obligations.

Should you require further information or clarification please contact Senior Operations Officer, Mr Krister Waern, on (02) 6640 2503.

Yours sincerely

Dimitri Young 22 May 2014

Dimitri Young
Senior Team Leader Planning, North East
Regional Operations

APPENDIX 2 - PLANT SPECIES TABLE

Botanical name	Common name	Life Form
<i>Acacia ulicifolia</i>	Prickly moses	Small shrub
<i>Andropogon virginicus</i> *	Whisky grass	Grass
<i>Aotus lanigera</i>	Golden candlesticks	Small shrub
<i>Austromyrtus dulcis</i>	Midgen berry	Small shrub
<i>Baeckea frutescens</i>	Weeping Baeckea	Small shrub
<i>Baloskion pallens</i>	Didgery sticks	Rush
<i>Baloskion tetraphyllum</i>	Tassel cord rush	Rush
<i>Blechnum indicum</i>	Swamp water fern	Fern
<i>Cypraea polystachyos</i>	Bunchy sedge	Sedge
<i>Dianella caerulea</i>	Blue flax lily	Herb
<i>Eucalyptus robusta</i>	Swamp mahogany	Tree
<i>Fimbristylis nutans</i>		Sedge
<i>Gahnia aspera</i>	Rough saw-sedge	Sedge
<i>Homoranthus virgatus</i>		Small shrub
<i>Hovea</i> sp.		Small shrub
<i>Imperata cylindrica</i>	Blady grass	Grass
<i>Kennedia rubicunda</i>	Dusky coral pea	Climber
<i>Lomandra longifolia</i>	Spiny-head mat-rush	Rush
<i>Lygodium microphyllum</i>	Climbing snake fern	Fern
<i>Pteridium esculentum</i>	Common bracken	Fern
<i>Selaginella uliginosa</i>	Swamp Selaginella	Clubmoss
<i>Senecio madagascariensis</i> *	Fireweed	Forb

* Introduced species

APPENDIX 3 - SOIL CHARACTERISITICS (11 JUNE 2014)

11 June 2014

Leda Manorstead Pty Ltd
Level 1, 46 Cavill Avenue
Surfers Paradise Q4127

Attention: Reg van Rij – Regional Manager - Residential

Dear Sir,

**Re: Soil characteristics in mapped Swamp Sclerophyll, Cobaki Estate,
New South Wales**

Further to your instructions, Gilbert & Sutherland (G&S) has undertaken a review of soil investigations completed by G&S and others at the Cobaki Estate development site. The purpose of this review was to determine the characteristics of soils within the mapped Endangered Ecological Community 'Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast' (Swamp Sclerophyll EEC).

The relevant section of the Scientific Committee's determination on the Swamp Sclerophyll EEC includes the following:

1. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Sclerophyll Forest on Coastal Floodplains generally occurs below 20 m (though sometimes up to 50 m) elevation, often on small floodplains or where the larger floodplains adjoin lithic substrates or coastal sand plains in the NSW North Coast, Sydney Basin and South East Corner bioregions.

Specifically we have been asked to consider whether the soils in the mapped area could be described as '*humic clay loams and sandy loams*'. It is significant that clay loams and sandy loams are textural descriptions of soils and such soils may be present in a broad range of soils classified and identified on the basis of 'soil orders' in accordance with the *Australian Soil Classification*¹. The soil mapping that G&S completed for the site identified the appropriate soil order in the Swamp Sclerophyll EEC area as Podosols.

Podosols are soils with B-horizons that are dominated by the accumulation of compounds of organic matter, aluminium and/or iron. Podsoils contain a B-horizon that has either:

- a visible dominance of iron compounds
- organic-aluminium and iron compounds
- organic-aluminium compounds

Podosols often have humic matter, derived from decomposing organic material. Humic clay loams and sandy loams may, or may not be present.

G&S has mapped the Podsoils on the site on the basis of our own soil investigations and prior investigations completed by Golder Associates and others. Boreholes BH27, BH28, BH29, BH30 and BH31 from G&S's (1998) *Acid Sulfate Soil Assessment*² correspond with the area mapped as Swamp Sclerophyll EEC.

The location of relevant boreholes are indicated on the attached drawing 11397 2 1, and the borehole logs are attached.

All logs indicate that the soils are dominated by fine to medium sand. This texture class has minimal to no cohesiveness, reflecting a lack of clay, in contrast to clay loams and sandy loams where clay represents a significant proportion of the soil. The presence of sapric materials and indurated (cemented) sand in many of the logs reflects the presence of humic matter. However, in the absence of any borehole logs referring to loamy sands, sandy loams or clay loams, it is evident that the soils present in the area mapped as Swamp Sclerophyll EEC are not humic clay loams nor sandy loams.

¹ Isbell, RF (1996) *The Australian Soil Classification*, CSIRO Publishing, Australia.

² Gilbert & Sutherland (1998) *Acid Sulfate Soil Assessment of Cobaki Lakes Estate, Cobaki*. Prepared for Leda Manors Pty Ltd.

We trust this is acceptable. Please do not hesitate to contact this office if you require any further details or elaboration.

Yours sincerely,



Nathan Zurig
Director/Principal Environmental Scientist
BAppSc(Env)(Hons)



Neil Sutherland
**Director/Principal Agricultural &
Environmental Scientist**
BTEC(Hgr)Agr PGDipLanWatMan
MScEnvMan CPAg MAIAS

Authors Nathan Zurig

Our Reference 11397 ADV260314 LNZ1D.docx

Your Reference -

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Attachments Drawing 11397 2 1 & Borehole Logs

BH27 – 31 and GW3.



Borehole: **GW3**

Project: GJ0640-1

Client: LEDA Developments

Northing:

Easting:

RL(m):

GILBERT + SUTHERLAND

Agricultural & Environmental Scientists

Depth (m): 2.00

Logged by: **DC**

Drilled by: Sutherland Exploration

Start date: 07.08.07

Completion date: 07.08.07

Depth NSL(m)	Drilling			Soil Description				Assays				Depth NSL(m)		
	Depth (RL) m	Method	Graphic log	Soil Description (as per McDonald et.al1990)	Secondary Soil type	Revised Standard Colour	Accessories	Additional Comments	Sample ID	Emerson class	pH(Field)			
											3	5	8	10
.5				FINE TO MEDUM SAND Grey, moist				Screen 0.5-2.0m						
				FINE TO MEDUM SAND Grey, wet										
				FINE TO MEDUM SAND Grey, wet										
				FINE TO MEDUM SAND Grey-brown (indurated)										
1.0														
1.5														
2.0														
2.5														
3.0														

Page: 1 of 1

SOIL PROFILE BORELOG BH 27

Subject: Cobaki Lakes

Job number: GJ9811

Client: Leda Manorstead Pty. Ltd.

Date:

Depth NSL (m)	Depositional environment	Sample Description	Accessories	Colour
0 – 1.1		SAND (S) Fine –medium sand.		10YR 5/2 and 10YR 6/1 from 0.8 to 1.1m.
1.1 – 1.6		SAND (S) Fine –medium sand	Cemented, indurated sand with refusal at 1.6m.	10YR 6/1 and 10YR 2/1
		MAXIMUM DEPTH OF BOREHOLE AT 1.6 m		

SOIL PROFILE BORELOG BH 28

Subject: Cobaki Lakes

Job number: GJ9811

Client: Leda Manorstead Pty. Ltd.

Date:

Depth NSL (m)	Depositional environment	Sample Description	Accessories	Colour
0 – 0.2		SAND (S) Fine-medium sand	Organics present (roots)	10YR 2/1
0.2 – 1.0		SAND (S) Fine-medium sand		10YR 6/1
1.0 – 1.35		SAND (S) Indurated sand	Very cemented at 1.1m. Refusal at 1.35m	10YR 2/1
		MAXIMUM DEPTH OF BOREHOLE AT 1.35 m.		

SOIL PROFILE BORELOG BH 29

Subject: Cobaki Lakes
 Job number: GJ9811
 Client: Leda Developments
 Date:

Depth NSL (m)	Depositional environment	Sample Description	Accessories	Colour
0 – 0.2		SAND (S) Fine-medium sand	Organics present	10YR 2/1
0.2 – 1.3		SAND (S) Fine-medium sand		7.5YR 5/2 to 0.8m, 7.5YR 4/2 to 1.3 and
1.3 – 1.5		SAND (S) sapric Fine-medium sand		7.5YR 3/1
1.5 – 1.8		SAND (S) indurated sapric Fine-medium sand	With increasing sapric content Silty clay lens at 1.55-1.6m Cemented profile from 1.6m onwards Refusal at 1.8m	10YR 2/1
		MAXIMUM DEPTH OF BOREHOLE AT 1.8m.		

SOIL PROFILE BORELOG BH 30

Subject: Cobaki Lakes

Job number: GJ9811

Client: Leda Manorstead Pty. Ltd.

Date:

Depth NSL (m)	Depositional environment	Sample Description	Accessories	Colour
0 – 0.5		SAND (S) Fine-medium sand	Organics present (roots etc) giving some consistency	10YR 2/1
0.5 – 1.05		SAND (S) Fine-medium sand		7.5YR 4/2 and 7.5YR 3/2 from 1m.
1.05 – 1.2		SAND (S) indurated sapric Fine-medium sand	very cemented from 1.1m onwards Refusal at 1.2m.	10YR 3/2
		MAXIMUM DEPTH OF BOREHOLE AT 1.2m.		

SOIL PROFILE BORELOG BH 31

Subject: Cobaki Lakes

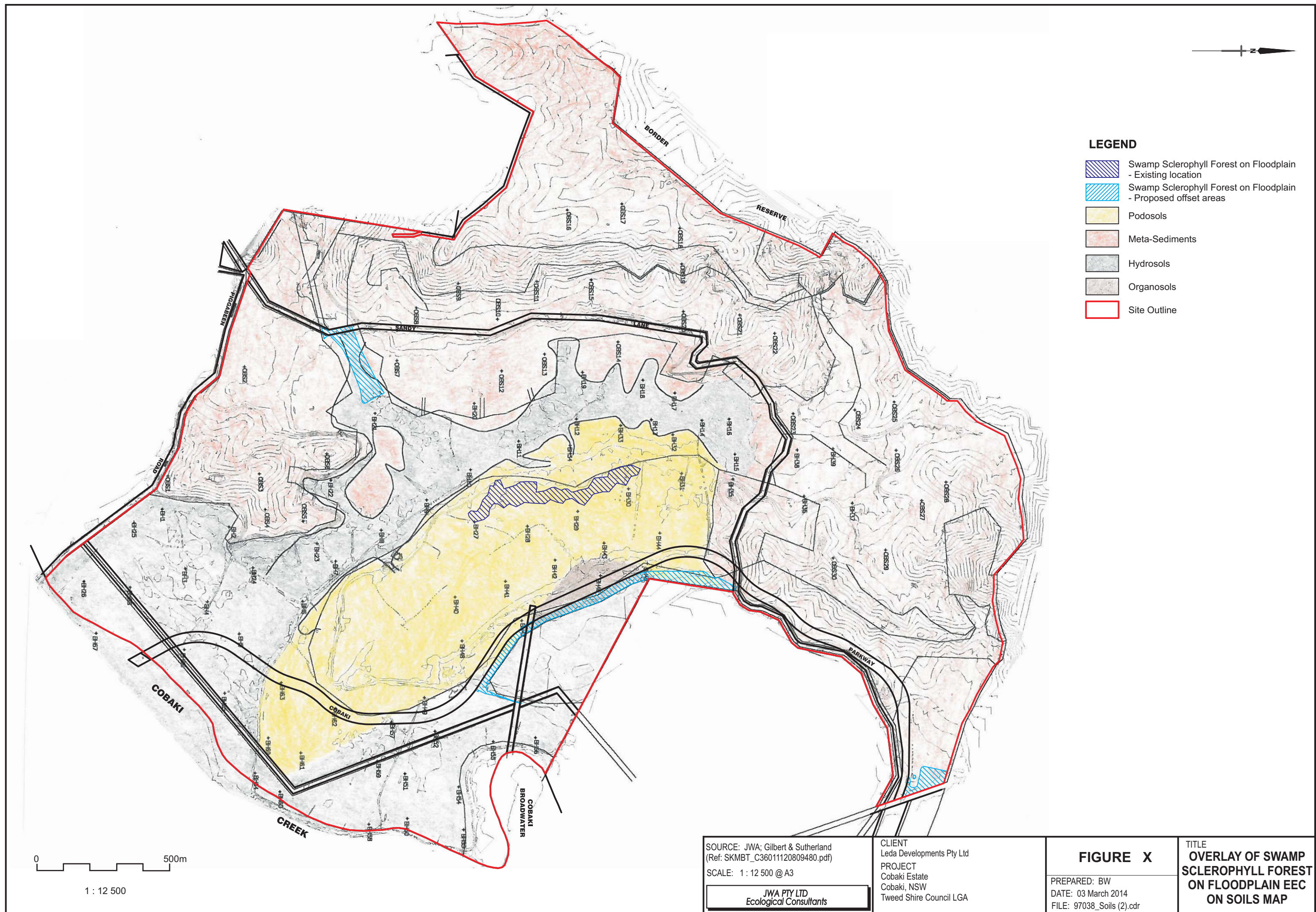
Job number: GJ9811

Client: Leda Manorstead Pty. Ltd.

Date:

Depth NSL (m)	Depositional environment	Sample Description	Accessories	Colour
0 – 0.2		SAND (S) Fine-medium sand	Organics present	10YR 2/1
0.2 – 1.45		SAND (S) Fine-medium sand	Bleached layer from 0.2 to 0.5m.	7.5YR 6/1 and and 5YR 7/1 (Bleached layer) 10YR 5/2 from 1.0 to 1.45m.
1.45– 1.50		SAND (S) sapric Indurated fine-medium sand	Refusal at 1.5m.	10YR 1.7/1
		MAXIMUM DEPTH OF BOREHOLE AT 1.5m.		

APPENDIX 4 - SOIL MAP



APPENDIX 5 - HYDROLOGICAL ASSESSMENT & FLOODING (27 MARCH 2014)

27 March 2014

Leda Manorstead Pty Ltd
Level 1, 46 Cavill Avenue
Surfers Paradise Q4127

Attention: Reg van Rij – Regional Manager - Residential

Dear Sir,

Re: Hydrological Assessment & Flooding, Cobaki Estate, New South Wales

Further to your instructions, Gilbert & Sutherland (G&S) has undertaken a review of Tweed Shire Council's Flood Model to determine the extent of the Cobaki Estate site that is considered floodplain, in accordance with the definition adopted by the Scientific Committee, established by the *Threatened Species Conservation Act 1995*. This assessment was undertaken to determine whether part of the site mapped as the Endangered Ecological Community 'Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast' (Swamp Sclerophyll EEC) is in fact situated on 'floodplain'. The area of interest is illustrated on Drawing no 11397 001.

The relevant section of the Scientific Committee's determination on the Swamp Sclerophyll EEC includes the following:

1. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Sclerophyll Forest on Coastal Floodplains generally occurs below 20 m (though sometimes up to 50 m) elevation, often on small floodplains or where the larger floodplains adjoin lithic substrates or coastal sand plains in the

NSW North Coast, Sydney Basin and South East Corner bioregions.

We note that the extent of the EEC is restricted in the determination to '*alluvial flats and drainage lines associated with coastal floodplains*'. Most importantly to our assessment is the definition of floodplains that the Scientific Committee has adopted, which is:

Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990)¹.

By this definition the extent of the pre-developed 100 year average recurrence interval (ARI) flood event, within the Cobaki Estate site will delineate the extent of 'floodplain' and therefore the possible extent of the Swamp Sclerophyll EEC.

In 2009, the Tweed Valley Flood Study was used by Aurecon² on behalf of Gilbert & Sutherland (G&S) to assess the flood extent across the site in its pre-development state. The Tweed Valley Flood Study³ was originally undertaken in 2005 using the 2 dimensional modelling package TUFLOW and built upon previous studies undertaken using the 1 dimensional ESTRY package. The Tweed Valley Flood Study was subsequently updated (WBM 2009)⁴, primarily to incorporate improved catchment topography based on 2007 Aerial Lidar Survey data. Hydrologic and hydraulic models were also updated to reflect advances in methodology and model development since the completion of the 2005 study.

In 2009, Gilbert & Sutherland obtained the latest version of the Tweed River flood model from WBM. All model files (including topography, hydraulic controls, roughness and boundary conditions) were provided by WBM to Gilbert and Sutherland and subsequently to Aurecon to carry out the flood assessment. The model spatial resolution is 40 m in the horizontal and comprises some 330,000 computation cells extending from upstream of Murwillumbah to the Pacific Ocean at Tweed Heads.

As part of its assessment Aurecon verified that the model supplied in 2009 was representative of the pre-developed flooding condition, based on the supplied topographic data, and adopted the supplied flood extent as the base-case against which the impacts of proposed development were assessed. For the purpose of determining the extent of the

¹ Speight JG (1990) Landform. In: 'Australian soil and land survey. Field handbook' Second edition (Eds. RC McDonald, RF Isbell, JG Speight, J. Walker, MS Hopkins), pp9-57. Inkata Press,

² Aurecon (October 29, 2009) 'Cobaki Lakes Estate Flood Assessment, Revision 1'. Prepared for Gilbert & Sutherland.

³ WBM Oceanics Australia (2005) 'Tweed Valley Flood Study'. Prepared for Tweed Shire Council.

⁴ BMT WBM (October 19, 2009) 'Tweed Valley Flood Study – 2009 Update'. Prepared for Tweed Shire Council.

proposed development were assessed. For the purpose of determining the extent of the floodplain, it is this pre-developed or base-case model that is relevant. As such, G&S has overlaid the base-case ARI 100 year flood extent of inundation over aerial imagery of the Cobaki site. This is illustrated on Drawing 11397 001. From this drawing it is apparent that based on the supplied topography (circa 2007), the area of vegetation in question would not be inundated by the ARI 100 year flood event.

It is apparent that the 2007 Lidar based topography incorporated some filling within the Cobaki Estate site. To confirm that this filling has not altered the pre-development or historical extent of flooding we have also overlaid the 2005 base-case ARI 100 year flood extent of inundation over aerial imagery of the site. Whilst a greater proportion of the site is inundated, this excludes the area of possible Swamp Sclerophyll EEC within the Cobaki Estate site, confirming our findings above.

Based on these assessments, and adopting the definition of floodplain relied upon by the Scientific Committee, we conclude that the Swamp Sclerophyll vegetation in question is not situated on floodplain.

We trust this is acceptable. Please do not hesitate to contact this office if you require any further details or elaboration.

Yours sincerely,



Nathan Zurig
Director/Principal Environmental Scientist
BAppSc(Env)(Hons)



Neil Sutherland
Director/Principal Agricultural & Environmental Scientist
BTEC(Hgr)Agr PGDipLanWatMan
MScEnvMan CPAg MAIAS

Authors Nathan Zurig

Our Reference 11397 ADV260314 LNZ1D.docx

Your Reference -

By ☐ Courier ☒ Email ☐ Facsimile ☐ Post

Attachments Drawings 11397 001 & 11397 002





ORIENTATION
NORTH

SCALE

100

200

300

400




500

600

metres

ROBINA

PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs www.access.gs

- LEGEND
-  Cobaki Estate - site boundary
 -  100 year ARI flood inundation extent (pre-development)
 -  Potential EEC - Swamp sclerophyll forest

SOURCES

Image source: Google Earth Pro
Image date: 20 September 2012

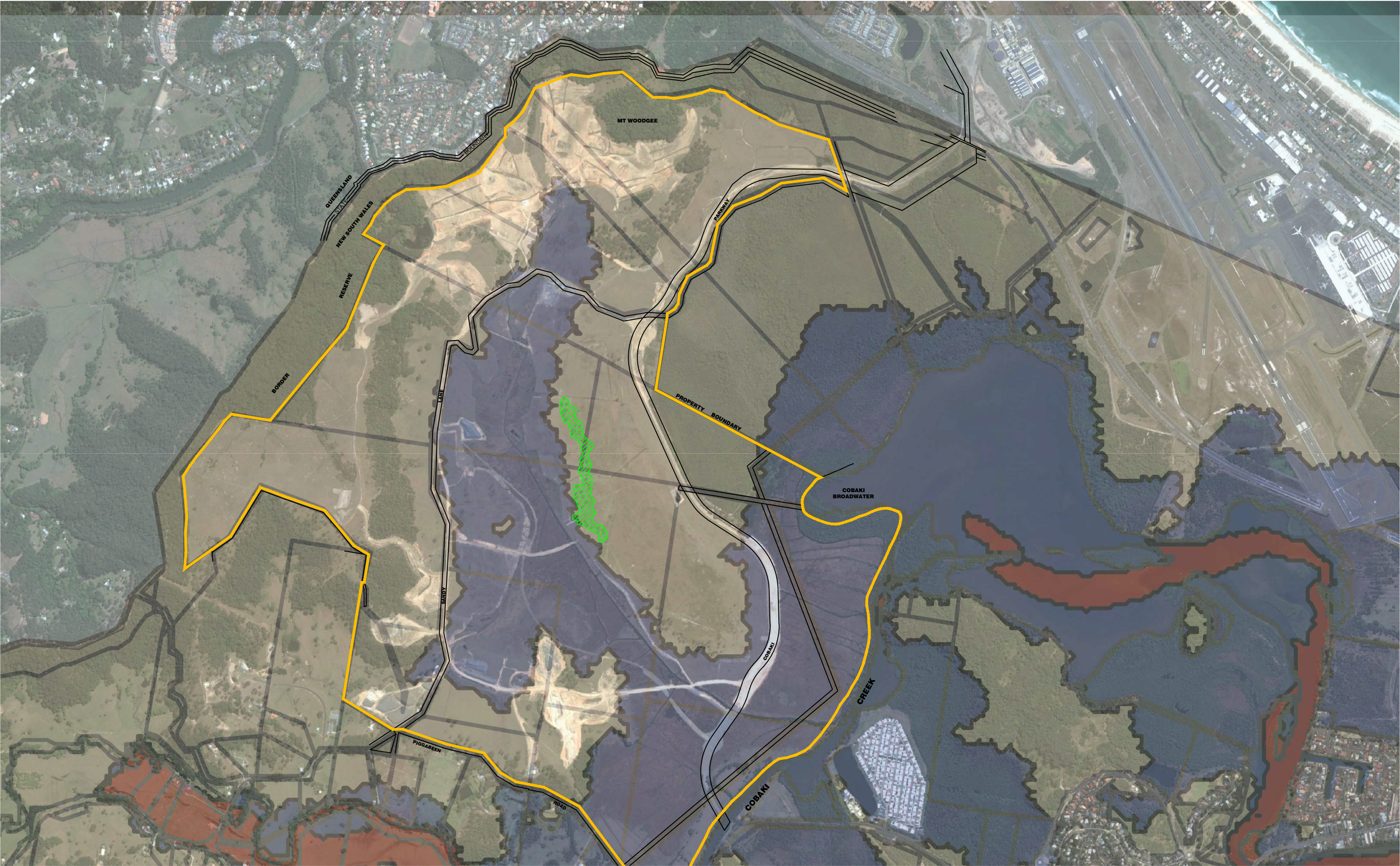
Flood inundation extent: Tweed Shire Council's online mapping database (mapping.tsc.gov.au) - accessed 27 March 2014

PROJECT COBAKI ESTATE		CLIENT LEDA DEVELOPMENTS		DRAWING SWAMP SCLEROPHYLL FOREST EEC AREA & FLOOD INUNDATION EXTENT		
SCALE 1:12 500@A3	DATE 27/03/2014	DRAWN AJF	CHECKED NTZ	PROJECT 11397	DRAWING 001	REVISION -

Brisbane Sydney Melbourne and regions



Agriculture. Water. Environment.



ORIENTATION
NORTH

SCALE
100 200 300 400 500 600
metres

ROBINA
PO Box 4115 Robina QLD4230 07 5578 9944
Email robina@access.gs www.access.gs

LEGEND

- Cobaki Estate - site boundary
- 100 year ARI flood inundation extent from 2005 Tweed Valley flood study
- Potential EEC - Swamp sclerophyll forest

SOURCES

Image source: Google Earth Pro
Image date: 20 September 2012

Flood inundation extent: Tweed Valley Floodplain Risk Management Study 2005, Part II Planning Controls for High Flow Areas, Figure 1 Lower Tweed, dated 20/06/2006

PROJECT
COBAKI ESTATE

CLIENT
LEDA DEVELOPMENTS

SCALE
1:12 500@A3

DATE
28/03/2014

DRAWN
AJF

CHECKED
NTZ

DRAWING
SWAMP SCLEROPHYLL
FOREST EEC AREA &
FLOOD INUNDATION EXTENT
(2005 TWEED VALLEY MODEL)

PROJECT
11397

DRAWING
002

REVISION
-

Brisbane Sydney Melbourne and regions

+GILBERT SUTHERLAND
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APPENDIX 6

Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological listing

NSW Scientific Committee - final determination

The Scientific Committee, established by the Threatened Species Conservation Act, has made a Final Determination to list Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions, as an ENDANGERED ECOLOGICAL COMMUNITY in Part 3 of Schedule 1 of the Act, and as a consequence to omit reference to Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion from Part 3 of Schedule 1 of the Act. Listing of endangered ecological communities is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with humic clay loams and sandy loams, on waterlogged or periodically inundated alluvial flats and drainage lines associated with coastal floodplains. Floodplains are level landform patterns on which there may be active erosion and aggradation by channelled and overbank stream flow with an average recurrence interval of 100 years or less (adapted from Speight 1990). Swamp Sclerophyll Forest on Coastal Floodplains generally occurs below 20 m (though sometimes up to 50 m) elevation, often on small floodplains or where the larger floodplains adjoin lithic substrates or coastal sand plains in the NSW North Coast, Sydney Basin and South East Corner bioregions. The structure of the community is typically open forest, although partial clearing may have reduced the canopy to scattered trees. In some areas the tree stratum is low and dense, so that the community takes on the structure of scrub. The community also includes some areas of fernland and tall reedland or sedgeland, where trees are very sparse or absent. Typically these forests, scrubs, fernlands, reedlands and sedgelands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (e.g. Pressey 1989a).

The composition of Swamp Sclerophyll Forest on Coastal Floodplains is primarily determined by the frequency and duration of waterlogging and the texture, salinity nutrient and moisture content of the soil. Composition also varies with latitude. The community is characterised by the following assemblage of species:

<i>Acacia irrorata</i>	<i>Acacia longifolia</i>
<i>Acmena smithii</i>	<i>Adiantum aethiopicum</i>
<i>Allocasuarina littoralis</i>	<i>Banksia oblongifolia</i>
<i>Banksia spinulosa</i>	<i>Baumea articulata</i>
<i>Baumea juncea</i>	<i>Blechnum camfieldii</i>
<i>Blechnum indicum</i>	<i>Breynia oblongifolia</i>
<i>Callistemon salignus</i>	<i>Calochlaena dubia</i>
<i>Carex appressa</i>	<i>Casuarina glauca</i>
<i>Centella asiatica</i>	<i>Dianella caerulea</i>
<i>Dodonaea triquetra</i>	<i>Elaeocarpus reticulatus</i>
<i>Entolasia marginata</i>	<i>Entolasia stricta</i>

<i>Eucalyptus botryoides</i>	<i>Eucalyptus longifolia</i>
<i>Eucalyptus resinifera</i> subsp. <i>hemilampra</i>	<i>Eucalyptus robusta</i>
<i>Ficus coronata</i>	<i>Gahnia clarkei</i>
<i>Gahnia sieberiana</i>	<i>Glochidion ferdinandi</i>
<i>Glycine clandestina</i>	<i>Gonocarpus tetragynus</i>
<i>Hydrocotyle peduncularis</i>	<i>Hypolepis muelleri</i>
<i>Imperata cylindrica</i> var. <i>major</i>	<i>Isachne globosa</i>
<i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i>	<i>Livistona australis</i>
<i>Lomandra longifolia</i>	<i>Lophostemon suaveolens</i>
<i>Melaleuca ericifolia</i>	<i>Melaleuca linariifolia</i>
<i>Melaleuca quinquenervia</i>	<i>Melaleuca sieberi</i>
<i>Melaleuca styphelioides</i>	<i>Morinda jasminoides</i>
<i>Omalanthus populifolius</i>	<i>Oplismenus aemulus</i>
<i>Oplismenus imbecillis</i>	<i>Parsonsia straminea</i>
<i>Phragmites australis</i>	<i>Polyscias sambucifolia</i>
<i>Pratia purpurascens</i>	<i>Pteridium esculentum</i>
<i>Stephania japonica</i> var. <i>discolor</i>	<i>Themeda australis</i>
<i>Villarsia exaltata</i>	<i>Viola banksii</i>
<i>Viola hederacea</i>	

2. The total species list of the community is considerably larger than that given above, with many species present at only one or two sites or in low abundance. The species composition of a site will be influenced by the size of the site, recent rainfall or drought conditions and by its disturbance (including fire, grazing, flooding and land clearing) history. The number and relative abundance of species will change with time since fire, flooding or significant rainfall, and may also change in response to changes in grazing regimes. At any one time, above-ground individuals of some species may be absent, but the species may be represented below ground in the soil seed banks or as dormant structures such as bulbs, corms, rhizomes, rootstocks or lignotubers. The list of species given above is of vascular plant species, the community also includes micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and invertebrate. These components of the community are poorly documented.

3. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is known from parts of the Local Government Areas of Tweed, Byron, Lismore, Ballina, Richmond Valley, Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Hastings, Greater Taree, Great Lakes and Port Stephens, Lake Macquarie, Wyong, Gosford, Hornsby, Pittwater, Warringah, Manly, Liverpool, Rockdale, Botany Bay, Randwick, Sutherland, Wollongong, Shellharbour, Kiama and Shoalhaven but may occur elsewhere in these bioregions. Bioregions are defined in Thackway and Creswell (1995). Major examples once occurred on the floodplains of the Tweed, Richmond, Clarence, Macleay, Hastings and Manning Rivers, although smaller floodplains would have also supported considerable areas of this community.

4. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has an open to dense tree layer of eucalypts and paperbarks, which may exceed 25 m in height, but can be considerably shorter in regrowth stands or under conditions of lower site quality. For example, stands dominated by *Melaleuca ericifolia* typically do not exceed 8 m in height. The most widespread and abundant dominant trees include *Eucalyptus robusta* (swamp mahogany), *Melaleuca quinquenervia* (paperbark) and, south from Sydney, *Eucalyptus botryoides* (bangalay) and *Eucalyptus longifolia* (woollybut). Other trees may be scattered throughout at low abundance or may be locally common at few sites, including *Callistemon salignus* (sweet willow bottlebrush), *Casuarina glauca* (swamp oak) and *Eucalyptus resinifera* subsp. *hemilampra* (red mahogany), *Livistona australis* (cabbage palm) and *Lophostemon suaveolens* (swamp turpentine). A layer of small trees may be present, including *Acacia irrorata* (green wattle), *Acmena smithii* (lilly pilly), *Elaeocarpus reticulatus* (blueberry ash), *Glochidion ferdinandi* (cheese tree), *Melaleuca linariifolia* and *M. styphelioides* (paperbarks). Shrubs include *Acacia longifolia* (Sydney golden wattle), *Dodonaea triquetra* (a hopbush), *Ficus coronata* (sandpaper fig), *Leptospermum polygalifolium* subsp. *polygalifolium* (lemon-scented tea tree) and *Melaleuca* spp. (paperbarks). Occasional vines include *Parsonsia straminea* (common silkpod), *Morinda jasminoides* and *Stephania japonica* var. *discolor* (snake vine). The groundcover is composed of abundant sedges, ferns, forbs, and grasses including *Gahnia clarkei*, *Pteridium esculentum* (bracken), *Hypolepis muelleri* (batwing fern), *Calochlaena dubia* (false bracken), *Dianella caerulea* (blue flax lily), *Viola hederacea*, *Lomandra longifolia* (spiny-headed mat-rush) and *Entolasia marginata* (bordered panic) and *Imperata cylindrica* var. *major* (blady grass). The endangered swamp orchids *Phaius australis* and *P. tankervillei* are found in this community. On sites downslope of lithic substrates or with soils of clay-loam texture, species such as *Allocasuarina littoralis* (black she-oak), *Banksia oblongifolia*, *B. spinulosa* (var. *collina* or var. *spinulosa*) (hairpin banksia), *Ptilothrix deusta* and *Themeda australis* (kangaroo grass), may also be present in the understorey. The composition and structure of the understorey is influenced by grazing and fire history, changes to hydrology and soil salinity and other disturbance, and may have a substantial component of exotic grasses, vines and forbs.

5. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions provides habitat for a broad range of animals, including many that are dependent on trees for food, nesting or roosting (Law *et al.* 2000). The blossoms of *Eucalyptus robusta* and *Melaleuca quinquenervia* are also an important food source for the Grey-headed Flying Fox (*Pteropus poliocephalus*) and Common Blossom Bat (*Sycoptes australis*) (Law 1994), as well as the Yellow-bellied Glider (*Petaurus australis*), Sugar Glider (*Petaurus breviceps*), Regent Honeyeater (*Xanthomyza phrygia*) and Swift Parrot (*Lathamus discolor*). Other animals found in this community include the Osprey (*Pandion haliaetus*), Australasian Bittern (*Botaurus poiciloptilus*), Large-footed myotis (*Myotis adversus*), *Litoria longoburensis* and Wallum Froglet (*Crinia tinnula*).

6. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions forms part of a complex of forested and treeless wetland communities found throughout the coastal floodplains of NSW. A recent analysis of available quadrat data from these habitats identified a distinct grouping of vegetation samples attributable to this community (Keith and Scott 2005). The combination of features that distinguish Swamp Sclerophyll Forest on Coastal Floodplains from other endangered ecological communities on the coastal floodplains include: its relatively dense tree canopy dominated by *Eucalyptus robusta*, *Melaleuca quinquenervia* or *E. botryoides*; the relatively infrequent occurrence of other eucalypts, *Casuarina glauca* or *Lophostemon suaveolens*; the occasional presence of rainforest elements as scattered trees or understorey plants; and the prominence of large sedges and ferns in the groundcover. It generally occupies small alluvial flats and peripheral parts of floodplains where they adjoin lithic substrates or coastal sandplains. The soils are usually waterlogged, stained black or dark grey with humus, and show little influence of saline ground water.

7. Swamp Sclerophyll Forest on Coastal Floodplains includes and replaces Sydney Coastal Estuary Swamp Forest in the Sydney Basin bioregion. It may adjoin or intergrade with several other endangered ecological communities, which collectively cover all remaining native vegetation on the coastal floodplains of New South Wales. These include Lowland Rainforest on Floodplain in the NSW North Coast bioregion, River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions (including the formerly listed Sydney Coastal River-Flat Forest in the Sydney Basin bioregion), Subtropical Floodplain Forest, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions and Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. For example, as soils become less waterlogged, Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions may adjoin or intergrade with River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. As soil salinity increases Swamp Sclerophyll Forest on Coastal Floodplains may intergrade with, and be replaced by, Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions. The boundaries between these communities are dynamic and may shift in

response to changes in hydrological regimes, fire regimes or land management practices (e.g. Johnston *et al.* 2003, Stevenson 2003). The Determinations for these communities collectively encompass the full range of intermediate assemblages in transitional habitats.

8. A number of vegetation surveys and mapping studies have been conducted across the range of Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. This community includes the *Eucalyptus robusta* (Swamp Mahogany) community identified on coastal alluvium by Douglas and Anderson (2002) and the Coastal Alluvium Swamp Forest complex defined by Anderson and Asquith (2002). In the Comprehensive Regional Assessment of the north-eastern NSW (NPWS 1999), those areas on floodplains mapped as 'Forest Ecosystem 112, Paperbark', and those areas on floodplains mapped as 'Forest Ecosystem 142, Swamp Mahogany' are included within this community. On the Tweed lowlands, this community includes '*Eucalyptus robusta* mid-high to very tall closed forest' (F7), '*Archontophoenix cunninghamiana*-*Melaleuca quinquenervia* very tall feather palm swamp forest' (F9), those parts of *Melaleuca quinquenervia* tall to very tall open to closed forest' (F8) on alluvial soils and parts of 'Floodplain Wetland Complex' (FL) dominated by *Eucalyptus robusta* or *Melaleuca quinquenervia* (Pressey and Griffith 1992). In the lower Hunter district, this community includes 'Swamp Mahogany-Paperbark Swamp Forest' (map unit 37), Riparian *Melaleuca* Swamp Woodland (map unit 42) and *Melaleuca* Scrub (map unit 42a) of NPWS (2000). In the Sydney-Gosford region, this community includes those parts of 'Freshwater Swamp complex' (map unit 27a) dominated by *Eucalyptus robusta* or *E. botryoides* (Benson 1986, Benson and Howell 1994) and parts of the 'Freshwater wetlands - on the floodplains' of Benson and Howell (1990) and Benson *et al.* (1996). In the Illawarra, this community includes 'Alluvial swamp mahogany forest' (map unit 35) of NPWS (2002). On the south coast, this community includes 'Northern Coastal Lowlands Swamp Forest' (forest ecosystem 175) of Thomas *et al.* (2000) and 'Coastal Sand Swamp Forest' (map unit 45) of Tindall *et al.* (2004). Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is included within the 'Coastal Floodplain Wetlands' and 'Coastal Swamp Forest' vegetation classes of Keith (2002, 2004). There may be additional or unmapped occurrences of Swamp Sclerophyll Forest on Coastal Floodplains within and beyond these surveyed areas.

9. The extent of the Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions prior to European settlement has not been mapped across its entire range. However, one estimate based on a compilation of regional vegetation maps suggests that Coastal Floodplain Wetlands, which include Swamp Sclerophyll Forest on Floodplains, currently cover 800-1400 km², representing less than 30% of the original extent of this broadly defined vegetation class (Keith 2004). Compared to this combined estimate, the remaining area of Swamp Sclerophyll Forest on Coastal Floodplains is likely to be considerably smaller and is likely to represent much less than 30% of its original range. For example, there were less than 350 ha of native vegetation attributable to this community on the Tweed lowlands in 1985 (Pressey and Griffith 1992), less than 2500 ha on the Clarence floodplain in 1982 (Pressey 1989a), less than 700 ha on the Macleay floodplain in 1983 (Pressey 1989b), up to 7000 ha in the lower Hunter - central coast district during the 1990s (NPWS 2000), and less than 1000 ha in the Sydney - South Coast region in the mid 1990s (Tindall *et al.* 2004), including less than 40 ha on the Illawarra plain in 2001 (NPWS 2002) and about 450 ha on the South Coast in the 1990s (Thomas *et al.* 2000).

10. Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions has been extensively cleared and modified. Large areas that formerly supported this community are occupied by exotic pastures grazed by cattle, market gardens, other cropping enterprises (e.g. sorghum, corn, poplars, etc.) and, on the far north coast, canefields. On the Tweed lowlands, Pressey and Griffith (1992) estimated that less than 3% of the original Floodplain Wetlands and Floodplain Forest remained in 1985. Similar estimates are likely to apply to Swamp Sclerophyll Forest on Coastal Floodplains in other parts of the NSW North Coast bioregion (Goodrick 1970, Pressey 1989a, 1989b). In the lower Hunter - central coast district, about 30 % of the original area of Swamp mahogany - paperbark forest was estimated to remain in the 1990s (NPWS 2000).

11. Land clearing continues to threaten Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions. A small minority of the remaining area occurs on public land (e.g. Pressey and Griffith 1992, NPWS 2000), with most occurring on productive agricultural land or in close proximity to rural centres. The remaining stands are severely fragmented by past clearing and further threatened by continuing fragmentation and degradation, flood mitigation and drainage works, landfilling and earthworks associated with urban and industrial development, pollution from urban and agricultural runoff, weed invasion, overgrazing, trampling and other soil disturbance by domestic livestock and feral animals including pigs, activation of 'acid sulfate soils', removal of dead wood and rubbish dumping (e.g. Pressey 1989a, b; Pressey and Griffith 1992, Boulton and Brock 1999, Johnston *et al.* 2003). Anthropogenic climate change may also threaten Swamp Sclerophyll Forest on Coastal Floodplains if future flooding regimes are affected (IPCC 2001, Hughes 2003). Localised areas, particularly those within urbanised regions, may also be exposed to frequent burning which reduces the diversity of woody plant species. Clearing of native vegetation; Alteration to

the natural flow regimes of rivers, streams, floodplains and wetlands; Invasion of native plant communities by exotic perennial grasses; Predation, habitat destruction, competition and disease transmission by feral pigs; Anthropogenic climate change; High frequency fire and Removal of dead wood and dead trees are listed as Key Threatening Processes under the Threatened Species Act (1995).

12. Large areas of habitat formerly occupied by Swamp Sclerophyll Forest on Coastal Floodplains have been directly drained by construction of artificial channels (e.g. Pressey 1989a, Boulton and Brock 1999). While much of the early drainage works were associated with agricultural development, more recently they are associated with urban expansion. Additional areas that have not been directly drained may have been altered hydrologically by changed patterns of flooding and drainage following flood mitigation works, particularly the construction of drains, levees and floodgates (Pressey and Griffith 1992). On the north coast of NSW, expansion of *Melaleuca quinquenervia* into open floodplain swamps has been attributed to artificial drainage and shortening of the hydroperiod (Johnston *et al.* 2003, Stevenson 2003). These changes appear to be closely associated with enhanced acidity, altered ionic ratios, increased dissolved organic carbon and sulfide oxidation in the soil profile (Johnston *et al.* 2003).

13. Relatively few examples of Swamp Sclerophyll Forest on Coastal Floodplains remain unaffected by weeds. The causes of weed invasion include physical disturbance to the vegetation structure of the community, dumping of landfill rubbish and garden refuse, polluted runoff from urban and agricultural areas, construction of roads and other utilities, and grazing by domestic livestock. The principal weed species affecting Swamp Sclerophyll Forest on Coastal Floodplains include *Andropogon virginicus* (whiskey grass), *Anredera cordifolia* (Madeira vine), *Ageratina adenophora* (crofton weed), *Baccharis halimifolia* (groundsel bush), *Cinnamomum camphora* (camphor laurel), *Lantana camara* (lantana), *Ligustrum sinense* (small-leaved privet), *Lonicera japonica* (Japanese honeysuckle) and *Ludwigia peruviana* (Keith and Scott 2005).

14. Small areas of Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions are contained within existing conservation reserves, including Bungawalbin, Tuckean and Moonee Beach Nature Reserves, and Hat Head, Crowdy Bay, Wallingat, Myall Lakes and Garigal National Parks. These occurrences are unevenly distributed throughout the range and unlikely to represent the full diversity of the community. In addition, wetlands within protected areas are exposed to hydrological changes that were, and continue to be initiated outside their boundaries. Some areas of Swamp Oak Floodplain Forest are protected by State Environmental Planning Policy 14, although this has not always precluded impacts on wetlands from the development of major infrastructure.

15. Given the dynamic hydrological relationship between Swamp Sclerophyll Forest on Coastal Floodplains, Coastal Saltmarsh and other endangered ecological communities on coastal floodplains, future management of water and tidal flows may result in the expansion of some communities at the expense of others. Proposals for the restoration of natural hydrological regimes and for the rehabilitation of acid sulfate soils may also result in changes to the distribution and composition of floodplain communities. Co-ordinated planning and management approaches across whole catchments will be required to address and resolve priorities between different management objectives.

16. In view of the above the Scientific Committee is of the opinion that Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate.

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