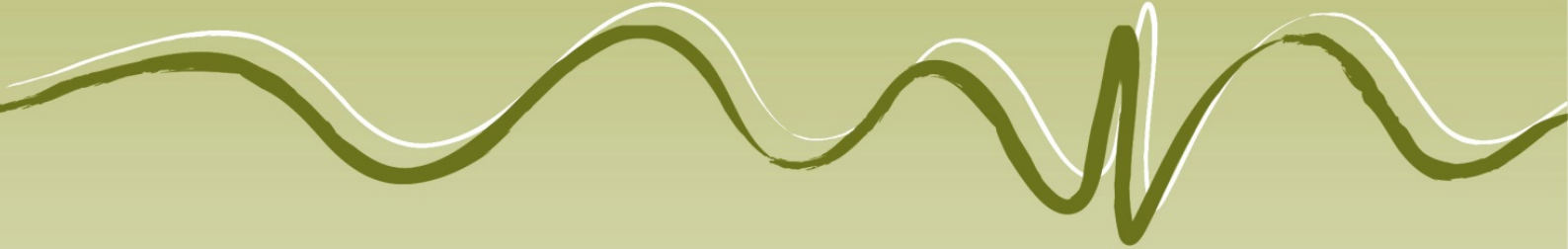


Warrell Creek to Nambucca Heads

Monitoring of In-situ Threatened Flora (Annual Report - Spring 2017)



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1. Introduction

As part of the Warrell Creek to Nambucca Heads (WC2NH) Pacific Highway upgrade project, a Threatened Flora Management Plan (TFMP) has been prepared by Ecos Environmental Pty Ltd (2014) to prescribe measures to manage all threatened flora species occurring on the project. A number of threatened flora occur on the edge of the construction footprint which are to be protected during the construction and operational phases of the upgrade. Measures to be implemented to protect in-situ specimens are outlined in Section 5 of the TFMP.

The TFMP requires that monitoring of in-situ roadside specimens be undertaken. Monitoring is to be undertaken initially after installing protective barriers (prior to the start of clearing) at six-monthly intervals for two years and once a year thereafter. An annual monitoring report is to be prepared at the end of each year describing the results of monitoring. This report represents the third annual monitoring report for the (spring) 2017 calendar year and third year of construction. This is expected to be the final report for the construction phase of the WC2NH project as project completion is scheduled for summer 2017/2018.

2. Methodology

All in-situ threatened flora were located and tagged prior to clearing activities commencing. Temporary fencing (orange bunting) and no-go signage was installed around all plants with ecologist supervision. The location of all threatened flora was shown on project sensitive area plans. Threatened flora within the project footprint were translocated prior to clearing commencing by Ecos Environmental Pty Ltd. A number of threatened plants have been retained in-situ outside the project clearing limit. These plants are the subject of this monitoring report and are shown in **Illustrations 2.1-2.6**. Monitoring of in-situ threatened flora was undertaken by GeoLINK ecologists, Jessica O’Leary, David Havilah and Frank Makin on six occasions at the following times:

- Prior to clearing commencing – 5 - 9 January 2015
- Six-monthly interval (autumn) – 25 - 29 May 2015
- 12-monthly interval (spring)– 26 - 27 November 2015
- 18-monthly interval (autumn) – 23 - 27 May 2016
- 24-monthly interval (spring) – 21 - 23 November 2016
- 36-monthly interval (spring) – 13 - 16 October 2017.

The following threatened flora species were monitored:

- Maundia (*Maundia triglochinosides*)
- Rusty Plum (*Niemeyera whitei*)
- Slender Marsdenia (*Marsdenia longiloba*)
- Spider Orchid (*Dendrobium melaleucaphilum*)
- Woolls’ Tylophora (*Tylophora woollsi*).

The following identification/ plant condition data was recorded for each in-situ specimen:

- genus/ species
- plant identification number
- leaf/ plant health condition(see condition class scores in **Tables 2.1 - 2.3** below)
- flower/ fruit presence
- new growth/ shoots
- recruitment
- notes were also made on weed infestations and evidence of any other impacts.

Attributes for evaluating species health and survival are captured in Condition Classes which are scored on a class of 0 to 5 (refer to **Tables 2.1 - 2.3** below) based on the WC2NH Threatened Flora Management Plan (Benwell, 2016).

Table 2.1 Condition Class scores applied to Slender Marsdenia and Woolls’ Tylophora

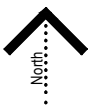
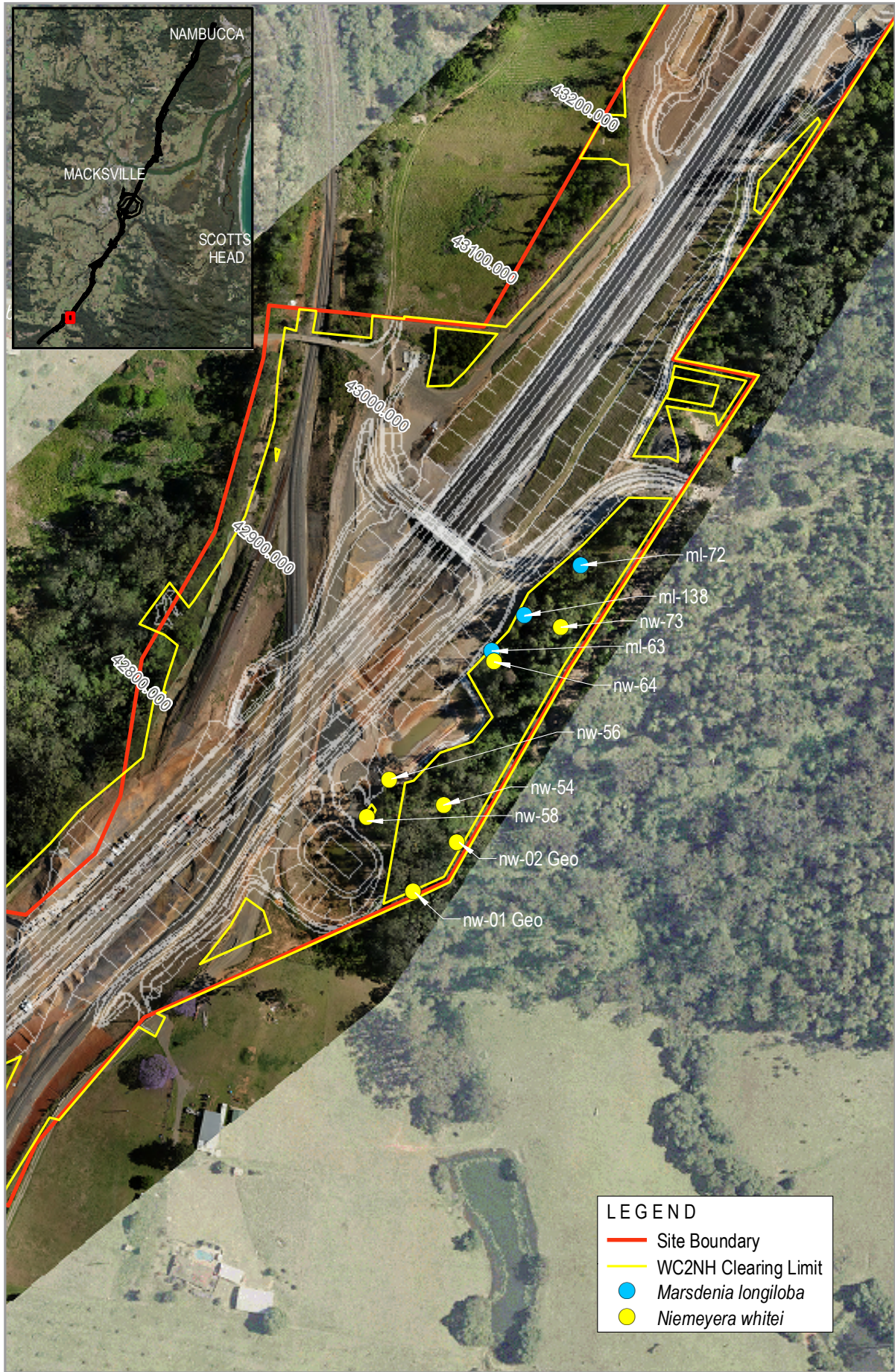
Score	Condition Class
0	dead
1	stem died back, no leaves or green stem, may be a live stem stub
2	stem with leaves, no active growth; green leafless stem
3	stem with leaves, active growth – i.e. new shoot growth stem with leaves and plant >75cm tall
4	plant with lots of leaves, mature or nearing maturity
5	plant flowering or seeding

Table 2.2 Condition scores applied to Rusty Plum and Maundia

Score	Condition Class
0	dead
1	leafless and no sign of re-shooting
2	pruned foliage retained, or small amount of re-shooting after defoliating, or foliage sparse/discoloured
3	vigorous re-shooting
4	crown recovering, foliage healthy
5	growing actively, flowering or seeding recorded

Table 2.3 Condition scores applied to Spider Orchid

Score	Condition Class
0	dead
1	pseudobulbs discoloured/being eaten/withering, no new growth
2	pseudobulbs healthy in colour, not withering, no new growth
3	plant small, not many healthy pseudobulbs, new growth occurring
4	several healthy pseudobulbs present, new growth occurring
5	several good sized, healthy pseudobulbs, flowering or seeding recorded



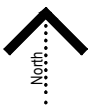
0 60

In-situ Threatened Flora Record Locations



LEGEND

- Site Boundary
- WC2NH Clearing Limit
- *Maundia triglochmoides*

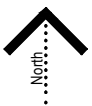


In-situ Threatened Flora Record Locations

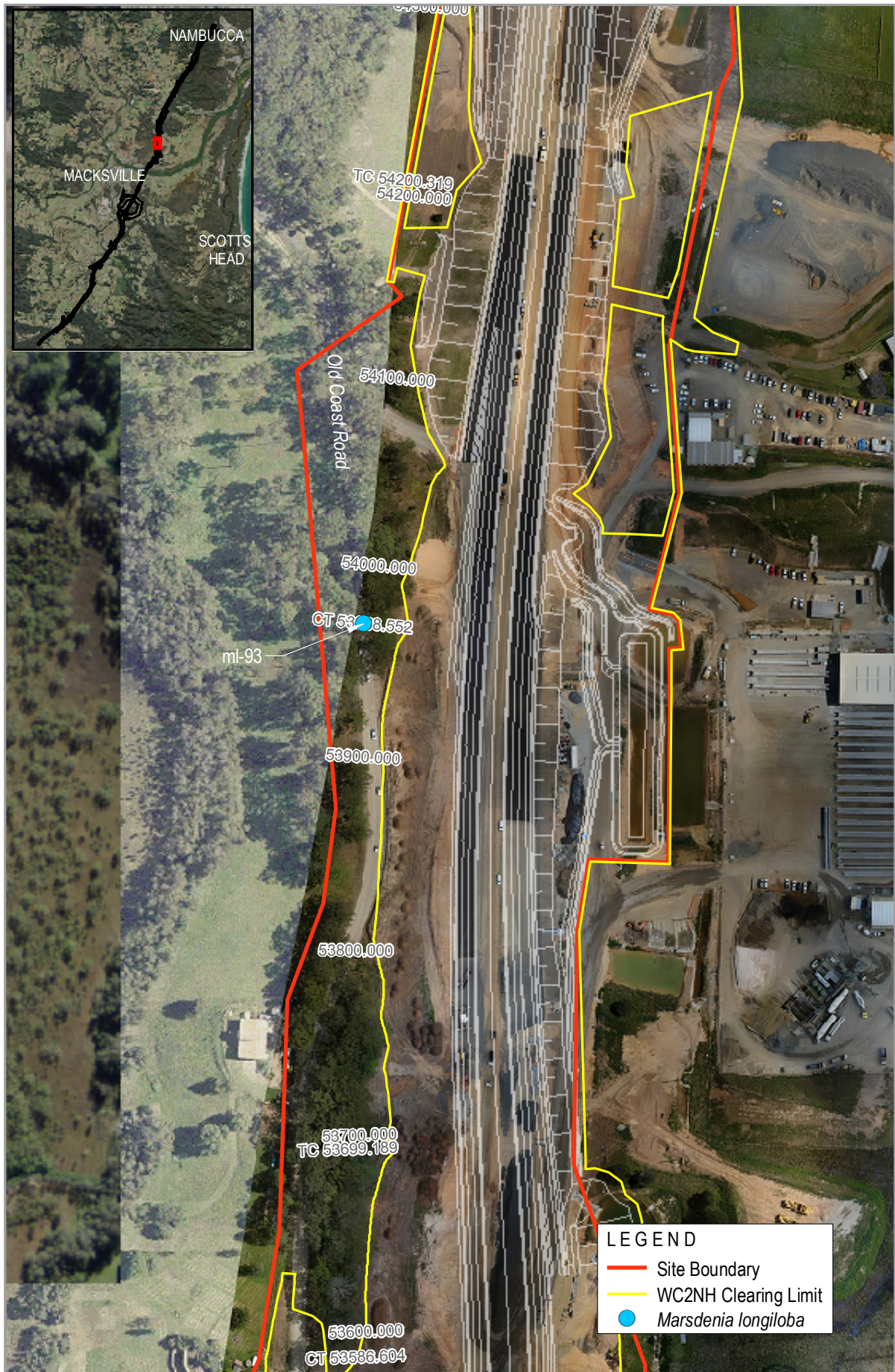


LEGEND

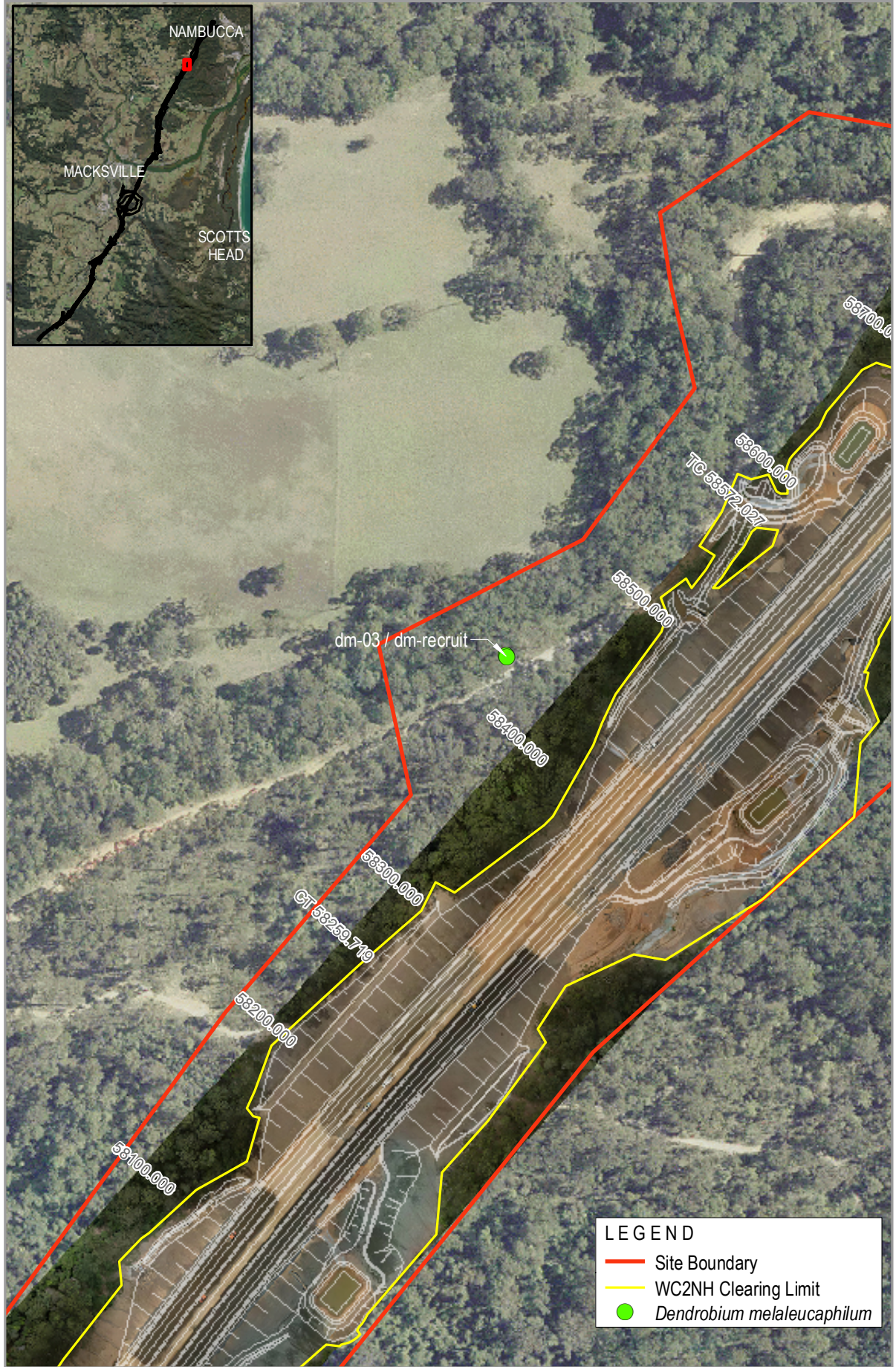
- Site Boundary
- WC2NH Clearing Limit
- Persicaria elatior***
- Autumn 2016
- Spring 2016



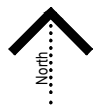
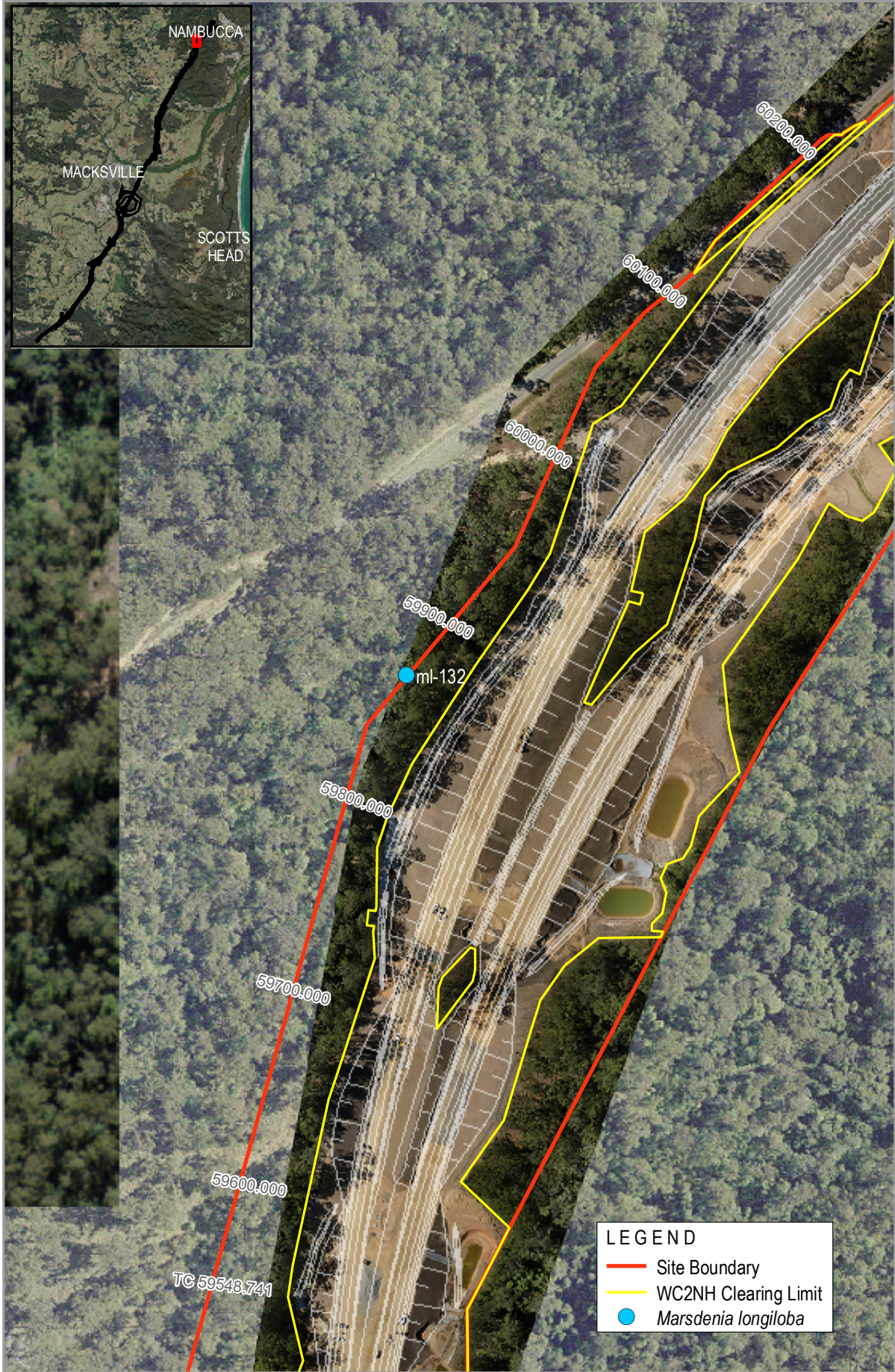
In-situ Threatened Flora Record Locations



In-situ Threatened Flora Record Locations



In-situ Threatened Flora Record Locations



0 60

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In-situ Threatened Flora Record Locations

WC2NH In-situ Threatened Flora and Habitat Monitoring Spring 2017
2378-1393

Illustration 2.6

3. Results

3.1 In-situ Threatened Flora

3.1.1 Monitoring results

Monitoring results for in-situ threatened flora are included below in **Tables 3.1 – 3.5**. Key points arising from the third and final year of monitoring are summarised below. Photographs of the various species are shown in **Plates 3.1 – 3.11**.

Tall Knotweed (*Persicaria elatior*)

- All Tall Knotweed plants within the monitoring area died back prior to the autumn 2015 monitoring surveys. A reference population of Tall Knotweed located in the Maclean locality (far north coast of NSW) was surveyed at the same time and was also found to have experienced complete die back during this period.
- New plants were identified within the monitoring area in autumn 2016 and were again recorded during spring 2016. This finding appears to be indicative of the natural life cycle of this species suggesting it may have an annual lifecycle. The subject population of this species was persisting in a healthy manner within the monitoring area during spring 2016.
- No Tall Knotweed plants were recorded during the spring 2017 monitoring event. Three months of low rainfall preceded the spring 2017 monitoring event (refer to **Table 3.6**) which may explain the lack of detectable plants at this location as no obvious signs of construction related impacts or disturbance to this population was recorded at the time of monitoring. No signs of project related erosion or sedimentation, entry into the delineated area or excessive or uncontrolled weed incursion was observed. Another nearby reference site in Maclean was surveyed on 18 September 2017 where a number of plants were recorded to be healthy and flowering. More detailed monthly monitoring of Tall Knotweed over differing seasonal conditions would be necessary to gain a further understanding of the lifecycle of this species.



Plate 3.1 No Tall Knotweed recorded during spring 2017, no obvious signs of construction related impacts or excessive weed incursions were observed.

Maundia (*Maundia triglochinos*)

Nambucca Floodplain

- Favourable growing conditions for Maundia (indicated by generally high rainfall) were present prior to and during construction in 2015. During this period large areas of Maundia were recorded adjacent to the project footprint in the Nambucca floodplain area. Since the commencement of monitoring the cover and abundance scores for this population has fluctuated over time.
- During the months preceding spring 2017 monitoring lower than usual rainfall levels were recorded which may have contributed to the reduction in cover and abundance of Maundia within the Nambucca Floodplain. Although a reduced percentage cover of Maundia has been recorded, these patches are distributed broadly across the monitoring site with good health and leaf condition with a class condition score of 3 to 4. To date this population of Maundia has had periods of higher and lower recorded numbers of cover and abundance which is typical of the lifecycle of this species which can be affected by natural hydrology and weather conditions with natural dieback occurring seasonally. During October 2017 156 mm of rain was recorded within the Macksville area which may make growing conditions favourable for Maundia during the spring/summer growing season.
- Similar reference populations in the Woodburn locality (far north coast of NSW) showed similar, apparent seasonal decreases in abundance.



Plate 3.2 Reduced patches of Maundia plants within the Nambucca Floodplain site appear to be in good health.



Plate 3.3 Healthy Maundia plants on the Nambucca Floodplain (centre of image).

Crouches Creek

- The population of Maundia within Crouches Creek was removed as part of the diversion of the creek in this location. Although translocation of this species was not prescribed as part of the WC2NH Threatened Flora Management Plan, salvage translocation was attempted within the new alignment of Crouches Creek. This translocation was considered to have been successful during the spring 2016 monitoring, however no visible Maundia plants were recorded within Crouches Creek during the spring 2017 monitoring event. It is possible that seasonal or natural die-back of this species may be occurring at this location. Alternatively, altered instream parameters due to the creek realignment, such as changes in water depth (Maundia prefers 30 - 60 cm water depth), sedimentation and/or reduced quality of substrate may have attributed to the lack of visible

Maundia plants within Crouches Creek at this time. On-going monitoring at this location would be required to get a better understanding of the success of the translocation of Maundia at this location. However, under the requirements of the TFMP translocation of Maundia within Crouches Creek was not a requirement due the species being locally abundant (within the Mid North Coast) and that the focus would be upon minimising impacts to retained populations of the species in-situ.



Plate 3.4 Maundia translocation site within Crouches Creek, no obvious signs of Maundia within the translocation site.



Plate 3.5 Maundia translocation site within Crouches Creek, no obvious signs of Maundia within the translocation site.

Spider Orchid (*Dendrobium melaleucaphilum*)

- The single in-situ Spider Orchid specimen remains in a healthy condition. The number of pseudobulbs (storage organs) on this plant has increased substantially during recent monitoring events. The recruitment of an additional individual occurring immediately below this plant on the same tree was first recorded during spring 2016. At the time of spring 2017 monitoring the strip of paperbark which the juvenile spider orchid was attached to was nearly detached. Yellow survey tape was wrapped around the bark with the expectation that the juvenile orchid will reattach to the tree trunk.



Plate 3.6 Existing mature Spider Orchid with evidence of flowering on pseudobulbs.



Plate 3.7 Juvenile Spider Orchid with yellow tape to affix strip of paperbark to the tree trunk.

Rusty Plum (*Niemeyera whitei*)

- In-situ Rusty Plums in the Cockburns Lane locality remain generally healthy and in good condition. During spring 2016 one plant (nw-56) recorded signs of edge effects with stunted yellowing leaves and minimal new growth due to its newly exposed position at the edge of the clearing limit. Spring 2017 monitoring has observed this plant to have healthy new growth and an increase in height. After consultation with the WC2NH botanist Dr Andrew Benwell, recommendations were made in spring 2016 report to install shade cloth, place mulch around the base of the tree and undertake supplementary watering of this plant. It appears that the placement of mulch or shade cloth was not implemented by Pacifico however supplementary watering has been undertaken post spring 2016 report last year and more recently during the three months preceding spring 2017 monitoring. It is now not considered necessary to implement these corrective measures given the health and growth of nw-56 has improved during recent months indicating that this plant may be adapting to the exposed conditions and has benefitted from supplementary watering.
- All other retained Rusty Plums were observed to be in good condition with new growth and height measurements recorded. Plants nw-64 and nw-73 recorded evidence of flowering; no fruit was recorded during spring 2017.
- Two Rusty Plums were detected during pre-clearing surveys in May 2017 and have now been added to the monitoring regime for this species. These plants appear to be in good health with no signs of disease or disturbance.



Plate 3.8 Rusty Plum (nw-56) with new growth appears to be improving in condition class compared to spring 2016.



Plate 3.9 Rusty Plum (nw-64) with new growth and evidence of flowering in the leaf axils.

Slender Marsdenia (*Marsdenia longiloba*)

- Slender Marsdenia plants at monitoring locations remain healthy with evidence of new growth. Evidence of regular die back of stems and plants has been a common observation with this species with the origin of stems being difficult due to sharing common rhizomes in some instances. This has made the tracking of individual plants over time problematic. Notwithstanding this, the monitoring to date has demonstrated the perseverance or re-emergence of Slender Marsdenia plants at monitoring locations.
- Consistent with previous results, spring 2017 monitoring recorded a number of plants which have died back. It may be that plants ml-72 and ml-63 have dead stems but that the stem bulb is still

alive below ground. It is also possible that the original ml-132 plant has died back but regrown as a new recruit or new plant from same stem bulb. Some plants have died back and regrown with young green plants now described where older mature plants were recorded previously.

- No Slender Marsdenia monitoring sites recorded any obvious construction related impacts by means of encroachment into protected areas, project related erosion or sedimentation or significant weed incursion.
- Site ml-93 has a healthy and dynamic population of Slender Marsdenia plants which are located directly adjacent to Old Coast Road which at varying times have been observed to receive increased dust deposition from passing traffic. Regardless, this population of plants has recorded large numbers of new recruits during spring 2016 and 2017 monitoring events.
- A number of plants previously included in the monitoring regime have been translocated as part of the approved WC2NH North-facing Ramps project.



Plate 3.10 Spring 2016 (pink tape) recruits of Marsdenia plants Old Coast Road Site (ml-93)



Plate 3.11 Spring 2017 (yellow tape) recruitment of Marsdenia plants Old Coast Road Site (ml-93)

Table 3.1 In-situ Threatened Flora Monitoring Results – Tall Knotweed

Tall Knotweed (<i>Persicaria elatior</i>)																																	
Plant ID #	Height (cm)					Leaf Condition					Flower/ Fruit Present					New Growth					Recruitment					Damage/ Disturbance					Notes		
	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016			
P1	42	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	All plants were found to be dead as of Autumn 2015. Recruitment of new plants was recorded from Autumn 2016 as shown below.
P2	56	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P3	30	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P4	26	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P5	35	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P6	42	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P7	25	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P8	18	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P9	35	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
P10	54	-	-	-	-	5	0	0	0	0	Y	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N		
New Plants Recorded as of Autumn 2016 (previous plants had died back)																																	
P11	-	-	-	50	100	-	-	-	1	5	-	-	-	Y	Y	-	-	-	Y	Y	-	-	-	N	Y	-	-	-	N	N	All plants with minor insect presence but otherwise healthy.		
P12	-	-	-	65	40	-	-	-	1	2	-	-	-	Y	N	-	-	-	Y	Y	-	-	-	N	N	-	-	-	N	N			
P13	-	-	-	90	45	-	-	-	3	4	-	-	-	Y	N	-	-	-	Y	Y	-	-	-	N	N	-	-	-	N	N			
P14	-	-	-	90	60	-	-	-	3	4	-	-	-	Y	N	-	-	-	Y	Y	-	-	-	N	N	-	-	-	N	N			
All plants previously recorded above have died back, no Tall Knotweed plants were recorded during spring 2017 monitoring, no obvious construction related impacts were recorded																																	

Table 3.2 In-situ Threatened Flora Monitoring Results – Maundia

Maundia (<i>Maundia triglochoides</i>)																																
Population	Cover-Abundance and (Condition Class Score)						Flower/ Fruit Present						New Growth						Recruitment						Damage/ Disturbance						Notes	
	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017		
Crouches Creek	20-40% (3)	30-60% (5)	30-60% (4)	-	10-20% (3)	- (0-1)	N	Y	N	-	N	-	N	Y	Y	-	Y	N	N	Y	Y	-	N	N	N	N	N	N	N	N	N	N/Y*
Nambucca Floodplain	10-20% (3)	70-80% (5)	70-80% (4)	10-20% (4)	20-40% (5)	10-20% (3)	N	Y	N	N	Y	N	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N

Table 3.3 In-situ Threatened Flora Monitoring Results – Spider Orchid

Spider Orchid (<i>Dendrobium melaleucaphilum</i>)																																					
Plant ID #	Length of longest pseudobulb (cm)						Leaf Condition						Number of pseudobulbs with leaves						New Growth						Recruitment						Damage/ Disturbance						Notes
	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	
DM3	30	35	35	35	35	40	2	2	2	2	3	4	6	6	7	25	25	20	Y	Y	Y	Y	Y	Y	N	N	Y	N	Y	N	N	N	N	N	N	N	Very healthy with signs of increased flowering activity.
DM Recruit	-	-	-	-	8	10	-	-	-	-	3	3	-	-	3	4	-	-	-	-	-	-	Y	Y	-	-	-	-	N	N	-	-	-	-	N	N	This new recruit was first observed during spring 2016 monitoring with increasing psuedobulbs recorded during spring 2017. Flagging tape was used to secure the piece of paperbark on which the plant was secured to the tree trunk in hope that the orchid will continue to attach to the tree or underlying layer of bark.

Table 3.4 In-situ Threatened Flora Monitoring Results – Rusty Plum

Rusty Plum (<i>Niemeyera whitei</i>)																																					
Plant ID #	Height (cm)						Leaf Condition						Flower/ Fruit Present						New Growth						Recruitment						Damage/ Disturbance						Notes
	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	
NW58	700	700	750	750	750	750	5	5	5	5	4	4	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	Not delineated with orange flagging, recommend install for additional protection.
NW56	100	100	100	110	120	130	5	4	4	3	2	3	N	N	N	N	N	N	Y	N	N	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	Discolouration of leaves due to being exposed (edge effects) during spring 16 however new healthy growth observed during spring 17.
NW73	600	600	600	600	600	650	5	5	5	5	4	5	N	N	N	N	N	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N/A
NW54	400	400	400	420	450	500	5	5	5	5	5	5	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	New growth shooting from roots.
NW64	500	500	500	550	600	650	5	5	5	5	5	5	N	N	N	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N/A
NW01-Geo	-	-	-	-	-	450	-	-	-	-	-	5	-	-	-	-	-	N	-	-	-	-	-	Y	-	-	-	-	-	N	-	-	-	-	-	-	Additional plants (not previously included in monitoring regime) appear in good health
NW02-Geo	-	-	-	-	-	500	-	-	-	-	-	5	-	-	-	-	-	N	-	-	-	-	-	Y	-	-	-	-	-	N	-	-	-	-	-	-	Additional plants (not previously included in monitoring regime) appear in good health

Table 3.5 In-situ Threatened Flora Monitoring Results – Slender Marsdenia

Slender Marsdenia (<i>Marsdenia longiloba</i>)																																						
Plant ID #	Height (cm)						Leaf Condition						Flower/ Fruit Present						New Growth						Recruitment						Damage/ Disturbance						Notes	
	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017	PC 2015	Aut 2015	Spr 2015	Aut 2016	Spr 2016	Spr 2017		
ML93	5	5	5	12	20	5-60	3	3	3	3	3	1-4	N	N	N	N	N	N	N	N	Y	N	Y	Y	N	N	N	Y	Y	Y	N	N	N	N	N	N	N	15 live plants now within 1 m radius of subject plant. All range from 2 – 4 in condition class. Some plants recorded during spring 2016 have died back however new recruits have also been recorded and are now at a count of 23 flagged individual plants.
ML92	5	8	10	8	-	-	2	2	2	2	-	-	N	N	N	N	-	-	Y	N	Y	N	-	-	N	N	Y	N	-	-	N	N	N	N	-	-	These plants were translocated as part of the approved north-facing ramps proposal.	
ML140	15	15	20	25	-	-	2	2	3	2	-	-	N	N	N	N	-	-	N	N	Y	N	-	-	N	N	Y	N	-	-	N	N	N	N	-	-		
ML131	5	-	-	-	-	-	1	0	0	0	-	-	N	-	-	-	-	N	N	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-	-		
ML132	40	40	50	52	30	50	3	3	3	2	3	3	N	N	N	N	N	N	Y	Y	Y	N	N	Y	N	N	N	N	N	Y	N	N	N	N	N	N	During Spring 2016 partially natural die back was recorded. The plant recorded during spring 2017 is fresh, green with new growth indicating possibly a new plant to the one previously recorded.	
ML72	5	5	8	15	31	100	2	3	3	3	4	1	N	N	N	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	Natural die back of the stem, possibly live stem bulb. No obvious signs of construction related impacts.	
MI138	5	5	5	10	40	230	2	0	0	2	3	4	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	Tall plant with mature leaves some yellowing.	
ML63	10	10	10	11	13	120	2	0	0	2	3	1	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	Natural die back of the stem, possibly live stem bulb. No obvious signs of construction related impacts.	

Table 3.6 Monthly Rainfall Data (mm) (source: WC2NH northern weather station, data from weathermation.com)

	<i>Jan</i>	Feb	<i>Mar</i>	Apr	<i>May</i>	Jun	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
2015			93.4	121	207	21	16	25	108	33.6	140	213
2016	99.4	36.2	47.4	90.8	12	328	31	167	37.8	48	35.8	47.8
2017	74.4	95.6	506.4	107	79.2	214	8.2	0.4	0	156		

3.1.2 Conclusion

Based on the monitoring results, the majority of in-situ threatened flora appear to be persisting with good condition scores for health overall (refer to **Table 3.7**). A number of sites and species including Slender Marsdenia and Maundia have recorded new growth and new recruits while other sites of the same species have undergone what appears to be seasonal or natural die-off. For example, Maundia in Crouches Creek was recorded to have been successfully translocated into the newly constructed creek realignment during spring 2016 monitoring, however does not appear to be present at the site during Spring 2017 monitoring. Slender Marsdenia has recorded plant die-back at a number of locations and also recruitment of new plants at the same sites over time.

Monitoring of the Spider Orchid has recorded a new recruit during spring 2016 which has persisted, with new growth also recorded during spring 2017. This additional plant has now been added to the monitoring regime for future data collection during the project operational phase of monitoring.

Tall Knotweed at the northern end of the Nambucca Floodplain was not recorded at all during spring 2017 monitoring. This result is not unusual for this species, which is known for fluctuations in presence at the subject monitoring site and also reference sites within the Maclean area (northern NSW).

Rusty Plum around the Cockburns Lane area appear to be in good health with all plants recording new growth and condition class scores of three or above during spring 2017. Two mature plants not previously monitored and added to the monitoring regime also appear in good health.

No in-situ threatened flora sites have recorded direct construction related impacts by means of access into protected areas, project related erosion and sedimentation or significant weed incursion. Edge effects as a result of clearing for the project alignment have been recorded to impact Rusty Plum (nw-56); however, the health of this plant seems to have improved with new green leaf growth and increase in height measurements indicating that this plant is adapting to its position on the edge of the clearing footprint. Slender Marsdenia at the edge of Old Coast Road are likely to receive increased levels of dust deposition as a result of traffic, when compared to plants further away from unsealed local roads. However, this site has a healthy and dynamic population of plants with 23 new individual plants recorded since spring 2016.

WC2NH project landscaping has been largely implemented across the project in accordance with the project Urban Design and Landscape Plans and RMS specifications which address the requirements of the TFMP with regard to:

- Re-use of locally sourced weed free topsoil with local topsoil seed bank.
- Revegetation with native ground covers, shrubs and small trees.
- Stabilisation of the soil via revegetation around in-situ threatened flora as soon as earthworks are completed.

Although the survival rates of in-situ threatened flora do not meet the performance indicator minimum requirements, no die-back or direct construction related impacts have been recorded as having contributed to the monitoring results to date. Corrective actions are discussed within the TFMP (refer to **section 5.3.5**) if the performance measures are not met; however, none of the corrective actions have been triggered based on the most recent monitoring results with regard to weed control, plant theft or protection from edge effects (although this measure was recommended during spring 2016).

Overall, the protective measures implemented for the project to safeguard retain threatened flora have been effective with no plant mortality directly associated with impacts from construction activities.

Table 3.7 Performance measures

Species	Survival rate at finish of clearing (October 2015/ spring 2015) is 100%, no accidental damage due to clearing	Survival rate at end of years 1-3 is >80%	Of surviving plants at end of each year >75% are in good condition (class 3 or >) healthy foliage, no signs of die-back or disease and new shoot growth present?			Any obvious signs of construction related impacts?	Considerations	Notes
			Year 1 - 2015	Year 2 - 2016	Year 3 - 2017			
Tall Knotweed (<i>Persicaria elatior</i>)	100% of pre-construction plants died back before. No accidental damage due to clearing.	No	No pre-construction plants were recorded during 2015.	100 % of plants recorded during autumn 2016 survived into spring 2016. All plants were recorded in good health with condition class of >3 no signs of disease or die-back. New shoot growth was present.	No 2016 plants were recorded during 2017.	No - construction related disturbances via encroachment into the protected area, project related erosion or sedimentation or excessive weed encroachment have been recorded.	No clearing was undertaken within the vicinity of this population of Tall Knotweed	This population of Tall Knotweed has previously recorded dieback likely due to seasonal or life cycles natural for the species. Three months of very low rainfall preceding the spring 2017 monitoring event may have contributed to the die back of this species.
Spider Orchid (<i>Dendrobium melaleucaophilum</i>)	Yes – 100% survival. No accidental damage due to clearing.	Yes - 100% survival.	Yes – 100% in good condition (score 2).	Yes – 100% in good condition, with new recruit. recorded also in good condition (score 3).	Yes – 100% (including new recruit) in good condition (Score 4).	No – these plants are located a safe distance from construction activities.		The health and size of this plant has been improving/ increasing over the monitoring period with a new recruit also recorded.
Maundia (<i>Maundia triglochoides</i>)	Yes - 100% survival. No accidental damage due to clearing.	Yes - 83% survival (10 of 12 monitoring events. recorded presence of healthy Maundia plants across the two sites).	Yes – 100% in good condition (score 4 and 4).	Yes – 100% in good condition (score 3 & 5).	No – Maundia Crouches Creek not observed. Yes – 100% of visible plants in good condition (score 3).	Potential impacts from translocation process may have caused the translocated plants to die-back over time Nambucca Floodplain: No - construction related disturbances via encroachment into the protected area, project related erosion or sedimentation or excessive weed encroachment have been recorded.	Dynamic nature of wetland species therefore cover and abundance are known to fluctuate due to climatic and hydrological conditions. Difficult to accurately count individual plants so percentage cover is used. Species life cycles also factor in fluctuations of abundance.	Three months of very low rainfall preceding the monitoring event may have contributed to some die back of this species.
Rusty Plum (<i>Niemeyera whitei</i>)	Yes - 100% survival. No accidental damage due to clearing.	Yes - 100% survival.	Yes – 100% in good condition (score 4 - 5).	Yes – 80% in good condition (score 2 - 5).	Yes – 100% in good condition (score 3 - 5).	Nw-56 recorded discolouration of leaves due to being exposed at edge of clearing footprint (edge effects) during spring 2016. However new healthy growth was observed during spring 2017. No construction related impacts were recorded for other Rusty Plum.	Recommendations to shade mulch and water nw-56 were advised to Pacifico (as per corrective actions) but not implemented however this plant appears to be adapting to the new exposed position with significant new leaf growth and minimal discolouration.	All retained Rusty Plum appear to be in good health. Two additional Rusty Plum records have been recorded and added to the monitoring regime.
Slender Marsdenia (<i>Marsdenia longiloba</i>)	No – 62% of plants were recorded as living. No construction related impacts were recorded.	No – 60% (3 of 5 remaining ML records).	No – 62% (5 of 8 records) recorded scores 0 – 3.	Yes -100% (5 of 5 records) recorded scores 3 – 4.	No – 60% (3 of 5 records) recorded scores 1 – 4.	No - construction related disturbances via encroachment into the protected area, project related erosion or sedimentation or excessive weed encroachment have been recorded.	Three plants were translocated for the North Facing Ramps Clearing footprint, so reduced records from 8 to 5. Natural seasonal die-back of this species is common, with die-back and re-emergence of plants from rhizomes typical.	

3.2 Slender Marsdenia and Woolls' Tylophora Habitat Condition Monitoring

3.2.1 Methodology

As required within the WC2NH TFMP, monitoring of potential changes in the habitat of Slender Marsdenia and Woolls' Tylophora is to be conducted within the indirect impact zone – i.e. within 10 m of the edge of clearing construction. Monitoring is to be conducted in areas of this habitat adjacent to the construction footprint and is to be plot based. Permanent plots were established in the indirect impact zones at 10 representative points in Slender Marsdenia and Woolls' Tylophora habitat as mapped by Dr Andrew Benwell in spring 2010. Each plot is 10 m wide and 20 m long, with the long axis parallel to the edge of clearing (refer to **Illustrations 3.1-3.3**). The corners of each plot were marked with pink flagging tape and the GPS co-ordinates of the corners of plots also recorded. Plots were established on 26 November 2015 around the time that clearing operations in the northern zone of the project were being completed. Data was collected at the plots again during autumn (23 - 27 May 2016) and spring (21 - 13 November 2016). The following parameters were measured at each plot (refer to Section 5.4 of the TFMP for more information):

- Native vegetation structure
- Level of weed incursion
- Microclimate class.

Photographs of the monitoring plots are shown in **Plates 3.12 and 3.13**.

3.2.2 Monitoring results

A summary of the results of the monitoring is provided in **Table 3.9**. While there has been changes in light infiltration and potential disturbance via edge effects, monitoring results shows that the quadrat plots have remained largely unchanged since the commencement of monitoring. An increased percentage cover of native vegetation in the groundcover and mid-storey strata has been recorded, but there has been no significant increase in percentage cover of existing weed species.

It should be noted that a review of Quadrat 9 (Q9) monitoring location was undertaken due to an increase in the presence of Broad-leaf Paspalum between autumn and spring monitoring (5 - 20 percent). This species is the dominant groundcover within an area of previously cleared access track located within the northern end of Q9. Based on this review, the Q9 quadrat location was relocated 15 m further south to capture a more representative example of Slender Marsdenia and Woolls' Tylophora habitat, excluding the area of previously cleared access track. This has reduced the weed level to less than five percent weed cover for monitoring to date in Q9.



Plate 3.12 Example of Habitat Condition Monitoring Plots

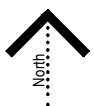


Plate 3.13 Example of Habitat Condition Monitoring Plots






LEGEND

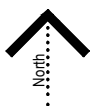
- Project boundary
- Clearing limit
- Quadrat








LEGEND

-  Project boundary
-  Clearing limit
-  Quadrat





LEGEND

-  Project boundary
-  Clearing limit
-  Quadrat

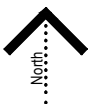


Table 3.6 Slender Marsdenia and Wools' Tylophora Habitat Condition Monitoring

Quadrat	Vegetation Structure (dominant species, height, cover)			Weed Level	Microclimate Class
	Canopy	Mid-storey	Ground cover		
1	Flooded Gum, Swamp Turpentine – 25m	Red Ash, Brush Box, Swamp Turpentine, Rosewood – 3-8m	Gristle Fern, Water Vine, Mat-rush, Native Jasmine – 0.5m	Lantana	
Spring 15	5%	50%	40%	<5%	5
Autumn 16	5%	50%	40%	5%	5
Spring 16	5%	45%	45%	5%	5
Spring 17	5%	60%	45%	5%	5
2	Swamp Turpentine, Forest Oak, Tallowwood – 20m	Black Wattle, Red Ash, Brush Box, Rosewood – 3-6m	Gristle Fern, Palm Lily, Mat-rush, Native Jasmine – 0.5m	Lantana	
Spring 15	15%	60%	10%	<5%	5
Autumn 16	15%	65%	15%	5%	5
Spring 16	15%	65%	15%	10%	5
Spring 17	15%	65%	20%	10%	5
3	Swamp Turpentine, Flooded Gum, Ironbark – 22m	Rosewood, Red Ash, Black Wattle, Cabbage Palm – 2-10m	Gristle Fern, Mat-rush, Native Jasmine – 0.5m	Lantana	
Spring 15	5%	70%	10%	<5%	1
Autumn 16	5%	70%	10%	<5%	1
Spring 16	5%	70%	10%	<5%	1
Spring 17	10%	70%	30%	<5%	1
4	Flooded Gum, White Mahogany, Swamp Turpentine – 25m	Red Ash, Forest Oak, Cabbage Palm, Rosewood -3-8m	Water Vine, Palm Lily, Saw-sedge, Gristle Fern – 0.5m	No weeds	
Spring 15	5%	10%	30%	-	2
Autumn 16	5%	10%	30%	-	2
Spring 16	5%	10%	35%	-	2
Spring 17	5%	10%	45%	-	2
5	Ironbark, Brush Box, Tallowwood, Swamp Turpentine – 28m	Forest Oak, Swamp Turpentine, Cabbage Palm, Palm Lily – 3-8m	Mat-rush, Gristle Fern, Palm Lily. Regrowth shrub species Cheese Tree and Banana Bush – 0.5m	Lantana	
Spring 15	50%	15%	15%	<5%	5
Autumn 16	50%	20%	15%	<5%	5
Spring 16	50%	20%	15%	<5%	5
Spring 17	55%	25%	25%	<5%	5
6	White Mahogany, Brush Box, Paperbark – 20m	Black Wattle, Cabbage Palm, Palm Lily, Geebung – 3-8m	Mat-rush, Gristle Fern, Palm Lily <1m	Lantana	
Spring 15	50%	40%	30%	5%	4
Autumn 16	50%	40%	30%	5%	4
Spring 16	50%	40%	35%	5%	4
Spring 17	55%	50%	35%	5%	4
7	Tallowwood – 20m	Red Ash, Rosewood, Acacia sp, Leptospermum sp – 2-8m	Gristle Fern, Bracken Fern, Mat-rush – 0.5m	No weeds	
Spring 15	10%	25%	50%	-	1
Autumn 16	10%	25%	50%	-	1

Quadrat	Vegetation Structure (dominant species, height, cover)			Weed Level	Microclimate Class
	Canopy	Mid-storey	Ground cover		
Spring 16	10%	25%	50%	-	1
Spring 17	15%	25%	50%	-	1
8	Paperbark, Brush Box, White Mahogany – 18m	Cheese Tree, Rosewood, Geebung, Lilly Pilly – 2-8m	Gristle Fern, Mat-rush, Bracken Fern, Water Vine, Palm Lily – 0.5m	Lantana	1
Spring 15	40%	40%	25%	5%	1
Autumn 16	40%	40%	30%	5%	1
Spring 16	40%	40%	30%	7%	1
Spring 17	40%	40%	35%	5%	1
9	Tallowwood, Swamp Turpentine, Flooded Gum – 28m	Palm Lily, Paperbark, Cabbage Palm, Acacia sp., Cheese Tree – 2-8m	Saw-sedge, Jasmine, Gristle Fern, Mat-rush - <0.5m	Lantana, Broad-leaved Paspalum	
Spring 15	40%	30%	25%	5%	1
Autumn 16	40%	30%	25%	5%	1
Spring 16	40%	30%	30%	<5%	1
Spring 17	45%	30%	40%	<5%	1
10	Flooded Gum – 30m	Sandpaper Fig, Red Ash 6-8m	Jasmine, Bracken Fern – 0.5m (5%)	Lantana <5%	
Spring 15	5%	30%	5%	<5%	4
Autumn 16	5%	30%	10%	<5%	4
Spring 16	5%	30%	20%	<5%	4
Spring 17	10%	30%	25%	<5%	4

3.2.3 Conclusion

To date there are no substantial changes in Woolfs' Tylophora and Slender Marsdenia habitat occurring adjacent to the clearing boundary as recorded from the monitoring plots. The minor changes in vegetation strata to date have not affected any microclimate class scores for any of the quadrats monitored (refer to summary of performance measures at **Table 3.10**). It is envisaged that any substantial changes to the condition/ composition of monitoring plots would be likely to be recorded over a longer time period from the initial disturbance associated with clearing for the project. This report is likely to present the complete data for the construction phase of the project as the scheduled project completion date is set for summer 2017/2018.

Table 3.7 Slender Marsdenia and Woolls' Tylophora Habitat Condition Performance Measures

<i>Quadrat</i>	<i>Plot crown-cover of exotic species is no more than 15% at end of Year 1</i>	<i>Plot crown-cover of exotic species is no more than 25% at end of Year 3</i>	<i>Baseline vegetation structure (height and crown cover) remains the same or increases in height and crown cover at the end of year compared to the previous year.</i>	<i>There is no increase in the microclimate exposure class (e.g. 1 to 2, or 4 to 5) compared to the previous year.</i>
1	No - weed cover not more than 5%	No - weed cover not more than 5%	No - the mid-storey percent cover recorded a decrease from 50% cover in Year 1 to 45% in Year 2 but an increase in percent cover to 60% in year 3.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
2	No - weed cover not more than 5%	No - weed cover not more than 10%	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
3	No - weed cover not more than 5%	No - weed cover not more than 5%	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
4	No weeds were recorded within this quadrat	No weeds were recorded within this quadrat	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
5	No - weed cover not more than 5%	No - weed cover not more than 5%	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
6	No - weed cover not more than 5%	No - weed cover not more than 5%	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
7	No weeds were recorded within this quadrat	No weeds were recorded within this quadrat	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
8	No - weed cover not more than 5%	No - weed cover not more than 5%	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
9	No - weed cover not more than 5%	No - weed cover not more than 5%	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.
10	No - weed cover not more than 5%	No - weed cover not more than 5%	Yes - all levels of height and crown cover has remained the same or recorded an increase when compared to previous year.	No - All microclimate exposure classes were recorded to remain the same between monitoring years.

4. Conclusion

Based on the monitoring results, in-situ threatened flora monitoring has observed fluctuations in presence/ absence and health condition scores for a number of the species subject to monitoring. The variation in presence/ absence and plant health amongst species such as Tall Knotweed, Maundia and Slender Marsdenia is not unusual for these species, which may exhibit seasonal or natural die off due to life cycle or seasonal and climatic influences. The fluctuation in results is not considered to be attributable to project related impacts, as no in-situ threatened flora sites have recorded direct construction related impacts by means of access into protected areas, project related erosion and sedimentation or significant weed incursion.

Although the survival rates of in-situ threatened flora do not meet the performance indicator minimum requirements, no die-back or direct construction related impacts have been recorded as having contributed to the monitoring results to date. Overall, the protective measures implemented for the project to safeguard retained threatened flora have been effective with no plant mortality directly associated with impacts from construction activities.

To date there are no substantial changes in Woolls' Tylophora and Slender Marsdenia habitat occurring adjacent to the clearing boundary as recorded from the monitoring plots. An increased percentage cover of native vegetation in the groundcover and mid-storey strata has been recorded, with no significant increase in percentage cover of existing weed species. The minor changes in vegetation strata to date have not affected any microclimate class scores for any of the quadrats monitored.

This report presents a complete set of results for the construction phase monitoring including pre-construction baseline monitoring and Years 1 – 3 of the construction phase. Project completion is scheduled for summer 2017/2018. From this time the project will enter the operational phase of monitoring and will be undertaken by the appointed ecological consultant.

5. References

Benwell, A. (2014). *Warrell Creek to Urunga Upgrade of the Pacific Highway Threatened Flora Management Plan, Version 4*. Unpublished document for Roads and Maritime Services, NSW.

Benwell, A. (2016). *Warrell Creek to Urunga Upgrade of the Pacific Highway Threatened Flora Management Plan, Version 5*. Unpublished document for Roads and Maritime Services, NSW.

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