Roads & Maritime

Threatened Rainforest Communities and Rainforest Plants Management Plan

Woolgoolga to Ballina Pacific Highway upgrade

August 2015

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 (also referred to as the clearance limits)
DECCW	NSW 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)
DoE	Commonwealth Department of the Environment (previously known as the Commonwealth Department of Sustainability, Environment, Water, Population and Communities)
DP&E	NSW Department of Planning and Environment (previously known as Department of Planning and Infrastructure)
DPI	NSW 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 to, or revegetated in a new area outside the project boundary
FFMP	Flora and Fauna Management Plan
Indirect impact	An impact that causes harm outside of the construction footprint as a result of a direct impact (i.e. edge effects, erosion etc.)
In situ	Locations where threatened plant populations already exist and occur naturally in the landscape and will be retained and managed. They are within the project boundary but outside the construction footprint.
MCoA	NSW Minister's Condition of Approval
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
Offset	An offset may be an area of land that is protected and managed to improve biodiversity values or an action that compensates for adverse impacts to biodiversity. Requirements for offsets are determined using an objective assessment of predicted loss of biodiversity at the development site and expected gain in biodiversity to be achieved at the offset site.
Performance threshold	This is a prescribed outcome that should it be reached, an assessment as to why the objectives are not being met will be undertaken and then appropriate corrective actions implemented.
The Project	Refers to 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.
Receival site	This is the site where plant populations would be translocated to, or revegetated in a new area outside the project boundary.
Revegetation	The planting of native species post construction to stabilise areas and restore bushland in areas that were required to be cleared as a result of construction, but not required for ongoing highway operations.
Roads and Maritime	Roads Maritime Services
SAP	Sensitive Area Plans
SPIR	Submissions / Preferred Infrastructure Report 2013
Stochastic event	Natural phenomenon such as storms, fires, floods, droughts etc. (random event)

Term	Definition
Targeted surveys	Field surveys completed in 2014 for Sections 1 to 11 that included targeted surveys for threatened rainforest communities and rainforest plant species under the EPBC Act and TSC Act.
TEC	Threatened Ecological Community
TFMP	Threatened Flora Management Plan
TRCRPMP	Threatened Rainforest Communities and Rainforest Plants Management Plan (this plan)
Threatened species	Any organism listed as vulnerable, endangered or critically endangered under state and/or Commonwealth legislation.
TSC Act	*Threatened Species Conservation Act 1995* (New South Wales)
Translocation	Deliberate transfer of plant material from one area to another for conservation purposes
UDLP	Urban Design and Landscape Plan
W2B	Woolgoolga to Ballina Pacific Highway Upgrade
Weeds	Plants that may threaten agricultural land adjacent to the project, have detrimental effects on the natural environment or impact human health. Includes noxious weed species under the *Noxious Weeds Act 1993* as categories W1, W2, W3 or W4.

1. Introduction

1.1 Project overview

NSW Roads and Maritime Services (Roads and Maritime) has received approval for the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project (the project / the action), on the NSW North Coast. Approvals were granted under Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) on 24 June 2014 and the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 14 August 2014. The location of the project is shown in **Figure 1-1**.

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.

The project will upgrade around 155 kilometres of highway and on completion will complete the four-lane divided road program between Hexham and the NSW / Queensland border. For the purposes of the EIS the project has been divided into 11 sections as illustrated in **Figure 1-1**.

Key features of the upgrade include:

- Duplication of 155 kilometres of the Pacific Highway to a motorway standard (Class M) or arterial road (Class A), with two lanes in each direction and room to add a third lane if required in the future
- Split-level (grade-separated) interchanges at Range Road, Glenugie, Tyndale, Maclean, Yamba / Harwood, Woombah (Iluka Road), Woodburn, Broadwater and Wardell
- Bypasses of South Grafton, Ulmarra, Woodburn, Broadwater and Wardell
- About 40 bridges over rivers, creeks and floodplains, including major bridges crossing the Clarence and Richmond rivers
- Bridges over and under the highway to maintain access to local roads that cross the highway
- Access roads to maintain connections to existing local roads and properties
- Structures designed to encourage animals over and under the upgraded highway where it crosses key animal habitat and wildlife corridors
- Rest areas located at about 50 kilometre intervals at Pine Brush (Tyndale), north of Mororo Road and north of the Richmond River; and
- A heavy vehicle checking station near Halfway Creek and north of the Richmond River.

Construction and delivery of the project will be undertaken in a number of separate stages. These stages are detailed in the Staging Report prepared to satisfy NSW Government Approval – Minister's Condition of Approval (MCoA) A7.

The Project is separated into 11 Sections as outlined below:

- Section 1 – Woolgoolga to Halfway Creek
- Section 2 – Halfway Creek to Glenugie
- Section 3 – Glenugie interchange to the Tyndale interchange
- Section 4 – Tyndale interchange to the existing highway at the Maclean interchange
- Section 5 – Maclean interchange to the Iluka Road interchange at Woombah
- Section 6 – Iluka Road at Woombah to Devil's Pulpit
- Section 7 – Devils Pulpit to Trustums Hill
- Section 8 – Trustums Hill to Broadwater National Park
- Section 9 – Broadwater National Park to the Richmond River
- Section 10 – Richmond River to the interchange at Coolgardie Road
- Section 11 – Coolgardie Road to the tie-in with the Pimlico to Teven project.

The project is jointly funded by the NSW and Australian governments. Both governments have a shared commitment to finish upgrading the highway to a four-lane divided road as soon as possible. Construction timing for Stage 1 is estimated for commencement in April 2015 and completion of the entire project is planned for the end of 2020. 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 and Devils Pulpit now complete and open to traffic. Altogether, these three projects would upgrade 164 km of the Pacific Highway. The Project does include a partial upgrade of the existing dual carriageways at Halfway Creek.

For a more detailed project description (as approved in late 2014) refer to the Roads and Maritime Services Woolgoolga to Ballina Pacific Highway Upgrade Submissions/Preferred Infrastructure Report (SPIR) dated November 2013 and the Woolgoolga to Ballina Staging Report (2015).

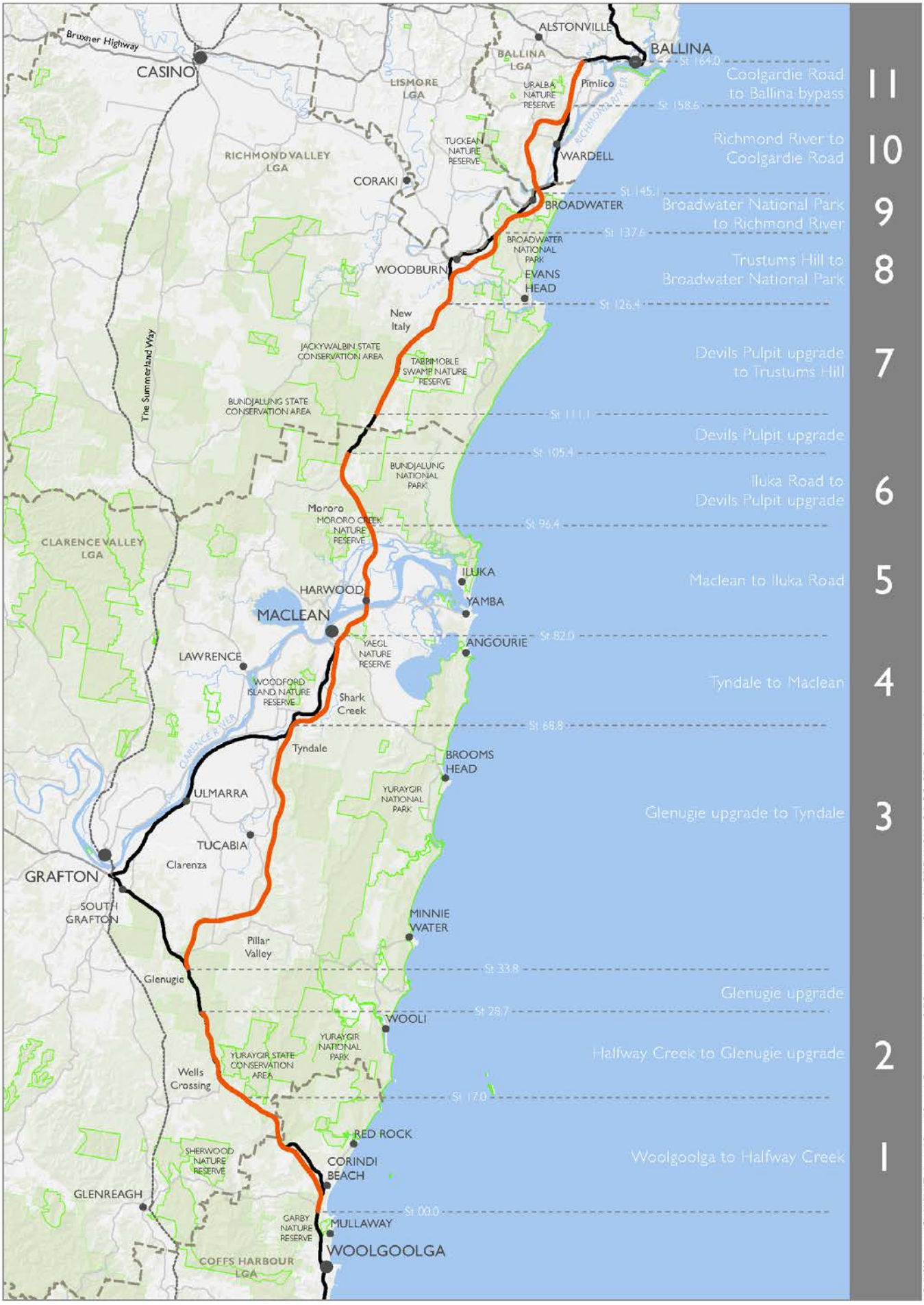


Figure 1-1 Project location and project sections

1.2 Purpose of this plan

This Threatened Rainforest Communities and Rainforest Plants Management Plan (TRCRPMP) has been developed to meet the requirements of the approval conditions detailed in **Table 1-1**.

Table 1-1 Project approval requirements and where addressed

Approval requirement		Where addressed
NSW approval		
MCoA B1	B1. The clearing of native vegetation shall be minimised with the objective of reducing impacts to any threatened species or EECs where feasible and reasonable, consistent with the following: a) clearing of native vegetation shall be limited to a total area of 931.7 hectares, within the SSI boundary defined in the document referred to in condition A2(c), subject to condition B1(b); b) clearing of native vegetation for ancillary facilities specified in the document referred to in condition A2(d) and outside the SSI boundary defined in the document referred to in condition A2(c) shall be limited to 4.75 hectares; c) clearing of threatened ecological communities shall be limited to the areas specified in Table 6-1 (under the column titled: Revised—direct impact (hectares)) of Appendix J of the document referred to in condition A2(c), subject to condition B1(d); d) clearing of the Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions shall be limited to a total area of 0.5 hectares; and e) clearing of Koala (*Phascolarctos cinereus*) primary and secondary habitat shall be limited to a total area of 375 hectares.	a) N/A b) N/A c) The extent of clearing in relation to threatened rainforest communities is detailed in Section 5.2. d) The extent of clearing in relation to threatened rainforest communities is detailed in Section 5.2. e) N/A
MCoA D8	The Applicant shall prepare and implement Threatened Species Management Plans to detail how impacts of the project (referred to as SSI) will be minimised and managed specifically for each species identified as significantly impacted in the documents listed in condition A2 or in accordance with condition D1. The Plans shall be developed from the draft Threatened Species Management Plans included in the documents listed in condition A2(c) (subject to condition D9), in consultation with OEH, DPI (Fisheries) and DoE, and to the satisfaction of the Secretary, and shall include but not necessarily be limited to: a) demonstration that adequate surveys have been undertaken to assess the impacts of the SSI with reference to the Mitigation Framework developed under condition D1, including baseline data collected from surveys, undertaken by a suitably qualified and experienced ecologist on threatened species and ecological communities within all habitat areas to be cleared of vegetation for the SSI, that are likely to contain these species and that are likely to be adversely impacted by the SSI (as determined by a suitably qualified expert). The data shall address the densities, distribution, habitat use and movement patterns of these species; b) identification of potential impacts on each species; c) details of and demonstrated effectiveness of the proposed avoidance and mitigation and management measures to be implemented for each threatened species including measures to at least maintain habitat values of habitat areas compared to baseline data and maintain connectivity for the relevant species; d) an adaptive monitoring program to assess the use of the mitigation measures identified in conditions B10 and D2. The monitoring program shall nominate appropriate and justified monitoring periods, performance parameters and criteria against which effectiveness of the mitigation measures will be measured and include operational road kill and fauna crossing surveys to assess the use of fauna crossings and exclusion fencing implemented as part of the SSI; e) monitoring methodology for threatened flora and fauna adjacent to the SSI footprint, f) goals and performance indicators to measure the success of mitigation measures, which shall be specific, measurable, achievable, realistic and timely (SMART), and be compared against baseline data; g) methodology for the ongoing monitoring of road kill, the species densities, distribution, habitat use and movement patterns, and the use of fauna crossings during construction and operation of the SSI, including the proposed timing, and duration of that monitoring; h) provision for the assessment of monitoring data to identify changes to habitat usage and whether this can be attributed to the SSI;	The requirements of this condition in the context of Rainforest Communities and threatened rainforest plants are addressed in this plan in the following sections: (a) Section 1 and 4 (b) Section 5 (c) Sections 5, 6, 7 and 8 (d) Section 9 (e) Section 9 (f) Sections 5.7 and 9 (g) N/A (h) N/A (i) N/A (j) Section 1.3 (k) Section 9 (l) Section 9.7 Expert and agency recommendations regarding the TRCRPMP are summarised and details as to how they have been addressed in this plan are provided in Appendix A.

Approval requirement		Where addressed
	i) details of contingency measures that would be implemented in the event of changes to habitat usage patterns, entities, distribution, and movement patterns attributable to the construction or operation of the SSI, based on adequate baseline data; j) mechanisms for the monitoring, review and amendment of these plans; k) provision for ongoing monitoring during operation of the SSI (for operation/ongoing impacts) until such time as the use and effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods, unless otherwise agreed by the Secretary in consultation with the OEH, DPI (Fisheries) and DoE; and l) provision for annual reporting of monitoring results to the Secretary and the OEH, DPI (Fisheries) and DoE, or as otherwise agreed by those agencies.	
Commonwealth approval		
EPBC 12	The approval holder must develop a Threatened Flora Management Plan(s) pursuant to the requirements of NSW approval condition D8 for each stage impacting on EPBC Act listed flora species. The Threatened Flora Management Plan must minimise impacts to EPBC Act listed flora species and communities to the satisfaction of the Minister and be submitted to the Minister for approval. The relevant stages cannot commence until the Threatened Flora Management Plan(s) for that stage is approved by the Minister. The approved plan(s) must be implemented.	The requirements of this condition are addressed in this plan for threatened rainforest communities and threatened rainforest plants protected under the EPBC Act. In addition threatened non-rainforest plants are addressed in a separate Threatened Flora Management Plan. Expert and agency recommendations regarding the TRCRPMP are summarised and details as to how they have been addressed in this plan are provided in Appendix A. Targeted survey reports are provided in Appendices F,G, H, I, J, K, L and M.

EPBC 14	In order to minimise impacts to threatened species and communities, and migratory species, the approval holder must develop and implement all Frameworks, Strategies, Plans or Programs, in accordance with the requirements of the following NSW approval conditions:
	a) The Mitigation Framework required by NSW approval condition D1;
	b) The Connectivity Strategy required by NSW approval condition D2 and the requirements of NSW approval condition B12;
	c) The Threatened Species Management Plans required by NSW approval condition D8 and D9;
	d) The Construction Soil and Water Quality Management Plan required by NSW approval condition D26(c);
	e) The Construction Flora and Fauna Management Plan required by NSW approval condition D26(e);
	f) The Borrow Site Management Plan required by NSW approval condition D22;
	g) The Water Quality Monitoring Program required by NSW approval condition D12; and
	h) The Ancillary Facilities Management Plan required by NSW approval condition D21.
		a) Aspects of this plan are summarised in the Mitigation Framework including targeted surveys and any changes to mitigation measures post SPIR.
		b) N/A
		c) The requirements of this condition are addressed in this plan
		d) N/A
		e) N/A
		f) N/A
		g) N/A
		h) N/A

SPIR Environmental Management Measures		
B11	The threatened species management plans prepared for the project will be finalised, as relevant to the element of the project to be constructed. Development of the plans will include responding, where feasible and reasonable to: • Recommendations from expert review undertaken as part of the Submissions / Preferred Infrastructure Report (and detailed in section 1.4 of the management plans). • Any conditions of approval.	This report forms the Threatened Rainforest Communities and Rainforest Plants Management Plan. Expert recommendations, conditions of approval and

Approval requirement		Where addressed
	• Results from baseline monitoring undertaken. The threatened species management plans will be finalised in consultation with the relevant State and Federal government agencies	baseline surveys have been considered and addressed in this plan.
B23	The pre-clearing process will be consistent with Roads and Maritime Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA projects (RTA, 2011) and include pre-clearing surveys to map the location of any threatened flora and/or fauna species, Threatened Ecological Communities and habitat.	Targeted threatened flora surveys have been completed, the surveys and findings are summarised in this plan in Section 4. Mapping is included in the technical reports in Appendices F, G, H, I, J, K, L and M. Figures identifying the most up to date location of rainforest communities and plants are also included in this plan in Section 2.
B24	The location of exclusion zones will be identified, with temporary fencing or flagging tape to indicate the limits of clearing (in accordance with Roads and Maritime Biodiversity Guidelines).	Exclusion zones and use of temporary fencing/flagging tape is described in Section 6.3.5.

This plan identifies the potential impacts of the project on the endangered Lowland Rainforest of the NSW North Coast and Sydney Basin Bioregion and endangered Littoral Rainforest in the South East Corner, Sydney Basin and NSW North Coast Bioregions under the NSW *Threatened Species Conservation Act 1995* (TSC Act).

The state listed Littoral Rainforest areas found in the project area are synonymous with the EPBC Act critically endangered Littoral Rainforest and Coastal Vine Thickets of Eastern Australia. However for the Lowland Rainforest areas only some patches in Sections 10 and 11 meet the thresholds to be classified as the EPBC Act critically endangered Lowland Rainforest of Subtropical Australia.

For the purposes of this plan these two rainforest communities will be referred to as:

- Lowland Rainforest; and
- Littoral Rainforest.

This plan also addresses threatened rainforest plants listed under the NSW TSC Act and EPBC Act which are considered to be directly impacted, or have the potential to be indirectly impacted by the project. The rainforest communities and threatened rainforest plants addressed in this plan have been confirmed to occur within the project boundary as a result of targeted flora surveys completed for Sections 1-11.

This plan does not include threatened non-rainforest plants as these species are addressed in the Threatened Flora Management Plan (TFMP). It should be noted rainforest plants detailed in this plan have also been included in the TFMP for completeness. A decision was made that the TFMP should be a comprehensive plan that covers all threatened plants in the project boundary to avoid confusion.

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

The objectives of the plan include providing:

- An effective threatened rainforest community and rainforest plants management plan in consideration of the concerns of the main stakeholders including expert and agency review
- A summary of the locations where threatened rainforest communities and plants have been confirmed to occur and extent of direct impacts as a result of the project
- Management and mitigation measures that would be implemented during pre-construction, construction and operation of the project to minimise impacts on threatened rainforest communities and plant populations; and

- A monitoring program to be implemented pre-construction, during construction and during the operation of the project to assess the effectiveness of the proposed mitigation measures and inform adaptive management.

1.3 Management structure and plan updates

1.3.1 Management structure

This plan provides a framework for those parts of the upgrade where the subject threatened rainforest communities and rainforest plant species have been identified for specific management and monitoring actions namely in Section 10 and 11. The surveys undertaken as part of developing this management plan will also help inform the Translocation Strategy required under MCoA D7 for all sections where threatened rainforest plants have been identified. Management measures for those minor areas of mapped lowland rainforest communities between Sections 1 to 3 will be addressed through the respective construction Flora and Fauna Management Plan required by MCoA D26(e).

The plan provides up-to-date information using the results of targeted surveys which have identified the occurrence of threatened rainforest communities and individual rainforest species within the project boundary. The surveys have also informed the location of mitigation measures, future monitoring sites and reporting programs.

This plan operates in conjunction with the Construction Environmental Management Plan (CEMP), project specific flora and fauna management plan (FFMP), Urban Design and Landscape Plan (UDLP) and aspects associated with updates and delivery incorporated into the Biodiversity Mitigation Framework. An overview of how this plan relates to other relevant project documentation is provided in **Figure 1-2**.

General responsibilities for environmental management would be outlined in the CEMP and FFMP. Responsibilities for implementation of this plan have been described throughout this document and are summarised in **Section 9.**

Roads and Maritime have finalised this plan in consultation with the NSW Department of Planning and Environment (DP&E), NSW Environment Protection Authority (EPA) and Commonwealth Department of Environment (DoE).

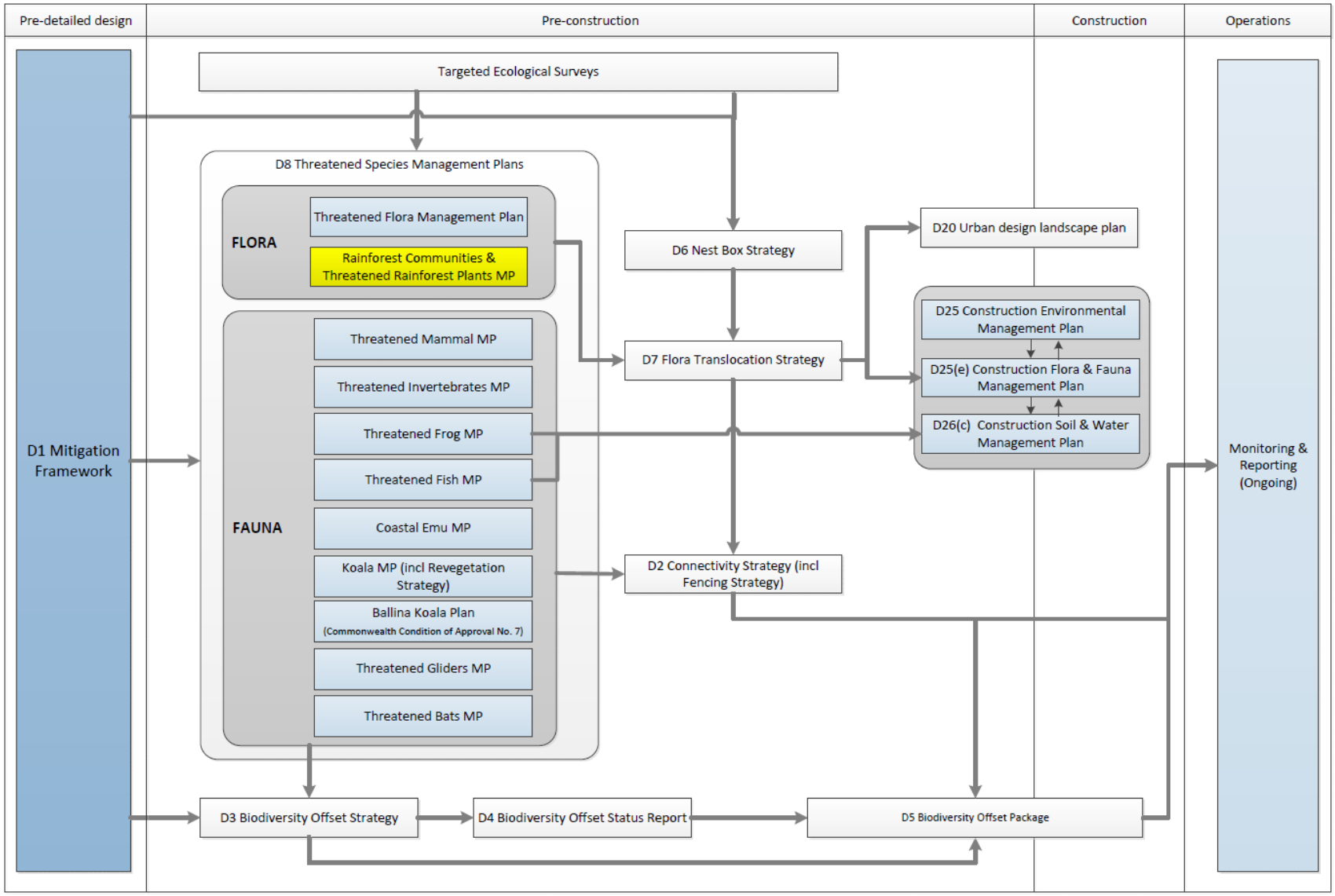


Figure 1-2 Project documentation overview

1.3.2 Plan updates

The plan is intended to be a dynamic document subject to continual improvement. This plan has been updated to ensure it incorporates the results of targeted surveys, meets the mitigation and management measures committed to in the Environmental Impact Statement (EIS) and SPIR and complies with MCoA D8. To date Roads and Maritime have updated this plan in three versions.

Version 1

The first update (Version 1 of the TRCRPMP) incorporated the majority of independent expert review and agency comments. This was completed in November 2013 and included with the submission of the SPIR documentation. The expert comments are summarised in **Appendix A**.

Version 2 and 3

Additional revisions to this TRCRPMP (Version 2 and Version 3) have been completed to incorporate the results of targeted threatened rainforest community and rainforest plant surveys undertaken between February 2014 and September 2014 and address remaining expert and agency comments. These amendments have been prepared by Amec Foster Wheeler. A summary as to how the remaining independent expert and agency administering authority comments have been addressed is detailed in **Appendix A**.

A summary of the process for updating the plan is illustrated in **Figure 1-3**.

It is noted that MCoA D8 requires the plan to be submitted and approved by the Secretary prior to commencement of construction of the relevant stages of the action, and implemented prior to commencement of construction of the relevant stages, unless otherwise agreed by the Secretary.

It is also noted any subsequent major updates to the TRCRPMP, such as incorporating any additional threatened rainforest species or increased impacts, will be submitted to the relevant agency for approval.

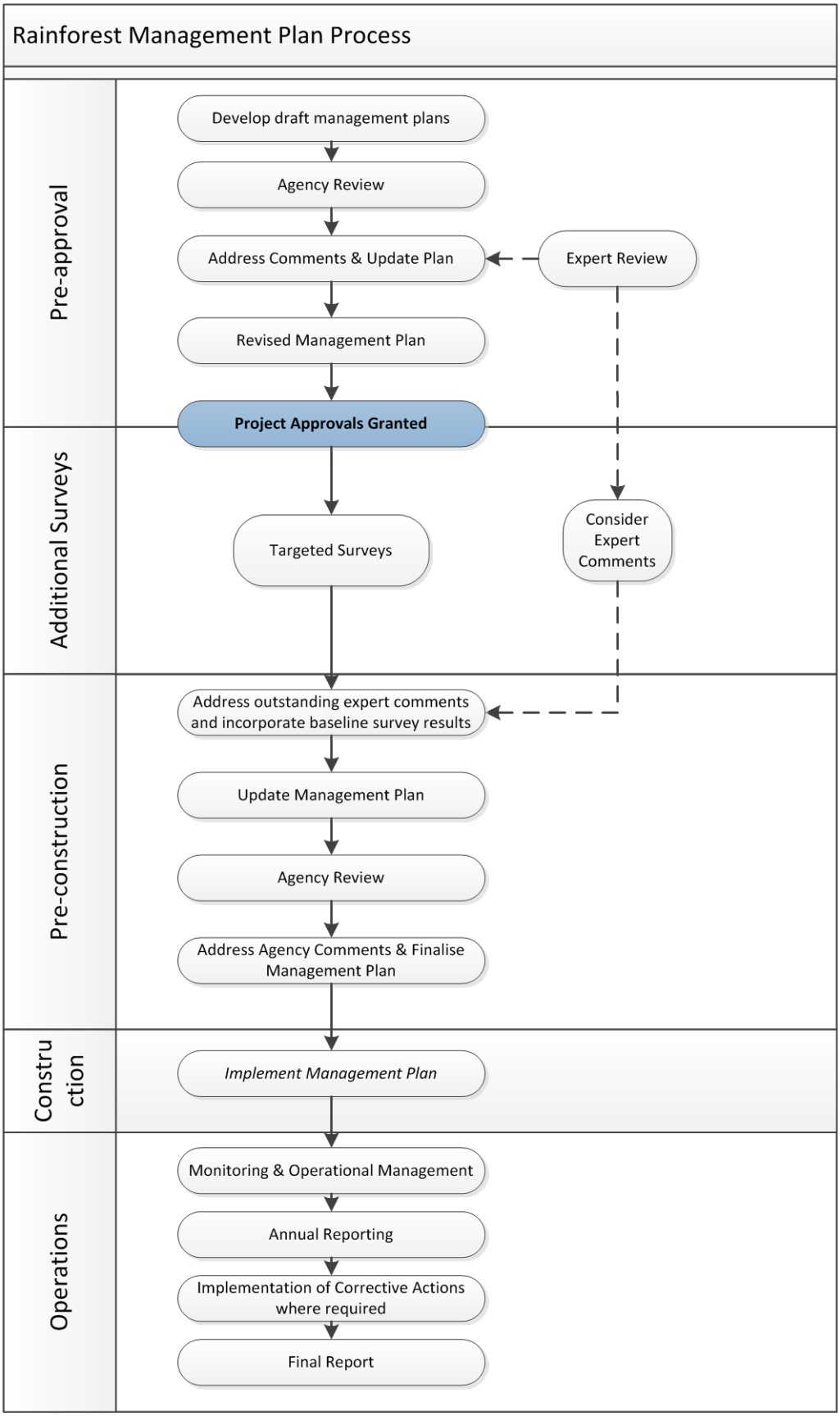


Figure 1-3 Process to develop and update management plan

1.4 Plan authors and expert review

Authors – Version 1

Version 1 of the TRCRPMP was prepared by Chris Thomson and Andrew Carty of Jacobs (previously known as Sinclair Knight Merz (SKM)), with Chris Thompson as the W2B biodiversity assessment technical lead. Flora assessments in rainforest habitat were undertaken by Lui Weber. The plan was further informed by Dr Melissa Van Zwieten of Melaleuca Group, and Mr David Fell of David Fell Environmental who provided survey data and expert assessments relating to sections of vegetation and threatened rainforest species.

Authors – Version 2

A number of vegetation surveys and targeted threatened plant surveys have been undertaken in Sections 10 and 11. Of note is that EMM were commissioned by Roads and Maritime to undertake a targeted rainforest community and rainforest plant survey of Sections 10 and 11 in February 2014. The EMM personnel involved in the field surveys and reporting are summarised in **Table 1-2**. Revisions of the TRCRPMP (Version 2 and Version 3) to incorporate the results of targeted surveys and address remaining expert and agency comments have been prepared by Bruce McLennan, Corey Callaghan and Berlinda Ezzy of Amec Foster Wheeler. Qualifications and experience of the authors involved in developing this plan are provided in **Table 1-2**.

Table 1-2 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.

Personnel	Qualifications	Experience
Berlinda Ezzy Amec Foster Wheeler	Bachelor of Applied Science, Natural Systems and Wildlife Management (Honours)	Berlinda has 14 years professional experience including working in the areas of environmental planning, impact assessments, ecology and environmental offsets. Berlinda's experience includes managing flora and fauna studies, delivering environmental offsets including application of various offset assessment tools and developing threatened species management plans. Berlinda has comprehensive knowledge and experience with State and Commonwealth legislation regarding environmental impact assessment, threatened species protection and environmental offset policies. Berlinda also has experience in natural resource management including vegetation management, fire management, weed management and monitoring.
Bruce McLennan Amec Foster Wheeler	Bachelor of Business, Rural Management, University of Queensland, Gatton, Queensland, Australia, 1982 Master of Sustainability Science, University of Southern Queensland, Toowoomba, Queensland, Australia, 2009	Bruce has over 10 years of ecology expertise complimented by an extensive history working in the rural industry. Bruce has significant experience undertaking vegetation surveys and threatened flora surveys. Having worked as a Vegetation Planning Officer with Greening Australia for a number of years, Bruce has a wide knowledge of vegetation management and rehabilitation techniques at a property scale. Bruce is also experienced in preparing vegetation management plans and translocation strategies for threatened flora species and ecological communities.
Dr Melissa Van Zwieten Melaleuca Group	Bachelor of Agricultural Science (Hons), Queensland University, 1993 PhD (Horticulture) 2000 Certificate IV Workplace Assessment and Training 2003	Melissa established Melaleuca Group in July 2008 with 8 years of experience in Environmental Consultancy. Melissa has extensive knowledge and experience in the field of environmental science, gained through a wide-range of consultancy and research projects for both private and government clients. Melissa's key projects have included flora and fauna assessments, reviews of environmental factors, vegetation and rehabilitation management plans, weed management plans, cemetery designs, assessment of environmental health indicators, impacts of imported agricultural pathogens, on-site effluent disposal assessment and contamination and acid sulfate soil assessments. In many of these projects, Melissa has assisted in developing design considerations and/or mitigation measures to ensure the best outcome for the environment. Melissa has been involved in over 30 reviews of environmental factors for a variety of bridge maintenance and road works for the RTA. These assessments have required a broad range of environmental expertise to ensure minimal environmental impacts. For example, flora and fauna impacts, proximity of watercourses, erosion and sedimentation controls, contamination issues (Lead based paints). These concerns had to be balanced by impacts on the community (e.g. noise and traffic control). In order to complete these projects, Melissa has had to gain an understanding of the works process for each individual project with regard to site specific conditions. She has recommended and had adopted variations in the works methodology incorporated into works along with assisting in detailing mitigation measures to ensure minimal environmental impact. Melissa is certified as a provisional environmental auditor with the RABQSA International. Melissa also has experience in developing and presenting training courses and facilitation of stakeholders. She has assisted in the organisation of and attended various seminars, conferences, toolbox talks and community information sessions
Mr David Fell David Fell Environmental	Associate Diploma of Applied Science, Southern Cross University, 1981	David has 27 years of experience in vegetation assessment and land resource management which has been gained throughout the tropics and subtropics of Australia and in Papua New Guinea. He is a recognised expert on the flora and vegetation ecology of Queensland and northern New South Wales and provides professional services to all levels of government, natural resource managers, industry, private landowners, indigenous and community organisations. David has conducted threatened flora surveys, vegetation mapping, habitat assessment and restoration planning projects throughout northern New South Wales and applies best practise survey methodology towards achieving optimal outcomes for clients. He has successfully delivered projects in rainforest, wet and dry sclerophyll, swamp sclerophyll, heathland, and wetland ecosystems. Project experience is summarised below. His background also includes the delivery of numerous Indigenous land resource planning and property management projects as well as invasive species management and

Personnel	Qualifications	Experience
		vegetation restoration planning and monitoring projects.
Renae Baker EMM	Bachelor of Science (Honours) Biodiversity and Conservation, Macquarie University, Sydney.	Renae has over 11 years experience across Australia, in project management and provision of flora and fauna surveys, bushfire assessment, statistical analysis and survey sampling design. Renae has completed a number of ecological surveys and impact assessments in NSW and other States including for infrastructure projects including the Hume Highway Duplication Project and Woologoolga to Ballina Pacific Highway Upgrade.
Andrew Benwell EMM	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	Andrew has 20 years of professional experience in natural ecosystem management in north-east NSW and south-east Qld. His expertise includes botanical surveys, vegetation classification and mapping, preparation of plans on vegetation rehabilitation and restoration, threatened species translocation, weed management, monitoring and research.

Expert review

An independent expert review of the plan was undertaken in August 2013 by Dr Andrew Benwell. Andrew has more than 20 years of professional experience in natural ecosystem management in north-east NSW and south-east Qld. His expertise includes botanical surveys, vegetation classification and mapping, preparation of plans on vegetation rehabilitation and restoration, threatened species translocation, weed management, monitoring and research, as well as the preparation of planning documents and providing expert advice. Andrew is the Director of Ecos Environmental Pty Ltd, which delivers a wide range of services relating to the survey and management of flora and fauna. Ecos Environmental 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.

Andrew's curriculum vitae, which details his relevant publications and work associated with threatened flora species, is provided in **Appendix B**. Andrew's recommendations have now been reviewed and assessed and, where appropriate, incorporated into the TRCRPMP. A summary of Andrew's recommendations and responses that have been incorporated into Version 2 of the TFMP is provided in **Appendix A**.

1.5 Consultation

Roads and Maritime has consulted with the NSW EPA, DP&E and the Commonwealth DoE during the development of this plan. Each agency was provided a copy of the Draft Version 2 TRCRPMP on 10 March 2015. Feedback received and Roads and Maritime response to issues raised have been included in **Appendix A** of the TRCRPMP. EPA advised on 31 March 2015 they have no further comment.

A summary of the consultation undertaken in finalising the plan is outlined in **Table 1-3**.

Table 1-3 Summary of agency consultation and how comments have been addressed

Document Version	Review Date	Summary of Comments	Section of Report Addressing Comments
NSW Department of Planning and Environment			
Version 2	March 2015	The Department notes that this version of the Plan has not been reviewed by relevant agencies. The Department will review a revised version following agency review and may have further comments at that stage.	The document has been provided to the Commonwealth DoE, NSW DP&E and EPA for review. Comments received have been incorporated and addressed as part of this final version.
		The Department notes that the Plan intends to satisfy conditions of the NSW and Commonwealth approvals. Will approvals be sought simultaneously or will one be sought first?	NSW and Commonwealth approvals of this plan will be sought simultaneously.
		The translocation of flora species for the Tintenbar to Ewingsdale project is cited as an example of successful mitigation measure. The example discusses actions which would be undertaken in 2013. This should be updated to current status (2015) of the translocation work.	Wording in Table 5.4 has been updated to reflect work that has been completed and current project timelines.
		Second paragraph – please reword the last two sentences as unclear as to what the sentences mean.	Final two sentences of second paragraph Section 6.3.3 of this report have been reworded to clarify the intended approach to translocation works.
		Condition D8(k) requires that the Plan provide for ongoing monitoring during operation for a minimum of three successive monitoring periods. Section 9 has different monitoring time period provisions for the in situ threatened plants (as per the condition), rainforest communities (no specific time periods) and habitat revegetation (three years or until success of the revegetation has been achieved against performance criteria). Please explain the inconsistencies and departures from the condition requirement.	The plan summarises monitoring that will occur during construction and then monitoring to occur during operation. Monitoring for in-situ rainforest plants and communities will be done annually during operation of the project until mitigation measures are proven effective for three consecutive monitoring periods as per Condition D8(k). Monitoring for revegetation will be monthly for year 1 (during construction), every 6 months for Years 2 and 3 and then annually. This is because revegetation has higher risk and requires more regular monitoring in the first few years of establishment. Monitoring requirements have been updated to ensure consistency between Section 8 and Section 9 and to reflect Condition D8(k).

Document Version	Review Date	Summary of Comments	Section of Report Addressing Comments
Version 2		Dr Benwell's recommendations have generally been addressed. The only notable outstanding recommendation is that a Rainforest Revegetation and Habitat Restoration Plan is prepared and implemented. RMS' response is that these provisions are better implemented in the project's Urban Design and Landscaping Plan. While the UDLP does require consideration of the location of existing vegetation and landscaping, revegetation of disturbed areas and monitoring and maintenance requirements for rehabilitated vegetation, the UDLP serves a primarily visual rather than ecological purpose. Can RMS please advise on how the ecological purpose of the Rainforest Revegetation and Habitat Restoration Plan would be captured in the UDLP and/or consult further with Dr Benwell on this?	Roads and Maritime do not consider that a separate rainforest revegetation sub-plan is required. The Urban Design and Landscape Plan (UDLP) for Section 10 and 11 will be prepared to ensure adequate detail is provided on the areas for restoration and revegetation of rainforest communities, ecological objectives and the methods to be adopted. The plan will be developed in consultation with suitably experienced ecologists to ensure the species and methods used are appropriate. This plan does include information on revegetation objectives, methods and monitoring in Sections 7.3.7, 8.3.3 and 9.4. It is acknowledged this is fairly high level information and more detail will be provided in the UDLP. The UDLP will serve as a document addressing both visual aspects of revegetation and landscaping as well as ecological function. Please note the UDLP will be submitted to DP&E for review and approval for those sections containing rainforest communities and rainforest plants. No additional consultation with Dr Benwell is considered necessary.
Commonwealth Department of the Environment			
Version 2	May 2015	The plan is required to include provision for ongoing monitoring during operation of the SSI (for operation/ongoing impacts) until such time as the use and effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods, unless otherwise agreed by the Secretary in consultation with the OEH, DPI (Fisheries) and DoE; and Table 8.3 – Operational Phase mitigation measures: The second monitoring point regarding at least 90 per cent of plants surviving, states that for the first twelve months, monitoring of vegetation will be monthly then every 6 months for 2 years. Section 9.2.2, In Situ Methods; states that monitoring will occur twice a year during construction then annually to 3 years. Please clarify if Table 8.3 covers in situ plants or translocated vegetation.	Table 8-3 addresses in situ rainforest plants and communities Section 9.2.2 has been updated to ensure that monitoring is undertaken as follows: • Every three months during the first year of construction; • Every six months during the second year of construction; and • Every 12 months thereafter for a minimum of three years post-construction (subject to achieving three consecutive monitoring periods as per MCoA D8 (k)). Following this period, a review of the monitoring would be undertaken to identify if further monitoring is required. The timing of surveys for cryptic species or species that may die back at certain times of the year due to climatic conditions will be optimised to allow the greatest chance of observing these species. All monitoring events (frequency and item) are listed in Table 10-1.

Document Version	Review Date	Summary of Comments	Section of Report Addressing Comments
2.1	May 2015	The plan is required to include details of and demonstrated effectiveness of the proposed avoidance and mitigation and management measures to be implemented for each threatened species including measures to at least maintain habitat values of habitat areas compared to baseline data and maintain connectivity for the relevant species; Details have been provided regarding avoidance, mitigation and management measures to be implemented for rainforest threatened species and communities. Effectiveness of these measures has not been demonstrated though appropriate monitoring and corrective actions have been proposed. Please provide details of and demonstrated effectiveness of the proposed avoidance, mitigation and management measures to be implemented.	Section 5.7 and Table 5-4 discuss the effectiveness of proposed mitigation measures proposed in the context of standard procedures to be applied and their effectiveness on previous projects. A range of issues have been discussed, specifically: • Accidental impacts to threatened in situ flora species • Impacts from weeds on in situ flora species • Unsuccessful revegetation • Edge effects and degradation of existing rainforest plants • Changes to hydrological and nutrient regimes • Lowering of the water table; and • Spread of pathogens. Against these issues, a range of mitigation measures have been examined assessing their history of success. The management of these issues, using the identified mitigation measures, have then been allocated an effectiveness rating ranging from low to high. Roads and Maritime consider adequate information on effectiveness of proposed avoidance, mitigation and management measures has been provided.

2. Lowland and littoral rainforest communities

2.1 Background

Lowland Rainforest of the New South Wales North Coast and Sydney Basin Bioregion is an Endangered Ecological Community in NSW, listed under the TSC Act. Assemblages of this vegetation community, where thresholds are met, are also protected under the EPBC Act, described as Lowland Rainforest of Subtropical Australia, listed as Critically Endangered under the EPBC Act. There are some areas of Lowland Rainforest in the project area (Sections 1, 2and 3) that do not meet the EPBC Act thresholds, but are threatened at the state level.

Littoral Rainforest in the South East Corner, Sydney Basin and NSW North Coast bioregions, is an Endangered Ecological Community in NSW listed under the TSC Act. This vegetation community is also described as Littoral Rainforest and Coastal Vine Thickets of Eastern Australia, listed as a Critically Endangered community under the EPBC Act. All patches of Littoral Rainforest in the project area are threatened both at the state and Commonwealth level.

These rainforest communities will be referred to as Lowland Rainforest and Littoral Rainforest and their extent in the project boundary is illustrated in **Figure 2-1**.

Lowland Rainforest occurs as tall (20 m to 30 m) 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 (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 (Scientific Committee 2004 and TSSC 2006). Condition thresholds for the rainforest communities were taken into account during targeted surveys and mapping of the extent of these threatened communities.

2.2 Existing knowledge

The threatened rainforest communities confirmed to occur in the project area, their status and locality are detailed in **Table 2-1**.

Table 2-1 Threatened rainforest ecological communities addressed in this plan

Threatened ecological community	Biometric vegetation type equivalents in the project	Status (EPBC Act)	Status (TSC Act)	Project Section
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	-	10 and 11
Lowland Rainforest in NSW North Coast and Sydney Basin Bioregions	-	-	Endangered	1, 2, 3, 10 and 11
Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	Tuckeroo - Riberry - Yellow Tulipwood littoral rainforest of the North Coast	Critically Endangered	-	10
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	-	-	Endangered	10

Both Lowland Rainforest and Littoral Rainforest communities listed under the TSC Act and EPBC Act have been confirmed and mapped within the project boundary (Sections 1, 2, 3, 10 and 11) during vegetation surveys and targeted rainforest surveys in 2014 as outlined in **Table 2-1**. The extent of these communities was indicated primarily by soil type, the presence of diagnostic canopy and understorey species and an assessment as to whether the vegetation met the required thresholds under the EPBC Act. Vegetation communities meeting the required thresholds for TECs were only identified in Section 10 and 11 as outlined in **Table 2-1** and illustrated in **Figure 2-1**. As a result of recent surveys some refinements have occurred to their extents and findings of the surveys are described in **Section 4**.

Refer to **Figure 2-1** for the locations of threatened rainforest communities in the project area.

The potential impacts to rainforest communities, as detailed in the EIS, Biodiversity working paper and also the *Supplementary Biodiversity Assessment* (Roads and Maritime 2013) have been updated in this plan as a result of additional targeted field surveys. The most up to date information on the extent of rainforest communities and potential direct and indirect impacts are described in **Section 5**.

2.3 Threats

Both rainforest 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. 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.

Weed invasion poses a major threat to Lowland Rainforest, with introduced vines and scramblers having particularly serious impacts (Floyd 1990). Many of these exotic species form dense thickets capable of smothering indigenous plants, reducing both reproduction and survival (Floyd 1990).

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. The invasion and establishment of exotic species in Lowland Rainforest results in a large reduction in the ecological function of the community. 'Invasion and establishment of exotic vines and scramblers' is listed as a Key Threatening Process under the TSC Act.

Rainforests are ‘fire excluding’ communities, which do not regenerate well from fire unlike other Australian vegetation types.

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.

ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

Figure 2.1
Rainforest Communities and Rainforest Species Records

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

LEGEND

- Chainage
- Alignment
- Watercourse
- Project Boundary
- Reserve

TCSAct EEC

- Lowland Rainforest On Floodplain In The New South Wales North Coast Bioregion

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
18/02/2015	JH	SC	BE	0	Issued for Use
30/01/2015	JH	BE	BE	A	Issued for Review

amec foster wheeler

N

0 250 500
Metres

1:27,000

(A3) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENRoads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\VegComms_RainforestSp_Mapping.mxd

ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

Figure 2.1
Rainforest Communities and Rainforest Species Records

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

LEGEND

- Chainage
- Alignment
- Watercourse
- Project Boundary
- Reserve

TCSAct EEC

- Lowland Rainforest On Floodplain In The New South Wales North Coast Bioregion

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
18/02/2015	JH	SC	BE	0	Issued for Use
30/01/2015	JH	BE	BE	A	Issued for Review

amec foster wheeler

N

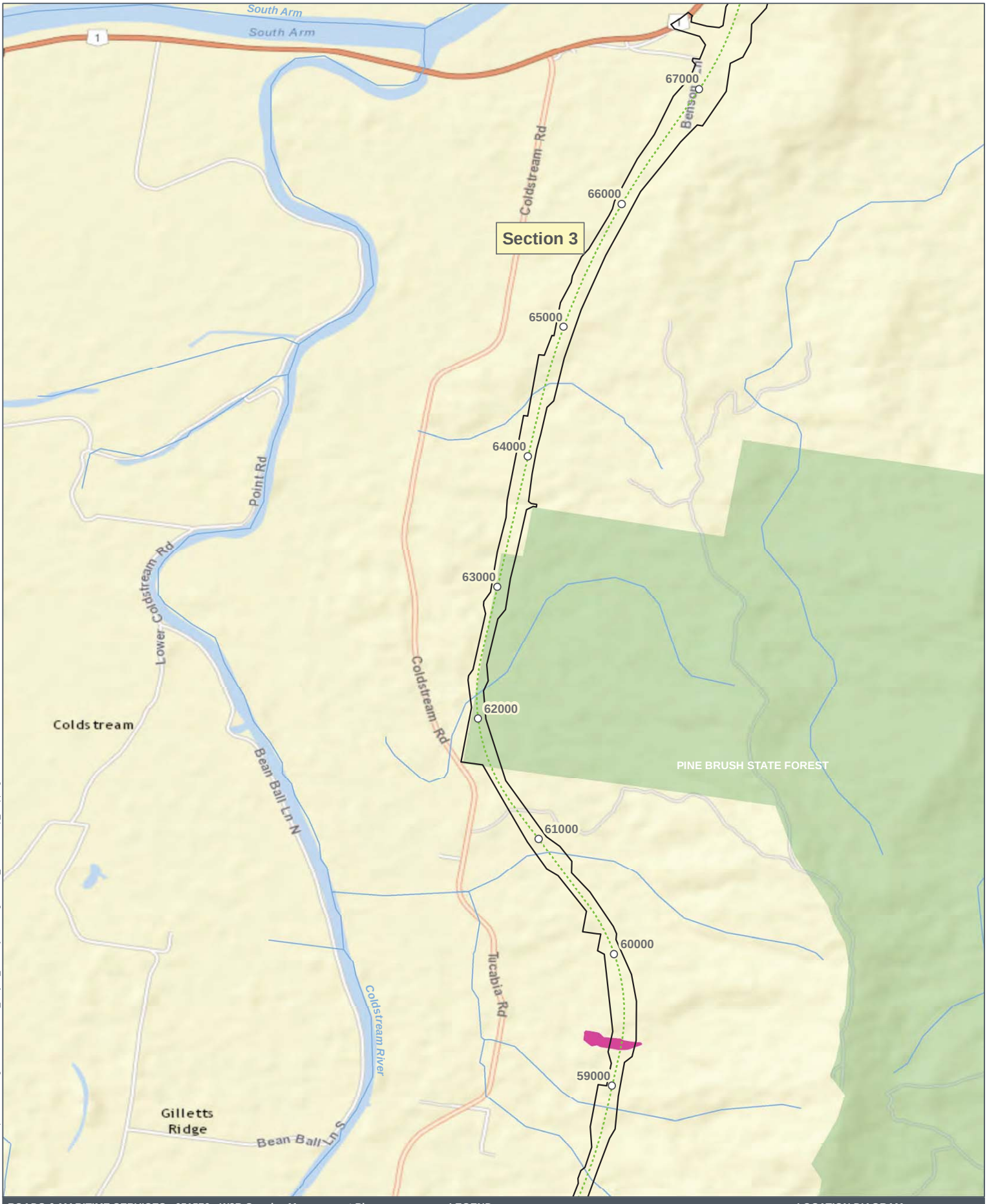
0 260 520
Metres

1:27,000

(A3) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENRoads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\VegComms_RainforestSp_Mapping.mxd



ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

Figure 2.1
Rainforest Communities and Rainforest Species Records

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

LEGEND

- Chainage
- Alignment
- Watercourse
- Project Boundary
- Reserve

TCSAct EEC

- Lowland Rainforest On Floodplain In The New South Wales North Coast Bioregion

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
18/02/2015	JH	SC	BE	0	Issued for Use
30/01/2015	JH	BE	BE	A	Issued for Review

amec foster wheeler

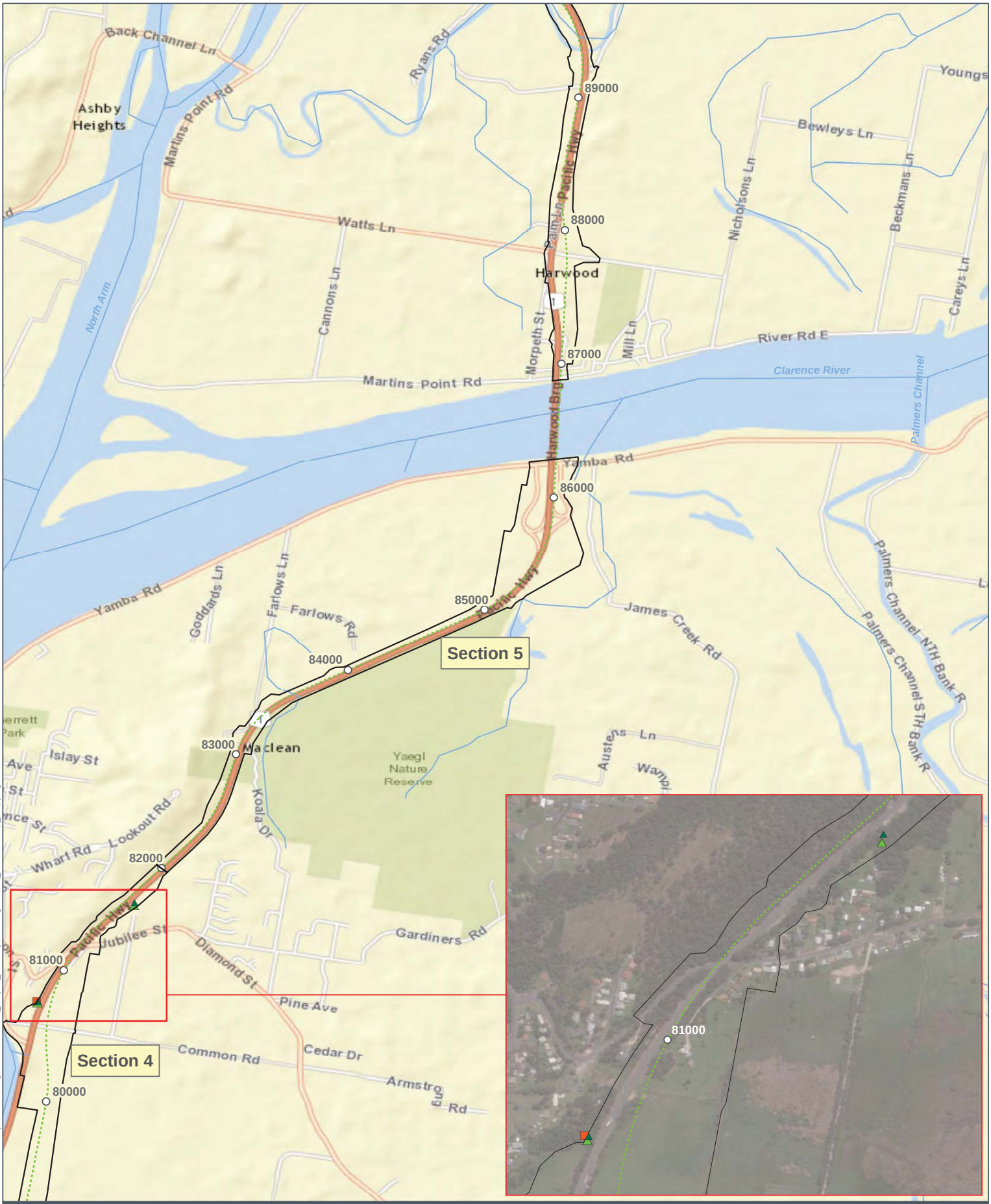
0 250 500
Metres

1:26,000

(A3) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENRoads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\VegComms_RainforestSp_Mapping.mxd



ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

Figure 2.1
Rainforest Communities and Rainforest Species Records

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

LEGEND

- Chainage
- Alignment
- Watercourse
- Project Boundary
- Reserve

Species

- ▲ *Endiandra muelleri* subsp. *bracteata*
- ▲ *Endiandra muelleri*
- ■ *Streblus pendulinus*

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
18/02/2015	JH	SC	BE	0	Issued for Use
30/01/2015	JH	BE	BE	A	Issued for Review

amec foster wheeler

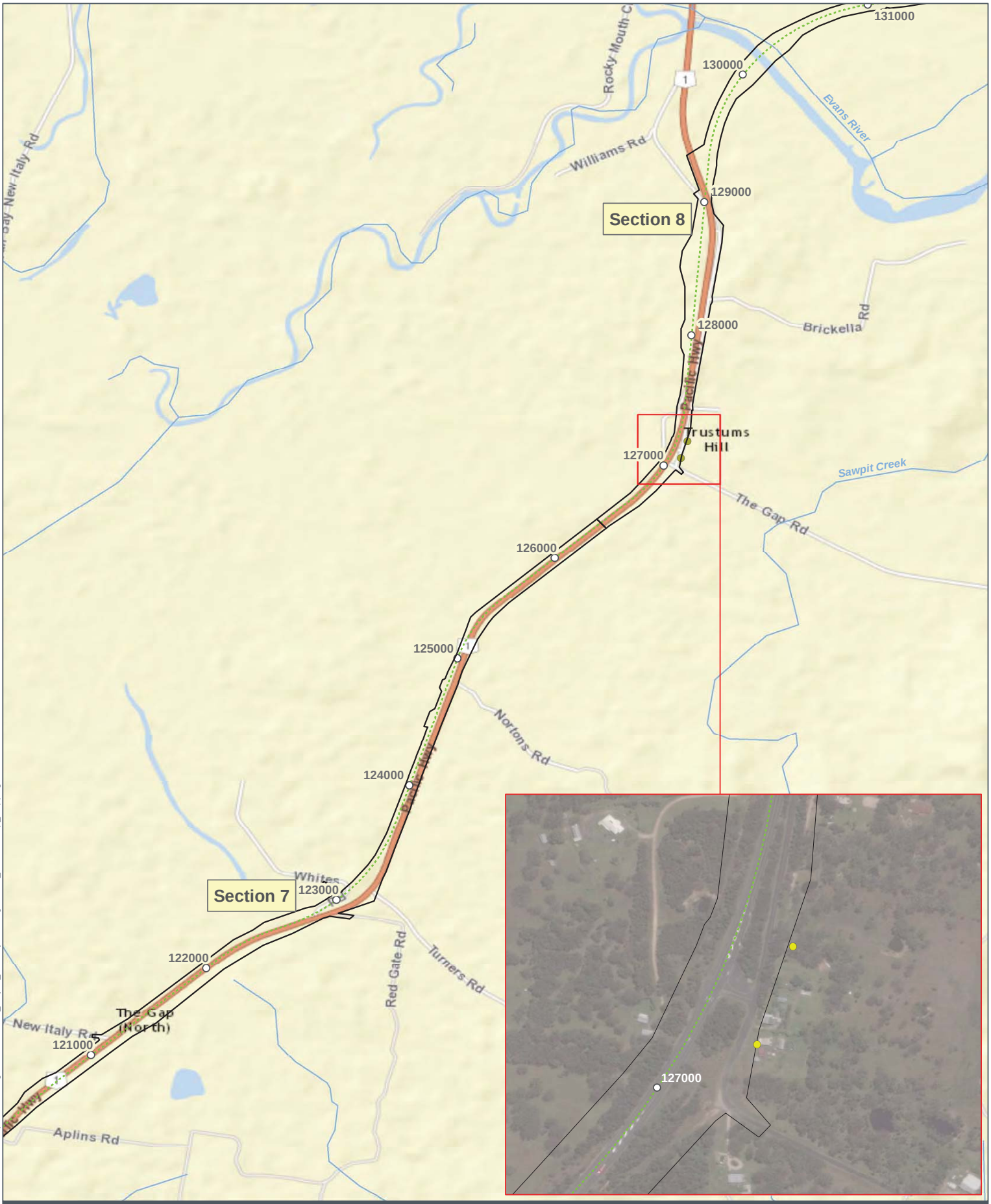
0 250 500
Metres

1:26,000

(A3) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENroads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\VegComms_RainforestSp_Mapping.mxd



ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

Figure 2.1
Rainforest Communities and Rainforest Species Records

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

LEGEND

- Chainage
- Alignment
- Watercourse
- Project Boundary
- Reserve

Species

- *Macadamia tetraphylla*

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
18/02/2015	JH	SC	BE	0	Issued for Use
30/01/2015	JH	BE	BE	A	Issued for Review

amec foster wheeler

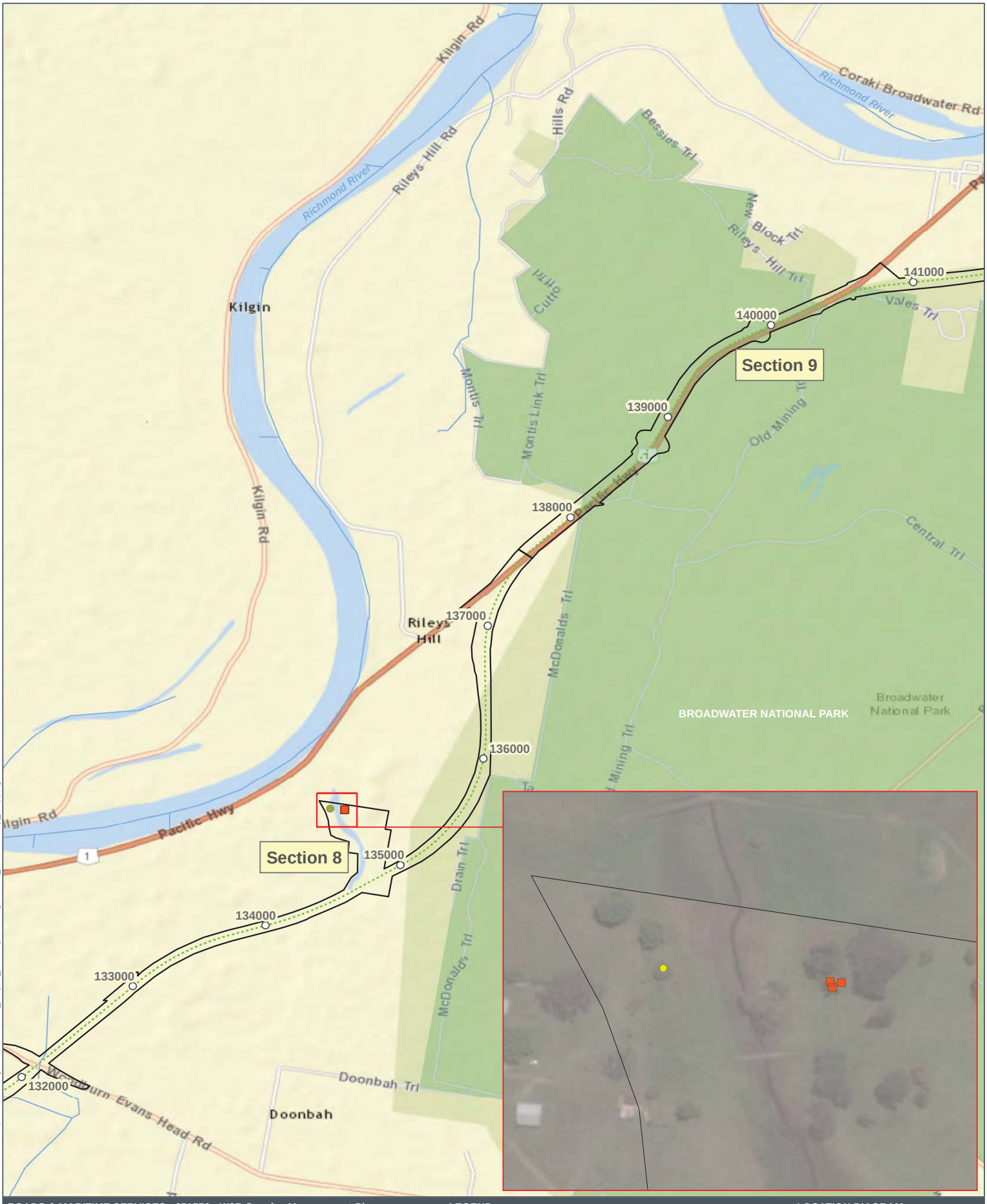
0 250 500
Metres

1:26,000

(A3) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENRoads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\VegComms_RainforestSp_Mapping.mxd



ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

Figure 2.1
Rainforest Communities and Rainforest Species Records

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

LEGEND

- Chainage
- Alignment
- Watercourse
- Project Boundary
- Reserve

Species

- *Macadamia tetraphylla*
- *Streblus pendulinus*

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
18/02/2015	JH	SC	BE	0	Issued for Use
30/01/2015	JH	BE	BE	A	Issued for Review

amec foster wheeler

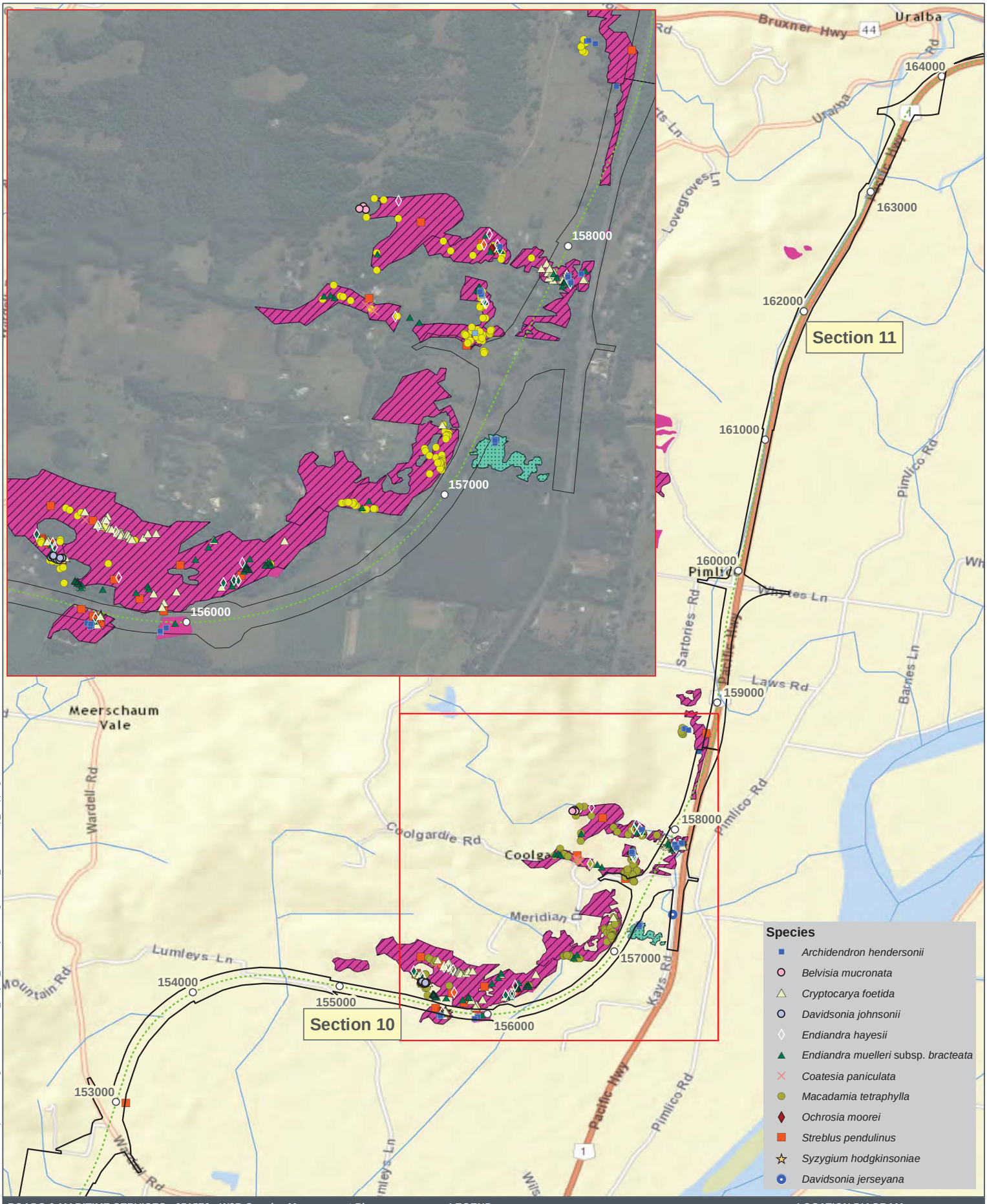
0 250 500
Metres

1:26,000

(A3) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\ENRoads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\VegComms_RainforestSp_Mapping.mxd



ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

Figure 2.1
Rainforest Communities and Rainforest Species Records

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia (Geoscience Australia) 2006

LEGEND

- Chainage
- Alignment
- Watercourse
- Project Boundary
- Reserve

TCSAct EEC

- Lowland Rainforest On Floodplain In The New South Wales North Coast Bioregion
- Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregion

EPBCAct EEC

- Littoral Rainforest and Coastal Vine Thickets of Eastern Australia
- Lowland Rainforest of Subtropical Australia

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
18/02/2015	JH	SC	BE	0	Issued for Use
30/01/2015	JH	BE	BE	A	Issued for Review

amec foster wheeler

N

0 250 500
Metres

1:26,000
(A3) GCS GDA 1994

LOCATION DIAGRAM

Path: W:\PROJECTS\Roads & Maritime Services\651570 - W2B Species Management Plans\2.0_Project_Delivery\GIS\VegComms_RainforestSp_Mapping.mxd

3. Rainforest plant species

3.1 Background

In addition to the listed threatened rainforest communities detailed above, a number of threatened rainforest plants have also been confirmed to occur within these communities and the Project area. These rainforest plant species are listed under the NSW TSC Act and Commonwealth EPBC Act. The individual rainforest flora species have been included in this plan as they predominantly occur in association with the rainforest communities. As a result these threatened rainforest plants 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.

3.2 Existing knowledge

Six threatened rainforest plant species have been confirmed as occurring within the construction footprint, or within 20 m of the construction footprint, between Sections 1 to 11. These threatened rainforest species along with their status under the EPBC Act and the TSC Act are listed in **Table 3-1**.

This plan does not cover the Carronia Vine (*Carronia multisepalea*), the host species for the listed Pink Underwing Moth (*Phyllodes imperialis*) known from the area, as it is not a threatened flora species. 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). This plant species is addressed within the Threatened Invertebrates Management Plan.

Table 3-1 Rainforest plant species confirmed as occurring within the project area

Species	Common name	Status EPBC Act	Status TSC Act
Archidendron hendersonii	White Lace Flower	-	V
Cryptocarya foetida	Stinking Cryptocarya	V	V
Endiandra muelleri subsp. *bracteata*	Green-leaved Rose Walnut	-	E
Macadamia tetraphylla	Rough-shelled Bush Nut	V	V
Streblus pendulinus syn. *S. brunonianus*	Siah's backbone	E	-
Syzygium hodgkinsoniae	Red Lily Pilly	V	V

Note: (E = endangered; V = vulnerable)

Threatened rainforest plants are predominantly component species of the Lowland and Littoral Rainforest assemblages occurring in Section 10 of the project; however, a small number have been identified within vegetation communities in Section 4 and 8 as detailed within Table 3-1. 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 rainforest plant species to be impacted by the project can be found in **Appendix C**. The location of where these species have been confirmed during recent targeted surveys within the project is shown in **Figure 2-1**. A summary of key findings to date for each species is provided in **Table 3-2**.

Table 3-2 Threatened rainforest species distribution and location within the project

Species name	Notes on distribution and abundance	Project section
Archidendron hendersonii	• This species occurs from northern Queensland south to the Richmond River in north-east NSW. The presence in Section 10 potentially represents the current southern distributional limit. • One individual was recorded within the construction footprint in Section 10, and is potentially part of a larger population occurring in rainforest habitats. Twenty-three individuals are within 20 metres of the project. • Individuals of this species have been recorded growing in Lowland Rainforest.	Section 10
Cryptocarya foetida	• It is known from Iluka in NSW to Fraser Island and east of Gympie, southern Queensland. • A total of 48 individuals have been recorded within and within 20m of the project construction footprint in Section 10. The population extends into surrounding private property. • The species has been recorded growing in Lowland Rainforest.	Section 10
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. • Previous surveys for the EIS and SPIR recorded a total of 10 individuals inside and outside of the project in Section 10. • This species was not recorded within the construction footprint or within 20 m of the construction footprint during 2014 flora surveys by EMM or Australian Museum Consulting. These subsequent surveys confirmed the species as E. pubens which is not a threatened species.	Not located within Project area
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 3 individuals within the construction footprint and 13individuals within 20 m of the project. • Three individuals were recorded within 20 m of the construction footprint in Section 4. No direct impacts to this species are anticipated within Section 4. • The species has been recorded growing in Lowland Rainforest.	Section 4 and 10
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. • A total of 10 individuals will be directly impacted by the Project. Five individuals occur within 20 m of the construction footprint. • The species has been recorded in Lowland Rainforest patches.	Section 8 and 10
Streblus pendulinus	• *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. • The species is relatively common with a wide distribution from south of Wollongong to the Queensland border. • This species is under review and is likely to be removed from its threatened status under the EPBC Act. • A total of 43 individuals have been recorded in and outside the project. Four individuals will be directly impacted by the Project and six occur within 20 m of the construction footprint. • It is likely the species occurs throughout most of the Lowland Rainforest patches and stands of swamp sclerophyll forest in the project area.	Section 4, 8 and 10
Syzygium	• 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	Section 10

Species name	Notes on distribution and abundance	Project section
hodgkinsoniae	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 alluvial and basaltic and metasediments based soils. • There are 6 records in the construction disturbance footprint and 4 individuals within 20 m of the construction footprint.. • The species has been recorded growing in Lowland Rainforest.	

3.3 Threats

Threatened rainforest 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 W2B 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.

4. Targeted surveys

Extensive vegetation surveys were completed for the project between 2006 and 2012 and a broad depth of ecological data for threatened flora contributed to the biodiversity assessments in the EIS. These surveys included seasonal targeted surveys for particular species and vegetation community mapping. A summary of the threatened flora species assessments described in the EIS and short summary of targeted surveys post EIS is provided in **Table 4-1**.

Table 4-1 Summary of threatened flora species-specific surveys included in the EIS

Project Section	Survey Period	Purpose
EIS Approvals Phase		
1-2	16-21 October 2006	• Mapping of vegetation communities
	18-24 Feb 2007	• Targeted searches for threatened flora species
	19-24 Aug 2010	• Targeted survey to map *Eucalyptus tetrapleura* distribution between Halfway Creek and Glenugie • Opportunistic observations of other threatened flora
	Nov 2011	• Re-survey of previously identified flora populations to identify any changes in distribution • Targeted searches for *Lindsaea incisa*, *Maundia triglochinoides*, and cryptic summer flowering species • Vegetation mapping in areas not previously surveyed
3-5	2-7 July 2007	• Mapping of vegetation communities
	6-11 Aug 2007	• Targeted searches for threatened flora species
	14-19 Oct 2007	• Targeted survey to map *Eucalyptus tetrapleura* distribution between Glenugie and Pillar Valley • Targeted searches to map the extent and distribution of *Angophora robur*
	23-27 Aug 2010	• Vegetation mapping of flora species on soft soil areas • Targeted searches for threatened flora species in soft soil areas • Additional flora surveys
	16-19 Nov 2010	• Targeted surveys to map the extent and distribution of *Angophora robur* from the Pillar Valley to Tyndale • Opportunistic observations of threatened flora species
	21-25 Oct 2011	• Supplementary surveys to map the extent and distribution of *Angophora robur* from Pillar Valley to Tyndale
	12-16 Dec 2011	• Re-survey of previously identified flora populations to identify any changes in distribution • Targeted searches for *Lindsaea incisa*, *Maundia triglochinoides*, and cryptic summer flowering species
6-8	May – June 2005	• Mapping of vegetation communities • Targeted searches for threatened flora
	2-7 Dec 2007	• Targeted surveys for *Melaleuca irbyana* and area of New Italy
	16-20 Jan 2012	• Re-survey of previously identified flora populations to identify any changes in distribution • Targeted searches for threatened cryptic summer flowering flora species including *Cyperus aquatilis*, *Oberonia titania*, *Lindsaea incisa*, *Arthraxon hispidus* and *Prostanthera cineolifera*
9-11	14-25 Mar 2005	• Mapping of vegetation communities • Threatened flora species surveys
	15-18 Aug 2006	• Mapping of vegetation communities
	30 Aug – 3 Sept 2010	• Mapping of vegetation communities • Threatened flora species surveys

Project Section	Survey Period	Purpose
	16-20 Jan 2012 13-16 Mar 2012	• Re-survey of previously identified flora populations to identify any changes in distribution • Targeted searches for threatened cryptic summer flowering flora species including *Cyperus aquatilis*, *Oberonia titania*, *Lindsaea incisa*, *Arthraxon hispidus* and *Prostanthera cineolifera*
Post-EIS Approvals		
1 – 11	Feb-Mar 2014 March – May 2014 July 2014	• Targeted vegetation community and threatened flora species surveys to confirm locations of previously recorded species and identify any new species • Record location and extent of threatened communities and flora species • Assess the quality of habitat for relevant EPBC Act listed flora species
10 and 11	February 2014	• Targeted rainforest community survey and rainforest plant survey • Identify suitable monitoring sites for establishment of monitoring plots.
1-11	Mar-May 2014 Sept 2014	• Targeted threatened flora surveys to confirm locations of previously recorded species and identify any new species • Record the location and extent of all threatened flora species. • Assess the quality of habitat for relevant EPBC Act listed flora species • Inform ongoing monitoring through the establishment of permanent sites for monitoring during construction and operation • As required, mark recorded threatened species to inform and develop translocation strategies

In accordance with the mitigation strategies for pre-construction management in this TRCRPMP described in **Section 6.3.1**, Roads and Maritime commissioned a number of additional pre-construction targeted threatened flora species and ecological community surveys to inform management and monitoring requirements during construction and operation of the W2B project. This information builds on that presented in the EIS and SPIR. The surveys were focussed on collecting up to date baseline information in regards to the location of threatened rainforest communities and rainforest flora populations in proximity to the project, and support the monitoring program including identification of impact and control sites.

Targeted vegetation surveys between Sections 1 to 11 that have informed this plan were completed by Jacobs, Biosis Pty Ltd, Ecosure Pty Ltd, Geolink, Melaleuca Group and Australian Museum Consulting. These surveys and key findings are summarised below.

In addition to baseline flora monitoring across the entire project area, Roads and Maritime commissioned EMM to identify suitable monitoring sites for establishment of monitoring plots and undertake a targeted rainforest plant and ecological community survey for Sections 10 and 11. This assessment aimed specifically to provide a more detailed ecological assessment of the rainforest communities and rainforest plant species prior to the commencement of construction. This survey and key findings are summarised below.

Fifteen rainforest plants were identified with the potential to occur in the project area. These species were targeted during various surveys which is summarised in **Table 4-2**.

Table 4-2 Rainforest species targeted during pre-construction surveys conducted post-EIS-approval

Species name	Targeted in Jacobs surveys, all sections	Targeted in GeoLINK surveys, Section 4	Targeted in EMM surveys, Sections 10 & 11	Targeted in Australian Museum Consulting, Sections 10 & 11
Acronychia littoralis (Scented Acronychia)	-	-	-	-
Acalypha eremorum (Acalypha)	-	-	-	-
Archidendron hendersonii (White lace flower)	-	-	Y	Y
Belvisia mucronata (Needle-leaf fern)	-	-	-	-

Species name	Targeted in Jacobs surveys, all sections	Targeted in GeoLINK surveys, Section 4	Targeted in EMM surveys, Sections 10 & 11	Targeted in Australian Museum Consulting, Sections 10 & 11
Cryptocarya foetida (Stinking Cryptocarya)	-	-	Y	Y
Davidsonia jerseyana (Davidson's Plum)	-	-	-	Y
Davidsonia johnsonii (Smooth Davidson's Plum)	-	-	Y	Y
Endiandra hayesii (Rusty Rose Walnut)	-	Y	-	Y
Endiandra muelleri subsp. *bracteata* (Green-leaved Rose Walnut)	Y	Y	Y	Y
Coatesia paniculata syn. *Geijera paniculata* (Axe-breaker)	-	-	-	Y
Macadamia tetraphylla (Rough-shelled Bush Nut)	Y	Y	Y	Y
Ochrosia moorei (Southern Ochrosia)	-	-	Y	Y
Streblus pendulinus syn. *S. brunonianus* (Siah's backbone)	Y	-	Y	Y
Syzygium hodgkinsoniae (Red Lily Pilly)	-	-	-	Y
Tinospora tinosporoides (Arrow Head Vine)	-	-	-	Y

Y = yes

- = not targeted

4.1 Targeted surveys – rainforest communities and threatened plants

4.1.1 Jacobs (all sections)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the W2B project area. These surveys were undertaken between 18 March and 7 May 2014, and 1 – 5 September 2014 with the purpose of the surveys to:

- Undertake targeted threatened flora surveys to confirm locations of previously recorded species and identify any new species
- Record the location and extent of all threatened flora species
- Assess the quality of habitat for relevant EPBC Act listed flora species
- Inform ongoing monitoring through the establishment of permanent monitoring sites including in-situ monitoring locations and control sites
- Where practical mark individual threatened plants in and adjacent to the project boundary to assist subsequent identification and management purposes.

The initial baseline monitoring surveys were completed between March and May 2014, and subsequent surveys in September 2014. The threatened species targeted in the pre-construction surveys included four rainforest species as shown in **Table 4-2**.

The surveys confirmed the presence of three threatened rainforest flora species across the project area, specifically:

- *Endiandra muelleri* subsp. *bracteata* (Green-leaved rose walnut)
  - Identified in Section 4
- *Macadamia tetraphylla* (Rough-shelled bush nut)
  - Identified in Section 8; and
- *Streblus pendulinus* (Siah's backbone)
  - Identified in Section 4 and 8.

Field surveys were conducted over a five-week period in autumn and a single week in early spring. The timing of the surveys was relatively sufficient for identifying the majority of threatened flora species in the study area.

For further detail regarding the survey and findings, including figures showing where species were recorded, refer to the technical report in **Appendix F**.

4.1.2 Biosis Pty Ltd (Section 1)

Biosis Pty Ltd was commissioned by Roads and Maritime to undertake threatened flora species surveys and assessments of Section 1 of the W2B to compliment previous surveys and information collected during preparation of the EIS. The survey area included the Section 1 project boundary and adjacent areas either side.

The objectives of the vegetation surveys were to:

- Verify the accuracy or otherwise of the vegetation community types that had been mapped within the corridor as part of the EIS;
- Undertake targeted threatened flora species surveys to confirm locations of previously recorded species and identify any new species
- Record the location and extent of threatened flora species; and
- Assess the quality of habitat for relevant EPBC Act listed flora species.

Surveys were completed between February and March 2014.

The vegetation mapping associated with the EIS was found to be consistent with the on-ground vegetation communities observed during these surveys. This included one patch of Lowland Rainforest protected at the state level which was confirmed within the study area.

No threatened rainforest plants were recorded in Section 1.

For further detail regarding the survey and findings, including figures showing where species were recorded, the technical report is provided in **Appendix G**.

4.1.3 Ecosure Pty Ltd (Section 2)

Ecosure Pty Ltd was commissioned by Roads and Maritime to undertake threatened flora species surveys and assessments of Section 2 of the W2B to compliment previous surveys and information collected during preparation of the EIS. The survey area included the Section 2 project boundary and areas either side. The purpose of the survey was to:

- Verify the accuracy or otherwise of the vegetation community types that had been mapped within the corridor as part of the EIS;
- Undertake targeted threatened flora species surveys to confirm locations of previously recorded species and identify any new species
- Record the location and extent of threatened flora species; and
- Assess the quality of habitat for relevant EPBC Act listed flora species.

Surveys were completed between March and May 2014.

One patch of Lowland Rainforest protected at the state level was confirmed within the study area. No threatened rainforest plants were identified in Section 2.

For further detail regarding the survey and findings, including figures showing where species were recorded, the technical report is provided in **Appendix H**.

4.1.4 GeoLINK (Section 3 and 4)

GeoLINK was engaged by Roads and Maritime to undertake vegetation surveys and reporting of Sections 3 and 4 of the project. The vegetation surveys and reporting included:

- Mapping of all vegetation communities within the project site
- Habitat condition assessments for each mapped vegetation community polygon
- Locating and mapping all threatened flora species; and
- Mapping and assessment of weed infestations.

Vegetation community mapping was generally in accordance with previous vegetation mapping prepared for the W2B as part of the EIS, the primary differences in mapping being refinement of the vegetation community boundaries. One patch of Lowland Rainforest protected at the state level was confirmed within the study area in Section 3. One patch around Black Snake Creek, recorded as Lowland Rainforest during the EIS, was re-classified as Subtropical Coastal Floodplain forest. Targeted surveyed determined that this community contained a high proportion of eucalypt species in the canopy strata (including Bloodwood, Brushbox and Swamp Turpentine).

One threatened rainforest flora species was detected during the field surveys:

- Green-leaved Rose Walnut (*Endiandra muelleri*).

Two individuals were confirmed north of Maclean in Section 4. For further detail regarding the survey and findings, including figures showing where species were recorded, refer to the technical report in **Appendix I** and **Appendix J**.

4.1.5 Melaleuca Group (Section 8)

Melaleuca Group was engaged by Roads and Maritime Services (RMS) to undertake vegetation surveys for Section 8 of the project. The vegetation surveys and reporting included:

- Mapping of all vegetation communities within the project site
- Habitat condition assessments for each mapped vegetation community polygon
- Locating and mapping all threatened flora species; and
- Mapping and assessment of weed infestations.

One threatened rainforest flora species was identified in the field:

- *Macadamia tetraphylla* (Rough-shelled Bush Nut)

For further detail regarding the survey and findings, including figures showing where species were recorded, refer to the technical report in **Appendix K**.

4.1.6 EMM (Sections 10 & 11)

EMM were commissioned by Roads and Maritime to conduct targeted surveys for rainforest communities and rainforest plant species in Section 10 and 11.

Field surveys for rainforest plant species were undertaken between 24 and 28 February 2014, in areas of vegetation mapped in the EIS as Lowland Rainforest and Littoral Rainforest within and up to 100 m of the project boundary in Sections 10 and 11. The purpose of the searches was to:

- Record the location and condition of threatened rainforest plants
- Ground-truth previously mapped areas of rainforest
- Tag each threatened plant with a unique identifier; and
- Identify suitable sites for establishment of monitoring plots.

Any areas of Littoral Rainforest or Lowland Rainforest that had not been mapped previously were also recorded.

The threatened species targeted in the pre-construction surveys included seven rainforest species. The surveys confirmed the presence of eight threatened rainforest flora species within Sections 10 and 11 both inside and outside the project boundary, specifically:

- *Archidendron hendersonii* (White Lace Flower)
- *Cryptocarya foetida* (Stinking Cryptocarya)
- *Davidsonia johnsonii* (Smooth Davidson's plum)
- *Endiandra muelleri* subsp. *Bracteata* (Green-leaved rose walnut)
- *Macadamia tetraphylla* (Rough-shelled bush nut)
- *Ochrosia moorei* (Southern Ochrosia)
- *Streblus pendulinus* (Siah's backbone or Whalebone Tree); and
- *Syzygium hodgkinsoniae* (Red Lilly Pilly).

Whalebone Tree was recorded in abundance in all areas of rainforest during the surveys. Given the numbers observed, a decision was made in the field not to record or tag each individual plant. Instead, the habitat of Whalebone Tree within Sections 10 and 11 was mapped along with individual records recorded during plot monitoring for this study, and for the EIS, and the number of trees within the project area was extrapolated from the plot data. A limitation of extrapolation is that areas that could be prohibitive to the species, such as dense thickets of exotic species are not considered and therefore occurrences of the species can be overestimated. Species identifications were difficult for four species; *Endiandra hayesii / muelleri subsp. bracteata* and *Acronychia littoralis / wilcoxiana*. Specimens of these species were collected for formal identification by herbaria.

EMM confirmed the rainforest communities as depicted in the EIS and identified a new small patch of Littoral Rainforest in Section 10.

For further detail regarding the survey and findings, including figures showing where species were recorded, refer to the technical report in **Appendix L**.

4.1.7 Australian Museum Consulting (Sections 10 & 11)

Australian Museum Consulting were commissioned by Roads and Maritime to undertake pre-construction vegetation surveys within Sections 10 and 11 of the W2B upgrade. Vegetation surveys were undertaken from 7 to 18 July 2014, and involved four main tasks:

1. Vegetation surveys to confirm the vegetation community mapping documented in the W2B Environmental Impact Statement (EIS);
2. Searches for flora species listed as threatened under the TSC Act and/or EPBC Act;
3. Habitat condition assessments species under the EPBC Act; and
4. Identification and mapping weed infestations.

It should be noted these surveys were undertaken post the EMM and Jacobs surveys for the same sections.

Flora surveys in winter are not optimal for the location and identification of flora species as most produce reproductive material used for their identification over spring and summer. However, two additional independent flora surveys have been undertaken for threatened flora and rainforest vegetation within the study area during summer and autumn, EMM (2014) in February 2014 and Jacobs (2014) between March 2014 and May 2014.

Eight patches of Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion/Lowland Rainforest of Subtropical Australia were ground-truthed during field surveys.

Two patches of Littoral Rainforest previously mapped have been re-classified as a result of these surveys in Section 10 and 11. The Littoral Rainforest area in Section 11 was found to be similar in species composition to that either side being Swamp Sclerophyll forest. There was a higher cover of palms in this location however it is not enough change in species composition to warrant the small patch being classified as Littoral Rainforest. The area in Section 10 was found to be similar in species composition to that in similar locations to the north and south, being Blackbutt-Pink Bloodwood shrubby open forest. It was found growing on old sand deposits.

Of the seven threatened flora recorded previously for these sections, Australian Museum recorded six. One species *Davidsonia jerseyana* (Davidsons Plum) was a new record for the area. The recorded seven rainforest species both inside and outside the project boundary were:

- *Archidendron hendersonii* (White Lace Flower)
- *Cryptocarya foetida* (Stinking Cryptocarya)
- *Davidsonia jerseyana (Davidsons Plum)*
- *Endiandra muelleri* subsp. *Bracteata* (Green-leaved rose walnut)
- *Macadamia tetraphylla* (Rough-shelled bush nut)
- *Streblus pendulinus* (Siah's backbone); and
- *Syzygium hodgkinsoniae* (Red Lilly Pilly).

For further detail regarding the survey and findings, including figures showing where species were recorded, refer to the technical report in **Appendix M**.

5. Potential impacts and management approach

This section provides an overview of the potential impacts to the threatened rainforest communities and rainforest 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 communities 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 **Sections 6** to **8** of this plan target the predicted impacts.

5.1 Potential impacts associated with the project

Impacts to threatened rainforest communities and threatened rainforest plant species were classified as either direct or indirect as defined below.

Direct impacts relate to species located within the construction footprint (also referred to as the clearing limits). Direct impacts to threatened rainforest communities and threatened rainforest plant species include removal of individuals, populations, and/or their preferred habitat.

The remaining threatened rainforest plants and rainforest communities in close proximity (within 20 m) to the project may 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.

5.2 Rainforest communities

5.2.1 Direct impacts

Seven Lowland Rainforest patches and one Littoral Rainforest patch will be impacted by the project in Sections 1, 2, 3, 10 and 11. The extent of rainforest communities to be directly impacted by the project and the area of these patches remaining adjacent to the project are described in **Table 5-1**.

Information on impacts to rainforest communities presented in the EIS have been updated to reflect the results of targeted threatened flora and threatened rainforest community surveys completed in 2014 (as summarised in **Section 4**).

Table 5-1 Impacts and remaining areas of Lowland Rainforest and Littoral Rainforest

Project section	Total rainforest patch (ha)	Area directly impacted (ha)	Area remaining following direct impact (ha)	Proportion of patch remaining after direct impact
Lowland Rainforest				
1	0.43	0.31	0.12	28%
2	0.0039	0.0039	0	0%
3	3.24	0.66	2.58	80%
10	1.08	0.520	0.87	80%
10*	65.58*	1.88*	64.05*	97%
11	7.07	0	7.07	100%
11*	5.51*	0	5.51*	100%
Total^	84.79	3.37	80.2	96% in total

Project section	Total rainforest patch (ha)	Area directly impacted (ha)	Area remaining following direct impact (ha)	Proportion of patch remaining after direct impact
Littoral Rainforest				
10	1.72	0.2	1.26	88%
Total	1.72	0.2	1.5	88% in total

Note: * impacts to Lowland Rainforest TEC; ^ areas <0.005 ha have not been included in disturbance calculations

5.2.2 Indirect impacts

Indirect impacts have the potential to impact remaining rainforest communities and plants in close proximity to the project during construction and/or operation, including:

- Accidental clearing or impacts to threatened rainforest communities and 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
- 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; and
- Spread of pathogens during construction.

5.3 Rainforest plants

5.3.1 Direct impacts

Six of the fifteen threatened rainforest plants identified as potentially occurring within the project area will be directly impacted (refer to **Table 5-2**) within Section 10. These individuals are located within the clearing footprint.

Table 5-2 Rainforest plant species directly impacted by the Project

Species name	No. of individuals directly impacted	Project Section
Archidendron hendersonii (White Lace Flower)	1	10
Cryptocarya foetida (Stinking Cryptocarya)	41	10
Endiandra muelleri subsp. *bracteata* (Green-leaved Rose Walnut)	3	10
Macadamia tetraphylla (Rough-shelled Bush Nut)	10	10
Streblus pendulinus syn. S. *brunonianus* (Siah's backbone)	4	10
Syzygium hodgkinsoniae (Red Lilly Pilly)	6	10

5.3.2 Indirect impacts

Indirect impacts to threatened rainforest plants follow similar impacts to the direct threats to the rainforest communities detailed in **Section 5.2.2**. Six of the fourteen threatened rainforest plants identified would be indirectly impacted (refer to **Table 5-3**), due to their location within 20 m of the project clearing footprint.

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 5.2.2**, 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).

Table 5-3 Rainforest plant species indirectly impacted by the Project

Species name	No. of individuals potentially indirectly impacted[#]	Project Section
Archidendron hendersonii (White Lace Flower)	22	10
Cryptocarya foetida (Stinking Cryptocarya)	7	10
Endiandra muelleri subsp. bracteata (Green-leaved Rose Walnut)	10	10
Macadamia tetraphylla (Rough-shelled Bush Nut)	5	8 and 10
Streblus pendulinus syn. S. brunonianus (Siah's backbone)	6	4, 8 and 10
Syzygium hodgkinsoniae (Red Lilly Pilly)	4	10

[#] Buffer of 20 m has been applied for all rainforest species except for Green-leaved Rose Walnut as it can occur in highly modified habitats and is not as dependent on shade or moisture.

5.4 Detailed design considerations

The detailed design presents further opportunities to avoid and minimise impacts to threatened species/populations, including:

- Avoiding or minimising vegetation removal wherever possible
- Where possible, final planning for construction compounds, ancillary infrastructure, access tracks and stockpile areas will be placed within cleared or disturbed areas, and away from threatened plants to avoid unnecessary clearing and indirect impacts; and
- When locating water quality treatment measures, consideration would be given to the competing environmental requirements of minimising impact to native vegetation, particularly where there could be threatened plant species, and also wildlife corridors and potential fauna habitat.

5.5 Mitigation and monitoring

To maintain consistency with the overarching biodiversity management framework developed for the project, the following objectives have been identified 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; and
- 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. Monitoring activities are included in a number of these plans and strategies, with offsets addressed in the Offset Strategy prepared for the project.

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, and SPIR. In general these measures related to:

- Provision of exclusion fencing to protect in situ threatened flora populations
- Management of indirect impacts to these in situ populations during construction
- Water quality, erosion and sediment control
- Weed management; and
- 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 plants directly impacted by the project. The details of any translocation activities for the project are addressed in separate Translocation Strategies prepared to satisfy MCoA D7. These will include a feasibility assessment in line with the projects offset strategy followed by translocation trials. The first of these Translocation Strategies have been completed for Sections 1 and 2 (RMS 2015).

This 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 Sections.

5.6 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 5-4**.

5.7 Adaptive management approach

This plan includes an adaptive management approach based on firstly identifying specific goals for management, followed by the implementation of management actions and finally the monitoring of the performance of these measures against the goals and identified thresholds. Prescribed corrective actions will be applied to improve mitigation where required.

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

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

Details of the proposed monitoring program are described in **Section 8**.

Table 5-4 Mitigation measures and evaluation of their effectiveness – past experiences

Issue	Mitigation measure	History of success	Effectiveness rating
Construction impacts to patches of Lowland Rainforest and Littoral Rainforest within the project footprint	Design refinements to minimise damage through avoidance where possible	As clarified in Section 1.17.2 and 1.17.3 of the Supplementary Biodiversity Assessment for W2B: The EIS project design would have impacted on 10.3 hectares of Lowland Rainforest, listed as endangered on the TSC Act, of which 5.8 hectares is consistent with the Commonwealth listed threatened ecological community on the EPBC Act. Adoption of the design refinement would reduce this direct impact to 2.5hectares (TSC Act listed) in sections 10 and 11, of which 2.0 hectares meets the criteria for listing on the EPBC Act. In addition a small area of Littoral Rainforest south of Coolgardie Road was subject to design refinement which reduced construction impacts to the maximum possible and As such, the design refinement would change the project impact to littoral rainforest by 0.03 hectares over the EIS design(Table 3-19) (taking the total project impact on littoral rainforest to 0.23 hectares).	High degree of success as threatened rainforest communities and individual plants are avoided.
Accidental impact to threatened rainforest plants to be retained in situ within the project boundary. These individuals are within 20m adjacent to the construction footprint.	Confirmation of what individuals 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 is determined by targeted surveys and pre-clearing surveys. Individuals to be tagged/marked in the field. 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 1: Preclearing*, *Guide 2: Exclusion zones*, 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.

Issue	Mitigation measure	History of success	Effectiveness rating
Impacts from weeds around retained *in situ* threatened plant populations' and incursion of invasive weeds in rainforest community patches.	Weed management procedures documented in the Roads and Maritime Biodiversity Guidelines, specifications and preferred infrastructure report are to be implemented to control weeds across the project area. In areas surrounding in situ threatened rainforest plants specific weed management measures will be undertaken by suitably qualified and experienced contractors to ensure no damage occurs to the species. Due to the sensitivity of some species weeds of greatest threat will be prioritised for treatment and monitoring will also be completed to ensure the effectiveness of those weed treatment measures. Revegetation of areas disturbed by construction to minimise weeds.	Guide 6 of the *Biodiversity Guidelines Protecting and managing biodiversity on RTA projects* (RTA 2011) provides a standard procedure for weed management. 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 and environmental weed control handbook*, NSW government, 2011.	Moderate, monitor against performance and implement weed management actions.
Revegetation adjacent to threatened rainforest communities and *in situ* rainforest plants is unsuccessful. Direct loss of threatened rainforest plants during construction.	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	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 ha area surrounding the	Moderate, monitor success and implement corrective actions as required.

Issue	Mitigation measure	History of success	Effectiveness rating
	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 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.	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 ha) would be undertaken in 2015 pending project approval. Transplant survival rates were generally above 90 per cent. However, for three species transplant survival rates were less than 60%. 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 2015 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.	
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	Moderate, monitor success and implement corrective actions as required.

Issue	Mitigation measure	History of success	Effectiveness rating
		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	
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.
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.

6. Pre-construction management measures

6.1 Potential impacts during pre-construction

There is the 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. These impacts close to construction areas can be avoided or minimised through the effective implementation of pre-construction management measures.

6.2 Management objectives

The objectives of this management strategy include:

- 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 activities that could impact the individuals
- Threatened rainforest communities and plants translocation strategy completed for relevant project sections
- Identification and translocation of all relevant threatened rainforest plants within the construction area as identified from feasibility assessment
- Weed and pathogen management protocols developed, approved, and implemented prior to construction commencing
- Identify exclusions zones prior to construction commencing including corridor and ancillary sites and access roads; and
- No unplanned loss of threatened rainforest plants as a result of project activities.

6.3 Management measures

6.3.1 Targeted surveys

Pre-construction targeted surveys for threatened rainforest plants and communities have now been completed for all sections of the project by licensed and appropriately qualified ecologists. These targeted surveys were completed during various seasons and climatic conditions to take into consideration the optimal time for species identification and to assess habitat requirements. Optimal timing for each species is summarised in **Table 6-1**.

These surveys were undertaken to collect comprehensive and up-to-date data on the distribution and abundance of threatened flora within the project area, mark threatened flora in the field to support future identification and support management actions, determine monitoring locations and collect baseline data to inform the development of the Translocation Strategy (refer to **Section 4**). Targeted surveys for Sections 1, 2, 3, 4, 8, 10 and 11 (where rainforest communities and plants were confirmed) are summarised in **Section 4**.

The outputs of the targeted surveys have enabled the accurate mapping of the distribution and abundance of threatened plant species within the construction footprint and also adjacent to the project, helping to identify those species that are directly or indirectly impacted by the project. Directly impacted relates to individuals located within the clearing limits/construction zone and indirectly impacted generally relates to those individuals located within 20 m 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.

The monitoring program proposed will identify if indirect impacts are occurring and identify any additional measures that may be required to ensure the survival of the *in situ* populations. The information will also assist in the identification of potential revegetation or translocation sites in consultation with landowners as part of the project offset strategy.

Any future surveys will also be undertaken by licensed and appropriately experienced ecologists, familiar with the threatened rainforest flora species and ecological communities of the region. This information will also be used to update the construction management measures in **Section 7** which will also form part of the CEMP and FFMP for the project.

Table 6-1 Optimum targeted survey timing for threatened rainforest plants

Species	Optimum survey time
Acronychia littoralis	May to August (fruits are a clear diagnostic feature)
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 jerseyana	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

6.3.2 Management of in situ threatened populations

Roads and Maritime are committed to conserving those threatened rainforest plant species and populations that occur outside the construction footprint but within the project boundary to the greatest extent possible. A number of measures will be required to be undertaken to conserve these species *in situ* to ensure they are not adversely impacted during construction or operation of the project.

Key management measures will include:

- Clearly identifying these species and their locations on the ground and in management documents including the Sensitive Area Plans (SAPs) included in the CEMP and FFMP
- Prior to commencement of construction, ensure that there is an appropriate exclusion zone established around these individuals or populations to ensure no activities including stockpiling etc. can occur in this area
- Targeted weed management measures will be considered for each section of the project where there are threatened plant species being managed *in situ*. The “weed management zones” will be clearly identified and targeted weed control methods will be described in the CEMP. Roads and Maritime will also ensure weed management is undertaken by suitably qualified and experienced contractors within these areas near threatened plant species; and
- Revegetation with native species reflective of the local area and pre-disturbed vegetation communities where possible will occur post construction. Revegetation design of areas adjacent to *in situ* threatened plant populations will ensure the plantings will not impact on the species (e.g. will not compete for light or moisture) and are consistent with their habitat requirements. Further

details of areas for revegetation and native species to be used, will be provided in the Urban Design and Landscape Plan (UDLP) for each section of the project.

6.3.3 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 for threatened flora species has been prepared for Sections 1 & 2 by Roads and Maritime (2015) to address the requirements of MCoA D7. A second translocation plan will be prepared for Section 3-11 by Roads and Maritime to further address the requirements of MCoA D7. Translocation will be considered for those threatened flora species that are within the construction footprint. The overall objective of threatened plant 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. 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 of threatened species would be undertaken in accordance with the Roads and Maritime translocation strategy. The work would be preceded by / include a feasibility assessment to determine the ecological needs of each species and the required characteristics of the receival sites.

Suitable translocation receival sites will be considered within the project boundary (but outside of the clearing footprint) where it is determined these areas are viable to support translocated individuals or populations. Or translocation receival sites may be placed in disturbed areas of offset land or compensatory habitat outside 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 no net loss in local plant populations being impacted by the project. A receival site would be 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 will be confirmed in the translocation strategy for a particular species and section.

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
- Warrell Creek to Urunga Upgrade: Threatened Flora Management Plan, Ecos Environmental Pty Ltd, December 2012; and
- Translocation strategy for *Maundia triglochinoides* as part of the Pacific Highway upgrade, Kempsey to Eungai, Parsons Brinkerhoff, April 2006.

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.

An assessment of the feasibility of translocating the threatened plants detailed in this management plan will occur. This assessment would be based on a review of translocation experience for individual threatened plants and involve the assessment of the benefits and risks of translocation for each threatened plant. Specifically this assessment would determine whether any threatened plants located within the clearing limits/construction zone could be successfully translocated, or propagated and planted into, an appropriate receiving site (which may include within the road reserve). 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 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; and
- Detail the habitat characteristics, 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 successful of the translocated individuals.

Translocation planning for rainforest species would include:

- Detail the translocation approach including a description of the methods to be used to salvage the threatened 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; and
- Describe the proposed propagation procedure for threatened 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 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 include:

- 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
- 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; and
- An implementation schedule summarising the translocation program requirements pre-construction, during and post-construction.

6.3.4 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 will be applied, to replace those populations lost as a result of construction. The seed collection and propagation activities will 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 in advance of any clearing works. Rainforest plant seed is usually unviable when stored and when collected would need to be either propagated in a nursery or sown at the selected site with minimal time delays. 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 loss of genetic flexibility to evolve with changing environments. To maintain genetic diversity, indirect genetic management would be required 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. The ideal seed collection period for each threatened rainforest plant is provided in **Table 6-2**. A number of site inspections may be required during these periods to investigate the onset of seed, and seed collection may be conducted over several visits during these optimum periods.

Table 6-2 Optimum periods for threatened flora seed collection

Species	Flowering period	Seed collection
Acronychia littoralis	January-February	May-August
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 jerseyana**	October-January July -September	January-February April-October
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

*Note: Flowering and fruiting times vary between sub-populations

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.

While most rainforest plant seeds do not store well they can be quite easily germinated in a nursery soon after collection. However they will 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 6-3**.

Table 6-3 Seed collection and storage methods

Process	Method
Seed collection	Seed collection would 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. As the seeds of the threatened species in this plan would not store, these need to be either planted to tubestock or planted out as soon as possible. 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 • 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 only 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 (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.

Planting of threatened rainforest plants would be targeted at planting in land acquired as part of the offset strategy or in areas within the road reserve that are unlikely to be impacted by maintenance or future road construction works. 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 experienced 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 6-4**.

Table 6-4 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. • Depending on the results of the seed trial, seeds would be propagated in seedling trays of standard seed propagation mix (e.g. pine bark fines, cracker dust, sand, vermiculite, slow release fertiliser) or within seedling trays containing only the natural soil type from the site. 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 approximately 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.

6.3.5 Temporary exclusion zones

An exclusion zone would be a designated “no go” area that clearly identifies areas to avoid and would be appropriately fenced by highly visible fencing materials 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 surveys and plant marking activities. The relevant protocols include:

- Exclusion zones to be identified and marked out prior to construction considering threatened rainforest species and rainforest communities 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; and
- 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 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); and
- 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.

6.3.6 Weed management

Weeds are plants that may threaten agricultural land adjacent to the project, have detrimental effects on the natural environment or impact human health. The objective of weed management is to prevent or minimise the spread of noxious and environmental weeds on Roads and Maritime project sites. *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.

A project specific Weed Management Plan will be developed and will be incorporated into relevant plans for the project (e.g. CEMP, FFMP). This will form the baseline for all weed management activities within the project area.

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 following information is included in these plans:

- Type and source of the weed/s
- Weed management priorities and objectives
- Sensitive environmental areas within or adjacent to the site, including threatened plant species populations and any different weed management actions and control methods to be adopted
- 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; and
- Communication strategies to improve contractor awareness of weeds and weed management.

Details on monitoring the performance of weed management in proximity to threatened plants, as well as corrective actions to be implemented in instances of change from performance measures, are provided in **Section 8**. This provides a consistent measure to be included in all weed management plans for threatened plants.

6.4 Mitigation goals and corrective actions

The pre-construction environmental planning measures for protected rainforest communities and listed rainforest plants that would be completed prior to the commencement of construction are summarised in **Table 6-5**.

Table 6-5 Pre-construction mitigation goals and corrective actions

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for Corrective Action	Corrective actions
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 surveys have not been undertaken in the optimum season for the threatened rainforest species prior to construction. Exclusion zones not in place or in-situ threatened rainforest species not marked prior to clearing commencing.	Delay clearing or construction until targeted surveys have been undertaken and species marked.
Threatened rainforest plants translocation strategy completed for relevant project sections.	Targeted survey findings used to develop the threatened plants translocation strategy.	Pre-construction.	Translocation strategy has not been completed and approved prior to construction activities impacting threatened species.	Delay construction in relevant area(s) 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.	Seed collection and plant material collection has not been undertaken prior to clearing works. Insufficient seed available prior to clearing works.	Collect seed and plant material from adjacent populations of the species outside the construction footprint, or from nearby locations.
Identification and translocation of all relevant threatened rainforest plants within the construction area. Selection of optimal translocation receival sites for threatened rainforest flora populations and threatened community restoration sites.	Identification of individuals for translocation.	Targeted survey to identify individuals for translocation prior to clearing.	Identification of individuals for translocation not undertaken prior to clearing works. Identified individuals not translocated prior to clearing works.	Construction postponed until all individuals have been appropriately identified and translocated. All individuals within and adjacent to the project appropriately flagged for removal, protection or translocation.

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for Corrective Action	Corrective actions
Weed management plan developed and approved prior to construction commencing. This information will be included in the CEMP and FFMP.	Develop a weed management 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. This information will be included in the CEMP and FFMP.	Weed management plan to be completed (as part of the Flora & Fauna Management Plan under MCoA D26 (e)) prior to construction commencing.	Weed Management 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 in relevant area(s) 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 threatened rainforest plants and rainforest communities outside approved limits of clearing.	Revegetation of disturbed habitat and monitoring of recovery.

7. Construction management measures

7.1 Potential impacts during construction

- Machinery moving around threatened rainforest plants has the potential to cause damage to these plants directly 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; and
- There would also be potential for the loss of those individuals proposed to be translocated through an incomplete or inadequate translocation processes.

7.2 Management objectives

- 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* during construction due to physical damage
- No notable increase in the abundance of weeds within threatened rainforest plant habitat, and rainforest communities during monitoring
- Adequately planned translocation carried out such that it maximises the chance of survival of the translocated plants
- The landscaping design includes details on revegetation requirements for areas adjacent to threatened plants and translocation/offset areas
- Dust managed in accordance with the CEMP which will aim to:
    - Identify significant dust sources
    - Identify targeted dust suppression measures to be implemented, including:
        - Use of water carts on unsealed surfaces and stockpiles
        - Cover loads on all trucks on public roads
        - Minimise tracked mud/dust on public roads
        - Modify or cease operations during high winds
        - Stabilise, revegetate and/or landscape all disturbed areas as soon as practicable
        - Prohibit burning or incineration of any material at any time
    - Inform dust monitoring and the use of dust deposition gauges at sensitive locations
    - Monitor complaints associated with dust generation
    - Facilitate training of personnel on air quality issues and safeguards; and
    - Vehicles, equipment, machinery used and all facilities – designed, operated and maintained to control the emission of smoke, dust and fumes.
- Water quality and soil quality managed in accordance with the CEMP which will aim to:
    - Inform the preparation of site specific erosion and sediment control plans and measures to be implemented, including:
        - Silt fences

- Sand bags
- Mulch materials and straw bales
- Sedimentation basins
- Clean water diversion berms

- Identify maintenance activities, inspections and responsibilities for ensuring the effectiveness of erosion and sediment control measures and continual improvement
- Inform design requirements for construction and operation phase water quality control structures and discharge points
- Inform water quality monitoring upstream and downstream of the project site during construction
- Minimise soil exposure during construction and progressive stabilisation and revegetation during construction
- Facilitate rehabilitation and landscaping works of disturbed areas which will be undertaken as soon as the works are complete; and
- Install signage at discharge points to assist workers to understand implications of dirty water release in sensitive areas.

7.3 Management measures

7.3.1 Work method statements

Work method statements would be prepared for specific activities that pose particular environmental risks. Work method statements would ensure sound environmental practices are implemented to minimise the risk of environmental incidents or system failures, in accordance with the CEMP.

Work method statements covering activities with the potential to impact on threatened plants would address all relevant management measures and be prepared in consultation with agencies, Roads and Maritime and the relevant project environmental staff prior to the commencement of identified activities.

7.3.2 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 communities and threatened rainforest plants. This training would identify the Lowland/Littoral rainforest patches and plants, with all personnel shown maps of their locations. The importance of following the clearing, translocation and rehabilitation protocols would be made clear for any personnel that require access to the site.

7.3.3 Pre-clearing surveys

Pre-clearing procedures would be outlined in the CEMP and project specific FFMP, and would be undertaken in accordance with Biodiversity Guidelines: Protecting and managing biodiversity on RTA Projects (RTA 2011), in order to minimise impacts on flora and fauna.

Prior to the commencement of clearing operations, pre-clearance surveys will be undertaken. This consists of an appropriately qualified and experienced ecologist/s surveying the area to be cleared and identifying all exclusion zones where native vegetation, in situ threatened plants and fauna habitats are to be retained. The pre-clearance survey is also an opportunity to confirm there are no additional individuals within the construction footprint or buffer areas from the last survey due to changes in seasonal conditions. If any additional species, or new populations, are found they will be recorded and assessed and then addressed by applying the Roads and Maritime New Finds Procedure.

7.3.4 Sensitive Area Plans (SAPs)

SAPs are important for identifying where threatened flora species 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 proposed translocated flora (with identification numbers) and be kept up to date. SAPs will be incorporated into all inductions, daily toolbox talks and provided to all personnel that require access to the particular area.

7.3.5 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) would be clearly marked
- 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; and
- 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* 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 TRCRPMP.

7.3.6 Sedimentation and erosion control measures

Detailed site specific erosion and sediment control plans would be prepared as part of the CEMP for each section of the project. Locations for erosion and sediment control measures 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 measures would be installed and maintained 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.

The CEMP will:

- Inform the preparation of site specific erosion and sediment control plans and measures to be implemented, including:
    - Silt fences
    - Sand bags
    - Mulch materials and straw bales
    - Sedimentation basins
    - Clean water diversion berms.
- Identify maintenance activities, inspections and responsibilities for ensuring the effectiveness of erosion and sediment control measures and continual improvement.

These measures would be routinely monitored weekly during construction and maintained as required.

7.3.7 Revegetation

The landscape design 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 and rainforest communities. 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).

Specific detail regarding revegetation including areas for revegetation, species to be used and maintenance will be described in the Urban Design and Landscape Plan (UDLP) for the project. A separate translocation strategy for threatened flora species has been prepared for Sections 1 & 2 by Roads and Maritime (2015) to address the requirements of MCoA D7. A second translocation plan will be prepared for Section 3-11 by Roads and maritime to further address the requirements of MCoA D7.

The design would contain specific revegetation measures adjacent to threatened plant and community locations to ensure these sites are adequately buffered with fast growing native species to prevent weeds becoming dominant. The designs would provide details of the maintenance schedule of the landscaped areas into operation.

Revegetation would commence as soon as practical upon completion of the construction activities within each section of the project.

Revegetation maintenance in areas near recorded threatened rainforest communities and rainforests plants would be planned in consultation with a sub-contractor who possesses the following skills:

- Experienced in identification of the local flora and communities, particularly subject threatened species, so that damage to individuals and native species in general does not occur during maintenance activities (these plants will be monitored); and
- 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. Remaining *in situ* threatened rainforest communities and rainforest plant populations would benefit from weed/rhizome free topsoil salvaged from any existing weed free forest 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 as well as corrective actions to be implemented in instances of change from performance measures are provided in **Section 9**.

7.3.8 Weed management

During construction the weed management requirements as specified in the CEMP and FFMP considering the location of in situ populations will be implemented. Refer to the weed management plan within the FFMP and CEMP for details. This plan will 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).

Weed management measures during construction will include:

- Communication strategies to improve contractor awareness of weeds and weed management
- Ensure all contractors have been made aware of SAPs and locations of threatened plant populations and exclusion zones
- Measures to prevent the spread of weeds such as topsoil management, vehicle wash downs and restricting vehicles to designated tracks and trails
- Appropriate disposal of weed infested materials and soils
- Identification of environmentally sensitive areas and weed zones where specific weed measures are required

- Targeting those weeds that are of the highest environmental or agricultural threat and risk of spreading for control; and
- Monitoring the effectiveness of weed control.

7.3.9 Water quality

As noted in **Section 7.3.6**, 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; and
- Specific measures for water detention basins including appropriate discharge where necessary.

7.3.10 Minimising dust

Dust impacts would be managed in accordance with the CEMP which will aim to:

- Facilitate the identification of dust sources
- Identify dust suppression measures to be implemented, including:
    - Use of water carts on unsealed surfaces and stockpiles
    - Cover loads on all trucks on public roads
    - Minimise tracked mud/dust on public roads
    - Modify or cease operations during high winds
    - Stabilise, revegetate and/or landscape all disturbed areas as soon as practicable
    - Prohibit burning or incineration of any material at any time
- Inform dust monitoring and the use of dust deposition gauges at sensitive locations, such as near in situ threatened flora populations
- Monitor complaints associated with dust generation
- Facilitate training of personnel on air quality issues and safeguards; and
- Vehicles, equipment, machinery used and all facilities – designed, operated and maintained to control the emission of smoke, dust and fumes.

Corrective measures would be adopted where a significant impact is noted and may include the addition of shade cloth screening installed around low growing species and *in* situ populations such as *Lindsaea incisa* to provide dust protection and maintain microclimate. The presence of dust on threatened plants would be monitored as part of the plant health monitoring as outlined in **Section 9**.

7.4 Mitigation goals and corrective actions

The construction environmental planning measures for protected rainforest communities and plants that would be completed during construction are summarised in **Table 7-1**.

Table 7-1 Construction phase mitigation measures and corrective actions

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for Corrective Action	Corrective actions
No loss or damage of Lowland or Littoral Rainforest outside of approved clearing limits. Zero mortality of threatened plants from *in situ* populations (for physical damage during construction) and no loss of threatened plants directly adjacent to the project.	Implementation of the Roads and Maritime clearing protocol. Clearing areas identified and approved within the clearing protocol. Exclusion zones fenced off, fencing checked regularly, faults rectified. Induct all construction staff at the commencement of construction works. Induct new staff as appropriate. Implementation of weed management as described in the CEMP and FFMP Up to date SAPs. 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 from over sun exposure, dust, edge effects).	Clearing areas identified and approved prior to clearing activities being undertaken. Exclusion zone fencing monitored at least weekly during construction. Faults rectified as soon as noticed. During construction as per individual monitoring and management plans. In-situ plants will be monitored every three months during first year of construction and every six months during second year of construction.	Clearing commences prior to clearing areas being marked out and approved. Any breech of exclusion zone fencing. Any loss of retained in situ threatened plants.	Delay construction until clearing areas has been marked out. Stop construction in the area of the fencing breach until exclusion fencing has been repaired. Investigate why breach in fencing occurred and implement corrective actions as required to prevent reoccurrence. Commence assessment of potential reasons for mortality, including seasonal fluctuations, natural events such as drought and fire within one month of trigger being identified. Compare with paired control site. Identify potential threats, implement corrective actions and modify monitoring as necessary.
Adequately planned translocation carried out such to maximise the chance of survival of the translocated plants.	Salvage and planting of identified plants for translocation undertaken at times, into suitable habitat and using appropriate methods that maximise the chance of plant survival prior to clearing.	At the optimal time of year for species prior to clearing works commencing. Once salvaged, plants would need to be monitored throughout the construction phase at least three times a year (summer, autumn, spring).	Plants identified for translocation are not translocated prior to commencement of construction.	Reserves of species tube stock or seed would be available to supplement and enhance population.
No notable increase in the abundance of weeds within Lowland and Littoral rainforest patches. No notable increase in the abundance of weeds within threatened plant habitat during monitoring of *in situ* populations.	Weed management plan contained within the FFMP and CEMP developed and implemented to control weeds. Monitoring surveys to include quantification of weed abundance and cover.	Every three months during the first year of construction. Every six months during the second year of construction.	Weed cover increases by ≥30% from the baseline cover in rainforest community patches. This will be measured at each monitoring event*.	Review methods and objectives of weed management plan. Implement adaptive management measures. Further weed mitigation measures implemented as required.
The landscaping design includes details on	Landscape design contains details on revegetation areas adjacent to	Landscape design developed prior construction.	Landscape design not developed prior to construction.	Delay construction until the landscape design has been developed.

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for Corrective Action	Corrective actions
revegetation requirements for areas adjacent to threatened plants and translocation/offset areas	threatened rainforest communities and in situ plants. Progressive revegetation adjacent to threatened rainforest communities and plants as construction permits.	Progress revegetation during construction, as areas become available.		
Dust managed in accordance with the CEMP.	Dust impacts would be managed in accordance with the CEMP including dust suppression measures. Where appropriate shade cloth screening would be installed on edge of construction footprint to protect low growing species.	Dust suppression would be implemented in accordance with the CEMP. Monitoring of dust on plants considered as part of plant health monitoring. Dust deposition is to be monitored monthly.	Dust related exceedances recorded from the dust monitoring within sections with *in situ* threatened rainforest communities and plants. Loss of ecological condition during plant health monitoring as a result of dust sources.	Review dust suppression procedures and update as required. Where appropriate, shade cloth screening installed on edge of construction footprint to protect low growing threatened flora.
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 controls included in the CEMP.	Erosion, sediment and water quality controls would be monitored weekly throughout the construction period and as soon as practical after storm events.	Breaches of erosion, sediment and water quality controls recorded. Loss of ecological condition recorded from 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.

*__Note__: If performance threshold is not encountered during audit or monitoring, corrective action is taken. For example if weed cover was 10% and an increase of 30% occurred over a monitoring period (making the total cover 13%), this would trigger an evaluation of what was occurring and corrective action to be taken

8. Operational management measures

8.1 Potential impacts during operational phase

- Degradation of translocation receiving sites, with potentially the death of translocated plants; and
- Degradation of retained rainforest plants and communities from edge effects.

8.2 Management objectives

- Zero mortality of retained *in situ* threatened plant populations has occurred during construction and for three consecutive monitoring periods post-construction and 80 per cent survival of tree, shrub and herbaceous perennials after three years
- At least 90 per cent of the plants planted as part of the revegetated areas have survived after the first year and 80 per cent after three consecutive monitoring events; and
- Less than five per cent weed cover at retained *in situ* threatened flora sites (end of monitoring program) and less than 30 per cent weed cover at other revegetation areas.

8.3 Management measures

8.3.1 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 and maintenance would be required to increase the extent and limit edge effects. The maintenance requirements for revegetation areas adjacent threatened rainforest communities and plants would be detailed in the urban design landscape 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 below.

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.

8.3.2 *In situ* threatened rainforest communities and plants

Ongoing mitigation for *in situ* threatened rainforest communities and rainforest plant populations would be undertaken for three consecutive monitoring events or until mitigation measures are proven effective. 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. Refer to **Section 9** for the *in situ* monitoring requirements.

Threatened species may differ in resilience, longevity and sensitivity to disturbance. Plant health may fluctuate seasonally in its natural environment depending on the species (e.g. shade loving species would need more attention to buffering disturbances). 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,

Areas within the road reserve requiring regular maintenance activities (i.e. mowing/slashing) have been included as part of the direct impact calculations. Maintenance such as mowing will not occur within areas of in situ threatened flora species/populations, or within exclusion zones.

8.3.3 Revegetation areas

Ongoing maintenance of revegetated and translocation areas adjacent to threatened plants/populations will be undertaken. Inspection, monitoring and maintenance is specified within the Roads and Maritime specifications including R178 and R179. Specific detail regarding revegetation including areas to be revetetated, species to be used and the maintenance program will be described in the Urban Design and Landscape Plan (UDLP) for the project. A separate translocation strategy for threatened flora species has been prepared for Sections 1 & 2 by Roads and Maritime (2015) to address the requirements of MCoA D7. A second translocation plan will be prepared for Section 3-11 by Roads and maritime to further address the requirements of MCoA D7. The recommended maintenance and monitoring schedule for the revegetated areas in the first year is outlined in **Table 8-1** and for years two and three in **Table 8-2**. An increased level of maintenance and monitoring will be completed in the first twelve month period and then tapers off as the revegetation becomes self-sustaining, but will be subject to performance measures being met.

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.

Table 8-1 Recommended monitoring and maintenance schedule (Year 1)

Monitoring	Timing	Maintenance
Site preparation	Commencement	Where weed infestations occur spray the area for weeds prior to planting using appropriate herbicides or pesticides and to the manufacturer's specifications. The area is to be left for at least two weeks prior to planting.
Watering	First month	Immediately post planting undertake watering in accordance with Specification R179. Undertake watering at 2 day intervals for four weeks after planting.
Watering	2-6 months	Watering will continue at weekly intervals gradually decreasing over time. The amount of watering will be in accordance with Specification R179.
Plant health	Monthly for 12 months	Carry out maintenance inspections of plantings at intervals not exceeding one month. Weeds not smothering plants, plants healthy with active growth, replanting required if plant survival not at required percentage. A written report to be submitted to Roads and Maritime by contractor after each maintenance inspection.
Weed control	Monthly	Keep all planting areas free of weeds. Weed removal to be undertaken at intervals not more than four weeks and ensure weeds do not flower to form seed heads. For noxious weeds take action as required by that local government authority. Dispose of weeds off site.
Plant replacement	Monthly for 12 months	The contractor will be responsible to replace missing or dead plants within fourteen days of detection. They must be of similar size and quality and identical species to that lost. Replacement plantings are to be watered for the first 12 weeks.
Stakes and tree guards	Monthly for 12 months	Repair any tree ties or tree guards that have broken or are missing. Replace as soon as practicable after being identified.

Table 8-2 Recommended monitoring and maintenance schedule (Year 2 and Year 3)

Monitoring	Timing	Maintenance
Mulch/weed suppression. Plant nutrient deficiency.	Every 6 months in Year 2 and 3.	Addition of mulch where required. Addition of fertiliser/nutrients where required. Weeds controlled within 2 metres of planting locations, blanket treatment of weed areas if appropriate or targeted treatment of weed outbreaks.
Weed and plant health	Every 6 months in Year 2 and 3.	Weeds not smothering plants, healthy active plant growth, replanting required if the target percentage survival rate not achieved.

8.3.4 Translocation

A separate translocation strategy for threatened flora species has been prepared for Sections 1 & 2 by Roads and Maritime (2015) to address the requirements of MCoA D7. A second translocation plan will be prepared for Section 3-11 by Roads and Maritime to further address the requirements of MCoA D7. For details specific to translocation; methods, relevant species locations, maintenance, ongoing monitoring requirements and translocation areas during operation, refer to the final translocation strategy for Sections 1 & 2 (as noted a separate translocation plan is being prepared by Roads and Maritime for Sections 3-11). .

8.3.5 Weed management

Weed management would be undertaken as part of the Roads and Maritime ongoing maintenance of landscaped areas. Weed management in areas with threatened plant populations will be undertaken by suitably qualified and experienced contractors that are familiar with threatened species of the area. Weed control measures would be implemented for *in situ* plant/population and revegetated areas adjacent to threatened plants.

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 **Section 9**.

Weed control for translocation sites would be included in the translocation strategy.

8.3.6 EPBC Act 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 m 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.

8.4 Mitigation goals and corrective actions

The measures for threatened rainforest communities and plants that would be completed during operation are summarised in **Table 8-3**.

Table 8-3 Operational phase mitigation measures and corrective actions

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for Corrective Action	Corrective actions if deviation from performance thresholds
Zero mortality of retained *in situ* threatened plant populations has survived during construction and for three consecutive monitoring periods post-construction and 80 per cent survival of tree, shrub and herbaceous perennials after three years.	Clearly identify in situ populations and exclusion zones. Implementation of weed management measures throughout operational period.	Threatened plant health monitoring and weed monitoring to occur as per Section 9. Monitoring to occur annually of in-situ monitoring sites and control sites. Monitoring will occur for a minimum of three years post-construction (subject to achieving three	Any mortality of in situ threatened plants for the first three consecutive monitoring periods post construction. After the above timeframe, more than a 20 per cent decline for an in situ threatened plant population over one monitoring event from the baseline	Commence assessment of potential reasons for mortality, including natural events such as drought and fire within one month of trigger being identified. Review weed maintenance schedule within one month of trigger being identified. Identify potential threats,

Main goals for mitigation	Proposed mitigation measure	Monitoring/timing frequency	Trigger for Corrective Action	Corrective actions if deviation from performance thresholds
		consecutive monitoring periods as per MCoA D8 (k)).	(depending on species specific seasonal fluctuations).	implement corrective actions and modify monitoring as necessary. Offset any additional threatened plant impacts that have occurred as a result of the Project.
At least 90 per cent of the plants planted as part of the revegetated areas have survived after the first year and 80 per cent survived after three consecutive monitoring events.	Regular maintenance activities such as watering, mulching, weed control and supplementary plantings as required as per the Revegetation Specification.	For the first twelve months monitoring of revegetation will be monthly. It will then go to every 6 months for two years. Monitoring will occur in Spring/Summer to evaluate the success of revegetation against performance objectives.	Monitoring and maintenance activities not being undertaken as per described in this document. More than 10 per cent of plants have died after year one, and more than 20% have died after three consecutive monitoring events.	Within one month of the trigger review and update maintenance methods as required. Identify any other potential threats and implement corrective actions as required. Any failed areas to be reseeded within 6 weeks of trigger. Ongoing monitoring and maintenance undertaken until plant health and/or ecological condition of habitat has been maintained at 80% survival after three consecutive monitoring events.
Less than five per cent weed cover at retained *in situ* threatened flora sites (end of monitoring program)	Implementation of weed management measures throughout operational period.	Threatened plant health monitoring and weed monitoring to occur as per Section 9. Weeds will be monitored in proximity to in situ flora populations annually. Monitoring will occur for a minimum of three years post-construction (subject to achieving three consecutive monitoring periods as per MCoA D8 (k)).	Weed cover increases by 10% from the baseline cover in areas surrounding *in situ* populations.* More than 30% weed coverage in revegetation areas.	Review weed maintenance program within one month of trigger being identified and update as required.

*Note: If performance threshold is not encountered during audit or monitoring, corrective action is taken. For example if weed cover was 10% and an increase in 10% occurred over a monitoring period (making the total cover 11%), this would trigger an evaluation of what was occurring and corrective action to be taken.

9. 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.
Objectives

9.1 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-construction, during and post-construction phases 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 mitigation measures, including protection of rainforest communities adjacent to the clearing extents and in situ threatened rainforest plant populations
- Further understanding the propagation and translocation requirements of individual threatened rainforest plant species
- Evaluating the success of habitat revegetation; and
- Zero mortality of retained in situ threatened rainforest plant populations during construction and for three consecutive monitoring periods post-construction and 80 per cent survival of tree, shrub and herbaceous perennials after three years.

9.2 *In situ* threatened rainforest plants

As noted in Section 4, targeted surveys have been undertaken to collect comprehensive up to date data on the location and number of threatened rainforest plants within the project area. The outputs from these surveys include details on the distribution and abundance of threatened species immediately adjacent to the project. The baseline data collected during these surveys has been used to update the monitoring program. During the targeted surveys control and species specific monitoring locations have been identified (Jacobs 2014).

Retained in situ threatened flora species/populations within the project area would be monitored during and post-construction until the mitigation measures have been proven successful for three consecutive monitoring periods. Post construction monitoring of in-situ rainforest plant and rainforest communities will be undertaken annually. A particular focus would be to identify any changes in health and condition which require management actions for remediation.

9.2.1 Monitoring goals

All retained in-situ threatened rainforest plants have survived during construction and for three consecutive monitoring periods post-construction and 80 per cent survived after three years, especially for trees, shrubs and large vines.

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.

9.2.2 Methods, timing, intensity and duration

Monitoring is to be conducted:

- Every three months during the first year of construction;
- Every six months during the second year of construction; and
- Every 12 months thereafter for a minimum of three years post-construction (subject to achieving three consecutive monitoring periods as per MCoA D8 (k)).

Following this period, a review of the monitoring would be undertaken to identify if further monitoring is required. The timing of surveys for cryptic species or species that may die back at certain times of the year due to climatic conditions will be optimised to allow the greatest chance of observing these species.

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

- Identification
    - Genus, species and subspecies.
    - 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 is 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.
- Site conditions
    - Plant community type.
    - Canopy cover.
    - Mid-storey cover.
    - Ground-layer cover and composition.
    - Weed abundance and composition.
    - Recruitment of canopy and mid-storey species.
    - 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.
    - Any other ecological impacts.
- Site photos (from same reference locations throughout monitoring period).

In situ monitoring sites and control monitoring sites have been finalised for the threatened flora species identified during targeted flora surveys by Jacobs in 2014.

There are six in situ monitoring locations for threatened rainforest species established by Jacobs (2014), see **Table 9-1**. The locations of these monitoring sites are illustrated in **Appendix F**. Monitoring locations for in situ threatened flora populations directly adjacent to the clearing boundary were established to collect baseline data for ongoing monitoring of plant health and habitat condition during construction and operation of the project.

The life history attributes of each species being monitored were also considered when determining the number of in situ and control plots for each species. Smaller wetland species that are potentially more susceptible to indirect impacts and climatic/seasonal conditions have a larger number of in situ and control plots where possible and larger trees and shrubs less susceptible to indirect impacts and climatic variability had less plots established particularly control plots.

Control sites comprise areas of threatened flora populations and their habitat that is remote from the impacts associated with the project. Control sites are located in relatively natural habitats with limited disturbance and threatening processes. Locations chosen generally comprise known threatened flora populations outside of the edge affected area.

Baseline data was collected at the in situ and control monitoring locations as part of the targeted surveys. Information collected includes condition scores on a scale from 0 to 5, leaf condition, flower/fruit presence, length of new shoots, disease symptoms, recruitment, weed abundance and composition cover and height.

The purpose of the 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 for lerps, locust plagues) and other natural phenomenon. Control sites provide a basis for determining if the source of potential impacts to a threatened species and their habitat are from the project or due to natural events unrelated to the project.

A summary of the in situ threatened 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.

Table 9-1 Monitoring sites for threatened rainforest plants

Species	Section	No of *in situ* monitoring sites	No of control sites
Acronychia littoralis	10	0	1
Archidendron hendersonii	10	2	1
Cryptocarya foetida	10	1	0
Endiandra muelleri subsp. bracteata	4 and 10	2	1
Macadamia tetraphylla	8 and 10	4	2
Ochrosia moorei	10	0	1
Streblus pendulinus	4, 8, 10 and 11	5	3

9.3 Rainforest communities

Monitoring sites of the Lowland and Littoral rainforest communities in Sections 10 and 11 of the project have been established by EMM (2014) and focus on patches within 50 metres of the project where access is achievable. The monitoring includes an assessment of habitat condition within remnant patches. Control sites have also been selected to monitor natural variation within the habitat condition which are not attributable to the impacts associated with the project.

9.3.1 Monitoring goals

Monitoring would provide reliable information such that sound conclusions can be drawn in relation to the management of rainforest communities. The overall monitoring objectives include:

- Evaluating the success of mitigation measures, including protection of in situ rainforest communities
- Evaluating any impacts to rainforest communities as a result of the project (e.g. edge effects, weed incursion, changes in microclimate); and
- Evaluating the success of weed control.

9.3.2 Habitat condition assessment

Habitat condition assessments have been undertaken for all patches of Lowland and Littoral rainforest within and directly adjacent to Section 10 and 11 of the project, and at control sites (refer to **Section 4**). These baseline scores will be used to evaluate the success of the mitigation measures.

9.3.3 Methods, timing, intensity and duration

Rainforest community monitoring was undertaken in Sections 10 and 11 over nine days by Andrew Benwell (Ecos Environmental) and Renae Baker (EMM) between 28 March 2014 and 9 April 2014. Monitoring sites were established in both control and impact sites. In accordance with the draft management plan, control sites were located within 100 m of the upgrade boundary, but beyond 20 m of the clearing boundary. Impact sites were located as close to the clearing boundary as was possible. Impact sites are sites expected to be subject to the indirect impacts of clearing, such as edge effects - weed invasion, changes in microclimate etc. Control sites are expected to remain the same once construction of the upgrade begins, and through operation of the upgrade.

Each impact site was paired with a control site of the same vegetation community and type. The exception to the absolute pairing of plots was Plot 10 and Plot 11. Because of the restricted distribution of Littoral Rainforest within the upgrade, no Littoral Rainforest impact site could be found to pair with Plot 10 (Littoral Rainforest control site). Plot 11 was therefore located in habitat similar to Plot 10, being a flat area with sandy/loamy soil, surrounded by paddocks and small in area. The sites were also located to encompass as many of the threatened plants recorded in the earlier surveys as possible, however, plot locations were also dependent on landholder agreement. Details of the paired sites are provided in **Table 9-2,** and locations are illustrated in **Appendix L**.

Table 9-2 Rainforest community monitoring details

Species	Vegetation community and type
Plots 1 & 5	Littoral Rainforest
Plots 2 & 3	Lowland Rainforest
Plots 4 & 6	Lowland Rainforest
Plots 7 & 12	Lowland Rainforest – Bangalow Palm
Plots 8 & 9	Lowland Rainforest
Plots 10 & 11	Littoral Rainforest/Lowland Rainforest
Plots 13 & 14	Lowland Rainforest

Plots were surveyed at each of the control and impact monitoring sites. A total of 14 plots were surveyed. The monitoring plots measured a total of 400 m^2, configured by an area of 20 m x 20 m. Each plot was divided into four sections called sub-plots (a,b,c and d), each measuring 20 m x 5 m (**Figure 9-1**). The long edge of the monitoring plot was aligned to be parallel with the clearing boundary of the upgrade. Sub-plot ‘a’ of each plot was always placed closest to the clearing boundary, while sub-plot ‘d’ was placed furthest from the boundary. The plot layout in relation to the clearing boundary is illustrated in **Figure 9-1**.

The south-east corner of each plot was used to record the position of the plot, and photographs of the plot were taken from this point. Australian hardwood stakes (1.2 m height) were used to mark the corners of each plot, while smaller stakes (60 cm height) were used to mark the ends of sub-plots a, b, c and d within each plot. The end of each stake was painted with purple paint.

Within each of the four sub-plots, the following was recorded for rainforest communities:

- The general health of the plants;
- Any disturbances or weed infestations;
- General attributes (slope, aspect, soils etc.); and
- All species present (including threatened rainforest plants) and their percent cover in each of the following categories: 0-1 m; 1-5 m; 5-10m.

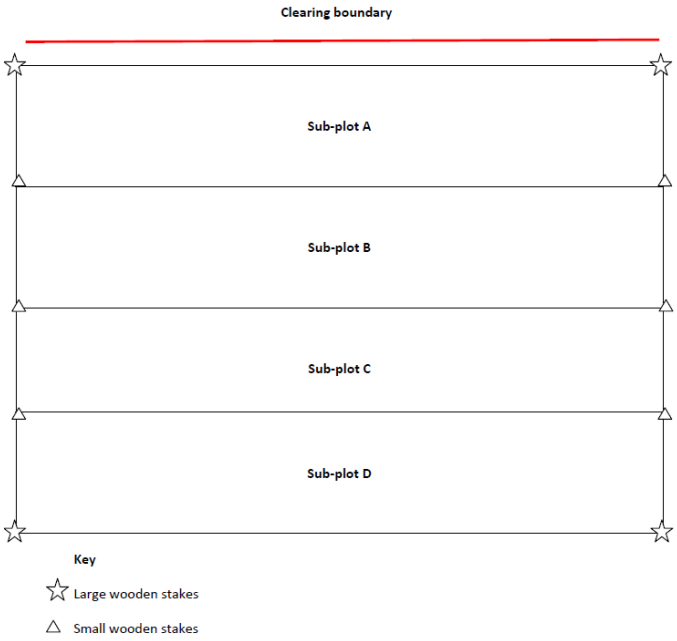


Figure 9-1 Plot layout for rainforest monitoring

Monitoring of rainforest communities would be undertaken twice a year (in autumn and spring) during construction and then annually during operation until the mitigation measures presented in this plan have been proven successful for three consecutive monitoring periods nominally three years.

9.4 Habitat revegetation

9.4.1 Objective

Evaluate the success of revegetation at locations adjacent to *in situ* threatened rainforest plants and rainforest communities.

9.4.2 Timing and methods

After the first year of maintenance of habitat revegetation, annual monitoring of revegetated areas adjacent to in situ threatened rainforest populations and communities would be undertaken using a condition assessment approach, modified from the BioBanking assessment methodology (DECC 2008), to evaluate the progress of revegetation against benchmark data for the target vegetation community. These tasks will be integrated into the landscape design for the project, as revegetation would benefit a diversity of flora species. Annual monitoring reports will be submitted by the contractor to Roads and Maritime detailing the success of revegetation. Monitoring of would be undertaken twice a year (in autumn and spring) during construction and then annually during operation until the mitigation measures presented in this plan have been proven successful for three consecutive monitoring periods nominally three years.

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); and

- 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 three 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.

Specific detail regarding revegetation including areas for revegetation, species to be used and maintenance will be described in the Urban Design and Landscape Plan (UDLP) for the project.

9.5 Translocation areas

Monitoring to be undertaken for the translocated threatened rainforest plants will be detailed in the site specific management plan prepared for each offset/translocation site. A separate translocation strategy for threatened flora species has been prepared for Sections 1 & 2 by Roads and Maritime (2015) to address the requirements of MCoA D7. A second translocation plan will be prepared for Section 3-11 by Roads and maritime to further address the requirements of MCoA D7.

9.6 Performance thresholds and corrective actions

The monitoring program, performance indicators and corrective actions to be implemented if monitoring identifies poor performance are outlined in **Table 9-3**.

Table 9-3 Performance measures and corrective actions during monitoring for habitat revegetation

Performance threshold	Corrective actions
More than 10% of plants have died after first 12 months of maintenance. More than 20% of plants have died after three years of maintenance. Total weed coverage is less than 30% in revegetation areas.	Review maintenance schedule for revegetated areas. Replace dead plants within specified timeframes. Increase weed control if required or review control methods being used.

9.7 Evaluation, project review and reporting

9.7.1 Responsibility

Roads and Maritime and its specialist consultants or contractors would be responsible for annual reporting and evaluating the monitoring information collected to implement this management plan.

9.7.2 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.

If monitoring results indicate a substantial decline in the health or number of individuals, or increase in weeds, as per the performance criteria, adaptive management measures would be implemented. These measures would be recommended by a qualified ecologist in the monitoring reporting for each period and may include (but would not be limited to) the following:

- Review of weed control measures and potentially an increase in weed control or change in control measures to minimise competition
- Watering of plants whilst young to promote establishment

- Replacement of planted individuals of species that have a survival rate below the thresholds listed above
- Replacement of retained individuals that have not survived due to edge effects associated with the project; and
- Reporting losses and underlying reasons in the monitoring reports.

9.7.3 Timing

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

10. Summary table and implementation schedule

An overall summary of the actions proposed in the above plan is provided in **Table 10-1**. It also identifies the person responsible for the actions and the estimated timing of the project.

Table 10-1 Summary table and implementation schedule of management plan.

No.	Task	Responsibility	Pre-construction	Construction	Post-construction (Year and Season)*																			
					Year 1				Year 2				Year 3				Year 4				Year 5			
					Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
1. Pre-construction management																								
1.1	Targeted surveys. Identify threatened plant species. Tag and mark threatened species in the field.	Roads and Maritime	X																					
1.2	Minimise areas for clearing	Roads and Maritime	X																					
1.3	Confirm monitoring sites	Roads and Maritime	X																					
1.4	Translocation Strategy	Roads and Maritime	X																					
1.5	Identify exclusion zones	Contractor	X	X																				
1.6	Weed Management Plan Weed management around in situ populations	Contractor	X	X																				
1.7	Seed collection	Contractor	X	X																				
2. Construction management																								
2.1	Construction work method statement	Contractor		X																				
2.2	Construction induction and training	Contractor		X																				
2.3	Seed collection and translocation	Contractor		X																				
2.4	Pre-clearing and clearing procedures	Contractor		X																				
2.6	Habitat revegetation	Contractor		X																				
2.7	Monitoring in situ rainforest flora populations	Contractor		X	X	X	X	X	X		X													
2.8	Weed management around in situ populations	Contractor		X	X	X	X	X	X		X													
3. Operational maintenance																								
3.1	Maintenance of revegetation (monthly for first year)*	Contractor			X	X	X	X	X			X	X			X								
4. Operational monitoring																								
4.1	Monitoring of in situ populations at control and reference sites. Once per year at best timing for particular species.	Roads and Maritime			X				X				X											

No.	Task	Responsibility	Pre-construction	Construction	Post-construction (Year and Season)*																			
					Year 1				Year 2				Year 3				Year 4				Year 5			
					Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
	(annually)*																							
4.2	Monitoring rainforest communities*	Roads and Maritime			X				X				X											
4.3	Monitoring of revegetation (annually)*	Contractor			X				X				X											
5. Evaluation and Reporting																								
5.1	Evaluation	Roads and Maritime				X				X				X										
5.2	Reporting	Roads and Maritime				X				X				X										

* as per MCOA condition D8(k), ongoing monitoring during operation of the SSI (for operation/ongoing impacts) is to be undertaken until such time as the use and effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods (years).

11. References

ANPSA 2006. Australian Native Plant Society (Australia) Website. Last updated January 2006http://asgap.org.au/melaleu2.html

ANPC (2004). Guidelines for the Translocation of Threatened Plants in Australia. 2nd Edition. Australian Network for Plant Conservation.

Australian Tree Seed Centre (1999) FloraBank Guidelines 2. Basic Methods for Drying, Extraction and Cleaning of Native Plant Seed. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Australian Tree Seed Centre and Mortlock (1999a) FloraBank Guidelines 6. Native Seed Collection Methods. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Australian Tree Seed Centre and Mortlock (1999b) FloraBank Guidelines 8. Basic Germination and Viability Tests for Native Plant Seed. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Connell Wagner (2008) Iluka Road to Woodburn Upgrading the Pacific Highway. Ecological Assessment –Working Paper July 2008. Report prepared for the NSW Roads and Traffic Authority

DECC (2007). Translocation Policy and Procedures. Draft Report prepared by the Department of Environment and Climate Change

DECC (2008). Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions. Department of Environment and Climate Change.

ECOS (2013). Pacific Highway Upgrade Tintenbar to Ewingsdale, Threatened Flora Translocation Project, Monitoring Report 1, ECOS Environmental Pty Ltd, January 2013.

Ecos Environmental Pty Ltd (2012) *Draft Warell Creek to Urunga Upgrade Threatened Flora Management Plan*, Prepared for NSW Roads and Maritime Services, Grafton, NSW.

Floyd A (1990) Australian rainforests in New South Wales. Volume 1. (Surrey Beatty and Sons: Sydney.)

Miles J., & P. Kendall (2006). Endangered Ecological Communities Survey and Mapping, Coastal Vegetation Communities - Littoral Rainforest and Coastal Saltmarsh. NSW Department of Environment and Conservation.

Mortlock, W. (1998a) FloraBank: Model Code Of Practice for Community-based Collectors and Suppliers of Native Plant Seed. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Mortlock, W. (1998b) FloraBank Guidelines 1. Native Seed Storage for Revegetation. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Mortlock, W. (1999) FloraBank Guidelines 3. Improving on Basic Native Seed Storage. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Mortlock, W. and the Australian Tree Seed Centre (1999a) FloraBank Guidelines 4. Keeping Records on Native Seed. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Mortlock, W. and the Australian Tree Seed Centre (1999b) FloraBank Guidelines 5. Seed Collection from Woody Plants for Local Revegetation. FloraBank, Greening Australia ACT, web address http://www.florabank.org.au.

Parsons *Brinkerhoff (2006) Translocation strategy for Maundia triglochinoides as part of the Pacific Highway upgrade, Kempsey to Eungai*, April 2006.

RTA (2011) Biodiversity Guidelines: Protecting and Managing Biodiversity on RTA projects, Transport Roads and Traffic Authority, September 2011.

Roads and Maritime (2012). Pacific Highway upgrade: Woolgoolga to Ballina Environmental Impact Statement. NSW Roads and Maritime Services.

Roads and Maritime (2013). Pacific Highway upgrade: Woolgoolga to Ballina Submissions / Preferred infrastructure report. NSW Roads and Maritime Services.

Roads and Maritime (2015) Pacific Highway upgrade: Woolgoolga to Ballina Submissions Flora Translocation Strategy for Sections 1 and 2 (Version 2). NSW Roads and Maritime Services.

Scientific Committee (2004) Final Determination to list Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner Bioregions as an Endangered Ecological Community. New South Wales, Office of Environment and Heritage.

Scientific Committee (2006) Final Determination to list Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions as an Endangered Ecological Community. New South Wales, Office of Environment and Heritage.

TSSC (2002) Approved Conservation Advice (s266B of the Environment Protection and Biodiversity Conservation Act 1999) Approved Conservation Advice for *Phyllodes imperialis* (southern ssp. ANIC 3333). DSEWPaC, Canberra.

TSSC (2011) Commonwealth Listing Advice on Lowland Rainforest of Subtropical Australia (Threatened Species Scientific Committee (TSSC), 2011) Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Vallee, L., Hogbin, T., Monks, l., Makinson, b., Matthes, M. and Rossetto M. (2004) Guidelines for the Translocation of Threatened Plants in Australia. Second Edition, Australian Network for Plant Conservation, Canberra.

Appendix A – Response to expert and agency comments

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
RCMP1	Glossary	Include a glossary of terms at the front of the management plan.	Adopted- plan updated	Glossary of terms has been further updated.
RCMP2	1.2	Doesn't describe the purpose and objectives of the plan. Recommendation: state the purpose and objectives	Adopted- plan updated	Section 1.2 has been amended to include additional information on the purpose and objectives of the Threatened Rainforest Communities and Rainforest Plants Management Plan.
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.	Reviewed and rejected. Advice from the Herbarium has been received to state that *Streblus pendulinus* is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* and the listing applies to the species across its entire range (including mainland Australia and Norfolk Island populations). When listed in 2003, *Streblus pendulinus* was considered to only occur on Norfolk Island and islands of the Pacific Ocean. At this time, mainl and populations were treated as a separate species (*Streblus brunonianus*). The taxonomy of the species has been reviewed and *Streblus brunonianus* is now considered a synonym of *Streblus pendulinus*. This taxonomic change was adopted by the Council of Heads of Australasian Herbaria in 2007 (APC 2007) and Queensland accepted change in November 2012 (e.g. Queensland Herbarium 2013). This current situation is under review and until the legislation is changed the species on the mainland will remain threatened under the EPBC Act.
RCMP4	5	Potential impacts and management approach. 1st paragraph, 2nd line – communities and plant species, with reference….	Adopted- plan updated	
RCMP5	5.2.1 and Table 5.1	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	Further clarification has now been made in the plan due to previous confusion. Wording has been changed to state that only some patches of TSC Act Lowland Rainforest in the project area meet the thresholds for Lowland Rainforest under the EPBC Act. The words 'synonymous with' have been removed and distinction made as to difference between NSW description and EPBC description. All Littoral Rainforest under the TSC Act is synonymous with Littoral Rainforest under the EPBC Act in the project area. This has also been clarified in Section 2.

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
RCMP6	5.2.1	Suggest title be changed to Direct and indirect impacts to threatened rainforest flora Take out Streblus	Adopted- plan updated	
RCMP7	5.5	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	Section 1 has been revised. It now clearly identifies the matters which this plan deals with and how it relates to other plans, such as the Threatened Flora Management Plan. This includes the addition of Figure 1-1. Translocation is discussed in further detail in Section 6.3.2. A Translocation Strategy has been prepared for Stage 1 and Roads and Maritime will commence preparations for translocation of later stages in the near future. Roads and Maritime are committed to identifying those species that are likely to be successfully translocated and trialling different methods. Learnings from previous translocations will also be considered in future translocation efforts. Further detail regarding translocation will be provided in a separate Translocation Strategy (Sections 3-11) developed to satisfy MCoA D7.
RCMP8	5.5	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	

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
RCMP10	Table 5-3	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 (i.e. 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 (i.e. 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	This TRCRPMP has been formulated to clearly identify the threatened rainforest communities and plants that have been confirmed to occur within the clearing footprint or within 20m of the clearing footprint (as they may be indirectly impacted). The plan then seeks to identify the appropriate mitigation measures that would be applied in the three different phases being pre-construction, construction and operation. Mitigation measures vary between these stages and they are clearly defined in Sections 5, 6 and 7. Outside the project was meant to be outside the 'project boundary'. The terms in-situ has been defined and the plan seeks to make it clear when a species or community is inside the clearing footprint or outside the clearing footprint but still within the project boundary (defined as in-situ). Mitigation measure 2nd column wording has been changed to reflect what was recommended.
RCMP11	Table 5-3	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 5-3	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	Roads and Maritime do not consider that a separate Rainforest Revegetation Plan is required in this instance. Further information regarding revegetation has been included in Section 8. This includes provisions for revegetation of rainforest communities and maintenance such as weed management. Revegetation performance objectives are also described in Section 8.4. Additional detail regarding revegetation will be provided in the Urban Design and Landscape Plan that is referenced in this plan.

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
RCMP13	5.7	The 2nd paragraph about SMART principles needs to go in the Introduction – Section 1.	Adopted- plan updated	
RCMP14	Table 6-1	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	A provision has been added to Section 7.3.4. In the event of an unexpected discovery of a threatened plant species, the construction staff are to follow the "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 or TRCRPMP.
RCMP16	5	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	Targeted surveys have been completed for Sections 1-11. Referred to as pre-construction surveys. These surveys included all areas within the project boundary including the clearing footprint and adjacent areas. These targeted surveys assessed vegetation communities, threatened plants and some surveys also included tagging/marking threatened species and confirming monitoring sites. These targeted surveys have been completed post approval. Contractor will also complete pre-clearance surveys just prior to clearing to make sure all species and communities are clearly marked and exclusion fencing erected etc.
RCMP17	5	p. 21, 2nd paragraph – isn't this about monitoring?	Adopted- plan to be updated prior to implementation	Wording has been amended.
RCMP18	5	p. 21, 3rd paragraph – experienced botanist to do targeted surveys, not ecologist	Adopted- plan updated	
RCMP19	5	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 (i.e. transplanting from one field site to another).	Adopted- plan updated	
RCMP20	5	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	Adopted- plan updated	

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
		the Translocation Strategy.		
RCMP21	5	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	5	Recommendation: Include T2E and BH2Y as example rainforest translocation projects.	Adopted- plan updated	
RCMP23	5	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	5	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	5	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	This level of information on trials will be provided in a separate Translocation Plan.
RCMP26	5	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	6.3.3	2nd paragraph – apart from pioneer rainforest species, rainforest seed doesn't store and should be sown straight away.	Adopted- plan updated	
RCMP29	6.3.3	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	
RCMP30	Table 6-3	Seed collection – only store pioneers species. The threatened species won't 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	Adopted- plan updated	

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
		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.		
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	6.3.5	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	Guide 6: Weed management of the Biodiversity Guidelines: protecting and managing biodiversity on RTA project (RTA 2011) provides details on what's to be done, when, who does the job. Additional weed management measures are also included to state targeted weed control measures will be implemented in areas adjacent to threatened flora populations and also that an appropriately qualified contractor undertakes weed management in areas adjacent to threatened flora species being managed *in situ*.
RCMP37	6.3	Title – Pre-construction mitigation measures …….	Adopted- plan updated	
RCMP38	7.2	Missing goal – Selection of optimal translocation receival sites for threatened flora and rainforest EEC restoration finalised well before	Adopted- plan updated	

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
		the start of translocation and road construction.		
RCMP39	7.2	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	7.3	Add dot point: All threatened plants on the edge of clearing (<5m) to chain mesh fenced.	Adopted- plan updated	
RCMP41	7.3	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	7.4	Title – Construction phase mitigation measures……	Adopted- plan updated	
RCMP43	7.4	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 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	To be reviewed prior to implementation	Roads and Maritime do not consider that a separate revegetation sub-plan is required in this instance Further information regarding managing *in situ* threatened plant species has been included in Section 5.3.2. This includes provisions for revegetation and weed management in proximity to these populations. It is considered the more appropriate document to detail revegetation requirements is the Urban Design and Landscape Plan. Revegetation planning will be informed by ecologists to ensure species used are appropriate and reflect what communities and habitat features were present prior to clearing.
RCMP44	7.4	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	

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
RCMP45	Table 7-1	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	7.4	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	8	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	Offsets are being addressed under a separate Offset Strategy.
RCMP48	8	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	8.3	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	Guide 6: Weed management of the Biodiversity Guidelines: protecting and managing biodiversity on RTA project (RTA 2011) provides details on what's to be done, when, who does the job. Additional weed management measures are also included to state targeted weed control measures will be implemented in areas adjacent to threatened flora populations and also that an appropriately qualified contractor undertakes weed management in areas adjacent to threatened flora species being managed *in situ*.
RCMP50	8.3	Tub-grinder mulch not be spread around in-situ threatened flora sites.	Adopted- plan updated	

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
RCMP51	8.4	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	9	My first reaction to the introduction to Section 9 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 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.	Adopted- plan to be updated prior to implementation	Roads and Maritime have developed a monitoring program that will ensure mitigation measures are implemented and they are effective. The monitoring program includes the use of control and impact sites so that any impacts to threatened rainforest species can be identified and addressed. The monitoring program also puts in place measures to ensure revegetation efforts are being implemented and that the objectives are being achieved. The monitoring program is clearly set out and responsibilities for monitoring will also be made clear.
RCMP53	9.3	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	Adopted- plan to be updated prior to implementation	Roads and Maritime have retained the 20mx20m plot for monitoring. This was deemed suitable to monitor rainforest communities and threatened flora populations. As there are a number of monitoring plots this will sample different areas of the patch. Observations of edge effects can also be made.

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
		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.		
RCMP54	9.6	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	9.4	Incorporate the use of salvaged topsoil seedbank in the revegetation of disturbed areas around in-situ threatened flora sites.	Adopted- plan updated	
RCMP56	9.4	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	Wording has been revised to be clearer that revegetation areas will be finalised in the Urban Design and Landscape Plan prior to construction commencing.
RCMP57	9.4	10%" I agree with the goal, but everywhere else its says "30%	Adopted- plan updated	
RCMP58	9.4	"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	Wording on monitoring sites has been updated to reflect the monitoring program and monitoring plots that have been established by Jacobs and EMM for rainforest plants and communities.
RCMP59	9.6	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	9.7	Each annual report should provide a description of the project methods and results up to that date and a discussion relating results	Adopted- plan updated	

Expert Comments				
ID No	Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2)
		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.		
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 landscaping.	Adopted- plan updated	
RCMP62	Introduction	Recommendation: Prepare a flow diagram of the 'Threatened Rainforest Communities and Rainforest Plants Management Plan' including the main actions required at each stage of implementation, ie. pre-construction, construction and post-construction.	Adopted- plan updated	

Comments received 7 May 2015

NSW Department of Planning and Environment Comments			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
1.	General	The Department notes that this version of the Plan has not been reviewed by relevant agencies. The Department will review a revised version following agency review and may have further comments at that stage.	The document has been reviewed by NSW Department of Planning and Environment and comments received on 24/3/2015, these comments have been incorporated into this version of the report (Version 2.2). The document was also sent to the Commonwealth Department of the Environment for review and their comments are described below.
2.	General	The Department notes that the Plan intends to satisfy conditions of the NSW and Commonwealth approvals. Will approvals be sought simultaneously or will	Approvals will be sought simultaneously.

NSW Department of Planning and Environment Comments			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
		one be sought first?	
3.	Section 1.1	Update description of the project as the Devils Pulpit upgrade has been completed.	Reference to Devils Pulpit updated in Section 1.1.
4.	Figures 2.1 to 2.7	Figures 2-4 to 2-7 are labelled Figure 2.1.	These figures are a map series showing the various project sections and rainforest plants and communities. As these figures are a map series and not standalone separate maps, these figures have been labelled as Figure 2-1.
5.	Table 5.4	The translocation of flora species for the Tintenbar to Ewingsdale project is cited as an example of successful mitigation measure. The example discusses actions which would be undertaken in 2013. This should be updated to current status (2015) of the translocation work.	Wording in Table 5.4 has been updated to reflect work that has been completed and current project timelines.
6.	Section 6.3.3	Second paragraph – please reword the last two sentences as unclear as to what the sentences mean. .	Final two sentences of second paragraph Section 6.3.3 of this report have been reworded to clarify the intended approach to translocation works.
7.	Section 9	Condition D8(k) requires that the Plan provide for ongoing monitoring during operation for a minimum of three successive monitoring periods. Section 9 has different monitoring time period provisions for the in situ threatened plants (as per the condition), rainforest communities (no specific time periods) and habitat revegetation (three years or until success of the revegetation has been achieved against performance criteria). Please explain the inconsistencies and departures from the condition requirement.	Section 9.3.3 and Section 9.4.2 have been edited to provide monitoring periods / timing reflecting Condition D8(k).
8.	Appendix A	Dr Benwell's recommendations have generally been addressed. The only notable outstanding recommendation is that a Rainforest Revegetation and Habitat Restoration Plan is prepared and implemented. RMS' response is that these provisions are better implemented in the project's Urban Design and Landscaping Plan. While the UDLP does require consideration of the location of existing vegetation and landscaping, revegetation of disturbed areas and monitoring and maintenance requirements for rehabilitated vegetation, the UDLP serves a primarily visual rather than ecological purpose.	Roads and Maritime do not consider that a separate revegetation sub-plan is required. Where revegetation is occurring within the project boundary, including for ecological communities, this will be identified and prescribed in the Urban Design and Landscape Plan. The plan will be developed in consultation with suitably experienced ecologists to ensure species used are appropriate, and suitable methods of revegetation are adopted. The plan will serve as a document addressing both visual aspects of revegetation and landscaping as well as ecological function. Maintenance and monitoring of revegetation is addressed in this plan in Section 7.3.6 and Section 8.3.3.

NSW Department of Planning and Environment Comments			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
		Can RMS please advise on how the ecological purpose of the Rainforest Revegetation and Habitat Restoration Plan would be captured in the UDLP and/or consult further with Dr Benwell on this?	No additional consultation with Dr Benwell is considered necessary.

Comments received 7 May 2015 and 14 July 2015

Department of the Environment			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
1.	General	EPBC 12 MCoA D8 - The Applicant shall prepare and implement Threatened Species Management Plans to detail how impacts of the project (referred to as SSI) will be minimised and managed specifically for each species identified as significantly impacted in the documents listed in condition A2 or in accordance with condition D1. The Plans shall be developed from the draft Threatened Species Management Plans included in the documents listed in condition A2(c) (subject to condition D9), in consultation with OEH, DPI (Fisheries) and DoE, and to the satisfaction of the Secretary, and shall include but not necessarily be limited to:	Noted.
2	Sections 1 and 4	a) demonstration that adequate surveys have been undertaken to assess the impacts of the SSI with reference to the Mitigation Framework developed under condition D1, including baseline data collected from surveys, undertaken by a suitably qualified and experienced ecologist on threatened species and ecological communities within all habitat areas to be cleared of vegetation for the SSI, that are likely to contain these species and that are likely to be adversely impacted by the SSI (as determined by a suitably qualified expert). The data shall address the densities, distribution, habitat use and movement patterns of these species; Several targeted vegetation and TEC surveys have confirmed the locations of rainforest species and TECs.	Noted.
3	Section 5	b) identification of potential impacts on each species; The plan has identified potential, direct and indirect impacts associated with the project.	Noted.
4	Section 6, 7 and 8	c) details of and demonstrated effectiveness of the proposed avoidance and mitigation and management measures to be implemented for each threatened species including measures to at least maintain habitat values of habitat areas compared to baseline data and maintain connectivity for the relevant species;	Section 5.7 and Table 5-4 discuss the effectiveness of proposed mitigation measures proposed in the context of standard procedures to be applied and their effectiveness on previous projects. A range of issues have been discussed, specifically: • Accidental impacts to threatened in situ flora species • Impacts from weeds on in situ flora species

Department of the Environment			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
		Details have been provided regarding avoidance, mitigation and management measures to be implemented for rainforest threatened species and communities. Effectiveness of these measures has not been demonstrated though appropriate monitoring and corrective actions have been proposed. Please provide details of and demonstrated effectiveness of the proposed avoidance, mitigation and management measures to be implemented.	• Unsuccessful revegetation • Edge effects and degradation of existing rainforest plants • Changes to hydrological and nutrient regimes • Lowering of the water table; and • Spread of pathogens. Against these issues, a range of mitigation measures have been examined assessing their history of success. The management of these issues, using the identified mitigation measures, have then been allocated an effectiveness rating ranging from low to high. Roads and Maritime consider adequate information on effectiveness of proposed avoidance, mitigation and management measures has been provided.
5	Section 9	d) an adaptive monitoring program to assess the use of the mitigation measures identified in conditions B10 and D2. The monitoring program shall nominate appropriate and justified monitoring periods, performance parameters and criteria against which effectiveness of the mitigation measures will be measured and include operational road kill and fauna crossing surveys to assess the use of fauna crossings and exclusion fencing implemented as part of the SSI; See comment against ID 4.	Monitoring is discussed in the following sections: • Sections 5.5 Mitigation and Monitoring – outlines the objectives for mitigation and monitoring measures proposed for the Project in consideration of the Biodiversity Management Framework • Section 6 Pre-construction Management Measures – outlines the key mitigation measures for implementation during pre-construction. Table 6-5 outlines these mitigation measures and specifies the monitoring frequency and timeframes to be achieved for each mitigation measure. Performance thresholds have also been specified for each which outlines the triggers for a corrective action • Section 7 Construction Management Measures – outlines the key mitigation measures for implementation during construction. Table 7-1 outlines these mitigation measures and the specific monitoring timing and frequency for each. Performance thresholds have been identified for each which outlines the trigger for a corrective action • Section 8 Operational Management Measures – outlines the key mitigation measures for implementation during operations. Table 8-3 outlines these mitigation measures and specifies monitoring timing and frequency for each. Performance thresholds have been identified for each which outlines the trigger for a corrective action; and • Section 9 Monitoring Program – outlines the monitoring objectives and goals for the project for rainforest plants and communities, specific monitoring that will be conducted and timeframes. Monitoring during construction and operation will be adaptive as if mitigation measures are found not to be effective then corrective actions are identified. This will enable an adaptive approach as issues arise they will be assessed and appropriate additional actions taken. Issues associated with fauna species such as road kill and fauna crossings are not applicable to this plan and are discussed in fauna specific plans or the Flora and Fauna Management Plan.

Department of the Environment			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
6	Section 9	e) monitoring methodology for threatened flora and fauna adjacent to the SSI footprint; See comment against ID 4.	As per the above comment, monitoring is discussed throughout the Threatened Rainforest Community and Rainforest Plants Management Plan. The methodology is outlined in Section 9 with specifics related to timing and frequency for the monitoring of specific issues for rainforest communities and plants for pre-construction, construction and operations outlined in Sections 6, 7 and 8 respectively.
7	Section 5.7 and 9	f) goals and performance indicators to measure the success of mitigation measures, which shall be specific, measurable, achievable, realistic and timely (SMART), and be compared against baseline data; Addressed	Noted.
8	Section 1.3	j) mechanisms for the monitoring, review and amendment of these plans; Addressed	Noted.
9	Section 9	k) provision for ongoing monitoring during operation of the SSI (for operation/ongoing impacts) until such time as the use and effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods, unless otherwise agreed by the Secretary in consultation with the OEH, DPI (Fisheries) and DoE; and Table 8.3 – Operational Phase mitigation measures: The second monitoring point regarding at least 90 per cent of plants surviving, states that for the first twelve months, monitoring of vegetation will be monthly then every 6 months for 2 years. Section 9.2.2, In Situ Methods; states that monitoring will occur twice a year during construction then annually to 3 years. Please clarify if Table 8.3 covers in situ plants or translocated vegetation.	Table 8-3 addresses in situ rainforest plants and communities as well as revegetation areas adjacent to the road corridor. It does not pertain to translocated plants as the management and monitoring of these plants will be outlined in the Translocation Strategy. Section 9.2.2 has been updated to ensure that monitoring is undertaken as follows: • Every three months during the first year of construction; • Every six months during the second year of construction; and • Every 12 months thereafter for a minimum of three years post-construction (subject to achieving three consecutive monitoring periods as per MCoA D8 (k)). Following this period, a review of the monitoring would be undertaken to identify if further monitoring is required. The timing of surveys for cryptic species or species that may die back at certain times of the year due to climatic conditions will be optimised to allow the greatest chance of observing these species.
10	Section 9.7	Provision for annual reporting of monitoring results to the Secretary and the OEH, DPI (Fisheries) and DoE, or as otherwise agreed by those agencies. Brief annual reports will be prepared by the contractor for Roads and Maritime Services, NSW.	Noted.
EPBC 12	This Plan for sections 1-11 of the highway	EPBC listed lowland Rainforest in Sub tropical Australia is limited to sections 10 and 11 of the highway upgrade. EPBC listed Littoral Rainforest is limited to section 10 of the highway upgrade. In ADDITION, *Cryptocarya foetida* (v), *Macadamia tetraphylla* (v), *Syzygium hodgkinsonia* (v) and *Sreblus pendulinus (*E) are found in Section 10. *Streblus pendulinus* is also found in sections 4 and 8.	Lowland Rainforest of Sub-tropical Australia • Figure 2.1 indicates this occurs in Section 10 and 11 • Table 2-1 indicates this and wording has been updated to reflect this also. • More reference to Table 2-1 and Figure 2.1 have been made where appropriate. Table 5-2 and Figure 2.1 highlight: *Cryptocarya foetida* - Section 10

Department of the Environment			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
			Macadamia tetraphylla –Section 8 & 10 *Sreblus pendulinus* – Section 4, 8 & 10 *Syzygium hodgkinsonia* – Section 10
12		As the rainforest MP forms part of Threatened Flora MP (condition 12) this would require the Minister's delegate's approval. A hard copy of the final version of the Plan must be submitted for consideration of approval.	RMS to submit the final hard copy of the Threatened Rainforest Plan to DotE for approval.
D8		Condition D8 applies to both threatened flora and fauna. EPBC condition 12 specifically relates to threatened flora species.	This plan and the TFMP cover off on the EPBC 12 for flora.
D8(a)	4	Compliant- information provided in section 4 indicates that adequate surveys have been undertaken by suitably qualified and experienced persons.	Acknowledged.
D8(b)	5, Figure 2.1	Table 5-1 indicates a total of 3.37 ha of Lowland Rainforest (includes both EPBC and NSW listed Ecological communities) will be directly impacted. No estimation has been made for the area that may be potentially impacted by indirect impacts, in particular given the location of this community in close proximity to the upgrade (section 10). It is also noted that this area includes habitat for Cryptocarya and Macadamia. A total of 0.2 ha will be impacted. No estimation has been made for the area that may potentially be indirectly impacted (Figure 2.1). Both direct and indirect impacts on EPBC listed rainforest flora species have been estimated as follows: Cryptocarya – 48 individuals Macadamia – 15 individuals Streblus – 10 individulas Syzigium – 10 individuals Please ensure that the numerical values provided for impact areas/individuals are consistent with those provided in the Biodiversity Offset Strategy.	Potential for indirect impacts are outlined in Section 5.2.2. The extent of indirect impacts on rainforest communities are difficult to predict therefore RMS has identified appropriate mitigation measures to reduce the indirect impacts occurring such as managing dust and weeds. Monitoring will allow for indirect impacts to be monitored and corrective actions put in place to prevent future impacts from occurring. Offsets are proposed for the estimated extent of direct impact to rainforest communities. For individual rainforest plants indirect impacts are presented based on applying a 10m or 20m buffer. Table 5-1 Please see the * or table note which explains impact calculation considerations. Low RF – 1.88 Litt RF – 0.2 Biodiversity Offsets Strategy (Table 4) Low RF – 1.88 Litt RF – 0.2 The data in this management plan is the most recent, has been reviewed thoroughly and represents the most accurate impact calculations for EPBC listed rainforest flora species. The areas/individuals presented in the Biodiversity Offset Strategy will be updated to reflect this plan if there is any inconsistency.

Department of the Environment			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
D8(c)	Table 5-4, section 6	Table 5-4 indicates that there is low certainty that the habitat values for the ecological communities and threatened rainforest plant species will be maintained due to edge effects including changes to hydrological and nutrient regimes. What contingency measure have been incorporated in determining offsets for uncertainty associated with indirect impacts?	Biodiversity Offset Plan addresses this matter. Section 7.4 provides guidance for the management of unforeseen impacts as a result of detailed design.
	6	Has translocation strategy for rainforest species completed and approved by NSW? If all targeted surveys have been completed, it is unclear why the species that have been identified for translocation have not been listed in this plan.	A Translocation Strategy has been developed for Sections 1 and 2 and soft soil work areas. Those threatened species proposed to be translocated were reflected in the TFMP. A Translocation Strategy is still being finalised for Sections 3-11 which will include an evaluation of rainforest plants. Therefore RMS is still finalising which rainforest species are able to be effectively translocated. Therefore this information is not currently available to be incorporated into this Rainforest Plan.
D8(d)	9	What is a substantial decline of population numbers? How does this relate to performance objective/s/thresholds?	Any decline greater than the performance threshold is considered to be significant in the context of the monitoring program. Measures outlined in Section 9.7.2 would be implemented should the decline exceed thresholds. Section 9.2.1 – All retained in-situ threatened rainforest plants have survived during construction and for three consecutive monitoring periods post-construction and 80 per cent survived after three years Table 9-3 – Performance measures and corrective action during monitoring for habitat revegetation: • No more than 10% of plants have died after first 12 months of maintenance. • No more than 20% of plants have died after three years of maintenance. • Total weed coverage is less than 30% in revegetation areas.
D8(e)	9	There is uncertainty associated with successful implementation of proposed monitoring programs due to pending landholder agreements. What contingency/offset measures would be provided in the event of failure to achieve the proposed outcomes (other than through the identified mechanism of 3 consecutive monitoring)?	Offsets Strategy Report suggest there is enough options available to achieve this as detailed below: Roads and Maritime will use potential offset properties from a number of different scenarios: 1. Properties Roads and Maritime currently owns or has commenced acquisition discussions with the landowners 2. Private properties where landowners have previously contacted Roads and Maritime about suitability of their properties for offsets 3. Applications received from a public Expression of Interest. 4. Review of the NSW BioBanking Register to identify any credits issued for species and communities that require offsetting.

Department of the Environment			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
D8(f)	9.5 and table 9-3	There is insufficient information in relation to habitat revegetation – e.g. areas identified, responsible party for revegetation, management , monitoring etc It is noted that information on translocation of rainforest species may be addressed separately in the Rainforest translocation strategy – please provide the relevant reference to this document within the Rainforest MP.	Section 6.3.3, 7.3.7, 8.3.3 and 9.4 outlines where to find the revegetation areas. References to the Urban Design and Landscape Plan and Translocation Strategy have be included into these sections as well.
D8(g)		This condition is applicable to fauna only	This condition is not applicable to this plan as outlined in Table 1-1
D8(h)		Has not been addressed.	This condition is not applicable to this plan as outlined in Table 1-1. It is fauna specific.
D8(i)		Review of management measures and monitoring regimes are proposed with additional offsets in the event of failure. Please see comments above for failures that may be associated with other potential causes for which contingency measures will need to be considered (e.g. land tenure issues, additional individuals found during pre-clearance surveys)	This condition is not applicable to this plan as outlined in Table 1-1. It is fauna specific about changes to habitat usage. Section 7.3.5: 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 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 TRCRPMP. Additional offsets may be required if impacts cannot be avoided.
D8(j)	1.3	Section 1.3 – in the event of any new EPBC listed flora species is found, or any significant changes to proposed management and monitoring measures in the Rainforest MP, the updated plan will need to be re submitted for the Minster's consideration of approval.	Noted. Any updates to the TRCRPMP will be submitted to the Minister for approval. TRCRPMP states in Section 1.3.2: Note that the administering authorities require approval of any updates to the TRCRPMP, incorporating the results of targeted surveys for particular sections, prior to construction commencing for that section. Wording has been added to include any major updates to the plan will also be submitted to the relevant assessment agency for approval.
D8(k)	8	Monitoring is proposed only up to 3 years following completion of construction. This is not considered as meeting the condition requirement.	Monitoring timeframes proposed are consistent with project conditions. The condition requires: k) provision for ongoing monitoring during operation of the SSI (for operation/ongoing impacts) until such time as the use and effectiveness of mitigation measures can be demonstrated to have been achieved over a minimum of three successive monitoring periods, unless otherwise agreed by the Secretary in consultation with the OEH, DPI (Fisheries) and DoE. Monitoring must demonstrate mitigation measures have been successful for a minimum of three consecutive periods meaning that monitoring could continue for a longer timeframe if mitigation has not

Department of the Environment			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
			been demonstrated to be successful.
D8(l)	3.1	Only the preparation of reports is mentioned. Under the EPBC Act, the annual compliance report will need to include information on the implementation of approved management plans.	Section 9.7.3 states: A brief annual report would be prepared by the contractor for distribution to the Roads and Maritime and other relevant government agencies. This reporting would document the methods and results of each monitoring event (up to date) and a discussion relating to the current year's results of monitoring to the results of the previous year. It is assumed this reporting covers the implementation of this management plan given its monitoring methods/results and comparison to previous baseline data will be captured.

Environmental Protection Agency			
ID No	**Section**	Comment / Recommendation	Recommendations that have been addressed (Version 3)
1.	General	EPA advised on 31 March 2015 they have no further comment.	Noted.

Appendix B – Dr A. Benwell 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.

Survey and Management of Terrestrial and Aquatic Flora and Fauna at Emigrant Creek Dam, report to Rous Water 2003.

Vegetation Regeneration and Landscape Plan for Community Titles development at Lot 2 Main Arm Road via Mullumbimby, for Leon Rubinstein. 2003.

Management plan for the Endangered Plant Rusty Green-leaved Rose Walnut (*Endiandra muelleri* subsp. *bracteata*) on Stage 3 of the Koala Beach Estate, Tweed Shire and plan implementation, for the Australian Koala Foundation on behalf of the Ray Group P/L. 2002

Survey and Management Plan for threatened plants on power line corridors in Byron Shire, report to Country Energy. 2002.

Review of Environmental Factors for emergency water supply works at Howards Grass (Lismore) & Middleton Way (Dorroughby), report to Rous Water. 2002.

Threatened species survey and mapping and rehabilitation advice for a floodplain rainforest remnant on Cudgera Creek impacted by proposed upgrade of Cudgera Creek Road, report to PES (RTA). 2002.

Vegetation survey of Stages 5, 6 & 7 Koala Beach Estate, Pottsville and Eight Point Tests for Threatened plants *Endiandra muelleri* subsp. *bracteata*, *Arthraxon hispidus* and *Archidendron hendersonii*, report to the Australian Koala Foundation on behalf of the Ray Group P/L. 2002

Flora, Fauna and Habitat Survey of Marshall's Ridge, North Ocean Shores, report to Greenfields Mountain P/L. 2002.

Flora survey and vegetation mapping of route options for the Sapphire Beach to Woolgoolga section of the Pacific Highway Upgrade, for Connell Wagner P/L. 2002.

Development Application - Boundary Fencing Billinudgel Nature Reserve and Greenfields Mountain P/L and associated Environmental Assessments (acid sulphate soils, aboriginal heritage, flora and fauna), prepared for the National Parks and Wildlife Service, Tweed Office. 2001

Flora and fauna survey and Revegetation Concept Plan for the proposed Dunoon Dam Site, prepared for Rous Water. 2001.

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

Flora and fauna survey of 'Harris Creek' (Gresford) and 'Hiddenvale' (Dungog), two properties in the Hunter Valley Region. Report to National Parks and Wildlife Service, Coffs Harbour. 2001

Flora surveys and rehabilitation proposal for ex-logging roads in Toonumbar, Yabbra and Tooloom National Parks, for Kyogle sub-district for the NSW National Parks and Wildlife Service. 2001

Flora survey and Eight Point Test for an occurrence of *Endiandra muelleri* subsp. *bracteata* on Stage 2 of the Koala Beach Estate, Pottsville, for the Australian Koala Foundation on behalf of the Ray Matrix P/L. 2001

Translocation, monitoring and habitat rehabilitation for nine species of Threatened rainforest tree, shrub and vine flora on the Yelgun-Chinderah section of the Pacific Highway upgrade, for Abigroup Contractors P/L and the NSW Roads and Traffic Authority. 2000-2001.

Flora Environmental Control Plan - Yelgun-Chinderah Pacific Highway Upgrade, report to Abigroup Contractors P/L and the NSW Roads and Traffic Authority. 2000.

Landscaping, Revegetation and Rehabilitation Environmental Control Plan for the Yelgun-Chinderah Pacific Highway Upgrade, report to Abigroup Contractors P/L and the NSW Roads and Traffic Authority. 2000.

Weed Control and Vegetation Clearing Environmental Control Plan for the Yelgun-Chinderah Pacific Highway Upgrade, report to Abigroup Contractors P/L and the NSW Roads and Traffic Authority. 2000.

Botanical survey and vegetation map of Nymboida National Park, for the NSW National Parks and Wildlife Service, Northern Tablelands Region. 1999-2000

Monitoring of the threatened species *Eleocharis tetraquetra* at Boambee, for RTA and the NSW National Parks and Wildlife Service. 2000-2001

Publications and Discussion Papers:

2013. Ballina Bypass *Arthraxon hispidus* (Hairy Joint Grass) Translocation Project. Discussion Paper presented at the 2013 Australian Network for Plant Conservation translocation workshop at the University of the Sunshine Coast.

2011. Life history and morphological variation in intraspecific seeder and resprouter populations of two species from rock outcrop vegetation in north-east New South Wales. *Australian Journal of Botany* 59, 1–10

2007. Response of Rock Outcrop and Fringing Vegetation to Disturbance by Fire and Drought. *Australian Journal of Botany* 55 (7) 735-748.

2006. Thomas, J., Hofmeyer, D. and Benwell, A. S. Bitou bush control (after fire) in Bundjalung National Park on the NSW North Coast. *Ecological Management and Restoration*, 7, 79-92.

1999. Species Recovery Plan for *Corchorus cunninghamii.* Prepared for the NSW National Parks and Wildlife Service.

1998. Post-fire seedling recruitment in coastal heathland in relation to regeneration strategy and habitat. Australian Journal of Botany. 46, 75-101.

1998. Species Recovery Plan for *Angiopteris evecta*. Prepared for the NSW National Parks and Wildlife Service.

1998. Species Recovery Plan for *Allocasuarina defungens*. Prepared for NSW National Parks and Wildlife Service.

1996 (co-author). Estimation of the Pre-1750 Forest Type Distribution for the Northern Study Area. Prepared for RACAC by the NSW National Parks and Wildlife Service.

1995. Interim Procedure for the Protection of High Conservation Value Examples of Inadequately Conserved Forest Types in North Eastern NSW. Report to the National Parks and Wildlife Service.

1994. (key contributor) Flora of North-east NSW Forests. North East Forests Biodiversity Report No.4. NSW National Parks and Wildlife Service.

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

(*Coatesia paniculata* syn. *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

Siah’s backbone

(*Streblus pendulinus syn. S. brunonianus)*

Source: BAAM

DESCRIPTION

Siah’s backbone (also known as 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-0-1: 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.

Appendix E – Conditions threshold for rainforest communities – 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.

Appendix F – Threatened Flora Pre-construction Survey Report Jacobs (2014)

Appendix G – Vegetation Survey Report Section 1 – Woolgoolga to Ballina Pacific Highway Upgrade – Biosis

Appendix H – Vegetation Survey Report for Section 2 of Woolgoolga to Ballina Pacific Highway Upgrade – Ecosure

Appendix I – Vegetation Survey Report for Section 3 of Woolgoolga to Ballina Pacific Highway Upgrade – Geolink

Appendix J – Vegetation Survey Report for Section 4 of Woolgoolga to Ballina Pacific Highway Upgrade – Geolink

Appendix K – Vegetation Survey Report for Section 8 of Woolgoolga to Ballina Pacific Highway Upgrade – Melaleuca Group

Appendix L – Rainforest Communities and Threatened Rainforest Plants Preconstruction Targeted Surveys and Baseline Monitoring Report for Section 10 & 11 of Woolgoolga to Ballina Pacific Highway Upgrade – EMM

Appendix M – Vegetation Survey Report for Section 10 & 11 of Woolgoolga to Ballina Pacific Highway Upgrade – Australian Museum Consulting