

Occurrence of Swamp Sclerophyll Forest EEC & assessment of impacts of proposed clearing, Marshall Way, Nambucca

Prepared for

De Groot & Benson, Coffs Harbour

by

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The author accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report and its supporting material by any third party.

G.N. Elks B.Sc (Botany), M.Litt (Ecology), MECA

Introduction

Background

A proposal to clear vegetation on Lot 1 DP1119830 for urban development has been formally assessed by Naturecall Environmental (2015). That report relied on geomorphological mapping to identify that part of the site potentially supporting an Endangered Ecological Community (EEC), but vegetation at that part of the site did not meet the floristic requirements for an EEC as listed in the Scientific Committee's Determination (Naturecall 2015 p. 26). However, a recent soil survey indicated that the geomorphological mapping appears inaccurate. One of the vegetation communities, swamp sclerophyll forest, may therefore meet the criteria for an EEC as listed in the Determination.

Greg Elks of Idyll Spaces Environmental Consultants has been engaged by de Groot & Benson to undertake a flora survey and assessment on part of the subject property mapped in Naturecall (2015) as swamp sclerophyll forest, part of which has been identified by a soil survey as potentially occurring on alluvial soil.

Swamp sclerophyll forest on alluvial soil landscapes is likely to be part of the Endangered Ecological Community (EEC) *Swamp Sclerophyll Forest on Coastal Floodplain* (SSF)(NSW Scientific Committee 17/12/2004). SSF is one of several EECs occurring on coastal floodplains in NSW.

The brief for this assessment is to:

- Undertake a flora survey of the area mapped as occurring on alluvial soil by Regional Geotechnical Solutions (which I understand is about 0.4ha) to collect comprehensive floristic and structural data;
- Compare the data with that provided by the NSW Scientific Committee determinations for swamp sclerophyll forest to assess whether or not the site vegetation meets the requirements for any EEC on floodplain;
- If so, undertake an assessment of significance (the 7-part test) to ascertain whether or not the removal of this vegetation would be likely to have a significant impact on an EEC.

Definitions: study area and subject site

For the purpose of this assessment:

- the study area is defined as that part of Lot 1 shown on Figure 1 as 'extent of alluvial soil' , as identified in a soil survey prepared by Regional Geotechnical Solutions (RTS 29 August 2016), together with a 50 metre buffer, and
- the subject site is that part of Lot 1 shown on Figure 1 as 'extent of alluvial soil'.

Assessment methodology

Aerial orthophotographs and maps were inspected online (<https://maps.six.nsw.gov.au>, <http://maps.au.nearmap.com>) to help identify and map the extent of the subject vegetation. The study area was surveyed over 2 hours on 26 September 2016 to identify flora and map vegetation communities.

Survey utilised two 20x20m (0.04ha) survey quadrats located in the subject site (Figure 1) to record information about the structure of the vegetation and to identify all plant species and their cover/abundance (Braun-Blanquet 6 point scale). Quadrats were located to coincide with the soil test sites TP5 and TP7 of RTS, both of which were located within the area mapped by Naturecall (2015) as swamp sclerophyll forest and identified by RDS (2016) as having a layer of alluvial soil up to 0.6 metres deep over residual soil developed from bedrock.

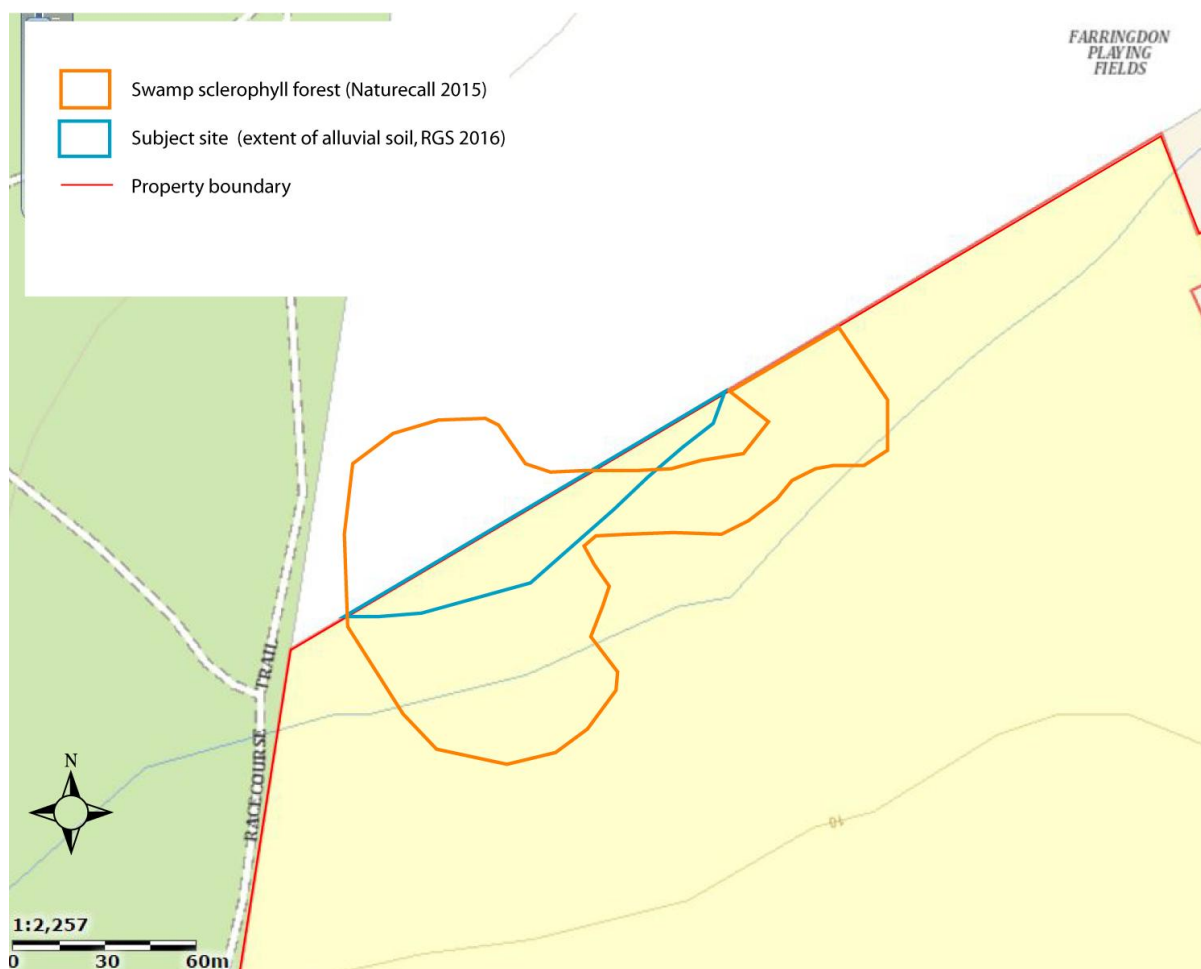


Figure 1. Extract from topographic map overlaid with SSF (Naturecall 2015), subject site & property boundary.

Results & Discussion

Overview of vegetation in the study area

The vegetation of the study area contains two main forest vegetation types (Figure 2); a swamp sclerophyll forest dominated by Swamp Mahogany *Eucalyptus robusta* with a ground layer of the sedge *Gahnia clarkei*, and a dry sclerophyll forest dominated by Scribbly Gum *E. signata* with a ground layer of Kangaroo grass *Themeda australis*.

These communities are appropriately classified in Naturecall (2015) as the Biometric vegetation types 'Swamp Mahogany swamp forest of the coastal lowlands on the North Coast' and 'Scribbly Gum - Red Bloodwood heathy open forest of the coastal lowlands of the North Coast' respectively.

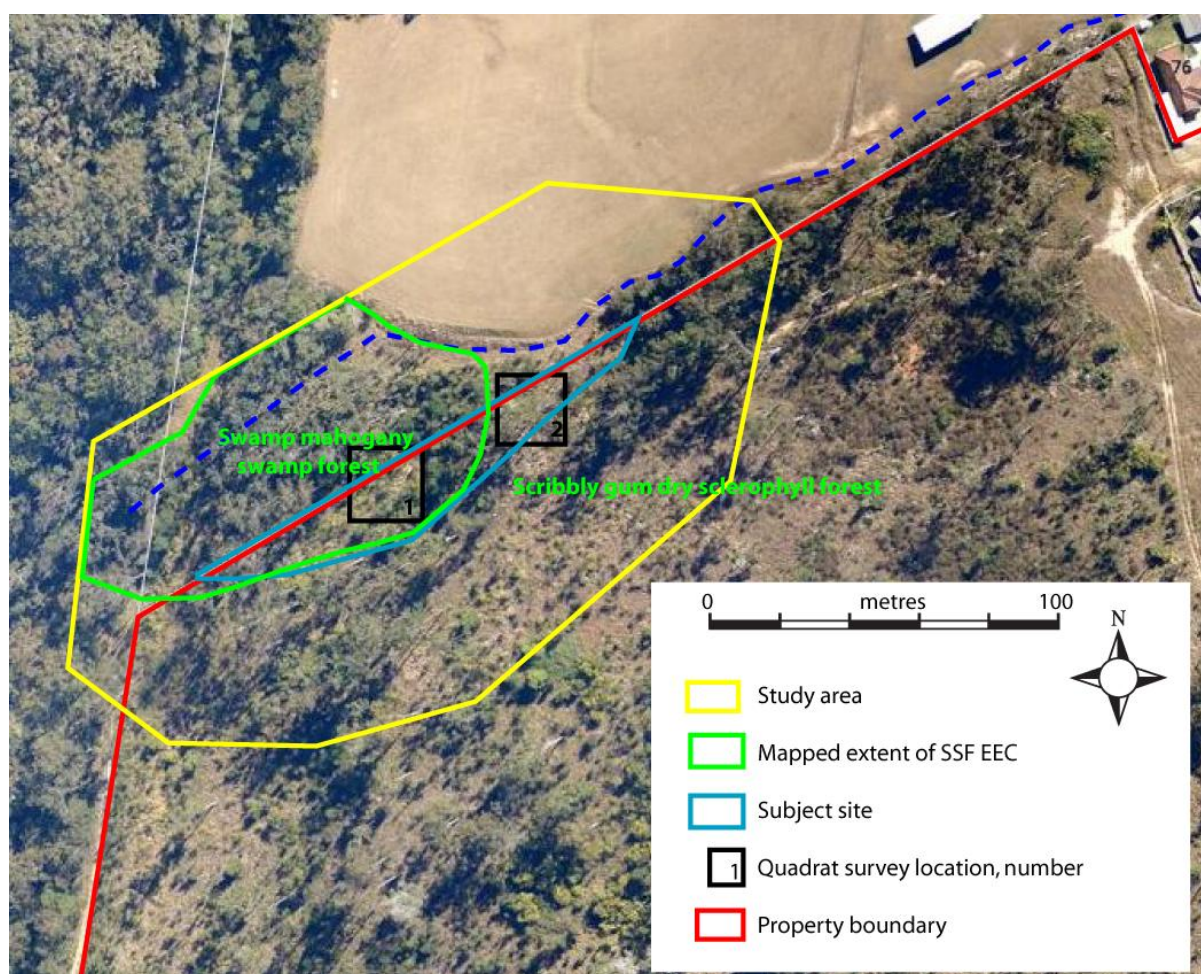


Figure 2. Aerial imagery dated July 2014 showing subject site, amended vegetation community mapping (Idyll Spaces 2016) and survey quadrat locations

The boundary between these communities is associated with a gradual change in the dominance of overstorey species. In the western part of the study area Swamp mahogany is clearly the dominant tree species; to the east there is an intermediate zone of *ca* 50 metre width characterised by the addition of Smooth-barked apple *Angophora costata* and Red mahogany *E. resinifera*, after which the dominant tree species is Scribbly gum. Similarly to the south there is an intermediate zone where Tallowwood is very common.

There is however an abrupt change in understorey vegetation from sedgeland to grassland in this intermediate zone, with the occurrence of Swamp Mahogany more or less limited to areas of sedgeland. Accordingly the outer limit of the swamp sclerophyll forest has been conservatively mapped to include all areas either where Swamp mahogany is present in the overstorey, or where sedges are common to dominant in the ground layer. This type was sampled by Quadrat 1.

The intermediate community with grassy ground layer vegetation could be classified as the Biometric vegetation type '*Smooth-barked Apple heathy open forest on sands of the North Coast*' and is indicative of drier and less fertile soil conditions than the adjoining swamp sclerophyll forest. Because of its small occurrence and transitional nature it has not been mapped separately, but included in the Scribbly gum community. It was sampled by Quadrat 2.

A flora inventory and quadrat data for the sampled quadrats are appended to this report.

Consideration of the requirements of Final Determination

The Final Determination listing SSF as an EEC refers to geographic, topographic, floristic and edaphic (soil) factors to indicate whether or not a vegetation community is part of the EEC SSF.

The subject site is located within Nambucca Shire, which is one of the known locations of the EEC SSF and the subject site therefore meets the geographic criteria. The other criteria are considered for each individual quadrat below.

Quadrat 1 – Swamp Mahogany Swamp Forest

Floristic criteria

The Determination (Paragraph 4) lists the most widespread and abundant dominant trees as being Swamp mahogany and Broadleaved paperbark *Melaleuca quinquenervia*. The dominant trees in Quadrat 1 are Swamp mahogany and Smooth-barked apple; Broadleaved paperbark does occur but only as young specimens and at low levels of cover. Smooth-barked apple is not recorded in the Determination or in Keith & Scott (2005) as occurring in the EEC SSF.

The Determination lists other trees that may be scattered throughout the EEC at low abundance or locally common at few sites including *Callistemon salignus* (Willow bottlebrush), *Casuarina glauca* (Swamp oak) and *Eucalyptus resinifera subsp. hemilampra* (Red mahogany), *Livistona australis* (Cabbage palm) and *Lophostemon suaveolens* (Swamp turpentine). Of these, only Willow bottle brush occurs in the quadrat.

The Determination lists groundcover of the EEC as composed of abundant sedges, ferns, forbs, and grasses including *Gahnia clarkei*, which is dominant in the quadrat, *Hypolepis muelleri*, which is common in the quadrat, and a few other species that are either absent from the quadrat or rare. Of the three vines listed as occurring in the EEC only one, *Parsonsia straminea*, occurs in the quadrat.

With the exception of the occurrence and co-dominance of Smoothbarked apple, which is an indication of atypical conditions, the flora of Quadrat 1 meets the floristic criteria for consideration as the EEC SSF.

Topographic criteria

The topographic criteria listed in Paragraph 1 of the determination are that the EEC occurs on alluvial flats and drainage lines associated with coastal floodplains, generally 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.

According to the material in RGS, the Macksville and Nambucca 1:100,000 soil landscape mapping indicates Quadrat 1 occurs on the Bowra Creek Transferral Landscape rather than on an alluvial soil landscape. Transferral soil landscapes are formed by deposits of mostly eroded parent materials washed from areas directly upslope, not by deposition along rivers and streams as in an alluvial soil landscape. They may however include 'valley flats', which may be considered to be miniature alluvial plain landforms (McDonald *et al* 2009) and are too small to be mapped at 1:100,000 scale.

The 1:25,000 geomorphological mapping (Troedson *et al* 2004) does not support the existence of alluvial flats in the study area. It maps the study area as occurring on bedrock geology, except for a narrow finger of Quaternary Valley Fill that comprises silt, clay, fluvial sand and gravel that extends only to within 60 metres east of Quadrat 1.

There is no drainage line, as in the course of a stream with defined bed and banks, in the study area, but a broad drainage depression exists and it is located some 40 or 50 metres north of the position shown on the topographic map.

Given the limitations of the soil and geomorphology mapping it is possible that that Quadrat 1 meets the topographic criteria as listed in the Determination.

Edaphic criteria

The Determination describes the soils as humic clay loams and sandy loams that are waterlogged or periodically inundated (Paragraph 1), stained black or dark grey with humus (Paragraph 6).

The RTS soil report categorises the soil at RP7, within Quadrat 1, as containing silty clay of alluvial origin and clearly shows soil stained dark grey with humus (photograph on page 5). The soil was not waterlogged but may have been periodically inundated.

It therefore seems to be a reasonable possibility that soil of Quadrat 1 meets the edaphic criteria of the Determination.

Quadrat 2 – Scribbly gum dry open forest

Floristic criteria

The most widespread and abundant dominant trees as listed in the determination are neither abundant or dominant in Quadrat 2; Swamp mahogany does not occur and Broadleaved paperbark occurs in the understorey as small young trees and at low levels of cover. The dominant trees in Quadrat 2 are Smooth-barked apple and Red mahogany *E. resinifera*. Smooth-barked apple is not recorded in the Determination or Keith & Scott (2005) as occurring in the EEC SSF, and Red mahogany is reported as 'scattered throughout at low abundance or locally common at few sites'. Red mahogany is also common in other vegetation communities

Blackbutt, which occurs in the quadrat and adjoining areas, is also not recorded in the Determination or in Keith & Scott (2005) as occurring in any floodplain EEC; its presence is most uncharacteristic of

floodplain assemblages as it is known to be intolerant of waterlogging

(http://www.dpi.nsw.gov.au/_data/assets/pdf_file/0008/356084/Eucalyptus-pilularis.pdf, page 4).

Other trees uncharacteristic of the EEC SSF occurring in Quadrat 2 include Pink Bloodwood *Corymbia intermedia* and *Acacia binervata*.

The understorey in the quadrat also contains a number of species not characteristic of the EEC SSF but rather of heathy vegetation on poorer soils, including *Hibbertia aspera*, *Ischaemum australe* and *Pultenaea retusa*. None of the vines listed as occurring in SSF occur in the quadrat, but the vine *Billardiera scandens* does. Sedges, which are abundant in the EEC SSF, are very rare in the quadrat. In total, eleven of the 32 species occurring in Quadrat 2 are not listed as occurring in the EEC SSF. The dominant ground layer species in the quadrat, Kangaroo grass *Themeda australis*, is recorded as occurring in the EEC SSF where there is an influence of lithic substrates upslope or on clay loam soils, but not as a dominant, whereas it is a very common dominant in dry forests, especially where they have not been continuously grazed.

Because of the frequent occurrence and dominance of species that are not recorded as occurring in the EEC SSF the flora of Quadrat 2 is unlikely to meet the floristic requirements for consideration as the EEC.

Topographic criteria

The presence of an alluvial flat is not indicated by either the local topography, which is clearly sloping, or indicated by the geomorphological mapping. In the vicinity of Quadrat 2 the broad drainage depression some 40 or 50 metres north of Quadrat 1 has been filled for sporting fields and replaced by a drain at the foot of the fill slope. I therefore consider that Quadrat 2 is unlikely to meet the topographic criteria as listed in the Determination.

Edaphic criteria

The RTS soil report categorises the soil at RP5, within Quadrat 2, as alluvial silty clay but it is not stained dark grey with humus (photograph on page 5), nor was it waterlogged. Because of this, the slope and the elevation above the drain it is unlikely to have been periodically inundated. It is therefore unlikely that soil of Quadrat 2 meets the edaphic criteria of the Determination.

Do the Quadrats meet the requirements of Final Determination?

Given that Quadrat 1 meets the geographic and floristic requirements of the Determination and the reasonable possibility that it also meets the topographic and edaphic criteria, the vegetation in Quadrat 1 should be considered to be part of the EEC SSF.

While the presence of Smooth-barked apple is inconsistent with the floristic requirements the vegetation in Quadrat 1 could be considered as transitional to the EEC and would therefore be included with the area of vegetation to the west of Quadrat 1, which clearly does meet the floristic criteria for the EEC SSF.

The boundaries of the EEC are shown in Figure 2. They may extend beyond the study area to the north and west. To the south the outer boundary was determined by the occurrence of Swamp mahogany and/or a ground layer with *Gahnia clarkei*; beyond this the forest was dominated by tallwood, a species not recorded in the EEC SSF, with an understorey of Kangaroo grass.

To the east, the frequent occurrence and dominance of species that are not recorded as occurring in the EEC SSF indicates that Quadrat 2 is unlikely to meet the floristic requirements. Similarly, it is unlikely to meet the topographic or edaphic criteria. Quadrat 2 is therefore considered to be transitional to the Scribbly gum community which occupies the remainder of the study area and is not part of the EEC SSF.

Assessment of impacts – the 7-part test

Type and extent of impacts of the proposal

The area of the EEC SSF that would potentially be affected by the proposed clearing on the subject property is estimated as 0.15ha; a further 0.19ha of the adjoining property adjoining the northern boundary of the subject property would be cleared in a strip 21m wide for an APZ and to properly connect the development to the existing drainage line. The total area of the community in the study area is 0.60ha. These estimates assume that the property boundary coincides with a remnant fenceline of star pickets crossing the study area in more or less the position indicated by the property boundary on the topographic map and on the Nearmap imagery.

No indirect or off-site impacts are considered likely.

TSC Act - Assessment of Significance

The TSC Act Assessment of Significance (i.e. the 7-part Test) outlines factors to be considered when determining whether an action, development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats.

The subject 'species' for the 7-part test is the endangered ecological community *Swamp sclerophyll forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* (EEC SSF).

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality

0.34ha of a total of 0.60ha of swamp sclerophyll forest in the study area would be removed by the proposal.

The location and nature of the proposal is such that habitat for the community would not become fragmented or isolated from other areas of habitat.

The habitat to be removed is very similar to the habitat to be retained. SSF in the study area occupies a niche in which plant species are adapted to their environment and appear to have been robust to the disturbances that have occurred since settlement. The proposal is therefore unlikely to be important to the long-term survival of the ecological community in the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)

Part (e) does not apply as critical habitat as listed under the TSC Act does not occur in the study area or locality.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Recovery plans or threat abatement plans have not been prepared for the EEC SSF. OEH is currently developing a targeted approach for managing Ecological Communities under the Saving our Species program. In the interim, the following management actions are proposed for this community (<http://www.environment.nsw.gov.au/savingourspeciesapp/>):

- Undertake research to determine minimum fire frequency.
- Collate existing information on vegetation mapping and associated data for this EEC and identify gaps in knowledge. Conduct targeted field surveys and ground truthing to fill data gaps and clarify condition of remnants.
- Prepare identification and impact assessment guidelines and distribute to consent and determining authorities.
- Use mechanisms such as Voluntary Conservation Agreements to promote the protection of this EEC on private land.
- Liaise with landholders and undertake and promote programs that ameliorate threats such as grazing and human disturbance.
- Enhance the capacity of persons involved in the assessment of impacts on this EEC to ensure the best informed decisions are made.
- Identify and prioritise other specific threats and undertake appropriate on-ground site management strategies where required.
- Undertake weed control for Bitou Bush and Boneseed at priority sites in accordance with the approved Threat Abatement Plan and associated PAS actions.
- Implement appropriate fire management practices.
- Collect seed for NSW Seedbank. Develop collection program in collaboration with BGT - all known provenances (conservation collection).
- Investigate seed viability, germination, dormancy and longevity (in natural environment and in storage).

To be consistent with these actions would require that the proposal undertake one or more of these actions in the area of SSF to be retained.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

The proposed activity includes the key threatening process (KTP) 'Native vegetation clearance'.

As no threat abatement plans have yet been prepared by the NSW National Parks and Wildlife Service, it is not possible to review the proposed activity in light of the plans.

Notwithstanding this, these key threatening processes may be considered in a generic sense *ie*: is the proposal likely to have a significant effect on threatened species, populations or ecological communities, or their habitats, and in particular, would it:

- cause fragmentation of ecological communities;
- reduce the viability of ecological communities by disrupting ecological functions;
- result in the destruction of habitat and loss of biological diversity; and
- lead to soil and bank erosion or riparian zone degradation.

Based on this assessment it is considered that the proposal would not be likely to fragment ecological communities, disrupt ecological functions, destroy habitat or lead to erosion and would not therefore be likely to increase the impact of the key threatening process.

Conclusions & Recommendations

It is concluded from the consideration of the TSC 7-part Test that the proposal would be unlikely to have a significant impact on threatened ecological communities, or their habitat. A Species Impact Statement is not recommended.

In order to be consistent with the management actions for the EEC SSF it is recommended that a vegetation management plan be prepared to identify and prioritise specific threats to the SSF to be retained and to recommend appropriate actions to avoid or minimise those threats..

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Flora inventory

	Cover/abundance		Frequency of occurrence
Scientific name	Quadrat 1	Quadrat 2	SSF EEC
<i>Acacia binervata</i>		2	Not recorded for SSF
<i>Acacia irrorata</i>	3	1	occasional small tree
<i>Acacia longifolia</i>	3	3	common shrub
<i>Acmena smithii</i>			occasional small tree
<i>Adiantum aethiopicum</i>			may occur
<i>Allocasuarina littoralis</i>			rare, lithic influence
<i>Angophora costata</i>	3	3	Not recorded for SSF
<i>Banksia oblongifolia</i>			rare, lithic influence
<i>Banksia spinulosa</i>			rare, lithic influence
<i>Baumea articulata</i>			may occur
<i>Baumea juncea</i>			may occur
<i>Billardiera scandens</i>		1	Not recorded for SSF
<i>Blechnum camfieldii</i>			may occur
<i>Blechnum indicum</i>			may occur
<i>Breynia oblongifolia</i>	2	1	may occur
<i>Callicoma serratifolia</i>		1	Not recorded for SSF
<i>Callistemon salignus</i>	2	2	occasional tree
<i>Calochlaena dubia</i>		2	common ground layer
<i>Carex appressa</i>			may occur
<i>Casuarina glauca</i>			occasional tree
<i>Centella asiatica</i>			may occur
<i>Cordyline stricta</i>	2		Not recorded for SSF
<i>Corymbia intermedia</i>		1	Not recorded for SSF
<i>Dianella caerulea</i>		2	common ground layer
<i>Dodonaea triquetra</i>	2	2	occasional shrub
<i>Elaeocarpus reticulatus</i>	1		occasional small tree
<i>Entolasia marginata</i>			common ground layer
<i>Entolasia stricta</i>	2	2	may occur
<i>Eucalyptus botryoides</i>			occasional tree
<i>Eucalyptus longifolia</i>			occasional tree
<i>Eucalyptus pilularis</i>		1	Not recorded for SSF
<i>Eucalyptus resinifera</i>		3	occasional tree
<i>Eucalyptus robusta</i>	3		characteristic dominant
<i>Eustrephus latifolius</i>		1	Not recorded for SSF
<i>Ficus coronata</i>			occasional shrub
<i>Gahnia clarkei</i>	5	1	common ground layer
<i>Gahnia sieberiana</i>			may occur
<i>Glochidion ferdinandi</i>	2	2	common small tree
<i>Glycine clandestina</i>			may occur
<i>Gonocarpus tetragynus</i>	1	2	may occur
<i>Hibbertia aspera</i>		2	Not recorded for SSF
<i>Hydrocotyle peduncularis</i>			may occur
<i>Hypolepis muelleri</i>	2		common ground layer
<i>Imperata cylindrica</i>	1	2	common ground layer
<i>Isachne globosa</i>			may occur
<i>Ischaemum australe</i>		3	Not recorded for SSF
<i>Leptospermum polygalifolium</i>		1	occasional shrub
<i>Livistona australis</i>			occasional tree
<i>Lomandra longifolia</i>		2	common ground layer
<i>Lophostemon suaveolens</i>	2	1	occasional tree
<i>Melaleuca ericifolia</i>			occasional shrub

<i>Melaleuca linariifolia</i>			occasional small tree
<i>Melaleuca quinquenervia</i>	2	2	characteristic dominant
<i>Melaleuca sieberi</i>			occasional shrub
<i>Melaleuca styphelioides</i>	1		occasional small tree
<i>Melastoma affine</i>	2		Not recorded for SSF
<i>Morinda jasminoides</i>			common vine
<i>Omalanthus populifolius</i>			may occur
<i>Oplismenus aemulus</i>			may occur
<i>Oplismenus imbecillis</i>	2		may occur
<i>Parsonia straminea</i>	1		common vine
<i>Persoonia sp</i>		1	Not recorded for SSF
<i>Phragmites australis</i>			may occur
<i>Pimelea linifolia</i>		1	Not recorded for SSF
<i>Polyscias sambucifolia</i>		1	may occur
<i>Pomax umbellata</i>	1		Not recorded for SSF
<i>Pratia purpurascens</i>			may occur
<i>Pteridium esculentum</i>	2	1	common ground layer
<i>Pultenaea retusa</i>		2	Not recorded for SSF
<i>Stephania japonica</i>			common vine
<i>Themeda australis</i>		5	rare, lithic influence
<i>Villarsia exaltata</i>			may occur
<i>Viola banksii</i>			may occur
<i>Viola hederacea</i>			may occur

Cover abundance: 1: <5% cover, uncommon; 2: <5% cover, common; 3: 5-<25% cover; 4: 25-<50% cover; 5: 50-<75% cover.

Quadrat data

Plot	MGA coordinates	Stratum	Height	Cover	Dominant species
1	56 497740 6608758	t	20m	15%	<i>Eucalyptus robusta</i> , <i>Angophora costata</i>
		m	8m	50%	<i>Acacia spp</i> , <i>eucalyptus</i> , <i>angophora</i> saplings
		g	1m	70%	<i>Gahnia clarkei</i>
2	56 497763 6608761	t	20m	25%	<i>Eucalyptus resinifera</i> , <i>Angophora costata</i>
		m	6m	30%	<i>Acacia spp</i>
		g	0.6m	70%	<i>Themeda australis</i> , <i>Ischaemum australe</i>

Photographs



Photo 1. Quadrat 1



Photo 2. Quadrat 2

RGS30982.1-AB

29 August 2016

de Groot & Benson
236 Harbour Drive
COFFS HARBOUR NSW 2450

Attention: Rob de Groot

Dear Rob,

RE: Proposed Residential Subdivision – Bellwood Road, Nambucca Heads
Geotechnical Assessment

1 INTRODUCTION

As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment of the upper soil profiles along the northwest edge of a residential subdivision that is proposed at Bellwood Road, Nambucca Heads (Lot 1 DP1119830).

The purpose of the work described herein was to assess the origin of the soils present in the upper soil profile along the northwest edge of the site. The presence of alluvial or colluvial soils is a factor in the determination of the ecological communities present at the site.

2 FIELD WORK

Field work for the assessment was undertaken 22 August 2016 and was based on the supplied subdivision plan (drawing No. 91111-DA-211, Amendment F, by de Groot & Benson) that showed the approximate extent of both Quaternary soils and tall open swamp sclerophyll forest based on previous large scale published mapping. Fieldwork included:

- Observation of site features and surrounding features relevant to the geotechnical conditions of the site; and
- Excavation of seven test pits (TP1 to TP7) with a four tonne excavator within the areas identified during the previous mapping.



The test pits were logged by an experienced Geotechnical Engineer. Test pit locations are shown on the attached Figure 1 and were measured with a hand held GPS. Engineering logs of the test pits are also attached.

3 SITE CONDITIONS

3.1 Surface Conditions

The site is bound by Marshal Way and Summer Place to the northeast, the Bellwood Road corridor to the southeast and south, bushland to the west, and by Farringdon Playing Fields to the northwest.

An aerial photograph showing the site location and setting is reproduced below.



Site location, Lot 1 DP1119830, as shown on the NSW DPI 'Six Viewer'

The site is located within a region characterised by gently to moderately undulating residual slopes and ridgelines, and broad alluvial gullies. Surface elevations range from around RL28m AHD in the southeast of the site to RL4m in the northwest. The site generally slopes down to the northwest, north and west at between about 4 to 6° with the lower lying area in the northwest of the site grading down to the northwest at between 1 and 2° towards a broad drainage depression/gully on the neighbouring property to the northwest. Surface slopes are generally convex in plan.

The area of the site covered by the assessment is along the northwest edge of the site which is characterised by gently sloping terrain at the foot slopes of a broad hillside.

To the northwest of the site are the Farringdon Playing Fields which have been constructed by cut to fill earthworks, with a cut up to about 1.8m high being present on the northwest boundary of Lots 1 to 7. The fields are at or near grade to the northwest of Lots 8 and 9 (i.e. to the northwest of TP3) and raised on fill that increases in height to about 1m towards the southwest corner of Lot 11.



The site is generally vegetated with native regrowth saplings that are between about 2 and 4m in height, and scattered mature native trees.

Typical site photographs are presented below.



3.2 Subsurface Conditions

The Nambucca Heads 1:25,000 Quaternary Geology Map indicates that the northern edge of the site is underlain by Quaternary Valley Fill that comprises silt, clay, fluvial sand and gravel. The 1:250,000 Dorrigo-Coffs Harbour Geology Map indicates that underlying the valley fill and over the remainder of the site are residual soils derived from the Nambucca Beds which comprise slate, phyllite, schistose, sandstone, conglomerate and basic volcanics.

The Macksville and Nambucca 1:100,000 soil landscape sheet indicates that the majority of the site belongs to the Newry Erosional/Residual Landscape which includes undulating rises and low hills on the metasediments of the Nambucca Beds. Along the northwest edge of the site and to the northwest of the site belongs to the Bowra Creek Transferal Landscapes which includes narrow,



often slightly convex alluvial fans and footslopes grading to open-depressions below erosional landscape on the Nambucca Beds.

The investigation encountered a variable soil profile as summarised in Table 1. Further details are presented on the attached engineering logs.

Table 1: Summary of Subsurface Conditions

Material Unit	Material Description	Depth to Base of Material Layer (m)						
		TP1	TP2	TP3	TP4	TP5	TP6	TP7
Topsoil	Clayey SILT, low plasticity, dark brown to dark grey, traces of fine sand	0.3	0.25	--	0.05	0.1	--	0.15
Alluvial Soil	Silty CLAY, medium plasticity, grey-brown with slight orange mottle	--	--	--	--	0.7	--	0.7
Colluvial Soil	Clayey SILT, low plasticity, pale grey and grey	--	0.4	--	--	--	0.3	--
Residual Soil - A	Clayey SILT, low plasticity, yellow-brown, traces of quartz gravel	0.6	0.6	--	0.45	--	--	--
Residual Soil - B	CLAY and Silty CLAY, medium to high plasticity, grey and yellow-brown mottled dark orange	≥ 0.9	≥ 0.8	≥ 0.7	≥ 0.7	≥ 0.8	≥ 0.6	≥ 0.9

Notes: -- indicates that the material was not encountered at the test location
 ≥ indicates that the base of the material was not encountered

The geotechnical units summarised above were defined taking into consideration the following:

- Alluvium: The general term for detrital deposits made by rivers or streams or found on alluvial fans, floodplains etc. – Collins Geology Dictionary;
- Colluvium: Unconsolidated material at the bottom of a cliff or slope, generally moved by gravity alone. It lacks stratification and is usually unsorted – Collins Geology Dictionary;
- Transferral Soil Landscapes: Alluvial and colluvial material deposited at the foot of hill slopes – Soil Landscapes of the Macksville and Nambucca 1:100,000 Sheets; and
- Residual: Weathered insitu soils derived from pre-existing rocks – Collins Geology Dictionary

Groundwater was not encountered, however a noticeably higher moisture content was observed within the alluvial soils encountered in TP5 and TP7 when compared to the residual soils. It should be noted that fluctuations in groundwater levels can occur as a result of seasonal variations, temperature, rainfall and other similar factors, the influence of which may not have been apparent at the time of the assessment.

Selected images of excavated profiles that illustrate the subsurface profiles encountered are presented below.



TP2 showing 0.25m of topsoil, overlying 0.15m of colluvial soil over residual soil



TP4 showing 0.05m of topsoil overlying residual soil



TP5 showing 0.1m of topsoil over 0.6m of alluvial silty clay



TP7 showing 0.15m of topsoil over 0.55m of alluvial silty clay

4 DISCUSSION

Test pits were excavated with a 4 tonne excavator along the northwest edge of Lot 1 DP1119830 to assess the extent of alluvial soils. Published Quaternary and soil landscape mapping indicates that alluvial and colluvial soils may be present in this area of the site.

The subsurface profiles encountered comprised soils of the following origins:

- Alluvial deposits at toe of hill associated with a poorly defined drainage line/depression;
- Colluvial silt deposits on the footslopes of the residual hillside; and
- Residual silt and clay soils present on the residual slopes.

The inferred extent of the alluvial soils based on the investigation is shown on Figure 1 and is typically present where surface levels are at or below RL4m.



Based on the results of the assessment it is inferred that the potential quaternary profile illustrated on the supplied drawing is inferred to be located to the north of the position shown, predominantly on the neighbouring property.

5 LIMITATIONS

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the material present. Under no circumstances, however, can it be considered that these findings represent the actual state of the material at all locations. If materials encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

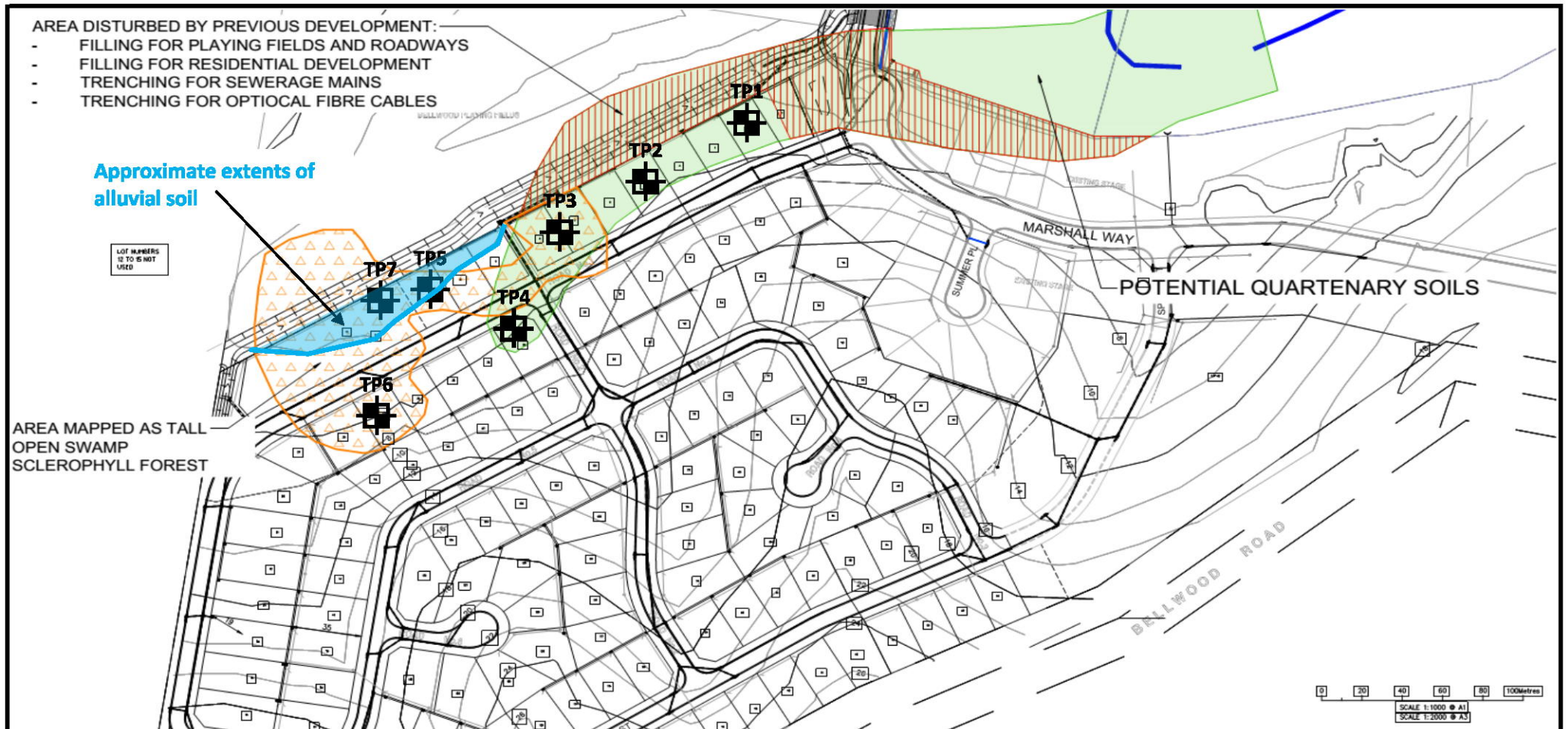
For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Simon Keen

Geotechnical Engineer

Attached: Figure 1
 Engineering Logs



Based on drawing 91111-DA-211, Ammendment F by de Groot & Benson Pty Ltd

	Client:	de Groot & Benson	Job No.	RGS30982.1
	Project:	Proposed Residential Subdivision	Drawn By:	SK
		Bellwood Road, Nambucca Heads	Scale:	As Shown
	Title:	Test Location Plan	Date:	23-Aug-16
			Drawing No.	Figure 1



ENGINEERING LOG - TEST PIT

CLIENT: de Groot & Benson
PROJECT NAME: Proposed Residential Subdivision
SITE LOCATION: Bellwood Road, Nambucca Heads
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP1
PAGE: 1 of 1
JOB NO: RGS30982.1
LOGGED BY: SK
DATE: 22/8/16

EQUIPMENT TYPE: Hitachi 46 Excavator **EASTING:** 497920 m **SURFACE RL:** Not Measured m
TEST PIT LENGTH: 1.9 m **WIDTH:** 0.5 m **NORTHING:** 6608855 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm Toothed Bucket	Not Encountered			0.5		ML	TOPSOIL: Clayey SILT, low plasticity, dark brown to dark grey, trace fine grained sand	M < w _p		HP	280	TOPSOIL
						ML	Clayey SILT: Low plasticity, yellow-brown, traces quartz gravel	M > w _p	VSt			RESIDUAL SOIL
						CH	CLAY: Medium to high plasticity, grey mottled dark red-orange, traces fine to medium quartz gravel	M > w _p	VSt			
				1.0			Hole Terminated at 0.90 m					
				1.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Frable			
		DCP(x-y) Dynamic penetrometer test (test depth Interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	



ENGINEERING LOG - TEST PIT

CLIENT: de Groot & Benson
PROJECT NAME: Proposed Residential Subdivision
SITE LOCATION: Bellwood Road, Nambucca Heads
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP2
PAGE: 1 of 1
JOB NO: RGS30982.1
LOGGED BY: SK
DATE: 22/8/16

EQUIPMENT TYPE: Hitachi 46 Excavator **EASTING:** 497869 m **SURFACE RL:** Not Measured m
TEST PIT LENGTH: 1.9 m **WIDTH:** 0.5 m **NORTHING:** 6608823 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm Toothed Bucket	Not Encountered			0.25m		ML	TOPSOIL: Clayey SILT, low plasticity, dark brown	M > w _p				TOPSOIL
						ML	Clayey SILT: Low plasticity, pale grey mottled grey	M < w _p	VSt			COLLUVIAL SOIL
						ML	Clayey SILT: Low plasticity, pale grey mottled yellow-brown	M > w _p	VSt			RESIDUAL SOIL
						CH	Silty CLAY: Medium to high plasticity, yellow-orange mottled dark orange	M > w _p	VSt			
				0.80m			Hole Terminated at 0.80 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Frable			
		DCP(x-y) Dynamic penetrometer test (test depth Interval shown)		Density		V	Very Loose	Density Index <15%
		HP Hand Penetrometer test (UCS kPa)		L		L	Loose	Density Index 15 - 35%
				MD		MD	Medium Dense	Density Index 35 - 65%
				D		D	Dense	Density Index 65 - 85%
				VD		VD	Very Dense	Density Index 85 - 100%

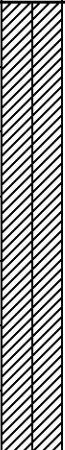


ENGINEERING LOG - TEST PIT

CLIENT: de Groot & Benson
PROJECT NAME: Proposed Residential Subdivision
SITE LOCATION: Bellwood Road, Nambucca Heads
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP3
PAGE: 1 of 1
JOB NO: RGS30982.1
LOGGED BY: SK
DATE: 22/8/16

EQUIPMENT TYPE: Hitachi 46 Excavator **EASTING:** 497823 m **SURFACE RL:** Not Measured m
TEST PIT LENGTH: 1.9 m **WIDTH:** 0.5 m **NORTHING:** 6608795 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm Toothed Bucket	Not Encountered			0.5		CL	Silty CLAY: Medium plasticity, pale brown to yellow-brown, traces fine to medium subangular quartz, traces charcoal fragments associated with tree roots	M < w _p	VSt / Fb			RESIDUAL SOIL
				1.0			Hole Terminated at 0.70 m					
				1.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀	50mm Diameter tube sample	VS	Very Soft	<25	D	Dry
	Water Level (Date and time shown)	CBR	Bulk sample for CBR testing	S	Soft	25 - 50	M	Moist
	Water Inflow	E	Environmental sample	F	Firm	50 - 100	W	Wet
	Water Outflow	ASS	Acid Sulfate Soil Sample	St	Stiff	100 - 200	W _p	Plastic Limit
Strata Changes		B	Bulk Sample	VSt	Very Stiff	200 - 400	W _L	Liquid Limit
		Field Tests		H	Hard	>400	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%	
		PID	Photoionisation detector reading (ppm)	Fb	Friable			
		DCP(x-y)	Dynamic penetrometer test (test depth Interval shown)	Density		V	Very Loose	
		HP	Hand Penetrometer test (UCS kPa)			L	Loose	
						MD	Medium Dense	
						D	Dense	
						VD	Very Dense	



ENGINEERING LOG - TEST PIT

CLIENT: de Groot & Benson
PROJECT NAME: Proposed Residential Subdivision
SITE LOCATION: Bellwood Road, Nambucca Heads
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP4
PAGE: 1 of 1
JOB NO: RGS30982.1
LOGGED BY: SK
DATE: 22/8/16

EQUIPMENT TYPE: Hitachi 46 Excavator **EASTING:** 497803 m **SURFACE RL:** Not Measured m
TEST PIT LENGTH: 1.9 m **WIDTH:** 0.5 m **NORTHING:** 6608746 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm Toothed Bucket	Not Encountered					ML	0.05m TOPSOIL: Clayey SILT, low plasticity, dark brown	w_p				TOPSOIL
						ML	Clayey SILT: Low plasticity, grey to pale grey mottled pale brown and orange-brown, traces of fine to medium quartz	$M < M_p$	VSt			RESIDUAL SOIL
						CL	0.45m Silty CLAY: Medium plasticity, yellow-brown mottled orange-brown, traces fine to coarse quartz gravel	$M > w_p$	VSt			
							0.70m Hole Terminated at 0.70 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Frable			
		DCP(x-y) Dynamic penetrometer test (test depth Interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	



ENGINEERING LOG - TEST PIT

CLIENT: de Groot & Benson
PROJECT NAME: Proposed Residential Subdivision
SITE LOCATION: Bellwood Road, Nambucca Heads
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP5
PAGE: 1 of 1
JOB NO: RGS30982.1
LOGGED BY: SK
DATE: 22/8/16

EQUIPMENT TYPE: Hitachi 46 Excavator **EASTING:** 497761 m **SURFACE RL:** Not Measured m
TEST PIT LENGTH: 1.9 m **WIDTH:** 0.5 m **NORTHING:** 6608762 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm Toothed Bucket	Not Encountered					ML	TOPSOIL: Clayey SILT, low plasticity, dark brown	M > w _p				TOPSOIL
		0.20m				CL	Silty CLAY: Medium plasticity, grey-brown with slight orange-brown mottle	M > w _p	F - St	HP	60	ALLUVIAL SOIL
		D										
		0.30m										
				0.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)		Moisture Condition	
Water		U ₅₀ 50mm Diameter tube sample		VS	Very Soft	<25		D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50		M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100		W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200		w _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400		w _L	Liquid Limit
Gradational or transitional strata		Field Tests		H	Hard	>400			
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Frable				
		DCP(x-y) Dynamic penetrometer test (test depth Interval shown)		Density	V	Very Loose	Density Index <15%		
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%		
					MD	Medium Dense	Density Index 35 - 65%		
					D	Dense	Density Index 65 - 85%		
					VD	Very Dense	Density Index 85 - 100%		



ENGINEERING LOG - TEST PIT

CLIENT: de Groot & Benson
PROJECT NAME: Proposed Residential Subdivision
SITE LOCATION: Bellwood Road, Nambucca Heads
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP6
PAGE: 1 of 1
JOB NO: RGS30982.1
LOGGED BY: SK
DATE: 22/8/16

EQUIPMENT TYPE: Hitachi 46 Excavator **EASTING:** 497731 m **SURFACE RL:** Not Measured m
TEST PIT LENGTH: 1.9 m **WIDTH:** 0.5 m **NORTHING:** 6608694 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm Toothed Bucket	Not Encountered					ML	Clayey SILT: Low plasticity, pale grey to grey	M < w _p	H / Fb			COLLUVIAL SOIL
						CL	Silty CLAY: Medium plasticity, grey-brown mottled yellow-brown	M < w _p	H / Fb			RESIDUAL SOIL
							Hole Terminated at 0.60 m					

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	W _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	W _L	Liquid Limit
Gradational or transitional strata		Field Tests		H	Hard	>400		
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Frable			
		DCP(x-y) Dynamic penetrometer test (test depth Interval shown)		Density	V	Very Loose	Density Index <15%	
		HP Hand Penetrometer test (UCS kPa)			L	Loose	Density Index 15 - 35%	
					MD	Medium Dense	Density Index 35 - 65%	
					D	Dense	Density Index 65 - 85%	
					VD	Very Dense	Density Index 85 - 100%	

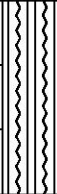


ENGINEERING LOG - TEST PIT

CLIENT: de Groot & Benson
PROJECT NAME: Proposed Residential Subdivision
SITE LOCATION: Bellwood Road, Nambucca Heads
TEST LOCATION: Refer to Figure 1

TEST PIT NO: TP7
PAGE: 1 of 1
JOB NO: RGS30982.1
LOGGED BY: SK
DATE: 22/8/16

EQUIPMENT TYPE: Hitachi 46 Excavator **EASTING:** 497740 m **SURFACE RL:** Not Measured m
TEST PIT LENGTH: 1.9 m **WIDTH:** 0.5 m **NORTHING:** 6608761 m **DATUM:** AHD

Drilling and Sampling					Material description and profile information					Field Test		Structure and additional observations
METHOD	WATER	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MATERIAL DESCRIPTION: Soil type, plasticity/particle characteristics, colour, minor components	MOISTURE CONDITION	CONSISTENCY DENSITY	Test Type	Result	
450mm Toothed Bucket	Not Encountered					CL	TOPSOIL: Silty CLAY, low plasticity, orange-brown					TOPSOIL
		0.40m				CL	Silty CLAY: Medium plasticity, pale brown to grey-brown, with very slight yellow-brown mottle increasing with depth	M > w _r	St			ALLUVIAL SOIL
		D	0.5									
		0.60m										
							Silty CLAY: Medium to high plasticity, yellow-brown	M > w _r	VSt			RESIDUAL SOIL
				1.0			Hole Terminated at 0.90 m					
				1.5								

LEGEND:		Notes, Samples and Tests		Consistency		UCS (kPa)	Moisture Condition	
Water		U ₅₀ 50mm Diameter tube sample		VS	Very Soft	<25	D	Dry
Water Level (Date and time shown)		CBR Bulk sample for CBR testing		S	Soft	25 - 50	M	Moist
Water Inflow		E Environmental sample		F	Firm	50 - 100	W	Wet
Water Outflow		ASS Acid Sulfate Soil Sample		St	Stiff	100 - 200	w _p	Plastic Limit
Strata Changes		B Bulk Sample		VSt	Very Stiff	200 - 400	w _L	Liquid Limit
Gradational or transitional strata		Field Tests		H	Hard	>400	Density Index <15% Density Index 15 - 35% Density Index 35 - 65% Density Index 65 - 85% Density Index 85 - 100%	
Definitive or distinct strata change		PID Photoionisation detector reading (ppm)		Fb	Frable			
		DCP(x-y) Dynamic penetrometer test (test depth Interval shown)		Density	V	Very Loose		
		HP Hand Penetrometer test (UCS kPa)			L	Loose		
					MD	Medium Dense		
					D	Dense		
					VD	Very Dense		