

DEPARTMENT OF TRANSPORT AND
MAIN ROADS

NOVEMBER 2020

**LOWLAND RAINFOREST
TEC BASELINE
MONITORING REPORT
KAWANA AND WOONDUM
OFFSETS AREAS 2020
COOROY TO CURRA
STAGE D**



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Lowland Rainforest TEC Baseline Monitoring Report Kawana and Woondum Offsets Areas 2020

Cooroy to Curra Stage D

Department of Transport and Main Roads

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1 INTRODUCTION AND PURPOSE

The Department of Transport and Main Roads (TMR) proposes to upgrade and realign a section of the existing Bruce Highway, including a bypass to the east of Gympie. This package of works is termed the Bruce Highway Cooroy to Curra Section D Project (the Project). The Project construction area extends for approximately 30 km and will include the acquisition of a project corridor to ultimately accommodate a six-lane divided carriageway.

TMR received conditions of approval (EPBC 2017/7941) for the Project from the Commonwealth Department of Agriculture, Water and Environment (DAWE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC approval conditions require the delivery of specific environmental offsets for direct and indirect impacts to the Lowland Rainforest of Subtropical Australia Threatened Ecological Community (Lowland Rainforest TEC) as a result of the Project.

To maintain compliance with the EPBC Act approval conditions, TMR is required to establish, manage and monitor two Project related environmental offset areas at Kawana and Woondum containing the Lowland Rainforest TEC.

The purpose of this report is to provide a baseline assessment of the ecological condition of each offset area located at Kawana and Woondum. In accordance with the EPBC 2017/7941 approval conditions, this baseline assessment involves the monitoring of vegetated buffer zones adjacent to the mapped areas of Lowland Rainforest TEC at each offset area, including mapping of vegetation communities within the buffer zones, weed presence and identifying sites for targeted natural regeneration.

This report communicates to TMR, the results of the 2020 baseline monitoring and provides recommendations to improve the ecological condition at the Kawana and Woondum offset areas. Specifically, this report provides details regarding the field survey methods, results and discussion on the following elements for each area in accordance with the requirements of the baseline and monitoring survey program, as prescribed by the Project Environmental Offsets Strategy (GHD 2019):

- details of the suitably qualified person (SQP)
- the establishment and location (GPS coordinates) of permanent monitoring sites at each offset area
- the results of baseline monitoring at each monitoring site in accordance with the BioCondition methodology (Eyre et al 2019) and the ‘Modified Qld Habitat Quality Guide (DAWE)’
- species richness collected at each site including discussion on the number of species recorded across each offsets area in relation to Appendix A of the Threatened Species Scientific Committee (TSSC) (2011) Commonwealth Listing Advice on Lowland Rainforest of Subtropical Australia. Department of Sustainability, Environment, Water, Population and Communities (Listing Advice)
- qualitative observations and photo monitoring points of evidence of past and current land use and degradation (including cleared areas, evidence of disturbance erosion rubbish, access track etc.)
- buffer zone assessments (Including Quaternary level vegetation site assessments, weed mapping and potential areas for natural regeneration and/or revegetation)
- conclusions and recommendation.

2 METHODS

In accordance with approval conditions the baseline monitoring was led by a suitably qualified person (refer CV Appendix A) and undertaken 5–6 May 2020.

The 2020 Lowland Rainforest TEC baseline monitoring was undertaken in accordance with the following methods:

- Project Draft Environmental Offsets Strategy (GHD 2019)
- The Threatened Species Scientific Committee’s Commonwealth Listing Advice on Lowland Rainforest of Subtropical Australia (TSSC, 2011) prepared by the Commonwealth of Australia describes different characteristics of the TEC and provides the key diagnostic criteria and threshold conditions for identifying the TEC (Listing Advice) (refer section 2.1).
- BioCondition: A Condition Assessment Framework for Terrestrial Biodiversity in Queensland method (Eyre et al, 2015) (refer section Eyre et. al., 2015).
- The Department of Environment and Science’s Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland (current version 5.0, March 2019) (Neldner et al., 2019).
- The Guide to determining terrestrial habitat quality A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy (the Guide) (DEHP 2017).
- Results of the field surveys were analysed using a combination of the BioCondition method and the *Modified QLD Habitat Quality spreadsheet – template* (DAWE 2019) (refer 2.4).

2.1 LOWLAND RAINFOREST TEC LISTING ADVICE

The results from all the survey sites within each offset area have been assessed against the key diagnostic characteristics for the Lowland Rainforest TEC taken from the Listing Advice including:

KEY DIAGNOSTIC CHARACTERISTICS:

- Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions, according to Interim Biogeographic Regionalisation for Australia (IBRA) version 6.1 (2004).
- The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments.
- The ecological community generally occurs at an altitude less than 300 m above sea level.
- The ecological community typically occurs in areas with high annual rainfall (>1300 mm).
- The ecological community is typically more than 2 km inland from the coast.
- The structure of the ecological community is typically a tall (20–30 m) closed forest, often with multiple canopy layers.
- Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A of the Listing Advice).

2.2 BIOCONDITION MONITORING AND SPECIES RICHNESS

The BioCondition monitoring was conducted at four newly established monitoring transects including two transects in each offset area, as listed in Table 2.1 and depicted on Figure 2.2 for Kawana and Figure 2.3 for Woondum. Each BioCondition monitoring site occupies a 100 m x 50 m (0.5 ha) area (within which 13 site-based ecological condition indicators are measured).

Table 2.1 Lowland rainforest TEC BioCondition monitoring locations (MGA Zone 56)

OFFSET SITE	BIOCONDITION SITE NO	GPS START	GPS CENTRE	GPS END
Kawana	KBC1	510570.0117 E	510528.2466 E	510568.3065 E
		7041740.854 N	7041739.338 N	7041723.134 N
Kawana	KBC2	510475.1617 E	510400.7614 E	510345.8546 E
		7041757.214 N	7041489.801 N	7041467.473 N
Woondum	WBC1	471367.2 E	471296.2 E	471332.3 E
		7096624 N	7096558 N	7096596 N
Woondum	WBC2	471223.4428 E	471262.0285 E	471307.5423 E
		7096497.726 N	7096497.726 N	7096508.902 N

The method for collecting monitoring data for the 13 site-based ecological condition indicators is summarised as follows:

- 100 x 50 m area:
 - number of large trees
 - recruitment of canopy species
 - tree canopy height
 - native tree species richness.
- along 100 m transect centreline:
 - native tree canopy cover
 - native shrub canopy cover
- 50 x 10 m sub-transect, centred from the 25 m point to the 75 m point along the centre transect, and encompassing 5 m either side of the transect:
 - non-native plant cover
 - plant species richness of shrubs
 - plant species richness of grass
 - plant species richness of forbs and others
- 50 x 20 m sub-transect, centred from the 25 m point to the 75 m point along the transect, and encompassing 10 m either side of the transect:
 - coarse woody debris
- five 1 x 1m quadrats, starting at the 35 m point and located on alternate sides of the centreline, 10 m apart along the 100 m transect, with an average value derived the five 1 x 1 m quadrats:
 - native grass cover
 - organic litter.

In addition to the 13 site-based ecological condition indicators collected, directional photos (N, E, S and W) from the 50 m transect centre of each monitoring transect, as well as photographs of groundcover at each 1 x 1 m quadrat were also undertaken for the purpose of monitoring visual changes of the vegetation over time.

Evidence of site degradation, such as accelerated soil erosion, pest animal presence or damage, pest plant infestations, and any other notable sign of degradation was also recorded.

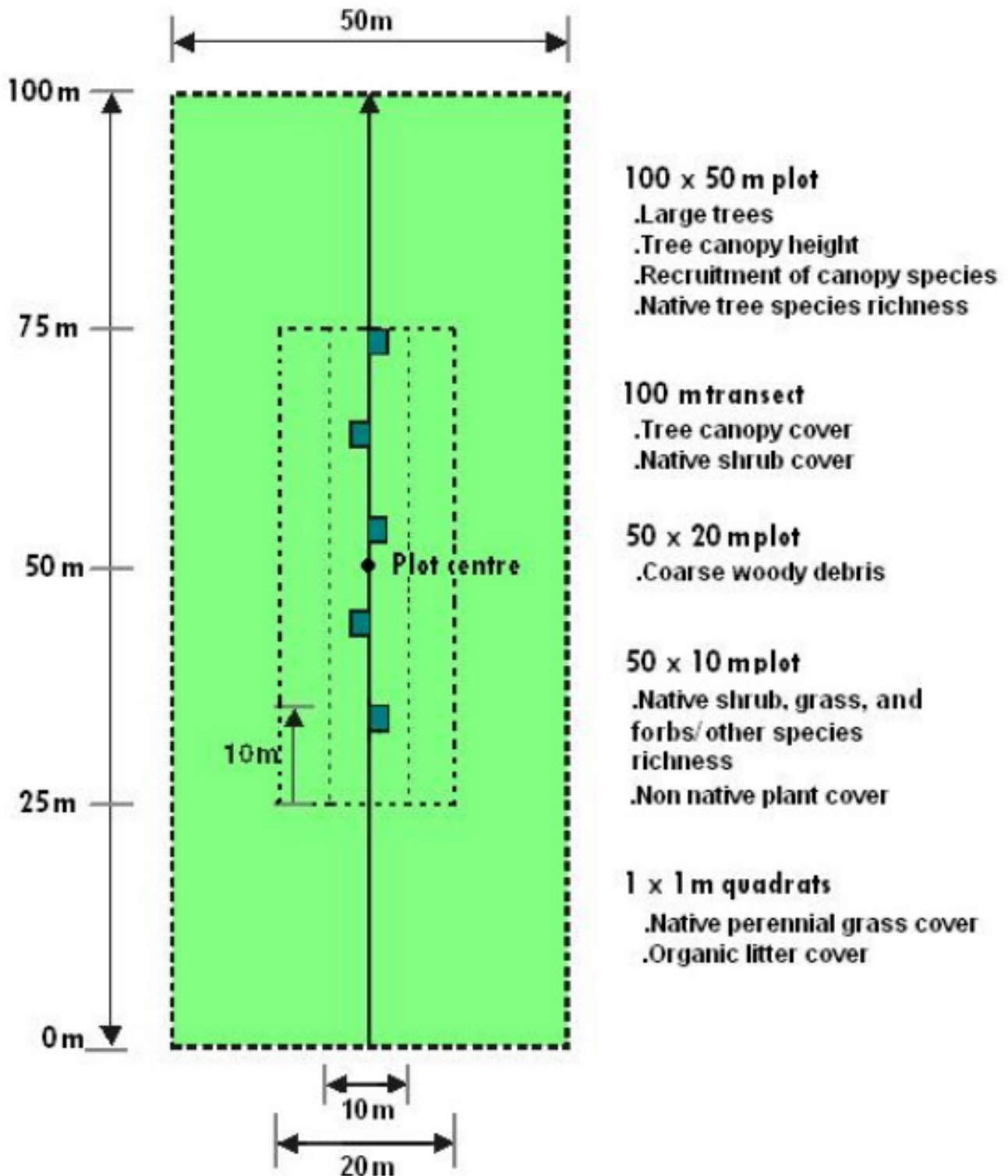


Figure 2.1 Standard layout of a BioCondition survey or monitoring transect

Within each survey site, plants were either identified in the field by the SQP or samples were collected in a field herbarium for later identification using suitable reference keys and reference material including:

- Rainforest Plants of Australia Rockhampton to Victoria. Interactive Key. (Harden et al 2014)
- Rainforest Trees and Shrubs – Second Edition (Harden, G. McDonald, B. & Williams 2018)
- Rainforest Climbing Plants – Revised Edition (Harden, G. McDonald, B. & Williams 2014).

Where plant samples were unable to be identified, or confirmed, they were forwarded to the Queensland Herbarium for verification. This provides quality assurance and an extra level of certainty for questionable identifications, as rainforest species can appear to be very similar, but in fact be a different species. This is most pertinent when assessing against key diagnostics in the Lowland Rainforest TEC Listing Advice where specific species are required to confirm presence/absence of a TEC.

The results of the species richness sampling for all sites were combined and were checked against the Appendix A of the Listing Advice to determine the number present as a baseline for each offset area as an entire patch.

2.3 BUFFER ZONE SURVEYS

Baseline Quaternary sites (Neldner et al 2019) were undertaken at regular intervals along each offset area buffer zone (refer Figure 2.2 for Kawana and Figure 2.3 for Woondum) for the following purposes:

- to verify the vegetation communities and regional ecosystems surrounding the mapped Lowland Rainforest TEC
- to determine the presence/absence of invasive plant and weed species
- to assess whether there are any suitable areas for assisted natural regeneration

Ongoing weed monitoring sites and assisted natural regeneration sites have been indicated for Kawana on Figure 4.1 and Woondum on Figure 4.4.

2.4 HABITAT QUALITY DATA ANALYSIS

Benchmarks for scoring site ecological condition were sourced from *BioCondition Benchmarks for Regional Ecosystem Condition Assessment South East Queensland for Regional Ecosystem 12.11.10* (DES, 2019) for Woondum and were also provided as *Draft Benchmarks for Regional Ecosystem 12.3.1a* by the Queensland Herbarium for Kawana.

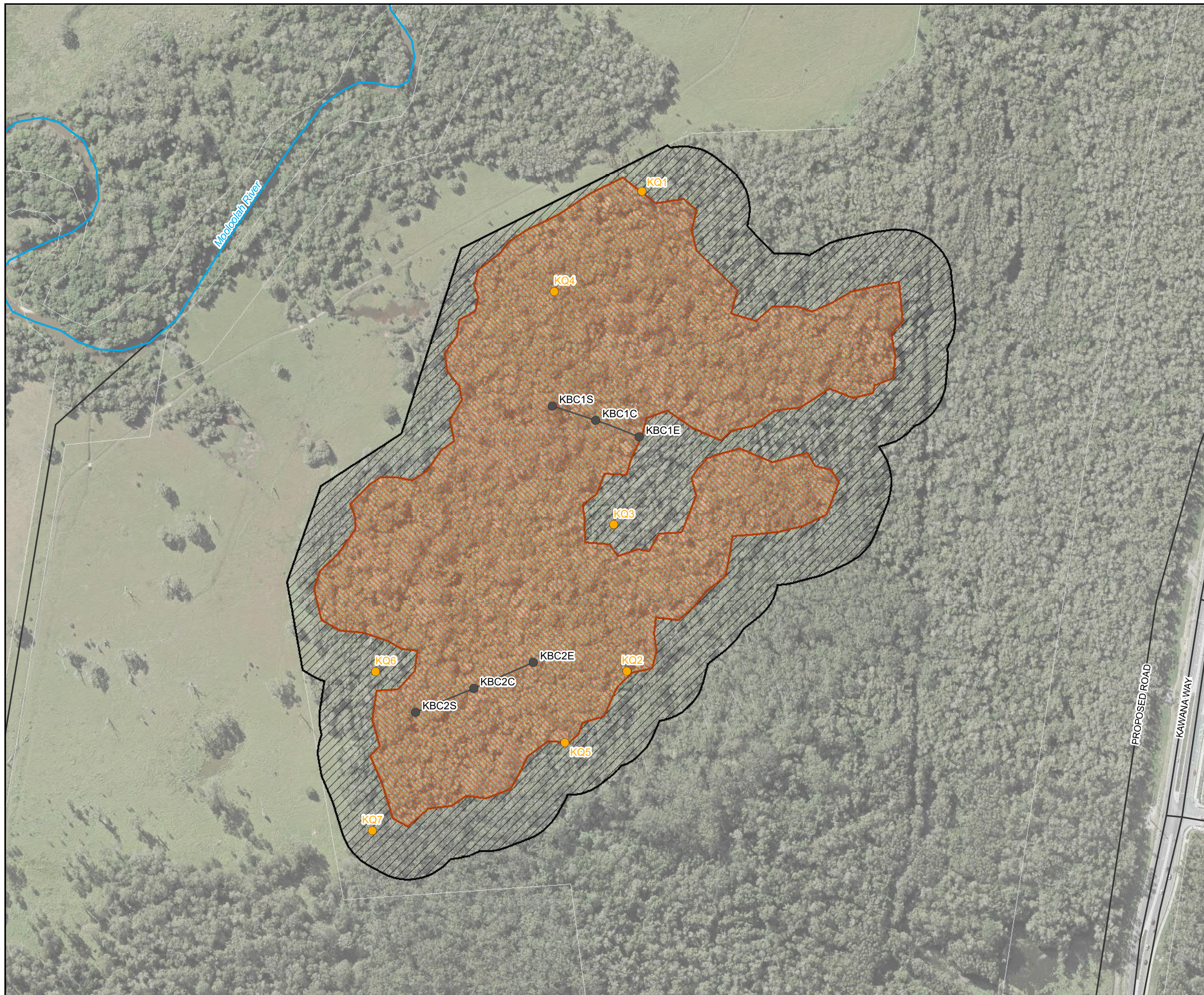
Site condition scores for each of the regional ecosystems are derived from ecological condition indicators collected from respective BioCondition monitoring transects. The data for each ecological condition indicator was scored against benchmark data for each regional ecosystem, to derive an overall quality score in accordance with ‘the Guide’ (DEHP 2017). Where multiple BioCondition transects were completed for the same regional ecosystem, the quality scores were averaged.

Site context including the GIS attributes of size of patch, connectedness, context and ecological corridors from the Guide were also included in the analysis but were however taken from previous assessments prepared for the Project Environmental Offsets Strategy (GHD 2019).

Additional assessments for attributes of ‘threats to the species’ and ‘the role of each offset site location to the overall population in the state,’ were also conducted.

The results of the ecological condition, site context and additional assessments were analysed to provide an overall habitat quality baseline score for each area using the *Modified QLD Habitat Quality spreadsheet – template* (DAWE 2019).

Figure 2.2
Kawana Offset Area and Baseline
Survey Sites



Legend

- BioCondition (2)
- Quaternary (7)
- Transect
- Watercourse
- Cadastre
- ▨ Lowland Rainforest TEC
- ▨ Threatened Ecological Communities (*offset buffer*)



Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A3
 1:3,500 Date: 23-Sep-20

Data sources: - DNRME, TMR, Translink, Geoscience Australia

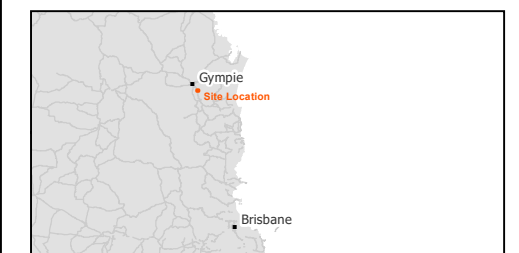
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Figure 2.3
Woondum Offset Area and Baseline
Survey Sites



Legend

- BioCondition (2)
- Quaternary (4)
- Photo Monitoring Site (2)
- Transect
- Watercourse
- Cadastre
- ▨ Lowland Rainforest TEC
- ▨ Threatened Ecological Communities (offset buffer)



Coordinate system: GDA 1994 MGA Zone 56
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Data sources: - DNRME, TMR, Translink, Geoscience Australia

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3 SITE HISTORY AND MONITORING CONDITIONS

3.1 MONITORING HISTORY

The 2020 Lowland Rainforest TEC baseline monitoring assessment at the Kawana and Woondum offset areas represents the first monitoring event in accordance with the EPBC 2017/7941 approval conditions.

3.2 CLIMATE AND RAINFALL

The temperature during the survey period was generally warm with an average maximum of 27.2°C. It was predominantly dry during the survey period with no precipitation received during the field survey.

3.2.1 KAWANA OFFSET AREA

Typical weather conditions at Kawana are historically dry during winter with mean minimum temperatures of 11.2°C, and mean maximum temperatures of 22°C, with mean monthly rainfall of approximately 95.4 mm per month (refer Table 3.1). During summer temperatures range between a mean minimum of 21.5°C and mean maximum of 29.6°C, with mean monthly rainfall of approximately 288.4 mm per month (refer Table 3.1) (BOM, 2020 – AWS040998).

The total annual rainfall received for 11 months preceding the survey was 1,611.1 mm and is slightly above the historical average of 1,466.1 mm. In addition, it is also slightly higher than the mean annual total rainfall for the region.

A summary of the weather conditions recorded within the region (Corbould Pk Racecourse BoM AWS 040759 and Caloundra Airport BoM AWS: 040998 – approx. 8 km from Kawana Offset Site) over the 12 months prior to survey, are presented in Table 3.1 and historical annual rainfall since 2014 presented in Table 3.2.

3.2.2 WOONDUM OFFSET SITE

Typical weather conditions at Woondum are dryer and more variable than the Kawana Site, with winter mean minimum temperatures of 7.8°C and a mean maximum temperatures of 22.3°C, with mean monthly rainfall of approximately 26.4 mm per month (refer Table 3.3). During summer temperatures range between a mean minimum of 20.2°C to a mean maximum of 32.7°C, with mean monthly rainfalls of approximately 109.7 mm per month (refer Table 3.3) (BOM, 2020 – AWS040998).

The total annual rainfall received for 12 months preceding the survey (632 mm), which is well below the annual average for the Gympie region of 1,150 mm.

A summary of the weather conditions recorded within the region (Gympie BoM AWS 040093, approx. 8 km from Woondum Offset Site) over the 12 months prior to survey, are presented in Table 3.3 and historical annual rainfall since 2014 presented in Table 3.4.

3.2.3 KAWANA OFFSET AREA

Table 3.1 Weather conditions (Caloundra Airport BoM AWS: 040998 – approx. 8 km from Kawana Offset Site) May 2019 to April 2020

	MAY 2019	JUN 2019	JUL 2019	AUG 2019	SEPT 2019	OCT 2019	NOV 2019	DEC 2019	JAN 2020	FEB 2020	MAR 2020	APRIL 2020	ANNUAL
Total Monthly Rainfall (mm)	80.6	252.5	19.9	13.8	28.2	151.2	43.8	47.0	167.3	650.8	156.0	TBC	1611.1 ¹
Mean Monthly Temperature (Min)	14.7	12.7	10.5	10.3	12.8	15.8	18.1	20.5	21.7	22.3	20.1	17.2	16.6
Mean Monthly Temperature (Max)	23.5	21.4	22.0	22.6	25.3	25.2	28.7	30.0	29.7	29.2	27.2	27.2	26.1

(1) Total excludes April 2020 rainfall.

Table 3.2 Historical annual rainfall (Corbould Pk Racecourse BoM AWS 040759 and Caloundra Airport BoM AWS: 040998 – approx. 8 km from Kawana Offset Site)

	2014	2015	2016	2017	2018	2019	2020 YTD
Total Annual Rainfall (mm)	1185.1	1591.4	1180.9	-	1682.0	1219.0	974.1

3.2.4 WOONDUM OFFSET AREA

Table 3.3 Weather conditions (Gympie BoM AWS: 040093 – approx. 13 km from Woondum Offset Site) May 2019 to April 2020

	MAY 2019	JUN 2019	JUL 2019	AUG 2019	SEPT 2019	OCT 2019	NOV 2019	DEC 2019	JAN 2020	FEB 2020	MAR 2020	APRIL 2020	ANNUAL
Total Monthly Rainfall (mm)	38.6	58.6	11.0	9.8	0.8	77.0	19.6	41.6	112.4	175.2	64.6	22.8	632.0
Mean Monthly Temperature (Min)	11.8	9.0	7.5	7.0	9.8	14.4	16.2	19.4	20.9	21.6	18.3	14.6	14.2
Mean Monthly Temperature (Max)	24.3	22.1	23.4	24.4	28.6	28.8	33.2	34.4	32.9	30.9	28.6	29.1	28.5

Table 3.4 Historical annual rainfall for Gympie, approx. 8 km from Woondum Offset Site (Gympie BoM AWS 040093)

	2014	2015	2016	2017	2018	2019	2020 YTD
Total Annual Rainfall (mm)	801.4	1106.2	776.8	-	981.2	548.4	375.1

4 DISCUSSION AND RESULTS

The following section provides the discussion and results of the baseline monitoring for the Kawana (refer Section 4.1) and Woondum offset areas (refer Section 4.2).

The data collected for each site has been analysed and is discussed in terms of each areas:

- site condition which has been presented graphically and scored against benchmark data for each regional ecosystem, deriving an overall quality score for each offset area against the Modified QLD Habitat Quality spreadsheet – template (DAWE 2019)
- species richness of entire Lowland Rainforest TEC offset area including an indication of the number of species present from Appendix A of the Listing Advice
- weed and invasive plant presence
- buffer zone management.

4.1 KAWANA OFFSET AREA

The Kawana offset area (Kawana) consists of a large patch (15.7 ha) of complex notophyll vine on coastal plains associated with Quaternary alluvium (Landzone 3). Two permanent baseline BioCondition monitoring sites were established within Kawana (refer Figure 2.2). In addition, several Quaternary level site assessments were undertaken to verify the regional ecosystems and weed presence/abundance within the mapped buffer zone (approx. 10.4 ha) surrounding the Lowland Rainforest TEC at Kawana (refer Figure 2.2).


The vegetation communities and regional ecosystems verified within the Kawana offsets area in association with the Lowland Rainforest TEC included RE 12.3.1a Complex notophyll vine forest on Quaternary alluvial plains and channels in areas of high rainfall (generally >1,300 mm). This community has been described in more detail in Table 4.1 and is mapped in association with the Lowland Rainforest TEC in Figure 4.1. Several areas of palm forest dominated by Piccabeen Palm (*Archontophoenix cunninghamiana*) also occur within the mapped Lowland Rainforest TEC associated with RE 12.3.1a. These areas have lower species diversity than the more complex areas of the patch where permanent monitoring sites have been established but do provide opportunities to be potentially improved through enhancement planting.

Field survey results for the vegetated buffer zone surrounding the mapped Lowland Rainforest TEC at Kawana returned the presence of the following vegetation communities and regional ecosystems:

- RE 12.3.5 – *Melaleuca quinquenervia* open forest on coastal alluvium.
- RE 12.3.2 – *Eucalyptus grandis* tall open forest on alluvial plains with vine forest understorey ('wet sclerophyll').
- Small strips of 'non-remnant' previously cleared pastures.

Results of the field surveys are presented in Appendix B with site photos in Appendix C. This data has been used to map each vegetation community and field verified regional ecosystem in association with the Lowland Rainforest TEC at Kawana in Figure 4.4. The results indicate that only the area of RE 12.3.1a is associated with the Lowland Rainforest TEC. In accordance with the Listing Advice, in addition to a patch of Lowland Rainforest TEC, a minimum buffer zone that extends 50 m beyond the trunks of the outermost trees in the patch is required to assist in the preservation of the patch to help protect the ecological community from spray drift (fertiliser, pesticide or herbicide sprayed in adjacent land) and other threats (i.e. weed invasion). The purpose of the buffer zone is to protect and manage the patch and to help avoid potential indirect impacts to the ecological community. Its purpose is not specifically to extend the patch through regeneration.

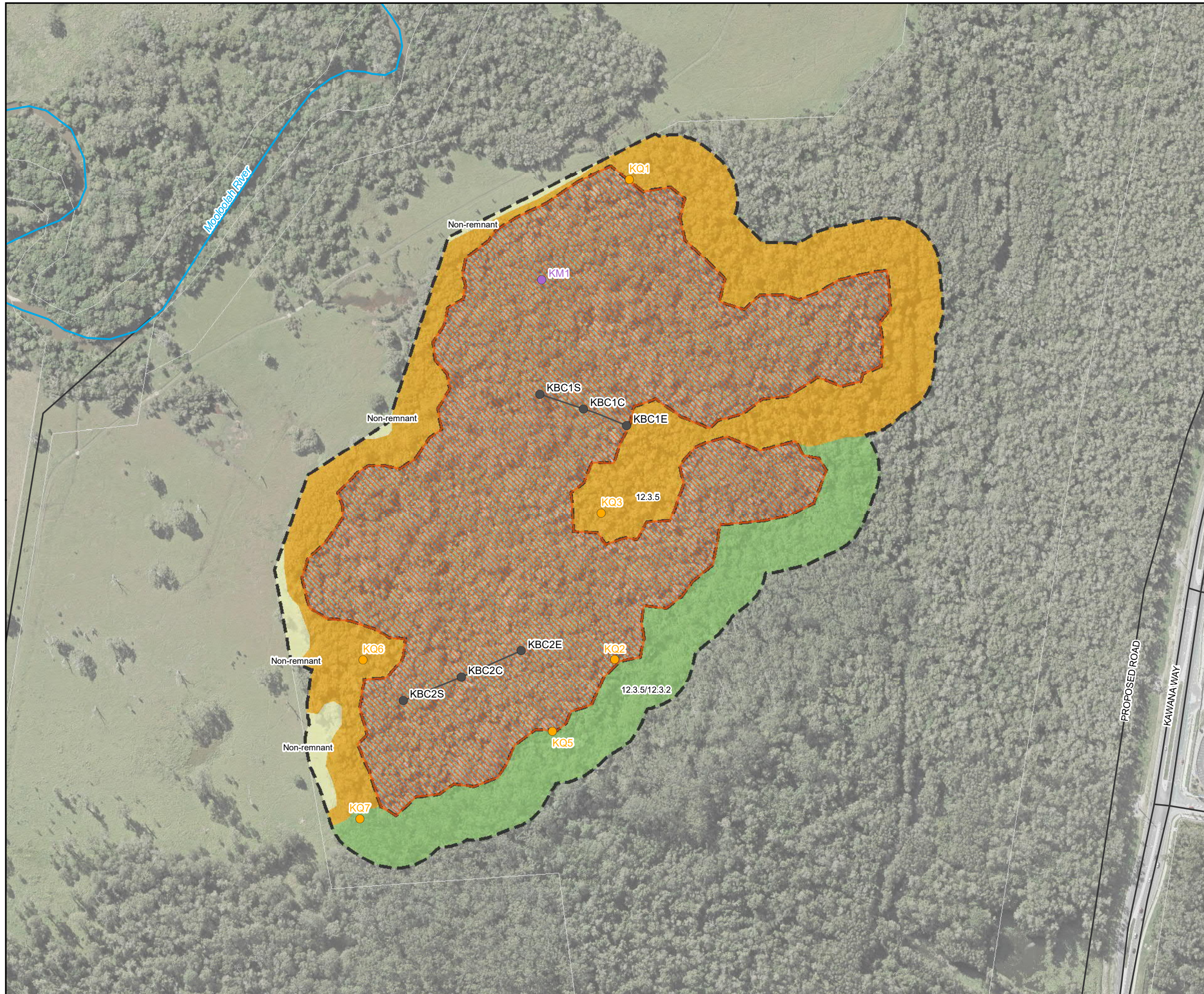
Table 4.1 Field verified vegetation community and regional ecosystem Kawana Lowland Rainforest TEC

COMPLEX NOTOPHYLL VINE FOREST ON COASTAL PLAINS WITH PATCHES OF ARCHONTOPHOENIX CUNNINGHAMIANA AND SCATTERED FICUS SPP		
Regional ecosystem (RE) code	12.3.1a	
Remnant status	Remnant	
RE VM Class	Endangered	
RE Biodiversity Status	Endangered	
Vegetation structure formation	Closed Complex Notophyll Vine Forest	
Ecological Dominant layer (EDL)	Tree 1	
EDL height (range)	28 m (15–30 m)	
EDL crown cover class	90–100%	
Landform	Coastal plain	
Soil type	Sandy loam	
Landzone	3	
Geology	Quaternary alluvial coastal plains.	
RE short description	Complex notophyll vine forest on Quaternary alluvial plains and channels in areas of high rainfall (generally >1300 mm).	
EPBC Act Threatened ecological community type	Lowland Rainforest TEC	
Tree 1 layer dominant species	<i>Mischocarpus pyriformis</i> , <i>Planchoniana australis</i> , <i>Syzygium francisii</i> , <i>Livistona australis</i> , <i>Ficus watkinsiana</i> , <i>Endiandra discolor</i> , <i>Diploglottis australis</i> , <i>Cryptocarya obovata</i> , <i>Archontophoenix cunninghamiana</i>	
Tree 2 layer dominant species	<i>Clerodendrum floribundum</i> , <i>Gossia bidwillii</i> , <i>Syzygium spp.</i>	
Shrub layer dominant species	<i>Atractocarpus chartaceus</i> , <i>Ficus fraseri</i> , <i>Tabernaemontana pandacaqui</i> , <i>Cordyline rubra</i> , <i>Helicia glabriflora</i>	
Ground layer dominant species	<i>Cissus antarctica</i> , <i>Trophis scandens</i> , <i>Smilax australis</i>	
Invasive plants (Bio Act)	None recorded in patch	
Disturbance notes	Large patches of simple palm forests	
Vegetation survey sites	KBC1, KBC2, KQ4	

Key for tables:

- Structural formation classes, qualified by height and crown cover : <1 m = dwarf; 1–2 m = shrubland/ heath; shrubs 2–8 m = scrub/ tall shrubland; trees 2–10 m = low forest/woodland, trees 10–30 m = forest/ woodland; >30 m = tall forest woodland
- Crown cover class (Walker & Hopkins 1992) : <0.2% = isolated trees or clumps; 0.2–20% = open woodland; 20–50% = woodland; 50–80% = open forest; 80–100% = closed forest

Figure 4.1
Kawana Offsets Area Vegetation
Communities and Monitoring Sites

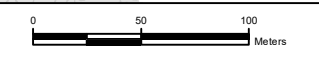


Legend

- BioCondition
- Weed Monitoring Site
- Photo Monitoring Site
- Transect
- Watercourse
- Cadastre
- ⊞ Threatened Ecological Communities (offset buffer)
- ▨ Lowland Rainforest TEC (RE 12.3.1a)

Field Verified Vegetation

- Cleared pastures (non-remnant)
- Melaleuca forest with notophyll vine forest understory on alluvium (RE 12.3.5 - remnant)
- Mixed Melaleuca forest and Eucalyptus grandis forest with notophyll vine forest understory on alluvium (RE 12.3.5/12.3.2 - remnant)



Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A3
 1:3,500 Date: 4/11/2020

Data sources: - DNRME, TMR, Translink, Geoscience Australia

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4.1.1 SITE CONDITION RESULTS KAWANA

The results of the two baseline BioCondition sites for Kawana are presented in Figures 4.2 and 4.3. The BioCondition parameters for each site have been represented graphically against benchmark data to indicate where the sites are performing well and/or have opportunity for improvement through intervention and management. Both sites performed well in relation to native tree richness, canopy cover and number of large trees.

There was an overabundance of coarse woody debris and organic litter at each site and a lack of native shrubs, native grasses, and native forbs and other species when compared to benchmarks. Table 4.2 show the results of the data analysis for each site assessed against the site condition scores from the modified habitat quality guide (DAWE 2019). The results indicate that both sites were very similar in ecological condition with the same score of 4.94 out of 7 for each site achieved.

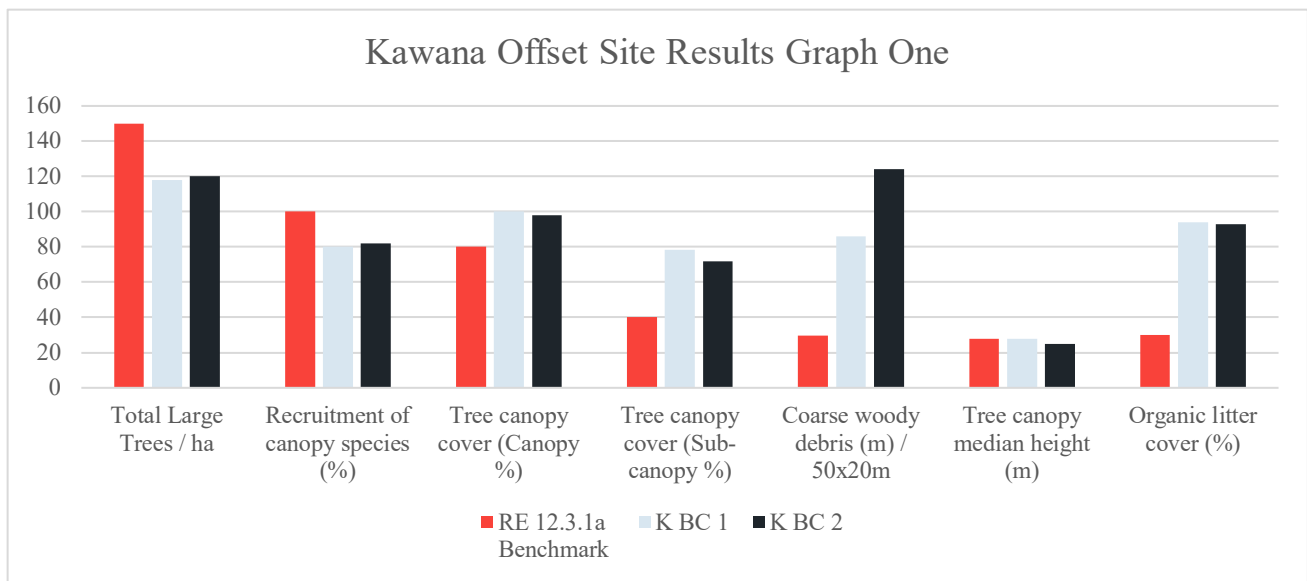


Figure 4.2 Kawana BioCondition site comparison results against benchmarks (Graph One)

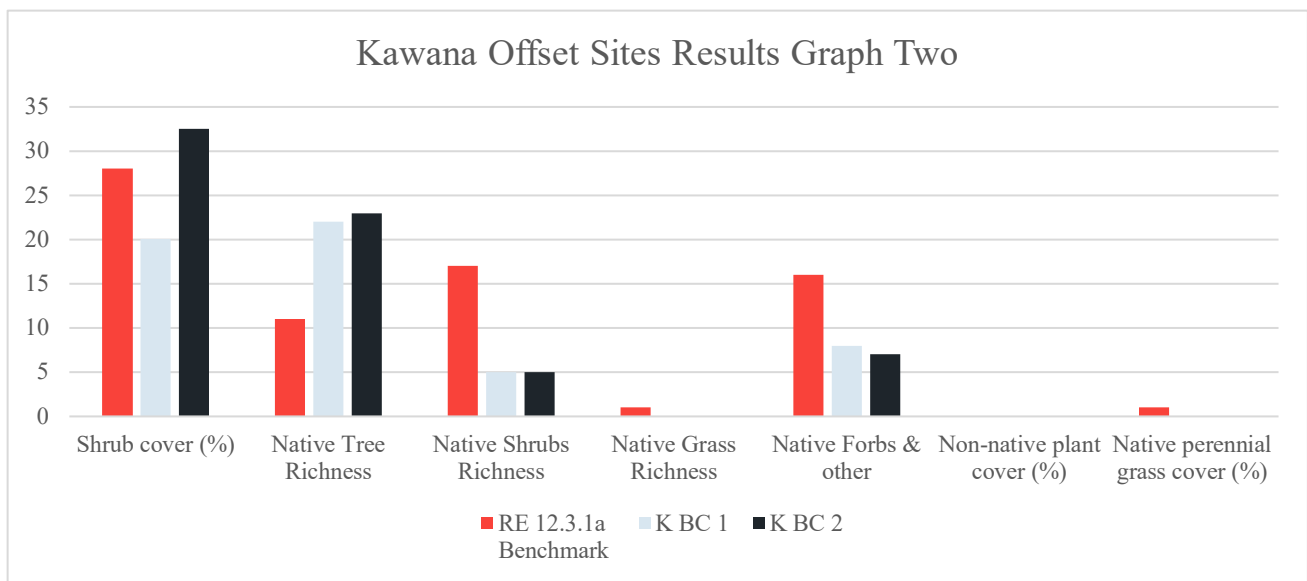


Figure 4.3 Kawana BioCondition site comparison results against benchmarks (Graph Two)

Table 4.2 Kawana site condition results

ASSESSMENT UNIT – REGIONAL ECOSYSTEM	KAWANA RE 12.3.1A								
Site Reference	Benchmark	KBC1			KBC2			Average% Benchmark	Score
Kawana Offset Site Condition	12.3.1a	Raw Data	% Benchmark	Score	Raw Data	% Benchmark	Score		
Recruitment of woody perennial species in EDL	100	80	80%	5	82	82%	5	81%	5
Native plant species richness – trees	11	22	200%	5	23	209%	5	205%	5
Native plant species richness – shrubs	17	5	29%	2.5	5	29%	2.5	29%	2.5
Native plant species richness – grasses	1	0	0%	2.5	0	0%	2.5	0%	2.5
Native plant species richness – forbs	16	8	50%	2.5	7	44%	2.5	47%	2.5
Tree Height Canopy	28	28	100%	5	25	89%	5		5
Tree Height Sub-canopy	8	10	125%		10	125%			
Tree Cover Canopy	80	100	125%	4	98	123%	4		4
Tree Cover Sub-canopy	28	60.5	216%		71.8	256%			
Shrub canopy cover	28	20.1	72%	5	32.5	116%	5	94%	5
Native grass cover	1	0	0%	0	0	0%	0	0%	0
Organic litter	30	94	313%	3	92.8	309%	3	311%	3
Large trees (euc plus non-euc)	150	118	79%	10	120	80%	10	79%	10
Coarse woody debris	295	860	292%	2	1240	420%	2	356%	2
Non-native plant cover	0	0	0%	10	0	0%	10	0%	10
Site Condition Score				56.5			56.5		56.5
<i>MAX Site Condition Score</i>				80			80		80
Site Condition Score – out of 7				4.94			4.94		4.94

4.1.2 SITE CONTEXT AND HABITAT QUALITY RESULTS KAWANA

Table 4.3 highlights the scores for each site against the site context and habitat quality assessments including the ‘role of site location to the Lowland Rainforest TEC overall population in the state’ and the ‘threat to the species.’ The site context scores were taken from previous assessments undertaken by GHD (2019) as part of developing the Project Offsets Strategy. Results of field surveys indicate there is a very low threat to the community apart from some invasive plant species occurring within the vegetated buffer zone. Furthermore, the site scored the maximum for ‘role of site location’ due to the size of the patch, quality of the patch, and the occurrence within >1,300 mm rainfall zone on lowland coastal plains. The Listing Advice suggests the largest occurrences in protected areas are in Springbrook National Park (approx. 260 ha), Lamington National Park (approx. 100 ha), Kondalilla National Park (approx. 95 ha) and the Glass House Mountains National Park (approx. 70 ha). The addition of the 15.7 ha patch at Kawana to the overall conservation of the Lowland Rainforest TEC is significant in relation to increasing both the extent and the overall area of the Lowland Rainforest TEC in Southeast Queensland in relation to those areas already protected, hence the maximum score. Table 4.4 provides the overall habitat quality results for the Kawana offset area indicating the importance of the site context and the good ecological condition.

Recommendations for improving the habitat score at Kawana have been provided in Section 5.

Table 4.3 Kawana site context results

SITE CONTEXT	KBC1	SCORE	KBC2	SCORE	AVERAGE KBC1/KBC2	AVERAGE SCORE
Size of patch (ha)	181	7	181	7	181	7
Connectedness	90	5	90	5	90	5
Context	37	4	37	4	37	4
Ecological Corridors	Within	6	Within	6	-	6
Role of site location to TEC overall population in the state	Yes	5	Yes	5	-	5
Threats to the species	Low	15	Low	15	-	15
Site Context Score		42		42		42
<i>MAX Site Context Score</i>		46		46		46
Site Context Score – out of 3		2.74		2.74		2.74

Table 4.4 Kawana habitat overall habitat quality baseline results

FINAL HABITAT QUALITY SCORE (WEIGHTED)	KBC1	KBC2	AVERAGE/FINAL
Site Condition score (out of 7)	4.94	4.94	4.94
Site Context Score (out of 3)	2.74	2.74	2.74
Habitat Quality score (out of 10)	7.77	7.77	7.77
Assessment Unit area (ha)	181	181	181.00
Total offset area (ha) for this MNES	181	181	181.00
Size Weighting	1.00	1.00	1.00
<i>Weighted Habitat Quality Score</i>	7.68	7.68	7.68

4.1.3 ASSESSMENT OF KAWANA OFFSET AREA AGAINST LOWLAND RAINFOREST TEC LISTING ADVICE INCLUDING SPECIES COMPOSITION

Table 4.5 provides a summary discussion of the results of the baseline monitoring recorded across the entire Kawana offset area for the Lowland Rainforest TEC against the key diagnostic characteristics from the Listing Advice, including an assessment of species richness for species recorded against those listed in Appendix A of the Listing Advice. The Kawana Lowland Rainforest TEC offsets area meets all the key diagnostic characteristics from the Listing Advice.

Table 4.5 Assessment of Kawana offsets area key diagnostic characteristics for the Lowland Rainforest TEC

CRITERIA	DISCUSSION	CONFORMS
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments.	The Kawana offsets area occurs on 'lowland' coastal plains associated with Quaternary alluvium.	Yes
The ecological community generally occurs at an altitude less than 300 m above sea level.	The Kawana offsets area is located approximate 17 m above sea level (GHD 2019).	Yes
The ecological community typically occurs in areas with high annual rainfall (>1300 mm).	The total annual rainfall received for 11 months preceding the survey (1,611.1 mm, April rainfall data was not available at the time this report was written) was slightly above the historical average of 1,466.1 mm.	Yes
The ecological community is typically more than 2 km inland from the coast.	The Kawana offsets area is located approximately 3 km from the coast.	Yes
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	The results of the two BioCondition sites indicate the canopy is within 20–30 m and total cover is above 70% (refer Appendix B).	Yes
Patches of the ecological community typically have high species richness (at least >30 woody species from Appendix A of the Listing Advice and better quality patches can have up to >40 species from Appendix A of the Listing Advice).	A total of 65 flora species were recorded across all sites containing 32 species from Appendix A of the Lowland Rainforest TEC (refer Appendix B).	Yes

4.1.4 WEED AND INVASIVE PLANT PRESENCE KAWANA

Under the *Biosecurity Act 2014* (Bio Act) everyone is obligated to take all reasonable and practical steps to minimise the risks associated with invasive plants under their control. This is called a general biosecurity obligation (GBO). No invasive plants were recorded within the BioCondition sites in the mapped Lowland Rainforest TEC. However, three invasive plants, one environmental weed and two naturalised pasture species were recorded in the vegetation buffer zone surrounding the community (refer Appendix B). The invasive plants and their status under the Bio Act have been listed in Table 4.6 below.

It is recommended annual weed control is undertaken in the vegetated buffer zone surrounding the mapped Lowland Rainforest TEC (refer Section 5.1).

Table 4.6 Invasive plants and naturalised pastures Kawana Lowland Rainforest TEC vegetated buffer zone

SPECIES NAME	INVASIVE PLANT STATUS (DAF)
<i>Desmodium uncinatum</i>	Environmental weed
<i>Digitaria violascens</i>	Naturalised pasture
<i>Ipomoea indica</i>	Other invasive
<i>Lantana camara</i>	Restricted invasive
<i>Paspalum scrobiculatum</i>	Naturalised pasture
<i>Passiflora suberosa</i>	Other invasive

4.1.5 VEGETATED BUFFER ZONE MANAGEMENT KAWANA

Results of field surveys further indicated there is a very low threat to the community apart from some invasive plant species occurring within the vegetated buffer zone. It is recommended the buffer zone is maintained and managed through ongoing weed control and stock exclusion to maintain a low risk level to the committed offset area (refer Section 5.1).

4.2 WOONDUM OFFSET AREA

The Woondum Offsets Area (Woondum) consists of a small patch (2.7 ha) of mixed notophyll vine forest on low hills of basaltically enriched colluvial slopes on metasediments of the Gympie province associated with Landzone 11. The small area of mixed notophyll vine forest on colluvium occurs as a small valley between two steeper ridges dominated by Eucalypt communities on shallow soils.

Two permanent baseline BioCondition monitoring transects were established within Woondum (refer Figure 2.3). In addition, several Quaternary level surveys were undertaken to verify the regional ecosystems and weed presence/abundance within the mapped buffer zone surrounding the mapped area of Lowland Rainforest TEC at Woondum (refer Figure 2.3).

The regional ecosystem verified within the Woondum offset area recorded in association with the Lowland Rainforest TEC included RE 12.11.10 Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics. This community has also been described in more detail in Table 4.7 and is mapped as shown on Figure 4.4.

Field survey results for the vegetated buffer zone surrounding the mapped Lowland Rainforest TEC at Woondum returned the presence of the following vegetation communities and regional ecosystems occurring on the steeper slopes with shallow soils adjacent to the mapped Lowland Rainforest TEC:

- RE 12.11.3 – *Eucalyptus siderophloia*, *E. propinqua* +/- *E. microcorys*, *Lophostemon confertus*, *Corymbia intermedia*, *E. acmenoides* open forest on metamorphics +/- interbedded volcanics.
- RE 12.11.5 – *Corymbia citriodora* subsp. *variegata* woodland to open forest +/- *Eucalyptus siderophloia*/*E. crebra*, *E. carnea*, *E. acmenoides*, *E. propinqua* on metamorphics +/- interbedded volcanics.
- High Value Regrowth RE 12.11.10 – Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics.

Results of the field surveys are presented in Appendix B with site photos in Appendix C and have been used to map each vegetation community and field verified regional ecosystem in association with the Lowland Rainforest TEC at Woondum (refer Figure 4.4).

The results indicate that only the remnant area of RE 12.11.10 is associated with the Lowland Rainforest TEC. However, in accordance with the Listing Advice, in addition to a patch of Lowland Rainforest TEC, a minimum buffer zone that extends 50 m beyond the trunks of the outermost trees in the patch is required to assist in the preservation of the patch to help protect the ecological community from spray drift (fertiliser, pesticide or herbicide sprayed in adjacent land) and other threats.

Table 4.7 Field verified vegetation community and regional ecosystem Woondum Lowland Rainforest TEC


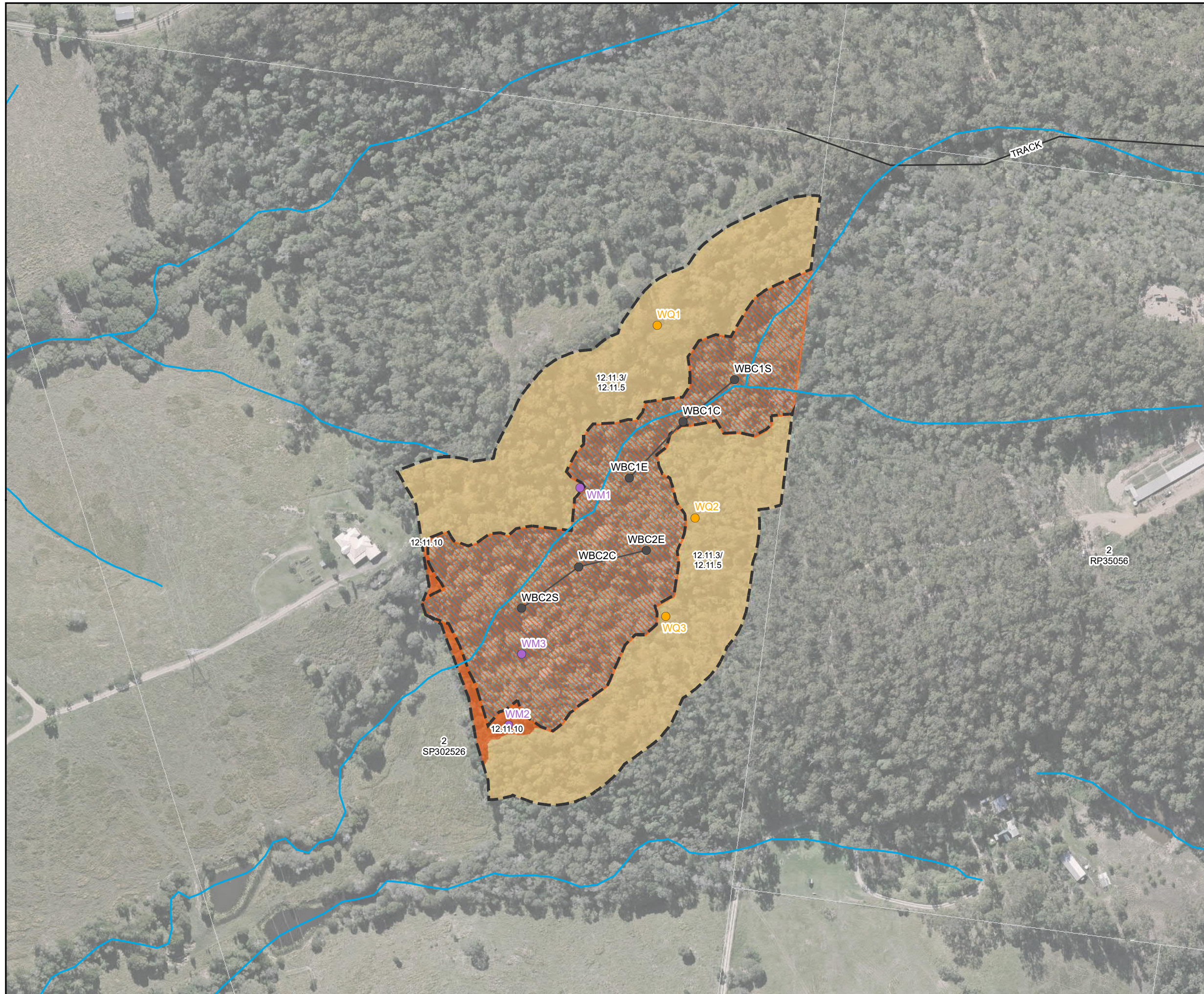
MIXED NOTOPHYLL VINE FOREST ON METAMORPHICS WITH EMERGENT ARAUCARIA CUNNINGHAMII		
Regional ecosystem (RE) code	12.11.10	
Remnant status	Remnant	
RE VM Class	Least Concern	
RE Biodiversity Status	No Concern at Present	
Vegetation structure formation	Closed Notophyll Vine Forest	
Ecological Dominant layer (EDL)	Tree 1	
EDL height (range)	24 m (15–30 m)	
EDL crown cover class	70–90%	
Landform	Low metasedimentary hills with basaltic influence	
Soil type	Light brown clay	
Landzone	11	
Geology	Metamorphic rocks (Gympie Province) with basaltic influence	
RE short description	Notophyll vine forest +/- Araucaria cunninghamii on metamorphics +/- interbedded volcanics	
EPBC Act Threatened ecological community type	Lowland Rainforest TEC	
Emergent	<i>Araucaria cunninghamiana</i>	
Tree 1 layer dominant species	<i>Argyrodendron trifoliolatum</i> , <i>Backhousia subargentea</i> , <i>Drypetes deplanchei</i> , <i>Flindersia australis</i> , <i>Mischocarpus pyriformis</i> , <i>Vitex lignum-vitae</i>	
Tree 2 layer dominant species	<i>Gossia bidwillii</i> , <i>Aphananthe philippensis</i> , <i>Cupaniopsis serrata</i> , <i>Jagera pseudorhus</i> , <i>Mallotus philippinensis</i> , <i>Polyscias elegans</i> , <i>Sarcopteryx stipata</i> , <i>Streblus brunonianus</i>	
Shrub layer dominant species	<i>Alyxia ruscifolia</i> , <i>Atractocarpus chartaceus</i> , <i>Capparis arborea</i> , <i>Cordyline rubra</i> , <i>Croton verreauxii</i> , <i>Tabernaemontana pandacaqui</i>	
Ground layer dominant species	<i>Cissus antarctica</i> , <i>Smilax australis</i> , <i>Austrosteenisia blackii</i>	
Invasive plants (Bio Act)	<i>Passiflora suberosa</i> ** , <i>Lantana camara</i> ** , <i>Dolichandra unguis-cati</i> ** , <i>Celtis sinensis</i> ** <i>Solanum seaforthianum</i> ** , <i>Solanum mauritianum</i> ** , <i>Rivina humilis</i> **	
Disturbance notes	Invasive plants and tracks	
Vegetation survey sites	WBC1, WBC2, WM1, WM2, WQ4	

Figure 4.4
Woondum Offsets Area Vegetation
Communities and Monitoring Sites

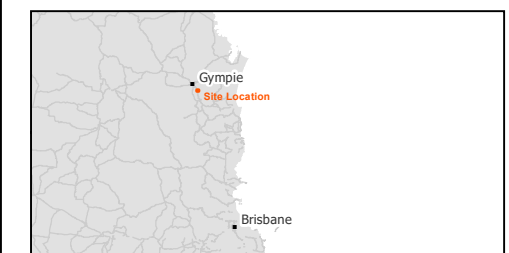


Legend

- BioCondition
- Weed Monitoring Site
- Photo Monitoring Site
- Transect
- Watercourse
- Cadastre
- ▬ Threatened Ecological Communities (*offset buffer*)
- ▨ Lowland Rainforest TEC (RE 12.11.10)

Field Verified Vegetation

- High Value Regrowth Mixed Notophyll Vine Forest On Metasediments (RE 12.11.10 - HVR)
- Mixed open shrubby Eucalypt forest on metasediments with *Lophostemon confertus*, *E. propinqua*, *E. siderophloia* (RE 12.11.3/12.11.5 - remnant)



Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A3
 1:2,500 Date: 23-Sep-20

Data sources: - DNRME, TMR, Translink, Geoscience Australia

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4.2.1 SITE CONDITION RESULTS WOONDUM

The results of the two baseline BioCondition sites for Woondum are presented in Figures 4.5 and 4.6. The BioCondition parameters for each site have been represented graphically against benchmark data to indicate where the Woondum offsets sites are performing well and/or have the opportunity for improvement through intervention and management.

Both sites performed well in relation to tree canopy height and cover, as well as native tree richness, native shrub richness, recruitments and number of large trees. There was an overabundance of shrub cover, coarse woody debris and organic litter at each site and a lack of native grasses and native forbs and other species when compared to benchmarks. Table 4.8 show the results of the data analysis for each site assessed against the site condition scores of the habitat quality guide (DAWE 2019). The results indicate that Woondum scored an average of 4.86 out of a possible 7 for site condition. BioCondition WBC1 was lacking an emergent layer which reduced its score and the overabundance of shrub cover and lack of native grasses and forbs and other species were consistent across both sites.

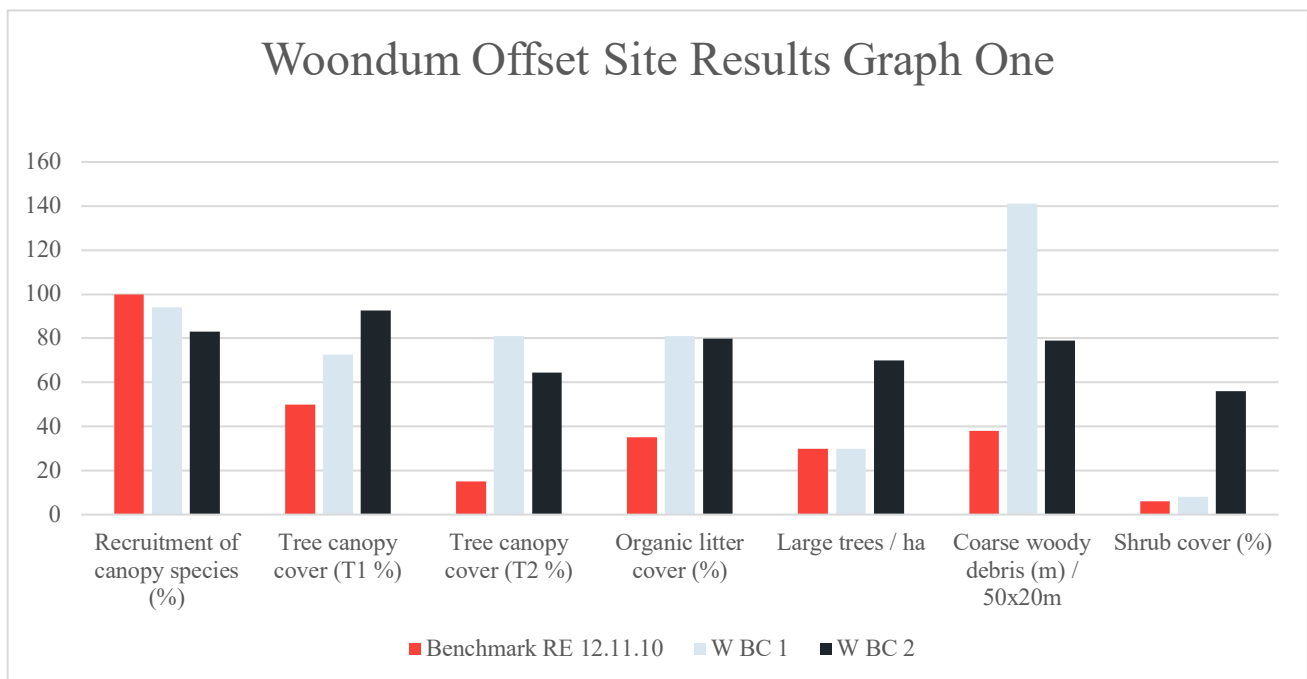


Figure 4.5 Woondum BioCondition site comparison results against benchmarks (Graph One)

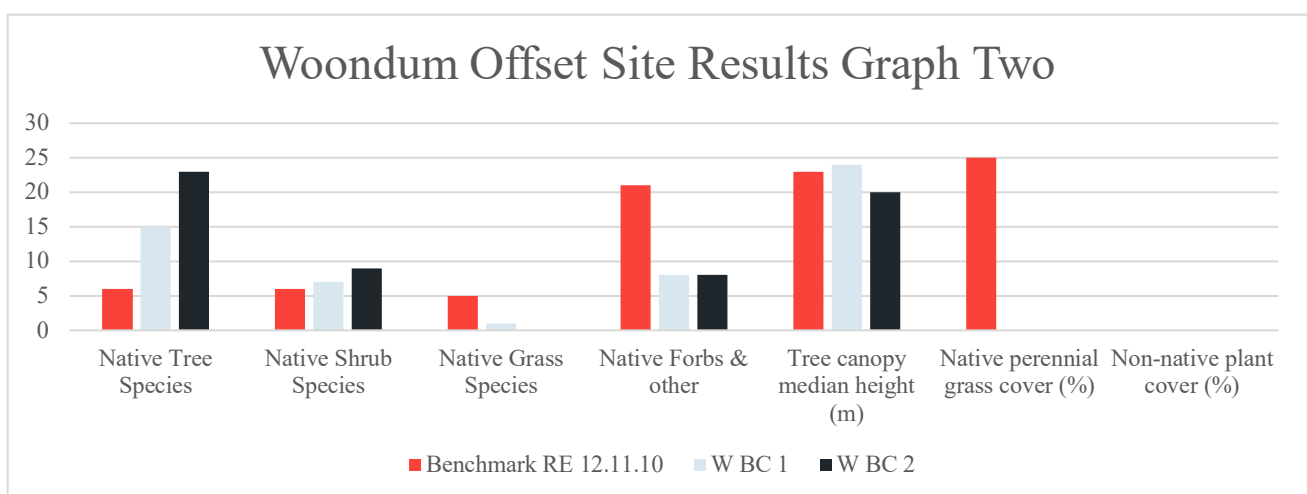


Figure 4.6 Woondum BioCondition site comparison results against benchmarks (Graph Two)

Table 4.8 Woondum site condition results

ASSESSMENT UNIT – REGIONAL ECOSYSTEM	WOONDUM RE 12.11.10								
Site Reference	Benchmark	WBC1			WBC2			Average% Benchmark	Score
Woondum Offset Site Condition	12.11.10	Raw Data	% Benchmark	Score	Raw Data	% Benchmark	Score		
Recruitment of woody perennial species in EDL	100	94	94%	5	83	83%	5	89%	5
Native plant species richness – trees	25	15	60%	2.5	24	96%	5	78%	3.75
Native plant species richness – shrubs	23	7	30%	2.5	9	39%	2.5	35%	2.5
Native plant species richness – grasses	1	1	100%	5	0	0%	0	50%	2.5
Native plant species richness – forbs	35	8	23%	2.5	8	23%	2.5	23%	2.5
Tree Height Emergent	33	0	0%	3.34	25	76%	5	38%	4.17
Tree Height Canopy	22	24	109%		20	91%		100%	
Tree Height Sub-canopy	8	10	125%		8	100%		113%	
Tree Cover Emergent	5	0	0%	3.34	6.5	130%	5	65%	4.17
Tree Cover Canopy	64	72.5	113%		88.5	138%		126%	
Tree Cover Sub-canopy	47	81	172%		64.3	137%		155%	
Shrub canopy cover	29	8	28%	2	56	193%	5	110%	3.5
Native grass cover	15	0	0%	0	0	0%	0	0%	0
Organic litter	54	81	150%	5	79.8	148%	5	149%	5
Large trees (euc plus non-euc)	88	30	34%	5	70	80%	10	57%	7.5
Coarse woody debris	705	1390	197%	5	790	112%	5	155%	5
Non-native plant cover	0	0	0%	10	0	0%	10	0%	10
Site Condition Score				51.18			60		55.59
<i>MAX Site Condition Score</i>				80			80		80
Site Condition Score – out of 7				4.48			5.25		4.86

4.2.2 SITE CONTEXT AND HABITAT QUALITY RESULTS WOONDUM

Table 4.9 highlights the scores for each site against the site context and habitat quality assessments including the ‘role of site location to the Lowland Rainforest TEC overall population in the state’ and the ‘threat to the species.’ The site context scores were taken from previous assessments undertaken by GHD (2019) as part of developing the Offsets Strategy.

Results of field surveys indicate there is a threat to the community predominantly associated with the presence of invasive plant species in within the community and buffer zone, in particular the presence of Cats Claw Creeper (*Dolichandra unguis-cati*) was observed in the vicinity of both BioCondition sites and in the south-western portion of the offset area and buffer zone (refer Figure 4.4).

The area of Lowland Rainforest at Woondum is quite small (2.7 ha) when compared to Kawana (15.7 ha) and the other areas of the community in protected areas such as Springbrook National Park (approx. 260 ha), Lamington National Park (approx. 100 ha), Kondalilla National Park (approx. 95 ha) and the Glass House Mountains National Park (approx. 70 ha). Furthermore, Woondum is likely to be below <1,300 mm average annual rainfall and is therefore a drier forest than Kawana. For these reasons Woondum scored lower than Kawana for the ‘role of site location to the Lowland Rainforest TEC overall population in the state.’

Table 4.10 provides the overall habitat quality results for the Woondum offset area. It is recommended the best opportunity for improving the habitat score at Woondum is to reduce the ‘threat to species’ associated with invasive plant species.

Recommendations for improving the habitat score at Woondum are provided in Section 5.

Table 4.9 Woondum site context results

SITE CONTEXT	WBC1	SCORE	WBC2	SCORE	AVERAGE WBC1/WBC2	AVERAGE SCORE
Size of patch	622	10	622	10	622	10
Connectedness	97	5	97	5	97	5
Context	50	4	50	4	50	4
Ecological Corridors	Not within	0	Not within	0	-	0
Role of site location to TEC overall population in the state	No	1	No	1	-	1
Threats to the species	Moderate	7	Moderate	7	-	7
Site Context Score		27		27		27
MAX Site Context Score		46		46		46
Site Context Score – out of 3		1.76		1.76		1.76

Table 4.10 Woondum Habitat overall habitat quality baseline results

FINAL HABITAT QUALITY SCORE (WEIGHTED)	W BC 1	W BC 2	AVERAGE/FINAL
Site Condition score (out of 7)	4.48	5.25	4.86
Site Context Score (out of 3)	1.76	1.76	1.76
Habitat Quality score (out of 10)	6.33	7.05	6.69
Assessment Unit area (ha)	622	622	622
Total offset area (ha) for this MNES	622	622	622
Size Weighting	1.00	1.00	1
<i>Weighted Habitat Quality Score</i>	6.24	7.01	6.62

4.2.3 ASSESSMENT OF WOONDUM OFFSET AREA AGAINST LOWLAND RAINFOREST TEC LISTING ADVICE INCLUDING SPECIES COMPOSITION

Table 4.11 provides a summary discussion of the results of the baseline monitoring recorded across the entire Woondum offset area for the Lowland Rainforest TEC against the key diagnostic characteristics from the Listing Advice, including an assessment of species richness for species recorded against those listed in Appendix A of the Listing Advice.

The Woondum offset area meets all the key diagnostic characteristics apart from occurring in areas with high annual rainfall (>1,300 mm). Due to the lower rainfall, the vegetation community at Woondum is drier in nature than Kawana and lacking wetter species such as Piccabeen palms (*Archontophoenix cunninghamiana*).

Table 4.11 Assessment of Woondum offsets area key diagnostic characteristics for the Lowland Rainforest TEC

CRITERIA	DISCUSSION	CONFORMS
The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments.	The Woondum offsets area occurs on colluvial slopes associated with basaltically enriched metasediments.	Yes
The ecological community generally occurs at an altitude less than 300 m above sea level.	The Woondum offsets area is located approximate 40 m above sea level (GHD 2019).	Yes
The ecological community typically occurs in areas with high annual rainfall (>1,300 mm).	The total annual rainfall received for 12 months preceding the survey (632 mm) was the was well below the historical average for the Gympie region of 1,150 mm.	No
The ecological community is typically more than 2 km inland from the coast.	The Woondum offsets area is located approximately 36 km from the coast.	Yes
The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.	The results of the two BioCondition sites indicate the canopy is within 20–30 m and total cover is above 70% (refer Appendix B).	Yes
Patches of the ecological community typically have high species richness (at least >30 woody species from Appendix A of the Listing Advice and better quality patches can have up to >40 species from Appendix A of the Listing Advice).	A total of 77 flora species were recorded across all sites containing 31 species from Appendix A of the Lowland Rainforest TEC (refer Appendix C).	Yes

4.2.4 WEED AND INVASIVE PLANT PRESENCE WOONDUM

Under the *Biosecurity Act 2014* (Bio Act) everyone is obligated to take all reasonable and practical steps to minimise the risks associated with invasive plants under their control. This is called a general biosecurity obligation (GBO). Three restricted invasive plants, two other invasive plants and two environmental weeds were recorded in the Woondum offsets area (refer Appendix B and Table 4.12).

Of importance, is the threat to the Lowland Rainforest TEC the invasive plants pose, in particular, the presence of Cats Claw Creeper (*Dolichandra unguis-cati*), Chinese Elm (*Celtis sinensis*) and Lantana (*Lantana camara*). Cats claw creeper was recorded within the vicinity of both BioCondition sites and in the southwestern portion of the buffer zone and is a major threat to the ecological condition of the Woondum Offsets area. It is recommended invasive plant weed management occurs throughout the Lowland Rainforest TEC offset area and in the buffer zones (refer Section 5.1).

Table 4.12 Invasive plants and naturalised pastures Woondum Lowland Rainforest TEC vegetated buffer zone

SPECIES NAME	INVASIVE PLANT STATUS (DAF)
<i>Celtis sinensis</i>	Restricted invasive
<i>Dolichandra unguis-cati</i>	Restricted invasive
<i>Lantana camara</i>	Restricted invasive
<i>Passiflora suberosa</i>	Other invasive
<i>Rivina humilis</i>	Environmental weed
<i>Solanum mauritianum</i>	Other invasive
<i>Solanum seafortianum</i>	Environmental weed

4.2.5 VEGETATED BUFFER ZONE MANAGEMENT WOONDUM

The purpose of the buffer zone is to protect and manage the patch and to help avoid potential indirect impacts to the ecological community. Its purpose is not specifically to extend the patch through regeneration. The small strip of High Value Regrowth RE 12.11.10 has long term potential to be incorporated into the mapped area of Lowland Rainforest TEC. However, it requires a high degree of weed control and assisted natural regeneration (refer Section 5).

5 RECOMMENDATIONS

This section provides recommended management actions required to improve the site condition for each offset area based on the findings of the baseline monitoring. The purpose of the recommendations are to improve each offset area's overall habitat quality score over time. Recommendations have been split into the following categories:

- Weed Control and Buffer Zone Management
- Revegetation and Natural Regeneration
- Other Recommendations (i.e. site access, fencing etc).

5.1 WEED CONTROL AND BUFFER ZONE MANAGEMENT

5.1.1 WEED CONTROL AND VEGETATED BUFFER ZONE MANAGEMENT KAWANA

Results of field surveys further indicated there is a very low threat to the community at Kawana apart from several invasive plant species occurring within the vegetated buffer zone. It is recommended the buffer zone (refer Figure 5.1) is maintained and managed through an annual weed control program targeting the weed species recorded during the baseline surveys listed in Table 5.1. A weed management area in the buffer zone has been identified in Figure 5.1.

Table 5.1 Invasive plants and naturalised pastures Kawana Lowland Rainforest TEC vegetated buffer zone

SPECIES NAME	INVASIVE PLANT STATUS (DAF)
<i>Desmodium uncinatum</i>	Environmental weed
<i>Ipomoea indica</i>	Other invasive
<i>Lantana camara</i>	Restricted invasive
<i>Passiflora suberosa</i>	Other invasive
<i>Schinus terebinthifolius</i>	Restricted invasive

In accordance with the requirements of the Project Draft Environmental Offsets Strategy (GHD 2019), it is also recommended ongoing weed monitoring is undertaken within the buffer zone and at all weed monitoring sites established during the baseline surveys points (Figure 4.1).

5.1.2 WEED CONTROL AND VEGETATED BUFFER ZONE MANAGEMENT WOONDUM

It is recommended the best opportunity for improving the habitat score at Woondum is to reduce the 'threat to species' associated with restricted invasive plant species. Of importance is the control of weeds associated with the threat to the community, in particular, the control of Cats Claw Creeper (*Dolichandra unguis-cati*), Chinese Elm (*Celtis sinensis*) and Lantana (*Lantana camara*). It is recommended the weed management area identified in the buffer zone and across the entire offsets area (refer Figure 5.2) is maintained and managed through an annual weed control program targeting the weed species recorded during the baseline surveys listed in Table 5.2.

Table 5.2 Invasive plants and naturalised pastures Woondum Lowland Rainforest TEC vegetated buffer zone

SPECIES NAME	INVASIVE PLANT STATUS (DAF)
<i>Celtis sinensis</i>	Restricted invasive
<i>Dolichandra unguis-cati</i>	Restricted invasive
<i>Lantana camara</i>	Restricted invasive
<i>Passiflora suberosa</i>	Other invasive
<i>Rivina humilis</i>	Environmental weed
<i>Solanum mauritianum</i>	Other invasive
<i>Solanum seaforthianum</i>	Environmental weed

5.2 REVEGETATION AND NATURAL REGENERATION RECOMMENDATIONS

5.2.1 REVEGETATION AND NATURAL REGENERATION KAWANA

Opportunities for improving ecological condition within the Kawana Offsets area includes targeted revegetation in areas of the mapped Lowland Rainforest TEC in the ecotones between the palm forests and more complex areas of the community. An area for targeted revegetation has been provided in (refer Figure 5.1). It is recommended an additional photo monitoring point is established in the area proposed to be revegetated at Kawana at site KM1 (refer Figure 5.1). It is important to note the entire recommended revegetation area mapped in Figure 5.1 does not have to be revegetated, it is recommended revegetation is based on the enhancement planting approach whereby plants are place in natural gaps and spaced out accordingly.

Field results indicated the Kawana offsets areas scored maximum for the presence of native tree species richness (refer Table 4.2). Despite this result it is recommended additional native trees from Appendix A of the Listing Advice are used in enhancement planting as well as planting of additional native shrubs, native grasses, and native forbs and other species associated within the Lowland Rainforest TEC provided in Table 5.3 which has been taken from a combination of the draft BioCondition Benchmarks for RE 12.3.1a (Queensland Herbarium 2019) and Appendix A of the Listing Advice.

Table 5.3 Kawana offsets recommended species for revegetation

REVEGETATION STRATA	RECOMMENDED SPECIES												
Native Trees and Shrubs	<table border="0"> <tr> <td><i>Acmena smithii</i></td> <td><i>Clerodendrum floribundum</i></td> </tr> <tr> <td><i>Arytera distylis</i></td> <td><i>Dysoxylum mollissimum</i></td> </tr> <tr> <td><i>Beilschmiedia elliptica</i></td> <td><i>Elaeocarpus obovatus</i></td> </tr> <tr> <td><i>Backhousia myrtifolia</i></td> <td><i>Glochidion ferdinandi</i></td> </tr> <tr> <td><i>Cryptocarya laevigata</i></td> <td><i>Guioa semiglauca</i></td> </tr> <tr> <td><i>Cryptocarya obovata</i></td> <td><i>Notelaea longifolia</i></td> </tr> </table>	<i>Acmena smithii</i>	<i>Clerodendrum floribundum</i>	<i>Arytera distylis</i>	<i>Dysoxylum mollissimum</i>	<i>Beilschmiedia elliptica</i>	<i>Elaeocarpus obovatus</i>	<i>Backhousia myrtifolia</i>	<i>Glochidion ferdinandi</i>	<i>Cryptocarya laevigata</i>	<i>Guioa semiglauca</i>	<i>Cryptocarya obovata</i>	<i>Notelaea longifolia</i>
<i>Acmena smithii</i>	<i>Clerodendrum floribundum</i>												
<i>Arytera distylis</i>	<i>Dysoxylum mollissimum</i>												
<i>Beilschmiedia elliptica</i>	<i>Elaeocarpus obovatus</i>												
<i>Backhousia myrtifolia</i>	<i>Glochidion ferdinandi</i>												
<i>Cryptocarya laevigata</i>	<i>Guioa semiglauca</i>												
<i>Cryptocarya obovata</i>	<i>Notelaea longifolia</i>												
Native Grasses	<table border="0"> <tr> <td><i>Ottochloa gracillima</i></td> </tr> <tr> <td><i>Oplismenus aemulus</i></td> </tr> </table>	<i>Ottochloa gracillima</i>	<i>Oplismenus aemulus</i>										
<i>Ottochloa gracillima</i>													
<i>Oplismenus aemulus</i>													
Native Forbs and other	<table border="0"> <tr> <td><i>Lomandra hystrix</i></td> </tr> <tr> <td><i>Dianella caerulea</i></td> </tr> </table>	<i>Lomandra hystrix</i>	<i>Dianella caerulea</i>										
<i>Lomandra hystrix</i>													
<i>Dianella caerulea</i>													

5.2.2 REVEGETATION AND NATURAL REGENERATION WOONDUM

The results of the field survey indicated Woondum has a high level of recruitment potential surrounding the two BioCondition sites (refer Figure 5.2). Two photo monitoring points (WM1 and WM2) were also established at Woondum in addition to the BioCondition sites in areas recommended to support natural regeneration (refer Figure 5.2).

There is however an area to the south west in Woondum surrounding monitoring point WM3 that is currently dominated by *Lantana camara* with some regenerating dry rainforest species. It is recommended that post weed control this area is revegetated in the areas mapped in Figure 5.2 using the species in Table 5.4 taken from a combination of the draft BioCondition Benchmarks for RE 12.11.10 (Queensland Herbarium 2019) and Appendix A of the Listing Advice are used to improve species richness for the offsets area

Table 5.4 Woondum offsets recommended species for revegetation

REVEGETATION STRATA	RECOMMENDED SPECIES														
Native Trees and Shrubs	<table border="0"> <tr> <td><i>Acacia disparrima</i></td> <td><i>Mallotus discolor</i></td> </tr> <tr> <td><i>Acmena smithii</i></td> <td><i>Melicope micrococca</i></td> </tr> <tr> <td><i>Backhousia kingii</i></td> <td><i>Pittosporum revolutum</i></td> </tr> <tr> <td><i>Breynia oblongata</i></td> <td><i>Pittosporum undulatum</i></td> </tr> <tr> <td><i>Cleistanthus cunninghamii</i></td> <td><i>Aphananthe philippinensis</i></td> </tr> <tr> <td><i>Ficus coronata</i></td> <td><i>Flindersia australis</i></td> </tr> <tr> <td><i>Ficus fraseri</i></td> <td><i>Flindersia schottiana</i></td> </tr> </table>	<i>Acacia disparrima</i>	<i>Mallotus discolor</i>	<i>Acmena smithii</i>	<i>Melicope micrococca</i>	<i>Backhousia kingii</i>	<i>Pittosporum revolutum</i>	<i>Breynia oblongata</i>	<i>Pittosporum undulatum</i>	<i>Cleistanthus cunninghamii</i>	<i>Aphananthe philippinensis</i>	<i>Ficus coronata</i>	<i>Flindersia australis</i>	<i>Ficus fraseri</i>	<i>Flindersia schottiana</i>
<i>Acacia disparrima</i>	<i>Mallotus discolor</i>														
<i>Acmena smithii</i>	<i>Melicope micrococca</i>														
<i>Backhousia kingii</i>	<i>Pittosporum revolutum</i>														
<i>Breynia oblongata</i>	<i>Pittosporum undulatum</i>														
<i>Cleistanthus cunninghamii</i>	<i>Aphananthe philippinensis</i>														
<i>Ficus coronata</i>	<i>Flindersia australis</i>														
<i>Ficus fraseri</i>	<i>Flindersia schottiana</i>														
Native Grasses	<table border="0"> <tr> <td><i>Oplismenus aemulus</i></td> </tr> <tr> <td><i>Ancistrachne uncinulata</i></td> </tr> </table>	<i>Oplismenus aemulus</i>	<i>Ancistrachne uncinulata</i>												
<i>Oplismenus aemulus</i>															
<i>Ancistrachne uncinulata</i>															
Native Forbs and other	<table border="0"> <tr> <td><i>Pararistolochia praevenosa</i></td> </tr> <tr> <td><i>Lomandra hystrix</i></td> </tr> <tr> <td><i>Dianella caerulea</i></td> </tr> </table>	<i>Pararistolochia praevenosa</i>	<i>Lomandra hystrix</i>	<i>Dianella caerulea</i>											
<i>Pararistolochia praevenosa</i>															
<i>Lomandra hystrix</i>															
<i>Dianella caerulea</i>															

5.3 OTHER RECOMMENDATIONS

5.3.1 KAWANA ADDITIONAL RECOMMENDATIONS

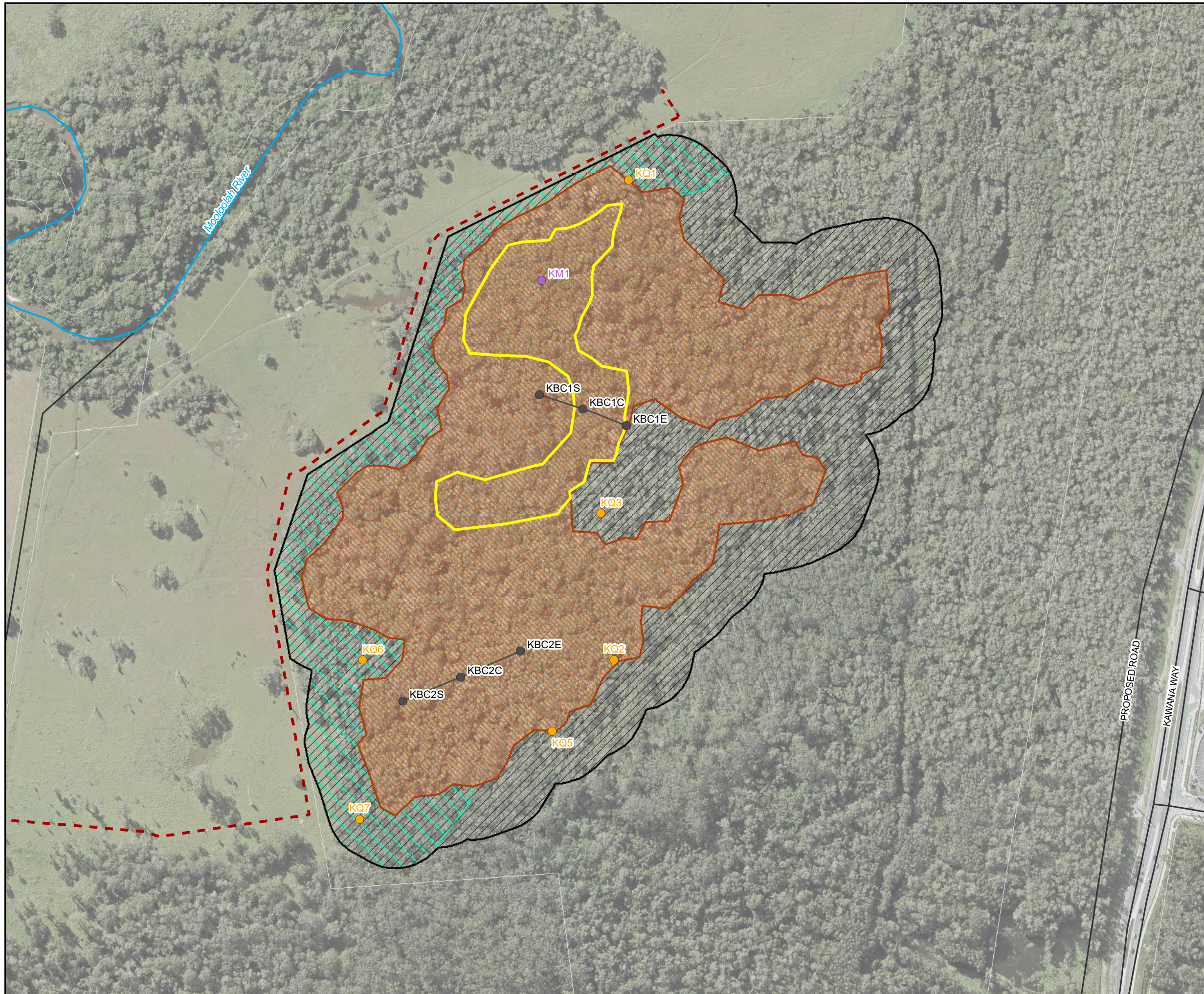
It is recommended an access track is slashed and maintained annually adjacent to the offset area to allow for ongoing weed control and monitoring (Figure 5.1). It is also recommended that stock are excluded from the offsets area to maintain a low risk level to the committed offset area. If fencing is required to achieve stock exclusion, it is recommended a cattle fence is established aligned along the proposed access track if required (Figure 5.1).

5.3.2 WOONDUM ADDITIONAL RECOMMENDATIONS

It is recommended an access track is maintained annually adjacent to the offset area to the north to allow for ongoing weed control and monitoring (Figure 5.2). It is also recommended an access track is installed along the western boundary with a gate that allows access to support revegetation activities into the western edge of the area (Figure 5.2).

It is also recommended that stock are excluded from the offsets with a cattle fence established aligned along the proposed access track along the western edge (Figure 5.2).

**Figure 5.1
Kawana Offsets Area Recommended
Management Areas**



- Legend**
- BioCondition
 - Weed Monitoring Site
 - Photo Monitoring Site
 - Proposed Access
 - Transect
 - Watercourse
 - Cadastre
 - ▨ Lowland Rainforest TEC
 - ▨ Weed Management
 - ▭ Recommended Revegetation Area
 - ▨ Threatened Ecological Communities (*offset buffer*)



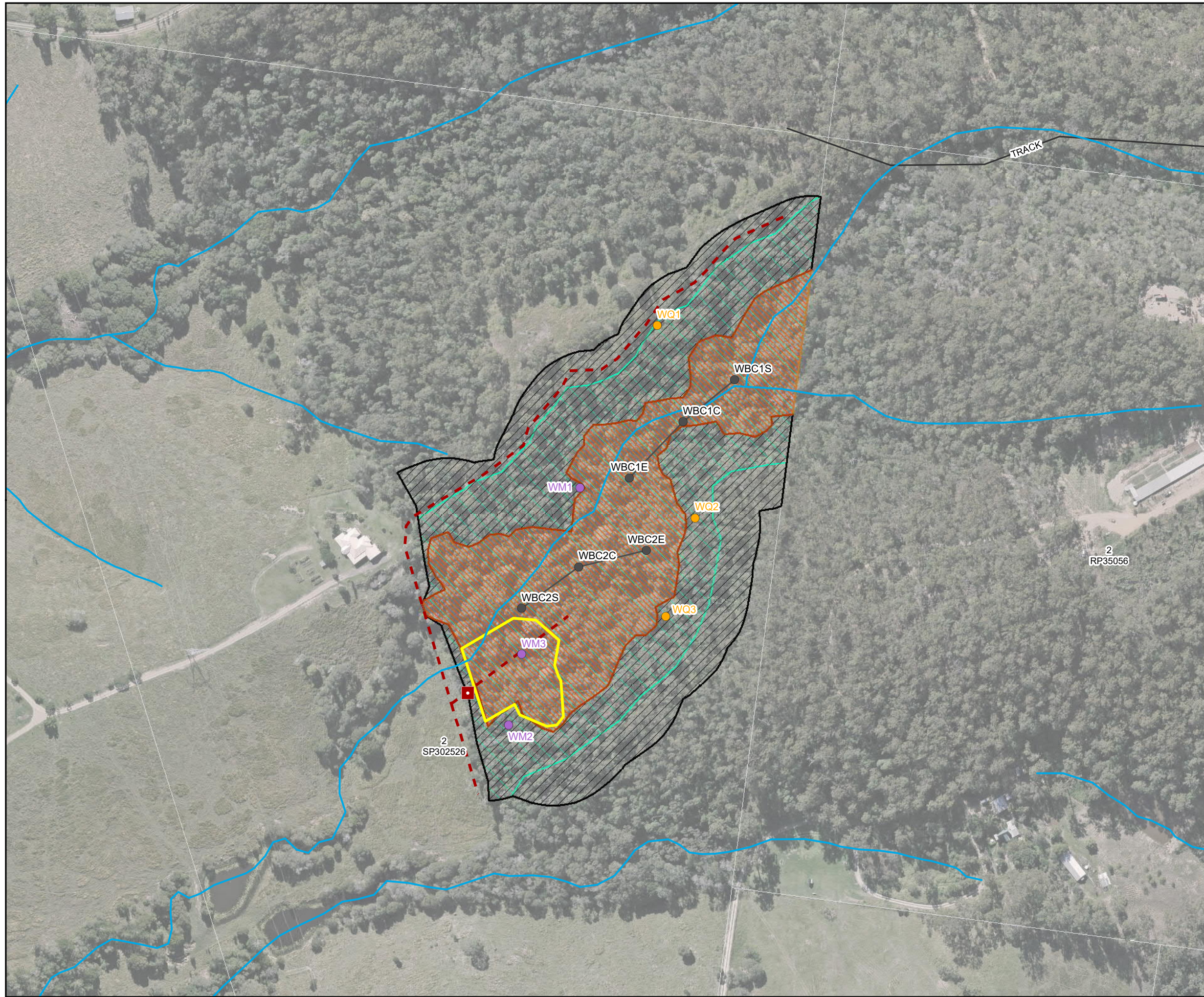
0 50 100
Meters

Coordinate system: GDA 1994 MGA Zone 56
 Scale ratio correct when printed at A3
 1:3,500 Date: 4/11/2020

Data sources: - DNRME, TMR, Translink, Geoscience Australia

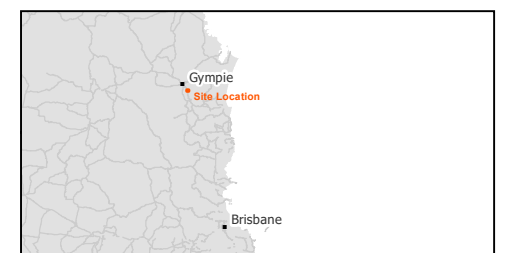
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**Figure 5.2
Woondum Offsets Area Recommended
Management Areas**



Legend

- BioCondition
- Weed Monitoring Site
- Photo Monitoring Site
- Proposed Access Gate
- Proposed Access Track
- Transect
- Watercourse
- Cadastre
- ▨ Lowland Rainforest TEC
- ▨ Weed Management Area
- ▨ Recommended Revegetation Area
- ▨ Threatened Ecological Communities (*offset buffer*)



0 50 100
Meters

Coordinate system: GDA 1994 MGA Zone 56

Scale ratio correct when printed at A3

1:2,500

Date: 23-Sep-20

Data sources: - DNRME, TMR, Translink, Geoscience Australia

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6 CONCLUSIONS

The results of the baseline surveys indicated that both Kawana and Woondum offset areas contained >30 species for species listed in Appendix A of the Listing Advice. Kawana conformed with all additional condition criteria to meet the lowland rainforest TEC from the Listing Advice. Woondum conformed with all but one criteria whereby the ecological community typically occurs in areas with high annual rainfall (>1,300 mm). The total annual historical average rainfall for the Gympie region is 1,150 mm, below the typical >1,300 mm rainfall.

Results of field surveys showed there was an overabundance of coarse woody debris and organic litter at Kawana and the area was lacking the richness for native shrubs, native grasses, and native forbs and other species when compared to benchmarks. Field surveys further indicated there is a very low threat to the Lowland Rainforest TEC at Kawana apart from some restricted invasive plant species occurring within the vegetated buffer zone. Furthermore, the site scored the maximum for 'role of site location' due to the size of the patch (15.7 ha), quality of the patch, and the occurrence within >1,300 mm rainfall zone on lowland coastal plains. The Listing Advice suggests the largest occurrences in protected areas are in Springbrook National Park (approx. 260 ha), Lamington National Park (approx. 100 ha), Kondalilla National Park (approx. 95 ha) and the Glass House Mountains National Park (approx. 70 ha). The addition of the 15.7 ha patch at Kawana to the overall conservation of the Lowland Rainforest TEC is significant in relation to increasing both the extent and the overall area of the Lowland Rainforest TEC in Southeast Queensland in relation to those areas already protected, hence the maximum score.

It is recommended the best opportunity for improving the ecological condition and habitat quality scores at Kawana is associated with maintaining a low risk of 'threat to species.' This would be achieved through ongoing weed control and stock exclusion, as well as targeted revegetation enhancement of native trees and shrubs, native grasses, and native forbs and other species associated with the Lowland Rainforest TEC in the ecotones between the palm forests and more complex areas of the community (refer Figure 5.2).

It is also recommended an access track is slashed and maintained annually adjacent to the Kawana offset area to allow for ongoing weed control and monitoring (Figure 5.1). It is also recommended that stock are excluded from the offsets area to maintain a low risk level to the committed offset area. If fencing is required to achieve stock exclusion, it is recommended a cattle fence is established aligned along the proposed access track (Figure 5.1).

The area of Lowland Rainforest TEC at Woondum is quite small (2.7 ha) when compared to Kawana (15.7 ha) and the other areas of the community in protected areas such as Springbrook National Park (approx. 260 ha), Lamington National Park (approx. 100 ha), Kondalilla National Park (approx. 95 ha) and the Glass House Mountains National Park (approx. 70 ha). Furthermore, Woondum is below <1,300 mm average annual rainfall and is therefore a drier forest than Kawana. For these reasons Woondum scored low as 'role of site location' to the overall Lowland Rainforest TEC.

It is recommended the best opportunity for improving the ecological condition and habitat quality scores at Woondum is to reduce the 'threat to species' associated with invasive plant species. Of importance is the threat to the Lowland Rainforest TEC from the restricted invasive plants, in particular, the presence of Cats Claw Creeper (*Dolichandra unguis-cati*), Chinese Elm (*Celtis sinensis*) and Lantana (*Lantana camara*). Cats claw creeper was recorded within the vicinity of both BioCondition sites and in the southwestern portion of the buffer zone and is a major threat to the ecological condition of the Woondum Offsets area. It is recommended that restricted invasive plant weed management occurs throughout the Lowland Rainforest TEC offset area and areas mapped for weed management in the buffer zones (refer Figure 4.4).

It is recommended an access track is maintained annually adjacent to the offset area to the north to allow for ongoing weed control and monitoring (Figure 5.2). It is also recommended an access track is installed along the western boundary with a gate that allows access to support revegetation activities into the western edge of the area (Figure 5.2). It is also recommended that stock are excluded from the offsets with a cattle fence established aligned along the proposed access track along the western edge (Figure 5.2).

7 LIMITATIONS

SCOPE OF SERVICES

This report has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or disturbance constraints.

RELIANCE ON DATA

In preparing the report, WSP has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

ENVIRONMENTAL CONCLUSIONS

In accordance with the scope of services, WSP has relied upon the data and has conducted environmental field surveys in the preparation of the report. The nature and extent of survey conducted is described in the report.

Varying degrees of non-uniformity are encountered across all natural areas. Hence no sampling technique can eliminate the possibility that results are not totally representative of conditions encountered. The conclusions are based upon the data and the ecological surveys and are therefore merely indicative of the environmental condition of the study area at the time of preparing the report.

Also, it should be recognised that conditions, including the presence of threatened biodiversity, can change with time. No sampling technique can eliminate the possibility that a species is present within the proposal area. For example, some flora may be present in the soil seed bank and some fauna species use habitats on a sporadic or seasonal basis and may not be present within the study areas during surveys.

Within the limitations imposed by the scope of services, the surveys and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the client (and no other party). WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Except as provided below parties other than the client should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

8 REFERENCES

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- Queensland Herbarium (2019) Draft RE 12.3.1a BioCondition Benchmarks. Queensland Herbarium, Queensland Department of Environment and Science, Brisbane, Qld.

APPENDIX A

SUITABLY QUALIFIED PERSON CV





STEVE LYNGCOLN

Principal Ecologist/ Botanist



5 years with WSP

20 years of experience

AREAS OF EXPERTISE

Terrestrial ecology

Regional ecosystem and threatened ecological community survey and mapping

Threatened flora surveys

Groundwater dependent ecosystems

Ecosystem rehabilitation

Environmental offsets

Ecological impact assessment

Project management

LANGUAGES

English

PROFILE

Steve has over 20 years' experience in environmental management in Queensland and New South Wales. He has a Masters in Environmental Science and is skilled and experienced in terrestrial ecology, vegetation survey and mapping, threatened flora surveys, groundwater dependent ecosystems, ecosystem rehabilitation and environmental offsets.

Steve has experience in the preparation and delivery of terrestrial ecology environmental impact assessments for clients in the transport, utilities and coal mining and sectors. He has experience working with regulators to obtain environmental approvals associated with ecological impact assessment for coal mines, coal seam gas operations, major roads, water pipelines, government infrastructure, electricity transmission lines and solar farms.

He has specialist experienced and knowledge in undertaking targeted surveys for threatened ecological communities (TECs) and threatened flora species as they relate to legislative requirements under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Nature Conservation Act 1992* (NC Act), and *Environmental Offsets Act 2014* (EO Act 2014).

Steve also has specialist experience in the preparation of rehabilitation revegetation and monitoring plans. Known within the industry for his in-depth knowledge of regional ecosystems and ecological impact assessment and rehabilitation throughout Queensland and New South Wales, accompanied with his proven ability to work with clients and regulators to deliver tangible on ground environmental outcomes, Steve has a unique blend of technical and management skills.

EDUCATION

Masters of Business Administration (MBA), University of Queensland.	2018
Masters of Environmental Science, University of New England	2015
Graduate Diploma in Natural Resources, University of New England	2008
Bachelor of Applied Science (Protected Area Management), University of Queensland	2003
Diploma in Applied Science (Nature Conservation) (distinction), University of Queensland	2001

PROFESSIONAL ASSOCIATIONS

Australasian Land & Groundwater Association	ALGA
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PROFESSIONAL EXPERIENCE

Transport sector

- **Bruce Highway Smart Motorways Project. Ecological Assessment 2020. Department of Transport and Main Roads. Principal Ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the terrestrial flora ecological assessment report.
- **Burleigh to Palm Beach (P2B). ISCA Assessment (2019-20). Department of Transport and Main Roads. Principal Ecologist**

Responsible for completing the Eco -1 Ecological Value and Eco – 2 Habitat Connectivity ISCA Sustainability Assessment.
- **The Narrabri to North Star (N2NS) section of the Inland Rail Project Ecology ISCA Assessment (2018). ARTC. Principal Ecologist.**

Responsible for completing the Eco -1 Ecological Value and Eco – 2 Habitat Connectivity ISCA Sustainability Assessment.
- **Cooroy to Curra Section D Energex and Telstra Vegetation Survey Report, Cooroy to Curra, Qld, Australia (2019). Department of Transport and Main Roads. Principal Ecologist.**

Responsible for leading field based threatened flora surveys, vegetation clearing assessments, and preparing the associated vegetation survey report.
- **Bruce Highway Interchange Upgrades - Maroochydore Road and Mons Road Ecological Assessment Report (WSP 2019). Department of Transport and Main Roads. Principal Ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the terrestrial flora ecological assessment report.
- **Bruce Highway Interchange Upgrades - Maroochydore Road and Mons Road ISCA Assessment (WSP 2019). Department of Transport and Main Roads. Principal Ecologist.**

Responsible for completing the Eco -1 Ecological Value and Eco – 2 Habitat Connectivity ISCA Sustainability Assessment.
- **Protected Plants Flora Survey Report, Beechmont Road Safety Improvements Project, Qld, Australia (2017). Department of Transport and Main Roads, Principal Ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the Flora Survey Report.
- **Toowoomba Range Clearance Upgrade Protected Plants Flora Survey Report Toowoomba, Qld, Australia (2017). Queensland Rail. Principal Ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the Flora Survey Report.
- **Nerang-Murwillumbah Road Hidden Woods Road Intersection Flora and Fauna Assessment, Nerang, Qld, Australia (2016). Department of Transport and Main Roads. Principal Ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the Flora Survey Report.

- **Toowoomba Second Range Crossing Project, Toowoomba, Qld, Australia (2016). Transport and Main Roads. Principal Ecologist.**

Responsible for leading field based ecological pre-clearance surveys for geotechnical sites and leading the project threatened flora survey.

- **ARTC Gowrie to Kagaru Project, Qld, Australia (2016). ARTC. Technical Lead Flora Ecology.**

Responsible for completing the initial corridor desktop assessment and identifying potential ecological constraints associated with matters of national and state significance. Assisted with stage 1 and stage 2 detailed ecology desktop assessments and field survey scopes of work.

- **Tinana Road Interchange Upgrade, Tinana, Qld, Australia (2015). Transport and Main Roads, Terrestrial flora ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the terrestrial flora ecological assessment report.

- **Boundary Road Interchange Upgrade, Narangba, Qld, Australia (2015). Transport and Main Roads. Terrestrial flora ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the terrestrial flora ecological assessment report.

- **Cooroy to Curra Section C Energex and Telstra Vegetation Survey Report, Cooroy to Curra, Qld, Australia (2015). Department of Transport and Main Roads. Principal Ecologist.**

Responsible for leading field based threatened flora surveys, vegetation clearing assessments, and preparing the associated vegetation survey report.

Utilities sector

- **Significant Impact Assessment for *Philotheca sporadica*, Darling Downs Solar Farm Powerline Connection, Qld, Australia (2017). Powerlink Queensland. Principal Ecologist.**

Responsible for preparation of the Significant Impact Assessment (SIA) for *P. sporadica* potentially impacted as a result of the proposed powerline connection.

- **Sunshine Coast Airport Runway Diversion Pipeline Project, Sunshine Coast, Qld, Australia (2016). Unitywater. Principal Ecologist.**

Responsible for the delivery of the protected plant and marine plant flora survey.

- **Russel Island Project Threatened Flora Survey Report, Brisbane, Qld, Australia (2015). Energex. Principal Ecologist.**

Responsible for the delivery of the protected plant survey and Flora Survey Report.

Mining and CSG

- **Dawson Coal Mine. Kianga Creek Diversion Revegetation Plan (2018). Anglo American. Principal Ecologist**

Responsible for the development and preparation of the Kianga Creek Diversion Revegetation Plan. The plan was based on achieving native ecosystems within the planned diversion similar to surrounding environment, aligned with sil types, underlying

geologies and stream bank and bed zones. A full risk assessment and management actions were also included in the development of the plan.

- **Peabody Energy Rehabilitation Monitoring Program, Qld (2017). Peabody Energy. Project manager**

Responsible for managing the delivery of Peabody's 2017 Rehabilitation Monitoring Program across all of its Queensland operations in accordance with the Peabody Rehabilitation Monitoring Methodology.

- **Blair Athol Coal Mine Rehabilitation Monitoring Plan (2016). Rio Tinto Coal. Project manager.**

Responsible for the delivery of the 2016 Rehabilitation current status review and update of the Blair Athol Rehabilitation Monitoring Plan (2016)

- **Origin Energy Darling Downs Solar Farm Project (2015-16). Origin Energy. Terrestrial flora ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems, conducting targeted botanical surveys for threatened flora species, and the preparation of the terrestrial flora section of the report.

- **Wesfarmers Curragh MDL162 Expansion Project (2014–2016). Wesfarmers. Terrestrial flora ecologist.**

Responsible for delivery of the terrestrial flora impact assessment, groundwater dependent ecosystem classification and mapping and preliminary environmental offset strategy.

- **Rolleston Coal Mine Expansion EIS (2012–2015). Glencore Coal Qld. Technical lead terrestrial ecology.**

Responsible for delivery of the terrestrial flora and fauna impact assessment, groundwater dependent ecosystem classification and mapping, and project environmental offset strategy.

- **Arrow Energy Rehabilitation Monitoring Project (2013–2014). Arrow Energy. Technical lead rehabilitation monitoring.**

Responsible for developing the rehabilitation monitoring methods, training key staff members and leading rehabilitation monitoring field teams.

- **Blair Athol Coal Mine Rehabilitation Revegetation Planning Report (2013). Rio Tinto Coal. Terrestrial ecologist and project manager.**

Responsible for developing revegetation plans for post coal mining rehabilitation domains at Blair Athol Coal Mine.

- **Blair Athol Coal Mine Micro-habitat Rehabilitation Planning Assessment (2013). Rio Tinto Coal. Terrestrial ecologist and project manager.**

Responsible for the development of micro-habitat plans for post coal mining rehabilitation domains.

- **Boundary Hill EIS (2012). Anglo American. Terrestrial flora ecologist.**

Responsible for the delivery of the terrestrial flora ecological impact assessment.

- **Meridian Seam Gas Soils and Vegetation Baseline Assessment (2012). Westside Corporation. Terrestrial ecologist and project manager.**

Responsible for surveying and mapping regional ecosystems and environmentally sensitive areas across the Meridian Seam Gas Project operations.

- **Washpool Environmental Impact Statement - Environmental Offset Strategy (2012). Aquila Resources. Technical lead terrestrial ecology.**

Responsible for the preparation of the project's environmental offset strategy.

- **Wards Well EIS (2011–2012). BHP Billiton Mitsubishi Alliance. Terrestrial flora ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems and threatened ecological communities, conducting targeted botanical surveys for threatened flora species, and the preparation of the terrestrial flora ecological impact assessment report.

- **Peak Downs Expansion Project EIS (2011–2012). BHP Billiton Mitsubishi Alliance. Terrestrial flora ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems and threatened ecological communities, targeted botanical surveys for threatened flora species, and preparation of the terrestrial flora ecological assessment report.

- **North Goonyella Coal Rehabilitation and Land Use Management Plan (2011–2012). Peabody Energy. Terrestrial ecologist.**

Responsible for developing revegetation plans for post coal mining rehabilitation domains.

- **New Acland Stage 3 EIS (2011). New Hope Coal. Terrestrial flora ecologist.**

Responsible for conducting vegetation and botanical surveys, and the preparation of the terrestrial flora Bluegrass Offsets Management Plan and associated Threatened Species Relocation Plan.

- **Togara North Expansion Project EIS (2011–2012). Xstrata Coal Qld. Terrestrial flora ecologist.**

Responsible for conducting field surveys and mapping for regional ecosystems and threatened ecological communities, and preparation of the terrestrial flora ecological impact assessment report.

- **Saraji East Pipeline (2011). BHP Billiton Mitsubishi Alliance. Terrestrial flora ecologist.**

Responsible for conducting targeted botanical field surveys, mapping regional ecosystems and threatened ecological communities, and the preparing the project terrestrial flora ecological assessment report.

- **Caval Ridge Pipeline Review of Environmental Factors (2011). Sunwater. Terrestrial flora ecologist.**

Responsible for conducting desktop constraints assessment and targeted field surveys for the purpose of identifying terrestrial flora and fauna constraints within the proposed pipeline corridor.

PROFESSIONAL DEVELOPMENT

Senior First Aid (nationally recognised)	2014
Queensland and NSW Coal Board Medical	2014
Standard 11 Surface Operations - Refresher	2018
Bio condition training, Queensland Herbarium	2011
Queensland Herbarium Regional Ecosystem Training	2009



STEVE LYNGCOLN
Principal Ecologist/ Botanist

PROFESSIONAL HISTORY

WSP	2018 - Present
Biodiversity Australia	2018
WSP/ Parsons Brinckerhoff	2014 - 2017
AECOM	2012 – 2014
Sinclair Knight Merz	2010 – 2012
SEQ Catchments Regional NRM Group	2005 – 2010
Queensland Parks and Wildlife Service	2001 – 2005

APPENDIX B

BASELINE VEGETATION SITE SURVEY
RESULTS AND SPECIES LISTS



B1 KAWANA BASELINE VEGETATION SITE SURVEY RESULTS

SURVEY SITES		KBC1	KBC2	KQ1	KQ2	KQ3	KQ4	KQ5	KQ6	KQ7
Field verified regional ecosystems (RE)		RE12.3.1a	RE12.3.1a	12.3.5	12.3.2	12.3.5	12.3.1a	12.3.5	12.3.5	12.3.5/12.3.2
Ecological dominant layer (EDL)		T1	T1	T1	T1	T1	T1	T1	T1	T1
EDL median height (m)		28	25	24	35	25	25	20	20	35
EDL Canopy Cover % (estimated Quaternary sites)		100	98	90	55	50	100	50	50	40
Species Name	Lowland Rainforest TEC Appendix A Flora Species									
<i>Acacia leiocalyx</i>										x
<i>Alphitonia excelsa</i>	x		x							x
<i>Alpinia caerulea</i>			x		x					
<i>Archontophoenix cunninghamiana</i>	x	x	x	x			x	x		
<i>Argyrodendron trifoliolatum</i>	x						x			
<i>Atractocarpus chartaceus</i>	x	x	x							
<i>Austrosteenisia blackii</i>		x	x							
<i>Beilschmiedia obtusifolia</i>		x	x							
<i>Blechnum indicum</i>									x	
<i>Castanospermum australe</i>	x		x							
<i>Calamus muelleri</i>	x	x	x					x		
<i>Callerya megasperma</i>				x						
<i>Cissus antarctica</i>	x	x								
<i>Commersonia bartramia</i>	x		x							
<i>Cordyline rubra</i>	x	x	x			x		x		
<i>Croton acronychioides</i>										
<i>Croton verreauxii</i>		x	x							
<i>Cryptocarya obovata</i>	x		x							
<i>Cryptocarya triplinervis</i>		x		x						
<i>Cyperus sp.</i>		x								
<i>Desmodium uncinatum**</i>										x
<i>Digitaria violascens*</i>										x
<i>Diospyros pentamera</i>	x		x							
<i>Diploglottis australis</i>	x	x								
<i>Endiandra discolor</i>		x	x	x				x		

SURVEY SITES		KBC1	KBC2	KQ1	KQ2	KQ3	KQ4	KQ5	KQ6	KQ7
<i>Eucalyptus grandis</i>		x			x			x		x
<i>Ficus coronata</i>	x			x	x					
<i>Ficus fraseri</i>	x	x	x							
<i>Ficus obliqua</i>	x	x					x			
<i>Ficus watkinsiana</i>	x	x	x	x			x			
<i>Freycinetia scandens</i>		x								
<i>Geitonoplesium cymosum</i>	x	x	x							
<i>Glochidion sumatranum</i>			x	x				x	x	x
<i>Gossia bidwillii</i>	x		x							
<i>Halfordia kendack</i>		x								
<i>Helicia glabriflora</i>	x	x	x							
<i>Ipomoea indica**</i>										x
<i>Jagera pseudorhus</i>	x	x								
<i>Livistona australis</i>	x	x	x		x	x		x		x
<i>Lantana camara**</i>									x	x
<i>Lophostemon suaveolens</i>				x	x				x	
<i>Machura cochinchinensis</i>	x		x							
<i>Melaleuca quinquenervia</i>		x	x	x		x		x	x	x
<i>Melicope elleryana</i>	x	x			x				x	
<i>Melodinus acutifolius</i>		x	x							
<i>Mischocarpus pyriformis</i>		x	x							
<i>Paspalum scrobiculatum*</i>							x			
<i>Passiflora suberosa**</i>										x
<i>Pittosporum multiflorum</i>	x		x							
<i>Pothos longipes</i>			x							
<i>Planchonella australis</i>	x	x	x							
<i>Planchonella chartacea</i>		x								
<i>Ripogonum album</i>		x	x							
<i>Sloanea australis</i>	x	x								
<i>Sloanea woollsii</i>	x	x								
<i>Smilax australis</i>	x	x								
<i>Streblus brunonianus</i>	x		x							
<i>Stenocarpus sinuatus</i>			x							

SURVEY SITES		KBC1	KBC2	KQ1	KQ2	KQ3	KQ4	KQ5	KQ6	KQ7
<i>Syzygium luehmannii</i>			x							
<i>Syzygium francisii</i>	x	x	x							
<i>Syzygium oleosum</i>		x								
<i>Symplocos thwaitesii</i>			x							
<i>Tabernaemontana pandacaqui</i>	x	x								
<i>Trophis scandens</i>			x					x		
Sub totals	31	35	35	9	6	4	4	9	6	11
Total native tree species		22	23	9	6	3	4	9	5	7
Total exotic species * and exotic invasive plant species**	6					1			1	4
Total shrub tree species		5	5							
Total forbs and other		8	7							
Total native grasses		0	0							
Proportion of canopy recruiting %		80	82							
Total Species	65									

B2 WOONDUM BASELINE VEGETATION SITE SURVEY RESULTS

SURVEY SITES		WBC1	WBC2	WM1	WM2	WQ1	WQ2	WQ3	WQ4
Field verified regional ecosystems (RE)		12.11.10	12.11.10	12.11.10/ 12.11.3	12.11.10 (HVR)	12.11.5 (HVR)	12.11.3	12.11.5	12.11.10 (HVR)
Ecological dominant layer (EDL)		T1	T1	T1	T1	T1	T1	T1	T1
EDL median height (m)		24	20	16	8	8	20	20	18
EDL Canopy Cover % (estimated Quaternary sites)		72.5	88.5	40	40	30	40	40	20
Species Name	Lowland Rainforest TEC Appendix A Flora Species								
<i>Acacia disparrima</i>			x	5%					x
<i>Acacia glaucophylla</i>				5%<					
<i>Acacia maidenii</i>		x			20-30%	x		x	
<i>Acronychia laevis</i>		x							
<i>Actephila lindleyi</i>	x		x						
<i>Adiantum hispidulum</i>		x	x						
<i>Alchornea ilicifolia</i>			x	5%<					
<i>Alectryon tomentosus</i>		x							
<i>Alphitonia excelsa</i>	x	x			5%<				
<i>Alyxia ruscifolia</i>		x	x	5%<					
<i>Aphananthe philippensis</i>	x		x						
<i>Araucaria cunninghamiana</i>	x	x	x						
<i>Argyrodendron trifoliolatum</i>	x		x						
<i>Arytera distylis</i>	x		x						
<i>Arytera divaricata</i>		x		5%<					
<i>Asplenium attenuatum</i>		x							
<i>Atractocarpus chartaceus</i>	x		x						
<i>Austrosteenisia blackii</i>			x						
<i>Backhousia subargentea</i>			x						
<i>Bosistoa medicinalis</i>			x						
<i>Capparis arborea</i>	x	x	x						
<i>Celtis sinensis**</i>									x
<i>Cissus antarctica</i>	x	x	x						
<i>Clerodendrum tomentosum</i>			x						

SURVEY SITES		WBC1	WBC2	WM1	WM2	WQ1	WQ2	WQ3	WQ4
<i>Commersonia bartramia</i>	x	x		5%<					
<i>Cordyline rubra</i>	x	x	x	5%<					
<i>Corymbia citriodora var. variegata</i>						x		x	
<i>Corymbia intermedia</i>							x		
<i>Croton verreauxii</i>		x							
<i>Cryptocarya laevigata</i>			x						
<i>Cupaniopsis parvifolia</i>					5%<				
<i>Cupaniopsis serrata</i>	x	x	x						
<i>Dioscorea transversa</i>	x		x						
<i>Diospyros fasciculosa</i>				5%<					
<i>Dissiliaria baloghioides</i>			x						
<i>Dolichandra unguis-cati**</i>		x	x		20-30%			x	
<i>Drypetes deplanchei</i>		x	x						
<i>Erythroxylon australe</i>					5%<				
<i>Eucalyptus acmenoides</i>							x		
<i>Eucalyptus propinqua var. propinqua</i>								x	
<i>Eucalyptus siderophloia</i>				5%		x	x		
<i>Eustrephus latifolius</i>	x		x						
<i>Everistia vacciniifolia</i>			x						
<i>Flindersia australis</i>	x		x						
<i>Flindersia schottiana</i>	x		x						
<i>Geitonoplesium cymosum</i>	x	x		5%<					
<i>Gossia bidwillii</i>	x	x	x	5%<	5%<				
<i>Jagera pseudorhus</i>	x			5%<		x			
<i>Lantana camara**</i>		x	x	50-60%	20%	x	x		x
<i>Lophostemon confertus</i>	x			10%		x	x		
<i>Mallotus philippinensis</i>	x	x	x	5%<		x	x	x	
<i>Medicosma cunninghamii</i>			x						
<i>Melia azedarach</i>	x								x
<i>Mischocarpus pyriformis</i>			x						
<i>Oplismenus aemulus</i>		x		5%<					
<i>Passiflora suberosa**</i>			x			x	x	x	
<i>Pilidiostigma rhytispermum</i>		x		5%<					

SURVEY SITES		WBC1	WBC2	WM1	WM2	WQ1	WQ2	WQ3	WQ4
<i>Pittosporum multiflorum</i>	x		x						
<i>Platynerium superbum</i>	x		x						
<i>Polyalthia nitidissima</i>		x	x						
<i>Polyscias elegans</i>	x	x	x	5%<	5%<	x	x		
<i>Psydrax odorata</i>		x							
<i>Rhodamnia dumicola</i>			x						
<i>Rivina humilis**</i>			x						
<i>Sarcopteryx stipata</i>	x	x							
<i>Sloanea australis</i>	x			5%<					
<i>Smilax australis</i>	x	x	x	5%<					
<i>Solanum aviculare</i>		x		5%<					
<i>Solanum mauritianum*</i>									x
<i>Solanum seafortianum**</i>		x	x						
<i>Stenocarpus sinuatus</i>			x						
<i>Streblus brunonianus</i>	x	x	x						
<i>Syzygium luehmannii</i>		x							
<i>Tabernaemontana pandacaqui</i>	x		x						
<i>Vitex lignum-vitae</i>			x						
<i>Wilkiea austroqueenslandica</i>	x	x	x						
<i>Wilkiea macrophylla</i>		x							
Sub totals	31	34	46	13	6	9	8	6	5
Total native tree species		15	24	12	4	7	7	4	2
Total exotic species * and exotic invasive plant species**	7	3	5	1	2	2	1	2	3
Total shrub tree species		7	9						
Total forbs and other		8	8						
Total native grasses		1	0						
Proportion of canopy recruiting %		94	83						
Total Species	77								

APPENDIX C

SITE PHOTOS AND MONITORING POINTS



C1 KAWANA SITE PHOTOS



Photo C.1 Kawana BC 1 North



Photo C.2 Kawana BC 1 East



Photo C.3 Kawana BC 1 South



Photo C.4 Kawana BC 1 West



Photo C.5 Kawana BC 2 North



Photo C.6 Kawana BC 2 East



Photo C.7 Kawana BC 2 South



Photo C.8 Kawana BC 2 West

C2 WOONDUM SITE PHOTOS



Photo C.9 Woondum BC 1 North



Photo C.10 Woondum BC 1 East



Photo C.11 Woondum BC 1 South



Photo C.12 Woondum BC 1 West



Photo C.13 Woondum Monitoring Site 1 (WM1)



Photo C.14 Woondum Monitoring Site 2 (WM2)



Photo C.15 Woondum BC 2 North



Photo C.16 Woondum BC 2 East



Photo C.17 Woondum BC 2 South



Photo C.18 Woondum BC 2 West

ABOUT US

WSP is one of the world's leading engineering professional services consulting firms. We are dedicated to our local communities and propelled by international brainpower. We are technical experts and strategic advisors including engineers, technicians, scientists, planners, surveyors, environmental specialists, as well as other design, program and construction management professionals. We design lasting Property & Buildings, Transportation & Infrastructure, Resources (including Mining and Industry), Water, Power and Environmental solutions, as well as provide project delivery and strategic consulting services. With approximately 48,000 talented people globally, we engineer projects that will help societies grow for lifetimes to come.

