NSW Roads and Maritime Services

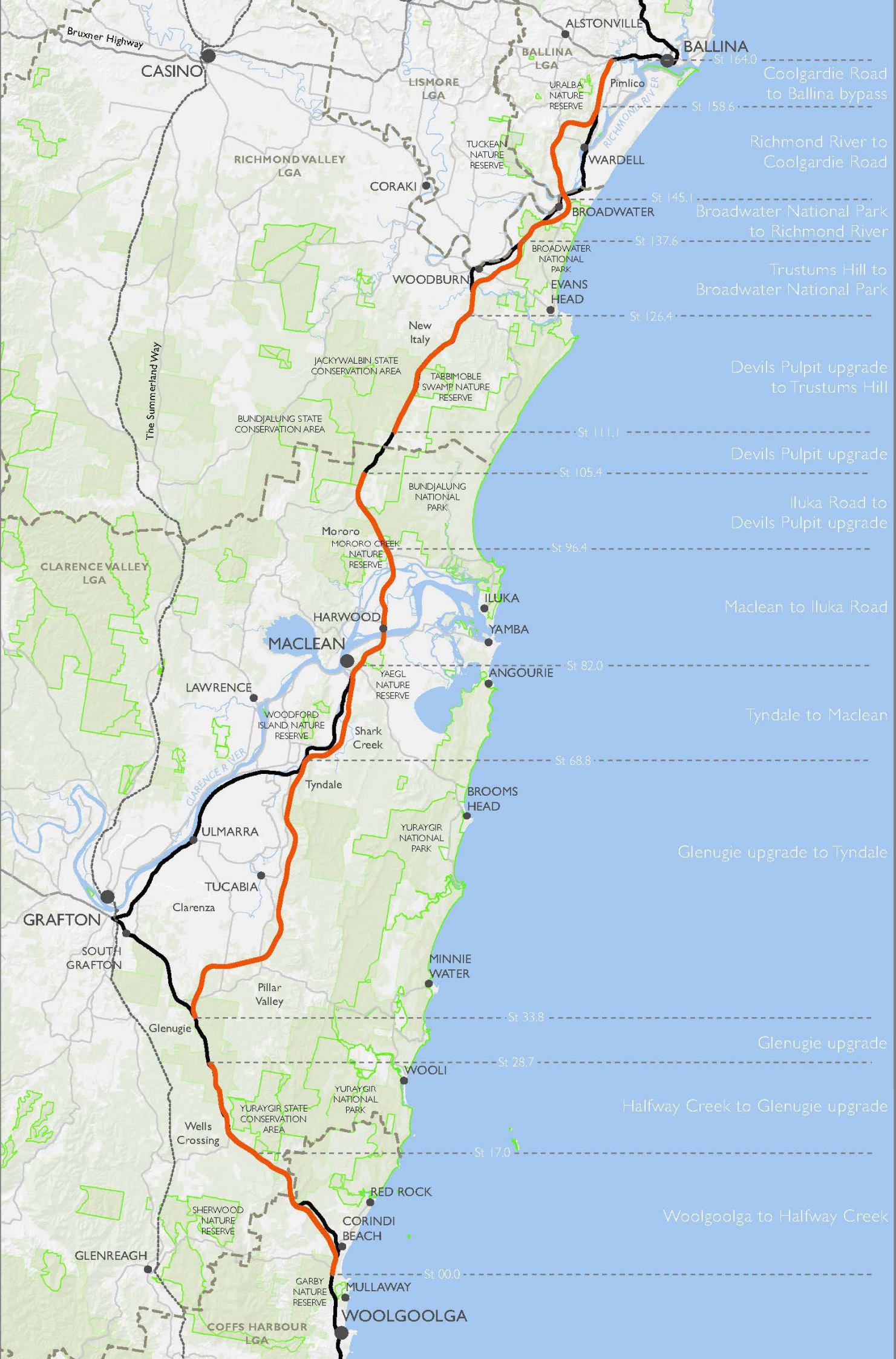
WOOLGOOLGA TO BALLINA PACIFIC HIGHWAY UPGRADE

RAINFOREST COMMUNITIES AND THREATENED RAINFOREST PLANTS MANAGEMENT PLAN

Version 1.0

November 2013

Prepared by: NSW Roads and Maritime Services, Aurecon and Sinclair Knight Merz


Bruxner Highway
CASINO
ALSTONVILLE
BALLINA
BALLINA LGA
LISMORE LGA
URALBA NATURE RESERVE
Pimlico
RICHMOND RIVER
St 164.0
Coolgardie Road to Ballina bypass
11
St 158.6
Richmond River to Coolgardie Road
10
TUCKEAN NATURE RESERVE
WARDELL
RICHMOND VALLEY LGA
CORAKI
St 145.1
BROADWATER
Broadwater National Park to Richmond River
9
St 137.6
BROADWATER NATIONAL PARK
Trustums Hill to Broadwater National Park
8
WOODBURN
EVANS HEAD
St 126.4
New Italy
JACKYWALBIN STATE CONSERVATION AREA
TABBIMOBLE SWAMP NATURE RESERVE
Devils Pulpit upgrade to Trustums Hill
7
The Summerland Way
BUNDJALUNG STATE CONSERVATION AREA
St 111.1
Devils Pulpit upgrade
St 105.4
BUNDJALUNG NATIONAL PARK
Iluka Road to Devils Pulpit upgrade
6
Mororo
MORORO CREEK NATURE RESERVE
St 96.4
CLARENCE VALLEY LGA
ILUKA
Maclean to Iluka Road
5
HARWOOD
YAMBA
MACLEAN
St 82.0
ANGOURIE
YAEGL NATURE RESERVE
LAWRENCE
WOODFORD ISLAND NATURE RESERVE
Shark Creek
Tyndale to Maclean
4
St 68.8
CLARENCE RIVER
Tyndale
BROOMS HEAD
YURAYGIR NATIONAL PARK
ULMARRA
Glenugie upgrade to Tyndale
3
TUCABIA
Clarenza
GRAFTON
SOUTH GRAFTON
MINNIE WATER
Pillar Valley
St 33.8
Glenugie
Glenugie upgrade
St 28.7
WOOLI
YURAYGIR NATIONAL PARK
YURAYGIR STATE CONSERVATION AREA
Halfway Creek to Glenugie upgrade
2
Wells Crossing
St 17.0
RED ROCK
SHERWOOD NATURE RESERVE
CORINDI BEACH
Woolgoolga to Halfway Creek
1
GLENREAGH
St 00.0
GARBY NATURE RESERVE
MULLAWAY
WOOLGOOLGA
COFFS HARBOUR LGA

Contents

Glossary of Terms

Term	Definition
CEMP	Construction Environmental Management Plan
CMS	Construction Method Statement
CoA	Conditions of Approval
Construction footprint	The direct area of the design alignment
DECCW	Department of Environment, Climate Change and Water (now known as OEH)
Direct impact	An impact that causes direct harm within the project boundary (i.e. clearing of vegetation)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Now known as the Department of Environment)
DoPI	Department of Planning and Infrastructure
DPI	Department of Primary Industries
EP&A Act	Environmental Planning and Assessment Act 1979
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EIS	Environmental Impact Statement (Biodiversity Assessment Working Paper)
Ex-situ	Locations where plant populations would be translocated or revegetated in a new area.
FFMP	Flora and Fauna Management Plan
Indirect impact	An impact that causes harm outside of the project boundary as a result of a direct impact (i.e. edge effects, erosion etc.)
In situ	Locations where plant populations already exist and occur naturally in the landscape.
NSW	New South Wales
OEH	Office of Environment and Heritage
The Project (aka Project boundary)	Refers to the all the proposed works in all eleven sections which includes the construction footprint with a 10 metre construction buffer, ancillary and compound sites and design changes.
Roads and Maritime	Roads Maritime Services
S/PIR	Submissions / Preferred Infrastructure Report
Stochastic event	Natural phenomenon such as storms, fires, floods, droughts etc. (random event)
RCTRMP	Rainforest Communities and Threatened Rainforest Plants Management Plan (this Plan)
TEC	Threatened Ecological Communities
Threatened species	Any organism listed as vulnerable, endangered or critically endangered under state and/or Commonwealth legislation.
TSC Act	Threatened Species Conservation Act 1995

1. Introduction

1.1 Project overview

NSW Roads and Maritime Services (Roads and Maritime) is seeking approval for the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project (the project / the action), on the NSW North Coast. The approval is sought under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The location of the project is shown in the figure above.

Since 1996, both the Australian and NSW governments have contributed funds to the upgrade of the 664-kilometre section of the Pacific Highway between Hexham and the Queensland border, as part of the Pacific Highway Upgrade Program.

Both governments have a shared commitment to finish upgrading the highway to a four-lane divided road as soon as possible. However, the actual timing of construction, opening to traffic and completion is dependent on funding negotiations between the Australian and NSW governments. Assessments would be adjusted accordingly based on actual opening dates, for example noise and traffic predictions.

The project would upgrade around 155 kilometres of highway and represents the last priority (known as 'Priority 3' in the upgrade program) in achieving a four-lane divided road between Hexham and the NSW/Queensland Border. The project therefore forms a major part of the overall upgrade program and when constructed, would complete the four-lane divided road program.

The project would be jointly funded by the NSW and Australian governments.

The project does not include the Pacific Highway upgrades at Glenugie and Devils Pulpit, which are located between Woolgoolga and Ballina. These are separate projects, with Glenugie now complete and Devils Pulpit under construction. Altogether, these three projects would upgrade 164 kilometres of the Pacific Highway. The project does include a partial upgrade of the existing dual carriageways at Halfway Creek.

A more detailed description of the Woolgoolga to Ballina Pacific Highway upgrade is found in the Pacific Highway upgrade: Woolgoolga to Ballina Environmental Impact Statement prepared by Roads and Maritime in December 2012.

1.2 Purpose of this plan

This plan identifies the potential impacts of the project on the critically endangered Lowland Rainforest and Littoral Rainforest vegetation communities and threatened rainforest plants which were considered to be directly impacted or at greatest risk from the project. This plan does not include threatened non-rainforest plants which would be impacted by the project, as they have been included in the Threatened Plants Management Plan.

This plan identifies the proposed mitigation measures to be implemented for threatened rainforest communities and associated plants and a program for monitoring the effectiveness of these measures.

- The objectives of the plan include providing:
- An effective threatened plant management plan with consideration to the concerns of main stakeholders.
- A summary of the locations where threatened plant populations may be impacted by the project.
- Management and mitigation measures that would be implemented during pre-construction, construction and operation of the project to minimise impacts on threatened plant populations.
- A monitoring program to be implemented pre-construction and during construction and operation of the project the effectiveness of the mitigation measures proposed and inform an adaptive management approach.

1.3 Management structure and plan updates

Management structure

This plan provides a framework for any part of the proposed upgrade between W2B that is of relevance to the subject species and specific locations. This plan would be updated during the detailed design or pre-construction stage of any proposal that may affect threatened species relevant to this plan. The final plan would be specific to the project section, stage, program of works or singular element of infrastructure which makes-up the overall W2B upgrade. The plan would operate in conjunction with the Construction Environmental Management Plan (CEMP) and project specific flora and fauna management plan (FFMP), or may be incorporated into a wider framework that includes such plans.

Roads and Maritime would finalise this plan in consultation with the NSW Department of Planning and Infrastructure (DoPI), NSW Office of Environment and Heritage (OEH) and Department of Sustainability, Environment, Water, Population and Community (DSEWPaC).

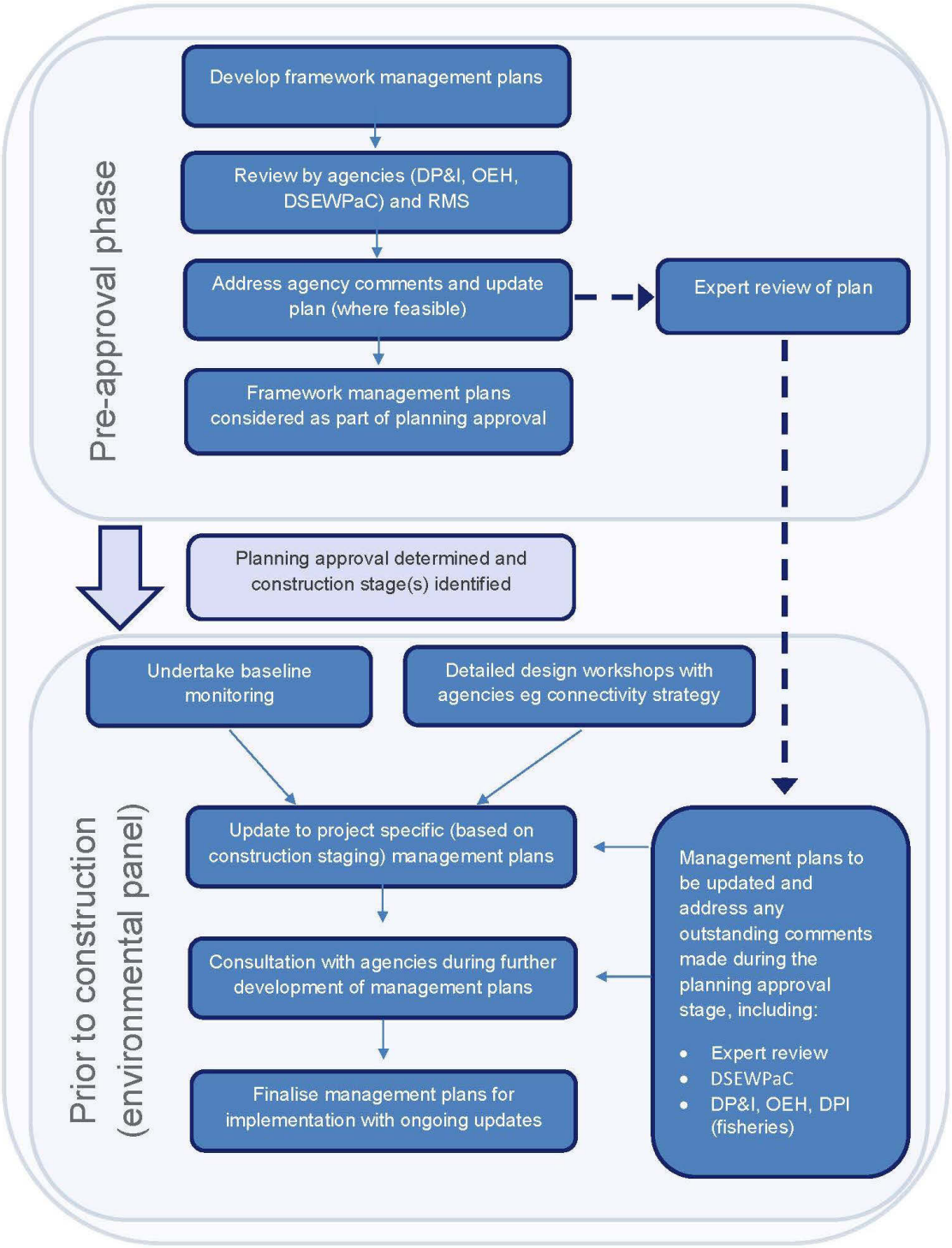
General responsibilities for environmental management would be outlined in the CEMP and FFMP. Responsibilities for implementation of this plan have been described throughout and summarised in **Chapter 8**. Following approval of the plan, the construction contractor and the contractors ecologists engaged for the relevant project sections would be responsible to oversee implementation of the plan.

Plan updates

The plan is intended to be a dynamic document subject to continual improvement. The management plan would be updated as required to meet the mitigation and management measures committed to in the EIS and S/PIR and any Conditions of Approval (CoA) for the project. Prior to implementation, the plan would be updated following independent expert review to incorporate any necessary changes that arise from that review. The process for the update of the plan is illustrated in **Figure 1-1** below.

This plan identifies the general locations proposed for conducting monitoring and the methods, variables and timing of the proposed monitoring program. Details have been provided on the parameters for the selection of the final monitoring sites, both impact and control sites. It is not possible to pre-select the monitoring sites at this point in the planning and design process, as this requires further consultation with adjacent landowners. The final selection of monitoring sites would be subject to further interrogation through the implementation of the targeted surveys (refer to **Section 4.3**) and confirmation of landowner access, and would be presented in the first annual monitoring report with the intention of repeated sampling to be conducted at these locations.

Figure 1-1 Process to develop management plan



1.4 Adaptive management approach

The management plan has been presented using an adaptive management approach based on firstly identifying specific goals for management, implementation of management actions followed by monitoring of the performance of these measures against the goals and identified thresholds. As a final step the monitoring would evaluate the effectiveness of the management measures using identified thresholds for performance and implementing corrective actions to improve mitigation where required.

To ensure the success of this approach the management goals presented in the plan have been based on the following SMART principles:

- **S**pecific.
- **M**easurable.
- **A**chievable.
- **R**esults-based.
- **T**ime-based.

1.5 Plan authors and expert review

The biodiversity assessment technical lead on the W2B project was Chris Thomson with flora assessments in rainforest habitat undertaken by Lui Weber. This management plan was prepared by Chris Thomson and Andrew Carty from Sinclair Knight Merz (SKM). **Table 1-1** details the qualifications and experience of the authors involved in developing this plan.

Table 1 Authors qualifications and experience

Personnel	Qualifications	Experience
Chris Thomson	Bachelor of Applied Science and Graduate Certificate in Natural Resources	Chris is a group practice leader for ecology with a Bachelor of Applied Science and Graduate Certificate in Natural Resources and seventeen years professional experience managing biodiversity assessments and scientific reporting. He is a highly experienced field ecologist with extensive experience on major road projects with the Roads and Maritime, having worked widely throughout NSW as the technical lead on a range of environmental assessments including several Pacific Highway upgrades, the Hume Highway, Great Western Highway, Princes Highway and New England Highway. Chris has extensive experience in the design of avoidance and mitigation measures for minimising impacts on threatened species with a high level of experience on infrastructure projects including the development of compensatory habitat and offset strategies, biodiversity connectivity strategies, mitigation and monitoring strategies and threatened species management plans.
Andrew Carty	Bachelor of Environmental Science, Certificate IV in Natural Area Restoration and Certificate II in Bush Regeneration	Andrew has a Bachelor of Environmental, Certificate IV in Natural Area Restoration and Management and Certificate II in Bush Regeneration. He has also completed the DECCW BioBanking Assessors Course. Andrew has ten years experience specialising in botany and flora ecology. His experience includes flora and fauna field survey design and implementation, species identification, habitat evaluation and assessment, weed management and natural resource management. Andrew has comprehensive knowledge and experience with State and Commonwealth legislation regarding environmental impact assessment, threatened species protection and noxious weed management for Australia. Andrew has undertaken numerous projects throughout NSW for the Roads and Maritime Services including detailed biodiversity impact assessments, options assessments, offset strategies and ecological monitoring. Andrew is qualified to undertake BioBanking assessments in accordance with the NSW DECCW BioBanking assessment methodology. Andrew is licensed by the appropriate authorities to undertake flora and fauna investigations.
Lui Weber	Bachelor of Science (Honours)	Lui Weber is a senior botanist with BAAM, specialising in flora identification and management. He has worked in a wide range of bioregions and ecosystems across Australia, from rainforests to dry forests, grasslands and wetlands. His expertise in plant identification and ecology has been sought in the preparation of various field guides and electronic media. Lui has extensive experience in projects involving vegetation survey and mapping, weed management, regeneration planning, conservation planning and environmental monitoring.

Expert review

An expert review of the plan was undertaken in August 2013 by Dr Andrew Benwell. Andrew has more than 20 years professional experience in natural ecosystem management in NE NSW and SE Qld and is the Director of Ecos Environmental Pty Ltd which delivers a wide range of services dealing with the survey and management of flora and fauna. Expertise includes botanical survey, vegetation classification and mapping, preparation of plans on vegetation rehabilitation and restoration, threatened species translocation, weed management, monitoring and research. As well as preparation of planning documents and provision of advice. Ecos also implements ecological management works including bush regeneration and habitat restoration, threatened species translocation, broad-scale planting, weed removal, seed collection, plant propagation, ecological monitoring, auditing and research.

A curriculum vitae which contains a list of published or relevant work on threatened flora species for Andrew Benwell is provided in **Appendix A,** and a copy of his review of the management plan is attached as Appendix B. The recommendations provided in this review have been summarised in Table 1-2. The table also identifies how each of the recommendations have been addressed. Recommendations have been addressed in one of three ways:

- Adopted - plan updated.
- Adopted - plan to be updated prior to implementation.
- To be reviewed - recommendation to be reviewed further by Roads and Maritime prior to implementation.

Table 2 Summary of recommendations from the expert review and how addressed in this plan

ID No	Section	Comment / Recommendation	How recommendations would be addressed
RCMP1	Glossary	Include a glossary of terms at the front of the management plan.	Adopted- plan updated
RCMP2	1.2	Doesn't describe the purpose and objectives of the plan. Recommendation: state the purpose and objectives	Adopted- plan updated
RCMP3	Table 3-2	Recommendation: Get confirmation from the Royal Botanical Gardens National Herbarium in Sydney that *Streblus pendulinus* is synonymous with *S. brunonianus* and therefore *S. pendulinus* is not a threatened species.	To be reviewed prior to implementation
RCMP4	4	Potential impacts and management approach. 1st paragraph, 2nd line – communities and plant species, with reference….	Adopted- plan updated
RCMP5	4.2.1 and Table 4-1	In section 2.1, the first two paragraphs, the plan says that Lowland Rainforest EEC under the TSC Act is synonymous with Lowland Rainforest EEC under the EPBC Act, and the same for Littoral Rainforest. I don't see why then lowland rainforest patches 4-7 in Table 4-1 are only protected under the TSC Act – see p. 12, Table 4-1.	To be reviewed prior to implementation
RCMP6	4.2.1	Suggest title be changed to Direct and indirect impacts to threatened rainforest flora Take out Streblus	Adopted- plan updated
RCMP7	4.5	2nd paragraph refers to "individual threatened species management plans". There doesn't to be any more information on these in this plan. Where do they fit into the framework? Should there be more information on their general contents for the overarching MP? 4th paragraph refers to running translocation trials. I can't see how time would permit running a translocation trial – it would take at least a couple of years to run and evaluate. The purpose of the feasibility assessment is to decide, based on available information, whether a species could be translocated with a reasonable chance of success.	To be reviewed prior to implementation Adopted- plan updated

ID No	Section	Comment / Recommendation	How recommendations would be addressed
RCMP8	4.5	Mitigation and monitoring • Include a discussion of the purpose and potential benefits (and risks) of translocation in the context of direct impact and loss of threatened species individuals (see WC2U TFMP). Translocation would not be factored into offset formulae. • Translocation receival sites would be located outside the project boundary, in disturbed sections of offset land. • Translocation would be conducted to prevent declines in population numbers of threatened species in the vicinity of W2B upgrade (note – without translocation in some form there would be a net loss of individuals due to the project). • The introduction of threatened species to receival sites (i.e. translocation) would be designed in a comparative experimental fashion to learn more about species ecology and translocation technology.	Adopted- plan updated
RCMP9		Include a general discussion of translocation including its purpose and objectives, the different types of translocation, history of use, general outcomes, reasons for failure etc by way of introduction to the Translocation Strategy.	Adopted- plan updated
RCMP10	Table 4-3	Expand the title to make it clearer what this table refers to. There are 3 or 4 tables further on in the MP that contains the same mitigation measures as this table. All this duplication becomes confusing, particularly when there are differences in wording and thresholds etc for the same mitigation measure. Is there a simpler way of formulating this MP? Table 4-3 Issue – 1st issue what does 'outside the project" mean? This appears to mean outside the project boundary (ie on private property)? Or does it mean outside the construction footprint but inside the project boundary? These terms need to be defined in the glossary of terms and consistently applied throughout the plan. Or is "outside" a typo and it should say inside the project (ie project boundary) during construction – that context would make more sense to me. Mitigation measure (2nd column), 1st Mitigation measure – Isn't the mitigation here Confirmation of what individuals are to be removed (ie those within the construction zone) and what individuals are to be retained in situ within the project boundary. This is determined by targeted survey and the pre-clearing survey.	To be reviewed prior to implementation Adopted- plan updated Adopted- plan updated
RCMP11	Table 4-3	If the 1st issue is about "Accidental impact to threatened rainforest plants outside the project during construction" then doesn't the table also need as issues - (i) direct loss of threatened flora and rainforest due to clearing and (ii) indirect impact to in situ threatened flora and rainforest retained in situ within the road reserve/project boundary, outside the construction zone? Recommendation: Include the above as issues.	Adopted- plan updated
RCMP12	Table 4-3	Revegetation issue p. 17. Mitigation – recommend NOT planned and implemented in the context of the landscape design. A Rainforest Revegetation and Habitat Maintenance Plan should be prepared for rainforest threatened flora and EEC areas within the road reserve – this should be separate from the Landscape Plan. Recommendation: A Rainforest Revegetation and Habitat Maintenance Plan is prepared for rainforest threatened flora and EEC areas within the road reserve, separate from the Landscape Plan.	To be reviewed prior to implementation
RCMP13	4.7	The 2nd paragraph about SMART principles needs to go in the Introduction – Section 1.	Adopted- plan updated

ID No	Section	Comment / Recommendation	How recommendations would be addressed
RCMP14	Table 5-1	These species can be surveyed for all year round except for the first two, where fruits are required for positive identification of *Acronychia littoralis* and flowers for *Acalypha eremorum*. All other species are readily identifiable from their leaves.	Adopted- plan updated
RCMP15	General	What if new threatened species are found within the project boundary during targeted surveys, or significantly increased numbers of already identified species are found? Does the plan need an unforseen impacts section? I note that the Biodiversity Guidelines has an unexpected finds section but this seems to relate to the construction phase. Recommendation: Include an unforseen impacts section in the plan.	Adopted- plan to be updated prior to implementation
RCMP16	4	p. 21, 1st paragraph – wouldn't the targeted surveys focus on the road corridor within the approved project boundary? Are these really pre-clearing surveys? Will the targeted surveys take place before submitting the EA/EIS or after?	To be reviewed prior to implementation
RCMP17	4	p. 21, 2nd paragraph – isn't this about monitoring?	Adopted- plan to be updated prior to implementation
RCMP18	4	p. 21, 3rd paragraph – experienced botanist to do targeted surveys, not ecologist	Adopted- plan updated
RCMP19	4	p. 21, last dot point – why juvenile plants? Results have shown that the larger an individual up to maturity, the greater the survival rate when translocated. Some species are not suited to translocation (ie. transplanting from one field site to another).	Adopted- plan updated
RCMP20	4	Include a general discussion of translocation including its purpose and objectives, the different types of translocation, history of use, general outcomes, reasons for failure etc by way of introduction to the Translocation Strategy.	Adopted- plan updated
RCMP21	4	p. 21, 2nd paragraph, last sentence. Reword as "Translocation would be undertaken for species that have suitable life history and/or propagation and/or transplanting traits, where the feasibility assessment concludes that translocation has a reasonable chance of success."	Adopted- plan updated
RCMP22	4	Recommendation: Include T2E and BH2Y as example rainforest translocation projects.	Adopted- plan updated
RCMP23	4	Include >Translocation Plans would generally follow the framework and issues of consideration set out in ANPC (2004) "Guidelines for the Translocation of Threatened Plants in Australia" <	Adopted- plan updated
RCMP24	4	p. 22 – suggest all this information be placed under 2 headings – Translocation Feasibility Assessment and Translocation, as mentioned for the first plan.	Adopted- plan updated
RCMP25	4	p. 23 – paragraph at top – see comment above. What sort of trials? How long would they take? Is this practical?	Adopted- plan to be updated prior to implementation
RCMP26	4	Include a section on the selection and timing of receival site selection so it isn't a rushed last minute decision.	Adopted- plan updated
RCMP27	General	Include a section on indirect management of genetic diversity.	Adopted- plan updated
RCMP28	5.3.1	2nd paragraph – apart from pioneer rainforest species, rainforest seed doesn't store and should be sown straight away.	Adopted- plan updated
RCMP29	5.3.1	Next page – no number (24), 2nd paragraph, 1st sentence. Most rainforest species are easy to germinate. They don't take several years to reach a size suitable for planting out – 1-2 yrs. Are we talking pioneer or mature-phase species?	Adopted- plan updated

ID No	Section	Comment / Recommendation	How recommendations would be addressed
RCMP30	Table 5-3	Seed collection – only store pioneers species. The threatened species wont store. Second dot point – 500 metres is way too far. 50m is fine. Third dot point – targeted surveys could only some indication of this for clonal species Last dot point for seed collection – secateurs for taking cuttings must be sterilised before use on each individual – carry suitable disinfectant. Seed storage – as indicated above, most rainforest seed should be cleaned and sown straight away. That's why it is probably best if the grower also does the seed collection. Most rainforest nurseries also collect their own seed. Seed propagation – don't use the bog method, the seed will rot! Rainforest species should be grown in supertubes not 120mm tubes to ensure good survival when planted out. Seedlings should be a minimum 40cm tall and well hardened off for good results.	Adopted- plan updated
RCMP31	General	Recommendation: Include seed propagation experiment comparing the effect of propagation using field/natural soil vs nursery soil media on plant survival after introduction.	Adopted- plan updated
RCMP32	General	p. 25, 1st word. This is called Planting-out (of tubestock), not transplanting. Transplanting is when you dig a plant up in the field and move it somewhere. What about planting non-threatened rainforest plants in the road reserve as part of revegetation works around in situ/retained threatened flora?	Adopted- plan updated
RCMP33	General	p. 25, 3rd paragraph – state whatever you are trying to say more clearly.	Adopted- plan updated
RCMP34	General	Recommendation: Edit text and other points about propagation methods as above.	Adopted- plan updated
RCMP35	General	1st line – "clearly identifies"…what?	Adopted- plan updated
RCMP36	5.3.3	A bush regenerator needs to be sub-contracted to carry out this work. The project really needs a bush regeneration team working full time on removing weeds from the in-situ threatened flora sites, revegetation areas and the road reserve generally.	To be reviewed prior to implementation
RCMP37	5.4	Title – Pre-construction mitigation measures ……..	Adopted- plan updated
RCMP38	6.2	Missing goal – Selection of optimal translocation receival sites for threatened flora and rainforest EEC restoration finalised well before the start of translocation and road construction.	Adopted- plan updated
RCMP39	6.2	2nd dot point – make a separate dot point of the second part - no loss of in-situ/retained threatened rainforest plants during construction due to direct physical damage.	Adopted- plan updated
RCMP40	6.3	Add dot point: All threatened plants on the edge of clearing (<5m) to chain mesh fenced.	Adopted- plan updated
RCMP41	6.3	2nd paragraph. Only maintenance for the first 12 months? Needs at least 3yrs in the operation phase. Recommendation: Maintenance of revegetation areas to be conducted for 3-5 years.	Adopted- plan updated
RCMP42	6.4	Title – Construction phase mitigation measures……	Adopted- plan updated
RCMP43	6.4	5th goal – the landscaping design…… Recommend that the revegetation planning not be carried out by the landscape architect but by an experienced, local bush regeneration/habitat restoration specialist. This should be the subject of a separate Rainforest Revegetation and Habitat Restoration Plan which addresses offset areas	To be reviewed prior to implementation

ID No	Section	Comment / Recommendation	How recommendations would be addressed
		outside the project boundary as well as disturbed areas adjoining in-situ threatened flora site within the project boundary. Recommendation: Prepare and implement a Rainforest Revegetation and Habitat Restoration Plan	
RCMP44	6.4	6th goal – dust management – tall shade cloth screening would be erected to protect low growing species close to the edge of clearing. This could also be applied to protect the newly cleared edge of rainforest until fast growing pioneer rainforest species plantings become established, particularly on the edge is on an exposed aspect – ie W, N and E. *Recommendation:* Install tall (3-4m high rolls) shade cloth screening along the cleared edge of rainforest EEC immediately after clearing to provide microclimate protection	Adopted- plan updated
RCMP45	Table 6-1	1st dot point – use the same thresholds as Table 6-1, second goal, column 4 – ie. At least 90% have survived after the first year and 80% after five years. No mortality due to direct physical damage caused by construction activities. Check thresholds for consistency 3rd dot point – 30% weed cover is too high, at least halve it. *Recommendation:* Revise thresholds as above.	Adopted- plan updated
RCMP46	6.4	Last paragraph – check wording, doesn't make sense. Again, contract an experienced, local bush regenerator/habitat restoration specialist to do this work	Adopted- plan updated
RCMP47	7	1st sentence – Didn't the plan talk about revegetation of offset areas earlier? If offset areas are going to be subject to a different revegetation plan then make it clearer and check report for consistency. Give these initiative separate headings to make it clearer.	To be reviewed prior to implementation
RCMP48	7	Should the title be – Operational phase monitoring and maintenance… Why only the first year? Maintenance of revegetation areas should be continued for a minimum of 3 years. Weed control is not needed every 3 months in the first year – 2 or 3 times a year is enough. Suggest you call this a maintenance schedule – monitoring is a separate activity. The bush regeneration industry knows how to establish a rainforest based on decades of experience (although most landscape architects probably don't). Yearly monitoring is enough.	Adopted- plan updated
RCMP49	7.3	Maintenance of in-situ threatened flora sites, which would involve weed removal and revegetation if required, be conducted as a package and implemented by a bush regenerator with local experience, rather than by the landscape architect or general weed control contractor.	To be reviewed prior to implementation
RCMP50	7.3	Tub-grinder mulch not be spread around in-situ threatened flora sites.	Adopted- plan updated
RCMP51	7.4	1st dots point: At least 90% have survived after the first year and 80% after five years. No mortality due to direct physical damage caused by construction activities. As above, be consistent throughout plan. 2nd dot point – why can't weed management be more pro-active than just maintaining current conditions? What if the rainforest is initially infested with young Camphor Laurel which if left would over run the rainforest? The goal should be to reduce weed cover, preferably to zero where practical. 3rd dot point - 30% weeds too high, at least halve it.	Adopted- plan updated
RCMP52	8	My first reaction to the introduction to Section 8 was that there is too much monitoring. The monitoring program comes across as a research style activity, but it's about something that has already been researched in detail. We already what the impacts of edge effects are on rainforest and how to mitigate them. The monitoring program needs to be kept relatively simple so that resources that should go into the actual revegetation and maintenance work are not splurged on monitoring of mitigation measures that we already know work, if properly implemented. What is proposed is a bit like monitoring the construction of a bridge. We already know how to build the bridge so why would you need a BACI monitoring program to study if the construction	Adopted- plan to be updated prior to implementation

ID No	Section	Comment / Recommendation	How recommendations would be addressed
		methods work?. What is needed is a comprehensive, best-practice revegetation and maintenance plan and a checking procedure to see it is implemented properly to a certain standard.	
RCMP53	8.3	Is the 20 x 20m plot a good design for studying edge effects? It is known that disturbance effects increase the closer you go to the edge of clearing. A sampling design that can pick up this level of detail would be much better than one big plot where all the detail is lumped together. *Recommendation:* Use the line intercept method rather than 20m x 20m quadrats/ plots to assess performance measures and monitor edge effects on in-situ stands of rainforest EEC. The line intercept method to consist of a 20m line laid out parallel with and at increasing distance from the cleared edge – suitable intervals would be 2m, 6m and 12m (from the edge of clearing). Divide each line into 2m long segments to provide 'samples' for statistical description and inference testing.	Adopted- plan to be updated prior to implementation
RCMP54	8.6	As already commented this threshold is not consistent with above and is too low. If only 60% of in-situ threatened plants have survived construction after five years, then at this rate of attrition you could assume that all would have after 12 yrs. I have suggested 80% survival above, but ever that is probably too low. The project should be able to achieve at least 80% survival for woody perennial plants – trees, shrubs, large vines. Shade requiring understorey species are more sensitive to disturbance. A one size fits all approach to threatened flora management is probably not appropriate – species specific thresholds would be better. I made a similar comment for the non-threatened rainforest plants.	Adopted- plan updated
RCMP55	8.4	Incorporate the use of salvaged topsoil seedbank in the revegetation of disturbed areas around in-situ threatened flora sites.	Adopted- plan updated
RCMP56	8.4	Last sentence – "The number and location of sites….." doesn't make sense – ie Revegetation areas will be determined following completion of revegetation activities? A Rainforest Revegetation and Habitat Maintenance Plan should be prepared for rainforest threatened flora/EEC areas within the road reserve – this should be separate from the Landscape Plan.	To be reviewed prior to implementation
RCMP57	8.4	10%" I agree with the goal, but everywhere else its says "30%	Adopted- plan updated
RCMP58	8.4	"cluster of permanent monitoring plots at each site" I doubt if this will be practical. Is the road reserve going to be wide enough? Roads and Maritime will likely minimise the width of the road reserve. As commented above, are 20 x 20m quadrats the best design for monitoring edge effects?	Adopted- plan to be updated prior to implementation
RCMP59	8.6	Table - As commented above, only 60% survival of in-situ rainforest plants after 5 yrs suggests all will be dead in 12 years…?	Adopted- plan updated
RCMP60	8.7	Each annual report should provide a description of the project methods and results up to that date and a discussion relating results to previous years. Leaving it to the final report in 5-8 years, much of it will be forgotten! Recommendation: Each annual report to provide a description of the project methods and results up to that date and a discussion relating the current year's results to previous years results.	Adopted- plan updated
RCMP61	General	What about a section on Topsoil Salvage and Re-use for Revegetation? Using topsoil seed bank salvaged from weed free areas of forest is potentially a far more effective method of revegetating disturbed areas and controlling weed invasion. There are major ecological and cost advantages to this widely used approach compared with hydromulching using commercially sourced native seed, tubestocking and uncoordinated use of salvaged topsoil. Recommendation: Incorporate the use of salvaged topsoil seedbank in the revegetation of disturbed areas around in-situ threatened flora sites and in general	Adopted- plan updated

ID No	Section	Comment / Recommendation	How recommendations would be addressed
		landscaping.	
RCMP62	Introduction	Recommendation: Prepare a flow diagram of the 'Rainforest Communities And Threatened Rainforest Plants Management Plan' including the main actions required at each stage of implementation, ie. pre-construction, construction and post-construction.	Adopted- plan updated

2. Lowland and Littoral Rainforest

2.1 Background

Lowland Rainforest of the New South Wales North Coast and Sydney Basin Bioregion is an Endangered Ecological Community in New South Wales (NSW) is listed under the Threatened Species Conservation (TSC) Act. This vegetation community is synonymous with the EPBC listed Lowland Rainforest of Subtropical Australia, which has the status of critically endangered under the EPBC Act. Refer to **Figure 2.1** and **Figure 2.2** at the end of this chapter for the location of the community.

Also covered by this plan is Littoral Rainforest in the South East Corner, Sydney Basin and NSW North Coast bioregions, an Endangered Ecological Community listed under New South Wales Threatened Species Conservation (TSC) Act. This vegetation community is synonymous with the EPBC listed Littoral Rainforest and Coastal Vine Thickets of Eastern Australia, which has the status of critically endangered under the EPBC Act. Refer to **Figure 2.1** and **Figure 2.2** for the location of the community.

Lowland Rainforest occurs as tall (20 to 30 metres) closed (>70% canopy cover) vegetation units. Species tend to be mesophyllic, with a lack of scleromorphic species. The canopy tends to be multilayered, made up of isolated emergent trees such as Hoop Pine (*Araucaria cunninghamii*), Figs (*Ficus* sp.) and Brushbox (*Lophostemon confertus*). A diverse species range defines the canopy, usually Hoop Pine, Figs, White Booyong (*Argyrodendron trifoliolatum*), Pepperberry (*Cryptocarya obovata*), Rosewood (*Dysoxylum fraserianum*) and Bolly Gum (*Neolitsea australiensis*). Understorey is sparse, with a range of palms, ferns and juvenile canopy species occurring. Lowland rainforest is also home to a range of epiphytes and lianas and buttressed trees are relatively common.

Littoral Rainforest occurs as low closed forest (< 20 metres), much lower where exposed. On headlands, this can be down to a two metre high thicket, in more protected gullies and hind dunes canopy height (and species diversity) increase. Littoral Rainforest is characterised by Lilly Pilly (*Acmena smithii*), Coast Banksia (*Banksia integrifolia*), Tuckeroo (*Cupaniopsis anacardioides*) and Cheese Tree (*Glochidion ferdinandi*). Apart from the most sheltered sites, ferns and palms tend to be absent from Littoral Rainforest, as are buttressed trees. Dominant species in littoral rainforest within the project include Tuckeroo (*Cupaniopsis anacardioides*), Hard Corkwood (*Endiandra sieberi*), Brown Bolly Gum (*Litsea australis*), Brushbox and Cudgerie (*Flindersia schottiana*).

The Lowland and Littoral rainforest communities are delineated mainly by soil type and species composition. The Lowland Rainforest typically occurs more than two kilometres from the coast often on soils of higher fertility, usually with a higher species diversity and structural complexity (NSW Scientific Committee 2006 and TSSC 2011). Littoral Rainforest is often found in close proximity to the coast, and as such, exposed to a variety of coastal processes such as salt spray and wind shear, although this community may also be present on back barrier sand dunes remote from substantial maritime influences such as the areas of littoral rainforest within the project (NSW Scientific Committee 2004 and TSSC 2006). Conditions thresholds for these rainforest communities are outlined in **Appendix C**.

2.2 Existing knowledge

The threatened rainforest communities identified in the project area and their status are detailed in Table 2-1. These communities are referred to as Lowland Rainforest and Littoral Rainforest hereafter in the plan.

Table 3 Rainforest threatened ecological communities addressed in the plan

Threatened ecological community	Biometric vegetation type equivalents in the project	Status (EPBC Act)	Status (TSC Act)
Lowland Rainforest in Sub-tropical Australia	White Booyong - Fig Subtropical Rainforest of the North Coast; Hoop Pine - Yellow Tulipwood Dry Rainforest of the North Coast; Black Bean - Weeping Lilly Pilly Riparian Rainforest of the North Coast	Critically Endangered	-
Lowland Rainforest in NSW North Coast and Sydney Basin Bioregions	-	-	Endangered
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast	Critically Endangered	-
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	-	-	Endangered

Note: (E – endangered; V- vulnerable)

Both Lowland Rainforest and Littoral Rainforest communities were mapped within the project (Section 1, 3, 9 and 10) in the field by project ecologists. The extent of these communities was indicated primarily by soil type and the presence of diagnostic canopy and understorey species. The location of the communities relative to the project is shown in **Figure 2-1** and **Figure 2-2**.

Chapter 3 describes the potential impacts to community, as detailed in the EIS, Biodiversity working paper and also the *Supplementary Biodiversity Assessment* (Roads and Maritime 2013). The local distribution and section where the species occurs is shown in **Table 2-2**.

Table 4 Threatened rainforest communities distribution and location within the project

Community name	Project section / Station (km)
Lowland Rainforest in Sub-tropical Australia and Lowland Rainforest in NSW North Coast and Sydney Basin Bioregions	Section 1, 3, 9,10, 11 Station:9.1-9.3, 46.6-46.9, 59.3-59.5, 146.9-147.3, 150.2-150.3, 151.6-152.0, 154.9-159.2, 160.0-161.2, 162.3-162.5
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia and Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	Section 9, 10, 11 143.9-145.1, 157.4-157.8, 158.7-158.9, 162.8-163.0

2.3 Threats

Both communities are threatened by ecological processes relating to their small size and isolation, particularly due to the reliance on the biophysical conditions associated with the intact vegetation structure. Once this is compromised, a range of issues collectively known as ‘edge effects’ can have a major impact on these vegetation communities and the species they contain.

As the edges of these communities are compromised a range of ecological processes can change. As mentioned, these communities are reliant on their specific microclimate, largely created by their biophysical structure. Once compromised, these conditions can be lost, at the expense of the ecology within. Once ‘space’ is made in these systems, weed invasion becomes a serious issue. The Lowland Rainforest and Littoral Rainforest are particularly susceptible to Lantana (*Lantana camara*), as this species can invade relatively intact communities and is particularly problematic as it increases the potential for fire in these communities. Rainforests are ‘fire excluding’ communities, which do not regenerate well from fire like other Australian vegetation types.

Lowland Rainforest is also widely infested with Camphor Laurel (*Cinnamomum camphora*), an aggressive canopy species which has a root allopathic effect, supressing native species growth and particularly germination. Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) is a major threat to Littoral Rainforest, smothering native species and also increasing fire occurrence and intensity.

Climate change and fire are also listed as major threats to these vegetation types. These issues are intricately related, with increasing temperatures and drought, these communities and the species they contain will be more susceptible to desiccation and hence fire. With increasing fire threat, there is a greater likelihood of canopy loss and weed invasion.

Figure 2-1 Lowland Rainforest and Littoral Rainforest

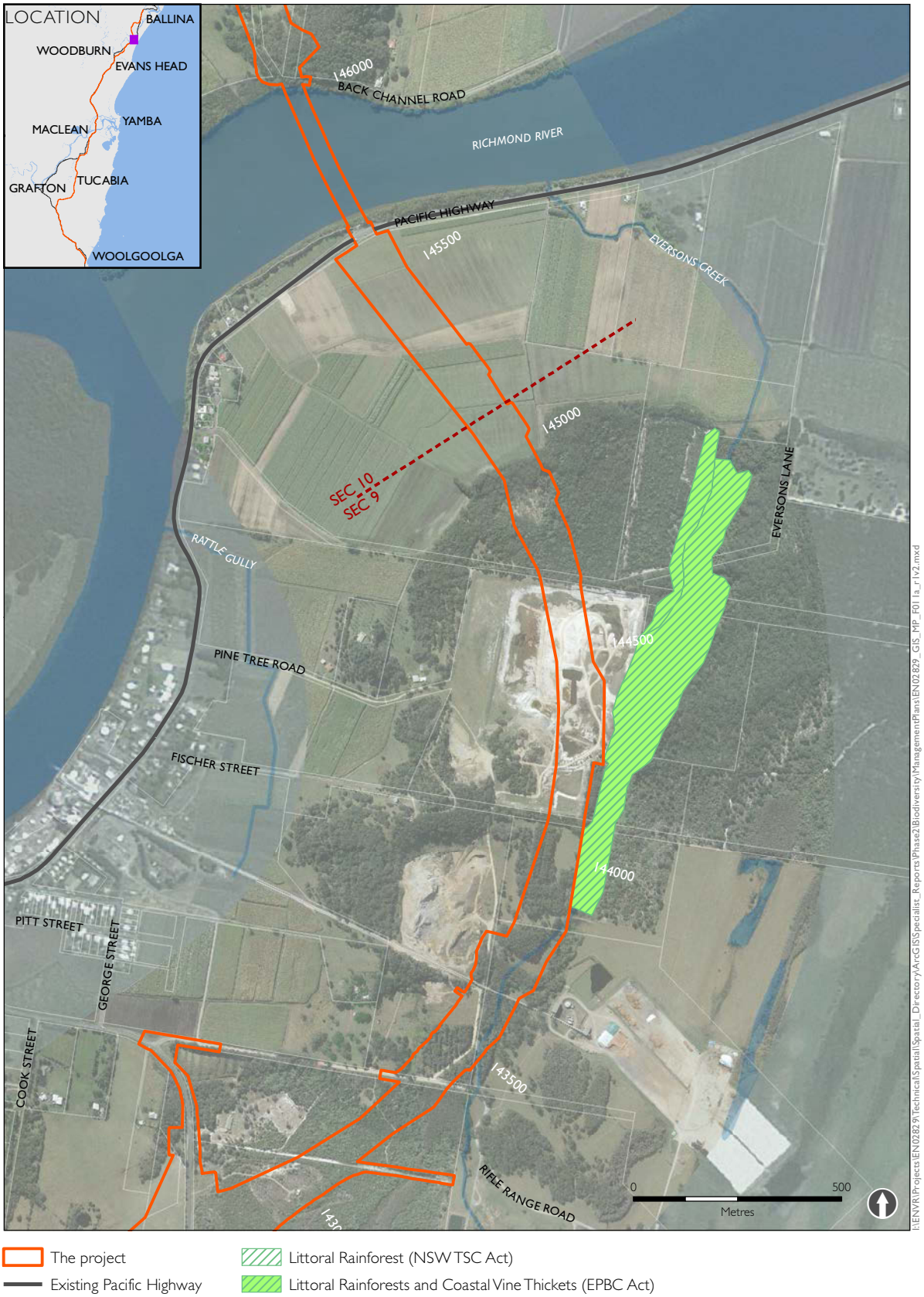
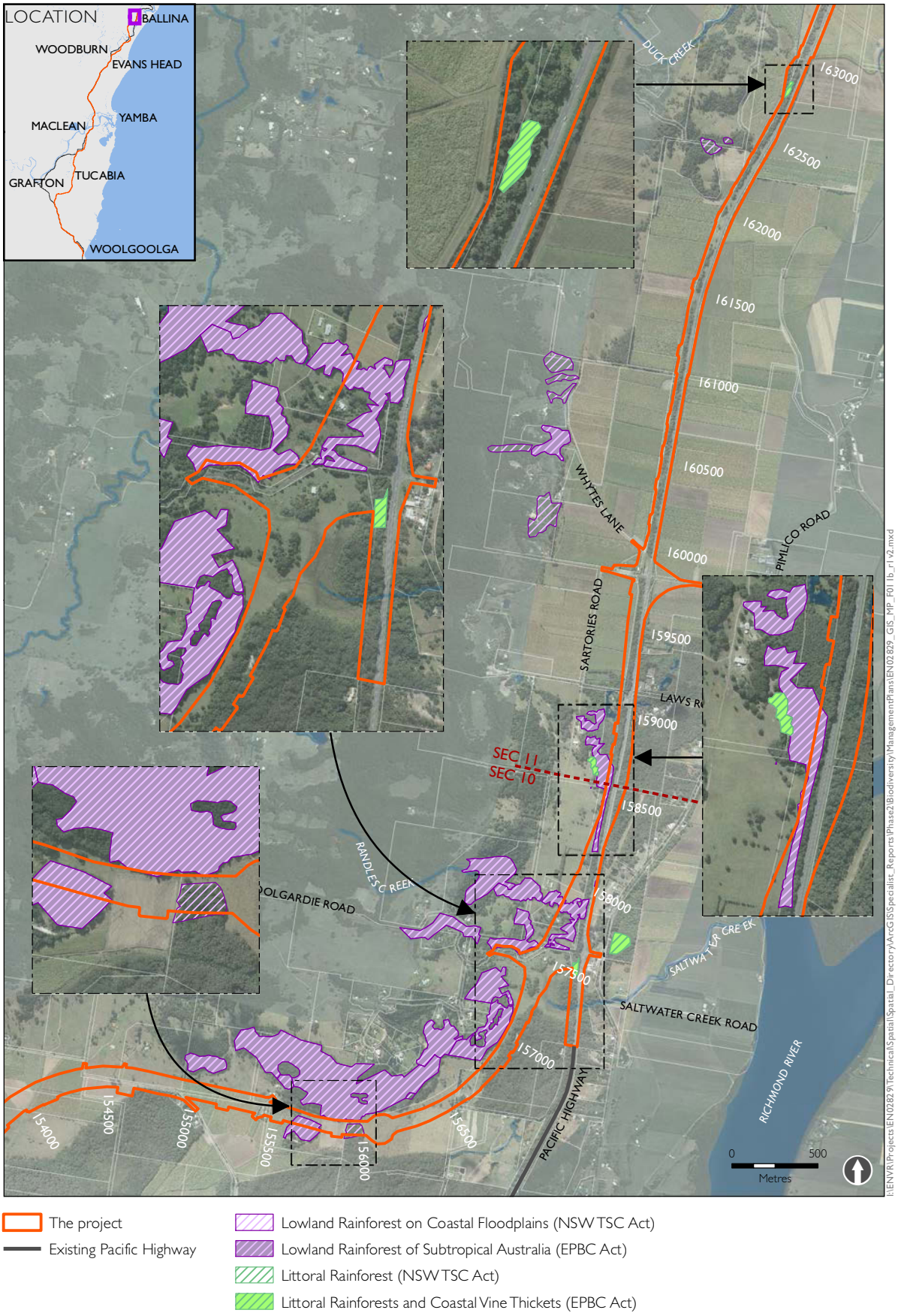


Figure 2-2 Lowland Rainforest and Littoral Rainforest



The project
Existing Pacific Highway
Lowland Rainforest on Coastal Floodplains (NSW TSC Act)
Lowland Rainforest of Subtropical Australia (EPBC Act)
Littoral Rainforest (NSW TSC Act)
Littoral Rainforests and Coastal Vine Thickets (EPBC Act)

3. Rainforest plants

3.1 Background

In addition to the listed threatened rainforest communities detailed above, several threatened plant species within these communities that are also listed in under the EPBC Act and TSC Act have been included in this plan. These species occur in close association with the rainforest communities, would be dependent on the specific biophysical conditions detailed in the previous sections and would be subject to the same threats as their host communities. The locations of these threatened rainforest species are displayed over numerous figures from the Biodiversity Assessment Working Paper (Roads and Maritime 2012) and *Supplementary Biodiversity Assessment* (Roads and Maritime 2013) and also in **Figures 2-3** to **Figure 2-7** at the end of this chapter.

3.2 Existing knowledge

Fourteen threatened rainforest plants have been identified in the project. All of these are associated with the Lowland Rainforest patches identified in Section 10 of the project. Threatened rainforest plants within Section 10 of the project and their status are provided in **Table 2-3**.

This plan does not cover the location of the Carronia Vine (*Carronia multisepalea*), the host species for the listed Pink Underwing Moth (*Phyllodes imperialis*) known from the area. This host plant is the only habitat for the moth where it exists as a 'collapsed shrub', where the vine grows in an upright form there is no association with the moth (TSSC, 2002). A separate plan has been developed for threatened invertebrates, which includes the Pink Underling Moth and Carronia Vine locations.

Table 5 Rainforest plant species addressed in the plan

Species	Common name	Status (EPBC Act)	Status (TSC Act)
Acronychia littoralis	Scented Acronychia	E	E
Acalypha eremorum	Acalypha	V	E
Archidendron hendersonii	White Lace Flower	-	V
Belvisia mucronata	Needle-leaf Fern	-	E
Cryptocarya foetida	Stinking Cryptocarya	V	V
Davidsonia johnsonii	Smooth Davidson's Plum	E	E
Endiandra hayesii	Rusty Rose Walnut	V	V
Endiandra muelleri subsp. *bracteata*	Green-leaved Rose Walnut	-	E
Coatesia paniculata syn. *Geijera paniculata*	Axe-breaker	-	E
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V
Ochrosia moorei	Southern Ochrosia	E	E
Streblus pendulinus syn. *S. brunonianus*	Whalebone Tree	E	-
Syzygium hodgkinsoniae	Red Lily Pilly	V	V
Tinospora tinosporoides	Arrow Head Vine	V	V

Note: (E – endangered; V- vulnerable)

Threatened rainforest plants are component species of the Lowland and Littoral Rainforest assemblages. As such, threatened rainforest plants have the same location, physical conditions, vegetation structure and threats and declines as the threatened vegetation communities from which they are derived.

A profile of each threatened plant species to be impacted by the project can be found in **Appendix C**. The location of these species within the project is shown in **Figure 2-3** to **Figure 2-7**. **Chapter 3** describes the potential impacts to each species, as detailed in the EIS Biodiversity working paper and the *Supplementary Biodiversity Assessment* (Roads and Maritime 2013). The local distribution and abundance of the threatened rainforest plants, as well as, the section where this species occurs is shown in **Table 2-4**.

Table 6Threatened rainforest species distribution and location within the project

Species name	Notes on distribution and abundance	Project section / station (km)
Acronychia littoralis	• The preferred habitat for this species is littoral rainforest on sand which does not occur in the project; however it is known to also occur in subtropical rainforest which is present in the project. • The distribution of Acronychia littoralis is found between Fraser Island in Queensland and Port Macquarie on the north coast of NSW. The project is not the limit of the known distribution for this species. • The species recorded in Section 8 and 10 with 39 records known in the region. During supplementary and design change surveys in Section 10, a clonal individual was recorded with 125 sucker shoots.	Section 8 and 10 Station: 136.3 and 158.6
Acalypha eremorum	• Two small populations between Coolgardie Road in Section 10. • Supplementary surveys recorded 71 individuals approximately 500 metres west of the project.	Section 10 Station:157.6 to 158.0
Archidendron hendersonii	• This species occurs from north Queensland south to the Richmond River in north-east NSW. The presence in Section 10 potentially represents the current southern distributional limit. • Twenty individuals were recorded in Section 10 and 11, and are potentially part of a larger population occurring in rainforest habitats. Ten individuals are in close proximity to the project and are greater than 50 metres up slope of the project.	Section: 10 and 11 Station: 155.7-156.1, 157.7-158.7, 160.7, 162.4-162.8
Belvisia mucronata	• It is restricted to Queensland and NSW where it is known in five locations north from Evans Head on the far north coast of NSW. • There are 53 records outside of the project. • A population occurs approximately 600 metres to the west of the project.	Section 10 Station: 157.9
Cryptocarya foetida	• It is known from Iluka in NSW to Fraser Island and east of Gympie, southern Queensland. • A total of 88 individuals have been recorded within and outside of the project in Section 10. The population extends into surrounding private property.	Section 10 Station: 155.5-156.5, 157.9
Davidsonia johnsonii	• It occurs only in south east Queensland and north east NSW • There are 4 individuals outside of the project in Section 10. Each individual has several sucker stems.	Section 10 Station: 155.5-155.7
Endiandra hayesii	• *Endiandra hayesii* is known from a restricted distribution in northern NSW and southern Queensland (Hyland, 1989). Records of this species are clustered in the Border Ranges and Nightcap Ranges area, and at a few scattered near-coastal locations. Harden (1990) gives the Clarence River as the southern limit. • *Endiandra hayesii* has been previously recorded in the local area (10 kilometre radius) to the south east of the subject population near Iluka and there is also a record from 1997 near Coffs Harbour. The individuals recorded in the project boundary are around 55 kilometres north of the southern distribution specified in Harden (1990) at the Clarence River near Iluka. • There are a total of 30 individuals inside and outside of the project in Section 10.	Section 10 Station: 155.5-156.4, 157.5-158.1
Endiandra muelleri subsp. *bracteata*	• This species occurs in Queensland and in north-east NSW south to Maclean. It is sparsely distributed within this range. This species has been previously recorded in the local area (10 kilometre radius) to the west of the project boundary at Maclean (Section 5) and at Section 10. • This species was recorded in Section 10, comprising 44 individuals in subtropical rainforest north and south of Coolgardie Road. Of these 44 individuals, none are within the project boundary, however 2 individuals are in close proximity to the project	Section 10 Station: 156.0-156.5, 157.5-158.1
Coatesia paniculata syn. *Geijera paniculata*	• It is known to occur in restricted habitat from Brisbane River and central Queensland coast and very rare in north east NSW in the Tweed, Lismore and Wardell districts. • A total of 25 individuals are known to occur outside of the project in Section 10	Section 10 Station: 155.7, 157.6
Macadamia tetraphylla	• The total population size of *Macadamia tetraphylla* is estimated to be between 1000 and 2000 mature individuals with around 75 key populations consisting of 5 to 20 mature specimens at each locality (Costello et al. 2009). Therefore the population in the study area could be regarded as a relatively large population and potentially represents up to 10 per cent of the entire population of *Macadamia tetraphylla*. • A total of 99 individuals have been recorded within and outside the project.	Section 10, 11 Station: 155.5-156.5, 157.1-157.2, 157.5-158.0, 158.8
Ochrosia moorei	• It occurs north from the Richmond River and in south east Queensland. Very sparsely distributed.	Section 10 Station: 157.9

Species name	Notes on distribution and abundance	Project section / station (km)
	• A total of 20 individuals are recorded in the area of the project, only 1 individual was found near the project outside the boundary.	
Streblus pendulinus syn. *S. brunonianus*	• *Streblus pendulinus* was originally endemic to Norfolk Island, but with recent taxonomic changes the species Streblus brunonianus has changed to the mainland species *Streblus pendulinus* and occurs throughout the coastal regions of NSW and Queensland and remains listed under the EPBC Act. • A total of 43 individuals have been recorded in and outside the project.	Section 10 Station: 155.5-156.2, 157.6-158.0
Syzygium hodgkinsoniae	• Occurs in a geographically disjunct distribution from the Richmond River in north-east New South Wales (NSW) to Maleny and Kin Kin in south-east Queensland, with disjunct populations in Kuranda and Gordonvale, north-east Queensland. The occurrence in the project boundary is near the southern distributional limit for the species. • It is found on alluvialand basaltic and metasediments based soils. • There are 26 records in the project area and a total of 8 individuals found near the project with 1 individual within 1 metre of the boundary.	Section 10, 11 Station:157.9, 162.5
Tinospora tinosporoides	• The Arrow-head Vine occurs south from the Richmond River to Burleigh Heads National Park in Queensland • This species is restricted to lowland subtropical rainforest, in most situations on floodplains and slopes on basalt soils. • There are a total of 60 individuals near but outside the project.	Section 10 Station: 160.5-161.2

3.3 Threats

Threatened flora populations are currently threatened by habitat loss and fragmentation from land clearing, weed invasion, stochastic events, habitat alteration and other disturbances. The threatened plant species covered in this management plan are being directly or indirectly impacted by the Woolgoolga to Ballina Pacific Highway upgrade project. The project would result in the exacerbation of threats to these threatened flora populations, and the aim of this management plan is to minimise the severity and duration of potential threatening processes, particularly for the remaining individuals which would be in close proximity to the proposed project boundary.

Figure 2-3 Threatened rainforest plants

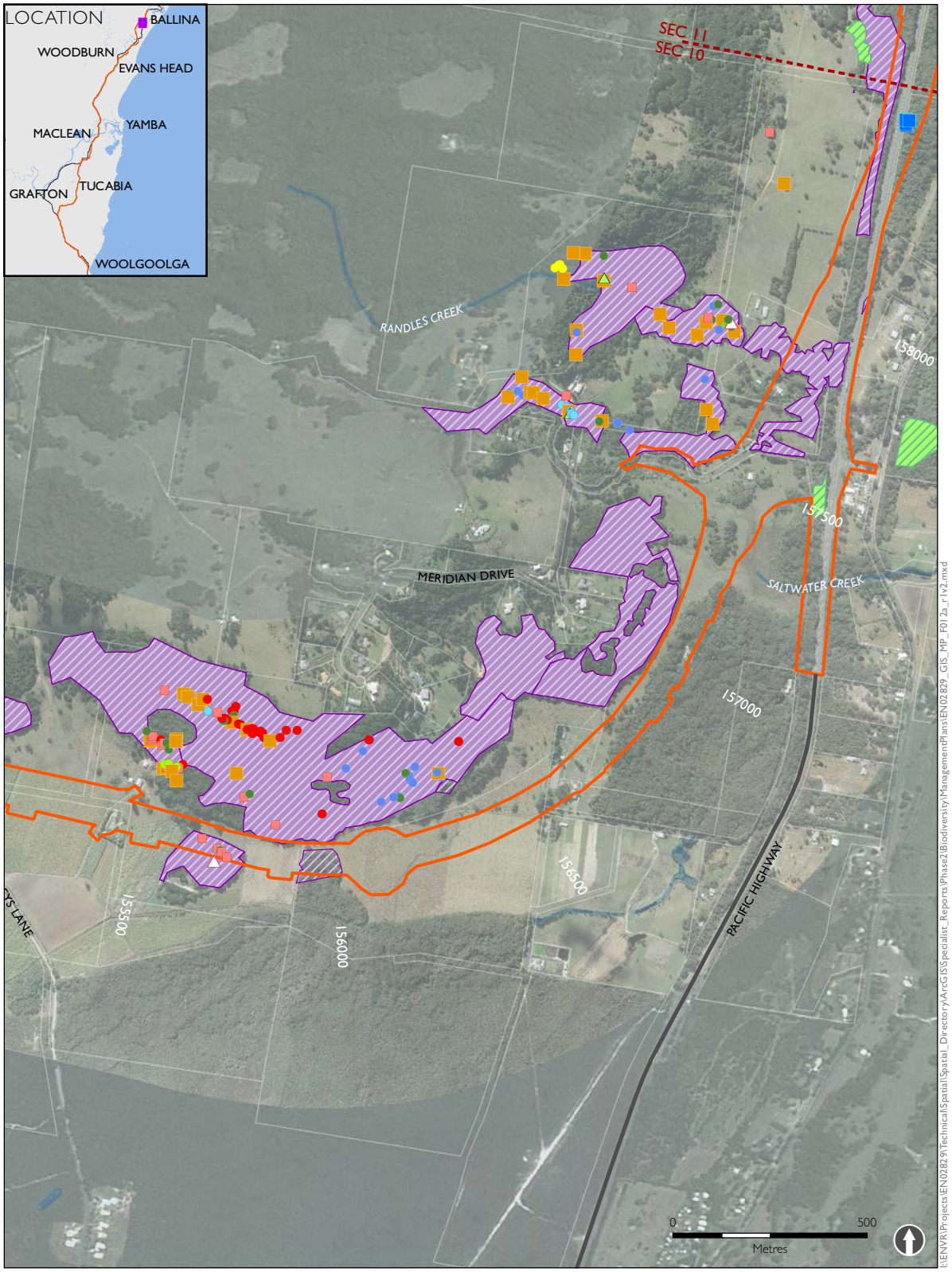
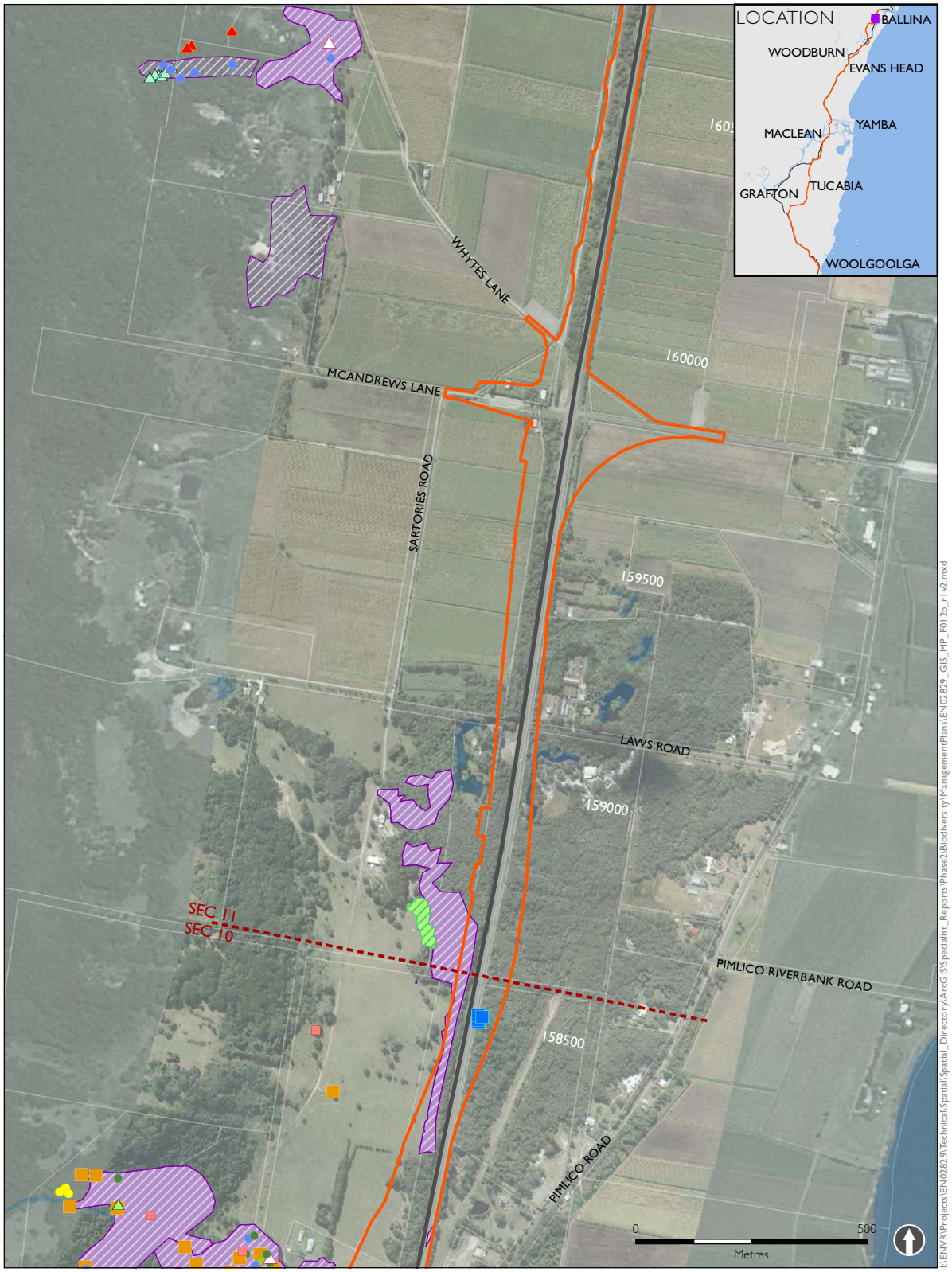


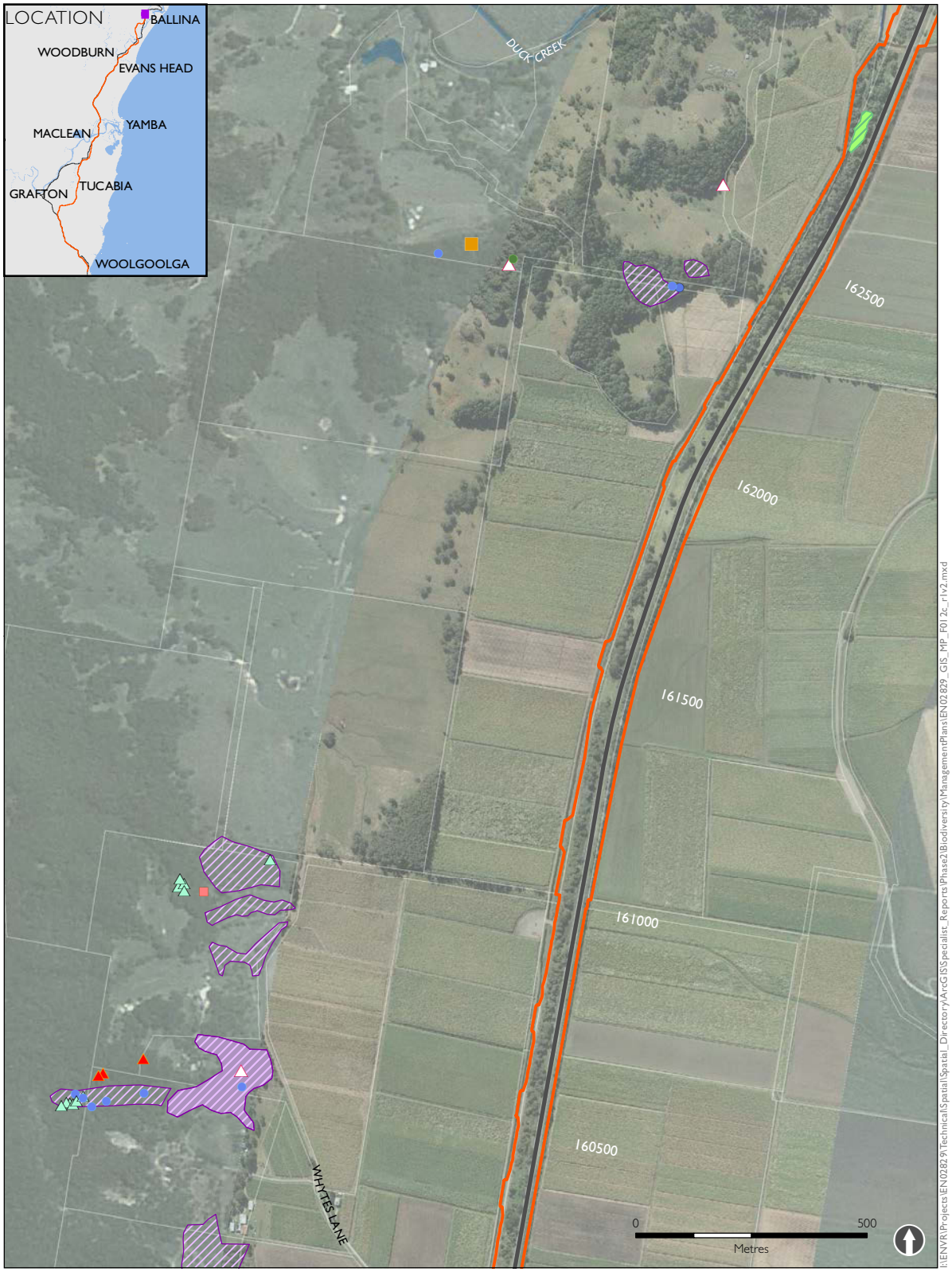
Figure 2-4 Threatened rainforest plants



The project
Littoral Rainforest (NSW TSC Act)
Littoral Rainforests and Coastal Vine Thickets (EPBC Act)
Lowland Rainforest on Coastal Floodplains (NSW TSC Act)
Lowland Rainforest of Subtropical Australia (EPBC Act)

Threatened rainforest plants
Acalypha sp. Big Scrub (A. eremorum in NSW)
Acronychia littoralis
Archidendron hendersonii
Archidendron muellerianum
Belvisia mucronata
Cryptocarya foetida
Cyperus aquatilis
Davidsonia johnsonii
Desmodium acanthocladum
Endiandra hayesii
Endiandra muelleri subsp. bracteata
Geijera paniculata
Macadamia tetraphylla
Marsdenia longiloba
Oberonia titania
Ochrosia moorei
Phaius australis
Prostanthera palustris
Streblus pendulinus
Syzygium hodgkinsoniae
Tinospora tinosporoides

Figure 2-5 Threatened rainforest plants



The project
Littoral Rainforest (NSW TSC Act)
Littoral Rainforests and Coastal Vine Thickets (EPBC Act)
Lowland Rainforest on Coastal Floodplains (NSW TSC Act)
Lowland Rainforest of Subtropical Australia (EPBC Act)

Threatened rainforest plants
Archidendron hendersonii
Endiandra hayesii
Endiandra muelleri subsp. bracteata
Macadamia tetraphylla
Marsdenia longiloba
Streblus pendulinus
Syzygium hodgkinsoniae
Tinospora tinosporoides

Figure 2-6 Threatened rainforest plants

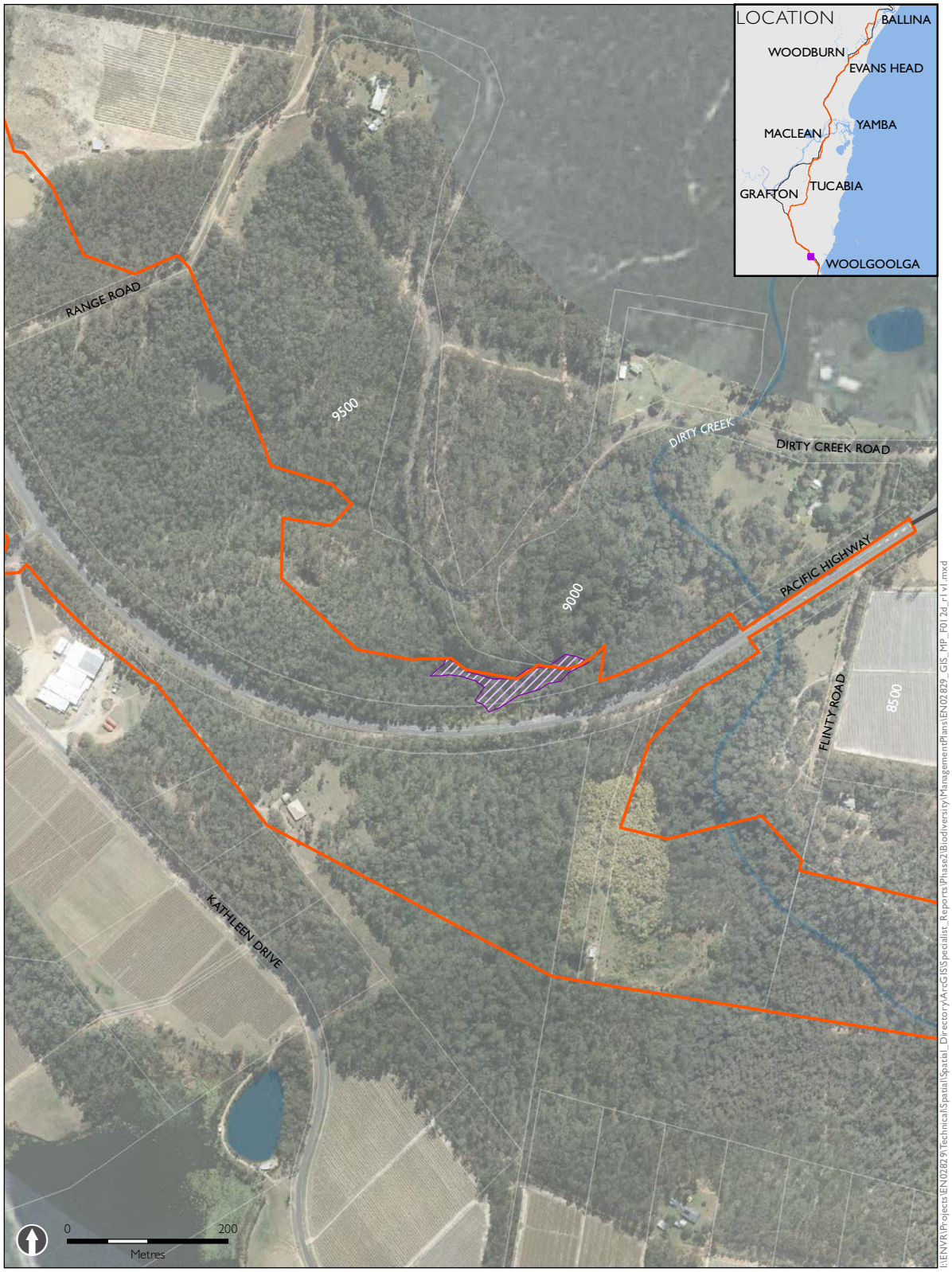
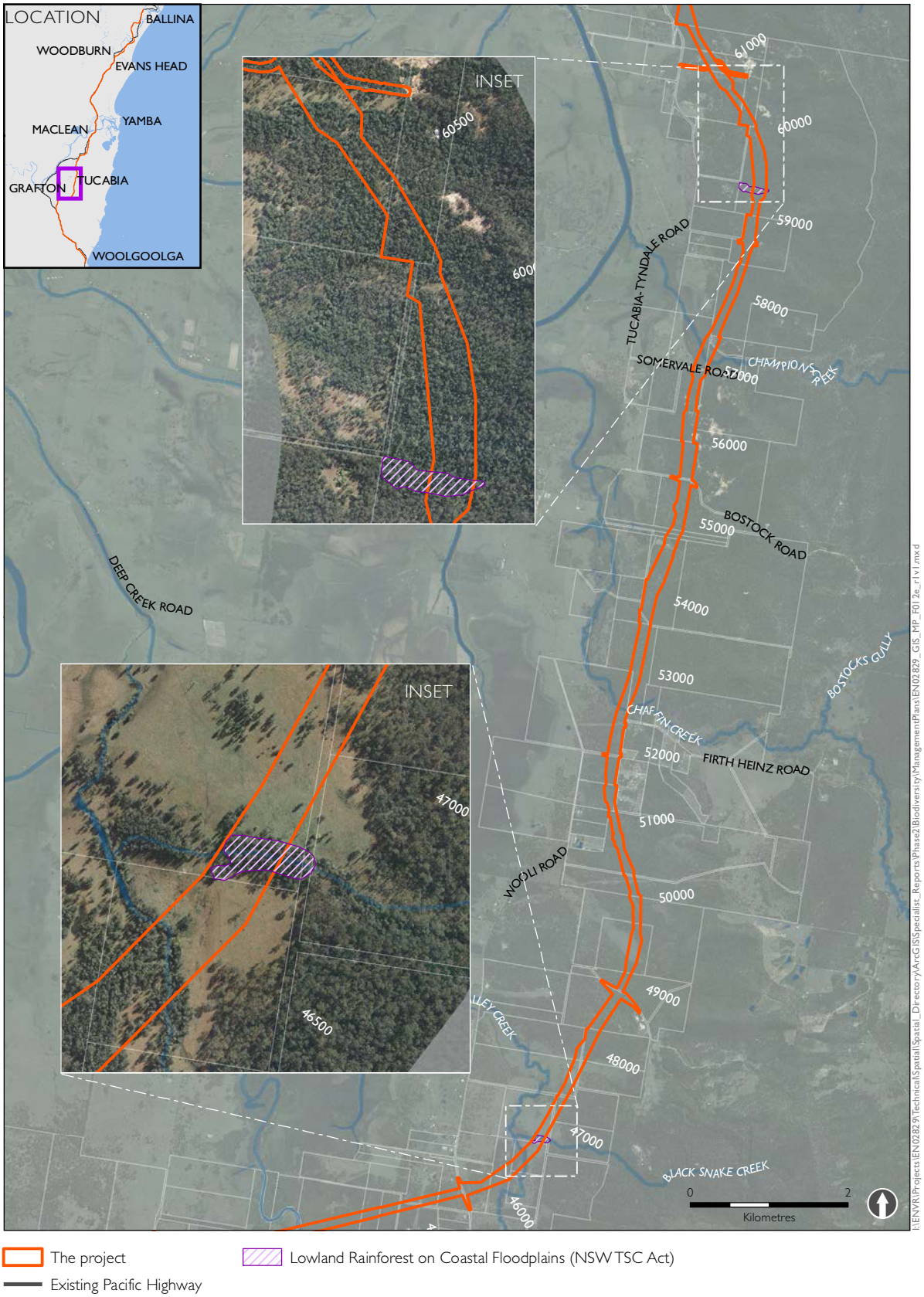


Figure 2-7 Threatened rainforest plants



4. Potential impacts and management approach

This chapter provides a brief overview of the potential impacts to the threatened rainforest communities and plant species, with reference to the more detailed impact assessment presented in the Biodiversity Working Paper (Roads and Maritime 2012) and *Supplementary Biodiversity Assessment* (Roads and Maritime 2013). It describes the potential impacts to the community and species at specific locations along the upgrade and during the pre-construction, construction and post-construction (operational) stages of the project. The mitigation approach presented in the EIS and documented in **Chapters 4** to **6** of the management plan target the predicted impacts.

4.1 Potential impacts associated with the project

The critically endangered EPBC/TSC listed rainforest communities (and listed plant species) have been a major design consideration for the project, with avoidance targeted for all occurrences, and substantial redesign and alterations to the proposed location of the carriageway driven by rainforest occurrence and subsequent avoidance. Management of remaining areas is a major consideration for the project, to ensure the issues for which intervention would be possible and can be managed. For areas avoided, increasing extent through revegetation, weed control, hygiene and revegetation were considered the main management approaches to minimise impacts to these communities and plant species.

Direct impacts include the removal of individual threatened rainforest plants and their associated habitat, resulting in restricted and isolated small populations and patches within the project.

The remaining threatened rainforest plants and rainforest communities in close proximity (up to 20 metres) to the project would potentially be subject to indirect impacts including edge effects and altered hydrological regimes. Where new edges have been created through areas of habitat there would be potential for edge effects such as changes to the amounts of light, moisture, wind and humidity in adjacent habitats potentially resulting in altered habitat conditions including weed invasion and altered habitat structure. Changes to hydrological regimes including the amount and quality of surface and groundwater entering habitats adjacent to the project would also be a potential threat to the remaining threatened rainforest plants downslope of the project.

4.2 Rainforest communities

4.2.1 Direct impacts

Direct impacts to threatened rainforest communities include clearance and hence loss of areas within the community. Three critically endangered Lowland Rainforest patches and two critically endangered Littoral Rainforest patches listed under the EPBC Act would be impacted by the project in Section 10. Patches of endangered Lowland Rainforest listed under the TSC Act in Section 1, 3 and 10 of the project would also be impacted. The rainforest communities impacted by the project and the area of these patches remaining adjacent to the project are provided in **Table 4-1**.

- **Table 4-1 Impacts and remaining areas of Lowland Rainforest and Littoral Rainforest**

Patch number / (approximate station)	Project section	Total patch area (ha)	Area impacted (ha)	Area remaining following impact (ha)	Proportion of patch remaining
Lowland Rainforest (EPBC Act and TSC Act)					
1 (155.5 to 156.0)	10	1.9	0.5	1.4	73%
2 (157.5 to 158.0)	10	10.5	1.0	9.5	90%
3 (158.0 to 159.0)	10, 11	3.0	0.5	2.5	81%

Patch number / (approximate station)	Project section	Total patch area (ha)	Area impacted (ha)	Area remaining following impact (ha)	Proportion of patch remaining
TOTAL	-	15.4	2.0	13.4	87% in total
Lowland Rainforest (TSC Act) remaining					
4 (9.0 to 9.3)	1	0.4	0.3	0.1	25%
5 (46.7 to 46.8)	3	1.5	0.7	0.8	58%
6 (59.3 to 59.5)	3	2.8	0.7	2.1	75%
7 (156.0 to 156.2)	10	0.7	0.5	0.2	29%
Total	-	5.4	2.2	3.2	59% in total
Littoral Rainforest (EPBC Act and TSC Act)					
1 (157.4 to 157.6)	10	0.2	0.3	0.1	33%
2 (162.8 to 163.0)	11	0.2	0.2	0	0%
Total	-	0.4	0.5	0.1	20% in total

4.2.2 Indirect impacts

Indirect impacts also have the potential to impact remaining patches of rainforest communities in close proximity to the project in the following manner:

- Accidental impact to threatened rainforest plants outside the project during construction.
- Increased potential for incursion of invasive weeds and subsequent habitat degradation.
- Increased light and exposure, wind speed and frequency and temperature, as well as changes in soil conditions at patch edges leading to a potential degradation of habitat.
- Changes to hydrological and nutrient regimes impacting the integrity of remaining patches. Changes may result from alternations made to creek alignments and from the operating road runoff.
- Lowering of the water table leading to changes to understorey floristic and possible canopy dieback.
- Spread of pathogens during construction.

4.3 Rainforest plants

4.3.1 Direct impacts

Direct impacts to threatened rainforest plants include clearance and hence loss of individuals. Of the fourteen threatened rainforest plants identified, five of these species would be directly impacted (refer to **Table 4-2**). All threatened rainforest plants impacted by the project are located in Section 10 of the project.

■ **Table 4-2 Direct and indirect impacts to threatened rainforest flora**

Species	No. of individuals present within the project area	No. of individuals directly impacted by the project	No. of individuals potentially indirectly impacted by the project
Acronychia littoralis (Scented Acronychia)	2	1 (125 stems)	0
Archidendron hendersonii (White Lace Flower)	20	0	10
Cryptocarya foetida (Stinking Cryptocarya)	88	13	0
Endiandra hayesii (Rusty Rose Walnut)	30	3	4
Endiandra muelleri subsp. bracteata (Green-leaved Rose Walnut)	44	0	2
Macadamia tetraphylla (Rough-shelled Bush Nut)	99	1	0
Streblus pendulinus syn. S. brunonianus (Whalebone Tree)	43	8	1
Syzygium hodgkinsoniae (Red Lilly Pilly)	8	0	1

4.3.2 Indirect impacts

Indirect impacts to threatened rainforest plants follow similar impacts to the indirect threats to the rainforest communities detailed in **Section 3.2.2**. Of the fourteen threatened rainforest plants identified, five of these species would be indirectly impacted (refer to **Table 4-2**).

As threatened rainforest species have evolved within the rainforest biophysical conditions, any alterations to such conditions may have an impact on the species, particularly their ability to reproduce and germinate. In addition to the indirect impacts detailed in **Section 4.2.2**, the Red Lilly Pilly (*Syzygium hodgkinsoniae*) would have a higher specific threat to Myrtle Rust fungus than other species as it belongs to the Myrtaceae family which are known to be susceptible (TSSC, 2011).

4.4 Avoidance measures

Design considerations, particularly applied to Section 10, have reduced the area of rainforest and threatened rainforest plant species impacted by the project. The EIS considered impacts to 14.9 hectares of Lowland Rainforest. Following request from DSEWPaC, a four kilometre area (155.0 – 159.0) was redesigned avoiding areas of Lowland Rainforest, threatened rainforest plant species and habitat for the Pink Underwing Moth (*Phyllodes imperialis smithersi*).

This redesign reduced the area of Lowland Rainforest impacted to three hectares and reduced the areas of Littoral Rainforest impact from 0.4 to 0.2 hectares. This alteration also reduced the area of impact on the Pink Underwing Moth's host plant habitat from 6.4 to 2.5 hectares (as noted in the Threatened invertebrate management plan) and reduced the impact on threatened rainforest plants from 68 individuals to 26 directly impacted and 18 indirectly impacted.

4.5 Mitigation and monitoring

To maintain consistency with the overarching biodiversity management framework, developed for the project, the following objectives would be implemented for the mitigation of impacts to threatened flora species:

- Maintain and protect existing biodiversity in general and listed species and communities in particular, as a priority, wherever possible.
- Maintain water quality and hydrological flow regimes.
- Minimise the loss of native vegetation.
- Minimise pollution and degradation.
- Offset unavoidable/ residual impacts to significant biodiversity.

The biodiversity management framework includes a mitigation strategy, a monitoring strategy and an offsets strategy for residual impacts on biodiversity. Each strategy informs the development of the next strategy. The mitigation strategy includes the project CEMP, the FFMP (prepared as a component of the CEMP) and individual threatened species management plans. The monitoring strategy includes the Ecological Monitoring Program, as well as, species-specific monitoring set out in the threatened species management plans.

A number of measures to mitigate and monitor the impact of the project on threatened rainforest communities and plants during construction and operation of the project were suggested in the EIS (biodiversity working paper). In general these measures related to:

- Provision of exclusion fencing to protect *in situ* threatened rainforest plants and communities within and immediately adjacent to the project.
- Water quality, erosion and sediment control.
- Weed management.
- Targeted revegetation of disturbed areas adjoining *in situ* threatened flora.

While translocation is not a mitigation measure, this plan describes an approach to translocation of threatened rainforest plants directly impacted by the project. This would include a feasibility assessment to decide, based on available information, whether a species could be translocated with a reasonable chance of success. This would be in line with the project offset strategy followed and by translocation trials. These measures would be outlined in a separate translocation strategy. A trial program would provide baseline information into the usefulness of propagation in the rehabilitation of rainforest plants.

This management plan details the parameters and methods for monitoring the effectiveness of the proposed mitigation measures for threatened rainforest communities and plants as part of an adaptive management program.

The measures to be taken to mitigate potential impacts and monitor the success of the mitigation strategies for threatened rainforest communities and plants have been outlined in the following Chapters.

4.6 Effectiveness of mitigation measures

A summary of the mitigation measures and an evaluation of their effectiveness, based on past experience with other highway upgrades, are described in **Table 4-3** below.

Table 4-3. Mitigation measures and evaluation of their effectiveness - past experiences

Issue	Mitigation measure	History of success	Effectiveness rating
Accidental impact to threatened rainforest plants to be retained in situ within the project boundary outside of the construction footprint.	Confirmation of what individual are to be removed (i.e. those within the construction footprint) and what individuals are to be retained in situ within the project boundary. This would be determined by targeted surveys and pre-clearing survey.Identify and maintain exclusion zones and limits of clearing. Weed management near retained threatened populations. Erosion and sediment control. Pre-clearing and clearing procedures. Construction related infrastructure to be planned and sited within cleared or disturbed areas and away from water courses.	Standard procedures have been developed by Roads and Maritime and documented in the Biodiversity Guidelines (RTA 2011). The guidelines were developed in consultation with OEH, NSW Department of Primary Industries (Fisheries), biodiversity specialists and Roads and Maritime staff including project managers, construction personnel and designers. Consultation was facilitated through a number of workshops carried out in 2009. These procedures have been developed using knowledge gained from a long history of upgrades on the Pacific Highway and other road projects in NSW. Guide 2: Exclusion zones, Guide 1: Preclearing and Guide 6: Weed management of Roads and Maritime Biodiversity Guidelines provides guides on the process to implemented pre and during construction to minimise environmental impacts. As such, the use of exclusion fencing, undertaking preclearing surveys and implementing weed management protocols is standard practise for the Roads and Maritime Pacific Highway projects. In addition, it is also standard practise for Roads and Maritime projects to have sediment and erosion control implemented to control sediment release from construction works areas. Roads and Maritime has successfully used sediment and erosion controls across a number of Pacific Highway projects. Protection of threatened plants in situ has also been successfully implemented on multiple upgrades of the Pacific Highway and other major highways in NSW. Recent examples include Glenugie, Tintenbar to Ewingsdale and Sapphire to Woolgoolga. Mitigation measures to protect threatened flora have been implemented for over at least 15 years on other upgrade projects. Construction and operational monitoring has been reported for numerous threatened flora species and reported on survival, resilience and recruitment of species. Where mortalities are reported these are included in an adaptive management framework. Roads and Maritime has successfully used water quality controls across a number of Pacific Highway projects. Procedures for water quality management on construction sites have been developed in accordance with the Blue Book principles and form part of the CEMP process.	Moderate, monitor success and implement corrective actions as required.
Impacts from weeds around retained *in situ* threatened plant populations' incursion of invasive weeds.	Management of edge effects particularly weed invasions, around retained threatened plant populations. Weed management plan developed and implemented to control weeds.	A standard procedure for weed management (guide 6) is included in *Biodiversity Guidelines Protecting and managing biodiversity on RTA projects* (RTA 2011). Roads and Maritime has developed standard weed management procedures that are implemented during construction and are reported as part of the FFMP process. This includes pre-clearing surveys to identify weeds and noxious species and map their location for on-going monitoring and control during construction. Operational monitoring of weeds is conducted around *in situ* populations of threatened flora and control undertaken where required. Weed monitoring during construction is a routine procedure for road upgrades with a long history of success in NSW. Reporting for on-going weed impacts and controls around threatened plants adjacent to the road have varied greatly in their success. The results suggest they are reliant on persistent effort, with on-going follow-up actions until such time as the population is proven to remain viable. Successful methods of control for weeds are also established in many publications, for example, *Noxious*	Moderate, monitor against performance and implement weed management actions.

Issue	Mitigation measure	History of success	Effectiveness rating
		and environmental weed control handbook, NSW government, 2011.	
Revegetation adjacent to threatened rainforest communities and *in situ* rainforest plants is unsuccessful. Direct loss of threatened rainforest plants during construction. Indirect impact to threatened rainforest flora retained in situ within the project boundary, outside the construction footprint.	Revegetation of areas adjacent to rainforest communities and plants within the project according to the landscape guideline. Development and implementation of a translocation strategy. Avoidance of impact where possible (during the detailed design stages) Translocation is a management option which may involve: - Translocation strategy developed to identify suitable plants and locations, translocation of plants out of areas of direct impact. - Establishment of translocation population in appropriate areas away from construction. - Seed collection and propagation (including a trial program) of threatened rainforest plant species as appropriate. - Establishment of ex-situ populations from seed and cutting material	A standard procedure for the reestablishment of native vegetation (guide 3) has been developed by Roads and Maritime and documented in the *Biodiversity Guidelines Protecting and managing biodiversity on RTA projects* (RTA 2011). The objective of this guide is to ensure good biodiversity outcomes, where native vegetation re-establishment is required, by managing site conditions, material sourcing and procurement, and seed and plant stock installation and establishment. All revegetation works would be based on sound ecological principles and be undertaken in accordance with the RTA's Landscape Guideline. Translocation of threatened and rare flora was undertaken for the Tintenbar to Ewingsdale (T2E) project (ECOS 2013). The translocation project entailed salvage transplanting of threatened and rare flora directly impacted by highway construction to the Tinderbox Creek translocation area, population enhancement through the introduction of additional individuals propagated from locally collected seed and cuttings, and restoration of the six hectares translocation site to functional subtropical rainforest habitat. A total of ten species and 93 individuals of threatened and rare flora were transplanted from the highway footprint to the translocation area at Tinderbox Creek near Bangalow in September 2011 and September 2012. Stage 1 of the rainforest restoration planting covering a 1.3 hectare area surrounding the September 2011 transplants, was completed in October 2011. Rainforest planting surrounding the September 2012 transplants and the remainder of the rainforest restoration area (~4.7 hectares) would be undertaken in 2013. Transplant survival rates were generally above 90 per cent. However, for three species transplant survival rates were less than 60 per cent. Details of transplant total number salvaged and survival rates from the T2E project to date for plants that would be impacted by the W2B project include: - Rough-shelled Bush Nut (*Macadamia tetraphylla*) – 37, 97%. - White Laceflower (*Archidendron hendersonii*) – 1, 0%. - Red Lilly Pilly (*Syzygium hodgkinsoniae*) – 1, 100%. - Veiny Laceflower (*Archidendron muellerianum*) – 1, 100%. The main tasks to be completed in 2013 for the T2E project includes planting the remainder of the translocation area with rainforest tube stock, maintaining the rainforest restoration area, seed collection and propagation and further monitoring and reporting. Roads and Maritime also has a seed collection guideline (RTA Seed Collection QA Specification R176) and the Florabank Guidelines and Model Code of Practice (www.florabank.org.au) which would be used for any proposed seed collection tasks.	Moderate, monitor success and implement corrective actions as required.

Issue	Mitigation measure	History of success	Effectiveness rating
	collected from impact areas (or other sites) to offset sites. - Maintenance of translocated threatened flora population/s. Offsetting or acquiring compensatory habitat to protect and/or improve threatened flora habitat.		
Edge effects including increased light availability, wind speed and temperature, as well as changes in soil conditions at patch edges leading to a degradation of remaining rainforest plants.	Revegetation of areas adjacent to rainforest communities and plants within the project according to the landscape guideline. Implementation of the erosion and sediment control plan as outlined in the CEMP.	A standard procedure for the reestablishment of native vegetation (guide 3) has been developed by Roads and Maritime and documented in the *Biodiversity Guidelines Protecting and managing biodiversity on RTA projects* (RTA 2011). The objective of this guide is to ensure good biodiversity outcomes, where native vegetation re-establishment is required, by managing site conditions, material sourcing and procurement, and seed and plant stock installation and establishment. All revegetation works would be based on sound ecological principles and be undertaken in accordance with the RTA's Landscape Guideline. It is standard practise for Roads and Maritime projects to have sediment and erosion control implemented to control sediment release from construction works areas. Roads and Maritime has successfully used sediment and erosion controls across a number of Pacific Highway projects.	Low to Moderate, monitor success and implement corrective actions as required.
Changes to hydrological and nutrient regimes impacting the integrity of remaining patches. Changes may result from alternations made to creek alignments and from the operating road runoff.	Implementation of a water quality management plan.	Roads and Maritime undertakes hydrology and flooding assessments for projects to inform the drainage design for road projects. These assessments generally have a principle objective for drainage design to maintain current waterway and drainage flows that mimic the existing conditions as closely as possible. Application of this objective generally minimises hydrological impacts to adjacent areas. Procedures including sediment and erosion control measures would be implemented to maintain water quality during construction, which would be included in the CEMP. These measures would be important in maintaining the current condition of threatened mammal habitat and to ensure water supplies have not been contaminated as a result of construction. Water quality monitoring, particularly following rainfall events, would identify if the hydrology and water quality has been adversely impacted by the project	Moderate, monitor success and implement corrective actions as required.
Lowering of the water table leading to changes to understorey floristic and canopy dieback.	Implementation of the groundwater management plan as outlined in the CEMP.	Groundwater inflows to cuttings resulting from the interception of the groundwater table would manifest in the form of localised seepage and potential instability of batter faces. These impacts can usually be managed through engineering mitigation measures such as drainage blankets. Groundwater seepage into the cuttings can also be collected in a subsurface drainage system (with possible treatment if required) transported to the nearest waterbody and/or GDE area such as wetlands, therefore not reducing the supply of groundwater that may currently flow towards these areas.	Low to Moderate, monitor success and implement corrective actions as required.

Issue	Mitigation measure	History of success	Effectiveness rating
Spread of pathogens during construction.	Pathogen management hygiene protocols established and pathogen management plan implemented. Exclusions zones. Construction induction.	A standard procedure for exclusions zones (guide 2) and pathogen management (guide 7) have been developed by Roads and Maritime and documented in the *Biodiversity Guidelines Protecting and managing biodiversity on RTA projects* (RTA 2011). The objective of this guide is to provide guidance for preventing the introduction and/or spread of disease causing agents such as bacteria and fungi. This guide also provides best practise hygiene protocols to prevent the introduction or spread of pathogens on Roads and Maritime project sites and during maintenance works for Phytophthora and Chytrid. Exclusion zones have been successfully used on many Pacific Highway projects to exclude construction activities from sensitive environments.	Moderate, monitor success and implement corrective actions as required.

5. Pre-construction management measures

5.1 Potential impacts during pre-construction

There is an opportunity to protect threatened rainforest plants and communities close to construction areas through implementation of pre-construction management measures. There would also be potential for accidental impact to threatened rainforest plants and communities when locating ancillary facility sites including heavy vehicle access as part of the pre-construction planning.

5.2 Mitigation goals

- Threatened rainforest communities and plants in close proximity to the project to be retained (*in situ*) would be identified, mapped and marked prior to commencement of construction.
- Threatened rainforest communities and plants translocation strategy completed for relevant project sections.
- Seeds and other propagation material to be collected from threatened rainforest plants prior to clearing works.
- Identification and translocation of all relevant threatened rainforest plants within the construction area as identified from feasibility assessment.
- Weed and pathogen management protocols developed and approved prior to construction commencing.
- Identify exclusions zones prior to construction commencing including corridor and ancillary sites and access roads.
- No loss of threatened rainforest plants outside of designated ancillary facilities and access roads.

5.2.1 Targeted surveys

Targeted surveys for threatened rainforest communities and plants would be required pre-construction to collect comprehensive up to date data on the location, health and number of threatened plants within the project, mark plants, collect baseline data and to inform the development of the translocation feasibility strategy and monitoring program(refer to **Section 5.3.2**). The optimum time to undertake these surveys have been indicated in Table **5-1**.

Table 5-1 Optimum targeted survey timing for threatened rainforest plants

Species	Optimum survey time
Acronychia littoralis	December-April (fruits required for positive identification)
Acalypha eremorum	September-June (flowers required for positive identification)
Archidendron hendersonii	Throughout the year
Belvisia mucronata	Throughout the year
Cryptocarya foetida	Throughout the year
Davidsonia johnsonii	Throughout the year
Endiandra hayesii	Throughout the year
Endiandra muelleri subsp. *bracteata*	Throughout the year
Coatesia paniculata syn. *Geijera paniculata*	Throughout the year
Macadamia tetraphylla	Throughout the year
Ochrosia moorei	Throughout the year
Streblus pendulinus syn. *S. brunonianus*	Throughout the year
Syzygium hodgkinsoniae	Throughout the year
Tinospora tinosporoides	Throughout the year

The targeted surveys would also enable the accurate mapping of the distribution and abundance of threatened rainforest communities and plants immediately adjacent to the project and would also assist in the identification of potential revegetation or translocation sites in consultation with landowners and as part of the project offset strategy.

For retained Lowland Rainforest patches, establishment of photographic reference points of edge zone condition, focussing on weed densities, evidence of recruitment events, drainage line condition (erosion, weed) would be collected during targeted surveys.

All targeted surveys would be undertaken by a licensed and appropriately experienced botanist and would involve:

- A review of the EIS and working paper to confirm the threatened plants that are known from or could potentially occur in and adjacent to the project up to 50 metres form the construction zone. Plants beyond 20 metres may be used as controls for on-going monitoring.
- Field survey to identify and mark threatened rainforest communities and plants to be retained (*in situ*) within the project and immediately adjacent to the project (subject to property access).
- Recording the location of all threatened rainforest communities and plants found during the field survey including GPS co-ordinates, identification number, plant height and other relevant details.
- A habitat condition assessment for ongoing monitoring of change in habitat for *in situ* populations.
- Identification of all plants within impact areas that may be suitable for translocation, particularly larger individuals (shown to have a greater survival rate when translocated).

As noted above, the data collected during the targeted surveys would be used to inform the detail design and monitoring program. For example, this data would be overlaid on the project design to identify if the threatened rainforest communities and plants would be directly or indirectly impacted. Directly impacted relates to individuals located within the clearing limits/construction zone and indirectly impacted generally relates to those individuals located within 20 metres of the clearing limits/construction zone. Threatened plants to be retained in situ include those individuals located within the project but outside the clearing limits/construction zone.

As such, this information would be used to update the construction management measures and monitoring program outlined in the following sections including existing habitat to be protected and the location exclusion fencing. These surveys would also inform the development of a project specific translocation strategy.

5.2.2 Translocation strategy

Translocation is defined as the 'deliberate transfer of plant material from one area to another for conservation purposes' (ANPC 2004). Its purpose in this project is to apply different translocation techniques on development impacts where declines in threatened species population numbers and genetic diversity are to be avoided. Techniques aim to establish a salvaged population (transplanted and propagated individuals) and compensate conservation efforts.

A separate translocation strategy would be prepared prior to construction for each section of the project for rainforest communities and plants. The translocation feasibility assessment and strategy would be developed in conjunction with the project offset strategy to identify potential offset sites suitable for translocation.

The overall objective of threatened rainforest translocation is to establish populations that are self-sustaining over the long term. There is no guarantee of translocation success and it should be viewed as a last resort as there may still be a net decline due to clearing. It is vital for the target species to recover and reproduce in a functioning habitat which requires detailed planning and long term commitment to monitoring (ANPC 2004). Translocation would be undertaken for species that have suitable life history traits where translocation may a viable option. This would be carried out with a feasibility assessment designed to comparatively research environmental characteristics to measure translocation success of receival sites and the ecological needs of a species.

It should be noted that translocation receival sites would be located outside of the project boundary, in disturbed areas of offset land or compensatory habitat. Translocation would not be factored into offset formulae, but rather aim to achieve a no net loss in local plant populations being impacted by the project. A receival site would selected upon inspection of any land that meets species specific habitat requirements and may be selected on Roads and Maritime owned properties, designated offset sites or private landowner land. This would be done in conjunction with the project offset strategy.

The translocation strategies for each section of the project would be informed by the targeted surveys. The following outline of a translocation strategy has been adopted from other Pacific Highway upgrade projects. Examples include the:

- Tintenbar to Ewingsdale Pacific Highway Upgrade: Rainforest translocation plan.
- Brunswick Heads to Yelgun Pacific Highway Upgrade: Rainforest translocation project.

The translocation strategy would generally follow the framework and issues of consideration set out in the ANPC (2004) Guidelines for Translocation of Threatened Plants Australia and would include the following information shown below.

Translocation feasibility assessment would include:

- An assessment of the feasibility of translocating the threatened rainforest plants details in this management plan. This assessment would be based on a review of translocation experience for individual threatened rainforest plants and involve the assessment of the benefits and risks of translocation for each threatened plant. Specifically this assessment would determine whether any threatened rainforest plants located within the clearing limits/construction zone could be successfully translocated, or propagated and planted into, an appropriate receiving site, preferably outside the road reserve, within an offset site or on private property (in consultation with landowners). For this to happen, a number of factors would be considered and would be documented in the feasibility assessment for each of the subject threatened rainforest plants including:
    - Species life history traits and population dynamics (e.g. timing, pollinators etc.).
    - Known distributional range, suitable habitat and potential recipient sites.
    - Type of translocation (e.g. re-stocking, re-introduction, introduction, conservation introduction).
    - Propagation potential (e.g. seed, cuttings, grafting, mycorrhizal associations, genetic etc.).
    - Survival rates and expectancy.

    - Cost and commitment of physical transfer and long term monitoring and management.
    - Contingency options (back-up options in case of failure).
    - Detail and confirmation of appropriate recipient sites.
- Detail the habitat, population dynamics, transplanting and propagation potential and recovery plan requirements for each threatened plant to be translocated. This would allow for suitable receiving sites to be identified to optimise the success of the translocated individuals.

Translocation planning would include:

- Detail the translocation approach including a description of the methods to be used to salvage the threatened rainforest plants for translocation, how receiving sites would be selected and where they would be located, and the resources required for the translocations. This would include development of a translocation procedure that outlines the machine and manual transplanting, and pruning requirements. Mechanical transplanting would usually be required for established tree species whereas manual transplanting would be sufficient for shrubs and smaller plants.
- Describe the proposed propagation procedure for threatened rainforest plants within the translocation receival sites to enhance the translocated population and provide back-up individuals to replace mortalities potentially incurred during transplanting. Propagation would also assist in increasing the long term population persistence of the threatened rainforest plants by establishing larger initial populations. Individuals would be propagated from seed or cuttings collected from the local threatened plant populations.
- A description of post-translocation actions including:
    - Maintenance activities such as weed control and bush regeneration.
    - Habitat restoration requirements if translocation receiving sites include disturbed or degraded vegetated areas.
    - Research and experimentation review and reporting requirements, for example where translocation and/ or propagation has not be undertaken previously for threatened plant species a trial translocation and/or propagation may be required. Details of the trial methods, timing etc would need to be outlined in the translocation strategy.
    - Monitoring requirements to document the establishment and survival of translocated and propagated plants. Monitoring would provide data to allow an assessment of the success of the translocation undertaken. The monitoring requirements are detailed in **Chapter 7**.
- An implementation schedule summarising the translocation program requirements pre, during and post-construction.

Translocation may be considered feasible for a threatened species that have not been translocated before if its ecological requirements, growth-form attributes and propagation characteristics indicate that employing a certain translocation method has a reasonable chance of success.

The location, size and suitability of receiving sites would require further consideration as part of the offset and revegetation strategies.

5.3 Management measures

5.3.1 Seed/cutting collection and propagation

Methods of propagation (such as seed and cutting) for plant translocation allow activities to collect a good genetic base from local populations of subject threatened species that would establish a viable population size.

Seed collection and propagation of threatened rainforest plants would be applied, to replace those populations lost as a result of construction. The seed collection and propagation activities would aim to raise individual threatened species as tubestock suitable for the re-introduction activities and to offset any potential die-off incurred as a result of construction for *in situ* populations and compensatory planting in offset areas.

Seed collection should be initiated at the earliest possible time in order to collect a suitable density of seeds prior to clearing. Experienced, licensed seed collectors would carry out all seed collection and may involve collecting seed up to 12 months in advance of any clearing works. Rainforest plant seed is usually unviable when stored and when collected would need to be sown at selected site without delay. Seed from pioneer phase species may be stored in species specific conditions. Seed collection would focus on threatened rainforest plants, with a range of rainforest species collected to ensure representation in revegetation and offset areas to be of similar species composition to surrounding areas.

It is important to consider genetic factors in the short term seed collection activities for securing long term resilience and persistence of translocated populations. Poorly selected genetic material can lead to population inbreeding, depression, and reduction or lose of genetic flexibility to evolve with changing environments. To maintain genetic diversity, indirect genetic management would be required in the form of a species genetic study or determining genetic variability through species habitat type and geographic position that can indirectly measure differences between populations.

Seed collection would need to target fruiting periods of threatened rainforest plants which generally occurs in spring and summer. **Table 5-2** outlines the ideal seed collection period for each threatened rainforest plant. A number of site inspection may be required in these periods to investigate the onset of seed, and seed collection may be conducted over several visits during these optimum periods.

Table 5-2 Optimum periods for threatened flora seed collection

Species	Flowering period	Seed collection
Acronychia littoralis	December-April	April (reproduces vegetatively)
Acalypha eremorum	September-June	September-June
Archidendron hendersonii	September-December	September-December
Belvisia mucronata	Spore capsules appear in November-February	Unknown
Cryptocarya foetida	September-January	February
Davidsonia johnsonii	September-November	January-April (reproduces vegetatively)
Endiandra hayesii	October-November	October-November
Endiandra muelleri subsp. *bracteata*	October-November	October-November
Coatesia paniculata syn. *Geijera paniculata*	April-May	May-October
Macadamia tetraphylla	August-October	January
Ochrosia moorei	December-February	Autumn
Streblus pendulinus syn. *S. brunonianus*	September-January	January-April
Syzygium hodgkinsoniae	February-March	December-January
Tinospora tinosporoides	October-November	December-January

If seed resources from the immediate site area are not available or sufficient, additional seed may need to be collected from other areas within the region. Suitable seed collection sites need to be identified to ensure adequate genetic diversity within the plant seed collected and the compatibility of the conditions of the receiving site.

Most rainforest species are easy to germinate, and would take 1-2 years for pioneer phase species and possibly longer for mature phase species to be of suitable size to plant out. The use of cuttings would also be required to provide the numbers of species in the lead time provided. The potential loss of some genetic diversity in the first generation is offset by the numbers of individuals restored into the environment. Cuttings would be taken from the greatest number of parent plants as possible to ensure some genetic variation in the second generation. The processes of seed collection and storage are outlined in **Table 5-3**.

Table 5-3 Seed collection and storage methods

Process	Method
Seed collection	Seed collection would only be undertaken within the local population, where possible. The collected seed from pioneer phase species can be stored for future use on the project to provide contingency for low survival rates of planted tubestock if required. The threatened species seed in this plan would not store and need to be planted out straight away. Seed collection, storage and propagation should follow recognised guidelines, in particular *RTA Seed Collection QA Specification R176* and the *Florabank Guidelines and Model Code of Practice* (www.florabank.org.au). ▪ Seed should be collected from as many as possible, widely spaced, healthy parent plants (not diseased) across the extent of the population. ▪ The aim would be to collect as much varied genetic material as possible, therefore seed should be collected from plants that are less likely to cross-pollinate (i.e. spaced more than 50 metres apart). ▪ Targeted surveys can give some indication of whether threatened rainforest plants are part of the same or different populations (e.g. the single *Acronychia littoralis* individual has reproduced 125 clonal stems). ▪ Isolated plants should be avoided where possible. ▪ Small sections of branches supporting unopened mature capsules should be collected. ▪ Sustainable collection techniques would be employed with no more than 20 per cent of the total seed crop on any plant collected, and the amount of vegetation removed would be minimised. However, plants to be totally removed could be excluded from this collection process. Sterilised secateurs would be used to remove small sections of branches supporting capsules (Australian Tree Seed Centre and Mortlock 1999a; Mortlock and the Australian Tree Seed Centre 1999b).
Seed storage	The basic requirements for good storage include the following: ▪ Seed collected only from fruit that is fully mature. ▪ Seed is well dried and cleaned. ▪ Storage should be in airtight containers at a constant temperature. ▪ Accurate record keeping should be implemented including collection data and location. (Mortlock 1998a)
Seed trials	Seed trials would be undertaken with seed grown plants in commercial potting mix and a mix containing the natural soil type from the site. The trial would aim to examine: ▪ The effect of the potting medium on growth and establishment of plants in the field. ▪ As an additional comparison, half of each of the above treatments would be planted with and without slow release fertiliser to study the effect of fertiliser addition on performance. This would provide useful information for future management and mitigation of this species assessing the effect of nursery soil medium and fertiliser application on the survival and establishment of propagated plants introduced to the wild, as these factors are currently poorly understood. ▪ A proportion of each of these treatments would be planted in each of the different 'habitats' deemed to be suitable on site adjacent to the highway including slopes and riparian areas and sediment basins.

Planting out (of tubestock) to the natural soil type would be carried out when the site has become available and free from construction activities. The seedlings should also be mature enough for replanting and planted at a time that is optimal for their survival i.e. in spring or summer.

Threatened rainforest plant species would not be planted in the road reserve. Planting of threatened rainforest plants would be targeted at planting in other Roads and Maritime land acquired as part of the offset strategy. Supplementary non-threatened rainforest plants would be selected for revegetation around retained *in situ* threatened flora populations to enhance habitat conditions and would be part of the landscape design.

Propagation of threatened species would only be done by qualified rainforest nurseries or plant propagators, under appropriate quarantine conditions, with appropriate threatened species approvals. There would be risks of introducing pathogens to the seedlings, or transferring pathogens from propagules. Only disease free tubestock would be introduced to receival sites. Methods of propagation are outlined in **Table 5-4**.

Table 5-4 Propagation methods

Process	Method
Cutting propagation	Cuttings should be collected from as many parent plants as possible. The aim of cutting propagation would be to provide effective backup to the principle form of propagule collection, through seed collection. However, due to recognised limitations of seed collection and propagation, cuttings maybe required to provide revegetation material.
Seed propagation	▪ Germination of the seed of rainforest species is usually quite easy by normal seed raising methods. No special pre-treatment is needed. ▪ Seeds would be propagated in seedling trays of standard seed propagation mix (e.g. pine bark fines, cracker dust, sand, vermiculite, slow release fertiliser). When about 1 cm tall the seedlings would be transplanted to super tubes (150 millimetres) and grown on until at least 40 centimetres tall, which may take 12 months or more It would be likely that larger propagated plants would have higher survival rates. ▪ Most of the seedlings would be planted out in the field when they reach 40 centimetres tall and be well hardened off (acclimatised to outdoor conditions) before planting out. If landscaping activities have been delayed some plants may need to be grown on further and potted into larger pots.

5.3.2 Temporary exclusion zones

An exclusion zone would be a designated “no go” area that clearly identifies areas to avoid and would be appropriately fenced to prevent damage to native vegetation. Exclusion zones can also be used to define clearing limits. The location and type of exclusion fencing to be used would be included in the CEMP. Further detail on exclusion zone establishment and maintenance can be found in the *Biodiversity Guidelines Protecting and managing biodiversity on RTA projects* (RTA 2011).

The establishment of exclusion zones would be marked out by a qualified ecologist and surveyor and would be based on the results of the targeted baseline survey and plant marking activities. The relevant protocols include:

- Exclusion zones to be identified and marked out prior to construction considering threatened rainforest species within 20 metres of the construction footprint.
- Exclusion zone fencing would be placed outside of the tree protection zone (drip zone) and in accordance with Australian Standard AS 4970-2009 Protection of trees on development sites.
- Appropriate signage would be erected to inform personnel about the purpose for the fencing. Signage would be clearly visible from a distance of 20 metres and be consistent in wording (i.e. Exclusion Zone or Environmental Protection Zone).
- All construction materials or equipment outside the exclusion zone would be stored in accordance with Australian Standard AS 4970-2009 Protection of trees on development sites i.e. outside of the tree drip line.
- All exclusion zones would be marked on a site plan used for construction with an aerial image underlay.
- Indication on the site plan including construction chainages or distance markers where the exclusion zones would be located.
- Clear labelling of exclusion zones on the site plan, including the type of fencing to be used and installation and maintenance requirements.

Temporary exclusion fencing along with appropriate signage would be required prior to any vegetation being clearing works being undertaken. The type of temporary exclusion fencing used may vary depending on the number of plants being protected and the sensitivity of the site. Fencing options may include (but are not limited to) the following:

- Highly sensitive sites – chain wire fencing.
- Permanent protection required – stock fencing or similar.
- Temporary fencing of specific small areas – para-web material and start pickets.
- Larger areas – capped star pickets and reflective spinning tape (helicopter tape).
- Delineation of low risk intrusion areas – earth bunding, mulch berms, sediment fencing or flagging tape.

Induction material to be presented to construction staff would detail the importance of EPBC/TSC listed species and communities and their management requirements, clearly identifying avoidance requirements before commencing work at each location. Exclusion zones may also be necessary should the occurrence of Myrtle Wilt be located within or immediately adjacent to the project.

5.3.3 Weed management

Guide 6: Weed management of the Biodiversity Guidelines: protecting and managing biodiversity on RTA project (RTA 2011) provides the requirements for weed management on all Roads and Maritime projects. The *Introductory Weed Management Manual* (Natural Heritage Trust 2004) also provides guidance for developing weed management plans.

In summary, Guide 6 requires a site weed assessment to be undertaken prior to construction for each staged section of the project. Data collected during the assessment would be used to develop a weed management plan, which would include details on the weed monitoring. The requirements of the weed management plan would be incorporated into relevant plans for the project (eg landscape management plan, CEMP or work method statements).

A separate weed management plan would be developed for each staged section of the upgrade, as part of the CEMP to provide guidance for preventing or minimising the spread of noxious and environmental weed species during pre-construction, construction and operation. The plan would outline weed management measures to be implemented during construction.

In general, weed management plans include descriptions and mapping of major weed infestations identified during pre-clearing surveys, with appropriate management actions outlined to be implemented for each infestation. The details in the weed management plans would most likely vary for each section of the project but should include:

- Type and source of the weed/s.
- Weed management priorities and objectives.
- Pro-active weed management applied throughout the project boundary.
- Sensitive environmental areas within or adjacent to the site.
- Location of weed infested areas.
- Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance.
- Measures to prevent the spread of weeds.
- Appropriate placement of tub grinder mulch that avoids being spread around retained *in situ* threatened flora sites.
- A monitoring program to measure the success of weed management.
- Communication strategies to improve contractor awareness of weeds and weed management.
- Coordination of a bush regeneration contractor for targeting weed control from retained in situ threatened rainforest flora populations and communities.

Details on monitoring the performance of weed management, as well as, corrective actions to be implemented in instances of change from performance measures are provided in **Chapter 7**. This provides a consistent measure to be included in all weed management plans for threatened plants.

General weed monitoring during construction and operation would be reported as detailed in the weed management plans and ecological monitoring program requirements.

5.4 Performance thresholds and corrective actions

Table 5-5 summarises the pre-construction environmental planning measures for protected rainforest communities and listed rainforest plants that would be completed prior to the commencement of construction.

Table 5-5. Pre-construction mitigation measures, performance measures and corrective actions

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Performance thresholds	Corrective actions if deviation from performance thresholds
Threatened rainforest communities and plants within and in close proximity to the project to be retained (*in situ*) would be identified, mapped and marked prior to commencement of construction	Pre-construction targeted surveys of threatened plants, to identify threatened rainforest plants for retention *in situ*, translocation and seed collection. Identification of exclusion zones and clearing limits. Construction related infrastructure to be planned and sited within cleared or disturbed areas of the ancillary site.	Targeted surveys to occur pre-construction (in the optimum season for the threatened rainforest plant species) to inform the detailed design. Baseline data collected during the targeted surveys to inform the mitigation measures and monitoring program prior to construction commencing. Detailed plans to be prepared showing the proposed location of construction related infrastructure and approved prior to commencement of construction.	Targeted survey not undertaken prior to construction in the optimum season for the threatened rainforest species. Damage to threatened rainforest plant habitat reported outside limits of clearing associated with ancillary facilities and access roads.	Delay construction until targeted surveys have been undertaken. Revegetation of disturbed habitat and monitoring of recovery.
Threatened rainforest communities and plants translocation strategy completed for relevant project sections.	Targeted survey findings used to develop the threatened plants translocation strategy.	Pre-construction.	Translocation strategy not completed prior to construction.	Delay construction until translocation strategy has been completed.
• Seeds and other propagation material to be collected from threatened plants prior to clearing works.	Targeted survey findings used to collect seeds and plant material to preserve the local gene pool and replant in offset areas.	Pre-construction.	Seeds collection and plant material collection not undertaken prior to clearing works.	Delay construction until seeds and propagules have been collected.
Identification and translocation of all relevant threatened rainforest plants	Identification of individuals for translocation.	Targeted survey to identify individuals for translocation prior to clearing.	Identification of individuals for translocation not undertaken prior to	Construction postponed until all individuals have been appropriately identified and translocated.

within the construction area. Selection of optimal translocation receival sites for threatened rainforest flora populations and threatened community restoration sites.			clearing works. Identified individuals not translocated prior to clearing works.	All individuals within and adjacent to the project appropriately flagged for removal, protection or translocation.
• Weed and pathogen management plan developed and approved prior to construction commencing.	Develop a weed and pathogen plan to provide detail on weed extent, location of high threat weeds and weed infestation within dissected rainforest areas. Plan also to provide details on potential pathogens and management measures to be implemented including for Myrtle Wilt infestation if present.	Weed and pathogen management plan to be completed prior to construction commencing.	Weed and pathogen plan not completed prior to construction commencing.	Delay construction if the weed and pathogen management plan has not been completed prior to construction.
Identify exclusions zones prior to construction commencing.	Identification of exclusion zones informed by targeted surveys.	Pre-construction informed by the targeted surveys.	Exclusions zones not identified prior to construction.	Delay construction until exclusions zones have been identified.
No loss of threatened rainforest plants outside of designated ancillary facilities and access roads.	Identification and marking of exclusion zones and clearing limits prior to clearing works. Construction related infrastructure to be planned and sited within cleared or disturbed areas of the ancillary site.	Detailed plans to be prepared showing the proposed location of construction related infrastructure prior to commencement of construction	Damage to habitat reported outside limits of clearing associated with ancillary facilities.	Revegetation of disturbed habitat and monitoring of recovery.

6. Construction management measures

6.1 Potential impacts during construction

- Machinery moving around threatened rainforest plants has the potential to cause damage to these plants directly or by allowing materials to fall on them.
- Machinery moving around threatened rainforest plants has the potential to impact these plants indirectly by compacting soil around the plants and compacting roots and changing water infiltration in these areas, introducing and/or spreading weeds, contaminating the soil and/or water and generating dust that could coat plants.
- Loss of retained in situ threatened rainforest flora and communities during construction due to physical damage.
- There would also be potential for the loss of those individuals proposed to be translocated through an incomplete or inadequate translocation processes.

6.2 Mitigation goals

- No loss or damage of Lowland or Littoral Rainforest or threatened rainforest plants outside of approved clearing limits.
- Less than 10 per cent mortality of threatened rainforest plants from *in situ* populations during translocation.
- No loss of threatened rainforest plants retained *in situ* threatened rainforest flora during construction due to physical damage including no notable increase in the abundance of weeds within threatened rainforest patches during monitoring of *in situ* populations.
- No increase in the cover/abundance of weed species within threatened rainforest patches.
- Adequately planned translocation carried out such that it maximises the chance of survival of the translocated plants.
- The revegetation plan includes details on revegetation requirements for areas adjacent to threatened plants and translocation/offset areas.
- Dust managed in accordance with the CEMP.
- Water quality managed in accordance with the CEMP.

6.3 Management measures

6.3.1 Work method statements

Work method statements would prepared for activities to ensure sound environmental practices have been implemented and to minimise the risk of environmental incidents or system failures, in accordance with the FFMP component of the CEMP. This management plan would be included as an annexure to the project CEMP.

Construction Method Statements (CMSs) would be prepared to address all construction lowland rainforest and rainforest species management requirements in consultation with relevant agencies, Roads and Maritime and the project EMR for all sections prior to the commencement of identified activities.

6.3.2 Induction and training

Induction and training would be conducted with all contractors and other staff that would be working in the area of known and potential Lowland or Littoral Rainforest habitat. This training would identify the Lowland/Littoral rainforest patches, with all personnel shown maps of the Lowland/Littoral rainforest patches. The importance of following the clearing, translocation and rehabilitation protocols would be made clear for any personnel that require access to the site.

6.3.3 Sensitive Area Plans (SAPs)

SAPs are important for identifying where threatened rainforest flora species and communities are located for day to day management of the project. A map (GIS format) would be prepared clearly showing sensitive locations of *in situ* populations and communities and proposed translocated flora (with identification numbers) and be kept up to date.

6.3.4 Clearing requirements

Clearing requirements are provided in the *Biodiversity Guidelines Guide 1* (Roads and Traffic Authority (2011)), and would also be detailed in the FFMP. The following clearing requirements apply to threatened rainforest species:

- All threatened rainforest plants identified for translocation would be translocated prior to clearing works being undertaken, as outlined in the translocation strategy.
- All patches of listed rainforest communities and threatened rainforest plants identified to be retained at the edge of the clearing limits/construction zone (*in situ*) would be protected during construction.
- All threatened plants and communities on the edge of clearing (<5 m) with chain meshed fencing.
- Where individual threatened rainforest communities and plants occur on the edge of a planned clearing zone and the clearing cannot be avoided, pruning of the trees or cutting tree trunks and leaving stumps in the ground, to regrow or sucker from the base, would be done where possible.
- All relevant construction staff would be made aware of the presence of individual threatened plants and populations of threatened species and the importance of protecting and avoiding impacts to individuals and rainforest communities during construction.
- Only individual plants marked with flagging tape colour-coded for removal would be removed.
- In the event of an unexpected discovery of a threatened and/or rare plant species, the construction staff are to follow the *Unexpected threatened species finds procedure* *Unexpected threatened species finds procedure* in the RTA Biodiversity Guidelines (RTA 2011). If the plant individual or population is a new species discovery it will need to be added to the final TFMP.

6.3.5 Sedimentation fencing

Detailed site specific erosion and sediment control plans would be prepared as part of the CEMP for each section of the project. Locations for sediment fencing would be identified using a risk based approach to determine the likelihood of sediment encroaching into *in situ* threatened rainforest plant locations and rainforest communities. Appropriate sediment fences would be erected where works are on or adjacent to sloped areas, and riparian areas and run off could occur to prevent local run-off directly impacting threatened rainforest plants and rainforest communities.

These details would be further designed on a site specific basis as part of the CEMP following the outcomes of the pre-construction surveys. These measures would be important in maintaining the current condition of threatened rainforest plant habitats, particularly the Lowland and Littoral rainforest communities.

Sedimentation fencing would be monitored weekly during construction and repaired if damaged or filled with trapped sediment.

6.3.6 Revegetation

The revegetation plan would provide specific details for the re-establishment of native vegetation within areas disturbed by construction, such as batters and bare areas to provide protection for *in situ* threatened species. Methods for topsoiling, seeding, planting and weed control would be in accordance with the *Biodiversity Guidelines: Protecting and managing biodiversity on RTA Projects* (RTA 2011).

The plan would contain specific revegetation measures adjacent to threatened rainforest communities and plant locations to ensure these sites are adequately buffered with fast growing native species to prevent weeds becoming dominant. The plan would contain a maintenance schedule for three - five years, the first year (timing) is described in the operational section.

Revegetation would commence during construction where possible or immediately upon completion of the construction activities within each section of the project or may commence earlier in the construction period if applicable. The revegetation of offset sites with rainforest communities would be detailed in a separate site specific revegetation plan that would come at later stage once offset sites are secured.

Revegetation maintenance would be planned in consultation and implemented by experienced bush regenerators (sub-contractor) who possess the following skills:

- Experienced in identification of the local flora and particularly subject threatened species, so that damage to individuals of threatened species and native species in general does not occur during maintenance activities (these plants will be monitored).
- Experienced with using bush regeneration and planting to restore and maintain threatened flora habitat.

Salvaged topsoil would be ideal to top-dress revegetation areas on disturbed roadsides. Revegetation around retained in situ threatened rainforest flora populations communities would benefit from weed/rhizome free topsoil salvaged from any existing weed free rainforest topsoil. This is an effective measure to reduce the level of weed invasion into ecologically sensitive areas.

Details on monitoring the performance of the revegetation adjacent to rainforest communities as well as corrective actions to be implemented in instances of change from performance measures are provided in **Chapter 7**.

6.3.7 Weed management

Weed management would be undertaken during construction according to the weed management plan and consider the location of in situ populations. Refer to the weed management plan for details. This plan would follow the Roads and Maritime Biodiversity Guidelines requirements (RTA 2011). This plan would focus on weeds and pathogens identified in the weed and pathogen plan relevant to the section where works are being undertaken, particularly Camphor Laurel and Lantana and Myrtle Rust infestation (if present).

6.3.8 Water quality

As noted in **Section 6.3.4**, procedures including sediment and erosion control measures would be implemented to maintain water quality during construction, which would be included in the CEMP. These measures would be important in maintaining the current condition of retained rainforest areas and include:

- Controlled access to watercourses by construction workers and vehicles.
- All refuelling and maintenance to be undertaken in designated bunded areas away from overland flow paths and low-lying areas.
- Specific measures for water detention basins including appropriate discharge where necessary.

6.3.9 Minimising dust

Dust impacts would be managed in accordance with the CEMP including dust suppression measures. Depending on rainfall, threatened rainforest patches and/or *in situ* plants retained in close proximity to the project may require periodical wash down, to remove dust if accumulation becomes excessive.

6.4 Performance thresholds and corrective actions

Table 6-1 summarises the environmental planning measures for protected rainforest communities and plants that would be completed during construction.

Table 6-1. Construction phase mitigation measures, performance measures and corrective actions

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Performance thresholds	Corrective actions if deviation from performance thresholds
No loss or damage of Lowland or Littoral Rainforest or threatened rainforest plants outside of approved clearing limits.	Exclusion zones fenced off and clearly marked. Exclusion fencing monitored with breaches repaired. Install tall (3-4m high rolls) shade cloth screening along the cleared edge of rainforest TEC immediately after clearing to provide microclimate protection (to prevent potential dieback form over sun exposure, dust, edge effects).	Clearing areas identified prior to clearing activities being undertaken. Exclusion zone fencing monitored monthly, faults rectified as soon as noticed.	Clearing commenced prior to clearing areas being marked out and approved. Breeches of exclusion zone fencing.	Delay construction until clearing areas have been marked out. Stop construction in the area of the breach until exclusion fencing has been repaired. Investigate why breach in fencing occurred and implement corrective actions as required to prevent reoccurrence.
Less than 10 per cent mortality of threatened rainforest plants from in situ populations No loss of threatened rainforest plants retained in situ threatened rainforest flora during construction due to physical damage including no notable increase in the abundance of weeds within threatened rainforest patches during monitoring of in situ populations.	Exclusion zones established and marked. Exclusion fencing monitored with breaches repaired. Dust and water quality controls implemented as per the CEMP. Weed management to be implemented as per the weed management plan. Monitoring surveys undertaken.	Exclusion zone fencing and water quality controls monitored, faults rectified as soon as noticed. Monitoring undertaken biannually during construction.	Breeches of exclusion zone fencing. Dust and water quality controls ineffective. At least 90% of the threatened in situ plants have survived after the first year and 80% after five years. Noxious and environmental weeds reported in areas adjacent to threatened plants. Spread of noxious and environmental weeds into properties adjoining the project noted in monitoring activities.	Stop construction in the area and repair faults in exclusions fencing and water quality controls. Review existing exclusion fencing and water quality controls measures and implemented additional measures as required Investigate reasons for decline in plant health and implement appropriate measures to prevent further decline. Revegetate within the road corridor as required to improve plant health.
No increase in the area/number of weed species within threatened rainforest patches.	Weed management plan developed and implemented to control weeds. Monitoring surveys to include quantification of weed abundance.	Monitoring of weed abundance during construction as per the weed management plan.	A notable increase (>30%) in weeds identified in threatened rainforest patches.	Review methods and objectives of weed management plan. Implement adaptive management measures. Further weed mitigation measures implemented as required.
Adequately planned translocation carried out such that it maximises the chance of survival of the	Translocation, maintenance and monitoring of threatened rainforest plants per the translocation strategy.	Qualified horticulturalist to undertake translocation at the best of year for identified plants prior to clearing	70% survival rate for translocated plants and threatened species seedlings after the first year and 50%	Propagules, seed stock and additional tube stock on hand to ensure no net loss of individuals should translocation fail.

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Performance thresholds	Corrective actions if deviation from performance thresholds
translocated plants.		activities. Maintenance and monitoring of translocated plants as per the translocation strategy.	surviving after five years. Translocated plants maintained effectively throughout construction.	
The landscaping design includes details on revegetation requirements for areas adjacent to threatened plants and translocation/offset areas	Landscape design contains details on revegetation areas adjacent to threatened rainforest communities and in situ plants. Progressive revegetation adjacent to threatened rainforest communities and plants as construction permits.	Landscape design developed prior construction. Progress revegetation during construction, as areas become available.	Landscape design not developed prior to construction.	Delay construction until the landscape design has been developed.
Dust managed in accordance with the CEMP.	Dust impacts would be managed in accordance with the CEMP including dust suppression measures. Depending on rainfall, rainforest patches retained in close proximity to the alignment may require periodical wash down, to remove dust if accumulation becomes excessive. If monitoring detects an impact then tall shade cloth screening would be erected to protect low growing species close to the edge of clearing.	Construction	No dust related exceedances recorded from the dust monitoring within sections with *in situ* threatened rainforest communities and plants. No loss of ecological condition during monitoring particularly from dust sources.	Review dust suppression procedures and update as required. Adequate dust suppression and wash down of rainforest plants / patches implemented as soon as possible.
Water quality managed in accordance with the CEMP	Adequate water quality controls installed surrounding retained rainforest patches and threatened flora. Procedures for maintenance and monitoring of water quality included in the CEMP.	Water quality controls would be monitored as a minimum weekly throughout the construction period and directly after storm events.	No significant breaches of water quality controls recorded. No loss of ecological condition recorded from the plant health monitoring particularly from altered water quality.	Review adequacy of the water quality controls and implement appropriate corrective actions. Review monitoring procedures for water quality controls and implement appropriate corrective actions.

7. Operational management measures

7.1 Potential impacts during operational phase

- Degradation of translocation receiving sites, with potentially the death of translocated plants.
- Degradation of retained rainforest plants and communities from edge effects.
- Degradation of water quality treatment facilities with corresponding reduction in downstream water quality impacting the integrity of the remaining threatened rainforest patches.

7.2 Mitigation goals

- At least 90% of the threatened in situ plants have survived after the first year and 80% after five years. No mortality due to direct physical damage caused by construction activities.
- No increase in weed cover from baseline conditions in adjacent rainforest communities
- Less than 10 per cent weed cover in revegetation areas adjacent to *in situ* threatened rainforest communities and plants.

7.3 Management measures

7.3.1 Maintenance of dissected threatened rainforest patches

Any loss of the retained in situ threatened rainforest patches could be exacerbated by what is known ecologically as 'edge effects'. This term describes a range of ecological processes that are increased by increased light and or nutrient conditions at the edge of an ecological system, usually resulting in increased weed impacts. Rainforests are particularly susceptible to such issues due to their unique biophysical requirements, mostly self-perpetuated. Revegetation maintenance would be required to increase the extent and limit edge effects. Ongoing weed management and replacement of any revegetation losses would also be required. The maintenance requirements for revegetation areas adjacent threatened rainforest communities and plants would be detailed in the revegetation plan.

Any weed infestation in these areas would require management to ensure no impact on core areas or areas of revegetation reinstatement adjacent to threatened rainforest communities and plants. Weed maintenance activities during operation have been outlined in the Ecological Monitoring Program.

The maintenance of any strategic plantings to firm up *in situ* threatened rainforest communities edges would require mitigation to ensure effectiveness. These have been outlined in the section below.

7.3.2 *In situ* threatened rainforest communities and plants

Ongoing mitigation for *in situ* threatened rainforest communities and plants would be undertaken until the mitigation measure has been proven to be successful. Maintenance activities would include watering if necessary, removal of damaging debris after storms, plantings to replace mortalities, removal of bags and stakes (if used) when the plants overtop them and weed control as necessary.

7.3.3 Revegetation areas

This measure applies to areas revegetated along the project corridor and not offset sites. The revegetation of offset sites with rainforest communities would be detailed in a separate site specific revegetation plan to come at a later stage once offset sites are secured. Ongoing maintenance of revegetated areas adjacent to threatened rainforest communities and plants would be undertaken and would form part of the revegetation plan requirements. Maintenance activities would include watering if necessary, removal of damaging debris after storms, plantings to replace mortalities, removal of bags and stakes (if used) when the plants overtop them, maintenance of mulch cover and weed control as necessary.

The revegetation plan would detail the maintenance schedule for revegetation areas. An example of a monitoring and maintenance schedule for the revegetation areas adjacent to threatened communities and plants as outlined in **Table 7-1** is implemented in the first year.

Table 7-7 Operational phase maintenance schedule first year

Monitoring	Timing	Maintenance
Site preparation	Commencement	Weeds and grass controlled within 2 metres of planting locations.
Watering weekly	First month	No plants wilting or with dried foliage.
Monitoring weeds and plant health	3 months	Weeds not smothering plants, plants healthy with active growth, replanting required if plant survival not at required percentage.
Weed control Mulching and fertilising of plants	3 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched and fertilised.
Monitoring weeds and plant health	6 months	Weeds not smothering plants, plants healthy with active growth, replanting required if plant survival not at required percentage.
Weed control Mulching and fertilising of plants	6 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched and fertilised.
Monitoring weeds and plant health	9 months	Weeds not smothering plants, plants healthy with active growth, replanting required if plant survival not at required percentage.
Weed control Mulching and fertilising of plants	9 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched and fertilised.
Monitoring weeds and plant health	12 months	Weeds not smothering plants, plants healthy with active growth, replanting required if plant survival not at required percentage.
Weed control Mulching and fertilising of plants	12 months	Weeds and grass controlled within 2 metres of planting locations, all plants mulched and fertilised.

7.3.4 Translocation

Refer to the translocation strategy for maintenance and ongoing monitoring requirements for translocation areas during operation.

7.3.5 Weed management

Weed management would be undertaken as part of the Roads and Maritime ongoing maintenance of landscaped areas. Additional weed control measures would be implemented for *in situ* plant/population, rainforest communities (up to 50 metres from the project where access is obtained) and revegetated areas adjacent to threatened plants and rainforest communities. Refer to the relevant project section weed management plan developed for further details on weed management.

The monitoring program would monitor weeds adjacent to *in situ* populations with corrective actions to be implemented if the abundance of weeds is above the performance thresholds. Monitoring and performance measures are provided in **Chapter 7**.

As noted in **Section 5.3.2**, weed control for translocation sites would be included in the translocation strategy.

7.3.6 EPBC offsets

Rainforest offset areas would be protected in perpetuity under a suitable management agreement to ensure remaining ecological values have been maintained and improved. Issues to be addressed include ongoing weed management, habitat extension, constituent threatened species protection, management and maintenance of a suitable buffer (50 metres from outer trunks) to maintain required integrity.

The restoration, management and maintenance of rainforest patches within offset sites would be detailed in a site specific management plan prepared for each offset site. These management plans would detail a wide range of restoration, management and maintenance requirements such as weed management, fencing, threatened species management, pest management and appropriate restoration methods.

7.4 Performance thresholds and corrective actions

Table 7-2 summarises the measures for threatened rainforest communities and plants that would be completed during operation.

Table 7-8 Operational phase mitigation measures, performance measures and corrective actions

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Performance thresholds	Corrective actions if deviation from performance thresholds
At least 90 per cent of retained in-situ threated rainforest plants have survived during construction and for three consecutive monitoring periods post-construction and 80 per cent survived after five years. No mortality due to direct physical damage caused by construction activities. No increase in weed cover from baseline conditions in adjacent rainforest communities	Maintenance of retained rainforest patches including weed management.	Ecological condition would be monitored biannually for at least five years and then reviewed based on results of monitoring. Maintenance activities such as weed management would be undertaken where identified as being required from the monitoring.	No substantial change to ecological condition (<10%) recorded in monitoring over five years. A notable increase in weed infestation (>20%).	Revegetation and implement adaptive measures as required if substantial change to ecological condition noted during monitoring surveys. Ongoing monitoring and maintenance undertaken until ecological condition has been maintained over a five years.
Less than 10 per cent weed cover in revegetation areas adjacent to in situ threatened rainforest communities and plants.	Maintenance of revegetation areas including weed management and supplemental plantings.	Revegetation areas would be monitored biannually for at least five years and then reviewed based on results of monitoring. Maintenance activities such as weed management and mulching would be undertaken where identified as being required from the monitoring.	No substantial change (<10%) to health of planted/seeded plants recorded in monitoring over five years. A notable increase in weed infestation (>10%).	Any failed plantings/seeded areas would be reinstated. Ongoing monitoring and maintenance undertaken until plant health has been maintained and potential threats minimised over a five years.

8. Monitoring program

Monitoring would be undertaken to determine the effectiveness of mitigation measures and would specifically focus on *in situ* threatened rainforest communities and plants and weed monitoring. The monitoring program would use a BACI approach (Before versus After / Control versus Impact) comparing before and after data with impact versus control sites. The monitoring program detailed below would be reviewed and updated as required following the targeted surveys and development of the translocation strategy.

As noted in **Section 5.2.1** targeted surveys would be undertaken to collect comprehensive up to date data on the location and number of threatened rainforest communities and plants within the project. These surveys would also include details on the distribution and abundance of threatened rainforest communities and plants immediately adjacent to the project. The baseline data collected during these surveys would be used to update the monitoring program. During the targeted surveys control and species specific monitoring locations would be identified.

8.1 Objectives

Monitoring would provide reliable information such that sound conclusions can be drawn in relation to the management of threatened rainforest communities and plants within the project. Monitoring would be undertaken during the pre, during and post-construction until monitoring indicates that the system has stabilised or such time as the management measures have proven to be effective for three consecutive monitoring periods. The overall monitoring objectives include evaluating the success of the mitigation measures and to further understand the propagation and translocation requirements of individual threatened rainforest plants.

8.2 Threatened rainforest plants

8.2.1 Monitoring goals

- At least 90 per cent of retained in-situ threated rainforest plants have survived during construction and for three consecutive monitoring periods post-construction and 80 per cent survived after five years, especially for trees, shrubs and large vines.

8.2.2 Selection of monitoring locations

Monitoring would be undertaken for threatened rainforest plants remaining *in situ* within the project and at control sites to evaluate the success of mitigation measures. The number and location of sites would be determined during the baseline surveys and reported in the first monitoring report. These locations would depend on property access. Where the same plant species occurs at greater than 20 metres from the project, this would be considered a control site.

8.2.3 Timing and methods

Monitoring of retained *in situ* threatened plants would be undertaken biannually (in autumn and spring) during construction and post-construction until the mitigation measures have been proven successful over three monitoring periods. A particular focus of the monitoring would be to identify any changes in plant health and condition which require management actions for remediation.

Following this period a review of the monitoring would be undertaken to identify if further monitoring is required.

Monitoring would include the documentation of the following information, as a minimum:

Identification

- Genus, species and subspecies and number of individuals.
- Identifier – unique plant number.
- Location – location; easting, northing & description.

Plant condition

- General condition – score on a scale of 0 to 5, where 0 is dead and 5 would be excellent.
- Leaf condition – healthy/unhealthy, colour, vigour.
- Flower/fruit – flower/fruit presence.
- Length of new shoots – average length of new shoots (estimate) and abundance of new shoots (counts or basic scale).
- Disease symptoms – evidence of disease (including presence / absence of Myrtle Rust, Cinnamon Fungus).
- Recruitment.
- Evidence of any other damage or disturbance.

Species may differ in resilience, longevity and sensitivity to disturbance. Plant health may seasonally fluctuate in its natural environment depending on the species (e.g. shade loving species would need more attention to buffering disturbances, particularly in the understorey). These factors would need to be considered when monitoring decline thresholds over any given monitoring event and a valid comparison to control sites would be useful.

Suitable control sites would be identified during the targeted surveys for the *in situ* threatened rainforest plants as discussed previously. Baseline data would also be collected at these control sites as part of the targeted surveys.

Control sites would comprise areas of threatened rainforest plants that are remote from the impacts associated with the project. Control sites should be located in relatively natural habitats with limited disturbance and threatening processes. Suitable locations may comprise known threatened rainforest flora outside of the edge affected area which would be generally > 20 metres from the road corridor.

The purpose of a control site is to monitor natural variation within populations and habitats which are not attributable to the impacts associated with the project. This natural variation may be from prevailing climatic conditions such as droughts and floods, widespread insect attack (i.e. dieback from insect attack) and other natural phenomena. Control sites provide a basis for determining if the source of potential impact to a threatened plant are from the project or due natural events unrelated to the project.

A summary of the *in situ* threatened rainforest plant monitoring data collected, as well as, an assessment of the effectiveness of protective measures and recommendations would be included in the annual monitoring report.

8.3 Rainforest communities

Monitoring of the Lowland and Littoral rainforest communities would be done in Section 10 of the project and focus on patches within 50 metres of the project where access is achievable. The monitoring would include an assessment of habitat condition within remnant patches. Control sites would also be selected to monitor natural variation within the habitat condition which are not attributable to the impacts associated with the project. The number and location of sites would be determined in the baseline surveys and reported in the first monitoring report.

8.3.1 Monitoring goals

- No increase in weed cover from baseline conditions in remnant rainforest communities adjoin the project.

8.3.2 Habitat condition assessment

Condition assessment would be undertaken for the remaining patches of Lowland and Littoral rainforest within and directly adjacent to Section 10 of the project, and at control sites to evaluate the success of the mitigation measures.

8.3.3 Methods and timing

The method would follow a Before-After-Control-Impact (BACI) study to compare pre-construction data with construction and post-construction data at impact sites (within 50 metres of the construction edge) and control sites in other Lowland Rainforest patches outside of the potential edge affected areas (control sites) subject to property access.

The baseline survey should ideally be conducted over two seasons (autumn and spring) to sample variation in the community. Biannual monitoring (autumn and spring) of remnant rainforest patches would be undertaken using a condition assessment that evaluates potential impacts by assessing cover of native vegetation and weeds. Following selection of monitoring sites as discussed above, a cluster of permanent monitoring plots (20 m x 20 m) would be established at each site, with the number of plots dependent on the size of the site area. The following would be recorded in each plot:

- Native plant species richness.
- Native over storey cover.
- Native mid-storey cover.
- Native ground cover (grasses).
- Native ground cover (shrubs).
- Native ground cover (other).
- Recruitment of canopy and mid-story species.
- Exotic plant cover, abundance and composition.
- Climatic events (e.g. drought, flood, unusually cold winter temperatures etc.).
- Maintenance carried out – when and what kind of maintenance carried out at the site since the last monitoring.

Monitoring of remnant areas would commence pre-construction and then occur biannually (in spring/summer) for a period of five years or until success of weed management has been achieved against performance criteria. The Geographic coordinates of plot locations are to be recorded and a photograph taken of the centre of the plot from the south east corner.

8.4 Revegetation areas

A landscape management plan would be prepared that deals with landscaping across all areas of the project. This section deals with habitat revegetation near rainforest remnants and adjacent to known populations of the targeted species, where these have been disturbance during construction. The number and location of sites would be determined post-construction and follow with revegetation activities.

8.4.1 Monitoring goal

- Not more than 10% weed coverage in revegetation areas over 5 years.

8.4.2 Timing and methods

Annual monitoring of revegetated areas would be undertaken using a condition assessment that evaluates the progress of revegetation by assessing cover of native vegetation and weeds and plant health. Following selection of monitoring sites, a cluster of permanent monitoring plots (20 m x 20 m) would be established in revegetation areas, with the number of plots dependent on the size of the site area. The following would be recorded in each plot:

- Native plant species richness.
- Native over storey cover.
- Native mid-storey cover.

- Native ground cover (grasses).
- Native ground cover (shrubs).
- Native ground cover (other).
- Exotic plant cover.

Monitoring of revegetation areas would commence 12 months after initial establishment and would occur annually (in spring/summer) for a period of five years or until success of the revegetation has been achieved against performance criteria. The Geographic coordinates of plot locations are to be recorded and a photograph taken of the centre of the plot from the south east corner.

8.5 Translocation areas

Monitoring to be undertaken for the translocated threatened rainforest plants would be detailed in the site specific management plan prepared for each offset/translocation site..

8.6 Performance measures and corrective actions

Performance thresholds and corrective actions for threatened rainforest plants are outlined below:

Performance thresholds	Corrective actions
At least 90 per cent of retained *in-situ* threated plants have survived during construction and for three consecutive monitoring periods post-construction and 80 per cent survived after five years.	Review mitigation measures used to protect retained *in situ* threatened plants if a decline in plant health has been observed during construction to identify threats. Review the weed schedule and update as required. Propagate stored seed and replace threatened plants. Review water quality and modify water controls as required. If a decline in plant health has been observed during operation review for potential threats and implement corrective actions and additional monitoring as necessary.
No increase is weed cover from baseline conditions in remnant rainforest communities adjoin the project	Review and update maintenance methods as required. Identify any other potential threats and implement corrective actions as required. Review water quality and modify water controls as required. Ongoing monitoring and maintenance undertaken until plant health and/or ecological condition of habitat has been maintained over five years.
Not more than 10% weed coverage in revegetation areas of 5 years	Review weed maintenance program and update as required.

The above performance and corrective actions would be reviewed and updated following the targeted surveys and development of the translocation strategy.

8.7 Evaluation, project review and reporting

8.7.1 Responsibility

The contractor employed to undertake the Lowland Rainforest, Littoral Rainforest and threatened plants monitoring for each component would be responsible for reporting and evaluating the monitoring information collected.

8.7.2 Timing

A brief annual report would be prepared by the contractor for distribution to the Roads and Maritime and other relevant government agencies (DP&I, OEH and DSEWPaC). This reporting would document the methods and results of each monitoring event (up to date) and a discussion relating the current year's results of monitoring to the result s of the previous year.

A final report would be prepared at the conclusion of the monitoring program. This report would incorporate all the methods and results of the monitoring and recommend any provisional measures (if deemed necessary) to facilitate the long-term survival of the threatened rainforest plants and rainforest communities within the project.

8.7.3 Adaptive management

There would be potential for natural variation in threatened rainforest communities and plants for a range of reasons. Further monitoring/assessment would be undertaken if a substantial decline of population numbers has been identified as being attributable to the construction and/or operation of the project. The monitoring/assessment would identify the cause of the decline and/or remedial actions to be commenced as necessary, taking into account potential causes such as dry seasons, population fluctuations and other natural variation. The monitoring/assessment would be dependent upon the monitoring already conducted prior to the decline being noted. Any contingency measures to be implemented would be agreed to by the relevant regulatory authorities (DoPI, OEH and SEWPaC) prior to being commenced. The following provides an indicative adaptive management strategy.

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9. Summary table and implementation schedule

Table 8.1 provides an overall summary of the actions proposed in the above plan. It also identifies the person responsible for the actions and the estimated timing of the project.

The program schedule would be updating following a review of the approval and project timelines.

- **Table 8-1: Summary table and implementation schedule of management plan.**

No.	Task	Responsibility	Pre-construction	Construction	Operational				
					Year 1	Year 2	Year 3	Year 4	Year 5
1.	Pre-construction management								
1.1	Undertake targeted surveys	Ecologist and design team	X						
1.2	Develop the revegetation plan, translocation strategy & weed management plan	Ecologist	X						
1.3	Initiate seed collection and propagation cutting collection	Ecologist	X						
1.5	Pre-clearing surveys	Contractor	X						
1.6	Identification of exclusions zones	Contractor	X	X					
2.	Construction management								
2.1	Contractor work method statements and induction	Roads and Maritime		X					
2.2	Clearing protocol	Contractor		X					
2.4	Implement translocation strategy	Contractor		X					
2.5	Implement weed and pathogen management plan	Contractor		X	X	X	X	X	X
2.6	Implement revegetation plan early if possible	Contractor		X					
2.7	Monitor exclusion zones	Contractor		X					
2.8	Removal of exclusion zones	Contractor		X					
2.9	Management of water quality	Contractor		X	X	X	X	X	X
2.10	Dust minimisation	Contractor		X					
3. Operational management									
3.1	Maintenance of dissected rainforest patches	Contractor			X	X	X	X	X
3.2	EPBC Offsets	Ecologist			X	X	X	X	X
3.3	Maintenance of revegetated areas	Contractor			X	X	X	X	X
3.4	Maintenance of plants in-situ, translocated or revegetated individuals	Contractor			X	X	X	X	X
3.5	Weed and pathogen management	Contractor			X	X	X	X	X
4. Monitoring program									
4.1	Habitat condition assessment	Ecologist	X	X	X	X	X	X	X
4.2	Plant health monitoring	Ecologist		X	X	X	X	X	X
4.3	Offset and revegetation monitoring programs	Ecologist		X	X	X	X	X	X
4.4	Evaluation and reporting	Ecologist	X	X	X	X	X	X	X

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Appendix A – Dr A. Benwell CV

CURRICULUM VITAE

Name: Andrew Samuel Benwell

Date of Birth: 11.1.55

Residential Address: 3 Short Street New Brighton NSW 2483

Postal Address: PO Box 641 Mullumbimby NSW 2482

Telephone: 0266 804817 **Email:** andrewbenwell@bigpond.com

Qualifications

Diploma of Horticulture
Victorian College of Agriculture and Horticulture, Burnley 1978

Bachelor of Arts with Honours (Biogeography)
Department of Geography and Planning, University of New England 1995

Doctor of Philosophy (Plant Ecology)
University of New England 2004

Selected Project Experience

Translocation Plan for threatened and rare flora on the Tintenbar to Ewingsdale Upgrade of the Pacific Highway, plan implementation and monitoring, for NSW Roads and Maritime Services. 2011-2013

Rainforest restoration plan and implementation for six hectares of lowland subtropical rainforest on the Tintenbar to Ewingsdale threatened flora translocation site, for Roads and Maritime Services. 2011-2013

Tree hollow survey, nest box plan, installation and monitoring, for the Tintenbar to Ewingsdale Upgrade of the Pacific Hwy, for Roads and Maritime Services. 2011-2013

Seed collection for the Mt Annan Botanical Gardens seedbank project. 2011-2013

Banora Point Upgrade Ecological Monitoring Program (Bush Hen, Microchiropteran Bats, Mitchells Rainforest Snail, Threatened Plant Species, EECs), for the Banora Point Upgrade Alliance and Roads and Maritime. 2011-2013.

Vegetation investigations and expert witness for Tweed Shire Council in the matter of Gales Holdings vs Tweed Shire Council in the NSW Supreme Court. 2011.

Impact Minimisation Strategy for threatened flora on the Tintenbar to Ewingsdale Upgrade of the Pacific Highway, the NSW Roads and Maritime Services. 2011

Monitoring of Plant Species Composition in Burnt and Unburnt Frontal Dune Vegetation in Bundjalung National Park during Aerial and Ground Spraying of Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) 2002-2011. Reports to the NSW National Parks and Wildlife Service. 2002-2011.

Translocation Plan for *Arthraxon hispidus* on the Tintenbar to Ewingsdale Upgrade of the Pacific Highway, report to the RTA. 2010.

Monitoring and research on the threatened species *Euphrasia sp. aff bella* at The Pinnacle, Border Ranges National Park, for Department of Environment Climate Change and Water. 2010-3

Preparation of Research, Management and Translocation Proposal for *Arthraxon hispidus* (Hairy Joint Grass) and implementation of the translocation, for the Ballina Bypass Alliance. 2009-2010

Translocation Plan, implementation and monitoring for the threatened species Rough-shelled Bush Nut (*Macadamia tetraphylla*), Arrow-head Vine (*Tinospora tinosporoides*) and Ball Nut (*Floydia praealta*), for the Ballina Bypass Allliance. 2009-2010

Cutting collection and propagation of the endangered plant Spiny Gardenia (Randia moorei) for the Hinze Dam project and Gold Coast City Council 2008-2010.

Hutley Road EIS – Vegetation Survey. Report to SMEC Australia. 2009

Mitigation Strategy for the Threatened Species *Arthraxon hispidus* (Hairy Joint Grass) on the Tintenbar to Ewingsdale Upgrade of the Pacific Highway. Report to the RTA. 2009

Osprey monitoring, weed management planning and landscaping advice on the Bonville Deviation Project, for Abigroup/Bilfinger Berger Australia. 2009

Pre-clearing Flora Survey, Weed Management Strategy, Targeted Bush Hen Survey and Ecological Monitoring Strategy - Banora Point Upgrade of the Pacific Highway, for the Banora Point Upgrade Alliance. 2009.

Translocation of Threatened Plant Species for the Ballina Bypass Project: Monitoring Report 1. Report to the Ballina Bypass Alliance. 2009

Targeted survey for threatened flora, assessment of translocation feasibility, Salvage Translocation Plan and management strategy for in situ threatened flora on the Sapphire to Woolgoolga Upgrade of the Pacific Highway, Report to the RTA. 2009

Maintenance, rehabilitation and monitoring of threatened species translocation areas for the Brunswick Heads to Yelgun Upgrade of the Pacific Highway, for the RTA. 2005-9

Environmental Audit of vegetation reinstatement at ten environmentally sensitive locations on the Southern Regional Water Pipeline between Ipswich and the Gold Coast. Report to the Southern Regional Water Pipeline Alliance. 2008

Vegetation Map and Flora Survey of the Nature Conservation Trust property at Banyabba north of Grafton. Report to the Nature Conservation Trust. 2008

Preparation of Seven-part Tests and Translocation Plans for Spiny Desmodium (*Desmodium acanthocladum*), Fragrant Myrtle (*Austromyrtus fragrantissima*) and Rough-shelled Bush Nut (*Macadamia tetraphylla*) in relation to proposed bridge reconstruction works in the Lismore City Council area. Reports to Lismore City Council. 2008.

Maintenance, rehabilitation and monitoring of three threatened species translocation areas for the Bonville Bypass project, for Abigroup Contractors P/L. 2006-8

Investigation of the condition of vegetation communities and the tolerance of plant species to variation in groundwater and soil chemistry at the tunnel section of the Tugun Bypass in NSW. Report to the Pacific Link Alliance. 2007

Tugun Bypass Translocation Project for Threatened and Rare Plants: Monitoring Report 1. Report to the Pacific Link Alliance. 2007

Targeted surveys for the rare forest ecosystems Craven Grey Box and Grey Box-Grey Gum for the Department of Environment and Conservation. 2007

Flora survey, Translocation Plan and plan implementation, for the Bonville Upgrade of the Pacific Highway, for Abigroup Contractors P/L. 2007-6

Translocation of the Great Barred Frog (*Mixophyes iteratus*) from Pine Creek on the Bonville Upgrade of the Pacific Highway, for Abigroup Contractors P/L. 2007.

Targeted Vegetation Survey of Floodplains and Lower Slopes on the
Far North Coast – 120 full floristic plots, data analysis and interpretation, and report review for DEC 2008-2006

Botanical survey, revegetation planning and seed collection for the South East regional water pipeline (Ipswich to the Gold Coast), for Southern Regional Water Pipeline Alliance 2007-2006

Plan of Management for Habitat Compensation Blocks A & E Cobaki Broadwater, co-authored with Ben Lewis, for the Tugun Bypass Alliance. 2007.

Flora and fauna survey and assessment report on proposed compensatory habitat lands for the Bonville Bypass project, for the RTA. 2007

Translocation Plan for Threatened and Rare Flora for the Tugun Bypass Project and implementation of works, Pacific Link Alliance. 2006

Vegetation Issues On Two Route Options Involving The Summerland Way (Grafton to Casino) And Connection Back To The Pacific Highway (Casino-Lismore-Byron Bay). Report to the NSW Roads and Traffic Authority. 2006

Monitoring of Roadside Threatened and Rare Plants on the Brunswick Heads to Yelgun Pacific Highway Upgrade, for Abigroup Contractors P/L. 2006

Vegetation Survey and Management Recommendations for Upgrade of Water Mains Supply Brunswick Heads, for Rous Water. 2006

Ecos Environmental P/L (2006). Vegetation Survey of the Preferred Route for The Upgrade of the Pacific Highway Between Sapphire to Woolgoolga. Report to Connell Wagner P/L.

Vegetation survey of the Tarong Energy Corp site at Glen Wilga, Chinchilla, for Parsons Brinckerhoff Australia. 2005

Vegetation survey of the Tarong Energy Corp ash dam extension site at Nanango, for Parsons Brinckerhoff Australia. 2005

Peer Review of Phase 1 & 2 of the Woodburn to Ballina Upgrade of the Pacific Highway, for Hyder Consulting, on behalf of the Roads and Traffic Authority. 2005.

Vegetation Management Plan for the Tugun Bypass project, for the Pacific Link Alliance (SMEC and Abigroup). 2005

Rainforest restoration on two compensatory habitat sites for the Brunswick Heads to Yelgun highway upgrade, for the Roads and Traffic Authority. 2005

Translocation Plan for Threatened Plants on the Alstonville Bypass, for the Roads and Traffic Authority. 2005.

Monitoring of Translocated and Roadside Threatened Species on the Yelgun to Chinderah Highway Upgrade (Year 4), for Abigroup Contractors P/L 2005.

Toowoomba City Remnant Vegetation Survey, for Toowoomba City Council. 2005-2004

Botanical survey and vegetation map of the Redland Bay South Development Site, for the Australian Koala Foundation on behalf of Redland Bay Southpark Corporation Pty Ltd and Medallist Development Pty Ltd. 2004.

Translocation Plan for threatened flora on the Brunswick Heads to Yelgun Pacific Highway Upgrade and implementation of works, for the Roads & Traffic Authority. 2005-2004

Management Plan for the threatened grass *Arthraxon hispidus* at Koala Beach Estate, Tweed Shire, and plan implementation, for the Australian Koala Foundation on behalf of the Ray Group P/L. 2005-2000.

Vegetation mapping and botanical surveys of the Tugun Bypass route, Gold Coast, for Parsons Brinckerhoff Australia Pty Ltd, Brisbane. 2004-2.

Management Plan for the endangered Smooth Davidsonia on a proposed rural tourist facility at 904 The Pocket Road, Byron Shire, for Pocket Mountain Retreat Pty Ltd. 2004.

Vegetation Rehabilitation Plan, advice and supervision of works at Emigrant Creek Dam, for Rous Water 2004.

Monitoring and analysis of the distribution of the endangered Square-stemmed Spike Rush, for the NSW Department of Environment and Conservation 2004-2000.

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Design of monitoring program and collection of baseline data for the 'Brunswick Saltmarsh Monitoring Program', for Sinclair Knight Merz and the RTA. 2001

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Appendix B – Dr A. Benwell- expert review

6/9/2013

WOOLGOOLGA TO BALLINA PACIFIC HIGHWAY UPGRADE

RAINFOREST COMMUNITIES AND THREATENED RAINFOREST PLANTS MANAGEMENT PLAN Version 3.0 August 2013.

Prepared by: NSW Roads and Maritime Services, Aurecon and Sinclair Knight Merz

Reviewed by: Dr Andrew Benwell (ECOS Environmental Pty Ltd)

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
1	Not included	Glossary of terms – e.g goal, objective, in-situ, direct impact, indirect impact, translocation, revegetation, threatened species, performance threshold, offset, project boundary, receival site, donor site etc. *Recommendation*: include a glossary of terms at the front of the RCTRPMP
2	1.2 Purpose and objectives	This section doesn't describe the purpose and objectives of the plan. The dot points give the contents of the plan (?) *Recommendation:* state the purpose and objectives
3	Table 3-2	Davidsonia johnsonii – "Each individual has several sucker stems" (not roots) Streblus pendulinus syn. S. brunonianus is not a threatened species. As the description says, it occurs throughout coastal regions of NSW and Qld. Syzygium hodgkinsoniae – 2nd dot point – is found on alluvial, basaltic and metasediment based soils. *Recommendation:* Get confirmation from the Royal Botanical Gardens National Herbarium in Sydney that *Streblus pendulinus* is synonymous with *S. brunonianus* and therefore *S. pendulinus* is not a threatened species.
4	4 Potential impacts and management approach	1st paragraph, 2nd line – communities and plant species, with reference….
5	4.2.1 Direct Impacts (to rainforest communities) and Table 4-1	In section 2.1, the first two paragraphs, the plan says that Lowland Rainforest EEC under the TSC Act is synonymous with Lowland Rainforest EEC under the EPBC Act, and the same for Littoral Rainforest. I don't see why then lowland rainforest patches 4-7 in Table 4-1 are only protected under the TSC Act – see p. 12, Table 4-1.
6	Table 4-2	Suggest title be changed to Direct and indirect impacts to threatened rainforest flora

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		Take out Streblus
7	4.5 Mitigation and monitoring	2nd paragraph refers to "individual threatened species management plans". There doesn't to be any more information on these in this plan. Where do they fit into the framework? Should there be more information on their general contents for the overarching MP? 4th paragraph refers to running translocation trials. I can't see how time would permit running a translocation trial – it would take at least a couple of years to run and evaluate. The purpose of the feasibility assessment is to decide, based on available information, whether a species could be translocated with a reasonable chance of success.
8	4.5 Mitigation and monitoring	4th paragraph, 1st sentence states that translocation is not a mitigation measure. I have included my comment and recommendation from the review of non-rainforest plants here - Reading the agency comments, DSEWPAC and EPA also have this view, but not DoPI. The ANPC (2004) guidelines describe different forms of ameliorative translocation. My personnel view is that when conducted for development, translocation is a mitigation measure, although not an offset. Approaching translocation as a form of offset is problematic, because the results of a translocation cannot be predicted with confidence, particularly over the long-term, as discussed in the WC2U RCTRPMP. Some threatened flora translocations have been relatively successful in the short-term, but many have failed or the outcome is uncertain. Most threatened flora translocations are essentially experimental. Often failures are due to problems with implementation that can be corrected or trialled again using a different method, hence the importance of monitoring and documentation of methods and results. The reviewer agrees with DSEWPAC that a translocation proposal is best considered as part of a larger offsets strategy for threatened flora that includes direct offsets. Roads and Maritime has taken this approach on previous Pacific Hwy upgrade projects such as BH2Y, Tugun and Bonville, where both compensatory habitat containing threatened species and translocation contributed to the offset package. *Recommendations*: • Include a discussion of the purpose and potential benefits (and risks) of translocation in the context of direct impact and loss of threatened species individuals (see WC2U TFMP). • Translocation would not be factored into offset formulae. • Translocation receival sites would be located outside the project boundary, in disturbed sections of offset land. • Translocation would be conducted to prevent declines in population numbers of threatened species in the vicinity of W2B upgrade (note – without translocation in some form there would be a net loss of individuals due to the project). • The introduction of threatened species to receival sites (i.e. translocation) would be designed in a comparative experimental fashion to learn more about species ecology and translocation technology.
9	Table 4-3	Expand the title to make it clearer what this table refers to. There are 3 or 4 tables further on in the MP that contain the same mitigation measures as this table. All this duplication becomes confusing, particularly when there are differences in wording and thresholds etc

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		for the same mitigation measure. Is there a simpler way of formulating this MP? Table 4-3 Issue – 1st issue what does 'outside the project" mean? This appears to mean outside the project boundary (ie. on private property)? Or does it mean outside the construction footprint but inside the project boundary? These terms need to be defined in the glossary of terms and consistently applied thoughout the plan. Or is "outside" a typo and it should say inside the project (ie project boundary) during construction – that context would make more sense to me. Mitigation measure (2nd column), 1st Mitigation measure – Isnt the mitigation here Confirmation of what individuals are to be removed (ie. those within the construction zone) and what individuals are to be retained in situ within the project boundary. This is determined by targeted survey and the pre-clearing survey.
10	Table 4-3	If the 1st issue is about "Accidental impact to threatened rainforest plants outside the project during construction" then doesn't the table also need as issues - (i) direct loss of threatened flora and rainforest due to clearing and (ii) indirect impact to in situ threatened flora and rainforest retained in situ within the road reserve/project boundary, outside the construction zone? *Recommendation:* Include the above as issues.
11	Table 4-3	Revegetation issue p. 17. Mitigation – recommend NOT planned and implemented in the context of the landscape design. A Rainforest Revegetation and Habitat Maintenance Plan should be prepared for rainforest threatened flora and EEC areas within the road reserve – this should be separate from the Landscape Plan. *Recommendation*: A Rainforest Revegetation and Habitat Maintenance Plan is prepared for rainforest threatened flora and EEC areas within the road reserve, separate from the Landscape Plan.
12	4.7 Adaptive management approach	The 2nd paragraph about SMART principles needs to go in the Introduction – Section 1.
13	5.2.1 Targeted surveys Table 5-1	These species can be surveyed for all year round except for the first two, where fruits are required for positive identification of Acronychia littoralis and flowers for Acalypha eremorum. All other species are readily identifiable from their leaves.
14	Not included	What if new threatened species are found within the project boundary during targeted surveys, or significantly increased numbers of already identified species are found? Does the plan need an unforseen impacts section? I note that the Biodiversity Guidelines has an unexpected finds section but this seems to relate to the construction phase. *Recommendation:* Include an unforseen impacts section in the plan.
15		p. 21, 1st paragraph – wouldn't the targeted surveys focus on the road

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		corridor within the approved project boundary? Are these really pre-clearing surveys? Will the targeted surveys take place before submitting the EA/EIS or after?
16		p. 21, 2nd paragraph – isn't this about monitoring?
17		p. 21, 3rd paragraph – experienced botanist to do targeted surveys, not ecologist
18		p. 21, last dot point – why juvenile plants? Results have shown that the larger an individual up to maturity, the greater the survival rate when translocated. Some species are not suited to translocation (ie. transplanting from one field site to another).
19		p. 21, 4th paragraph – within 20m. As discussed for the other plan, only likely to get significant changes within the life of a 8 yr monitoring program in the first 10m.
20	Not included – introduction to the translocation strategy 5.2.2	What is translocation? Translocation is defined as the "deliberate transfer of plants or regenerative plant material from one place to another, including existing or new sites or those where the taxon is now extinct." (ANPC 2004)…..etc. Translocation is a means of maintaining or increasing the numbers of a threatened species when a direct loss occurs. Land offsets may have indirect benefits for threatened species, such as, a population may be protected that would have become degraded due to lack of restrictions on land use, or a population may increase due to habitat rehabilitation provided as part of an offset package. Without translocation (i.e. salvage transplanting and/or addition of individuals by propagation/compensatory introduction) there may still be a net decline in threatened species populations due to clearing. There are different types of translocation including salvage transplanting and compensatory introduction, the two principle forms of translocation to be applied on the W2B project. *Recommendation:* Include a general discussion of translocation including its purpose and objectives, the different types of translocation, history of use, general outcomes, reasons for failure etc by way of introduction to the Translocation Strategy.
21	5.2.2 Translocation strategy	p. 21, 2nd paragraph, last sentence. Reword as "Translocation would be undertaken for species that have suitable life history and/or propagation and/or transplanting traits, where the feasibility assessment concludes that translocation has a reasonable chance of success."
22		p. 21, dot point examples could be more relevant – the T2E and BH2Y translocation projects were for lowland rainforest species and involved significant rainforest habitat restoration components; the WC2U translocation plan is for wet sclerophyll species and there is no habitat restoration component. *Recommendation:* Include T2E and BH2Y as example rainforest translocation projects.
23	Not included	Include >Translocation Plans would generally follow the framework and issues of consideration set out in ANPC (2004) "Guidelines for the Translocation of Threatened Plants in Australia" <

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
24		p. 22 – suggest all this information be placed under 2 headings – Translocation Feasibility Assessment and Translocation, as mentioned for the first plan.
25		p. 23 – paragraph at top – see comment above. What sort of trials? How long would they take? Is this practical?
26	Issue not addressed – selection of receival sites	This important decision could be described in more detail, including how such sites are identified, when and where. When would the selection of receival sites occur? Would they be sited on offset land or other Roads and Maritime owned properties? How can receival site selection proceed in a planned and organised way? *Recommendation:* Include a section on the selection and timing of receival site selection so it isn't a rushed last minute decision.
27	Issue not addressed – management of genetic diversity	The Framework RCTRPMP does not directly address the issue of managing genetic diversity. Section 4.2.4 and 4.2.3 of the WC2U RCTRPMP provide some simple guidelines for maintaining genetic diversity. Why is it important? *Recommendation:* Include a section on indirect management of genetic diversity.
28	5.3.1 Seed collection and propagation	2nd paragraph – apart from pioneer rainforest species, rainforest seed doesn't store and should be sown straight away.
29		2nd paragraph – mentions range of rainforest species to be collected – this is very important for rainforest revegetation. Should include more general information on this and include it in the table, as it tends to get lost in the focus on threatened species.
30		Next page – no number (24), 2nd paragraph, 1st sentence. Most rainforest species are easy to germinate. They don't take several years to reach a size suitable for planting out – 1-2 yrs. Are we talking pioneer or mature-phase species?
31	Table 5-3	Seed collection – only store pioneers species. The threatened species wont store. Second dot point – 500 metres is way too far. 50m is fine. Third dot point – targeted surveys could only some indication of this for clonal species Last dot point for seed collection – secateurs for taking cuttings must be sterilised before use on each individual – carry suitable disinfectant. Seed storage – as indicated above, most rainforest seed should be cleaned and sown straight away. That's why it is probably best if the grower also does the seed collection. Most rainforest nurseries also collect their own seed. Seed propagation – don't use the bog method, the seed will rot! Rainforest species should be grown in supertubes not 120mm tubes to ensure good survival when planted out. Seedlings should be a minimum 40cm tall and well hardened off for good results.
32	Not included	Include seed propagation trials using field and nursery soil medium, as per Table 4-3 in the non-rainforest species MP. A trial comparing two

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		different types of soil medium for growing seedlings/cuttings in pots – i.e. standard commercial propagation mix and the local natural soil type – and the effect of this on survival when the seedling/cutting tubestock are introduced to the field/receival site. *Recommendation:* Include seed propagation experiment comparing the effect of propagation using field/natural soil vs nursery soil media on plant survival after introduction.
33		p. 25, 1st word. This is called Planting-out (of tubestock), not transplanting. Transplanting is when you dig a plant up in the field and move it somewhere. What about planting non-threatened rainforest plants in the road reserve as part of revegetation works around in situ/retained threatened flora?
34		p. 25, 3rd paragraph – state whatever you are trying to say more clearly.
35	Table 5-4	Table 5-4 –Cutting propagation - use a nursery specialising in the propagation of native rainforest plants from cuttings. Don't use the bog method! Grow mature-phase rainforest species in supertubes, not 120mm tubes – these are used for fast growing eucs and wattles. *Recommendation:* Edit text and other points about propagation methods,as above.
36	5.3.2 Temporary exclusion zones	1st line – "clearly identifies"…what?
37	5.3.3 Weed management – general issue not included in plan – make weed management more pro-active	Can weed management within the road reserve be made more pro-active, so weed removal is carried out throughout the road reserve? On every project I have worked on, only a minimal amount of effort has been made to remove invasive environmental weeds from the road reserve which often become a breeding ground for woody weeds in particular. A bush regenerator needs to be sub-contracted to carry out this work. The project really needs a bush regeneration team working full time on removing weeds from the in-situ threatened flora sites, revegetation areas and the road reserve generally.
38	Table 5-5	Title – **Pre-construction** mitigation measures …….
39		Missing goal – Selection of optimal translocation receival sites for threatened flora and rainforest EEC restoration finalised well before the start of translocation and road construction.
40	6. Construction management measures 6.2 Mitigation goals	2nd dot point – make a separate dot point of the second part - no loss of in-situ/retained threatened rainforest plants during construction due to direct physical damage.
41	6.3.1 Work method statements	What is a CMS?
42	6.3.3 Clearing requirements	Add dot point: All threatened plants on the edge of clearing (<5m) to chain mesh fenced.
43	6.3.5 Revegetation	2nd paragraph. Only maintenance for the first 12 months? Needs at least 3yrs in the operation phase.

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		Recommendation: Maintenance of revegetation areas to be conducted for 3-5 years.
44	Table 6-1	Title – **Construction phase** mitigation measures……
45		5th goal – the landscaping design……. Recommend that the revegetation planning not be carried out by the landscape architect but by an experienced, local bush regeneration/habitat restoration specialist. This should be the subject of a separate Rainforest Revegetation and Habitat Restoration Plan which addresses offset areas outside the project boundary as well as disturbed areas adjoining in-situ threatened flora site within the project boundary. *Recommendation:* Prepare and implement a Rainforest Revegetation and Habitat Restoration Plan
46		6th goal – dust management – tall shade cloth screening would be erected to protect low growing species close to the edge of clearing. This could also be applied to protect the newly cleared edge of rainforest until fast growing pioneer rainforest species plantings become established, particularly on the edge is on an exposed aspect – ie W, N and E.
47	Not included – temporary microclimate protection	Erect tall shade cloth screening (3m high rolls) to protect rainforest species close to the edge of clearing from over-exposure and dust, thereby minimising potential dieback. This would be applied to protect the edge of rainforest until fast growing pioneer rainforest species plantings become established, particularly where the edge is on an exposed aspect – ie W, N and E. *Recommendation:* Install tall (3-4m high rolls) shade cloth screening along the cleared edge of rainforest EEC immediately after clearing to provide microclimate protection.
48	7. Operational management measures 7.2 Mitigation goals	1st dot point – use the same thresholds as Table 6-1, second goal, column 4 – ie. <u>At least 90% have survived after the first year and 80% after five years. No mortality due to direct physical damage caused by construction activities.</u> Check thresholds for consistency 3rd dot point – 30% weed cover is too high, at least halve it. *Recommendation:* Revise thresholds as above.
49	7.3.1 Maintenance of dissected threatened species patches	Last paragraph – check wording, doesn't make sense. Again, contract an experienced, local bush regenerator/habitat restoration specialist to do this work
50	7.3.2 Revegetation areas	1st sentence – Didn't the plan talk about revegetation of offset areas earlier? If offset areas are going to be subject to a different revegetation plan then make it clearer and check report for consistency. Give these initiative separate headings to make it clearer.
51	Table 7-1	Should the title be – **Operational** phase monitoring and maintenance… Why only the first year? Maintenance of revegetation

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		areas should be continued for a minimum of 3 years. Weed control is not needed every 3 months in the first year – 2 or 3 times a year is enough. Suggest you call this a maintenance schedule – monitoring is a separate activity. The bush regeneration industry knows how to establish a rainforest based on decades of experience (although most landscape architects probably don't). Yearly monitoring is enough.
52	Not included	Maintenance of in-situ threatened flora sites is best carried out as a package including weed control and revegetation. This would be applied to a specified area surrounding each in-situ threatened flora site, and possibly important sites outside the project boundary but directly adjoining it. This work should be planned in consultation with and implemented by a bush regeneration/habitat restoration sub-contractor, rather than by the landscape architect or general weed control sub-contractor. The personnel doing this work need to be:- (i) experienced in identification of the local flora and particularly the subject threatened species, so that damage to individuals of threatened species and native species in general does not occur during maintenance activities (these plants will be monitored). (ii) experienced with using bush regeneration and planting to restore and maintain threatened flora habitat. Roads and Maritime has not developed standard weed management procedures that are implemented during construction as part of FFMP and targeted to in-situ threatened flora. *Recommendation*: Maintenance of in-situ threatened flora sites, which would involve weed removal and revegetation if required, be conducted as a package and implemented by a bush regenerator with local experience, rather than by the landscape architect or general weed control contractor.
53	Issue not addressed	Clearing/tub grinder mulch applied in revegetation areas adjoining threatened species has the potential to interfere with native species regeneration and encourage weed growth and pathogens. There should be more information available about how recent projects have managed this issue and what the outcomes were – e.g. the Glenugie Upgrade and Devils Pulpit. *Recommendation:* Tub-grinder mulch not spread around in-situ threatened flora sites.
54	7.4 Performance thresholds and corrective actions	1st dots point: At least 90% have survived after the first year and 80% after five years. No mortality due to direct physical damage caused by construction activities. As above, be consistent throughout plan. 2nd dot point – why cant weed management be more pro-active than just maintaining current conditions? What if the rainforest is initially infested with young Camphor Laurel which if left would over run the rainforest? The goal should be to reduce weed cover, preferably to zero where practical. 3rd dot point - 30% weeds too high, at least halve it.
55	Table 7-2	Title – **Operational** phase mitigation measures…….
56	8. Monitoring program General comment	My first reaction to the introduction to Section 8 was that there is too much monitoring. The monitoring program comes across as a research style activity, but it's about something that has already been

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		researched in detail. We already what the impacts of edge effects are on rainforest and how to mitigate them. The monitoring program needs to be kept relatively simple so that resources that should go into the actual revegetation and maintenance work are not splurged on monitoring of mitigation measures that we already know work, if properly implemented. What is proposed is a bit like monitoring the construction of a bridge. We already know how to build the bridge so why would you need a BACI monitoring program to study if the construction methods work?. What is needed is a comprehensive, best-practice revegetation and maintenance plan and a checking procedure to see it is implemented properly to a certain standard.
57	8.2 Threatened rainforest plants 6.1.2 (?) Monitoring goals	As already commented, this threshold is not consistent with above and is too low. If only 60% of in-situ threatened plants have survived construction after five years, then at this rate of attrition you could assume that all would have after 12 yrs. I have suggested 80% survival above, but ever that is probably too low. The project should be able to achieve at least 80% survival for woody perennial plants – trees, shrubs, large vines. Shade requiring understorey species are more sensitive to disturbance. A one size fits all approach to threatened flora management is probably not appropriate – species specific thresholds would be better. I made a similar comment for the non-threatened rainforest plants.
58	6.1.4 Timing and methods	How is the monitoring data for in-situ threatened plants to be collected? Will the data be collected using transects/quadrats/line intercepts/individual plants? At what intervals will the data be collected? By what criteria will it be determined if the “mitigation measures have proven successful” – 2nd line. *Recommendation:* Shouldn’t the above points be established in the over-arching MP?
59	8.3 Rainforest communities 8.3.3 Methods and timing	Is the 20 x 20m plot a good design for studying edge effects? It is known that disturbance effects increase the closer you go to the edge of clearing. A sampling design that can pick up this level of detail would be much better than one big plot where all the detail is lumped together. *Recommendation:* Use the line intercept method rather than 20m x 20m quadrats/ plots to assess performance measures and monitor edge effects on in-situ stands of rainforest EEC. The line intercept method to consist of a 20m line laid out parallel with and at increasing distance from the cleared edge – suitable intervals would be 2m, 6m and 12m (from the edge of clearing). Divide each line into 2m long segments to provide ‘samples’ for statistical description and inference testing.
60	8.4 Revegetation areas	Last sentence – “The number and location of sites…..” doesn’t make sense – ie Revegetation areas will be determined following completion of revegetation activities?

Point No.	Section/Table Number	Comment (Note - some comments have a *Recommendation*, although all points are recommended for inclusion in the plan.)
		A Rainforest Revegetation and Habitat Maintenance Plan should be prepared for rainforest threatened flora/EEC areas within the road reserve – this should be separate from the Landscape Plan.
61	8.4.1 Monitoring goal	"10%" I agree with the goal, but everywhere else its says "30%
62	8.4.2 Timing and methods	"cluster of permanent monitoring plots at each site" I doubt if this will be practical. Is the road reserve going to be wide enough? Roads and Maritime will likely minimise the width of the road reserve. As commented above, are 20 x 20m quadrats the best design for monitoring edge effects?
63	8.6 Performance measures	Table - As commented above, only 60% survival of in-situ rainforest plants after 5 yrs suggests all will be dead in 12 years…?
64	8.7 Evaluation, project review and reporting 8.7.2 Timing	Each annual report should provide a description of the project methods and results up to that date and a discussion relating results to previous years. Leaving it to the final report in 5-8 years, much of it will be forgotten! *Recommendation:* Each annual report to provide a description of the project methods and results up to that date and a discussion relating the current year's results to previous years results.
65	Issue not addressed	What about a section on Topsoil Salvage and Re-use for Revegetation? Using topsoil seed bank salvaged from weed free areas of forest is potentially a far more effective method of revegetating disturbed areas and controlling weed invasion. There are major ecological and cost advantages to this widely used approach compared with hydromulching using commercially sourced native seed, tubestocking and uncoordinated use of salvaged topsoil. *Recommendation*: Incorporate the use of salvaged topsoil seedbank in the revegetation of disturbed areas around in-situ threatened flora sites and in general landscaping.
66	Introduction	*Recommendation:* Prepare a flow diagram of the 'Rainforest Communities And Threatened Rainforest Plants Management Plan' including the main actions required at each stage of implementation, ie. pre-construction, construction and post-construction.

Appendix C – Species profiles

Acalypha (*Acalypha eremorum*)

Source: BAAM

DESCRIPTION

Acalypha is an open-branched twiggy-looking shrub 2 – 4 m tall. The branches have conspicuous raised spots and often bear spines at the tips. The rounded, almost stalkless leaves are 0.3 – 3.5 cm long, with blunt teeth and five to seven veins on each side of the midrib. They are paler below and when young may be softly hairy. In drought the plant is often completely leafless. Tiny male and female flowers occur separately but on the same plant. The fruits are globular, though somewhat flattened, capsules about 3 mm in diameter.

LEGISLATIVE STATUS

TSC Act: ENDANGERED.

DISTRIBUTION

Though widespread and moderately common in south-east Queensland, in NSW it occurs in only a few localities, including the Chaelundi, Lismore and Burringbar areas.

HABITAT

Subtropical rainforest, dry rainforest and vine thickets.

THREATS

- Browsing and trampling by cattle.
- Fire.
- Clearing of habitat.
- Weed infestation, particularly by Lantana.
- Trampling by visitors.

White Lace Flower

(*Archidendron hendersonii*)

Source: BAAM

DESCRIPTION

White Lace Flower is a tree to 18 m tall, with light-brown bark. Its leaves are divided twice, into glossy hairless leaflets separated unequally by the midvein. Up to ten fragrant, fluffy creamy-white flowers are bunched in heads. Woody orange pods develop, splitting and curling to reveal glossy black seeds displayed against the red or yellow interior of the pod.

LEGISLATIVE STATUS

TSC Act: VULNERABLE.

DISTRIBUTION

From north Queensland south to the Richmond River in north-east NSW. It is found on a variety of soils including coastal sands and those derived from basalt and metasediments.

HABITAT

Riverine and lowland subtropical rainforest and littoral rainforests.

THREATS

- Loss of habitat through clearing and fragmentation.
- Habitat degradation through weed invasion and disturbance.
- Illegal collection of seeds for horticulture.
- Current or potential future land management practices do not support conservation
- Coastal locations are likely to be exposed to saltwater intrusion, and increased intensity of storms/winds Browsing and trampling by cattle.

Needle-leaf Fern

(*Belvisia mucronata*)

Source: BAAM

DESCRIPTION

This fern has an underground stem that is densely covered with dark coloured scales. Fronds are up to 45 cm long, with a 1-5 cm stem. There are two different forms of fronds; those with and those without spores. Fronds with spores have a long (10-25 cm) tail-like tip section which contains the plant's reproductive spores on the lower side.

LEGISLATIVE STATUS

TSC Act: ENDANGERED.

DISTRIBUTION

In Australia, this species is restricted to Queensland and NSW. In NSW, it is known from only five locations on the far north coast, north from Evans Head.

HABITAT

- Forms small clumps on trees or rocks in dry rainforest or along creeks in moist open forest.
- Occurs in low numbers at all sites Riverine and lowland subtropical rainforest and littoral rainforests.

THREATS

- Fire.
- Forestry activities.
- Risk of local extinction due to low numbers.
- Weed invasion, particularly Lantana.

Stinking Cryptocarya

(*Cryptocarya foetida*)

Source: BAAM

DESCRIPTION

Stinking Cryptocarya is a small to medium-sized tree growing to 20 m tall, with a dark green crown, and brown, slightly fissured bark. The leaves are oval-shaped with a bluntly pointed tip, 5 – 12 cm long and 2 – 6 cm wide, dark green on the upper surface and paler below. The main leaf vein is prominent, yellow and characteristically crooked. The species is named from the offensive odour of the small creamy flowers, which are borne in small clusters. The purplish to black, fleshy, globular fruits are about 1 cm in diameter, and enclose a single round seed.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

Coastal south-east Queensland and north-east NSW south to Iluka.

HABITAT

- Found in littoral rainforest, usually on sandy soils, but mature trees are also known on basalt soils.
- The seeds are readily dispersed by fruit-eating birds, and seedlings and saplings have been recorded from other habitats where they are unlikely to develop to maturity.
- Though seedlings can be fairly numerous, few mature trees are known.

THREATS

- Risk of local extinction because populations are small.
- Clearing and fragmentation of habitat for coastal development, agriculture and roadworks.
- Infestation of habitat by weeds.
- Trampling by visitors when accessing beach areas through littoral rainforest.
- Fire.

Smooth Davidson's Plum

(*Davidsonia johnsonii*)

Source: http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10209

DESCRIPTION

Smooth Davidson's Plum is a bushy, well-branched tree 5 – 12 m tall, with a dense crown. The smooth, glossy leaves are large and divided into 7 - 9 toothed leaflets. Small, pinkish flowers are borne in loose clusters. The plum-like fruits are prized bush food.

LEGISLATIVE STATUS

TSC Act: ENDANGERED; EPBC Act: ENDANGERED.

DISTRIBUTION

Restricted distribution in south-east Queensland and north-east NSW south to Tintenbar.

HABITAT

- Lowland subtropical rainforest and wet eucalypt forest at low altitudes (below 300m).
- Many trees are isolated in paddocks and on roadsides in cleared landForms small clumps on trees or rocks in dry rainforest or along creeks in moist open forest.

THREATS

- Risk of local extinction because populations are small.
- Clearing and fragmentation of habitat.
- Infestation of habitat by introduced weeds.
- Grazing by domestic stock.
- Roadworks.
- Fire.
- Collection of fruit for bush food, and root suckers for propagation.

Rusty Rose Walnut

(*Endiandra hayesii*)

Source: BAAM

DESCRIPTION

Often a small crooked tree, but it can grow to 35 m tall. It has grey to grey-brown bark, which is smooth or slightly scaly. The dull, hairy leaves are egg-shaped and measure 6 – 12 cm long and 3 – 6 cm wide. The leaves have a closely veined appearance. Flowers are small and white to pale green, and are held in small clusters. The fleshy fruits are egg-shaped, 2.5 – 3 cm long, and purplish-black when ripe.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

A restricted distribution from Burleigh Heads in Queensland to the Richmond River in north-east NSW. It is locally abundant in some parts of its range in NSW.

HABITAT

Sheltered moist gullies in lowland subtropical and warm temperate rainforest on alluvium or basaltic soils.

THREATS

- Clearing and fragmentation of habitat for development, agriculture and road-works.
- Timber harvesting activities.
- Infestation of habitat by weeds.
- Fire.

Green-leaved Rose Walnut

(*Endiandra muelleri subsp. Bracteata)*

Source: BAAM

DESCRIPTION

A tree up to 30 m tall with brown bark, often with loose round plates. Twigs and branchlets are covered in hairs. The moderately glossy leaves are oval or drawn out towards the tips, and measure 6 – 12 cm long and 3 – 5 cm wide, with three to five pairs of side veins. Flushes of new growth are pinkish-green. Flowers are small, yellowish and hairless, and are held in small clusters. The fleshy fruits are egg-shaped, 2.5 – 3 cm long and black when ripe.

LEGISLATIVE STATUS

TSC Act: ENDANGERED

DISTRIBUTION

Occurs in Queensland and in north-east NSW south to Maclean. It is sparsely distributed within this range.

HABITAT

Subtropical rainforest or wet eucalypt forest, chiefly at lower altitudes.

THREATS

- Clearing and fragmentation of habitat for coastal development, agriculture and road-works.
- Infestation of habitat by weeds.
- Frequent fire.
- Trampling by visitors.
- Land management practices are not appropriate for conservation

Axe-breaker

(*Geijera paniculata)*

Source: BAAM

DESCRIPTION

Axe-Breaker grows from 3 to 6 m in height, and has a dense head of deep green to yellow-green foliage. As its name suggests, its timber is very hard. Its branchlets are bright green turning grey to brown, and finely wrinkled. The smooth, glossy, dark-green leaves are oval, and measure 5 – 10 cm long, are bluntly pointed at the tips, and are strongly fragrant when crushed. The leaf-stalk is about 11 mm long and deeply channelled on the upper surface. Flowers are small and white in small clusters. The dry brown fruit contain glossy black seeds. Species scientific name is now *Coatesia paniculata*

LEGISLATIVE STATUS

TSC Act: ENDANGERED

DISTRIBUTION

Moderately common in restricted habitat in Queensland between the Brisbane River and the central Queensland coast, but very rare in north-east NSW, where it is known from the Tweed, Lismore and Wardell areas.

HABITAT

Axe-Breaker is found in dry subtropical rainforest and vine scrub, often along rivers.

THREATS

- Clearing and fragmentation of habitat for development and agriculture.
- Risk of local extinction because numbers are low.
- Infestation of habitat by introduced weeds, particularly vine weeds and Lantana.
- Grazing and trampling by domestic stock.
- Fire

Rough-shelled Bush Nut

(*Macadamia tetraphylla)*

Source: BAAM

DESCRIPTION

The Rough-shelled Bush Nut is a small to medium-sized, usually densely bushy, tree growing up to 18m tall. The leaves are 7 – 25 cm long and oblong or slightly lance-shaped. The leaf-margins are toothed and prickly. Creamy pink to purplish flowers hang in long strings among the leaves. The fruit is woody brown and globular, 2 – 3 cm in diameter. The edible seeds are enclosed in a hard, wrinkled, brown shell inside a round green husk. Most commercial macadamias are hybrids of this species and the Queensland species *Macadamia integrifolia.*

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

Confined chiefly to the Richmond and Tweed Rivers in north-east NSW, extending just across the border into Queensland.

HABITAT

Found in subtropical rainforest, usually near the coast.

THREATS

- Clearing and fragmentation of habitat for coastal development, agriculture and roadworks.
- Risk of local extinction due to low numbers.
- Grazing and trampling by domestic stock..
- Fire.
- Invasion of habitat by weeds.
- Loss of local genetic strains through hybridisation with commercial varieties.

Southern Ochrosia

(*Ochrosia moorei)*

Source: BAAM

DESCRIPTION

Southern Ochrosia is a small tree, sometimes crooked with several stems, growing up to 11 m tall. The bark is very dark brown, finely wrinkled and rough. The leaves are 8 – 20 cm long, arranged in twos or threes, varying in shape but tapering to a long point at the tips and gradually narrowing at the base. They are green and shiny, paler beneath, and thin in texture. When picked, the leaf-stalk exudes a milky sap. Small white flowers are held in small clusters at the ends of branchlets. The shiny scarlet fruit is oval-shaped and 4 – 8 cm long

LEGISLATIVE STATUS

TSC Act: ENDANGERED, EPBC Act: ENDANGERED

DISTRIBUTION

Southern Ochrosia is found in north-east NSW north from the Richmond River, and in south-east Queensland. It is very sparsely distributed within this range

HABITAT

Southern Ochrosia is found in riverine and lowland subtropical rainforest.

THREATS

- Clearing and fragmentation of habitat for coastal development, agriculture and roadworks.
- Risk of local extinction because populations are small.
- Invasion of habitat by introduced weeds.
- Collection of seed for horticulture

Whalebone Tree

(*Streblus pendulinus syn. S. brunonianus)*

Source: BAAM

DESCRIPTION

The Whalebone Tree is a tree or large shrub that grows to 6 m in height. The leaves are elliptic or egg-shaped to lanceolate, usually 5–8 cm long and 1–4 cm wide, with margins that are regularly toothed. The upper surface of the leaves may be either rough or smooth, whilst the underside is always rough. Leaves are attached by a stalk (petiole) 3–8 mm long. Juvenile leaves are approximately 15 cm long, often narrow and lobed at the base. The species exudes milky white latex when damaged, or when stalks are snapped off. The species has male and female flowers produced on separate plants (dioecious). The male flowers are in catkins (cylindrical flower clusters) recorded up to 20 cm long, with individual flowers 10–50 mm long. The female flowers are solitary or few in a spike 5–10 mm long; the style and stigma lobe are slender and tapering. The fruit is fleshy, red and about 5–8 mm long.

LEGISLATIVE STATUS

EBPC: ENDANGERED

DISTRIBUTION

Occurs from Cape York Peninsula to Milton, south-east New South Wales (NSW), as well as Norfolk Island

HABITAT

The Whalebone Tree is found in warmer rainforests, chiefly along watercourses. The altitudinal range is from near sea level to 800 m above sea level. The species grows in well developed rainforest, gallery forest and drier, more seasonal rainforest (ATRP 2010).

THREATS

- Grazing pressures and associated habitat changes
- Restricted geographical distribution
- Infestation of habitat by weeds.
- Infection by parasites
- Low numbers of individuals
-

Red Lily Pilly

(*Syzygium hodgkinsoniae)*

Source: BAAM

DESCRIPTION

This is a small tree to about 11 m tall. Its paired leaves are oval shaped or slightly elongated, 8 - 15 cm long, with a short blunt point at the tips. The flowers are off-white, fluffy and honey scented, about 25 mm in diameter, and are held in clusters at the ends of stems. The fruit are 4 cm in diameter, round and bright red. A thin layer of flesh, with a distinctive smell like that of an ashtray, encloses a single large seed.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

A restricted range from the Richmond River in north-east NSW to Gympie in Queensland. Locally common in some parts of its range, but otherwise sparsely distributed.

HABITAT

Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils.

THREATS

- Clearing and fragmentation of habitat for development, agriculture, road-works and powerlines.
- Weed infestation and general degradation of rainforest habitat.
- Grazing and trampling of seedlings and saplings by domestic stock.
- Roadside slashing and mowing.
- Illegal collection for horticulture.
- Large scale, high intensity fire is likely to cause significant damage to the population

Arrow Head Vine

(*Tinospora tinosporoides)*

Source: BAAM

DESCRIPTION

Arrow-head Vine is a tall woody climber. The triangular leaves with broadly notched bases give the plant its common name, though leaf-shape varies through to oval. The leaves are thick, stiff, glossy, and are mostly 8 – 13 cm long. The leaf stalk is 5 – 12 cm long, with a swelling at each end, and a characteristic twist or angle at its junction with the stem. Male and female flowers are borne on separate plants, and are small and inconspicuous in long branched clusters. The fleshy fruits are produced in groups of three

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

North from the Richmond River in north-east NSW, where it is locally common in some parts of its range. Also recorded from a single location in south-east Queensland

HABITAT

Wetter subtropical rainforest, including littoral rainforest, on fertile, basalt-derived soils

THREATS

- Clearing and fragmentation of habitat for development, agriculture, and roading.
- Risk of local extinction because populations are small at some locations.
- Grazing and trampling by domestic stock.
- Fire.
- Invasion of habitat by introduced weeds.
- Accidental damage to plants when cutting introduced vines during bush regeneration.

Appendix D - Conditions thresholds for rainforest communities

Lowland Rainforest of Subtropical Australia (TSSC 2011)

The key diagnostic characteristics of the listed ecological community are:

- 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 (>1300mm).
- The ecological community is typically more than 2 km inland from the coast.
- The structure of the ecological community is typically a tall (20 m–30 m) closed forest, often with multiple canopy layers.
- Patches of the ecological community typically have high species richness (at least 30 woody species).

Condition thresholds:

The listed **Lowland Rainforest of Subtropical Australia** ecological community comprises those patches that meet the key diagnostic characteristics (above) and the **condition thresholds** (below).

Table D-9:Lowland Rainforest condition threshold criteria

Patch Type (evidence of remnant vegetation & regeneration status)	A Natural remnant evident by the persistence of mature residual trees from Appendix B. AND	B Some residual trees from Appendix B are present plus evidence of either; natural regeneration*1 AND/OR regeneration with active management*2 AND	C A non-remnant patch that has recovered through a) natural regeneration*1 AND/OR b) supplementary planting that has stature and quality that is reflective of the „Description" *3 AND
Patch Size (excludes buffer zone)	≥ 0.1 ha AND	≥ 1 ha AND	≥ 2 ha AND
Canopy Cover (over entire patch)*4		Emergent/canopy/subcanopy*4 cover is ≥ 70% AND	
Species Richness (over entire patch)	contains ≥ 40 native woody species*5 from Appendix A AND		contains ≥ 30 native woody species*5 from Appendix A AND
Percent of total vegetation cover that is native *6 (use sample plot)	≥70% of vegetation *6 is native		≥50% of vegetation *6 is native
Notes: *1 Evidence of natural regeneration is shown by the presence of seedlings of a range of native species that did not originate through deliberate plantings. *2 A patch that is actively managed has regular (e.g. every 1–2 years) on the ground human regenerative activity			

such as weed control or supplementary plantings.

*3 Closed canopy, 20–30 m tall, of representative species (e.g. white booyong, hoop pine, figs, brush box, yellow carabeen, red cedar, rosewood, white beech)

*4 Canopy cover (projective foliage cover) is estimated over the entire patch. When assessing the ecological community, the canopy includes the emergents and subcanopy (everything above 10 m tall). Canopy/sub-canopy includes all trees and vines (native and non-native).

*5 Woody species are trees, shrubs or vines that contain wood or wood fibres that consist mainly of hard lignified tissues. Excluded from woody species are graminoids, other herbs and non-woody vines.

*6 Total vegetation cover includes emergents/canopy/subcanopy and understorey and ground layers.

Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (TSSC 2006)

Key Diagnostic Characteristics

The key diagnostic features of the ecological community are described below to aid its identification.

- The ecological community occurs in the following IBRA bioregions: Cape York Peninsula (from Princess Charlotte Bay southwards), Wet Tropics, Central Mackay Coast, South Eastern Queensland, NSW North Coast, Sydney Basin and South East Corner.
- Patches of the ecological community occur within two kilometres of the east coast, including offshore islands, or adjacent to a large body of salt water, such as an estuary, where they are subject to maritime influence.
- The structure of the ecological community typically is a closed canopy of trees that can be interspersed with canopy gaps that are common in exposed situations or with storm events. Usually, several vegetation strata are present. However, where there is extreme exposure to salt laden winds, these strata may merge into a height continuum rather than occurring as distinct vegetation layers. The canopy forms a mosaic due to canopy regeneration, typically in the form of basal coppice following canopy decapitation due to prevailing salt laden winds and storm events. Wind sheared canopy can be present on the frontal section leading to closed secondary canopies. Emergents may be present, for example, species from the genera Araucaria (northern bioregions only), Banksia or Eucalyptus. The ground stratum of the vegetation typically is very sparse.
- The ecological community contains a range of plant life forms including trees, shrubs, vines, herbs, ferns and epiphytes. To the north, most plant species diversity is in the tree and shrub (i.e. canopy) layers rather than in lower strata. The converse generally occurs from the Sydney Basin Bioregion southwards. Feather palms, fan palms, large leaved vascular epiphytes and species that exhibit buttressing are generally rare. Ground ferns and vascular epiphytes are lower in diversity in littoral rainforests compared to most other rainforest types.
- Plants with xeromorphic and succulent features are generally more common in littoral rainforest than in hinterland rainforest types. Canopy stem sizes also tend to be smaller compared to that in hinterland rainforest. Trunks rarely host mosses though lichens are usually common.
- Whilst species can be regionally predictable, there may be considerable variation in the composition of individual stands of the ecological community within any given bioregion. Attachment A provides a list of flora species for each relevant bioregion.

Condition Thresholds

The listed Littoral Rainforest and Coastal Vine Thickets of Eastern Australia ecological community comprises those patches that meet the key diagnostic characteristics (above) and the condition thresholds presented below.

- Small patches can be resilient and viable, but the minimum size of a patch needs to be 0.1 ha; AND
- The cover of transformer weed species (as identified in Attachment A) is 70% or less. Transformer weeds are highly invasive taxa with the potential to seriously alter the structure and function of the ecological community. This threshold recognises the relative resilience and recoverability of the ecological community to invasion by weed species; AND
- The patch must have:
  - at least 25% of the native plant species diversity characteristic of this ecological community in that bioregion;

OR

  - at least 30% canopy cover of one rainforest canopy (either tree or shrub) species (Attachment A, excluding Banksia and Eucalyptus species that may be part of the ecological community).

Condition Threshold Notes

Where gaps in the canopy exist, they should be in the process of regenerating with the usual suite of rainforest gap species for the site. Where weed invasion is significant, natural regeneration of native gap species may be limited.

As species diversity diminishes from northern to southern latitudes, it is important to take into account the natural diversity of a patch in a particular bioregion when examining specific sites. For example, it is possible to find littoral rainforest stands that are dominated by single tree species or a small number of species (Miles & Kendall 2006). If such patches are in good condition, they will also be representative of the ecological community and they may also contain rainforest dependent fauna species.

The condition criteria outlined above represent the minimum level for patches to be included in the listed ecological community.