Vegetation Management Plan

Lot 47 DP751395 Miles Street Yamba

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Prepared for: Garrard Building Pty Ltd

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3041-1108	Third issue	21/07/2023	DGH

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1. Site Description

1.1 Introduction and Background

GeoLINK has prepared this Vegetation Management Plan (VMP) on behalf of Garrard Building Pty Ltd with regard to the future subdivision and development of Lots 46 and 47 DP751395 Miles Street, Yamba in the Clarence Valley Local Government Area (LGA). A Development Application has been lodged with Clarence Valley Council (CVC) for development of Lot 46 and part of Lot 47 under SUB 2019/0492. As part of the DA a VMP was prepared for a portion of deemed waterfront land in the southwest corner of the development site to support a Controlled Activity Approval required under the *Water Management Act 2000* (WM Act).

CVC has requested a VMP also be prepared/ submitted for part of Lot 46 to the east of the development site which is identified as a floodway in the *West Yamba Urban Release Area Flood Impact Assessment* (BMT WBM 2018). As part of the proposal the proponent proposes to dedicate this land to Council. Council have requested that: "*the VMP is to include requirements for ongoing maintenance responsibilities for the floodway to ensure:*

a) *The floodway (Lot 903) functions as required,*

b) *Lot 903 is managed as per the requirements below of the Rural Fire Service,*

c) *That environmental conditions are retained to not impact the two threatened flora species that occur at this location.*

It is understood that point b) above has been addressed through recent changes to the subdivision design hence this requirement is not relevant to the preparation of this VMP.

1.2 Expert Review and Input

On request from CVC, the Biodiversity and Conservation Division (BCD) of the Biodiversity, Conservation and Science Directorate in the Environment and Heritage Group of the Department of Planning and Environment have provided advice/ comments on the Biodiversity Development Assessment Report and VMPs prepared for the proposal. In relation to this VMP for Lot 47 they have provided the following comment:

5. The VMPs for both Lots 46 and 47 are to be prepared by an expert in wetland botany and ecology to ensure the most appropriate methods for management of the Rotala habitat are incorporated into the VMPs.

To address this and other comments provided by BCD in relation to Rotala, the proponent engaged Dr Andrew Benwell (ecologist/ botanist) who has experience in providing advice/ managing numerous threatened flora species including Rotala. Dr Benwell's report is included as **Appendix C** with recommended management/ monitoring for Rotala incorporated into this VMP.

1.3 Site Description

The site for the purposes of this VMP comprises part of Lot 47 DP 751295, Miles Street, Yamba associated with the floodway identified in the *West Yamba Urban Release Area Flood Impact Assessment* (BMT WBM 2018). It is noted that a separate VMP for an area of deemed 'waterfront land' has been prepared for part of Lot 46 DP 751295.

The site comprises a low-lying portion of land which has been historically cleared and modified as part of previous agricultural pursuits. This site includes areas of cleared pastureland and areas of regrowth native vegetation. The site has in recent history been subject to cattle grazing. Two dwellings and a dam occur on the site. While estuarine systems occur in close proximity to the site, no estuarine waters enter the site.

Illustration 1.1 shows the locality of the site and **Illustration 1.2** shows the site itself.

1.4 The Proposal

The proposal which has triggered this VMP is for the further filling (20,000m³) and subdivision for residential development of Lot 46 and part of Lot 47. GeoLINK completed a *Biodiversity Development Assessment Report* (BDAR) to support a Statement of Environmental Effects (SEE) for the subdivision application, which was lodged with CVC under SUB 2019/0492.

Since lodgement of the DA, the subdivision concept has been revised and an amended application is in progress. A concept plan is provided at **Appendix A**.

0 1 Km

Locality Plan - Illustration 1.1

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Source of base data: OpenStreet Map
Date: 19/07/2023

GDA 1994 MGA Zone 56

LEGEND

- Site boundary (subject to VMP)
- Development area
- Cadastre
- Watercourse

0 110 Metres

The Site - Illustration 1.2

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Vegetation Management Plan - Lot 47 DP751395 Miles Street Yamba
3041-1086

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Drawn by: AB Checked by: RE Reviewed by: DGH
Source of base data: ESRI World Imagery
Date: 19/07/2023
Revision A

1.5 Biodiversity Values

The following biodiversity values were identified at the site as part of biodiversity studies undertaken by GeoLINK (2019) to support SUB 2019/0492.

1.5.1 Vegetation

Three native vegetation communities occur at the site (refer **Table 1.1**) in varying states of disturbance. Native vegetation at the site is shown at **Illustration 1.3**.

Areas of woody native vegetation are generally in good condition with low levels of woody weeds (minor Winter Senna, Lantana, Camphor Laurel) and few introduced vines or herbs. Lippia (*Phyla nodiflora*) occurs in some parts of paperbark swamp forest (PCT 1064) and sedgeland areas (PCT 780). The introduced herb Cuphea (*Cuphea carthagenensis*) is common within parts of PCT 780.

Sedgeland areas (PCT 780) are highly disturbed from grazing stock and previous landuse (slashing) and host pasture grasses and the introduced herb Cuphea at low densities. Sedgeland areas show high resilience and would be expected to regenerate with ease once cattle are removed from the site.

Table 1.1 Native Vegetation Communities

Plant Community Type	*Comments*	*Area (ha)*
PCT 1064: Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion Dominated by Broad-leaved Paperbark (*Melaleuca quinquenervia*) with occasional Swamp Oak (*Casuarina glauca*). Midstorey sparse. Groundcover of patchy Bare Twigrush (*Baume juncea*). Open wetland areas are dominated by Spike-rush (*Eleocharis acuta*) and Water Spinach (*Enydra woollsii*).	Good condition – some cattle disturbance.	4.53
PCT 1064: Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion Dominated by Narrow-leaved Carpet Grass (*Axonopus fissifolius*), Couch (*Cynodon dactylon*), Blady Grass (*Imperata cyclindrica*) and *Setaria sphacelata*. Scattered regrowth saplings are present to varying extent throughout including Broad-leaved Paperbark, Swamp Box and Swamp Oak.	Occasional regrowth in areas of pasture land	2.6
PCT 837: Forest Red Gum Swamp Box of the Clarence Valley lowlands of the NSW North Coast Open woodland dominated by Pink Bloodwood (*Corymbia intermedia*). Midstorey absent. Groundcover slashed/grazed Blady Grass (*Imperata cylindrica*), pasture grasses.	Highly disturbed and generally lacking a native midstorey.	2.64
PCT 780: Coastal floodplain sedgelands, rushlands, and forblands of the North Coast Disturbed ephemeral wetland (slashed, grazed). Trees and shrubs absent. Typical species: *Baumea articulata*, *Eleocharis acuta, Persicaria strigosa, Philydrum lanuginosum, Ludwigia peploides, Bacopa monnieri*. Cuphea* (*Cuphea carthagenensis*) is a common weed species.	Areas subject to regular slashing as part of current maintenance regime.	1.29
*Introduced species	**Total**	**11.06**

LEGEND

- Site boundary (subject to VMP)
- Development area
- Cadastre
- Dam
- Watercourse
- Non-native vegetation (landscaping)
- PCT 837: Forest Red Gum – Swamp Box of the Clarence Valley lowlands of the NSW North Coast Bioregion (Zone 1)
- PCT 837: Forest Red Gum – Swamp Box of the Clarence Valley lowlands of the NSW North Coast Bioregion (Zone 2)
- PCT 837: Forest Red Gum – Swamp Box of the Clarence Valley lowlands of the NSW North Coast Bioregion (Zone 3)
- PCT 1064: Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (Zone 1)
- PCT 1064: Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (Zone 2)
- PCT 1064: Paperbark swamp forest of the coastal lowlands of the NSW North Coast Bioregion and Sydney Basin Bioregion (Zone 3)
- PCT 1227 Swamp Box swamp forest of the coastal lowlands of the NSW North Coast Bioregion (Zone 1)
- PCT 1227 Swamp Box swamp forest of the coastal lowlands of the NSW North Coast Bioregion (Zone 2)
- PCT 1235: Swamp Oak swamp forest of the coastal lowlands of the NSW North Coast Bioregion
- PCT 780: Coastal floodplain sedgelands, rushlands, and forblands of the North Coast
- Non-native Tree (Mango)
- Planted Native Vegetation (Flame Tree)
- Planted Native Vegetation (Plum Pine)
- Raptor nest
- Stag (no hollows)

0 60 Metres

Vegetation Plan - Illustration 1.3

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Vegetation Management Plan - Lot 47 DP751395 Miles Street Yamba
3041-1087

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Date: 19/07/2023
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1.5.2 Threatened Flora

The following two threatened flora species have been identified on the site:

Rotala (*Rotala tripartita*)

Initial survey of sedgeland areas at Lot 47 detected Rotala almost immediately within disturbed sedgeland (slashed and grazed) dominated by *Baumea rubiginosa*. Samples were sent to the NSW Herbarium for confirmation before proceeding with further targeted survey. Following confirmation, targeted survey was completed of all wetland environments in Lots 46 and 47. Rotala was recorded extensively in Lot 47 where wetland communities are extensive and moist boggy areas with surface water and a high table water were present. Numerous seedlings were observed growing within tractor wheel ruts at some locations, while other plants also occurred in association with the margins of Broad-leaved Paperbark swamp forest. The concentrated population within the north-east of Lot 47 is extensive and significant in a local context. Within Lot 46, sedgeland areas are less well developed, more disturbed and species poor – a single plant was recorded.

As noted, following a hot and dry summer, all Rotala at the site had died, but had flowered and seeded prior to this time, suggesting that future plants are likely to germinate during suitable conditions. The site has been subject to ongoing slashing and grazing for many years (several decades). The fact that a Rotala population has persisted during this time suggests the species has some resilience.

It is suspected that other adjacent nearby allotments may also provide habitat for Rotala where wetland areas occur. Lot 18 DP1090409 and Lot 2 DP790910 (to the north of the site) support wetland and drainage areas and are considered highly likely to support Rotala populations. It is suspected seed from Rotala is dispersed in flood events, through surface water dispersal. Records of Rotala occurring on the site and a species polygon drawn in accordance with the Biodiversity Assessment Method (BAM) requirements are shown in **Illustration 1.4**.

Spider Orchid (*Dendrobium tetragonaum var. melaleucaphilum*)

Initial surveys on Lot 47 identified a population of Spider Orchids growing on Prickly-leaved Tea Trees (*Melaleuca stypheloides*) within Paperbark forest associated with PCT 1064. No Spider Orchids were detected on Lot 46. Records of Spider Orchid occurring on the site and a species polygon drawn in accordance with the Biodiversity Assessment Method (BAM) requirements are shown in **Illustration 1.4**.

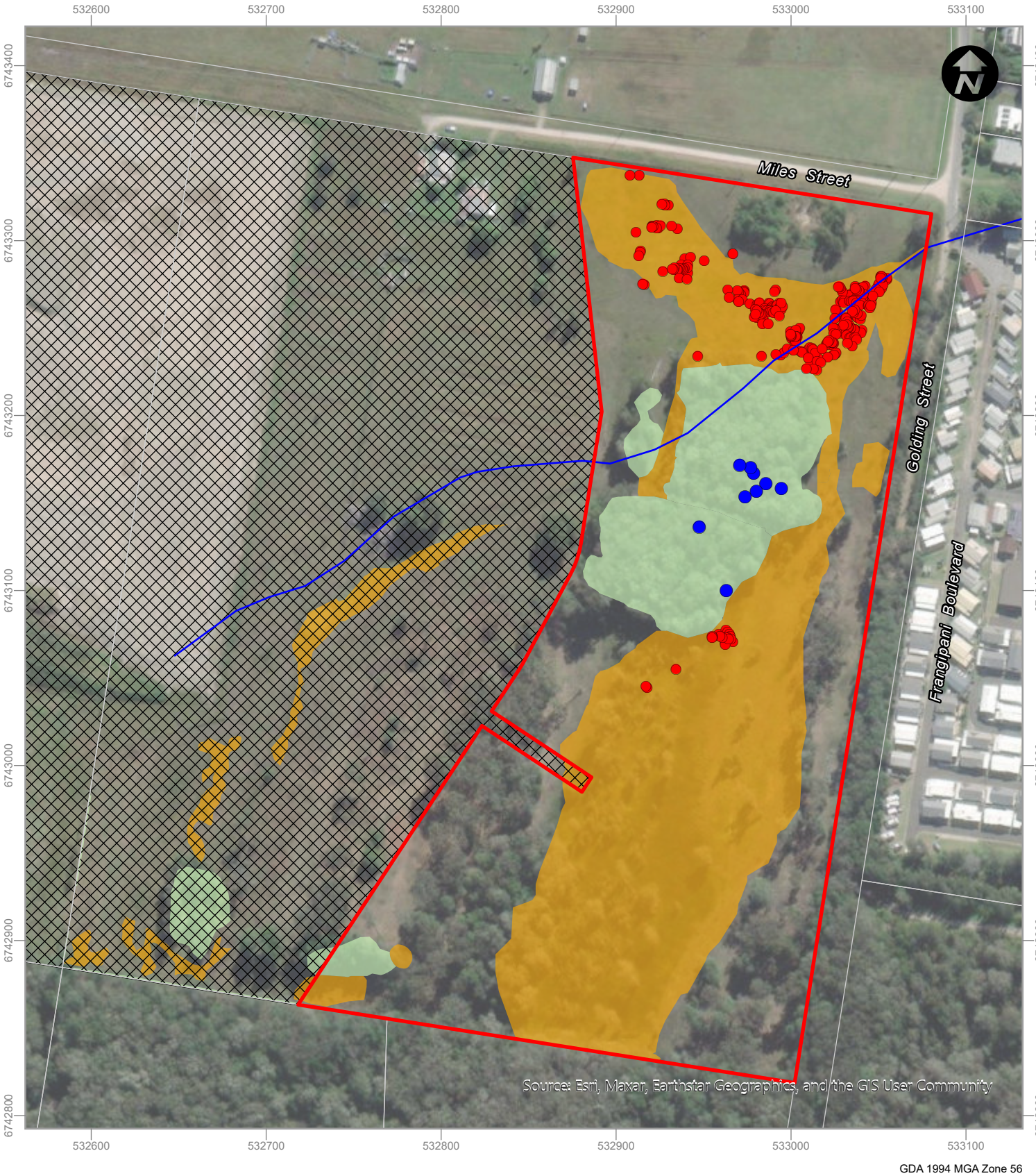
1.5.3 Threatened Ecological Communities

Native vegetation at the site is floristically characteristic of four threatened ecological communities (TECs) associated with alluvial floodplains listed in the BC Act:

- Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion (floristically analogous with PCT 837).
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South-East Corner Bioregions (floristically analogous with PCT 1064).
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregions (floristically analogous with PCT 780).

1.5.4 Threatened Fauna

No threatened fauna were recorded as part of the BDAR. While Eastern Osprey have historically nested at the site, the tree which hosted the old nest has been removed as part of approved clearing under DA2018/0553. Due to the disturbed nature of the site and the paucity of habitat, the site does not provide suitable habitat for any resident threatened fauna.



GDA 1994 MGA Zone 56

LEGEND

- Site boundary (subject to VMP)
- Development area
- Cadastre
- Spider Orchid species polygon
- Spider Orchid
- *Rotala tripartita* species polygon
- Rotala tripartita
- Watercourse

0 60 Metres

Threatened Flora - Illustration 1.4

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Vegetation Management Plan - Lot 47 DP751395 Miles Street Yamba
3041-1104

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2. Statutory Matters

CVC have requested this VMP relating to DA2019/0492. The SEE for the DA has addressed relevant environmental legislation including:

- *Environmental Planning and Assessment Act 1979* (EP&A Act).
- *Biodiversity Conservation Act 2016* (BC Act).
- State Environmental Planning Policy (SEPP) 44 – Koala Habitat Protection
- *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

3. Aims, Objectives and Performance Criteria

3.1 Aims and Objectives

The aim of this VMP is to prescribe requirements for ongoing maintenance responsibilities for the site to ensure:

- The floodway functions as required. It is noted that the flood modeller for the development has advised that flood modelling for the site has been undertaken on the basis that vegetation roughness at the site would remain as it currently is, hence it is understood that vegetation on the site cannot be embellished through additional plantings.
- Environmental conditions are maintained to not impact the two threatened flora species that occur at the site.

3.2 Performance Criteria

The following performance criteria are proposed to address the above aims/ objectives:

1. Vegetation roughness is maintained as it currently is.
2. Weeds are continually reduced and supressed at the site.
3. The development to the west of the site is not to alter the hydrology of the site.
4. Healthy populations of the threatened species, Rotala and Spider Orchid are maintained on the site.

A monitoring program would be implemented to measure the above performance criteria and the success of these in achieving the aims of this VMP.

4. Vegetation Management

4.1 Introduction

Given the constraints associated with maintaining the floodway it is understood that replanting of native vegetation within Lot 47 is not possible. Maintenance of the site will therefore focus on weed control, removal of cattle and maintaining threatened species habitat at the site. This VMP is written on the assumption that the hydrology of the site would be maintained on the site post-construction of the development. Further information on the maintenance of hydrology at the site is provided in the SEE and BDAR for the proposal.

In relation to Rotala habitat at the site, expert advice on management of the species has been provided by Dr Andrew Benwell (refer to **Appendix C**). Proposed management includes habitat being managed by a combination of tractor slashing and periodic low intensity burning.

Spider Orchids grow on Prickly Paperbark at the site. Environmental conditions for this species would be maintained at the site with implementation of weed control and ensuring the hydrology of the site is maintained in order to maintain host tree health.

4.2 Management Zones

Given the factors outlined in the above section only two managements zones are proposed as detailed in the following sections along with proposed management actions. Vegetation zones are shown below in **Illustration 4.1.**

4.2.1 Management Zone 1

Management Zone 1 includes all areas of sedgeland (PCT 780) and wet pasture within Lot 47 including habitat for the threatened species, Rotala. It excludes more permanently waterlogged areas in the southern portion of the site (PCT 1064 – Zone 2). Prescribed actions within Management Zone 1 are summarised at **Table 4.1**. Photo monitoring points for this vegetation zone are shown on **Illustration 4.1** and below in **Plate 4.1** to **Plate 4.4**.

The key management aim for Zone 1 is to ensure that a healthy population of Rotala is maintained on the site. Recommended management measures for Rotala are included in the expert report provided by Dr Andrew Benwell (refer to **Appendix C**). Recommended management measures for the species include:

- Low intensity fire with Rotala habitat to be burnt every 2-4 years in winter or early spring; and
- Tractor slashing of all Rotala habitat to be undertaken twice a year in autumn and spring. Summer slashing should be avoided to minimise disturbance to Rotala plants as they mature and produce seed. After a winter/ early spring burn, slashing would not be carried out before Rotala seedlings have set seed. Inspection of plants before slashing will be required in these instances.

Table 4.1 Prescribed Actions - Management Zone 1

Action	*Requirement*	*Timing*	*Responsibility*
Removal of cattle	Cattle grazing is to cease on the site.	Upon approval of DA/ VMP	Landowner
Slashing	*Tractor slashing would be undertaken of the entire management zone.	Twice annually in autumn and spring	Landowner
Low intensity fire	#Low intensity burns would be undertaken in all parts of the management zone	Every 2-4 years in winter or early spring	Landowner
Initial weed control	Foliar herbicide treatment of all weeds; refer to prescriptions at **Appendix B**.	Upon approval of DA/ VMP	Landowner
Ongoing weed control	Foliar herbicide treatment of all weeds; refer to prescriptions at **Appendix B**.	Twice annually (December, March)	Landowner

** Summer slashing should be avoided to minimise disturbance to Rotala plants as they mature and produce seed.*
 # After a winter-early spring burn, slashing would not be carried out before Rotala seedlings have set seed. Check by inspecting plants before slashing.

Plate 4.1 Photo point 1 (bearing 220°) management zone 1

Plate 4.2 Photo point 2 (bearing 120°) management zone 1

Plate 4.3 Photo point 3 (bearing 100°) management zone 1

Plate 4.4 Photo point 4 (bearing 170°) management zone 1

4.2.2 Management Zone 2

Management Zone 2 comprises all parts of the site excluding those captured by Management Zone 1. It includes all sclerophyll forest areas including those currently regenerating. Habitat for the threatened species Spider Orchid occurs within this zone. Prescribed actions within Management Zone 2 are summarised at **Table 4.2**. Photo monitoring points for this vegetation zone are shown **Illustration 4.1** and below in **Plate 4.5 to Plate 4.9**.

Table 4.2 Prescribed Actions - Management Zone 2

Action	*Requirement*	*Timing*	*Responsibility*
Removal of cattle	Cattle grazing is to cease on the site.	Upon approval of DA/ VMP	Landowner
Initial weed control	Foliar herbicide treatment of all weeds; refer to prescriptions at **Appendix B**.	Upon approval of DA/ VMP	Landowner
Ongoing weed control	Foliar herbicide treatment of all weeds; refer to prescriptions at **Appendix B**.	Twice annually (December, March)	Landowner

Plate 4.5 Photo point 5 (bearing 195°) management zone 2

Plate 4.6 Photo point 6 (bearing 275°) management zone 2

Plate 4.7 Photo point 7 (bearing 40°) management zone 2

Plate 4.8 Photo point 8 (bearing 90°) management zone 2

Plate 4.9 Photo point 9 (bearing 15°) management zone 2

4.3 Work Plan Summary

Based on the actions prescribed in **Section 4.2**, a summary of all works within all Management Zones is provided at **Table 4.3**. Note that the ability to complete works may be impeded by various factors including inclement weather. As such, the timing of prioritised works in **Table 4.3** is a guide only.

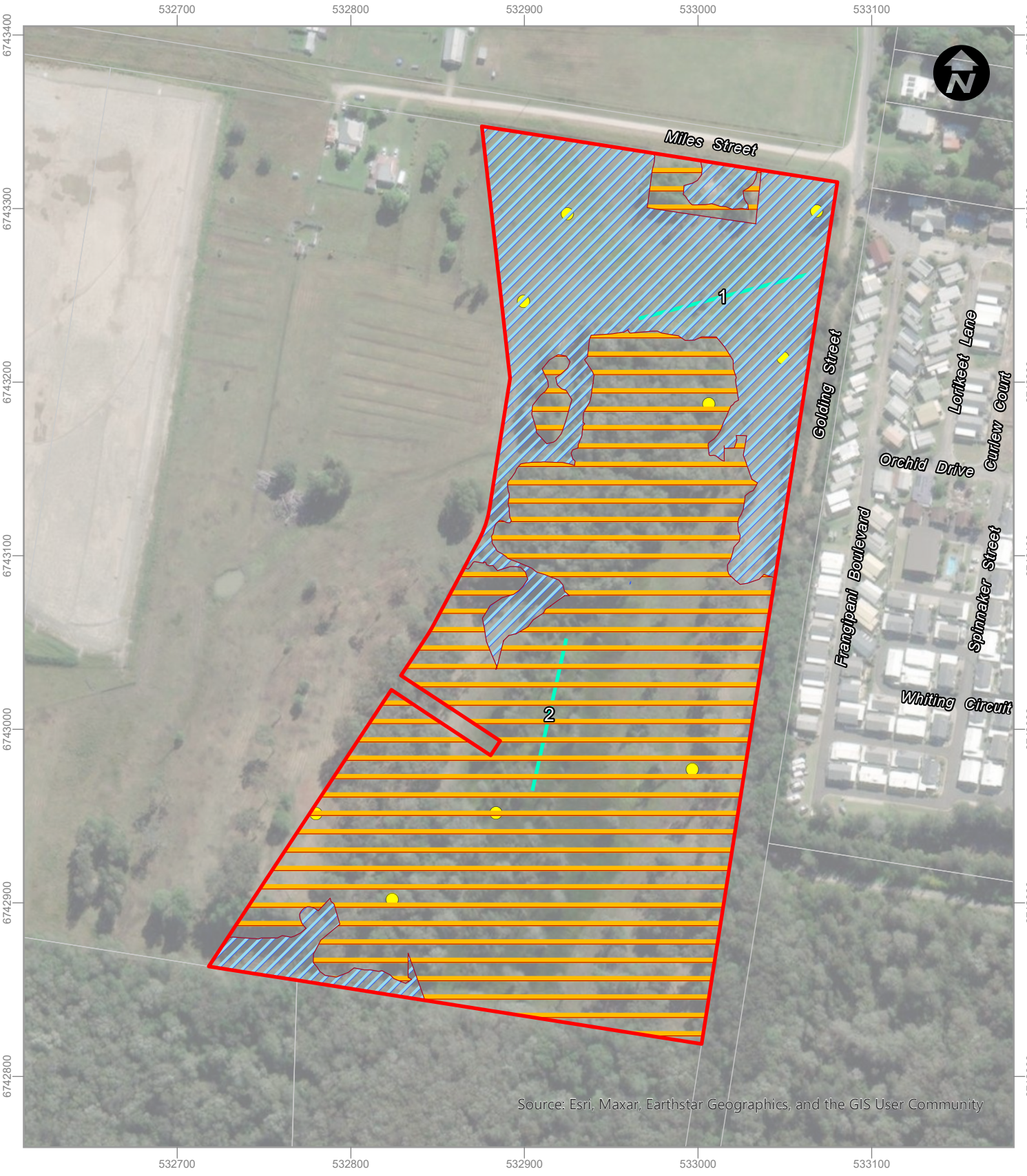
Table 4.3 Summary of Works Schedule

Mgmt Zone	*Cattle Removal*	*Slashing*	*Low intensity fire*	*Initial Weed Control*	*Ongoing Weed Control*
1	✓	✓	✓	✓	✓
2	✓			✓	✓

4.4 Works Schedule

The works prescribed in this VMP may only commence following approval of this plan by Council.

Initial weed control shall be implemented within six months following written approval of this VMP.



LEGEND

- Site boundary (subject to VMP)
- Cadastre
- Vegetation management zone 1
- Vegetation management zone 2
- Rotala transect
- Photo location

GDA 1994 MGA Zone 56

0 60 Metres

Vegetation Management Zones - Illustration 4.1

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Vegetation Management Plan - Lot 47 DP751395 Miles Street Yamba
3041-1104

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5. Monitoring and Reporting

5.1 Monitoring

5.1.1 General Monitoring

Formal monitoring shall be undertaken within both management zones. Formal monitoring would require:

- Installation (and survey by GPS) of permanent photo points at locations identified within each management zone (refer to **Illustration 4.1** and **Plate 4.1** to **Plate 4.9**.
- Inspection of management zones at 12 monthly intervals, with tasks including:
  - Inspection of vegetation.
  - Assessment of weed cover.
  - Photographs from permanent photo points.
  - Assessment of vegetation health.
- Preparation of a brief annual report with notes on:
  - Weed control requirements during the maintenance period.
  - Details of any vegetation die-back or signs of ill health.
  - Recommendations for any other additional works (eg. further weed control).

5.1.2 Threatened Flora Monitoring

Monitoring of the threatened species, Spider Orchid and Rotala would be undertaken annually for five years as described below.

5.1.2.1 Spider Orchid

During each monitoring event a count of the total number of Spider Orchids would be undertaken within the population to allow comparisons of population abundance over time to identify any population trends.

In addition five host trees (with Spider Orchids) would be selected for plant health monitoring over time. During baseline monitoring the GPS location of these would be recorded with these trees marked with flagging tape and a unique identification. The following data would be recorded during each monitoring event to enable analysis of plant growth and survival:

- Tree ID number.
- Date.
- Number of orchids within host tree.
- New growth.
- Overall condition (refer to **Table 5.1** below).
- Photo.

Table 5.1 Condition Scores Applied to Spider Orchid

Score	*Condition*
0	Dead
1	Pseudobulbs discoloured or grazed or withering, no new growth
2	Pseudobulbs healthy in colour, not withering, no new growth
3	Plant small, few healthy pseudobulbs, new growth occurring
4	Several healthy pseudobulbs present, new growth occurring
5	Several good sized, healthy pseudobulbs, flowering or seeding recorded

5.1.2.2 Rotala

Monitoring for Rotala is to be undertaken in summer annually as this is the recorded flowering season for this species on the site. Two 100 m transects are to be established and monitored as shown in **Illustration 4.1** with the following recorded:

- Date.
- Photo of transect from start and end point.
- Presence/ absence of Rotala within twenty 5 m portions of the transect.
- General description of the health of any Rotala present.
- If present the general extent of Rotala is to be mapped by undertaking random meanders of habitat and taking GPS points to define the extents of its occurrence.

5.2 Reporting/ Analysis

5.2.1 General Reporting

Annual monitoring reports are to be completed and supplied to Council and shall include the following information:

- A timetable of works/ monitoring completed in that year for both management zones.
- Results of the monitoring completed with regard to performance criteria.
- Comments on any problems at the site and how these have been managed.
- Photographs from fixed photo points showing the progress of the plantings.
- A log of herbicide use during all maintenance operations.
- Any other relevant information or recommendations for future maintenance.

Where performance criteria have not been met, corrective actions must be provided. In the event that Rotala is not detected at the site after two years or a decline in health/ abundance of Spider Orchid is detected, the ecologist must reassess management measures for the species in collaboration with Council and any relevant stakeholders including Dr Andrew Benwell. Agreed changes to management of these species must be implemented by the proponent as agreed.

References

Ecos (2023). Additional information on ecology, impact and management of a populationof the endangered plant species Rotala tripartite (Rotala) on a proposed residential subdivision at 52-54 Miles Street, Yamba. Report prepared for GeoLINK.

GeoLINK (2022). *Biodiversity Development Assessment Report Lot 46 DP751395 Miles Street Yamba.* Report prepared for Garrard Building Pty Ltd.

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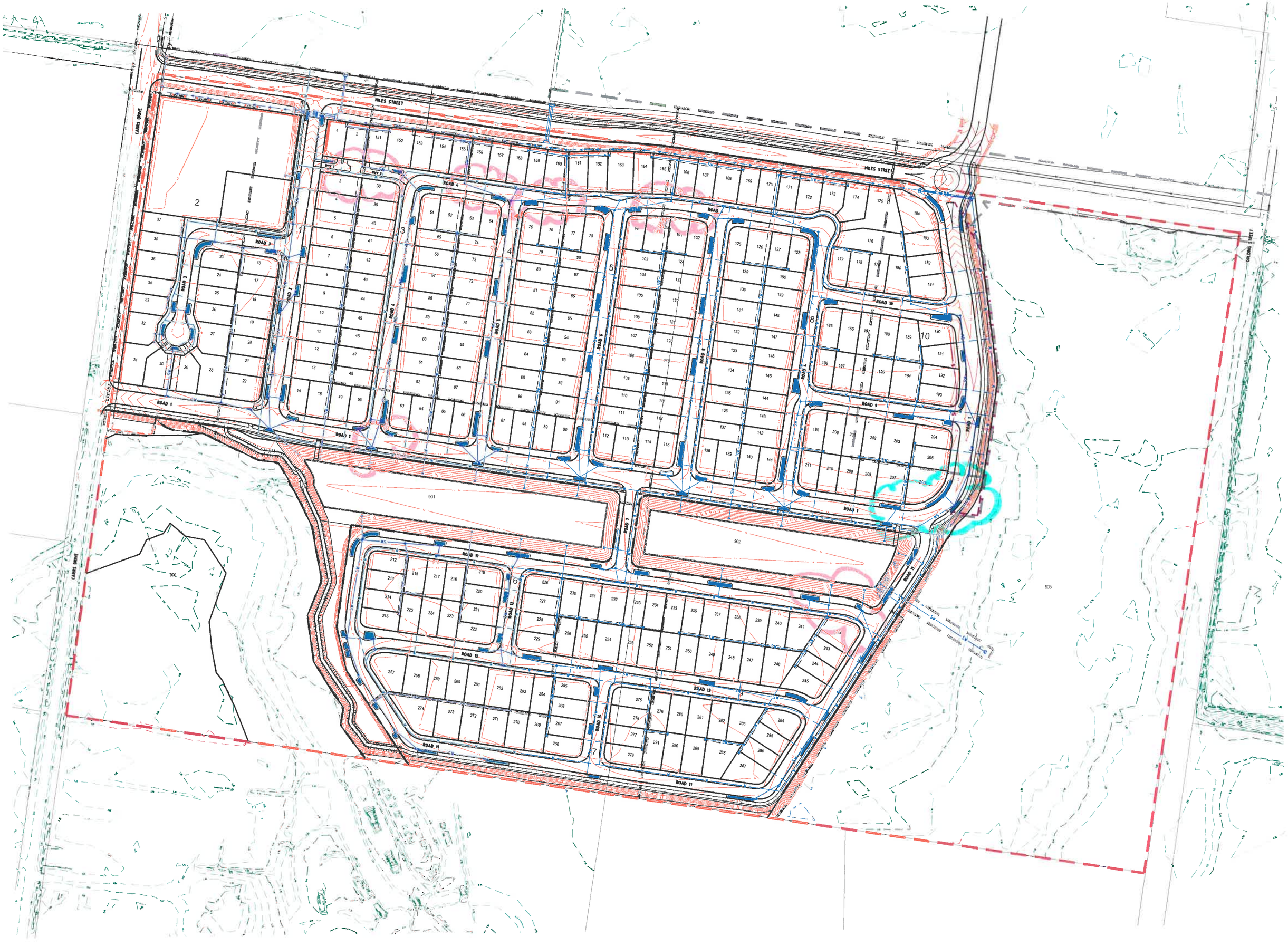
Appendix A

Revised Concept


MILES STREET
MILES STREET
CAIRNS DRIVE
GOLDING STREET
ROAD 1
ROAD 2
ROAD 3
ROAD 4
ROAD 5
ROAD 6
ROAD 7
ROAD 8
ROAD 9
ROAD 10
ROAD 11
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ROAD 13
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901
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903
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Appendix B

VMP Prescriptions

Lot 47 DP751395 - PRESCRIPTIONS FOR VEGETATION MANAGEMENT

NOTE: These prescriptions are to apply to works at Lot 47 DP751395. Significant variation to any of these methodologies requires agreement from Clarence Valley Council.

Removal of Cattle

Cattle are to be removed from the site upon approval of the DA/ VMP.

Weed Control

Initial weed control within all parts of the site is to be undertaken upon approval of the DA/ this VMP.

Following the above, annual weed control is to be undertaken twice annually in December and March.

The following weed control actions are prescribed:

- Poisoning established woody weeds (Camphor Laurel, Winter Senna, Lantana, Groundsel) in-situ.
- Remove exotic vines (Coastal Morning Glory) using standard bush regeneration techniques (eg. the 'cut, scrape and paint' technique).
- Use of foliar spray to control areas of pasture grasses and aquatic herbs (Lippia, Cuphea). Weed control and preparation in grassland areas must be sensitive to regenerating woody native species (eg, Swamp Oak, Broad-leaved Paperbark, Willow Primrose, Eclipta).

Weed control works apply, (but may not be limited to) to introduced species recorded at the site within **Table B.1**. Following initial works, ongoing weed control will be required to control emerging weed infestations.

TABLE B.1 ENVIRONMENTAL WEEDS RECORDED AT THE SITE

Scientific name	*Common name*	*Biosecurity Act 2015*
Ageratum houstonianum	Billygoat Weed	
Asclepias curassavica	Red-head Cotton Bush	
Axonopus fissifolius	Carpet Grass	
Baccharis halimifolia	Groundsel Bush	**Regional Recommended Measure** Land managers should mitigate the risk of spread/establishment of the plant from their land.
Bidens pilosa	Farmer's Friends	
Cenchrus clandestinum	Kikuyu	
Chloris gayana	Rhodes Grass	
Cinnamomum camphora	Camphor Laurel	
Cuphea carthagenensis	Cuphea	
Ipomoea cairica	Coast Morning Glory	
Lantana camara	Lantana	**Prohibition on dealings** Must not be imported into the State or sold
Ochna serrulata	Ochna	
Paspalum mandiocanum	Paspalum	
Paspalum urvillei	Vasey Grass	
Passiflora suberosa	Corky Passionfruit	
Passiflora subpeltata	White Passionflower	
Phyla nodiflora	Lippia	
Polygala paniculata	Milkwort	

Scientific name	Common name	Biosecurity Act 2015
Psidium cattleyanum	Cherry Guava	
Senecio madagascariensis	Fireweed	**Prohibition on dealings** Must not be imported into the State or sold
Senna pendula var. glabrata	Winter Senna	
Setaria sphacelata	Pigeon Grass	

Weed control notes:

- Weed control must be completed by professional, experienced contractors only.
- Contractors must be advised on the need to complete works sensitively to avoid damaging any native vegetation and threatened flora habitat (eg. Rotala habitat).
- Due to wetland environments frog habitat, foliar spraying should use 'frog friendly' forms of Glyphosate and be completed outside of any flood events where water levels may be higher than usual.
- Foliar spraying should not occur if rain is predicted in the coming 48 hours and should be completed in dry, still conditions.

Slashing

Tractor slashing is to be undertaken twice annually (Autumn and Spring) within management zone 1 in perpetuity. The following considerations should be taken into account in relation to slashing:

- Only slashing of vegetation zone 1 as shown in **Illustration 4.1** is to be undertaken.
- Slashing should be delayed where ground conditions are too wet and would lead to bogging.
- After a winter-early spring burn, slashing would not be carried out before Rotala seedlings have set seed. Check by inspecting plants before slashing.

Low intensity fire

A low intensity burn of management zone 1 would be undertaken every 2-4 years in winter or early spring.

Appendix C

Expert Advice on Rotala Impacts and Management

Additional information on ecology, impact and management of a population of the endangered plant species *Rotala tripartita* ('Rotala') on a proposed residential subdivision at 52-54 Miles Street, Yamba. Application No: SUB2023/0001

Prepared for:

Geolink

Level 1, 64 Ballina St

Lennox Head, NSW 2478

Prepared by:

Ecos Environmental (Dr Andrew Benwell)

3 Short St, New Brighton 2483

4/7/2023

Contents

1 Introduction

Ecos Environmental (Dr Andrew Benwell) has been engaged by Geolink to assess the impact of a proposed residential subdivision located at 52-54 Miles Street Yamba, NSW 2464, comprising Lot 46 DP 751395 and Lot 47 DP 751395 (the 'Subject Site') on the endangered plant species *Rotala tripartita* ('Rotala'), including whether there is likely to be a decline in the species, and to make recommendations on how to manage its habitat within the Subject Site.

Clarence Valley Council (CVC), the determining authority for the proposed sub-division, has requested this additional information on Rotala in relation to a letter from the Department of Planning and Environment – Biodiversity and Conservation Division dated 3 March 2023 recommending that several points of the Biodiversity Development Assessment Report (BDAR) and Vegetation Management Plan be revised.

Ecos Environmental has been engaged by Geolink to address Point 3 of BCD's letter:

> *3. A suitably qualified expert in wetland biology and ecology assesses the likely impacts from filling the proposed development areas on the adjoining wetland areas to help council determine whether the proposal is likely to have a serious and irreversible impact (SAII) on Rotala tripartita.*
>
> *The report should address but not be limited to:*
> *a. The change in landscape morphology.*
> *b. Hydrological impacts such as quality and quantity of stormwater inflow, altered water flow and altered wetting and drying regimes of the wetland.*
> *c. Consideration of whether the impacts are likely to result in the decline of the Rotala population on the subject land.*

All Rotala records from the Subject Site are on slightly lower terrain including a designated floodway and are excluded from the development area (Figure 1). The letter from BCD is concerned with possible indirect impacts *from filling the proposed development areas on the adjoining wetland areas* may cause a serious and irreversible impact (SAII) to the Rotala population.

Following this introduction, Section 2 presents brief background information on the development proposal and site. Section 3 contains an ecological profile of *Rotala tripartita* including its habitat requirements and life history. Section 4 describes the Rotala population. Section 5 examines the impact of development on the hydrology of Rotala habitat. Section 6 recommends management measures to maintain suitable habitat for Rotala and Section 7 presents the assessment conclusion.

The author (Dr Andrew Benwell) has professional experience in wetland plant ecology of the NSW North Coast including botanical survey, plant community mapping, threatened species recovery plans, specialist research, monitoring and translocation. Threatened wetland species he has worked on for the public and private sectors include *Eleocharis tetraquetra, Arthraxon hispidus, Maundia triglochinoides, Phaius australis, Persicaria elatior, Centranthera cochinchinensis, Cyperus aquatilis and Rotala tripartita.* A CV can be supplied on request.

2 Background

2.1 Development proposal

Application No: SUB2023/0001. The development proposal is for a 284 lot subdivision consisting of 277 low density residential lots, 1 medium density residential development lot, 1 commercial development lot, 1 low density development lot, 3 drainage reserve lots and 1 open space reserve lot (BDAR Geolink 2022). The total area of the property consisting of Lots 46 and 47 is approximately 42ha. About one third is excluded from development and includes a designated floodway and swampy drainage lines supporting freshwater wetland and paperbark in the north east and south west of the Subject Site where Rotala has been recorded (Figure 1). The northern side of the site adjoining Carr Dv and Miles St has already been filled with 3 m of material under a previous approval (see Figure 1 'consolidated fill').

2.2 Natural Environment

2.2.1 Landform

The proposal is located on the estuarine floodplain of the Clarence River and the topography is flat to very gently sloping with slightly lower terrain across the southern part of the property that acts as a floodway directing runoff during heavy rain southeast and south towards Lake Wooloweyah, a large lake connected to the Clarence River. Difference in elevation from the highest to lowest point of the site is approximately 1-2 m. The site is 3 km from the sea and underlain by Pleistocene marine sand and Recent estuarine clay and silt alluvium from the Clarence River deposited during floods.

2.2.2 Vegetation

Most of the site is cleared and has a long history of agricultural land use consisting mainly of cattle grazing, and sugar cane cultivation in the past is also reported. Remnants of *Melaleuca quinquenervia-M. stypheloides* swamp sclerophyll forest, disturbed *Lophostemon suaveolens* floodplain forest and freshwater wetland occur in the east, south and southwest of the site (see Figure 1).

Rotala is associated with the mapped plant communities *PCT 780: Coastal floodplain sedgelands, rushlands, and forblands of the North Coast*, and *PCT 1064 Paperbark swamp forest* (Figure 1), both excluded from the development footprint. Cattle appear to have grazed the whole property, including areas where Rotala has been recorded, for several decades and are still present.

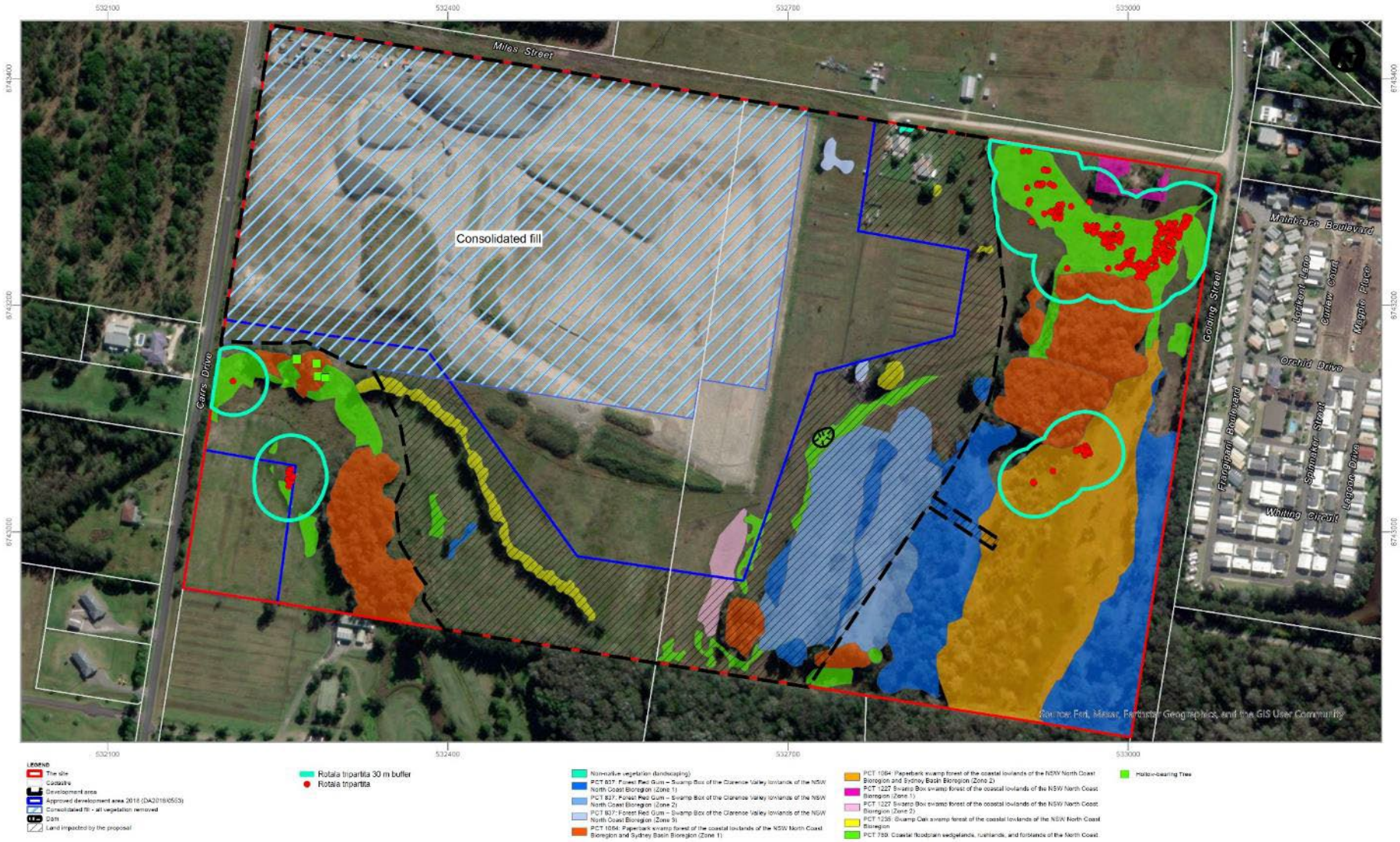

Figure 1: **The Subject Site, showing boundaries of the site (red line), development area (dashed black line), approved development area 2018 (blue line) and area impacted by this proposal (lighter hatching). Rotala records are red dots. See legend. Source: BDAR**

Biodiversity Impacts - Illustration 5.1

Information shown is for illustrative purposes only
Drawn by: AB Reviewed by: DGH
Source of base data: ESRI World Imagery
Date: 22/06/2023
Revision: C

2.2.3 Present drainage

The slightly lower relief along the eastern and southern sides of the Subject Site acts as a floodway directing runoff from the site and surrounding urban land from Golding Street south towards the Lake Wooloweyah basin. This is a designated floodway and excluded from development. The southwestern corner of the site is also slightly more low lying and receives runoff from Carr Drive, which is also directed southwards via a swampy drainage line and excluded from development (BDAR, Geolink 2022).

3 Ecological Profile of Rotala (*Rotala tripartita*)

3.1 Conservation Status

Endangered (NSW *BC Act*)

3.2 Description of species

Herbaceous, upright annual to 40 cm high, or decumbent perennial 10 -20 cm high with short stolons 10-40 cm long often present, producing short leafy shoots and flowers. Leaves glabrous, opposite, often decussate, sessile, ovate to lanceolate, 2-20 mm long and 1-5 mm wide, lower surface often paler than upper surface. Flowers sessile, solitary in axils of very small leafy bracts, dense along stems. Hypanthium c. 1 mm long. Sepals 3 or rarely 4, appendages longer than sepals. Petals 3 or rarely 4, elliptic, ± colourless to red. Stamens 3 or rarely 4, inserted near base of hypanthium. Style c. 0.5 mm long. Capsule globose, c. 1.5 mm long, 3-valved,

3.3 Distribution

NSW
Rare in NSW, known from fewer than 10 locations in a triangle between Casino, Grafton and Yamba, including Shannon Dam, Pillar Valley, Rappville, Pacific Highway Devils Pulpit, Mongogarie and Dilkoon (BDAR). Also in Qld and NT.

Local
The nearest known populations to Yamba are 20 km north at the intersection of Jacky Bulbin Flat Rd and the Pacific Highway (also referred to as Devils Pulpit, which is the adjacent range where the species does not occur), and Pillar Valley 30 km southwest, indicating the species' very sparse distribution.

3.4 Habitat and soil

Rotala tripartita appears to prefer marsh habitat where soil moisture persists for several months without extended periods of flooding and soil waterlogging. On coastal floodplains with a high water table and slight undulations and depressions, such as the Subject Site, marsh and swamp habitat are differentiated by subtle topographic–hydrological gradients. Marsh occurs on the margins of and slightly upslope of swamp habitat, and downslope of elevated, freely draining topsoil. Marsh, swamp and freely draining soils have different,

intergrading soil profiles and plant communities. Swamp soils ate generally peaty due to accumulation of organic matter under saturated, anaerobic conditions, and can form on alluvium or sand. A marsh soil is usually an organic loam with a lower organic matter and higher clay or sand content. Marsh habitat is flood prone, but surface water drains away rapidly and in the dry season it can dry out and carry fire.

3.5 Plant community

Rotala occurs in *PCT 780: Coastal floodplain sedgelands, rushlands, and forblands of the North Coast*, and to a lesser extent *PCT 1064 Paperbark swamp forest* on the Subject Site (Figure 1). Both of these plant communities have a modified species composition and structure as a result of clearing and grazing, and a high percentage exotic species in the ground layer.

Appendix 1 records the present species composition and structure of PCT 780 in two 20 m x 50 m plots in the northeast of Lot 47 and south west of Lot 46 where Rotala was recorded in June 2023.

3.6 Species life history

Bionet describes Rotala as an annual or short-lived perennial. The plants recorded on Lot 47 in November 2018 appeared to be annual as they died out in summer, 3-4 months after being recorded (BDAR, Geolink 2022). This is consistent with the species listing information which states: "There appear to be extreme fluctuations in abundance of the species, with plants observed to germinate prolifically and establish in large numbers after substantial rainfall. Individuals disappear above-ground during dry periods and may only persist during these times in the seed-bank."

By contrast, the author found that Rotala plants monitored on the W2B project at Jacky Bulbin Rd and the Pacific Highway were perennial, as they persisted in situ for 2 years in a cleared paddock, then for another 5 years after being translocated (Ecos Environmental 2021). More than half the translocated plants died, but some survived for five years. Many flowers were produced but no seedling recruitment was observed in five years. Plants spread 10-30 cm by prostrate stolons that took root at nodes. They died back during the year in dry or cold conditions and appeared to persist by means of leafless stolons (see Plate 8). Additional watering was carried out that may have prolonged their life span.

The Rotala plants recorded on Lots 46 and 47 in June 2023 by Ecos Environmental and Geolink (approx. 10) appeared to be older plants rather than recent seedlings (see Plates 1 and 2). They could have germinated in hoof depressions or tractor ruts in 2022 and gone undetected until June 2023, which would make them about 12 months old.

Photographs of Rotala at Mongogarie (south of Casino) supplied by David Havilah show dense, advanced Rotala seedlings that appear to have germinated after fire, as indicated by lack of dead grass and other litter, blackened litter on the ground, and new grass and sedge shoots (see Plates 6 and 7). David Havilah confirmed there was evidence of a recent fire at the Monogogarie location. Fire appears to remove the seed dormancy normally preventing

germination of most Rotala seed from the soil seedbank, thereby allowing mass seed germination to occur after rain.

The 'extreme' fluctuations in Rotala abundance referred to in the Bionet species profile is simply a natural expression of the life cycle of a short-lived disturbance specialist. Mass germination of seedlings after fire is typical of this class of plants. Occasional individuals may also germinate and establish in bare ground created by cattle hooves, tractor wheel ruts and other haphazard disturbances that remove plant cover from the soil surface (like fire), exposing seed to dormancy breaking light and warmth (and other cues). Flooding can also create 'gaps' in ground cover that trigger seed germination but has to be prolonged to kill ground layer plants, not just defoliate them (this is less likely in marsh habitat). Individuals can apparently persist as perennials but generally they are uncommon or rare.

4 Rotala population on the Subject Site

4.1 Population fluctuation

The biodiversity assessment surveys carried out by Geolink provide a record of the abundance and location of Rotala on the Subject Site over a five-year period, from 2018 to 2023 (Table 1). Rotala was first recorded in the southeast section of the Subject Site on Lot 47 in November 2018 (see Figure 1) then from summer 2019 was not recorded again on Lot 47 until the site inspection for this report in June 2023. The first record of Rotala on Lot 46 was in January 2021, then again in 2023.

The BDAR notes that: "Rotala can be a difficult species to survey for as it is an annual or short-lived perennial responsive to rainfall and seasonal conditions. During inappropriate conditions the species lies dormant in the seed bank and is not detectable. The Threatened Biodiversity Data Collection (TBDC) prescribes a survey period for Rotala as between December and March and notes: "Survey within about 6 months of soaking rainfall. Species will be absent above ground if the habitat remains dry for over 6 months. Short-lived perennial, easily overlooked in the field in the dense habitat that it occurs." The best time to survey for Rotala is in summer, but the species can be recorded throughout the year as shown by records from spring and autumn on Bionet and those from June 2023.

Geolink carried out frequent biodiversity assessment surveys that included flora or were specifically for Rotala (and timed for summer) from 2018 to 2021 (Table 1), so it can be assumed that the Rotala population data accurately record the Rotala population on the Subject Site.

Table 1: Biodiversity field surveys conducted by Geolink on Lots 46 and 47 between 2018 and 2023 (Source: BDAR; Table 4.2)

Date	Site Assessed	Task
26/06/2018	Lots 46 and 47	Initial assessment and stratification, VI plots, incidental fauna survey
16/07/2018	Lots 46 and 47	VI plots, incidental fauna survey
17/07/2018	Lots 46 and 47	Paddock tree survey for DA2018/0553, incidental fauna survey, GPS PCT 780 boundaries
30/10/2018	Lots 46 and 47	Targeted flora surveys, stick nest survey, bird census x 2, incidental fauna survey
31/10/2018	Lots 46 and 47	bird census x 2, incidental fauna survey. First recording of Rotala.
8/11/2018	Lots 46 and 47	Target flora surveys (Rotala, Maundia), incidental fauna survey
28/01/2018	Lots 46 and 47	Coastal Petaltail survey # 1, Rotala inspection, incidental fauna survey
8/02/2018	Lots 46 and 47	Coastal Petaltail survey # 2, Rotala inspection, incidental fauna survey
28/03/2019	Lot 46 only	Target flora surveys (SSSR, Swamp Foxglove, Tall Knotweed), incidental fauna survey, Rotala inspection
5/8/2020	Lot 46 only	Vegetation assessment for BAR, Rotala inspection (both lots), incidental fauna survey
30/9/2020	Lot 46 only	Vegetation assessment for VMP, Rotala inspection (both lots), incidental fauna survey
20/10/2020	Lots 46 and 47	Rotala inspection (both lots), incidental fauna survey
01/12/2020	Lots 46 and 47	Rotala inspection (both lots), incidental fauna survey
28/01/2021	Lots 46 and 47	Rotala inspection (both lots), incidental fauna survey
28/02/2021	Lots 46 and 47	Rotala inspection (both lots), incidental fauna survey
20/04/2021	Lots 46 and 47	Vegetation assessment and mapping, additional VI plots, SAT plot, wetland flora survey, incidental fauna survey
10/6/2023	Lots 46 and 47	Rotala inspection (both lots), Ecos Environmental and Geolink

Changes in the Rotala population on the Subject Site between 2018 and 2022 are described in the BDAR as follows: “Rotala (*Rotala tripartita*) was first recorded on the Subject Site on Lot 47 in November 2018, when an estimated population of 650 plants were present. Further targeted surveys on numerous occasions failed to detect the species since this time, until a small population was detected in association with several melonhole depressions in the south-west of Lot 46 on 28/01/2021. An estimated 45 plants were recorded, the majority of which are up to 20 cm in height; only one plant was in fruit. Plants were typically

within dense Setaria. Despite the good conditions and regular summer rain, no Rotala was recorded within Lot 47 on this same occasion where a robust population was previously recorded in 2018.

“The established population at Lot 47 (recorded November 2018) was used as a population indicator and was inspected on the following occasions: 29/01/2019, 8/02/2019, 28/03/2019, 5/8/2020, 30/9/2020, 20/10/2020, 01/12/2020, 28/01/2021. No plants were ever recorded during these times, and it was assumed that suitable prior rainfall had not occurred to create favourable conditions for the species. Rotala was recorded on Lot 46 outside of the development footprint on 28/01/2021 but was absent within the more substantial known habitat at Lot 47; the reasons for this are not known. Further incidental assessment on 20/04/2021 involved a random meander through the NE corner of Lot 47 (previous Rotala records) and small isolated patches of PCT 780 as part of habitat mapping.

“Rotala was recorded extensively in Lot 47 where wetland communities are extensive and moist boggy areas with surface water and a high table water were present. Numerous seedlings were observed growing within tractor wheel ruts at some locations, while other plants also occurred in association with the margins of Broad-leaved Paperbark swamp forest. As noted, following a hot and dry summer, all Rotala at the site had died, but had flowered and seeded prior to this time, suggesting that future plants are likely to germinate during suitable conditions. The site has been subject to ongoing slashing and grazing for many years (several decades).”

4.2 Germination trigger

Environmental processes that may trigger the germination of Rotala seed on the Subject Site include rainfall pattern, tractor slashing, grazing and fire. These processes or factors trigger seed germination by altering habitat and removing the dormancy mechanism normally preventing germination of Rotala seed in habitat unsuitable for seedling establishment.

The BDAR suggests that flooding rain was the environmental factor producing the large Rotala population recorded on Lot 47 in November 2018, but also notes that no plants appeared at the same location after flooding rain in 2021, even though some appeared on Lot 46. The BOM rainfall record in 2018 shows a spike of high rainfall in Aug-Sept/2018 (about 250 mm), followed by four major flood events in 2020-2022 (see Figure 2). Rotala was only recorded on Lot 47 after the spring 2018 rainfall event, not in the other years, for reasons that are not clear.

The photograph of Rotala on the Subject Site in 2018 supplied by Geolink (Plate 5) appears to show evidence of fire, similar to the photos from Mongogarie (Plates 6 and 7), which suggests plants recorded in 2018 on the Subject Site could have germinated after an earlier low intensity fire. Rotala plants in Plate 5 appear to be seedlings a few months old and may have germinated after heavy rain in Aug-Sept 2018 (Figure 2). This rainfall event was preceded by a drier than average period of about three months (conditions suitable for a pasture burn) and then another, more intense dry period extending into summer (Figure 2) when the population is reported to have died out . However, there is no mention of evidence of fire in the BDAR and David Havilah considered it unlikely (pers. comm.).

Generally, it appears that rainfall pattern, tractor slashing, grazing and fire can act as triggers to stimulate germination of Rotala seed. CVC will probably be responsible for site management of the floodway and areas outside the residential footprint and is unlikely to continue cattle grazing. That leaves tractor slashing and fire as strategies available for managing the site to maintain suitable habitat conditions for the Rotala population. Generally, the aim would be to maintain a fairly open ground layer with gaps to enable germination and seedling establishment, as described in Section 6 below.

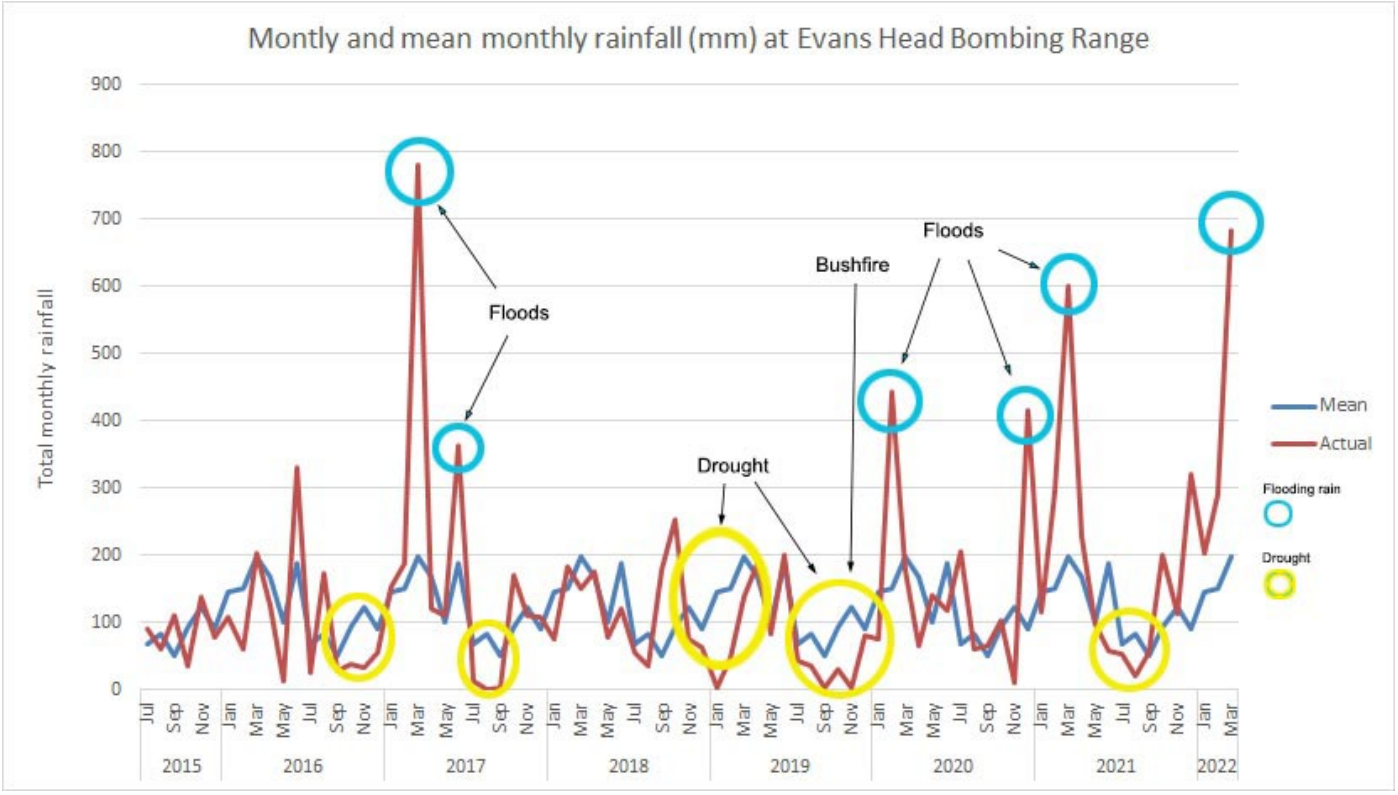

Figure 2: Monthly and mean monthly rainfall for Evans Head Bombing Range approximately 30 km north of Yamba, 2015 to 2022. The weather pattern was characterised by high rainfall variability with frequent droughts (defined as three or more months of below average rainfall) and floods (the bushfire shown in 2019 did not affect the Subject Site). Source: Ecos Environmental (2022).

5 Development impact on the hydrology of Rotala habitat

5.1 Introduction

Being a species of marshy habitat and adjoining an expanding urban area, the residential development has the potential to alter the hydrological regime of Rotala habitat, including depth and duration of flooding, and soil wetting and drying regime. This could cause change in germination conditions or survival of germinated seedlings, and possible decline (or increase) in Rotala abundance. In assessing the hydrological impact of the development on Rotala below, the reports prepared by expert hydrologists are relied on to indicate possible changes in the hydrological regime in Rotala habitat on the Subject Site.

The following issues relating to site hydrology that may impact on the Rotala population are examined below:

- Duration and height of flooding from stormwater run-off.
- Stormwater quality management (sedimentation and eutrophication).
- Groundwater Impacts.

5.2 Duration and height of flooding from stormwater run-off

The BDAR reporting on hydrology modelling by Biome Pty Ltd describes the impact of the proposal on duration and height of flooding from stormwater run-off as follows: “Regarding the timing of flows within the floodway, depending on the event, critical storms (i.e. with the highest flows) have a duration between 3-6 hours, meaning the storm peak flow will generally be reached after about 3 hours from the onset of the storm. Based on 1D modelling, the floodway flows generally subside after around 10 hours from the onset of the storm.

“The stormwater basin will provide detention of flows, thereby ensuring that the peak flows leaving the site in the post-development situation do not exceed the peak flows in the pre-development situation, for a range of storm events.

“A simulation of pre and post construction flood inundation was undertaken by Biome Consulting for the Q2 and Q100 events at two sites:
Site 1 – fork of branched waterway in the south-west corner of the site subject to VMP.
Site 2 – first order waterway in northern part of floodway representing threatened flora habitat subject to VMP.

For site 1, the model indicated that flood peak levels for Q2 and Q100 events being the same but with slightly increased water heights after the peak for a period of time. Such a minor change would be unlikely to affect ecological values associated with the waterway in the south west of the site.

For site 2, the model indicated very similar flood peaks and duration for the Q2 and Q100 events suggesting that the frequency and duration of flows entering the receiving environment will be similar to the pre-development situation.

Drainage of the floodway appears to occur north to south with the proposed stormwater outlet from the site positioned south of threatened flora habitat (see Figure 1, narrow projection on Lot 47 near Rotala habitat) further attenuating the risk of impacts to threatened flora habitat from changes in hydrology.

Conclusion

From the modelling studies carried out, there is unlikely to be a significant change in duration and height of flooding of off-site areas including habitat for threatened flora species within floodway as a result of stormwater run-off from the residential area.

5.3 Stormwater Management

Low lying areas are susceptible to changes in species composition caused by sedimentation and eutrophication originating in run-off from construction sites, roads, residential areas and other sites of soil disturbance associate with changes in land use (DPE 2022). Eutrophication of soil poses a significant risk to the long-term survival wetland threatened plant species such as Rotala and should be reduced as much as possible.

Management of stormwater run-off described in Geolink (2022) and Biome (2023) includes use of various structures including stormwater detention basins/bio-ponds/bio-retention ponds. Stormwater management will include two detention basins with the eastern basin discharging via a grass swale into the floodway and the western basin discharging into the second order stream. The stormwater outlet for the eastern basin consists of both pipe (1x450mm RCP) and weir flow. As the invert of the basin and subsequent downstream invert of the pipe outlet is quite low (0.8m AHD), construction of a shallow swale is required to outlet this pipe within the floodway (see Figure 1, narrow projection on Lot 47 near Rotala habitat). The swale will be approximately 60 m from the piped outlet and have a 2.5 m base. The swale has been designed as grassed/vegetated and will convey approximately 0.5m^3/s.

Water quality management described in Biome Consulting (2023) states on p. 2:
"The results of modelling including a comparison between the pre-developed, developed (untreated), and developed (treated) scenarios are summarised in the table below (i.e. Table 1). Treatment measures have been sized to achieve the water quality targets specified within Table H2 of the DCP and will ensure that surface water pollutant loads are reduced by at least 85%, 60% and 45% for TSS, TN and TP respectively of the developed flow.

Table 1 Pre-Development vs Developed (Untreated) vs Developed (Treated) Nutrient & Sediment Loads

Catchment ID	Pollutant	Pre-Development (kg/yr)	Developed (Untreated) (kg/yr)	Developed (Treated H2 requirments) (kg/yr)
Overall Site (TOTAL)	TSS	11,041	34,510	3,619
	TP	13	66	21.6
	TN	107	435	236

“In comparison to the pre-development scenario, whilst increases in nutrient loads (TN and TP) are expected as a result of urbanisation of the site, sediment loads are generally expected to largely decrease due to the inclusion of stormwater treatment measures within the development. To achieve a reduction in nutrient loads that would meet with pre-developed conditions an 80% reduction in TP and 75% reduction in TN would be required from the untreated developed flow.”

The report notes on p. 3 “bioretention performance as a ratio of bioretention treatment area exhibits a non-linear relationship comparable to a logarithmic regression. This relationship implies that treatment performance increases rapidly with treatment area size then reaches a point of ‘diminishing performance’ where incremental increases in basin size result in only marginal increases in bioretention performance.”

Regarding the size of bio-retention ponds, the report states: “ the most optimal treatment area is 1-2% of the total contributing catchment area. It is noted that whilst the information provided above represents catchments modelled within Queensland climates, it is deduced that a similar relationship would be prevelant for catchments within the site locality.

“The bioretention treatment measures for the proposed development have been sized to achieve the required load based reductions specified in Table H2 of the DCP. The resultant filter treatment areas equate to approximately 1.1% of the developed contributing catchment. It is therefore considered that the optimal treatment basin size has been provided for each catchment.

Furthermore, increasing the size of the basins would likely not offer a material change in of treatment efficiency but would result in large assets delivered to Council and therefore increase maintenance costs.

Attachment A of Biome Consulting (2023):

The current version of the Clarence Valley Council DCP as sourced from the link below specified the current water quality targets within TABLE H2.

https://www.clarence.nsw.gov.au/files/assets/public/building-and-development/files/development-control-plans/residential-dcp_29_july_2022.pdf

TABLE H2 Default Water Quality Targets

WATER QUALITY PARAMETER	DEFAULT TARGET
Gross Pollutants	90% of average annual load retained
Total Phosphorus (TP)	60% of average annual load retained
Total Nitrogen (TN)	45% of average annual load retained
Total Suspended Solids (TSS)	85% of average annual load retained

Appendix 2 at the end of this report includes diagrams showing the current design of two bio-retention basins and how they will linked with housing. This design is repeated across the site.

Summary comment

It appears from water quality performance measure for the Subject Site, intended to be consistent with those of CVC (see Table H2 above), after treatment of run-off in the system of bio-retention structures, 40% of Total Phosporus (TP) and and 60% Total Nitrogen (TN) will still remain in treated run-off from the construction site and later from the residential area, which will be discharged onto the floodway containing Rotala habitat and drain southwards.

Table 1 from the Biome report (see above) indicates that measured in kg/yr, P will increase from 13 kg/yr 'pre-development' to 21.6 kg/yr 'developed with treatment in the bio-ponds'; N will increase from 107 kg/yr pre-development to 236 kg/yr developed and after treatment in the bio-ponds. This is roughly a doubling of pre-development N and P concentration in run-off to the floodway.

If spread over the whole low lying area supporting wetland vegetation, including PCTs 780 and 1064 (i.e. ~10 ha), these increases in nutrient input (kg/yr) would probably have a relatively mild stimulating effect on plant growth. Any stimulating effect would probably attenuate rapidly with increasing distance from the discharge point so its position in relation to Rotala plants is important, which appears to have been considered. Concentrations of N and P in the present soil are already likely to be elevated as a result of the long history of cattle grazing, compared to a soil still in its natural state, unmodified by agriculture.

Vegetation and soil monitoring plots recorded during and after construction would be required to accurately determine the indirect effects of changes in land use (i.e. grazing and no grazing) and stormwater run-off (pre- and post-construction; before and after treatment) on plants communities and the Rotala population.

5.4 Groundwater Impacts

Regional Geotechnical Solutions Pty Ltd (RGS) carried out a geotechnical assessment of the residential subdivision that involves placement of between 1.5 and 3m of fill across the site. The impact of fill on groundwater conditions was assessed with regard to:

• The potential for consolidation settlement due to the placement of between 1.5 and 3m of controlled fill;

• An estimate of potential consolidation settlement, and the approximate lateral extents to which the settlement is predicted to occur; and

• Potential influence of the fill surcharge on existing groundwater levels.

The RGS report made the following findings: "The development includes the placement of up to about 3m of fill over the existing marine sand and silt deposits. The fill is expected to be placed progressively over many months with small height increases (i.e. fill lifts) applied over large areas, rather than the full surcharge being applied over a short period.

Groundwater was measured during the site investigation at depths of between 0.2 and 0.9m.

The marine soils below the groundwater level that underlie the site comprise two components – the soil particles themselves and water. Consolidation settlement occurs due to the reduction in volume of the saturated soil because of the increase in total stress and the drainage of excess pore water pressure. On this basis, at sites that experience large consolidation settlements there is the potential that the groundwater level surrounding the applied load/surcharge to be influenced and can rise. Groundwater levels would be expected to fluctuate at the site by up to about 1m due to tidal influences and in response to rainfall and particularly extended rainfall events.

Conclusion:

On this basis and due to the limited predicted consolidation settlement, the influence of the fill surcharge on the groundwater levels on surrounding sites is expected to be negligible.

5.5 Summary of hydrological impacts on Rotala habitat

The hydrological reports conclude that there will be no significant change in the height and duration of flooding in areas surrounding the residential development as a result of filling the residential footprint (as fill area is small in relation to the area of the surrounding Clarence floodplain), or to ground water levels from the weight of three metres of fill, which models show respond primarily to rainfall and tidal fluctuation.

The main hydrological risk to Rotala habitat from the development is change in water quality of storm water run-off, particularly elevated levels of major plant nutrients N and P remaining in stormwater after treatment in a network of bio-retention basins to be constructed in the residential area. Eutrophied run-off has the potential to produce changes in the structure and species composition of the wetland plant community PCT 780 which provides habitat for Rotala. Potential changes include (i) increased soil concentrations of major plant nutrients, (ii) increased biomass and density of herbaceous ground layer plants, and (iii) changes in species compostion including increase in exotic species.

The bio-retention technology to be applied to the residential development (Biome Pty Ltd 2023) appears to be state of the art and able to substantially reduce N and P concentration in run-off discharged to the floodway and Rotala habitat. Although substantially reduced, the data provided suggests that levels of N and P in stormwater run-off afterr treatment are likely to be twice those of run-off on the undeveloped site. However, in terms of (i) kg/yr of nutrient discharged to floodway, (ii) attenuation effects with increasing distance from the discharge point and (ii) previous cattle grazing, likely impact on Rotala habitat will probably be at the lower end of the scale (qualitatively speaking), but this is by no means certain, and may still have an adverse affect on the Rotala population on the Subject Site.

6 Maintenance of Rotala habitat

The maintain habitat conditions most likely to perpetuate a population of Rotala on the Subject Site, it is recommended that Rotala habitat areas by managed with a combination of tractor slashing and periodic, low intensity burning. 'Rotala habitat' is assumed to comprise all or most of the low-lying parts of the site excluded from development.

6.1 Tractor slashing

Tractor slashing has been carried out in recent years to suppress sapling regrowth on the designated floodway, and also appears to have helped maintain suitable habitat conditions for Rotala by reducing vegetation height and density, and forming micro-disturbance sites were Rotala seed can germinate, Observations showed that some Rotala seed germination occurs in tractor wheel ruts although generally only very sporadically and in low numbers.

Without slashing, the floodway and other open areas would rapidly regenerate to forest and displace the Rotala population. Small Melaleuca saplings were observed on the floodway during fieldwork in 2023.

Timing

Tractor slashing twice a year is recommended in Autumn and Spring. Summer slashing should be avoided to minimise disturbance to Rotala plants as they mature and produce seed.

After a winter-early spring burn, slashing would not be carried out before Rotala seedlings have set seed. Check by inspecting plants before slashing.

If slashing only is used to manage Rotala habitat, a small population may persist in tractor wheel ruts, or as dormant seed in the soil seedbank, but species seedbanks decay and need to renewed to prevent the species dying out. To maintain a healthy population of Rotala on the site, occasional burns are recommended, with aim of stimulating large scale seed germination.

6.2 Low intensity fire

Observations of the population ecology of Rotala on the Subject Site and other locations indicate that Rotala can appear in large number for a short period after fire disturbance, then die-off and persist as dormant seed, until the next disturbance. This is the natural life cycle of the species which is adapted to utilise open conditions in the earliest stages of plant community regrowth after fire.

To maintain a healthy population, the site should be burnt every 2 to 4 years in winter or early spring when conditions are favourable. The site should be burnt when fuel (i.e. ground layer vegetation and litter), weather and soil moisture conditions are suitable for a complete burn of ground layer, herbaceous plants. Advice can be sought NPWS rangers who carry out ecological burns in local National Parks. Fire breaks around the perimeter of the Subject Site are already planned as part of the Vegetation Management Plan.

A *Bushfire Risk Management Plan* (BushfireSafe Aust 2021) has been prepared for the proposal. The Plan notes the following:

- A perimeter road has been designed along the entire length of the floodway (eastern side of development.
- The development has been designed with a 21 metre wide perimeter road along the bushfire hazard interface.
- A minimum 25 metre Asset Protection Zone (APZ) along the forest vegetation adjacent to the southwestern margins of the site and a minimum 9 metre APZ from the remnant and riparian vegetation areas is prescribed.

6.3 Monitoring

As already emphasised, a monitoring strategy with clear objectives, methods and scheduling is essential to determine how treated stormwater run-off and site management measures (slashing and burns) affect the Rotala population and wetland habitat.

7 Conclusion

Assuming (i) the accuracy of hydrological models used in reports to assess hydrological impacts, reviewed above; and (ii) application of habitat management measures as described in Section 5, the likelihood of the residential development having a Serious and Irreversable Impact (SAII) on the Rotala population, resulting in a significant decline in the population, is considered to be low.

There is unlikely to be any major change in depth and duration flooding due to run-off from the filled residential area but data presented in reports indicate that stormwater discharged to low lying wetland habitat containing the Rotala records, will have about twice the concentration of N and P as pre-development run-off. However, as the quantity of nutrient in terms of kg/yr added to the low lying area is relatively small, the risk of eutrophication of habitat is also considered to be low.

Implementation of the habitat management regime described in Section 5 would increase the likelihood of the species persisting on the site. There is no certainty of outcome as the extent of the dormant Rotala seedbank on the Subject Site, which is crucial to the contined presence of Rotala, is largely unknown and simply assumed to be present based on where the species has previously been recorded.

A monitoring strategy is essential to determine how stormwater treatment and habitat management measures affect the Rotala population and wetland plant communities.

References

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Department of Planning and Environment (2022). Flood Impact and Risk Assessment: Flood Risk Management Guide LU01. NSW Gov.

Ecos Environmental (2021). Woolgoolga to Ballina Pacific Highway upgrade**.** Annual Threatened Flora Translocation Monitoring Report. Report to TfNSW.

Geolink (2022). Biodiversity Development Assessment Report. Lot 46 & 47 DP751395 Miles Street Yamba: Proposed Subdivision.

RGS (2022). Geotechnical Assessment Yamba Gardens Residential Estate 52-54 Miles St, Yamba, Report by Kahuna No. 1 Pty Ltd, Regional Geotechnical Solutions

Photographs

Plate 1: About 10 Rotala were recorded on Lot 47 in June 2023 in the same location plants were recorded in 2018. This plant has turned red and is starting to die back due to cold conditions.

Plate 2: A Rotala recorded on Lot 46 in June 2023 at the same location plants were recorded in 2021. This plant is turning brown and dying back due to cold conditions.

Plate 3: Wetland community PCT720 on Lot 47 in June 2023 dominated by the exotic herb *Cuphea carthegenicus*.

Plate 4: Wetland community PCT 720 on Lot 46 in June 2023, browning off due to cold temperatures.

Plate 5: Rotala seedlings on Lot 47 in November 2018. Photo supplied by D. Havilah.

Plate 6: Dense Rotala seedlings germinated after fire on a property at Mongogarie, south of Casino. Photo supplied by D. Havilah.

Plate 7: Rotala seedlings germinated after fire on a property at Mongogarie, south of Casino. Photo supplied by D. Havilah.

Plates 8-10: Rotala plants translocated from near the intersection of Jacky Bulbin Rd and the Pacific Highway to a recipient site 1 km south, for the Woolgoolga to Ballina project. Some plants survived for five years after being transplanted. **Plate 8** (top) – reddish stolons (prostrate, perennating stems) with small shoots. **Plates 9-10**. - clump of Rotala 3-5 cm high spreading by stolons and close up. Sept 2020

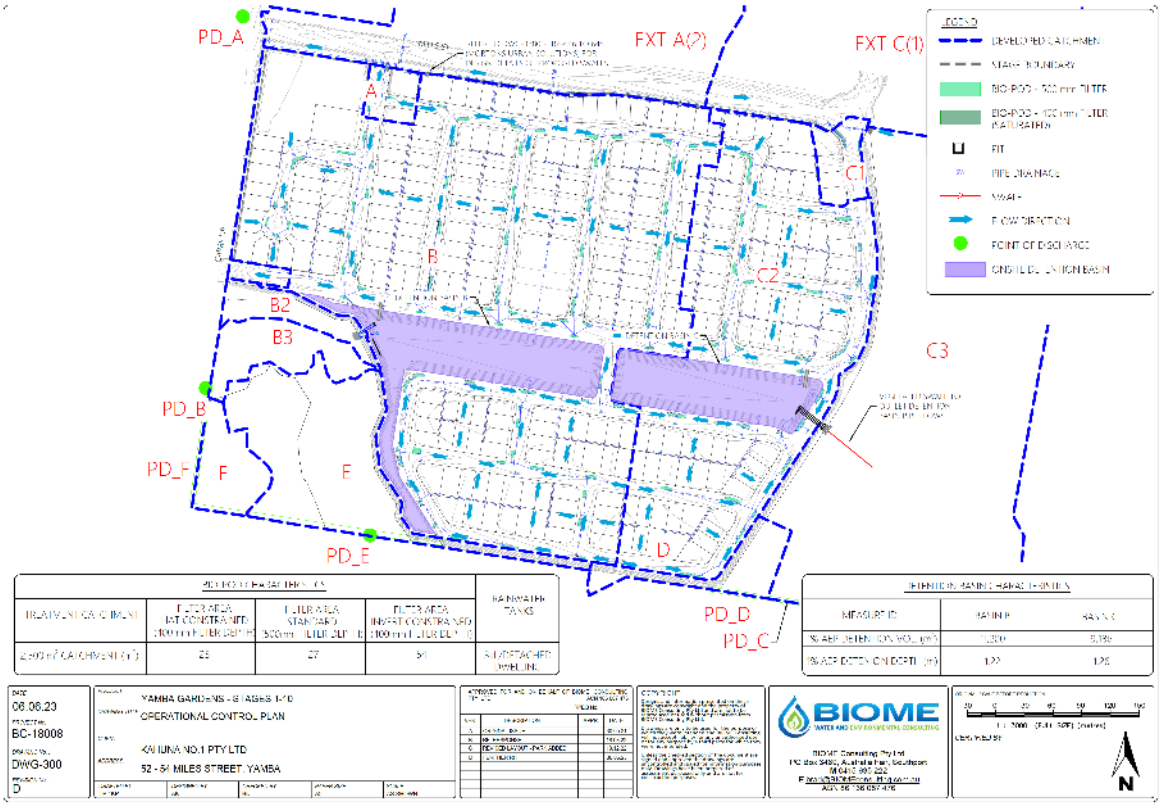
Appendix 1: Present species composition and structure of PCT 780 in two 20 m x 50 m plots in the northeast of Lot 47 and south west of Lot 46, at the locations where Rotala was recorded in June 2023.

Lot 47	0532986 6743264 (UTM, GDA)	20/6/2023
Plot = 20 m x 50 m	Miles St/Golding St	
Species	**Crown-cover**	**Native/Exotic**
Cuphea carthegenicus	4	e
Schoenus brevifolius	3	n
Cyperus polystachyos	3	n
Axonopus affine	3	e
Paspalum dilatatum	3	e
Polygala multiflora	2	e
Centella asiatica	2	n
Alternanthera denticulate	2	n
Cynodon dactylon	2	n
Philydrum lanuginosum	2	n
Aster subulatus	2	e
Juncus cognatus	2	e
Baumea articulata	2	n
Enydra fluctuans	2	n
Bacopa monneiri	2	n
Hypocheirus radicata	2	e
Melaleuca stypheloides	1	n
Asclepias currasavica	1	e
Cyperus rotundus	1	e
Christella sp.	1	n
Melaleuca quinquenervia	1	n
Andropogon virginicus	1	e
Rotala tripartita	1	n

Lot 46	0532217 6743126 (UTM, GDA)	20/6/2023
Plot = 20 m x 50 m	Carr Drive	
Species	**Crown-cover**	**Native/Exotic**
Eleocharis acuta	5	n
Cuphea carthegenics	4	e
Baumea articulata	3	n
Paspalum dilatatum	3	e
Philydrum lanuginosum	2	n
Baumea rubiginosa	2	n
Juncus ursitatus	2	n
Axonopus affine	2	e
Cyperus polystachyos	2	n
Schoenus brevifolius	2	n
Persicaria strigosa	2	n

Polygala multiflora	2	e
Ranunculatus inundatus	1	n
Christella sp.	1	n
Asclepias currasavica	1	e
Casuarina glauca	1	n
Cyperus rotundus	1	e
Senecio madagascarensis	1	e
Alternanthera denticulate	1	n
Rotala tripartita	1	n

Appendix 2: Location of two bio-retention basins and how they will be linked with housing. This design is repeated across the site. Below is the design the bioretention media which is a soil/particulate medium (source: Biome Pty Ltd 2023)



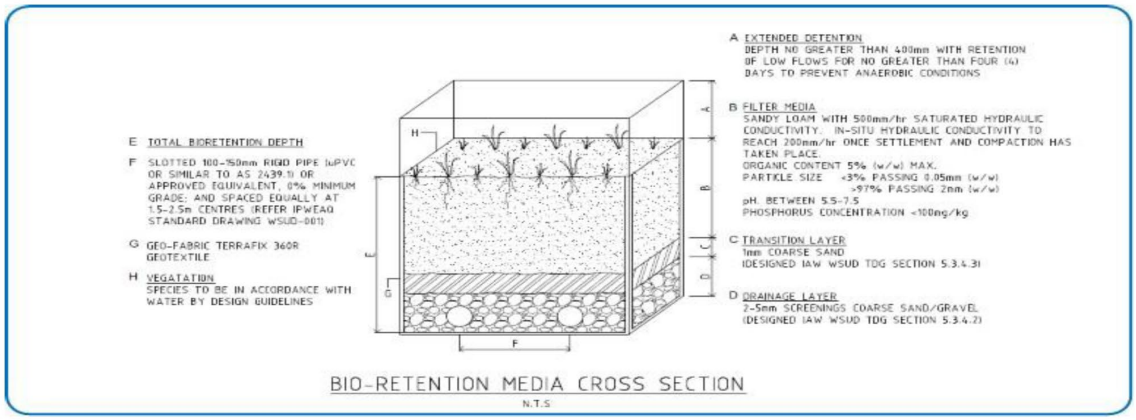


Figure 7.1 Bioretention specifications (Typical)