

NSW Roads and Maritime Services

WOOLGOOLGA TO BALLINA | PACIFIC HIGHWAY UPGRADE THREATENED FLORA MANAGEMENT PLAN

Sections 1 to 11 (including Soft Soil Work Areas)

Version 3

August 2015

**Prepared by: NSW Roads and Maritime Services, Aurecon,
Sinclair Knight Merz and Amec Foster Wheeler**

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Glossary and Abbreviations

Term	Definition
CEMP	Construction Environmental Management Plan
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 OEHL)
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
EPA	NSW Environment Protection Authority
EP&A Act	NSW <i>Environmental Planning and Assessment Act 1979</i>
EPBC Act	Commonwealth <i>Environment Protection and Biodiversity Conservation Act 1999</i>
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 project boundary (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 Ministers Condition of Approval
NSW	New South Wales
OEHL	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.
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	NSW Roads and Maritime Services
SAP	Sensitive Area Plans
SPIR	Submissions / Preferred Infrastructure Report
Stochastic event	Natural phenomenon such as storms, fires, floods, droughts etc. (random event)
Targeted surveys	Field surveys completed in 2014 for Sections 1 to 11 for threatened flora species listed under the EPBC Act and TSC Act.
TFMP	Threatened Flora Management Plan (this plan)
Trigger for corrective action	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.
TRCMP	Threatened Rainforest Communities and Plants Management Plan
Threatened species	Any organism listed as vulnerable, endangered or critically endangered under State and/or Commonwealth legislation.

Term	Definition
TSC Act	<i>Threatened Species Conservation Act 1995</i>
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 <i>Noxious Weeds Act 1993</i> 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 NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) on 24 June 2014 and under the Commonwealth *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 km 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 km 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 the figure above.

Key features of the upgrade include:

- Duplication of 155 km 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 transit of animals over and under the upgraded highway where it crosses key animal habitat or known wildlife corridors
- Rest areas located at about 50 km intervals at Pine Brush (Tyndale), north of Mororo Road and north of the Richmond River
- 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 – Ministers 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 Commonwealth governments. Both governments have a shared commitment to finish upgrading the highway to a four-lane divided road as soon as possible. Construction is expected to commence mid 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 Woolgoolga to Ballina project sections

1.2 Purpose of the plan

This Threatened Flora Management Plan (TFMP) has been developed to meet the approval condition requirements of MCoA D8, and Commonwealth EPBC Act Condition of Approval (CoA) 12. This TFMP addresses all Sections (1 to 11) and soft soil work areas of the Project (see **Figure 1.2**).

The requirements of these approvals, commitments made in the SPIR, and where each is addressed in this report are detailed in **Table 1-1**.

This TFMP identifies the potential impacts of the upgrade on threatened flora species listed under the EPBC Act and NSW *Threatened Species Conservation Act 1995* (TSC Act) which are considered to be directly impacted, or have the potential to be indirectly impacted by the project.

Targeted surveys of threatened flora species and populations have confirmed there are 22 species that are directly or indirectly impacted by the Project. The threatened flora species identified as directly and/or indirectly impacted by the Project are:

- Rough-barked Apple (*Angophora robur*)
- White Lace Flower (*Archidendron hendersonii*)
- Hairy Joint Grass (*Arthraxon hispidus*)
- Stinking Cryptocarya (*Cryptocarya foetida*)
- Water Nutgrass (*Cyperus aquatilis*)
- Square-stemmed Spike-rush (*Eleocharis tetraquetra*)
- Green-leaved Rose Walnut (*Endiandra muelleri* subsp. *bracteata*)
- Square-fruited Ironbark (*Eucalyptus tetrapleura*)
- Four-tailed Grevillea (*Grevillea quadricauda*)
- Lindernia (*Lindernia alsinoides*)
- Slender Screw Fern (*Lindsaea incisa*)
- Rough-shelled Bush Nut (*Macadamia tetraphylla*)
- Maundia (*Maundia triglochinoides*)
- Weeping Paperbark (*Melaleuca irbyana*)
- Yellow-flowered King of the Fairies (*Oberonia complanata*)
- Soldiers Crest Orchid (*Oberonia titania*)
- Knotweed (*Persicaria elatior*)
- Singleton Mint Bush (*Prostanthera cineolifera*)
- Moonee Quassia (*Quassia* sp. *Moonee Creek*)
- *Rotala tripartita*
- Siah's Backbone (*Streblus pendulinus*); and
- Smooth-barked Rose Apple (*Syzygium hodgkinsoniae*)

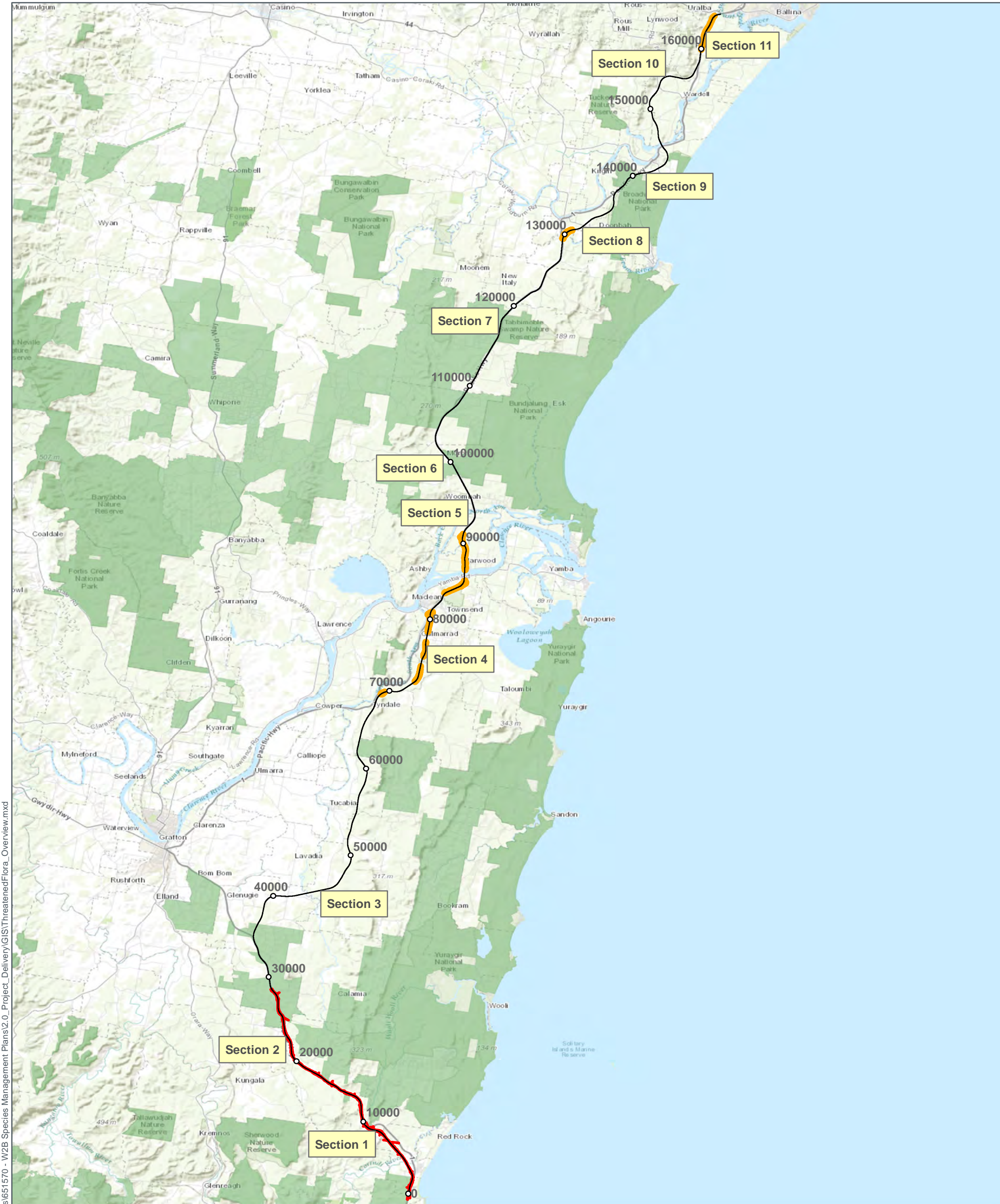


Figure 1.2

WORK REQUEST NUMBER: RMS

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

○ Chainage (metres)

— Alignment

Section 1 and 2

Soft soil area

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
26/03/2015	JH	NG	BE	0	Issued for Use
24/03/2015	JH	NG	BE	A	Issued for Review

0 5 10
Kilometers

1:390,000
(A3) GCS GDA 1994

Amec Foster Wheeler does not guarantee the accuracy or completeness of the map and does not make any warranty about the data.
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Table 1-1 Project approval requirements and where addressed

Approval requirement		Where addressed
NSW approval		
MCoA D8	<p>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:</p> <p>(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;</p> <p>(b) identification of potential impacts on each species;</p> <p>(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;</p> <p>(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;</p> <p>(e) monitoring methodology for threatened flora and fauna adjacent to the SSI footprint;</p> <p>(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;</p> <p>(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;</p> <p>(h) provision for the assessment of monitoring data to identify changes to habitat usage and whether this can be attributed to the SSI;</p> <p>(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;</p> <p>(j) mechanisms for the monitoring, review and amendment of these plans;</p> <p>(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</p> <p>(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.</p>	<p>The requirements of this condition are addressed in this plan.</p> <p>(a) is addressed in Section 1.4 and Section 2.</p> <p>(b) is addressed in Sections 4.1, 5.1 and 6.1.</p> <p>(c) is addressed in Sections 4, 5 and 6.</p> <p>(d) is addressed in Section 8.</p> <p>(e) is addressed in Sections 7.3.1 and Section 8.</p> <p>(f) is addressed in Section 4.5 and Section 8.</p> <p>(g) is not applicable to flora.</p> <p>(h) is addressed in Section 8.</p> <p>(i) is addressed in Sections 5.4, 6.4 and 7.4.</p> <p>(j) is addressed in Section 1.3 and Section 8.4.</p> <p>(k) is addressed in Section 8.</p> <p>(l) is addressed in Section 8.5.</p> <p>Expert and agency recommendations regarding the TFMP (received for the first update) are summarised and details as to how they have been addressed in this plan are provided in Appendix A.</p> <p>Technical survey reports are included in Appendix D.</p>
Commonwealth approval		
EPBC-12	<p>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 to the satisfaction of the Minister and be submitted to the Minister for approval. The relevant stages cannot commence until</p>	<p>The requirements of this condition are addressed in this plan.</p> <p>Expert and agency recommendations regarding the TFMP (received for the first update) are summarised and</p>

Approval requirement		Where addressed
	the Threatened Flora Management Plan(s) for that stage is approved by the Minister. The approved plan(s) must be implemented.	details as to how they have been addressed in this plan are provided in Appendix A.
SPIR Environmental Management Measure		
B11	<p>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:</p> <ul style="list-style-type: none"> 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. Results from baseline monitoring undertaken. <p>The threatened species management plans will be finalised in consultation with the relevant State and Federal government agencies.</p>	<p>This report forms the TFMP for all project sections 1-11 and soft soil works.</p> <p>Expert recommendations, conditions of approval and baseline surveys have been considered and addressed in this plan.</p>
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 for the Project. The surveys and findings are summarised in this plan in Section 2. Appendix C includes figures showing the confirmed locations of threatened flora species for all project sections.
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 5.3.5.
B27	A weed management plan will be developed as part of the CEMP, in accordance with the Roads and Maritime Biodiversity Guidelines (RTA, 2011a) and the Introductory Weed Management Manual (Richards, 2004).	The management of weeds have been addressed in Sections 4.4, 5.3.6, 5.3.7 and 7.3.3. Weed management will also be addressed in the CEMP.
B51	Ancillary facilities will be located in cleared or sparsely treed portions of the ancillary facility sites and avoid unnecessary clearing of native vegetation.	This commitment is reflected in Section 4.2.
B53	The project boundary footprint in Section 1 will be reviewed to identify any opportunities to avoid significant impacts to the existing population of Slender Screw Fern.	Slender Screw Fern (<i>Lindsaea incisa</i>) is a species that is highly variable and changes in abundance with climatic conditions. It grows in damp locations on stream edges and in and on the margins of freshwater swamps. During detailed design for Section 1 the species was confirmed in small numbers. During more recent surveys in 2014 an additional population was recorded in Section 1. This was due to ideal climatic conditions in Section 1 during the survey (April 2014) with numerous plants shooting from underground rhizomes. Other populations were also confirmed in Sections 2, 3 and 6. Roads and Maritime has been unable to avoid all individuals of the species at this stage and further monitoring of the populations will occur for those individuals being retained adjacent to the project.
B54	The project footprint and placement of sedimentation basins will be evaluated to minimise impacts to Slender Screw Fern.	Extensive surveys have been undertaken to identify areas of Slender Screw Fern (<i>Lindsaea incisa</i>). Placement of infrastructure will consider the occurrences of these species and seek to avoid impacting Slender Screw Fern. Sections 4.3, 4.5,

Approval requirement		Where addressed
		5.3, 5.4, 6.3 and 6.4 discuss mitigation measures to minimise impacts on threatened flora species.
B61	<p>Detailed design will investigate measures to reduce impacts to <i>Maundia triglochinos</i>:</p> <ul style="list-style-type: none"> Near North of New Italy (Population 12). Near Redbank Creek (Population 14). 	<p><i>Maundia</i> (<i>Maundia triglochinos</i>) has been recorded in a number of sections of the project including Section 1, 2, 3 and 7. Individuals have been confirmed within the project clearing footprint and within a 20 m buffer from the clearing footprint. The clearing footprint has been reduced where possible in proximity to Redbank Creek to avoid individuals of this species in Section 1.</p> <p>At Redbank Creek, the culverts are designed to ensure their hydraulic performance, while also considering fish passage. There is a lot of scour protection through this creek line and this is due to bank erosion, flow velocities and providing opportunities for fish to migrate under the alignment (providing pools to replicate existing conditions as best we can). Therefore there are a number of considerations to be taken into account in proximity to Redbank Creek.</p>

It should be noted this plan addresses all threatened plant species listed under the EPBC Act and TSC Act for completeness. Five of these 22 species are also rainforest plants and are included in the Threatened Rainforest Communities and Plants Management Plan (TRCMP). The TRCMP focuses on the occurrence of threatened rainforest communities and threatened rainforest plant species that occur within the rainforest communities. These species include White Lace Flower (*Archidendron hendersonii*), Stinking Cryptocarya (*Cryptocarya foetida*), Green-leaved Rose Walnut (*Endiandra muelleri* subsp. *bracteata*), Rough-shelled Bush Nut (*Macadamia tetraphylla*) and Siah's Backbone (*Streblus pendulinus*).

The objectives of the plan include providing:

- An effective TFMP with consideration to the concerns of main stakeholders including expert and agency review.
- An overarching management framework for all threatened flora for the project.
- Information on the likely extent of direct and indirect impacts to threatened flora as a result of the Project, including updated information collected during targeted surveys.
- Mapping identifying the confirmed locations of threatened flora populations during targeted surveys in proximity to the Project.
- Management and mitigation measures that will be implemented during pre-construction, construction and operation of the project to minimise impacts on threatened flora populations.
- A monitoring program to be implemented during pre-construction, construction and operation of the project to assess the effectiveness of the mitigation measures and inform an adaptive management approach.

1.3 Management structure and plan updates

Management structure

This TFMP provides an overarching management framework for avoiding, minimising and mitigating impacts on threatened flora species.

The plan provides up-to-date information using the results of targeted surveys completed in 2014 which have identified the occurrence of threatened flora species within the project boundary and informed the location of mitigation measures. This plan also informs future monitoring and reporting programs, by describing the final monitoring sites, methods, variables and timing of this program as detailed in **Section 8**. Details have also been provided for the parameters of site selection of the final monitoring sites (*in situ* monitoring sites and control sites) which have been identified through targeted surveys undertaken for the project.

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 Translocation Strategy. An overview of how this TFMP relates to other relevant project documentation is provided in **Figure 1.3**.

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).

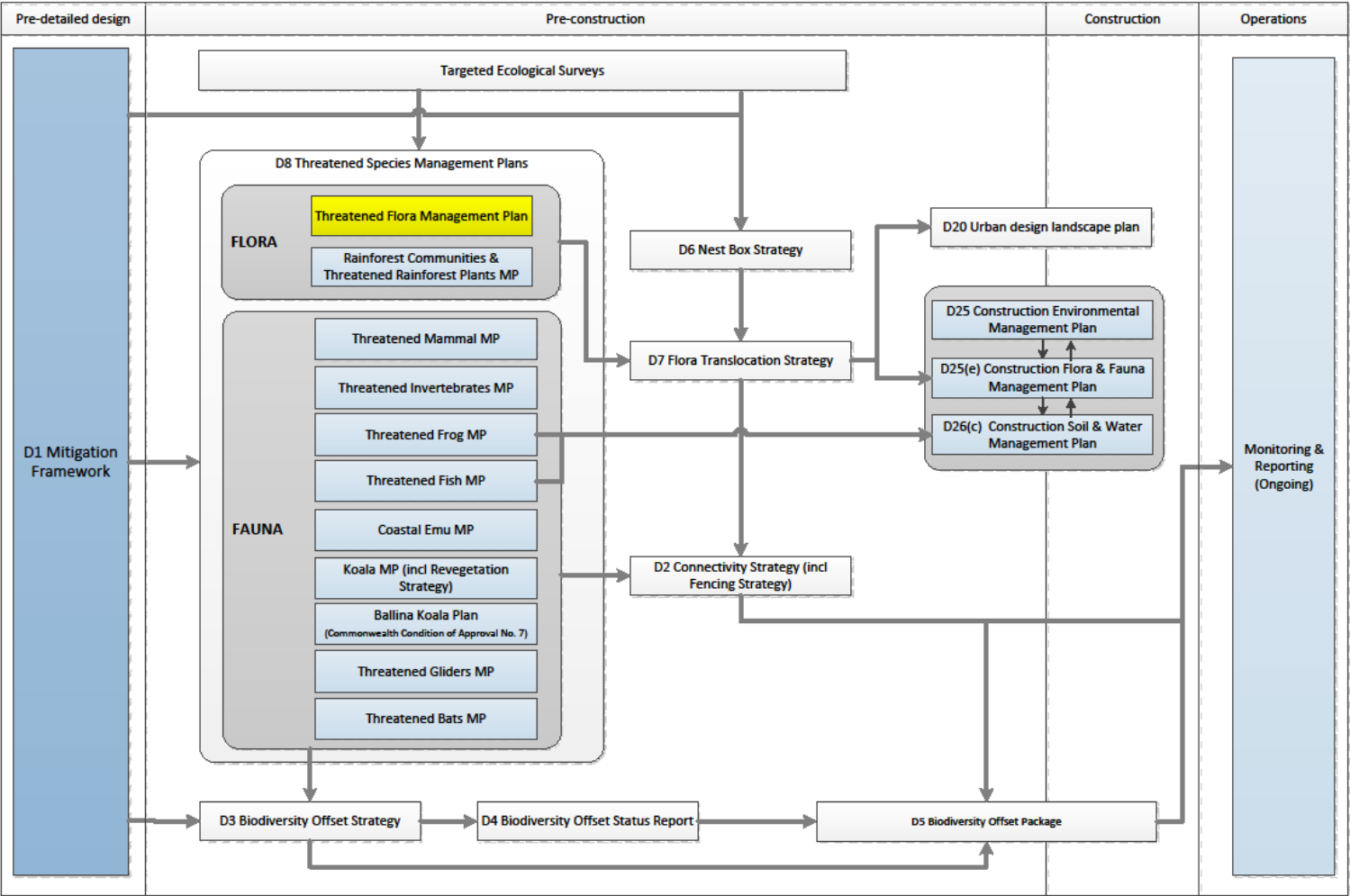


Figure 1.3 Project documentation overview

Plan updates

The plan is intended to be a dynamic document subject to continual improvement. The TFMP has been updated to incorporate results of targeted threatened flora surveys and to ensure that it meets the mitigation and management measures committed to in the Environmental Impact Statement (EIS) and SPIR, and conditions of approval including MCoA D8.

Roads and Maritime has updated this plan in stages, as detailed in the Biodiversity Mitigation Framework (MCoA D1) and the Staging Plan (MCoA A7). This is to reflect the staged nature of construction of the project and the staggered nature of the targeted threatened flora survey schedule.

To date the following updates have taken place:

- Version 1 update – the first update of the draft TFMP incorporated the majority of independent expert review and agency comments received. This was completed in November 2013 and was included with the submission of the SPIR documentation. The expert comments are summarised in **Appendix A**.
- Version 2 update – the second update of the TFMP was undertaken to address the approval conditions, incorporate results of additional targeted baseline surveys for threatened plants, remaining expert comments and agency feedback received on the Version 2 TFMP. This update relates only to Stage 1 of the project (including Sections 1, 2 and soft soil works areas). A summary of how the remaining independent expert and agency administering authority comments have been addressed is detailed in **Appendix A**. Version 2 of the TFMP was approved by the Secretary on 30 April 2015.
- Version 3 update – a third update of the TFMP has been completed to incorporate results of threatened flora surveys for Sections 3 to 11. The details of these surveys have been included in **Section 2** of this document. Once Version 3 of the TFMP has been approved by the Secretary it will supersede Version 2.

A summary of the process for updating the TFMP is illustrated in **Figure 1.4**.

In addition to the updates described above, Roads and Maritime (or a nominated Contractor on Roads and Maritimes behalf) may amend the Plan in the event that new species of threatened flora are identified during future surveys and other pre-construction activities to ensure effective protection and management. The Plan may also be amended during construction and operations as deemed necessary for the protection and management of threatened flora species in the project boundary.

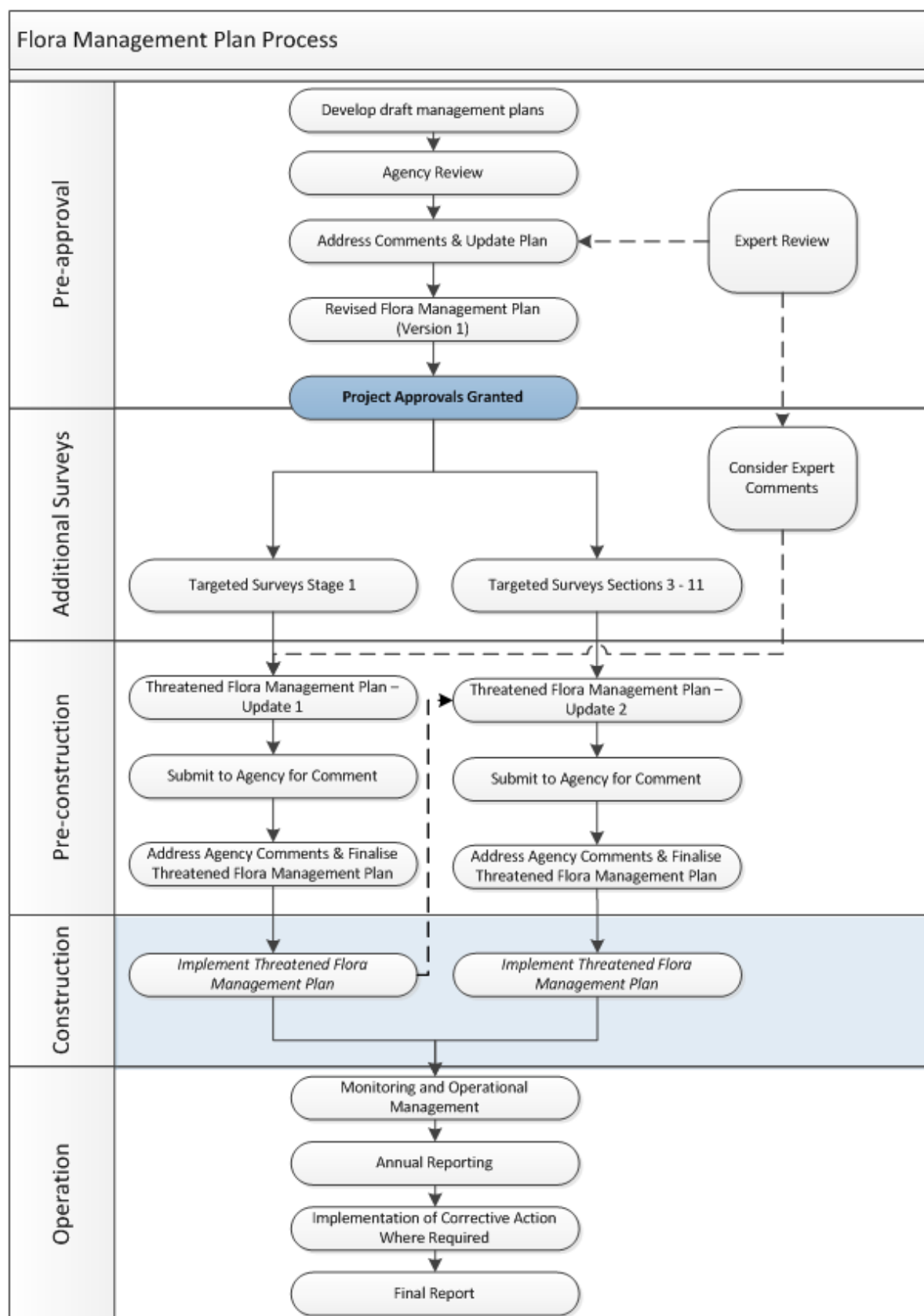


Figure 1.4 Process for development and updating of this TFMP

1.4 Plan authors and expert review

Authors – Version 1

Updates to Version 1 of the TFMP were prepared by Chris Thompson as the biodiversity assessments technical lead, and Andrew Carty as the flora assessments technical lead from Jacobs (previously known as Sinclair Knight Mertz (SKM)). Targeted threatened flora assessment surveys were undertaken by Andrew Carty, Alex Callen, Jon Carr and Lui Weber from Jacobs.

Authors – Version 2

Targeted threatened flora surveys relevant to the Version 2 update of the TFMP were undertaken by Biosis, Ecosure and Jacobs. The Biosis surveys of Section 1 were led by Jane Murray and Monica Campbell, with assistance in the field from ecologists, Alexandra Cave, Kristy Kay, and Toby Steelcable. The Ecosure surveys of Section 2 were led by Elvira Lanham, Alan House and supported by Teresa James, Justin Mallee, Nicola Head and Emily Hatfield. Jacobs completed surveys across the entire project area and personnel involved in the work included Chris Thomson, Andrew Carty and Jonathon Carr.

Revisions of the TFMP (Version 2) to incorporate results of targeted surveys and address remaining expert and agency comments have been prepared by Richard Floyd and Berlinda Ezzy of Amec Foster Wheeler.

Authors – Version 3

Targeted threatened flora surveys undertaken of Sections 3 to 11 informed the Version 3 update of the TFMP. These surveys were undertaken by Geolink, AECOM, Biosis, Melaleuca, Australian Museum Consulting and Jacobs. The results of these surveys were reviewed with results used to identify Project impacts on threatened flora species reported in this plan. Version 3 updates were undertaken by Amec Foster Wheeler.

An overview of the experience and qualifications of contributors to each version of this TFMP is provided in **Table 1-2**.

Table 1-2 TFMP authors' qualifications and experience

Personnel	Qualifications	Experience
Chris Thomson Jacobs	Bachelor of Applied Science and Graduate Certificate in Natural Resources	Chris Thomson has a Bachelor of Applied Science and Graduate Certificate in Natural Resources with seventeen years' professional experience in the fields of ecology and natural resource management. He is highly experienced in the design and implementation of ecological monitoring programs, flora and fauna surveys, threatened fauna management plans and ecological impact assessment, having completed numerous studies for clients such as the Roads and Maritime and Department of Defence. Chris has considerable experience in the preparation and implementation of species specific management plans and monitoring programs.
Andrew Carty Jacobs	Bachelor of Environmental Science, Certificate IV in Natural Area Restoration and Certificate II in Bush Regeneration	<p>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.</p> <p>Andrew has over 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.</p> <p>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.</p> <p>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.</p>
Jonathon Carr Jacobs	Bachelor of Environmental Science and Management	Jonathon has extensive field experience in a diversity of terrestrial and aquatic ecosystems throughout NSW that has given him a broad understanding of flora and

Personnel	Qualifications	Experience
		fauna identification and ability to describe key ecological attributes with particular focus on threatened species and communities. In the field, he has undertaken several botanical surveys in dry and wet woodland/forest, rainforest, grasslands, heathland, wetlands, and mallee scrubland. He has also used a range of mobile GPS devices to map vegetation, and undertaken plot based habitat condition/quality assessments. Jonathon's technical skills have been applied to impact assessment and vegetation/habitat mapping associated with REFs and EIS projects. Jon has worked throughout NSW in the Sydney Region, Hunter Valley, Riverina, Blue Mountains, North Coast, South Coast and in Queensland, Victoria and South Australia.
Jane Murray Biosis	Bachelor of Applied Science Bush Regeneration Cert. 2 NSW BioBanking Assessor	Jane is the Resource Group Manager / Principal Ecologist (botanist) at Biosis (Sydney) with over twelve years' experience in ecology gaining experience on various; Defence, rail, road, mining and power projects across metropolitan and regional NSW, QLD and Victoria. Jane's technical skills include biophysical and condition based botanical assessments, peer review, environmental/species impact assessments, EPBC Act referrals, ecological constraints identification, botanical identification, weed assessments and vegetation community association mapping. Jane is also an accredited BioBanking Assessor (No. 0115) and has also participated in scientific advisory panels consulting with communities, stakeholders, students, councillors and colleagues for ecologically robust project outcomes.
Dr Monica Campbell Biosis	Bachelor of Science (Honours) Doctor of Philosophy (Plant Ecology)	Monica has over 11 years' experience as an ecologist and botanist in northern New South Wales and Queensland. She is highly experienced in the design and implementation of ecological field surveys including targeted surveys for threatened plant species and the translation of botanical information into assessments of fauna habitat values and functions. Monica is highly proficient in understanding and interpreting the provisions of Commonwealth, State and Local Government legislation having an environmental and natural resource management focus. Monica regularly provides a high level of service and advice in the areas of ecological survey and impact assessments, vegetation and weed management, threatened flora identification and management, Regional Ecosystem mapping and classification, BioCondition assessments and ecosystem restoration strategies to public sector and private industry clients. Monica has extensive experience in providing ecological assessments and advice to inform linear infrastructure developments. In her recent role as Senior Ecologist on the award winning Logan Water Alliance, she navigated numerous water and wastewater infrastructure projects through the complexities of the Environment Protection and Biodiversity Conservation Act 1999, Vegetation Management Act 1999 and Nature Conservation Act 1992, ensuring each project was delivered in accordance with legislative requirements while meeting construction budgets and time-frames.
Anthony Steelcable Biosis	Bachelor of Environmental Science Diploma of Conservation and Land Management	Anthony is an environmental consultant with over 11 years' experience working in the natural resource management field gaining experience on various rail, road, mining and power projects across a range of key areas. The core of Anthony's experience is centred on biophysical and condition based aquatic assessments, environmental impact assessments, targeted threatened species searches and the provision of advice on how to ameliorate or prevent detrimental impacts to these species, species recovery planning, Commonwealth (EPBC) referrals and state approvals.
Kirsty Kay Biosis	Bachelor of Environmental Science	Kirsty Kay has nine years' experience as a consultant botanist. She has experience in all areas of botanical survey and assessment, including flora and fauna habitat surveys, vegetation community mapping, vegetation condition assessments, ecological monitoring, and targeted threatened species surveys. She has worked on numerous projects throughout Victoria, Tasmania and Queensland in a variety of ecosystems. She has extensive experience in conducting habitat hectare assessments as well as developing native vegetation management plans. Kirsty also has experience in managing the implementation of offset plans, including management of sub-contractors. Kirsty has experience in the assessment of large scale infrastructure projects such as dams, pipelines, utilities, mines, and transport and development of mitigation plans. She has also undertaken assessments of National Parks and conservation reserves and development of biodiversity management plans including weed management. She has a particular interest in threatened species management, plant species identification and mitigation of development impacts.

Personnel	Qualifications	Experience
Alexandra Cave Biosis	Bachelor of Science in Biodiversity Conservation and Masters of Science in Wildlife Conservation	Alex is a qualified and experienced field biologist with experience working on environmental projects across NSW. These projects, including species impact statements and Commonwealth referrals, have allowed Alex to develop skills conducting threatened fauna searches and habitat assessments, survey design and implementation, hollow-bearing tree assessments, ecological constraints assessments and terrestrial GPS integrated ecological field mapping.
Elvira Lanham Ecosure	Bachelor of Environmental Science Doctor of Philosophy (Ecology)	<p>Elvira has been involved in ecological consultancy and research for the past 18 years and has completed projects throughout NSW, Queensland and overseas including work in the USA and Mongolia. She has experience in flora and fauna impact assessment, threatened species monitoring and management and project management of large environmental projects. Elvira is experienced in the use of a variety of ecological field techniques such as vegetation survey, cage, pitfall and funnel trapping, visual encounter surveys, techniques for surveying nocturnal birds and mammals.</p> <p>Elvira has a particular interest and expertise in frog and reptile surveys and has completed ecological survey work and input into fauna friendly road design for a number of projects within the vicinity of the Woolgoolga to Ballina Pacific Highway upgrade. These projects include: Pacific Highway upgrade (Brunswick to Yelgun), Tugun Bypass and Dunoon Dam ecological assessment. She has also carried out survey and assessment for the Camden Valley Way Upgrade, in south western Sydney and was project manager on a road kill mitigation project for the northern suburbs of Sydney for RMS.</p>
Alan House Ecosure	Bachelor of Science (Botany) Doctor of Philosophy (Ecology)	<p>Alan has over 35 years' experience as an ecologist in both research and consulting, working mainly in Queensland and New South Wales. He is a specialist in forest ecology, biodiversity in agricultural landscapes, landscape ecology, plant population genetics, conservation management planning, botanical surveys, ecological impacts of climate change and invertebrate ecology.</p> <p>Alan's core technical skills are related to vegetation ecology, field botany, landscape ecology, conservation management and flora and fauna impact assessments. Alan has employed his skills and knowledge in the publication of over 40 peer-reviewed papers, 2 book chapters and edited 4 books.</p>
Teresa Ann James Ecosure	Bachelor of Science (Honours)	<p>Teresa has more than 30 years' experience as a botanist and has undertaken vegetation surveys for many projects in NSW including on the central and north coasts, Sydney and the Blue Mountains. She has been involved with several road linear infrastructure projects including the Pacific Highway upgrade at Kempsey, Great Western Highway upgrade in the Blue Mountains, electricity transmission line construction at Nowra, Eastern Gas Pipeline (Duke Australia Operations) in Sydney and rail corridors in the Bankstown – Yagoona area.</p> <p>More recently she has been involved with several offset projects. Both NSW and Commonwealth offset policies (local government, state and federal) and associated offset calculation methodologies were used or consulted including the NSW OEH interim offset policy of State significant development (SSD) and State significant Infrastructure (SSI) projects. As an accredited BioBanking assessor she is familiar with the Biodiversity Banking and Offsets Scheme and Biometric vegetation types.</p> <p>Much of Teresa's work concerns the identification, assessment and management of threatened ecological communities and species.</p>
Justin Mallee Ecosure	Bachelor of Environmental Science Diploma of Agriculture	Justin has been working as an ecologist/botanist for eight years for local government and private consultancies in New South Wales and Queensland. Justin has experience conducting flora surveys targeting threatened species, identifying and mapping significant flora species, the translocation of threatened species and the developing of monitoring and biodiversity projects and extension materials for a range of projects.
Nicola Head Ecosure	Bachelor of Science	Nicola is a graduate ecologist with experience working throughout South East Queensland and NSW. Throughout her career to date Nicola has worked across multiple facets of ecology including terrestrial flora and fauna ecology, aquatic ecology and disease ecology. Her primary focus has been on flora and vegetation assessment having conducted many flora surveys within the Brigalow Belt bioregion in Queensland and northern New South Wales. Nicola has also completed training in flora identification and vegetation classification (Regional Ecosystems).

Personnel	Qualifications	Experience
Emily Hatfield Ecosure	Bachelor of Urban and Environmental Planning Associate Diploma of Applied Science (Wilderness Reserves & Wildlife)	Emily has been working in the environmental industry for 18 years. She has experience in flora and fauna assessment along linear infrastructure, threatened species monitoring, fauna habitat assessment, project planning, administration and management, environmental assessment and report writing. A versatile member of Ecosure, Emily has also contributed to the design and facilitation of community engagement projects, as well as assisting in the field with aquatic surveys and bush regeneration. Emily has a particular interest in best practices in wildlife crossings and corridors, producing a report for Redlands City Council using a Geographic Information Systems tool to represent the movement of fauna throughout the local government area. She has also contributed to the captive breeding programs for rare and threatened species including spotted tailed quoll, squirrel glider and golden brush-tailed possum.
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.
Richard Floyd Amec Foster Wheeler	Bachelor of Science Graduate Diploma Natural Resources (Ecosystem Management)	Richard Floyd has more than 19 years' professional experience undertaking and managing ecology studies throughout Australia. Richard's experience has primarily been with mining and linear infrastructure such as roads, rail and pipelines. He has coordinated aquatic and terrestrial ecology studies for numerous major projects within Australia. Richard has developed threatened species management plans including management and monitoring regimes for the conservation of threatened flora and fauna species, including NSW. Richard is licensed by the appropriate authorities to undertake flora and fauna investigations.
Christopher White AECOM	Bachelor of Science (Hons)	Chris has been a consultant ecologist for over 9 years and a senior project manager for the past four. During this time he has provided expert ecological advice for a range of major projects including both the Tarcutta Bypass and the Hume Highway duplication project in southern New South Wales, the expansion of Melbourne's Urban Growth Boundary on behalf of the Growth Areas Authority, Melbourne Water's Waterways Alliance, and the Geelong Saltworks Urban Renewal Project. His involvement in key infrastructure and development projects in NSW and Victoria has demanded an in-depth understanding of the application of both state and national biodiversity policy. Prior to beginning his career in consulting, Chris was employed as a research assistant in the Department Of Geography and Environmental Science, Monash University.
Dr Thomas Wright AECOM	PhD Bachelor of Natural Resource Management (Hons I)	Tom is a Senior Botanist with eight years' experience studying vegetation management issues across eastern Australia. Since joining AECOM in 2011, Tom has lead a number of options assessments and detailed ecological studies on a variety of large-scale road infrastructure projects. Through these projects, Tom has developed much experience providing specialist ecological direction for major roads projects, and has demonstrated a sound understanding of NSW environmental guidelines and procedures. Tom also has practical experience dealing with Commonwealth and NSW environmental legislation and policy. At the Commonwealth level, Tom has also been involved in dealing with offset conditions under the new EPBC Act offset policy, and has ran industry sessions on behalf of AECOM to explain to clients how this new policy may affect their projects.
David Charely Wildsearch Environmental Services	Bachelor of Science (Zoology and Botany)	David has 33 years' experience as a natural resource manager and field ecologist. He worked for the NSW National Parks and Wildlife Service for over 23 years as a ranger and senior ranger gaining valuable experience in the management of our natural resources including bushfire, threatened species (particularly the Eastern Osprey, Eastern Bristlebird, Hastings River Mouse, Coxen's Fig-Parrot, Fleay's

Personnel	Qualifications	Experience
		<p>Barred Frog and various rare plants); and pest species management. He also managed a number of major federally funded environmental programmes.</p> <p>Since leaving the National Parks and Wildlife Service he has established a private environmental consultancy. His areas of expertise include: threatened species survey and management; particularly threatened mammals and birds, migratory shorebird and waterbird survey and management; management of threatened species habitat on private lands; and pest species management. He has managed or been involved in many significant fauna surveys and threatened species management programmes.</p>
David Fell Melaleuca	Associate Diploma of Applied Science, Southern Cross University	<p>David has 27 years' 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.</p> <p>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. He has successfully delivered projects in rainforest, wet and dry sclerophyll, swamp sclerophyll, heathland, and wetland ecosystems.</p>
Dr Melissa Van Zwieten Melaleuca	PhD (Horticulture) Bachelor of Agricultural Science (Hons) Certificate IV Workplace Assessment and Training	<p>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. This expertise has been gained through a wide-range of consultancy and research projects for both private and government clients.</p> <p>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.</p>
David Havilah	Bachelor of Science (Biology)	<p>David is an experienced ecological consultant who has developed a broad range of skills from working on a variety of small and large-scale projects. He specialises in undertaking terrestrial flora and fauna surveys and providing high quality ecological assessments within Queensland and New South Wales. This work has included designing and implementing threatened species management plans and ecological monitoring plans. David has a detailed working knowledge of environmental legislation relevant to ecological impact assessment and an ability to balance practical applications of environmental requirements with good environmental outcomes.</p>
Dr Tom Pollard	PhD (Vegetation Ecology of Tasmanian Dry closed-forest) Bachelor of Science (Hons I) (Botany & Rainforest Ecology)	<p>Tom is a botanist and ecologist who works on a variety of projects relating to ecological assessment and management. Since completing his PhD studies in rainforest ecology, he has worked as an ecologist for State government, and for not-for-profit and private organisations. His interests are in biogeography, rainforest ecology and threatened species management.</p> <p>Tom has had substantial working experience in ecological assessment, and providing technical advice and reporting for a range of clients in the private and public sectors.</p>

Expert review

An independent expert review of Version 1 of the TFMP 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 TFMP. 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, NSW Department of Planning and Environment (DP&E) and the Commonwealth Department of the Environment (DoE) during the development of this plan. Each agency was provided a copy of the Draft Version 2 TFMP (Sections 1, 2 and early works) on 18 December 2014. All comments received and Roads and Maritime responses have been included in **Appendix A** of the TFMP. A summary of the key issues raised and proposed amendments in finalising this TFMP are outlined in **Table 1-3**. Approval was received from all agencies for Version 2 of the TFMP.

All agencies were then provided with a Draft Version 3 (Sections 1 – 11) of the TFMP that addressed threatened flora species impacts in remaining Sections 3-11. Comments have now been received on this version and they are also summarised in **Appendix A**. These comments have now been addressed.

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

Document Version	Review Date	Summary of Comments	Section of Report Addressing Comments
Department of Planning and Environment			
2	March 2015	What measures would be put in place to ensure that RMS' road reserve maintenance activities (e.g. mowing/slashing) during operation of the road do not impact on threatened species in-situ in the road reserve.	The construction footprint includes areas required for the highway upgrade and maintenance areas such as table drains that may need to be mown/slashed. Any threatened plants within these areas have been calculated as being directly impacted for the purposes of the TFMP. Therefore the threatened plant species being retained as in-situ should not be within the maintenance areas to be maintained as cleared. However to ensure those threatened plants being retained as in-situ that may occur adjacent to these maintenance areas are not impacted appropriate mitigation measures have been included in Section 7.3.1. One requirement will be that Roads and Maritime issues sensitive area documentation to the RMS Asset Maintenance that clearly identifies the locations of threatened flora species. It will also be ensured the in situ threatened plants are within suitable habitats for their long term survival such as their natural habitat, or they may be within revegetation areas with appropriate native species surrounding the plants.
Environmental Protection Authority			
2	March 2015	<p>Angophora robur hybridisation.</p> <p>Results indicate that the majority of Angophora robur in the Wave 3 area are likely to be hybrids. Following the conclusions and recommendations in Appendix F the EPA supports the upholding of the existing distribution mapping within the project area. For consistency this will also apply to potential offset properties where the same issue of hybridisation is likely to occur.</p> <p>However it appears that this recommendation will not be applied to stage 1 works where only a single individual will be protected in-situ i.e. the mapping of the extent of Angophora robur has not been upheld. Whilst topographical position, substrate etc. may assist in rapid identification, will the RMS undertake extensive sampling of all mapped individuals to verify identification? If not then all mapped Angophora robur should be assumed to be pure.</p>	<p>Section 2.3 provides further explanation concerning the identification of Angophora robur within Stage 1 works. Jacobs was commissioned to undertake sampling and genetic testing of Angophora robur within the early works area at Tyndale. Genetic testing was completed on specimens from this location. The majority of species were confirmed as hybrids with one Angophora robur. In addition, GeoLink was commissioned to take samples from four unconfirmed Angophora sp. at the Tyndale cut. Herbarium results are yet to be received.</p> <p>Other than these specific locations, the rest of the Angophora robur occurrences (including hybrids) will be assumed to be Angophora robur.</p> <p>RMS does not intend to undertake further genetic testing and therefore all potential Angophora robur will be treated as being the species and all to be impacted will be offset.</p> <p>Reporting of Angophora robur has been amended to ensure consistency with the above statements.</p>
2	March 2015	Dry conditions at the time of targeted survey resulted in non-location or retraction of Maundia, Cyperus, Arthaxon. Given the wet 2014/2015 summer the EPA recommends that the RMS assumes presence of these populations and maps the likely extent of habitat within the study area. For example if during targeted pre-clearing surveys for Maundia an area	Surveys for threatened flora have been extensive and undertaken over a variety of seasons. Pre-construction targeted threatened flora surveys in 2014 were undertaken between March to May 2014, July 2014 and Sept 2014 across various seasons including a wet period hence why some additional flora populations were confirmed. For some properties where access was unavailable Roads and Maritime

Document Version	Review Date	Summary of Comments	Section of Report Addressing Comments
		<p>previously inundated may contain rhizomes and seed stock below ground. The EPA is not advocating translocation of above ground individuals but it could be possible to salvage the below ground material for transferal to suitable habitat or nurseries for propagation and later planting to preferred but unoccupied habitat created by the road. A feasibility assessment would need to be undertaken to justify this action or alternatively an assessment could conclude that an upstream in situ remnant will provide a similar outcome by repopulating suitable habitat during appropriate conditions.</p> <p>Why limit translocation sites to outside the project boundary? Is the intention to remove future road maintenance constraints?</p>	<p>will undertake a risk assessment to identify the potential for threatened flora to be found on those properties. Where a property has a high risk these areas will be surveyed and should any additional threatened flora be recorded the TFMP will be updated. Sensitive Area Plans will be prepared including mapping for the project to incorporate data from all surveys undertaken to date.</p> <p>Translocation options have been assessed for each species recorded in Sections 1, 2 and early works in the Flora Translocation Strategy (Sections 1 and 2) which was provided for Agency consultation. Salvage of below ground material for Maundia is not proposed.</p> <p>Section 7.3.1 has been updated to outline the mitigation measures proposed to protect threatened species within the Project boundary. Further, reporting has been updated to state that RMS would explore translocation sites within the Project boundary where practical to do so.</p>
2	March 2015	<p>MCoA D8(k) requires monitoring until such time as the mitigation measure can be demonstrated to be effective over 3 monitoring periods or until such time as agreed with the EPA. There is no direction from the project approval to limit monitoring to 5 years if corrective actions are implemented. This may appear to be a reasonable time frame for monitoring, but irrespective of this, the RMS is still required to consult with the EPA to negotiate a new monitoring time frame. Please update the TFMP to reflect this.</p>	<p>Section 7.3 and Section 8 has been amended to align monitoring with Condition MCoA D8 that states "ongoing mitigation for in situ threatened flora species/populations would be undertaken until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring events". RMS notes the MCoA D8(k) requirement to consult further with EPA prior to any changes to these timeframes.</p>
Department of the Environment			
2	March 2015	<p>Please update this plan to include both the extent of direct and indirect impacts.</p>	<p>Tables 4.1 and 4.2 have been included to show the extents of direct and indirect impacts on threatened flora species. Impacts within the construction footprint (calculated as direct impacts) and up to 20m from the construction footprint (calculated as indirect impacts).</p>
2	March 2015	<p>As surveys have now been undertaken for stage 1 and 2, the impacts and locations of impacts should now be known in relation to ancillary facilities. Please provide further information in regards to the quantum of impact from proposed ancillary facilities.</p>	<p>Descriptions concerning the placement of ancillary activities have been provided demonstrating efforts to avoid impacts on threatened flora species. It is not expected that threatened flora species will be impacted as ancillary activities will be placed in cleared areas, more than 50 m away from waterways and on relatively stable land. These measures along with other measures (e.g. use of exclusion fencing) will avoid impacts on threatened flora species.</p> <p>No quantum of impact from these facilities has been incorporated into this plan, as they have not been approved for use. Further to the Ancillary Sites that were detailed, assessed and approved in the EIS / SPIR documentation, Ancillary facilities required for Stage 1 activities are subject to further consideration by the individual Contractors for these works. Any Ancillary Sites are required to be assessed and approved through the approval requirements of MCoA B73, B74, B75,</p>

Document Version	Review Date	Summary of Comments	Section of Report Addressing Comments
			and Ancillary Facilities Management Plan required by MCoA D21.
2	March 2015	In-situ plants – what monitoring is proposed to ensure these are retained? What happens if the plants are not retained? The Department considers that offsets would be required to compensate for the loss of these plants. Please update plan to reflect this	Section 8.2 has been amended to outline in situ threatened flora species proposed monitoring measures. Further, the plan has been updated to state that any additional impacts to threatened plants resulting from the project will be offset.
2	March 2015	Actions within this table must be time bound; thresholds and corrective actions are required for each mitigation measure proposed in the table. Please define –damage. This should relate to clearing and accidental incursions/trampling, but also from impacts such as run off. In the row regarding exclusion zones, please address potential damage to exclusion zones. If this results in mortality of the threatened flora, a corrective action must include securing additional offsets (for EPBC Act listed flora in accordance with the EPBC Act Offsets Policy).	Tables 5.4, 6.1 and 7.3 have been amended to specify the triggers for corrective actions and when they should take place. The term damage has been further clarified in Table 5.4 and includes accidental clearing, incursions, trampling, and smothering as a result of sediment run-off. Under Table 5.4 it is stated that additional offsets are to be provided for any impacts to threatened flora not accounted for in the Offsets Strategy.
2	March 2015	Please provide the key goals from the CEMP in regards to dust and water and soil quality that is proposed to be achieved for threatened flora. e.g. no impacts from reduced water quality? No reduced water quality in the vicinity of threatened flora? The Department notes that the draft CEMP for dust does not include threatened flora as 'sensitive receivers', or references to threatened flora more generally. On this basis, the issue of dust management for threatened flora needs to be included in this plan. Please update to address this.	Section 6.2 has been updated to outline the key commitments for managing dust, soil and water quality during construction to avoid, minimise and mitigate impacts on threatened flora species.
2	March 2015	Specific erosion and sedimentation commitments are required as a part of this plan. Please update.	Section 6.3.6 has been updated to outline key commitments associated with managing erosion and sedimentation during construction. A reference has also been provided to the CEMP which outlines measures for implementing erosion and sediment control measures in greater detail. RMS notes that the CEMP for the relevant stages of the Project are subject to separate condition of approval.
2	March 2015	In accordance with the requirements of the conditions, monitoring must occur until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring periods	The TFMP including Section 7.3.1 and Section 8 have been amended to state that ongoing mitigation for in situ threatened flora species/populations would be undertaken until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring events.

Note – A full list of all comments and responses is provided in **Appendix A**.

2. Threatened flora surveys

Extensive vegetation surveys of Sections 1 to 11 were completed for the project between 2006 and 2014 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 is provided in **Table 2-1**.

Table 2-1 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	<ul style="list-style-type: none"> Mapping of vegetation communities
	18-24 Feb 2007	<ul style="list-style-type: none"> Targeted searches for threatened flora species
	19-24 Aug 2010	<ul style="list-style-type: none"> Targeted survey to map <i>Eucalyptus tetrapleura</i> distribution between Halfway Creek and Glenugie Opportunistic observations of other threatened flora
	Nov 2011	<ul style="list-style-type: none"> Re-survey of previously identified flora populations to identify any changes in distribution Targeted searches for <i>Lindsaea incisa</i>, <i>Maundia triglochinos</i>, and cryptic summer flowering species Vegetation mapping in areas not previously surveyed
3-5	2-7 July 2007	<ul style="list-style-type: none"> Mapping of vegetation communities
	6-11 Aug 2007	<ul style="list-style-type: none"> Targeted searches for threatened flora species
	14-19 Oct 2007	<ul style="list-style-type: none"> Targeted survey to map <i>Eucalyptus tetrapleura</i> distribution between Glenugie and Pillar Valley Targeted searches to map the extent and distribution of <i>Angophora robur</i>
	23-27 Aug 2010	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Targeted surveys to map the extent and distribution of <i>Angophora robur</i> from the Pillar Valley to Tyndale Opportunistic observations of threatened flora species
	21-25 Oct 2011	<ul style="list-style-type: none"> Supplementary surveys to map the extent and distribution of <i>Angophora robur</i> from Pillar Valley to Tyndale
	12-16 Dec 2011	<ul style="list-style-type: none"> Re-survey of previously identified flora populations to identify any changes in distribution Targeted searches for <i>Lindsaea incisa</i>, <i>Maundia triglochinos</i>, and cryptic summer flowering species
6-8	May – June 2005	<ul style="list-style-type: none"> Mapping of vegetation communities Targeted searches for threatened flora
	2-7 Dec 2007	<ul style="list-style-type: none"> Targeted surveys for <i>Melaleuca irbyana</i> and New Italy
	16-20 Jan 2012	<ul style="list-style-type: none"> Re-survey of previously identified flora populations to identify any changes in distribution Targeted searches for threatened cryptic summer flowering flora species including <i>Cyperus aquatilis</i>, <i>Oberonia titania</i>, <i>Lindsaea incisa</i>, <i>Arthraxon hispidus</i> and <i>Prostanthera cineolifera</i>
	14-25 Mar 2005	<ul style="list-style-type: none"> Mapping of vegetation communities Threatened flora species surveys
9-11	15-18 Aug 2006	<ul style="list-style-type: none"> Mapping of vegetation communities

Project Section	Survey Period	Purpose
	30 Aug – 3 Sept 2010	<ul style="list-style-type: none"> Mapping of vegetation communities Threatened flora species surveys
	16-20 Jan 2012 13-16 Mar 2012	<ul style="list-style-type: none"> Re-survey of previously identified flora populations to identify any changes in distribution Targeted searches for threatened cryptic summer flowering flora species including <i>Cyperus aquatilis</i>, <i>Oberonia titania</i>, <i>Lindsaea incisa</i>, <i>Arthraxon hispidus</i> and <i>Prostanthera cineolifera</i>
Post-EIS Approvals		
1 – 11	Feb-Mar 2014 March – May 2014 July 2014	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Targeted rainforest community survey and rainforest plant survey Identify suitable monitoring sites for establishment of monitoring plots.
1-11	Mar-May 2014 Sept 2014	<ul style="list-style-type: none"> 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 described for pre-construction management in this TFMP (**Section 5**) Roads and Maritime has commissioned a number of additional pre-construction targeted threatened flora species surveys to identify the occurrence of threatened flora species, to ensure surveys were conducted across various seasonal conditions, and inform management and monitoring requirements during construction and operation of the W2B.

In addition to baseline threatened flora monitoring across the entire project area (Jacobs, 2014a), Roads and Maritime commissioned specialist ecological consultants to undertake individual targeted threatened flora surveys for Sections 1 to 11 to provide greater spatial coverage and a more detailed assessment of these sections prior to the commencement of construction.

This section of the TFMP provides a summary of the targeted threatened flora surveys undertaken for the Project and discusses the survey purpose, methodology, survey timing and results. **Appendix D** contains the full technical survey reports.

2.1 Targeted surveys – Section 1

2.1.1 Biosis (2014a)

Biosis Pty Ltd was commissioned by Roads and Maritime to undertake threatened flora species surveys and assessments of Section 1 of the Project 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 purpose of the survey was to:

- 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 surveys confirmed the presence of four threatened flora species within Section 1, specifically:

- Hairy Joint Grass (*Arthraxon hispidus*)
- Square-stemmed Spike-rush (*Eleocharis tetraquetra*)
- Maundia (*Maundia triglochinoides*); and
- Moonee Quassia (*Quassia* sp. *Moonee Creek*).

Hairy Joint Grass (*Arthraxon hispidus*), previously unrecorded in Section 1, was recorded as a single small population along a drainage line inside the project boundary. Although previously unrecorded, this species is semi-annual, with adult plants tending to die back over winter and in response to changes in water level within its preferred habitat.

A number of small, sparsely distributed populations of Square-stemmed Spike-rush (*Eleocharis tetraquetra*) were recorded within the broader areas of where previous populations (i.e., those detailed in the EIS) had been recorded, although individual plants were not always at previously recorded locations. A new population was also recorded in a culvert associated with the existing highway. The minor spatial variation in coverage of this species is likely attributable to temporal fluctuations in rainfall and area of suitable wetland habitat.

Maundia (*Maundia triglochinoides*) was recorded at seven locations within Section 1, although not always where previous recordings had been made. Again, the shift in spatial extent of Maundia (*Maundia triglochinoides*) is likely attributable to changes in the wet/dry cycle of the overarching wetlands as well as dispersal efficiency of individual plants.

A number of populations of Moonee Quassia (*Quassia* sp. *Moonee Creek*) were confirmed where previous EIS studies had located the species. Additional occurrences of the species in the same general location were recorded by Biosis during this targeted survey.

Due to restrictions with land access the areas between chainage 7000-7500 and at 9000 of Section 1 were unable to be surveyed. These areas represent approximately 13.99 ha, or 5% of the survey area. Remote assessment was undertaken and it was noted that vegetation communities present in adjoining accessible project areas extended into these inaccessible areas. Targeted flora surveys will be conducted in these areas once property acquisition has been finalised, and prior to clearing for construction. Timing of these surveys is limited to when access becomes available, and the TFMP will be updated to incorporate the results of these surveys should any additional threatened flora species be observed.

2.1.2 Jacobs (2014a)

In addition to the targeted survey of Section 1 undertaken by Biosis (2014a), Jacobs was commissioned by Roads and Maritime to undertake an additional targeted threatened flora survey and baseline monitoring throughout the Project. The purpose of the Jacobs-led survey was 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 surveys confirmed the presence of five threatened flora species within Section 1, specifically:

- Square-stemmed Spike-rush (*Eleocharis tetraquetra*)
- Lindernia (*Lindernia alsinoides*)
- Slender Screw Fern (*Lindsaea incisa*)
- Maundia (*Maundia triglochoides*); and
- Moonee Quassia (*Quassia* sp. Moonee Creek).

The timing of surveys was also focused on meeting suitable climatic and seasonal conditions for cryptic species, including Slender Screw Fern (*Lindsaea incisa*), Water Nutgrass (*Cyperus aquatilis*), Hairy Joint Grass (*Arthraxon hispidus*), *Rotala tripartita*, Lindernia (*Lindernia alsinoides*), Knotweed (*Persicaria elatior*) and Maundia (*Maundia triglochoides*).

Results of the surveys by Jacobs found a new threatened flora species Lindernia (*Lindernia alsinoides*). Individuals were recorded both within the construction footprint and outside the project boundary. The species has not been recorded in the project area previously; however, habitat conditions during the early 2014 survey period were optimal for this species, with populations recorded in large areas of swampy habitat shallowly inundated along Red Bank Creek and tributaries.

Hairy Joint Grass (*Arthraxon hispidus*), recorded in the previous survey by Biosis, was not observed in the Jacobs led surveys. This is likely because the extent of the species previously recorded in Section 1 had died back due to dry and cold conditions experienced over winter. Similarly, Water Nutgrass (*Cyperus aquatilis*), recorded in previous surveys, was not observed, likely because preceding dry climatic conditions may have restricted germination.

2.2 Targeted surveys – Section 2

2.2.1 Ecosure (2014)

Ecosure Pty Ltd was commissioned by Roads and Maritime to undertake threatened flora species surveys and assessments of Section 2 of the Project 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:

- 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. The surveys confirmed the presence of three threatened flora species within the study area, specifically:

- Square-fruited Ironbark (*Eucalyptus tetrapleura*)
- Slender Screw Fern (*Lindsaea incisa*); and
- Maundia (*Maundia triglochinos*).

Three distinct sub-populations of the Square-fruited Ironbark (*Eucalyptus tetrapleura*) were recorded by Ecosure, all north of Halfway Creek. These sub-populations had a combined total of 144 trees, the northernmost containing the majority – 102 individuals. The number of individuals observed by Ecosure is significantly lower than that specified in the EIS for Section 2 which was for 1,213 individuals covering 14.3 ha near the project boundary. However it appears that the majority of this population sits outside the current project boundary for Section 2. The Square-fruited Ironbark (*Eucalyptus tetrapleura*) can be difficult to detect because of its similarity with other Ironbarks in the local area. As such, Ecosure used fruit and or buds beneath tree canopies to confirm the species.

A total of eight distinct populations of Maundia (*Maundia triglochinos*) were recorded in Section 2 by Ecosure. Four of these populations were in pools associated with Halfway Creek, with two populations comprising approximately 15 individuals occurring within the current project boundary, and a further 18 individuals occurring outside of the current project boundary. Four smaller populations were recorded along a permanent creek, three of which comprising 9 individual plants were within the current project boundary, and the fourth comprising 3 individual plants occurring outside the current project boundary. A population previously recorded in Wells Crossing Flora Reserve was not present during the 2014 surveys due to contraction of swampy areas in the Reserve.

Three populations of Slender Screw Fern (*Lindsaea incisa*) were confirmed by Ecosure. The largest population (hundreds of individual plants) were recorded in the Wells Crossing Flora Reserve, which was consistent with information presented in the EIS. This population is just outside the current project boundary. Two additional populations were recorded within the project boundary, each comprising several hundred individuals.

A single individual of Square-stemmed Oxal (*Oxal angulata*) previously reported in the EIS could not be located during the survey despite a thorough search at the recorded location, and more broadly throughout Section 2.

2.2.2 Jacobs (2014a)

In addition to the targeted survey of Section 2 undertaken by Ecosure, Jacobs was commissioned by Roads and Maritime to undertake additional targeted threatened flora surveys and baseline monitoring throughout the Project. The purpose of the Jacobs led survey was 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 ; and
- 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 surveys confirmed the presence of four threatened flora species within Section 2, specifically:

- Square-fruited Ironbark (*Eucalyptus tetrapleura*)
- Slender Screw Fern (*Lindsaea incisa*)
- Maundia (*Maundia triglochinos*); and
- Square-stemmed Olax (*Olax angulata*).

The Square-fruited Ironbark (*Eucalyptus tetrapleura*), Slender Screw Fern (*Lindsaea incisa*), Maundia (*Maundia triglochinos*), and Square-stemmed Olax (*Olax angulata*) had all been recorded in previous surveys of Section 2 either by Ecosure or EIS studies. No major variations in the spatial extent of the Square-fruited Ironbark (*Eucalyptus tetrapleura*), Slender Screw Fern (*Lindsaea incisa*) and Maundia (*Maundia triglochinos*), compared to previous recordings were observed during the Jacobs led survey. The Square-stemmed Olax (*Olax angulata*) had died back due to being smothered by a fallen tree, with one or two shoots regenerating. Following on from these surveys a subsequent survey was commissioned by Roads and Maritime in May 2015 to assess the location where the Square-stemmed Olax had been previously recorded. After a thorough search no individuals were confirmed. As such no direct or indirect impacts to the species are being reported as this was the only individual identified within the project to date.

Water Nutgrass (*Cyperus aquatilis*), though recorded in previous surveys, was not observed during the 2014 survey, likely because preceding dry climatic conditions may have restricted germination.

2.3 Targeted surveys of soft soil work areas

Early soft soil works will be carried out as part of Stage 1 in three waves (as illustrated in **Figure 1.2**):

1. Wave 1 – Soft soils works at Harwood (Section 5)
2. Wave 2 – Soft soils works at Whytes Road to Pimlico (Section 11); and
3. Wave 3 – Soft soils works between Tyndale and Iluka Road (Section 4 and 5) and at Tuckombil Canal, Woodburn (Section 8).

Jacobs (2014a) was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including soft soil work areas.

The initial baseline monitoring surveys were completed between March and May 2014, and subsequently in September 2014. The surveys confirmed the presence of one species within the clearing limits and three threatened flora species adjacent to the clearing limits of Wave 1 and Wave 3, specifically:

1. Wave 1 - Soft soils works at Harwood (Section 5)
 - a) Knotweed (*Persicaria elatior*) (within and adjacent)
2. Wave 2 - Soft soils works at Whytes Road to Pimlico (Section 11)
 - a) Nil recorded
3. Wave 3 - Soft soils works between Tyndale and Iluka Road (Section 4 and 5)
 - a) Sandstone Rough Barked Apple (*Angophora robur*) (adjacent)
 - b) Green-leaved Rose Walnut (*Endiandra muelleri subsp. bracteata*) (adjacent)
 - c) Knotweed (*Persicaria elatior*) (within and adjacent)
 - d) Siah's Backbone (*Streblus pendulinus*) (adjacent); and
4. Wave 3 - Soft soils works at Tuckombil Canal, Woodburn (Section 8)
 - a) Nil recorded.

Within the Wave 1 soft soil works area, a population of 8 individuals of the Knotweed (*Persicaria elatior*) was recorded within the construction footprint, and an additional 2 individuals recorded adjacent (20 m buffer) to the construction footprint. Additional populations of Knotweed (*Persicaria elatior*) comprising 13 individuals were recorded within Wave 3 Section 4 construction footprint, and a further 31 individuals recorded adjacent (20 m buffer) to the construction footprint.

Three threatened flora species have been recorded within close proximity to the clearance limits/construction footprint of Wave 3 being Siah's Backbone (*Streblus pendulinus*), Sandstone Rough Barked Apple (*Angophora robur*) and Green-leaved Rose Walnut (*Endiandra muelleri* subsp. *bracteata*). Between Tyndale and Iluka Road (Section 4), two individuals of Green-leaved Rose Walnut (*Endiandra muelleri* subsp. *bracteata*) have been recorded adjacent to the Wave 3 soft soil works area, however only one individual is within 10 metre buffer. One individual of the Sandstone Rough Barked Apple (*Angophora robur*) occurs in close proximity to the construction footprint of Wave 3 (but outside 20m buffer). One individual plant of Siah's backbone was recorded within a 20 metre buffer of the construction footprint.

It should be noted that individuals identified as Sandstone Rough Barked Apple (*Angophora robur*) within and adjacent to the construction footprint for the Wave 3 (Tyndale) area were resurveyed by Jacobs in August 2014 and a report finalised in November 2014. Specimens were collected and sent to the NSW Herbarium. All of the individuals within the construction footprint have been confirmed as hybrid *Angophora* sp. (Jacobs, 2014b). Only one individual was confirmed as Sandstone Rough Barked Apple (*Angophora robur*) and it is located adjacent to proposed soft soil works but outside the 20m indirect buffer.

2.4 Targeted surveys – Section 3

2.4.1 Geolink (2014a)

Geolink was engaged by Roads and Maritime to undertake ecological surveys and reporting for Section 3 of the Project. The vegetation surveys and reporting included:

- Undertaking vegetation surveys and mapping of all vegetation communities within the Project Site
- Identification of threatened flora species to identify any such species listed under the NSW TSC Act or EPBC Act
- Identification and mapping of areas of Noxious weed infestations as listed under the *Noxious Weeds Act 1993*; and
- Conducting habitat condition assessments to facilitate a later assessment of habitat offsets for threatened species/ communities listed under the EPBC Act.

Ecological surveys of Section 3 were undertaken in August 2014. The surveys confirmed the presence of two threatened flora species including:

- Rough-barked Apple (*Angophora robur*); and
- Four-tailed Grevillea (*Grevillea quadricauda*).

Geolink (2014a) identified an estimated 500+ individuals of Rough-barked Apple (*Angophora robur*) within an area to the north of Section 3 associated with areas of Dry Sclerophyll forest. The species was previously detected in this area as part of flora surveys undertaken as part of the W2B EIS (SKM, 2013) where it occurs sympatrically with the similar species, Broad-leaved Apple (*Angophora subvelutina*). Whilst a number of *Angophora* trees were able to be identified on site as either Rough-barked Apple (*Angophora robur*) or Broad-leaved Apple (*Angophora subvelutina*) based on fruit size, many *Angophora* trees were unable to be identified accurately as no fruit was present. Instead of identification of Rough-barked Apple (*Angophora robur*) on site previous predictive mapping prepared by SKM (2013) was ground-truthed. The predictive mapping was found to accurately capture the occurrence of *Angophora* sp. within the Project Site.

It should be noted that subsequent detailed surveys of Rough-barked Apple (*Angophora robur*) populations were completed by Jacobs (2014b) in August 2014. The Jacobs survey data has therefore replaced that of Geolink for determining final impacts to the Rough-barked Apple (*Angophora robur*) populations.

On site an aggregation of 18 Four-tailed Grevillea (*Grevillea quadricauda*) were found associated with an area of riparian rainforest on the eastern side of the alignment (outside the clearing limits). This cluster of plants had also been recorded during previous ecological investigations undertaken within the study area (SKM, 2013).

Access limitations for a number of properties in Section 3 restricted the total coverage of the GeoLink (2014a) surveys. A desktop risk based assessment will be undertaken assessing the potential for threatened flora to be present on site based on potential habitat, known records in proximity to the property and land uses. For properties with a high risk additional targeted surveys will be undertaken prior to clearing. Timing of these surveys is limited to when access becomes available, and the TFMP will be updated to incorporate the results of these surveys should any additional threatened flora species be observed.

2.4.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 3. The purpose of the Jacobs survey was 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; and
- 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 surveys confirmed the presence of four threatened flora species within Section 3, specifically:

- Rough-barked Apple (*Angophora robur*)
- Four-tailed Grevillea (*Grevillea quadricauda*)
- Maundia (*Maundia triglochoides*); and
- Weeping Paperbark (*Melaleuca irbyana*).

Rough-barked Apple (*Angophora robur*) was recorded within and in proximity to the alignment. There were no major changes to previous surveys in terms of distribution and abundance. It should be noted that subsequent more detailed surveys were undertaken by Jacobs (2014b) of the Rough-barked Apple (*Angophora robur*) populations in August 2014 and more recently in mid 2015. From the area around Tyndale where early works are proposed a number of specimens were sent to the NSW Herbarium. A large proportion of these specimens were determined to be hybrids, and therefore are not the threatened species. Due to the large number of potential Rough-barked Apple (*Angophora robur*) in the project area, and complexity and lengthy timeframes with genetic testing, Roads and Maritime are proposing to take a conservative approach and have included all potential Rough-barked Apple (*Angophora robur*) within the impact assessments (except for those specimens determined as hybrids by the NSW Herbarium in the area of early works in Section 3).

Four-tailed Grevillea (*Grevillea quadricauda*) was recorded within and adjacent to the alignment. There were no major changes from previous surveys. Plants in the southern population of the alignment were observed as damaged and regenerating.

Maundia (*Maundia triglochinos*) was recorded within Section 3. Within the alignment the species was observed in low to moderate abundance at several locations in comparison to previous observations, most likely due to the below average rainfall received in the study area. Some populations were in better condition than others. There were no major changes from previous surveys in terms of distribution and abundance.

Weeping Paperbark (*Melaleuca irbyana*) was recorded well outside of the Project area within Section 3. This species does not occur within the Construction Footprint or in an area of indirect impact. There were no major changes in results from previous surveys.

2.5 Targeted surveys – Section 4

2.5.1 Geolink (2014b)

Geolink was engaged by Roads and Maritime to undertake vegetation surveys and reporting of Section 4 of the Project. Section 4 of this project is approximately 13.2 km and involves a deviation of approximately 800 m to the east of the existing highway, which is proposed to be built to full motorway standard (Class M).

The purpose of the survey and report was to document the findings of the vegetation surveys undertaken of Section 4 of the W2B 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.

Three threatened flora species were detected during the field surveys:

- Rough-barked Apple (*Angophora robur*)
- Green-leaved Rose Walnut (*Endiandra muelleri*); and
- Knotweed (*Persicaria elatior*).

Approximately 245 individuals of Rough-barked Apple (*Angophora robur*) were detected within an area to the south of Section 4 associated with an area of Angophora Dry Sclerophyll forest. 108 individuals are located within the construction footprint. This species was previously detected in this area as part of flora surveys undertaken as part of the W2B EIS (SKM, 2013) where it occurs sympatrically with the similar species, Broad-leaved Apple (*Angophora subvelutina*). On a precautionary basis and for the purposes of this report any *Angophora* sp. identified in proximity to Section 4 have been recorded as a potential Rough-barked Apple (*Angophora robur*).

Two individuals of Green-leaved Rose Walnut (*Endiandra muelleri*) were identified during the survey north of Maclean associated with areas of Flooded Gum (*Eucalyptus grandis*), Tallowwood Moist Open Forest. An additional Green-leaved Rose Walnut (*Endiandra muelleri*) was detected to the west of the project site in the vicinity of the Maclean Interchange during flora surveys undertaken as part of the W2B EIS (SKM, 2013).

Approximately 157 individuals of Knotweed (*Persicaria elatior*) were detected within a number of areas of Paperbark swamp (dominated by *Melaleuca quinquenervia*) along the floodplain in proximity to Maclean. This species was not detected as part of flora surveys undertaken as part of the W2B EIS.

2.5.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 4. The purpose of the Jacobs survey was 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; and
- 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 surveys confirmed the presence of four threatened flora species within Section 4, specifically:

- Rough-barked Apple (*Angophora robur*)
- *Endiandra muelleri* subsp. *bracteata*
- Knotweed (*Persicaria elatior*); and
- Siah's Backbone (*Streblus pendulinus*).

Rough-barked Apple (*Angophora robur*) was recorded within and in proximity to the alignment. It should be noted subsequent more detailed surveys were undertaken by Jacobs (2014b) of the Rough-barked Apple (*Angophora robur*) populations in August 2014. Specimens were sent to the NSW Herbarium. A large proportion of these species were determined to be hybrids and not the threatened species. Due to the large number of potential Rough-barked Apple (*Angophora robur*) in the project area, and the complexity and lengthy timeframes associated with genetic testing, Roads and Maritime are proposing to take a conservative approach and have assumed all potential Rough-barked Apple (*Angophora robur*) as being Rough-barked Apple (*Angophora robur*), other than areas where genetic testing has confirmed otherwise.

Two individuals of *Endiandra muelleri* subsp. *bracteata* were recorded adjacent to the project area in Section 4 comprising a juvenile plant and mature medium sized tree.

Knotweed (*Persicaria elatior*) was recorded in Section 4 which was not previously identified. Habitat conditions in Section 4 were suitable for the species during the survey period. Supplementary surveys undertaken in September 2014 observed that the plants had died back.

One individual of Siah's Backbone (*Streblus pendulinus*) was recorded within Section 4 at the Maclean intersection, co-occurring with the threatened *Endiandra muelleri* subsp. *bracteata*. This species was not previously identified.

Access limitations for a number of properties in Section 4 restricted the total coverage of the GeoLink and Jacobs surveys. Many of these areas have been identified as cultivated sugar cane paddocks yet, where remnant vegetation is present, a risk based assessment will be undertaken using habitat association and the proximity of known records. Additional surveys will be undertaken prior to clearing in high risk areas. Timing of these surveys is limited to when access becomes available, and the TFMP will be updated to incorporate the results of these surveys should any additional threatened flora species be observed.

2.6 Targeted surveys – Section 5

2.6.1 Geolink (2014b)

Geolink was engaged by Roads and Maritime to undertake vegetation surveys and reporting of Section 5 of the Project. Section 5 of the project is approximately 14.4 km starting at the Maclean interchange and ending at the Iluka Road Interchange at Woombah. This section would be a duplication of the existing Pacific Highway alignment, with most of the highway upgraded to motorway standard (Class M).

The purpose of the survey and report was to document the findings of the vegetation surveys undertaken of Section 5 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 flora species was detected during the field surveys, specifically the Knotweed (*Persicaria elatior*). Approximately 93 individuals of Knotweed (*Persicaria elatior*) were detected within a number of areas of Paperbark swamp (dominated by *Melaleuca quinquenervia*). This species was not detected as part of flora surveys undertaken as part of the W2B EIS.

2.6.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 5. The purpose of the Jacobs survey was 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; and
- 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 surveys undertaken within Section 5 did not identify any threatened flora species within Section 5.

2.7 Targeted surveys – Section 6

2.7.1 AECOM (2014)

AECOM Australia Pty Ltd was engaged by Roads and Maritime to deliver vegetation surveys, habitat tree assessments, and nest box management services for Section 6 of the Project. The surveys were conducted between 10 and 13 June 2014.

The scope of the works required the following tasks to be completed within the study area:

- Mapping the extent of vegetation communities according to Biometric vegetation-type
- Identify and map the location of threatened flora (see Section 3.0)
- Assess the availability of habitat for threatened species and ecological communities listed under the EPBC Act; and
- Identify and map the extent of weeds listed under the NSW Government's *Noxious Weeds Act 1993* as well as WONS.

Three threatened flora species were identified during the surveys, specifically:

- Water Nutgrass (*Cyperus aquatilis*)
- Slender Screw Fern (*Lindsaea incisa*); and
- Singleton Mintbush (*Prostanthera cineolifera*).

Eight sub-populations of Water Nutgrass (*Cyperus aquatilis*) were observed with a total population size of approximately 100 individuals estimated to occur within the study area. This was a modest increase of twenty individuals compared to previous surveys, and included additional sub-populations recorded at chainages 97100, 10400 and 103150. A previously recorded population at chainage 103150 was not identified.

Slender Screw Fern (*Lindsaea incisa*) was recorded as twelve discrete sub-populations with an estimated population area of 0.37ha to be disturbed. The distribution of Slender Screw Fern (*Lindsaea incisa*) was consistent with the results of previous assessments throughout the study area.

Consistent with previous surveys throughout the study area, Singleton Mintbush (*Prostanthera cineolifera*) was found to be confined to the banks of Tabbimoble Creek amongst stands of Paperbark Swamp Forest of the Coastal Lowlands of the North Coast. Approximately 200 individuals were recorded across two sub-populations, found either side of the highway. The majority of records were found on the west side of the highway.

Access limitation for a number of properties in Section 6 restricted the total coverage of the AECOM (2014) surveys, however this report recommends that no surveys of these areas are necessary. However, a precautionary assessment of these areas by the project ecologist will be undertaken prior to clearing, and if there is considered to be a high risk of threatened flora species occurring, additional surveys will be commissioned. Timing of these surveys is limited to when access becomes available, and the TFMP will be updated to incorporate the results of these surveys should any additional threatened flora species be observed.

2.7.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 6. The purpose of the Jacobs survey was 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; and
- 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 surveys confirmed the presence of five threatened flora species within Section 6, specifically:

- Slender Screw Fern (*Lindsaea incisa*)
- Knotweed (*Persicaria elatior*)
- Singleton Mint Bush (*Prostanthera cineolifera*); and
- *Rotala tripartita*.

Slender Screw Fern (*Lindsaea incisa*) was recorded within Section 6. However, habitat conditions were not ideal for the species at Mororo State Forest until the end of the survey period (May 2014) with very few plants recorded in March 2014.

Knotweed (*Persicaria elatior*) was recorded within Section 6 and was not previously identified. Supplementary surveys in September 2014 identified that the plants had died back.

Singleton Mint Bush (*Prostanthera cineolifera*) was recorded within Section 6 with no major changes from previous surveys identified.

Two individuals of *Rotala tripartita* were identified within Section 6 in an area of wetland habitat. This species was not previously identified in the project area in the EIS. Specimens were confirmed by the National Herbarium of NSW.

No individuals of Water Nutgrass (*Cyperus aquatilis*) were recorded within Section 6 despite targeted surveys in areas of suitable habitat in a range of climatic conditions over the survey period. The dry climatic conditions were considered unsuitable for detecting the species and the cooler season (autumn) may have restricted the germination of any soil-stored seed following rainfall during the survey period.

2.8 Targeted surveys – Section 7

2.8.1 Biosis (2014b)

Biosis was commissioned by Roads and Maritime to undertake ecological assessments of Section 7 of the Project. Surveys were undertaken between 7 and 11 July 2014.

The objectives of the ecological assessment were to:

- Verify the accuracy or otherwise of vegetation community mapping prepared in support of the EIS
- Assess the quality of habitat provided by mapped vegetation communities for Commonwealth listed threatened species that have been confirmed or assessed as having a moderate to high likelihood of occurrence in the project locality
- Record the location and extent of threatened flora species
- Record the location and extent of weed infestations; and
- Undertake a hollow bearing tree survey in order to prepare a Nest Box Management Plan.

A total of three threatened flora species were recorded within the Study area during the survey, namely:

- Water Nutgrass (*Cyperus aquatilis*)
- Maundia (*Maundia triglochinosoides*); and
- Weeping Paperbark (*Melaleuca irbyana*).

A number of Water Nutgrass (*Cyperus aquatilis*) individuals and small populations were recorded in drainage lines and periodically inundated areas encompassed by the Study Area.

Maundia (*Maundia triglochinosoides*) has previously been recorded in a number of locations within the Study Area, however only two populations were recorded during this survey. Differences in the distribution and abundance of Maundia (*Maundia triglochinosoides*) can be attributed to changes in the wet/dry cycle of suitable habitat (i.e. drainage lines) as well as dispersal of individuals throughout the area.

One relatively large population of Weeping Paperbark (*Melaleuca irbyana*) was recorded within the Study Area, just south of the New Italy Rest Area.

Access limitation for a number of properties in Section 7 restricted the total coverage of the Biosis (2014b) surveys. Although vegetation communities for these areas were able to be identified remotely, a risk based assessment will be undertaken using habitat association and the proximity of known records, and additional surveys will be undertaken for more cryptic flora species prior to clearing in high risk areas. Timing of these surveys is limited to when access becomes available, and the TFMP will be updated to incorporate the results of these surveys should any threatened flora species be observed.

2.8.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 7. The purpose of the Jacobs survey was 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; and
- 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 surveys confirmed the presence of two threatened flora species within Section 7, specifically:

- Maundia (*Maundia triglochinos*); and
- Weeping Paperbark (*Melaleuca irbyana*).

Maundia (*Maundia triglochinos*) was observed during the surveys in low to moderate abundance at several locations in comparison to previous observations, most likely due to the below average rainfall received in the study area. There were no major changes from previous surveys in terms of distribution and abundance. Some populations were in better condition than others.

Weeping Paperbark (*Melaleuca irbyana*) was recorded during the field surveys. There were no major changes from previous surveys.

No individuals of previously detected Water Nutgrass (*Cyperus aquatilis*) were recorded within Section 7 despite targeted surveys in areas of suitable habitat in a range of climatic conditions over the survey period. The dry climatic conditions were considered unsuitable for detecting the species and the cooler season (autumn) may have restricted the germination of any soil-stored seed following rainfall during the survey period.

2.9 Targeted surveys – Section 8

2.9.1 Melaleuca Group (2014)

Melaleuca Group was engaged by Roads and Maritime to undertake vegetation surveys of Section 8 of the Project which extends north 11.1 km from south of Gap Road to Broadwater National Park about 600 m southwest of the Montis Trail. Surveys were conducted between 12 and 21 February 2014 and 7 to 10 April 2014. Weather conditions at the time of the survey were hot and dry during February and overcast with occasional light rain in April.

The objectives of the vegetation survey were to undertake:

- Vegetation surveys, mapping of vegetation communities
- Assessment of habitat condition
- Mapping and identification of NSW TSC Act and the EPBC Act listed flora species; and
- Mapping and identification of weeds.

Targeted field surveys carried out throughout the study area identified the occurrence of three threatened flora species:

- Hairy Joint Grass (*Arthraxon hispidus*)
- Rough-shelled Bush Nut (*Macadamia tetraphylla*); and
- Yellow-flowered King of the Fairies (*Oberonia complanata*).

Hairy Joint Grass (*Arthraxon hispidus*) was identified occurring in a single polygon within a grazed area dominated by exotic grasses. The estimated population at this location was >1000 plants occupying an area of 1.5 ha.

One mature Rough-shelled Bush Nut (*Macadamia tetraphylla*) was identified during the survey occurring in a cleared and grazed paddock.

Yellow-flowered King of the Fairies (*Oberonia complanata*) was identified in clumps of orchids on the southern side of three senescent swamp oak trees. In total 26 individuals were identified.

2.9.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 8. The purpose of the Jacobs survey was 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; and
- 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 surveys confirmed the presence of four threatened flora species within Section 8, specifically:

- Hairy Joint Grass (*Arthraxon hispidus*)
- Rough Shelled Bush Nut (*Macadamia tetraphylla*)
- Yellow-flowered King of the Fairies (*Oberonia complanata*); and
- Siah's Backbone (*Streblus pendulinus*).

Hairy Joint Grass (*Arthraxon hispidus*) was recorded in Section 8. Survey results indicated that below average rainfall was likely to have restricted the distribution of the species during the survey.

One individual of Rough Shelled Bush Nut (*Macadamia tetraphylla*) was recorded in Section 8 in an open paddock adjacent to the proposed ancillary site at Lang Hill. Previous surveys had not recorded this species outside of Section 10.

Yellow-flowered King of the Fairies (*Oberonia complanata*) was recorded in Section 8 which had not been identified in the project area in previous survey efforts. This species was recorded on three separate host trees with a total of 22 individuals observed in a range of age classes.

Siah's Backbone (*Streblus pendulinus*) was recorded in Section 8 which had not been identified in the project area in previous survey efforts. Three specimens were recorded adjacent to the proposed excavation site at Lang Hill, including one small tree and two juvenile plants.

2.10 Targeted surveys – Section 9

2.10.1 Melaleuca Group (2014)

Melaleuca Group was engaged by Roads and Maritime to undertake vegetation surveys of Section 9 of the Project which extends north of Broadwater National Park 7.6 km to south of the Richmond River. Surveys were conducted between 12 and 21 February 2014 and 7 to 10 April 2014. Weather conditions at the time of the survey were hot and dry during February and overcast with occasional light rain in April.

As per the project brief, requirements for floristic survey include the following components:

- Vegetation surveys, mapping of vegetation communities
- Assessment of habitat condition
- Mapping and identification of NSW TSC Act and the EPBC Act listed flora species; and
- Mapping and identification of weeds.

The survey of Section 9 undertaken by Melaleuca Group did not identify any threatened flora species.

2.10.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 9. The purpose of the Jacobs survey was 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; and
- 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 surveys confirmed the presence of Lesser Swamp-orchid (*Phaius australis*). These individuals were located well outside the proposed clearing boundary, and were not within an area of Indirect Impact.

2.11 Targeted surveys – Section 10

2.11.1 Australian Museum Consulting (2014)

The Australian Museum Consulting was engaged by Roads and Maritime to undertake ecological studies of Section 10 of the Project which extends northwards 13.5 km from the southern side of the Richmond River just east of Broadwater to the proposed interchange at Coolgardie Road.

Vegetation surveys were undertaken from 7 to 18 July 2014, and involved four main tasks:

- Vegetation surveys to confirm the vegetation community mapping documented in the Project EIS (RMS et al. 2012a)
- Searches for flora species listed as threatened under the TSC Act and/or EPBC Act
- Habitat condition assessments species under the EPBC Act; and
- Identification and mapping weed infestations.

The field surveys identified eight threatened flora species, specifically:

- White Lace Flower (*Archidendron hendersonii*)
- Stinking Cryptocarya (*Cryptocarya foetida*)
- *Endiandra muelleri* subsp. *bracteata*
- Smooth-barked Rose Apple (*Syzygium hodgkinsoniae*)
- Rough-shelled Bush Nut (*Macadamia tetraphylla*)
- Davidson's Plum (*Davidsonia jerseyana*)
- Whalebone Tree (*Streblus pendulinus*); and
- Hairy Joint Grass (*Arthraxon hispidus*).

15 individuals of White Lace Flower (*Archidendron hendersonii*) were recorded growing in Lowland Rainforest, north of the intersection of Coolgardie Road with the Pacific Highway and further south.

47 individuals of Stinking Cryptocarya (*Cryptocarya foetida*) were recorded within the study area growing in Lowland Rainforest, north of the intersection of Coolgardie Road with the Pacific Highway, and further south. 25 of these were juvenile species and therefore their identification was difficult to confirm. A conservative approach has been taken and they have been treated as *Cryptocarya foetida* for the purposes of estimating impacts to the species.

Seven individuals of *Endiandra muelleri* subsp. *bracteata* were recorded within the study area growing in Lowland Rainforest, north of the intersection of Coolgardie Road with the Pacific Highway.

Five individuals of Smooth-barked Rose Apple (*Syzygium hodgkinsoniae*) were recorded within the study area growing in Lowland Rainforest, north of the intersection of Coolgardie Road with the Pacific Highway and further south.

10 individuals of Rough-shelled Bush Nut (*Macadamia tetraphylla*) were recorded within the study area growing in Lowland Rainforest, west of the intersection of Coolgardie Road with the Pacific Highway.

One Davidson's Plum (*Davidsonia jerseyana*) was recorded within the study area growing in Lower Richmond Mesic Successional wet/swamp Sclerophyll Forest/Rainforest as described by Sheringham et al. (2008), south of the intersection of Coolgardie Road with the Pacific Highway. This individual is not within the Construction Footprint or within an area of Indirect Impact.

One Whalebone Tree (*Streblus pendulinus*) was recorded within the study area growing in Lower Richmond Mesic Successional wet/swamp Sclerophyll Forest/Rainforest as described by Sheringham et al. (2008), to the north east of the intersection of Hillside Lane with Wardell Road.

Nine individuals of Hairy Joint Grass (*Arthraxon hispidus*) were recorded within the study area growing in cleared land often adjacent to Lowland Rainforest and areas prone to flooding. Nine patches of Hairy Joint Grass (*Arthraxon hispidus*) were delineated in this survey.

Access limitation for a number of properties in Section 10 restricted the total coverage of the Australian Museum Consulting (2014) surveys. These areas are identified in the attached Australian Museum Consulting (2014) report in Appendix D. Additional surveys have been recommended for these areas and a risk based assessment will be undertaken using habitat association and the proximity of known records. Where the risk of occurrence of threatened flora is deemed high, additional surveys will be undertaken prior to clearing. Timing of these surveys is limited to when access becomes available. Once these surveys are completed, the TFMP will be updated to incorporate the results of these surveys should any additional threatened flora species be observed.

2.11.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 10. The purpose of the Jacobs survey was 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; and
- 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 surveys confirmed the presence of two threatened flora species within Section 10, specifically:

- Hairy Joint Grass (*Arthraxon hispidus*); and
- Soldiers Crest Orchid (*Oberonia titania*).

Several additional populations of Hairy Joint Grass (*Arthraxon hispidus*) were identified within Section 10. Some previously mapped populations were not present during the survey potentially due to altered management regimes. Further, during the survey period rainfall had been below average which is likely to have restricted the distribution of the species during the survey.

One individual specimen of Soldiers Crest Orchid (*Oberonia titania*) was identified near the edge of the clearing boundary within Section 10.

2.12 Targeted surveys – Section 11

2.12.1 Australian Museum Consulting (2014)

The Australian Museum Consulting was engaged by Roads and Maritime to undertake ecological studies of Section 11 of the Project which extends northwards 5.4 km from Coolgardie Road to the tie-in with the Pimlico to Teven Project.

Vegetation surveys were undertaken from 7 to 18 July 2014, and involved four main tasks:

- Vegetation surveys to confirm the vegetation community mapping documented in the Project EIS (RMS et al. 2012a)
- Searches for flora species listed as threatened under the NSW TSC Act and/or EPBC Act
- Habitat condition assessments species under the EPBC Act; and
- Identification and mapping weed infestations.

The survey of Section 11 undertaken by Australian Museum Consulting did not identify any threatened flora species.

2.12.2 Jacobs (2014a)

Jacobs was commissioned by Roads and Maritime to undertake targeted threatened flora surveys and baseline monitoring throughout the Project, including Section 11. The purpose of the Jacobs survey was 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; and
- 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 survey of Section 11 undertaken by Jacobs (2014a) did not identify any threatened flora species.

3. Threatened plant populations

25 threatened flora species were previously identified during the EIS as being within and/or proximate to the project boundary. These species were targeted during pre-construction flora surveys (as summarised in **Section 2**) and are listed in **Table 3-1** along with their status under the EPBC Act and the TSC Act. The most up to date information on the location of these threatened flora species and proximity to the project boundary recorded during pre-construction targeted surveys are illustrated in **Appendix C**.

A profile for each of these threatened flora species is provided in **Appendix E**.

Table 3-1 Threatened flora species previously identified during the EIS

Species	Common name	Status EPBC Act	Status TSC Act
<i>Angophora robur</i>	Sandstone Rough Barked Apple	V	V
<i>Archidendron hendersonii</i>	White Lace Flower	-	V
<i>Arthraxon hispidus</i>	Hairy Joint Grass	V	V
<i>Cryptocarya foetida</i>	Stinking Cryptocarya	V	V
<i>Cyperus aquatilis</i>	Water Nutgrass	-	E
<i>Davidsonia jerseyana</i>	Davidson's Plum		
<i>Eleocharis tetraquetra</i>	Square-stemmed Spike-rush	-	E
<i>Endiandra muelleri bracteata</i>	Green-leaved Rose Walnut	-	E
<i>Eucalyptus tetrapleura</i>	Square-fruited Ironbark	V	V
<i>Grevillea quadricauda</i>	Four-tailed Grevillea	V	V
<i>Lindernia alsinoides</i>	Lindernia	-	E
<i>Lindsaea incisa</i>	Slender Screw Fern	-	E
<i>Macadamia tetraphylla</i>	Rough-shelled Bush Nut	V	V
<i>Maundia triglochinosoides</i>	Maundia	-	V
<i>Melaleuca irbyana</i>	Weeping Paperbark	-	E
<i>Oberonia complanata</i>	Yellow-flowered King of the Fairies	-	E
<i>Oberonia titania</i>	Soldiers Crest Orchid		V
<i>Olax angulata</i>	Square-stemmed Olax	-	V
<i>Persicaria elatior</i>	Knotweed	V	V
<i>Phaius australis</i>	Southern Swamp Orchid	E	E
<i>Prostanthera cineolifera</i>	Singleton Mint Bush	V	V
<i>Quassia</i> sp. Moonee Creek	Moonee Quassia	E	E
<i>Rotala tripartita</i>	-	-	E
<i>Streblus pendulinus</i>	Siah's Backbone	E	-
<i>Syzygium hodgkinsoniae</i>	Red Lilly Pilly	V	V

4. Potential impacts and management approach

This section provides an overview of the potential impacts to threatened flora species as informed by targeted threatened flora surveys of the Project. It describes the potential impacts to threatened species at specific locations where encountered 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 SPIR are documented in Sections 5, 6 and 7 of the TFMP and target the predicted impacts.

4.1 Potential impacts associated with the project

Impacts to threatened flora were classified as either direct or indirect, as defined below.

- Direct impacts relate to species located within the construction footprint or also referred to as the clearing limits. Direct impacts to threatened flora species include removal of individuals, populations, and/or their preferred habitat. Some populations directly impacted occur as small isolated populations (e.g. Hairy Joint Grass) while other populations directly impacted occur across a broader area (e.g. Lindernia).
- Indirect impacts relate to non-aquatic and shade-requiring threatened flora species that are located within a 10 m buffer of the construction footprint. For aquatic and shade-requiring species indirect impacts have been assessed for those plants within a 20 m buffer of the construction footprint. This was recommended by the expert as an appropriate buffer for these types of species. Indirect impacts may include edge-effects and altered hydrological regimes. Where new edges have been created through habitat removal there is potential for edge-effects such as changes to the amount of light, moisture, wind and humidity, potentially resulting in altered conditions within habitats, changes in species assemblage, structure, or weed invasion. Potential impacts to hydrological regimes within the project area include changes in the quality and quantity of surface and groundwater entering aquatic habitats within and adjacent to the project boundary. Potential indirect impacts to threatened flora species downslope from the project area may also result from changes in the flow, quality and quantity of surface water and groundwater.

4.1.1 Direct impacts

20 threatened flora species were identified as occurring within the construction footprint of the Project and will therefore be directly impacted. These species and the extent of direct impacts are outlined in **Table 4-1** and **Table 4-2**. Species locations are illustrated in figures in **Appendix C**.

4.1.2 Indirect impacts

Apart from the direct impacts to the threatened flora species detailed above, a number of indirect impacts also have the potential to impact remaining plants in proximity to the Project during construction or operation including:

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

22 species have the potential to be indirectly impacted by the Project as they have been confirmed to occur within the specified 10 m – 20 m buffer distances from the construction footprint. A summary of the species and respective areas of potential indirect impacts are provided in **Table 4-1** and **Table 4-2**. Species locations are illustrated in figures in **Appendix C**.

Table 4-1 Direct and indirect impacts identified in the targeted threatened flora surveys

Section	Common name	Scientific name	Construction footprint		Indirect impact (within 10m)		Indirect impact (within 10m to 20m)	
			Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)
Section 1	Hairy Joint Grass*	<i>Arthraxon hispidus</i>	2	-	-	-	-	-
	Water Nutgrass*	<i>Cyperus aquatilis</i>	1	0.021	-	-	-	-
	Square-stemmed Spike-rush*	<i>Eleocharis tetraquetra</i>	253	0.815	43	0.118	48	0.120
	Maundia*	<i>Maundia triglochinosoides</i>	5	0.075	5	0.038	-	-
	Moonee Quassia	<i>Quassia sp. Moonee Creek</i>	73	0.080	137	0.105	250	0.126
	Lindernia*	<i>Lindernia alsinoides</i>	1811	-	18	-	91	-
	Slender Screw Fern*	<i>Lindsaea incisa</i>	-	0.013	-	-	-	0.003
Section 2	Water Nutgrass*	<i>Cyperus aquatilis</i>	6	0.003	-	-	-	-
	Square-fruited Ironbark	<i>Eucalyptus tetrapleura</i>	822	20.285	193	6.337	115	4.870
	Lindernia*	<i>Lindernia alsinoides</i>	-	-	-	-	4	-
	Maundia*	<i>Maundia triglochinosoides</i>	34	0.075	45	0.072	16	0.073
Section 3	Rough-barked Apple	<i>Angophora robur</i>	6443	87.895	1146	20.691	1208	19.572
	Hairy Joint Grass*	<i>Arthraxon hispidus</i>	1	-	-	-	-	-
	Four-tailed Grevillea	<i>Grevillea quadricauda</i>	3	-	35	0.017	14	-
	Maundia*	<i>Maundia triglochinosoides</i>	3	0.016	-	-	1	-
Section 4	Rough-barked Apple	<i>Angophora robur</i>	108	2.618	3	0.462	8	0.425
	Green-leaved Rose Walnut	<i>Endiandra muelleri subsp. bracteata</i>	-	-	-	-	2	-
	Knotweed*	<i>Persicaria elatior</i>	53	0.153	3	-	1	0.006
	Siah's Backbone*	<i>Streblus pendulinus</i>	-	-	-	-	1	-

Section	Common name	Scientific name	Construction footprint		Indirect impact (within 10m)		Indirect impact (within 10m to 20m)	
			Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)
Section 5	Knotweed*	<i>Persicaria elatior</i>	23	0.047	25	0.069	68	0.084
Section 6	Water Nutgrass*	<i>Cyperus aquatilis</i>	113	-	-	-	-	-
	Slender Screw Fern*	<i>Lindsaea incisa</i>	-	0.370	-	0.058	-	0.148
	Singleton Mintbush	<i>Prostanthera cineolifera</i>	609	0.424	260	0.188	106	0.229
	<i>Rotala tripartita</i> *	<i>Rotala tripartita</i>	-	-	-	-	2	-
Section 7	Water Nutgrass*	<i>Cyperus aquatilis</i>	8	-	2	-	1	-
	Maundia*	<i>Maundia triglochinosoides</i>	11	0.023	16	-	1	-
	Weeping Paperbark	<i>Melaleuca irbyana</i>	1582	2.761	132	0.322	41	0.203
Section 8	Hairy Joint Grass*	<i>Arthraxon hispidus</i>	38	0.238	2	-	8	0.038
	Rough-shelled Bush Nut	<i>Macadamia tetraphylla</i>	-	-	2	-	-	-
	Yellow-flowered King of the Fairies*	<i>Oberonia complanata</i>	18	0.033	1	0.013	6	-
	Siah's Backbone*	<i>Streblus pendulinus</i>	-	-	-	-	2	-
Section 10	White Lace Flower*	<i>Archidendron hendersonii</i>	1	-	4	-	18	-
	Stinking Cryptocarya*	<i>Cryptocarya foetida</i>	41	-	1	-	6	-
	Green-leaved Rose Walnut	<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	3	-	10	-	3	-
	Smooth barked Rose Apple	<i>Syzygium hodgkinsoniae</i>	6	-	4	-	-	-
	Rough-shelled Bush Nut*	<i>Macadamia tetraphylla</i>	10	-	-	-	3	-
	Siah's Backbone*	<i>Streblus pendulinus</i>	4	-	1	-	2	-
	Hairy Joint Grass*	<i>Arthraxon hispidus</i>	347	1.232	47	0.697	53	0.846
	Soldiers Crest Orchid*	<i>Oberonia titania</i>	-	-	-	-	13	-

**These species are either aquatic or shade requiring species and therefore a 20 metre buffer has been applied to determine potential Indirect Impacts to these species. Remaining species have a 10 metre Indirect Impact buffer applied.*

A summary of total impacts for each threatened plant species is summarised below in **Table 4-2**.

Table 4-2 Summary of impacts on threatened flora species

Common name	Scientific name	Locations	Total Direct Impact Construction footprint		Indirect impact (within 10m)		Indirect impact (within 10m to 20m)	
			Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)
Rough-barked Apple	<i>Angophora robur</i>	Sections 3 and 4	6551	90.513	1149	21.153	1216	19.997
White Lace Flower*	<i>Archidendron hendersonii</i>	Section 10	1	-	4	-	18	-
Hairy Joint Grass*	<i>Arthraxon hispidus</i>	Sections 1, 3, 8 and 10	388	1.47	49	0.697	61	0.884
Stinking Cryptocarya*	<i>Cryptocarya foetida</i>	Section 10	41	-	1	-	6	-
Water Nutgrass*	<i>Cyperus aquatilis</i>	Sections 1, 2, 6 and 7	128	0.024	2	-	1	-
Square-stemmed Spike-rush*	<i>Eleocharis tetraquetra</i>	Section 1	253	0.815	43	0.118	48	0.12
Green-leaved Rose Walnut	<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	Sections 4 and 10	3	-	10	-	5	-
Square-fruited Ironbark	<i>Eucalyptus tetrapleura</i>	Section 2	822	20.285	193	6.337	115	4.87
Four-tailed Grevillea	<i>Grevillea quadricauda</i>	Section 3	3	-	35	0.017	14	-
Lindernia*	<i>Lindernia alsinoides</i>	Sections 1 and 2	1811	-	18	-	95	-
Slender Screw Fern*	<i>Lindsaea incisa</i>	Sections 1 and 6	-	0.383	-	0.058	-	0.151
Rough-shelled Bush Nut*	<i>Macadamia tetraphylla</i>	Sections 8 and 10	10	-	2	-	3	-
Maundia*	<i>Maundia triglochinosoides</i>	Sections 1, 2, 3 and 7	53	0.189	66	0.11	19	0.073
Weeping Paperbark	<i>Melaleuca irbyana</i>	Section 7	1582	2.761	132	0.322	41	0.203
Yellow-flowered King of the Fairies*	<i>Oberonia complanata</i>	Section 8	18	0.033	1	0.013	6	-
Soldiers Crest Orchid*	<i>Oberonia titania</i>	Section 10	-	-	-	-	13	-
Knotweed*	<i>Persicaria elatior</i>	Sections 4 and 5	76	0.2	28	0.069	69	0.09
Singleton Mintbush	<i>Prostanthera cineolifera</i>	Section 6	609	0.424	260	0.188	106	0.229
Moonee Quassia	<i>Quassia sp. Moonee Creek</i>	Section 1	73	0.08	137	0.105	250	0.126
-	<i>Rotala tripartita</i>	Section 6	-	-	-	-	2	-
Siah's	<i>Streblus</i>	Sections 4, 8	4	-	1	-	5	-

Common name	Scientific name	Locations	Total Direct Impact Construction footprint		Indirect impact (within 10m)		Indirect impact (within 10m to 20m)	
			Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)	Count (Points)	Area (Polygon)
Backbone*	<i>pendulinus</i>	and 10						
Smooth-barked Rose Apple	<i>Syzygium hodgkinsoniae</i>	Section 10	6	-	4	-	-	-

*These species are either aquatic or shade requiring species and therefore a 20 metre buffer has been applied to determine potential Indirect Impacts to these species. Remaining species have a 10 metre Indirect Impact buffer applied.

It is important to note that prior to clearing, pre-clearance surveys will be undertaken by suitably qualified environmental officers to reconfirm the threatened flora populations identified during the targeted flora surveys. If seasonal conditions changed from the last survey any new individuals that may be identified will be recorded and assessed. These surveys will also ensure that threatened flora species are tagged and appropriate mitigation measures are implemented to provide protection during construction, such as establishment of exclusion zones. Any new individuals confirmed will then be addressed through the Roads and Maritime New Finds Procedure. This measure is also described in Section 6.3.3 of this TFMP.

4.2 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
- 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.

4.3 Mitigation and monitoring

The following objectives would be implemented for the mitigation of impacts to threatened flora species:

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

Mitigation for the project will be addressed in the project-specific 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 potential impacts to threatened flora during construction and operation of the project were detailed in the EIS, Biodiversity Working Paper and SPIR. In general terms, 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 for the project are addressed in a separate Translocation Strategy prepared to satisfy MCoA D7. This will include a feasibility assessment in line with the projects offset strategy followed by translocation trials. These measures will be outlined in a separate translocation strategy (refer to **Section 5.3.3**).

This management plan details the parameters and methods for monitoring the effectiveness of the proposed mitigation measures for threatened flora 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 flora have been set out in detail in the following sections.

4.4 Effectiveness of mitigation measures

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

Table 4-3 Mitigation measures and evaluation of their effectiveness for threatened flora

Issue	Mitigation measure	History of success	Effectiveness rating
Impacts to threatened flora to be retained <i>in situ</i> within the project boundary (outside the construction footprint).	<p>Determine extent of threatened flora populations to be directly impacted, and those that can be retained <i>in situ</i> that occur outside the construction footprint.</p> <p>Identify and maintain exclusion zones and limits of clearing.</p> <p>Weed management near retained threatened flora.</p> <p>Erosion and sediment control.</p> <p>Pre-clearing and clearing procedures.</p>	<p>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.</p> <p>Protection of threatened plant populations <i>in situ</i> has been used successfully on multiple upgrades of the Pacific Highway and other major highways in NSW. Recent examples include Glenugie, Tintenbar to Ewingsdale and Sapphire to Woolgoolga, however the associated mitigation measures go back over at least 15 years on other upgrades. Construction and operational monitoring has been reported for numerous threatened flora species and reported on survival, resilience and recruitment of species such as <i>Quassia</i> species Moonee Creek. Where mortalities are reported these are included in an adaptive management framework.</p>	High
Impacts from weeds around retained <i>in situ</i> threatened plant populations.	<p>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.</p> <p>In areas surrounding <i>in situ</i> threatened plants specific weed management measures will be undertaken by suitably qualified and experienced</p>	<p>Roads and Maritime has developed standard weed management procedures that are documented in the Biodiversity Guidelines (RTA 2011). These measures 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 <i>in situ</i> populations of threatened plants and control undertaken where required. Weed monitoring during construction is a routine procedure for road upgrades with a long history of success in NSW.</p> <p>Reporting for on-going weed impacts and controls around threatened plants adjacent to the road have varied greatly in</p>	Moderate, monitor against performance and implement weed management actions

Issue	Mitigation measure	History of success	Effectiveness rating
	<p>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.</p> <p>Top soil management.</p>	<p>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.</p> <p>Roads and Maritime has undertaken revegetation of disturbed areas successfully on a number of road projects. Roads and Maritime have also successfully managed top soil for reuse as part of the landscaping and revegetation management.</p>	
Direct loss of threatened plants during construction.	<p>Avoidance of impact where possible (during the detailed design stages).</p> <p>Translocation is a management option which may involve:</p> <ul style="list-style-type: none"> • Translocation strategy developed to identify suitable plants and locations, translocation of plants out of areas of direct impact. • Establishment of translocation population in appropriate areas and suitable habitats away from construction. • Seed collection from threatened plant species as appropriate, for establishment of <i>ex situ</i> populations on offset sites. • Establishment of <i>ex situ</i> populations from seed and cutting material collected from impact areas (or other sites) to offset sites. • Maintenance and monitoring of translocated threatened flora population/s. <p>Revegetation of appropriate sites with germinated/struck seedlings.</p> <p>Offsetting or acquiring compensatory habitat to protect and/or improve threatened flora habitat.</p>	<p>Roads and Maritime have successfully in the past refined the design to avoid threatened plants. This may be through relocating stockpile areas, narrowing construction corridors where possible etc.</p> <p>The procedures used for translocation depend on the species and Roads and Maritime typically follows industry best practice as reported in ANPC (2004) <i>Guidelines for Translocation of Threatened Plants Australia</i>, RTA Seed Collection QA Specification R176 and the Florabank <i>Guidelines and Model Code of Practice</i> (www.florabank.org.au) and the Nursery Industry Accreditation Scheme Australia (NIASA) Best Management Practice Guidelines - 4th Edition, updated 2010.</p> <p>Propagation and replanting of threatened plant species and salvage and translocation of threatened plants may be done in conjunction with offset requirements. This has not been done often by Roads and Maritime as a general construction procedure. However Roads and Maritime have successfully translocated the following threatened flora species included in this plan on the following projects:</p> <ul style="list-style-type: none"> - <i>Arthraxon hispidus</i>: Ballina Bypass and T2E projects. - <i>Linsaea incisa</i>: Sapphire to Woolgoolga project. - <i>Macadamia tetraphylla</i>: T2E project - <i>Melaleuca irbyana</i>: Glenugie upgrade. <p>Roads and Maritime has also successfully translocated a number of other threatened plants not included in this plan, as such they have not been detailed in this table.</p> <p>Translocation is not seen as a mitigation measure and would be trialled for other species if required as a condition of approval with on-going monitoring to be conducted to measure the success.</p>	Moderate to high, monitor against performance and implement contingencies where required.
Populations of	Water quality managed in	Roads and Maritime has successfully used water quality	High

Issue	Mitigation measure	History of success	Effectiveness rating
threatened flora adversely impacted by changes to the water quality within and immediately adjacent to the project.	accordance with procedures in the CEMP.	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. W2B Water Quality Management Program and Water Quality Monitoring Program will also outline how water quality and hydrology will be managed on site during construction and operation.	

4.5 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:

- **Specific.**
- **Measurable.**
- **Achievable.**
- **Results-based.**
- **Time-based.**

Details of the proposed monitoring program are described in **Section 8** and include monitoring retained *in situ* threatened plants, translocated sites and revegetation areas adjacent to threatened plants.

5. Pre-construction management measures

5.1 Potential impacts during pre-construction

There is an opportunity to protect threatened flora species within and close to construction areas through implementation of pre-construction management measures. Therefore there is potential for accidental impact to threatened plants to occur when locating ancillary facility sites including heavy vehicle access as part of pre-construction planning.

5.2 Management objectives

The objectives of the management strategy include:

- Threatened plants within and in close proximity to the project to be retained (*in situ*) would be identified, mapped and clearly marked prior to commencement of construction.
- A completed and approved threatened plants translocation strategy for relevant project sections.
- Seeds and other propagation material to be collected from threatened plants located within the project area where possible and where they can be used to supplement feasible translocation works.
- Identify exclusions zones prior to construction commencing and finalise locations of ancillary sites and access roads outside these exclusion zones.

5.3 Management measures

5.3.1 Targeted surveys

Targeted surveys for threatened plants have 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 5-1**.

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 5.3.3**).

Targeted surveys for W2B have been completed and are summarised in **Section 2**.

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 to inform measures to facilitate their protection as *in situ* populations. Updated figures illustrating the location of threatened plants is included in **Appendix C** of this TFMP. Threatened plants to be retained *in situ* include those individuals located within the approved project boundary but outside the construction footprint/clearing limits. The monitoring program proposed will identify if indirect impacts are occurring and then to 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 W2B Biodiversity Offset Strategy.

Any future surveys will also be undertaken by licensed and appropriately experienced ecologists, familiar with the threatened flora species of the region. This information will also be used to update the construction management measures in **Section 6** which will form part of the CEMP and FFMP for the project.

5.3.2 Management of in situ threatened plant populations

Roads and Maritime are committed to conserving those threatened plant species and populations that occur outside the construction footprint but within the approved 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 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
- 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
- Placement of ancillary activities to avoid impacts on threatened flora species. This will be achieved through compliance with approval conditions and SPIR commitments which includes locating ancillary activities in cleared areas, more than 50 m away from waterways and on relatively stable land. These measures along with other measures (e.g. use of exclusion fencing) will avoid impacts on threatened flora species.

5.3.3 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 Sections 1 and 2 has been prepared by Roads and Maritime to address the requirements of MCoA D7 and has been submitted to agencies for approval.

Translocation will be considered for those threatened flora species that are within the construction footprint. The Translocation Strategy has assessed nine species for translocation feasibility. Of these nine species, eight are confirmed to be directly or indirectly impacted by the proposed works within Sections 1 and 2 (see **Table 5-1** for list of species).

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 would be undertaken for threatened species that have suitable life history traits where translocation may be a viable option. This would be carried out with a feasibility assessment designed to comparatively research environmental characteristics to measure translocation success of receipt sites and the ecological needs of a species.

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. Translocation receival sites may also 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 would rather aim to achieve a 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:

- Warrell Creek to Urunga Upgrade: Threatened Flora Management Plan, Ecos Environmental Pty Ltd, December 2012
- Translocation strategy for *Maundia triglochinoides* as part of the Pacific Highway upgrade, Kempsey to Eungai, Parsons Brinkerhoff, April 2006; and
- The translocation strategy would generally follow the framework and issues of consideration set out in the ANPC (2004) *Guidelines for Translocation of Threatened Plants Australia* and would include the following information shown below.

Translocation feasibility assessment would include:

An assessment of the feasibility of translocating the threatened plants detailed in this management plan. 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. 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 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 including:

- Maintenance activities such as weed control and bush regeneration
- Habitat restoration requirements if translocation receiving sites include disturbed or degraded vegetated areas
- Research and experimentation review and reporting requirements, for example where translocation and/ or propagation has not been undertaken previously for threatened plant species a trial translocation and/or propagation may be required. Details of the trial methods, timing etc. would need to be outlined in the translocation strategy.
- Monitoring requirements to document the establishment and survival of translocated and propagated plants. Monitoring would provide data to allow an assessment of the success of the translocation undertaken; and
- An implementation schedule summarising the translocation program requirements pre-construction, during and post-construction.

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

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

5.3.4 Seed/cutting collection and propagation

Methods of propagation (such as seed and cuttings) 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 plant species feasible for translocation would be applied to replace those populations directly lost as a result of construction. Where a threatened species is propagated for planting into an area without established vegetation, seed collection and propagation will extend to include other flora species that grow in association with that threatened species. These other native species which provide suitable habitat for the threatened species are also to be translocated to the same location. It should be noted some threatened species may require to be planted into an established vegetation community that provides suitable microhabitats such as shade. The seed collection and propagation activities would aim to raise individual threatened species as tubestock suitable for the re-introduction activities and to offset any potential die-off incurred as a result of construction near *in situ* populations, at translocated sites and for compensatory planting in offset areas.

Seed collection would be initiated at the earliest possible time in order to collect a suitable density of seeds prior to clearing. Experienced, licensed seed collectors would carry out all seed collection and may involve collecting seed up to 12 months in advance of any clearing works. Seed would need to be collected at the appropriate time and stored before clearing works begin. Timing for seed collection and collection of individuals is outlined in the Flora Translocation Strategy. If seed is unable to be collected prior to clearing then Roads and Maritime will source seeds at the right time of year from nearby populations.

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 in the form of a species genetic study or the determination of genetic variability through species habitat type and geographic position.

Seed collection would be undertaken within the local population, where possible, and would involve:

- Collected seed stored for future use on the project to provide contingency for low survival rates of planted tubestock if required
- 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); and
- Seed collection would need to target fruiting periods of threatened plants which generally occurs in spring and summer.

The ideal seed collection period for each threatened plant that has been identified as directly or indirectly impacted by the proposed works within Section 1 and 2 of the Project is outlined in **Table 5-1** as per the Translocation Strategy. Seed collection strategies for threatened plants in Sections 3-11 will be outlined in a subsequent Translocation Strategy to be prepared and submitted for agency approval.

Table 5-1 Optimum periods for threatened flora seed collection

Species	Flowering Period	Seed Collection
<i>Arthraxon hispidus</i>	March-May	May-June
<i>Cyperus aquatilis</i>	October-February	February-May
<i>Eleocharis tetraquetra</i>	October-February	January-April
<i>Eucalyptus tetrapleura</i>	August-October	November-December
<i>Lindernia alsinoides</i>	Spring and autumn	Late Spring and Autumn
<i>Lindsaea incisa</i>	Spore capsules appear in November-February	March-June
<i>Maundia triglochinoides</i>	October-March	March-May
<i>Quassia</i> sp. Moonee Creek	November-December	March-April

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 north coast bioregion. 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. Further detail will be described in the Flora Translocation Strategy for each section.

Some threatened plant species are difficult to germinate, and when germination does happen, it would take several years to be of suitable size to plant out. The use of cuttings may also be required if seed is not available for collection or does not propagate well. The potential loss of some genetic diversity in the first generation would be offset by the numbers of individuals restored into the environment. Cuttings would be taken from the greatest number of parent plants as possible to ensure some genetic variation in the second generation. The processes of seed collection and storage are outlined in

Table 5-2.

Table 5-2 Seed collection, storage and propagation methods

Process	Method
Seed collection	<ul style="list-style-type: none"> 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 500 metres apart). 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. Secateurs would be used to remove small sections of branches supporting capsules. <p>(Australian Tree Seed Centre and Mortlock 1999a; Mortlock and the Australian Tree Seed Centre 1999b)</p>
Seed storage	<p>The basic requirements for good storage include the following:</p> <ul style="list-style-type: none"> 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. <p>(Mortlock 1998a)</p>
Seed trials	<p>Seed trials would be undertaken with seed grown plants in commercial potting mix and a mix containing the natural soil type from the site. Transplanting to the natural soil type would be carried out when seedlings are about 15 cm tall. Tree seedlings would be grown on until at least 40 cm tall, shrub species 30 cm tall, before introduction to the receival site. Herbaceous species should be robust and healthy before introduction. All tubestock would require a hardening off period (i.e. adjustment to outdoor conditions) prior to planting. The trial would aim to examine:</p> <ul style="list-style-type: none"> 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.

Transplanting to the natural soil type should be carried out when the site is available and free from site preparation 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.

A number of propagation methods have been assumed for threatened plants to improve results based on typical genus or family propagation success and are recommended during trails (Ralph 2009 and ANPS 2009). The processes of propagation are outlined in **Table 5-3**.

Propagation of threatened species would only be done by qualified nurseries or plant propagators, under appropriate quarantine conditions, with appropriate threatened species approvals. There are risks associated with introducing pathogens to the seedlings, or transferring pathogens from propagules. Only disease free tubestock would be introduced to receival sites.

Table 5-3 Propagation methods

Process	Method
Seed propagation	<ul style="list-style-type: none"> Germination from seed is generally the most cost effective and efficient method which produces populations with greater genetic diversity compared to other propagation methods. Some species may require special pre-treatment such as soaking, washing, stratification, scarification and smoke. The 'saturated soil medium method' may be required for most sub-aquatic and wetland species, where the pot containing the seeds is placed into a saucer of water until germination occurs, which results in moisture reaching the seeds by capillary action and ensures that the seeds do not dry out (ASPSA 2006). Seeds would be propagated in seedling trays of standard seed propagation mix (e.g. pine bark fines, cracker dust, sand, vermiculite, slow release fertiliser). When about 1 cm tall the seedlings would be transplanted to 120 millimetre tubes, or super tubes depending on the species, and grown on until at least 40 centimetres tall. In the case of fast growing species this may take 9-12 months, for slower growing species 18 months or more. It would be likely that larger propagated plants would have higher

Process	Method
	<p>survival rates.</p> <ul style="list-style-type: none"> Most of the seedlings would be planted out in the field when they reach 40 centimetres tall and after hardening off. If revegetation activities have been delayed some plants may need to be grown further and potted into larger pots.
Cutting propagation	<p>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.</p>

5.3.5 Exclusion zones

An exclusion zone is a designated “no go” area that clearly identifies an area that is not to be disturbed, and would be appropriately fenced, to prevent damage to native vegetation and *in situ* populations of threatened plants occurring. It will also assist to prevent the distribution of pests, weeds and disease into the area. 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 and informed by the targeted surveys marking and mapping of threatened plants. Further detail on exclusion zone establishment and maintenance can be found in the *Biodiversity Guidelines* (RTA 2011).

The relevant protocols for exclusion zones include:

- Exclusion zones to be identified and marked out prior to clearing works considering threatened species mapped by the targeted surveys
- Exclusion zone fencing would be placed outside 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 needs to 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 should 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
- Indicate on the site plan construction stations or distance markers where the exclusion zones would be located; and
- Exclusion zones would be clearly labelled on the site plan, including the type of fencing to be used and installation and maintenance requirements.

Exclusion zones would be delineated with temporary fencing. The type of temporary fencing used may vary depending on the number of plants being protected, specific species requirements and the sensitivity of the site. Fencing options may include (but are not limited to) the following:

- Highly sensitive sites – chain wire fencing (where appropriate)
- 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.

Ancillary facilities sites have been considered in the EIS and SPIR and a commitment made to siting facilities within cleared areas and disturbed vegetated areas. A number of proposed ancillary facility site locations were ground-truthed to ensure threatened plants were not present. Stockpiles and laydown areas, as well as tracks would need to be identified in the field and include appropriate fencing such as exclusion fencing near threatened plants.

5.3.6 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.

In summary, Guide 6 requires a site weed assessment to be undertaken prior to construction for each staged section of the project. Data collected during the assessment would be used to develop a weed management plan, which would include details on the weed monitoring. Appropriately qualified persons will complete the weed surveys prior to construction to identify weed species, their location and density.

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

Targeted weed management measures will also be considered for each section of the project where there are threatened flora species being managed *in situ* which are located adjacent to the construction areas or operational areas of the road corridor. The “weed management zones” will be clearly identified and targeted weed measures will be described in the FFMP and Sensitive Area Plans (SAPs) developed as part of 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.

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.

5.4 Mitigation goals and corrective actions

The environmental management measures for threatened flora species that are to be completed prior to the commencement of construction are outlined in **Table 5-4**.

Table 5-4 Mitigation measures and corrective actions for threatened flora during pre-construction

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective actions
<p>Threatened plants within 20m of the construction footprint to be retained (in situ) would be identified, mapped and marked prior to commencement of construction.</p> <p>This information will be included in the CEMP and FFMP.</p>	<p>Targeted surveys of threatened plants to be completed to identify threatened plants for retention in situ, translocation and seed collection.</p> <p>Update the TFMP as appropriate.</p> <p>Identification of exclusion zones and clearing limits prior to clearing.</p> <p>Construction related infrastructure to be planned and sited within cleared or disturbed areas of the ancillary site. Targeted surveys conducted if necessary.</p>	<p>Targeted surveys to occur pre-construction (in the optimum season for the threatened plant species) to inform the detailed design.</p> <p>Baseline data collected during the targeted surveys to inform the mitigation measures and monitoring program prior to construction commencing.</p> <p>Detailed plans to be prepared showing the proposed location of construction related infrastructure, proximity to in situ populations of threatened plants, exclusion zone and approved prior to commencement of construction.</p> <p>Plants to be clearly identified/fenced on the ground prior to commencement of construction.</p>	<p>Targeted surveys for threatened flora have not been undertaken prior to construction in the optimum season for the threatened species.</p> <p>Damage (e.g. accidental clearing, incursions, trampling, smothering as a result of sediment run-off) to threatened flora habitat reported outside limits of clearing associated with ancillary facilities and access roads.</p>	<p>Delay construction until targeted surveys have been undertaken.</p> <p>Revegetation of disturbed habitat outside clearance limits and monitoring of recovery every three months until successfully reinstated.</p> <p>Additional offsets to be provided for any impacts to threatened flora not accounted for in the Offsets Strategy.</p>	Roads and Maritime
Threatened plants translocation strategy completed for relevant project sections.	Targeted survey findings used to develop the threatened plants translocation strategy.	Prior to construction activities impacting threatened species locations.	Translocation strategy has not been completed and approved prior to construction activities impacting threatened species.	Delay construction activities that would impact threatened species until translocation strategy has been completed and approved.	Roads and Maritime

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective actions
	Translocation sites confirmed.				
Seeds and other propagation material to be collected from threatened plants prior to clearing works.	Targeted survey findings used to identify plants for collection of seed 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 outside the construction footprint, or from nearby locations within 6 weeks of the trigger for corrective action occurring or during the next appropriate season.	Project Contractor
Identify exclusions zones prior to construction commencing including corridor and ancillary sites and access roads.	Identification of exclusion zones informed by targeted surveys.	Identification of exclusion zones informed by targeted surveys and identified and approved by construction clearing limits prior to clearing works to mark and flag exclusion zones. Follow-up inspection after surveying road corridor.	Exclusion zones have not been identified and approved prior to construction.	Delay construction until exclusions zones have been identified, approved and established.	Project Contractor

6. Construction management measures

6.1 Potential impacts during construction

Potential impacts to threatened flora species during construction include:

- Machinery operating around threatened flora has the potential to cause direct impact through damage caused by physical contact or by allowing materials to fall on them.
- Machinery moving around threatened flora has the potential to cause indirect impacts by compacting soil and crushing root systems around the plants 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.
- There would also be potential for the loss of those individuals proposed to be translocated through an incomplete or inadequate translocation processes.

6.2 Management objectives

The performance criteria of the management strategy during construction include:

- Zero mortality of threatened plants from *in situ* populations due to a direct physical damage during construction and no loss of threatened plants directly adjacent to the project
- No notable increase in the abundance of weeds within threatened plant habitat during monitoring of *in situ* populations
- 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:
 - 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
 - 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.
- Manage information and site access (where possible) to limit the damage or potential for illegal collection of threatened plants from within and directly adjacent to the project area as far as practicable for Roads and Maritime.
- Establishment of control monitoring locations for each species/population where practical in areas of habitat greater than 50 metres from the project boundary where there has been limited disturbance and there are minimal existing threatening processes.

6.3 Management measures

6.3.1 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.

6.3.2 Induction and training

Induction and training would be conducted with all relevant contractors and other staff that would be working in the areas of known and potential threatened flora species habitat and distribution within the project. This training would identify what the individual threatened species look like, threatened flora species habitat, crossing zones and key threats. The importance of following the clearing, translocation and rehabilitation protocols would be made clear for any personnel that require access to the site. Species profiles are included in **Appendix E** of this plan.

6.3.3 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.

6.3.4 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.

6.3.5 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 plant species:

- All threatened plants identified for translocation would be translocated prior to clearing works being undertaken, as outlined in the translocation strategy
- All threatened plants identified to be retained at the edge of the clearing limits/constriction zone (*in situ*) would be protected during construction
- Where individual threatened plants occur on the edge of a planned clearing zone and the clearing cannot be avoided, pruning of the trees branches 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 during construction
- Only individual plants marked with flagging tape colour-coded or identified 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 RMS *Unexpected threatened species finds procedure* which will be included in the FFMP prepared for the project. If the plant individual or population is a new species discovery it will need to be added to the final TFMP.

6.3.6 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 plant locations. Appropriate measures would be installed and maintained where works are located adjacent to known threatened plants. 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 details would be further designed on a site specific basis as part of the CEMP and sub-plans prior to the commencement of construction activities. These measures would be important in maintaining the current condition of threatened plant habitats, particularly wetlands, swamps and creek lines which support *Maundia triglochoides*, *Cyperus aquatilis*, *Eleocharis tetraquetra* and *Arthraxon hispidus*. These measures would be routinely monitored weekly during construction and maintained as required.

6.3.7 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. 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 UDLP for the project.

The design would contain specific revegetation measures adjacent to threatened plant 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 flora species would be planned in consultation with a sub-contractor who possesses the following skills:

- Experienced in identification of the local flora and particularly subject threatened species, so that damage to individuals of threatened species and native species in general does not occur during maintenance activities (these plants will be monitored); 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 flora 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 8**.

6.3.8 Weed management

During construction the weed management requirements as specified in the CEMP and FFMP will be implemented (as described in **Section 5.3.6**).

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
- Monitoring the effectiveness of weed control.

6.3.9 Pathogens and plant diseases

During construction pathogen and plant disease management requirements as specified in the CEMP will be implemented onsite to prevent spread of pathogens and disease from affected areas to unaffected areas.

Management measures during construction will include:

- Communication strategies to improve contractor awareness of pathogens and plant diseases. Ensure all contractors have been made aware of SAPs and locations of threatened plant populations and exclusion zones.
- Measures to prevent the spread of pathogens such as vehicle wash downs and restricting vehicles to designated tracks and trails.
- Exclusion zones established in the event of disease identification during construction.
- Appropriate disposal of plant materials and soils.
- Identification of environmentally sensitive areas and zones where specific measures are required.
- Monitoring the effectiveness of pathogens and disease control.

6.3.10 Dust management

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 8**.

6.4 Mitigation goals and corrective actions

The construction environmental planning measures for threatened flora species, and corrective actions if the measure deviates from the performance criteria are outlined in **Table 6-1**.

Table 6-1 Mitigation measures and corrective actions during construction phase

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective actions
Zero mortality of threatened plants from <i>in situ</i> populations (from 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 as required under the clearing protocol.	Clearing areas identified and approved prior to clearing activities being undertaken.	Clearing areas have not been marked out and approved prior to construction.	Delay construction until clearing areas have been marked out.	Project Contractor
	Exclusion zones fenced off to protect in situ threatened plants. Induct all construction staff at the commencement of construction works. Induct new staff as appropriate.	Exclusion zone fencing monitored at least weekly during construction. Faults rectified as soon as noticed.	Exclusion zone fencing is damaged or ineffective.	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.	Project Contractor
	Monitor in-situ plants at established monitoring sites during construction.	Every three months during the first year of construction. Every six months during the second year of construction.	Any loss of retained in situ threatened plants.	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.	Project Contractor

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective actions
No notable increase in the abundance of weeds within threatened plant habitat during monitoring of <i>in situ</i> populations.	Implementation of weed management as described in the CEMP and FFMP. Up to date SAPs.	Every three months during the first year of construction. Every six months during the second year of construction.	Noxious and environmental weeds reported in areas adjacent to threatened plants. Spread of noxious and environmental weeds into properties adjoining the project noted in monitoring activities.	Review the weed management maintenance schedule and update as required. Implement appropriate weed measures as required within one month of the trigger for corrective action.	Project Contractor
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 prior to clearing, into suitable habitat, and using appropriate methods that maximise the chance of plant survival.	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).	All plants identified for translocation have not been translocated prior to commencement of construction.	Stop construction in vicinity of threatened plants. Investigate appropriate translocation activities. If translocation cannot be undertaken use reserves of species tube stock or seed to supplement and enhance populations.	Project Contractor
The landscaping design includes details on revegetation requirements for areas adjacent to threatened plants and translocation/offset areas.	Revegetation and habitat management requirements included in the landscape design for areas adjacent to threatened plants. Specifically includes revegetation maintenance planned in consultation and implemented by experienced bush regenerators for areas adjacent to <i>in situ</i> populations.	Appropriate measures incorporated into the Urban Design and Landscape Plan	Landscape design has not included specific revegetation requirements for areas adjacent to threatened plants and translocation/offset areas.	Plan to be updated to include specific requirements prior to commencement of implementation of plan.	Project Contractor
Dust managed in accordance with the CEMP.	Dust impacts would be managed in accordance with the CEMP including dust suppression measures.	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 exceedances recorded from dust monitoring within sections containing threatened plants.	Review dust suppression procedures to ensure adequate dust management. Where appropriate, shade cloth screening installed on edge of construction footprint to protect low growing threatened flora.	Project Contractor

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective actions
Water and soil quality managed in accordance with the CEMP.	<p>Adequate soil and water quality controls installed surrounding retained threatened plants.</p> <p>Procedures for maintenance and monitoring of erosion and sediment controls included in the CEMP.</p>	Erosion, sediment and water quality controls would be monitored weekly throughout the construction period and as soon as practical after storm events.	<p>Breaches of erosion, sediment and water quality controls recorded.</p> <p>Loss of ecological condition recorded from plant health monitoring particularly from altered water quality.</p>	<p>Review adequacy of the erosion, sediment and water quality controls and implement appropriate corrective actions.</p> <p>Commence review of monitoring procedures for controls and implement appropriate corrective actions.</p>	Project Contractor
Reduce impacts to threatened orchid species through illegal collection.	<p>Restrict the availability of information identifying where orchids occur within the project area, and in close proximity to the project area.</p> <p>Limit site access to areas where orchids naturally occur and may be being managed in situ.</p>	Threatened orchid populations will be regularly monitored during construction and post construction as part of the overall monitoring program.	There is evidence of public access to the orchid areas and/or evidence of illegal collection.	Discuss potential corrective measures with the regulatory authorities.	Project Contractor

7. Operational management measures

7.1 Potential impacts during operational phase

Potential impacts to threatened flora during the operational phase include:

- Degradation of retained threatened plant populations and habitat from edge effects; and
- Degradation of aquatic threatened plants associated with reduced water quality and/or changes to hydrological regimes.

7.2 Management objectives

The performance criteria of the management strategy during operations include:

- 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 five 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.

7.3 Management measures

7.3.1 *In situ* threatened flora species/populations

Ongoing mitigation for *in situ* threatened flora species/populations would be undertaken until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring events. 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 8** for the *in situ* and translocation 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, particularly for *Arthraxon hispidus* and *Maundia triglochinoides*.

To avoid impacts on *in situ* threatened flora species from road maintenance activities, sensitive area documentation will be handed over and discussed with RMS Asset Maintenance identifying the locations of threatened flora species.

7.3.2 Revegetation areas

Ongoing maintenance of revegetated 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. The recommended maintenance and monitoring schedule for the revegetated areas in the first year is outlined in **Table 7-1** and for years two and three in **Table 7-2**. 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 7-1 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 7-2 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.

7.3.3 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 8**.

7.4 Mitigation goals and corrective actions

The operational environmental planning measures for threatened flora species and corrective actions if the measure deviates from the performance criteria are detailed in **Table 7-3**.

Table 7-3 Mitigation measures and corrective actions for threatened flora during highway operation phase

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective actions
<p>Zero mortality of retained in situ threatened plant populations during construction and for three consecutive monitoring periods post-construction.</p> <p>Post the above period 80 per cent survival of tree, shrub and herbaceous perennials after three years.</p>	<p>Clearly identify in situ populations and exclusion zones.</p> <p>Implementation of weed management measures throughout operational period.</p>	<p>Threatened plant health monitoring and weed monitoring to occur as per Sections 8.</p> <p>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 consecutive monitoring periods as per MCoA D8 (k)).</p>	<p>Any mortality of in situ threatened plants for the first three consecutive monitoring periods post construction.</p> <p>Post the above timeframe more than a 20 per cent decline for an in situ threatened plant population over one monitoring event from the baseline (depending on species specific seasonal fluctuations).</p>	<p>Commence assessment of potential reasons for mortality, including natural events such as drought and fire within one month of trigger being identified.</p> <p>Review weed maintenance schedule within one month of trigger being identified.</p> <p>Identify potential threats, implement corrective actions and modify monitoring as necessary.</p> <p>Offset any additional threatened plant impacts that have occurred as a result of the Project.</p>	<p>Project Contractor (for first year)</p> <p>Roads and Maritime</p>

Performance goals	Proposed mitigation measure	Monitoring/timing frequency	Trigger for corrective actions	Corrective actions	Responsible party for corrective actions
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 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. 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.	Project Contractor (for first year) Roads and Maritime
Less than five per cent weed cover at retained <i>in situ</i> 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 Sections 8. Weeds will be monitored in proximity to <i>in situ</i> 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 <i>in situ</i> populations.* More than 30% weed coverage in revegetation areas.	Review weed maintenance program within one month of trigger being identified and update as required.	Project Contractor (for first year) Roads and Maritime

* 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.

8. Monitoring program

Monitoring would be undertaken to determine the effectiveness of mitigation measures and would specifically focus on *in situ* threatened flora species/populations, weed monitoring and revegetation measures.

8.1 Objectives

Monitoring would provide reliable information such that sound conclusions can be drawn in relation to the management of threatened plants. Monitoring would be undertaken during the pre-construction, construction and operation phases until such time as the management measures have proven to be effective. The overall monitoring objectives include:

- Evaluating the success of mitigation measures, including protection of *in situ* threatened flora populations
- Further understanding the propagation and translocation requirements of individual threatened plant species; and
- Evaluating the success of habitat revegetation.

8.2 *In situ* threatened flora species/populations

As noted in **Sections 5.3.1** targeted surveys have been undertaken to collect comprehensive up-to-date data on the location and number of threatened plants within the project. The outputs from these surveys include details on the distribution and abundance of threatened plant 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 species specific *in situ* and control monitoring sites have been identified (Jacobs, 2014a). To assess condition and success of mitigation measures to protect *in situ* threatened flora species, control monitoring locations for each species/population have been established in areas of habitat greater than 50 metres from the project boundary where there has been limited disturbance and where there are minimal existing threatening processes. A total of 82 monitoring locations have been established addressing 92 threatened flora occurrences for the entire Project.

Weed management will be undertaken as outlined in **Sections 5.3.6, 6.3.8 and 7.3.3**. Monitoring of *in situ* populations will assess presence of weeds and the requirements for corrective actions. Where monitoring surveys identify outbreaks of weeds appropriate management measures will be implemented as per the Weed Management Plan. The CEMP will also outline key requirements for the management of weeds during construction.

A monitoring report is to be prepared annually. All monitoring and reporting is to be independently overseen by the project ecologist.

8.2.1 Methods, timing, intensity and duration

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. A particular focus would be to identify any changes in health and condition which require management actions for remediation.

To ensure *in situ* threatened plant species are retained and protected throughout the construction of the Project, monitoring of *in situ* threatened plant populations is to be undertaken every three months for the first year of construction and twice per year (during autumn and spring) during construction. Monitoring of translocated flora populations is to commence in June 2015. 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 (e.g. *Antraxon hispidus*, *Cyperus aquatilis*) 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.
 - Threats from erosion and sedimentation, dust and water quality.
 - 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 project during targeted flora surveys by Jacobs in 2014 (Jacobs, 2014a). There are 69 *in situ* monitoring locations and 23 control sites in total for Sections 1 to 11. The locations of these monitoring sites are contained within the Jacobs report in **Appendix D**. 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.

8.3 Translocated plants/sites

All threatened species directly impacted by the Project will be assessed for translocation suitability. At this time, species identified in Sections 1 and 2 have been assessed for translocation suitability in the *Flora Translocation Strategy Sections 1 and 2, Woolgoolga to Ballina Pacific Highway Upgrade* (RMS 2015) while species identified in Sections 3-11 will be assessed at a future date. The translocation feasibility assessment is based on:

- Biological characteristics of species of relevance to translocation
- Practicality of propagule collection and other techniques to potentially be employed for translocation
- Prospects for successful establishment
- Availability of suitable receiving sites (appropriate habitat and tenure); and
- Past translocation success.

The following species were determined to be suitable for translocation within Sections 1 and 2:

- Hairy Joint-grass (*Arthraxon hispidus*) – feasible
- Moonee Creek Quassia (*Quassia* sp.) – feasible
- Noah's False Chickweed (*Lindernia alsinoides*) – feasible
- Slender Screw-fern (*Lindsaea incisa*) – feasible
- Square-fruited Ironbark (*Eucalyptus tetrapleura*) – feasible
- Square-stemmed spike-rush (*Eleocharis tetraquetra*) – feasible

Monitoring of the translocations sites will be undertaken as per the Translocation Strategy and would be conducted during and after construction. Monitoring of translocation sites will include assessment of the following factors:

- Bio-physical site characteristics
- Stochastic weather events, and ability to control or supplement e.g. water availability during establishment
- Genetic issues affecting the likelihood of inbreeding depression, achievement of reproductive viability, retention of local adaptation, and maintenance of evolutionary potential of translocated populations
- Ecological factors, including herbivory, disturbance and competition.

Various management measures and corrective actions have been presented in **Sections 5, 6 and 7** in the event that translocation sites do not satisfy the main goals for mitigation. For further information please refer to the Translocation Strategy (2015).

Roads and Maritime are also offsetting residual direct impacts to threatened flora species as detailed in the W2B Biodiversity Offset Strategy.

8.3 Habitat revegetation

8.3.1 Objective

Evaluate the success of habitat revegetation at locations adjacent to *in situ* threatened flora populations.

8.3.2 Timing and methods

After the first year of maintenance of habitat revegetation (**Section 7.3.2**), annual monitoring of revegetated areas adjacent to *in situ* threatened flora populations 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. Methodologies will also include photo monitoring. These tasks would 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.

8.3.3 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 8-1**.

Table 8-1 Performance measures and corrective actions during monitoring for habitat revegetation

Trigger for corrective actions	Corrective actions
Greater than 10% of plants have died after first 12 months of maintenance.	Review maintenance schedule for revegetated areas.
Greater than 20% of plants have died after three consecutive monitoring events.	Replace dead plants within specified timeframes.
Total weed coverage is more than 30% in revegetation areas.	Increase weed control if required or review control methods being used.

8.4 Evaluation, project review and reporting

Detailed threatened flora reports will be prepared outlining the results of any monitoring undertaken pertaining to the project.

8.4.1 Responsibility

Roads and Maritime and its specialist consultants or contractors would be responsible for reporting and evaluating the monitoring information collected.

8.4.2 Adaptive management

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 monitoring reporting for each species 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.

8.4.3 Timing

A brief annual report will be prepared by the contractor for distribution to Roads and Maritime and relevant government agencies summarising the monitoring results for that period. These reports would outline the results of the monitoring undertaken including the success or otherwise of the mitigation measures.

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 plants within the project.

9. Summary table and implementation schedule

An overall summary of the actions proposed in the above plan is provided in **Table 9-1**. It also identifies the person responsible for the actions and the estimated scheduling of each action within the project.

Table 9-1 Summary table and implementation schedule of the 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	Weed Management Plan Weed management around in situ populations	Contractor	X	X																				
1.6	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	Pre-clearance survey prior to clearing and establish exclusion zones	Contractor		X																				
2.4	Seed collection and translocation	Contractor		X																				
2.5	Implement clearing procedures	Contractor		X																				
2.6	Habitat revegetation	Contractor		X																				
2.7	Monitoring in situ flora populations	Contractor		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
2.8	Weed management around in situ populations	Contractor		X																				
3. Operational maintenance																								
3.1	Maintenance of revegetation (monthly for first year)*	Contractor			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
4. Operational monitoring																								
4.1	Monitoring of in situ populations and control 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
4.2	Monitoring of revegetation*	Contractor			X				X				X											
5. Evaluation and reporting																								
5.1	Annual reports (note reporting period subject to construction completion date)	Roads and Maritime		X	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).

10. References

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- Melaleuca Group (2014). *Vegetation Surveys Sections 8 and 9 of the Woolgoolga to Ballina Pacific Highway Upgrade*. Prepared for Roads and Maritime Services Grafton, NSW.
- Parsons Brinkerhoff (2006) *Translocation strategy for Maundia triglochinos as part of the Pacific Highway upgrade, Kempsey to Eungai*, April 2006.
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- Roads and Maritime Services, Aurecon, Sinclair Knight Merz (2013) *Upgrading the Pacific Highway Woolgoolga to Ballina Upgrade Supplementary Biodiversity Assessment*, Transport, Roads and Maritime Services, NSW.
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Appendix A – Response to expert and agency comments

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

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
TFIMP1	Glossary	Include a glossary of terms at the front of the plan.	Adopted- plan updated	Glossary of terms has been further updated.
TFIMP2	1.2	This section doesn't describe the purpose and objectives of the plan. <i>Recommendation:</i> State the purpose and objectives of the W2B Threatened Flora Management Plan	Adopted- plan updated	Section 1.2 has been amended to include additional information on the purpose and objectives of the W2B Threatened Flora Management Plan.
TFIMP3	1.3	Not sure about the approach of a Framework TFMP and then stage-specific TFMPs. This may lead to a lot of duplication of reporting, increased 'green-tape' and significantly higher costs. Why not one threatened flora management plan for the whole project? The number of threatened species affected by the project is not particularly high.	To be reviewed prior to implementation	Clarification has been made that the TFMP when finalised will apply to the whole project and provides an overarching framework. The plan is being updated in stages due to construction and targeted surveys being staged. A new diagram has been included in Section 1.3 that shows how the TFMP relates to other project documentation. An updated diagram has also been included in Section 1.3 that shows how the TFMP will be updated in stages as targeted surveys are completed.
TFIMP4	1.3	Include rare species (such <i>Dichrocephala integrifolia</i>) as not listed under the TSC Act or EPBC Act in the Plan. Include the (TSC Act) endangered <i>Rotala tripartite</i> which was recorded in 2006 after completing the Iluka to Woodburn vegetation survey report	To be reviewed prior to implementation	Consistent with the project's Terms of Reference and legislative requirements Roads and Maritime has addressed threatened plant species that are known or likely to occur within the project area. Threatened plants are 'endangered' and 'vulnerable' species under the TSC Act or EPBC Act. The endangered <i>Rotala tripartite</i> has been recorded in Section 6 as a result of targeted surveys in 2014. Two individuals have been recorded outside the construction footprint. The TFMP will be updated to include this species and findings from the targeted surveys.
TFIMP5	3.3	Bullet point to be reworded to 'targeted revegetation of disturbed areas adjoining in-situ threatened flora' Include this into the objectives/goals.	Adopted - plan updated	

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
TFIMP6	4.3.2	<p>Translocation proposal is best considered as part of a larger offsets strategy for threatened flora that includes direct offsets.</p> <p><i>Recommendations:</i></p> <ul style="list-style-type: none"> • 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 as an introduction to the Translocation Strategy. • 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 where practical to learn more about species ecology and translocation technology. • Include a section on the selection/allocation of receival sites. 	Adopted- plan updated	<p>Additional wording was included as required.</p> <p>Translocation is discussed in Section 5.3.3. Further detail regarding translocation of specific plant species will be provided in a separate Translocation Strategy developed to satisfy MCoA D7.</p> <p>Roads and Maritime will have a Translocation Strategy for Sections 1, 2 and early works, and a Translocation Strategy for Sections 3-11.</p>
TFIMP7	5.3.5	<p>Roads and Maritime has not developed standard weed management procedures that are implemented during construction as part of FFMP and targeted to in-situ threatened flora.</p> <p><i>Recommendation:</i> 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.</p>	To be reviewed prior to implementation	<p>Roads and Maritime has standard weed management guidelines for all of its projects that will be followed. The weed management guidelines as stipulated by the (RTA 2011) and (Natural Heritage Trust 2004) have been applied as a baseline approach in the TFMP Section 5.3.6. 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 <i>in situ</i>.</p> <p>Further detail regarding weed management for the project is to be prepared as part of the CEMP.</p>

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
TFIMP8	4.3.5	Tub-grinder mulch not be spread around in-situ threatened flora sites.	Adopted- plan updated	
TFIMP9	General	<p>The six mitigation measures listed to address this issue are all forms of translocation, although the way it is written might suggest otherwise. For example, “seed collection for establishment of threatened species on offset sites” is translocation.</p> <p>The three core mitigation measures for direct loss are:</p> <ol style="list-style-type: none"> 1. Avoidance of impact where possible, including during the detailed design stages (ie. 85% and 100% detailed design) 2. Translocation – compensatory introduction to offset/receival sites, salvage transplanting to offset/receival sites, relocation to a nearby site with matching habitat, population enhancement to promote long-term population viability and so on. 3. Offsets – e. g. acquire and protect threatened flora habitat, improve threatened species habitat elsewhere etc. 	Adopted-plan updated	
TFIMP10	General	Move SMART principles to the start of the plan and consider throughout; clarify ‘adaptive management’.	Adopted- plan updated	
TFIMP11	4.3.1	<p>Update table with:</p> <p>Arthraxon hispidus – Dec. to May</p> <p>Cyperus aquatilis - Jan to June</p> <p>Maundia triglochinos – spring, summer, autumn</p> <p>Melaleuca irbyana – all year</p>	Adopted- plan updated	
TFIMP12	4.3.1	For non-aquatic threatened species, the indirect impact zone would be defined as within 10m of the edge of clearing. For aquatic species and shade-requiring species such as the two orchids occurring on the project, the indirect impact species would be 20m.	To be reviewed prior to implementation	<p>Clarification has been given to the TFMP in Section 5.3.1 to reflect the target measures suggested.</p> <p>Quantification of indirect impacts to threatened plants has adopted these buffers.</p>
TFIMP13	4.3.2	<p>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 as an introduction to the Translocation Strategy.</p> <p>* this point is about the same issue as point 6.</p>	Adopted- plan updated.	
TFIMP14	4.3.2	Second last paragraph about “translocation trials” may need to be reworded as ‘trial’ indicates a preliminary or test translocation to be conducted before the full translocation, which I don’t think was intended(?) Suggest including >	Adopted- plan updated.	

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
		translocation may be considered feasible for a threatened species that has <u>not been translocated before if its ecological requirements, growth-form attributes and propagation characteristics indicate that translocation employing a certain method has a reasonable chance of success</u>		
TFIMP15	4.3.2	<i>Recommendation:</i> Include a section on the selection/allocation of receival sites.	Adopted- plan updated.	
TFIMP16	4.3.3 and Table 4-2	Change title to <u>Threatened plant propagation</u> , or <u>Seed/cutting collection and propagation</u> The requirements specified in some paragraphs would be clearer in dot point format. What about a more general intro to this section – how does propagation fit into the overall process of translocation? 2 nd paragraph– replaced stoned with stored. 3 rd paragraph – suggest using dot point format. Table 4-2 Arthraxon hispidus Flowering Period – March-May; Seed collection – May-June. 6 th paragraph – Some (not many) threatened species are difficult to germinate..... The use of cuttings <u>may</u> also be required if seed is not available for collection or does not propagate well.	Adopted- plan updated.	
TFIMP17	4.3.3	Include a section on indirect management of genetic diversity.	Adopted- plan updated.	
TFIMP18	Table 4-3	Set out this experimental initiative more clearly.	Adopted- plan updated.	
TFIMP19	4.3.3	p.20, reword 3 rd paragraph. See also results of previous threatened flora translocation projects for the Pacific Highway upgrade.	Adopted- plan updated.	
TFIMP20	4.3.3	p. 20, last paragraph – Suggest change wording to: <u>>Propagation of the threatened species would only be done by qualified/ experienced nurseries or plant propagators, and only disease free tubestock would be introduced to the receival sites.</u>	Adopted- plan updated.	
TFIMP21		Put seed propagation first Replace “bog method” with >saturated soil medium method< 2nd dot point, suggest change to >would be transplanted to 120mm tubes, or	Adopted- plan updated.	

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
		super tubes depending on the species, and grown on until at least 40cm tall. In the case of fast growing species this may take 9-12 months, for slower growing species 18 months or more... 3rd dot point – suggest change wording to >planted out when at least 40cm tall and after hardening off.....		
TFIMP22		Provide more detail on the revegetation sub-plan – ie. what, where, how and when.	Adopted- plan to be updated prior to implementation.	Roads and Maritime do not consider that a separate revegetation sub-plan is required in this instance. Further information regarding managing <i>in situ</i> 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.
TFIMP23	Table 4-5	3 rd goal, Corrective action, suggest rewording to – Delay construction until seeds and propagules have been collected <u>>only if they cannot be collected elsewhere in the local area including outside the construction zone.<</u>	To be reviewed prior to implementation.	Clarification has been made in the TFMP. The priority will be to collect seeds and plant material for propagation from those plants within the project corridor. Where the plant material may not be available in time before construction then Roads and Maritime will investigate the potential to collect seed and plant material from adjacent or nearby to the project corridor. This is outlined in Table 5-5. This is to avoid unnecessary delays to the project. More detailed information regarding the above and timing will be discussed in the Translocation Strategy.
TFIMP24	5.2	1 st dot point – Suggest <u>>zero mortality due to direct physical damage during construction.</u> “No notable increase in the abundance of weeds” should be a separate dot point. 2 nd dot point – this dot point implies that translocation would be carried out during construction? Salvage transplanting is normally carried out pre-construction. Propagation may start pre-construction or during construction. Last dot point – Water quality and <u>>soil quality<</u> managed in accordance with the CEMP. Non-aquatic threatened plants may be threatened by changes to soil quality, including erosion and sedimentation.	Adopted- plan updated.	

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
TFIMP25	5.3.3	Suggest including >Sensitive Area Plans (Maps)< as a separate heading. SAPs are important for identifying where threatened flora are located for day to day management of the project. They should be kept up to date and clearly show the locations of in-situ and to-be-translocated threatened flora with their identification numbers.	Adopted- plan updated.	
TFIMP26	5.3.1	"including risks to threatened frogs" – what are they?	Adopted- plan updated.	
TFIMP27	5.3.5	2 nd paragraph – take out Quassia sp. Moonee Creek, generally occurs on slopes.	Adopted- plan updated.	
TFIMP28	5.3.6	Revegetation and habitat maintenance around in situ threatened flora should be a bush regeneration task, not part of the broad-scale landscaping	Adopted- plan updated.	
TFIMP29	5.3.6	Incorporate the use of salvaged topsoil seedbank in the revegetation of disturbed areas around in-situ threatened flora sites.	Adopted- plan updated.	
TFIMP30	5.3.7	Weed management. During construction?	Adopted- plan updated.	
TFIMP31	5.3.8	Install shade cloth screening along the edge of vegetation containing low growing, in-situ threatened species such as <i>Lindsaea incisa</i> for dust protection and to maintain microclimate.	Adopted- plan to be updated prior to implementation.	Table 6-1 has been amended to include the installation of shade cloths as a corrective measure for low growing species and <i>in situ</i> populations if dust is noted as having an impact.
TFIMP32	6.2	Main goals. Suggest that the goals be numbered. <u>First goal/row</u> – suggest the goal be set at zero mortality for physical damage during construction. Other projects have shown this is quite achievable. Any mortality due to direct physical damage is not acceptable, as the principle contractor may be prosecuted by EPA. There are two goals in the one sentence – put the weeds one as a separate goal. Proposed mitigation measures – include SAPs (see 5.3 above) <u>Second goal/row</u> – Proposed mitigation measures, suggest reword to include >undertaken at times, into suitable habitat and using appropriate methods< that maximise the chance of plant survival..... Monitoring timing/frequency – give the specific monitoring interval – e.g. 1 st year – 3-monthly	Adopted- plan updated Adopted- plan updated	These recommendations have been adopted.

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
		<p>Performance thresholds – suggest change to >All plants identified for translocation have been translocated<</p> <p>Corrective action – tubestock would be propagated anyway as part of population enhancement (for most species).</p> <p><u>Third goal/row</u></p> <p>Suggest reword as >revegetation and habitat management requirements for areas adjoining in-situ threatened flora prepared in a separate scoping sub-plan< or make into a separate goal. Employ specialist bush regenerator to implement.</p>	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 <i>in situ</i> threatened plant species has been included in Section 5.3.2 and Section 8. This includes provisions for revegetation and weed management in proximity to these populations as well as monitoring. It is considered the more appropriate document to detail revegetation requirements is in the Urban Design and Landscape Plan.
TFIMP33	5.4	Include measures to guard against illegal orchid collecting.	To be reviewed prior to implementation	A management goal to limit the illegal collection of orchids and other threatened flora has been included in Section 6.2. Roads and Maritime has limited ability to stop illegal orchid collection. However where orchids occur in the project corridor Roads and Maritime will restrict access to information regarding their location and also limit access to the area where possible.
TFIMP34	5 and 6	<p>Both sections 5 and 6 of the plan concern the management of in-situ (roadside) threatened flora. At least 50% of the framework TFMP appears to deal with in-situ threatened flora from various angles. Is this the most efficient way to approach management of threatened flora?</p> <p>Translocation is arguably more important and technically difficult to implement, so you would expect it take up at least as much space as management of in situ threatened flora...?</p>	Adopted- plan to be updated prior to implementation	A priority is given to protecting and managing threatened flora species where they naturally occur (referred to as <i>in situ</i>). Translocation of those plant species that cannot be avoided is also addressed in this TFMP and detail is provided as to how translocation will be managed. Refer to Section 5.3.3. Further details regarding what species are to be translocated, how and where will be provided in a separate Translocation Strategy.
TFIMP35	6.3	<p>Refine the specification of performance thresholds.</p> <p>The goal for weeds is less than 5% weed cover at in-situ threatened flora sites at the end of the monitoring program.</p>	Adopted- plan updated	

ID No	Chapter or Section	Comment / Recommendation	Recommendations that have been addressed (Version 1)	How recommendation has been addressed (Version 2.1)
TFIMP36	6.0	Provide more detail on the revegetation sub-plan – ie. what, where, how and when.	Adopted- plan to be updated prior to implementation	Roads and Maritime do not consider that a separate revegetation sub-plan is required in this instance. Further information regarding managing <i>in situ</i> 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 in the Urban Design and Landscape Plan.
TFIMP37	6.0	Clarify the monitoring schedule, including the frequency of monitoring in each year (1-8?), specify the monitoring interval (e.g. year 2, 6-monthly....), for each aspect of the TFMP being monitored, and type of data to be recorded. Clarify and revise the description of performance thresholds	Adopted- plan to be updated prior to implementation	Further information and clarity has been provided to address monitoring. Monitoring of in situ populations, the location and purpose of monitoring sites as well as monitoring revegetation are discussed in Section 8. Performance goals, thresholds and corrective actions are also detailed.
TFIMP38	6.3.3	6.3.3 Weed management. This is repeating a previous section	To be reviewed prior to implementation	The weed management provisions in Section 6.3.3 have been reviewed to reference the Roads and Maritime Biodiversity Guidelines and also measures noted in SPIR. In addition, specific weed management requirements regarding threatened plants being managed in-situ have also be detailed.
TFIMP39	6.4 and Table 6-1	Clarify and revise the description of performance thresholds as described above – set out clearly.	Adopted- plan to be updated prior to implementation	Clarification has been provided on the performance threshold and how it acts as a trigger for a further assessment and implementation of corrective actions.
TFIMP40	6.0	What about monitoring of the translocation work?	Adopted- plan updated	
TFIMP41	6.5	Objectives to be clearer set out in dot point format, checking wording.	Adopted- plan updated	
TFIMP42	6.6	In-situ populations. For what species will the project really survey and collect “details on the distribution and abundance of threatened species immediately adjacent to the project” (2 nd sentence) – ie outside the project boundary?	To be reviewed prior to implementation.	Targeted surveys have now been completed for all sections of the project. The surveys included up to 20m from the construction boundary or greater in some areas. 25 flora species were targeted and 20 have been confirmed to occur within the Project clearing footprint. Additionally, threatened flora occurring within a 10m and/or 20m buffer have also

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				been identified, mapped and recorded in the field and will be managed as in-situ populations. The TFMP has been updated to incorporate results of targeted surveys including updated figures in Appendix C.
TFIMP43	7.1	Methods, timing, intensity and duration The first paragraph needs to be reworded. Until what mitigation measures have proven successful? Describe how they would be assessed as having succeeded. How long are the 3 consecutive monitoring periods?	Adopted- plan updated	
TFIMP44	7.2	Describe for what species and where this monitoring would be applied	Adopted- plan updated	
TFIMP45	7.3	Translocation Why all the detail about monitoring in-situ threatened flora and nothing about monitoring the translocations?	Adopted- plan updated	
TFIMP46	7.5	Performance measures and corrective actions –Same comments as the performance tables above.	Adopted- plan updated	

Summary of recommendations from agency review and how addressed in this plan

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 2.1)
Department of Planning and Environment			
DPE1	Section 1.1	Include a figure to show the location of the Stage 1 works covered by the Threatened Flora Management Plan. Devils Pulpit was completed and opened to traffic in March 2014. Update reference to Devils Pulpit being under construction.	An additional figure has been prepared to show all Project sections and soft soil works area. The reference to Devils Pulpit has been amended to state that this Section is complete.
DPE2	Table 6-1	Relevance of the goal to reduce impacts to threatened orchid species. The Stage 1 report has not identified threatened orchid species in sections 1 and 2 and soft soil treatment areas.	This report covers all sections of the project. Orchid management measures have been provided in the plan.
DPE3	Section 7.3	What measures would be put in place to ensure that RMS' road reserve maintenance activities (e.g. mowing/slashing) during operation of the road do not impact on threatened species in-situ in the road reserve.	The construction footprint includes areas required for the highway upgrade and maintenance areas such as table drains that may need to be mown/slashed. Any threatened plants within these areas have been calculated as being directly impacted for the purposes of the TFMP. Therefore the threatened plant species being retained as in-situ should not be within the maintenance areas to be maintained as cleared. However to ensure those threatened plants being retained as in-situ that may occur adjacent to these maintenance areas are not impacted appropriate mitigation measures have been included in Section 7.3.1. One requirement will be that Roads and Maritime issues sensitive area documentation to the RMS Asset Maintenance that clearly identifies the locations of threatened flora species. It will also be ensured the in situ threatened plants are within suitable habitats to be sustained such as their natural habitat, or they may be within revegetation areas with appropriate native species surrounding the plants.
Environmental Protection Authority			
EPA1	Page 16 – 2.1.1	Is it likely that the 13.99ha of unsurveyed area will contain threatened flora species i.e. are there records in the vicinity/adjacent area with similar habitat? If so will the targeted flora surveys be undertaken at the appropriate time of year?	These areas have been assessed to identify biometric vegetation type and habitat quality score. However, these areas will be ground-truthed for threatened plant species when land access becomes available prior to construction. If additional threatened plant species are confirmed this information will be provided to the relevant agency and the TFMP updated. An additional survey will be undertaken during pre-clearance surveys prior to clearing to confirm the recorded threatened plant species and it will also allow for any additional populations to be recorded and addressed through the New Finds Procedure.
EPA2	Page 20	Angophora robur hybridisation. Results indicate that the majority of Angophora robur in the Wave 3 area are likely to be hybrids. Following the conclusions and recommendations in Appendix F the EPA supports the upholding of the existing distribution mapping within the project area. For consistency this will also apply to	Section 2.3 provides further explanation concerning the identification of <i>Angophora robur</i> within Stage 1 works. Jacobs was commissioned to undertake sampling and genetic testing of <i>Angophora robur</i> within the early works area at Tyndale. Genetic testing was completed on specimens from this location. The majority of species were confirmed as hybrids with one <i>Angophora robur</i> . In addition, GeoLink was

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		<p>potential offset properties where the same issue of hybridisation is likely to occur.</p> <p>However it appears that this recommendation will not be applied to stage 1 works where only a single individual will be protected in-situ i.e. the mapping of the extent of <i>Angophora robur</i> has not been upheld. Whilst topographical position, substrate etc.. may assist in rapid identification, will the RMS undertake extensive sampling of all mapped individuals to verify identification? If not then all mapped <i>Angophora robur</i> should be assumed to be pure.</p>	<p>commissioned to take samples from four unconfirmed <i>Angophora</i> sp. at the Tyndale cut. Herbarium results are yet to be received. It is suspected that 3 of the 4 are hybrids. Other than these specific locations for early works, the rest of the <i>Angophora robur</i> occurrences (including hybrids) will be assumed to be <i>Angophora robur</i>. RMS does not intend to undertake further genetic testing and therefore all potential <i>Angophora robur</i> (outside of early works area at Tyndale) will be treated as being the species and all to be impacted will be offset.</p> <p>Reporting of <i>Angophora robur</i> has been amended to ensure consistency with the above statements.</p>
EPA3	Page 22 – Table 3.2 <i>Maundia</i>	Following recent above average rainfall the opportunity now exists to test the assumption that “further inundation of the pools will result in additional species being found”.	<p>Extensive surveys for threatened flora species have been undertaken for Sections 1 to 11. These were undertaken over various seasons and conditions. Including after rainfall which is why a number of additional records were found. RMS does not intend to undertake further baseline surveys for threatened flora where surveys have already been completed.</p> <p>It should be noted prior to clearing a pre-clearance survey will be undertaken to reconfirm the flora populations, ensure they are tagged and exclusion zones and fencing is erected. Any additional species that may have come up since the last survey will be recorded at this time.</p>
EPA4	Page 33 - 5.2	<p>Collection of seed and propagation material prior to clearing is generally poorly undertaken by the RMS and it's contractors. This understandably stems from restricted opportunities during the short lead up time from engagement of contractor to start of construction.</p> <p>Seed collection and plant propagation could be a very worthwhile project with significant conservation gains if resourced sufficiently. The EPA notes the commitment in section 5.3.4 to undertake seed collection up to 12 months in advance of any clearing works. Given this section of the upgrade will commence in April (3 months time) will the RMS be able to meet this commitment? We are currently within an ideal period to undertake this work.</p>	<p>Seed collection for threatened plants is proposed to occur prior to clearing where possible. The Flora Translocation Strategy (Sections 1 and 2 and early works) identifies those species where seed collection may be feasible and proposed collection to commence April and May 2015.</p> <p>Where seed collection from within the construction footprint is unable to occur prior to clearing then seed collection from adjacent populations at the right time of year will be undertaken. This is outlined in Section 5.3.4.</p> <p>Formal seed collection from non-threatened native species won't occur before construction commences as the soil seed bank will be utilised as the primary restocking agent. The heads of the trees and associated fruiting material from the clearing operations will be included in the topsoil mix.</p>
EPA5	Page 33 - 5.3.1	Dry conditions at the time of targeted survey resulted in non-location or retraction of <i>Maundia</i> , <i>Cyperus</i> , <i>Arthaxon</i> . Given the wet 2014/2015 summer the EPA recommends that the RMS assumes presence of these populations and maps the likely extent of habitat within the study area. For example if during targeted pre-clearing surveys for <i>Maundia</i> an area previously inundated may contain rhizomes and seed stock below ground. The EPA is not advocating translocation of above ground individuals but it could be possible to salvage the below ground material for transferal to suitable habitat or nurseries for propagation and later planting to preferred but	<p>Surveys for threatened flora have been extensive and undertaken over a variety of seasons. Pre-construction targeted threatened flora surveys in 2014 were undertaken between March to May 2014 and Sept 2014 across various seasons including a wet period hence why some additional flora populations were confirmed. Roads and Maritime don't intend on undertaking any additional flora surveys until pre-clearance surveys are done prior to clearing.</p> <p>Translocation options have been assessed for each species in the Flora Translocation Strategy which was submitted for Agency consultation. Salvage of below ground material for <i>Maundia</i> is not proposed.</p>

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		<p>unoccupied habitat created by the road. A feasibility assessment would need to be undertaken to justify this action or alternatively an assessment could conclude that an upstream insitu remnant will provide a similar outcome by repopulating suitable habitat during appropriate conditions.</p> <p>Why limit translocation sites to outside the project boundary? Is the intention to remove future road maintenance constraints?</p>	<p>Section 7.3.1 has been updated to outline the mitigation measures proposed to protect threatened species within the Project boundary. Further, reporting has been updated to state that RMS would explore translocation sites within the Project boundary where practical to do so.</p>
EPA6	Page 47 – 7.3.1	<p>MCoA D8(k) requires monitoring until such time as the mitigation measure can be demonstrated to be effective over 3 monitoring periods or until such time as agreed with the EPA. There is no direction from the project approval to limit monitoring to 5 years if corrective actions are implemented. This may appear to be a reasonable time frame for monitoring, but irrespective of this, the RMS is still required to consult with the EPA to negotiate a new monitoring time frame. Please update the TFMP to reflect this.</p>	<p>Monitoring timeframes have been amended to state that “ongoing mitigation for in situ threatened flora species/populations would be undertaken until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring events”.</p>
Department of the Environment			
DoE1.	-	<p>The Department notes that the plan still includes relatively general information about site specific mitigation measures proposed and still defers some of the key mitigation measures to other sub plans (e.g. section 5 of the plan). This issue was raised by the Department in 2013. The Department considers that if key mitigation measures are to be deferred to sub plans, this plan needs to set the standards that these sub plans must meet and should include key commitments for each specific occurrence of threatened flora the sub plans must adhere to. This would then provide confidence that mitigation measures will effectively reduce the level of impacts to threatened flora.</p>	<p>It is considered appropriate that some mitigation measures in the TFMP refer to more specific and detailed sub-plans that will be the primary document (e.g. Translocation Plan or CEMP). All applicable mitigation measures to be adopted for threatened plants are outlined in this TFMP and where applicable a reference is made to a separate sub-plan as to where further detail will be provided.</p>
DoE2.	-	<p>There seems to be confusion in the plan between performance thresholds and triggers for corrective actions. Performance thresholds are thresholds that are trying to be met and for which deviation from these thresholds would result in corrective actions being implemented (as is written in the headings of tables within the document).</p> <p>On the other hand triggers for corrective actions are negative outcomes which would trigger corrective actions. Currently the majority of the actions/statements under the performance measures heading are actually triggers for corrective actions. Therefore, as currently written, deviation from these measures, which would trigger corrective actions, would in effect result in corrective actions being implemented when the desired outcome is being achieved. The actions under the heading or the terminology used in the</p>	<p>Tables 5-4, 6-1 and 7-3 have been amended to ensure consistency in the use of the terms ‘triggers’ and ‘performance thresholds’. The tables now refer to Mitigation Goals and Triggers for Corrective Action. Text has been amended in this column to reflect negative outcomes which trigger an assessment of corrective actions.</p>

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		heading needs to be amended to address this inconsistency.	
DoE3.	Page 5	Please update this plan to include both the extent of direct and indirect impacts.	Minor text amendment has been made. Section 4.1 of this report specifically addresses direct impacts as a result of threatened species located in the disturbance footprint and indirect impacts for species located in the buffers specified.
DoE4.	Page 13	Please address agency feedback from the draft submitted as part of the PIR for the project. The Department notes that many of the comments provided in 2013 on an earlier draft of this plan still have not been addressed.	This version of the TFMP has been updated on multiple occasions to address comments provided by DoE, other agencies and expert review. DoE's previous comments were addressed in the version of the TFMP which was submitted with the SPIR. The Project was then approved. MCoA D8 requires RMS to develop the Threatened Species Management Plans from the draft Threatened Species Management Plans which were included with the SPIR. Version 3 (this version) of the plan has been provided to relevant agencies for comment and feedback incorporated into the final version submitted for approval.
DoE5.	Page 15	Please clarify whether these surveys are intended to meet the requirements of the mitigation strategy requirements (Condition D8)	The targeted flora surveys undertaken of the Project were carried out to meet the requirements of Condition D8 and the Mitigation Framework. This has included capturing baseline data from targeted threatened flora surveys which were undertaken by suitably qualified and experienced ecologists within all habitats to be cleared of vegetation for the SSI. Survey data has been collected and analysed to determine impacts from the proposed infrastructure development.
DoE6.	Page 16	Please provide an assessment of the likely occurrence of threatened flora species within the areas yet to be surveyed and further commitments as to how any threatened species finds within this area will be addressed. For example, will surveys be undertaken at a suitable time of year to identify threatened flora species that may occur? Will a revised version of the Threatened Flora Plan be submitted for approval that addresses any threatened species found, and avoidance and mitigation measures, and will the Plan require approval prior to clearance of these areas?	<p>These areas have been assessed to identify biometric vegetation type and habitat quality scores. Roads and Maritime will undertake a desktop risk assessment for those properties remaining which have not been surveyed due to land access not being available. Where a property is determined as a low risk for containing threatened flora species (such as being cleared, developed for cane farming, no known nearby records) a specific targeted survey will not be completed. If a property is determined as a high risk and likely to contain threatened plant species (such as contains suitable habitat for threatened plants and there are nearby records) a targeted survey will be completed prior to any works occurring on that property. If additional threatened plant species are confirmed this information will be provided to the relevant agency and the TFMP will be updated.</p> <p>An additional survey will be undertaken during pre-clearance surveys prior to clearing to confirm the recorded threatened plant species. It will also allow for any additional populations to be recorded and addressed through the New Finds Procedure.</p>
DoE7.	Page 20 and 22	Reference to hybrid angophora - Unless hybrids can easily be identified (which the Angophora reports states they cannot) (or samples from each individual recorded is sent to the Botanic Gardens), all specimens identified	Jacobs was commissioned to undertake sampling and genetic testing of <i>Angophora robur</i> within the early works area at Tyndale. Genetic testing was completed on specimens from this location. The majority of species were confirmed as hybrids with one <i>Angophora robur</i> . Other than these specific locations, the rest of the <i>Angophora</i>

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		during pre-clearance surveys must be assumed to be the species (not hybrids). Please update the plan to reflect this requirement.	<i>robur</i> occurrences (including hybrids) will be assumed to be <i>Angophora robur</i> . RMS does not intend to undertake further genetic testing and therefore all potential <i>Angophora robur</i> (outside of populations at the Tyndale early works area) will be treated as being the species and all to be impacted will be offset. Reporting of <i>Angophora robur</i> has been amended to ensure consistency with the above statements.
DoE8.	Page 23	Please provide a justification for the use of the 20 metre buffer for indirect impacts	Justification has been provided in Section 4.1 and states "indirect impacts relate to non-aquatic and shade-requiring threatened flora species that are located within a 10 m buffer of the construction footprint. For aquatic and shade-requiring species indirect impacts have been assessed for those plants within a 20 m buffer of the construction footprint." These distances were recommended as part of the expert review.
DoE9.	Page 26	Please provide the number of hectares of Hairy Joint Grass to be impacted based on the targeted surveys.	See Tables 4-1 and 4-2 for estimated direct and indirect impacts. The species was recorded in Sections 1, 3, 8 and 10 and has been provided offsets for these populations which are reflected in the W2B Biodiversity Offsets Strategy.
DoE10.	Page 27	Please clarify the units used to measure the moonee quassia. Does the term "individuals" correspond to the use of the term "stem"?	As it is difficult to determine distinct individuals in multi-stemmed or clonal shrubs and herbaceous species (e.g. <i>Eleocharis tetraquetra</i>) without digging them up, the following approach was adopted. If multiple stems could be seen as arising from one base then they were counted as being one individual. If there was not an obvious surface or shallow sub-surface connection between one stem and another, then the separate stems were counted as individuals.
DoE11.	Page 33	As surveys have now been undertaken for stage 1 and 2, the impacts and locations of impacts should now be known in relation to ancillary facilities. Please provide further information in regards to the quantum of impact from proposed ancillary facilities.	Descriptions concerning the placement of ancillary activities have been provided demonstrating efforts to avoid impacts on threatened flora species. It is not expected that threatened flora species will be impacted as ancillary activities will be placed in cleared areas, more than 50 m away from waterways and on relatively stable land. These measures along with other measures (e.g. use of exclusion fencing) will avoid impacts on threatened flora species. No quantum of impact from these facilities has been incorporated into this plan, as they have not been approved for use. Further to the Ancillary Sites that were detailed, assessed and approved in the EIS/SPiR documentation, Ancillary Sites required for Stage 1 activities are subject to further consideration by the individual Contractors for these works. Any Ancillary Sites are required to be assessed and approved through the approval requirements of MCoA B73, B74, B75, and Ancillary Facilities Management Plan required by MCoA D21.
DoE12.	Page 34, section 5.3.2	Please provide maps and minimum buffers/exclusion zones proposed for each threatened plant occurrence that has now been surveyed in stage 1. Based on the information currently included in the plan the Department is	Extensive surveys have been undertaken of the entire W2B project (Sections 1 to 11) to identify and capture locations of all threatened species within the proposed Project boundary. All threatened species locations have been identified to sub-metre accuracy

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		assuming that all threatened plants within the project footprint that will not be cleared will be within a proposed buffer. Sufficient information also needs to be included in this plan to ensure that this measure can be monitored to confirm the ongoing survival of these plants, and that these measures are auditable. Please update accordingly.	and are maintained in RMS's GIS database for reference throughout project delivery. Details of species located within the area of Direct Impact (within the construction footprint) are contained in Section 4 of this plan. Buffer distances for the protection of threatened flora species will be established via exclusion fencing installed as part of the pre-clearing process during the construction phase. Most up to date maps showing the location of threatened flora in proximity to the road corridor are provided in Appendix C.
DoE13.		In-situ plants – what monitoring is proposed to ensure these are retained? What happens if the plants are not retained? The Department considers that offsets would be required to compensate for the loss of these plants. Please update plan to reflect this.	Section 8.2 has been amended to outline <i>in situ</i> threatened flora species proposed monitoring measures. Further, the plan has been updated to state that any additional impacts to threatened plants resulting from the project will be offset.
DoE14.	Page 41, table 5-4	Actions within this table must be time bound; thresholds and corrective actions are required for each mitigation measure proposed in the table Please define –damage. This should relate to clearing and accidental incursions/trampling, but also from impacts such as run off In the row regarding exclusion zones, please address potential damage to exclusion zones. If this results in mortality of the threatened flora, a corrective action must include securing additional offsets (for EPBC Act listed flora in accordance with the EPBC Act Offsets Policy).	Tables 5-4, 6-1 and 7-3 have been amended to reflect under what conditions corrective actions will triggered and when they should take place. Text has been amended in this column to reflect negative outcomes which trigger corrective actions. The term damage has been further clarified in Table 5-4 and includes accidental clearing, incursions, trampling, and smothering as a result of sediment run-off. Under Table 5-4 it is stated that additional offsets are to be provided for any impacts to threatened flora not accounted for in the Offsets Strategy.
DoE15.	Page 42, section 6.2	Please provide the key goals from the CEMP in regards to dust and water and soil quality that is proposed to be achieved for threatened flora. E.g. no impacts from reduced water quality? No reduced water quality in the vicinity of threatened flora? The Department notes that the draft CEMP for dust does not include threatened flora as 'sensitive receivers', or references to threatened flora more generally. On this basis, the issue of dust management for threatened flora needs to be included in this plan. Please update to address this.	Section 6.2 has been updated to outline the key commitments for managing dust, soil and water quality during construction to avoid, minimise and mitigate impacts on threatened flora species.
DoE16.	Page 43, section 6.3.3.	Please confirm that SAPs would also be in place for threatened flora adjacent to the clearance area, but not considered as <i>in situ</i>	SAPs will be prepared to protect threatened flora adjacent to the clearance area. These occurrences are defined as <i>in situ</i> .
DoE17.	Page 43, section 6.3.5	Specific erosion and sedimentation commitments are required as a part of this plan. Please update.	Section 6.3.6 has been updated to outline key commitments associated with managing erosion and sedimentation during construction. A reference has also been provided to the CEMP which outlines measures for implementing erosion and sediment control measures in greater detail. RMS notes that the CEMP for the relevant stages of the Project are subject to separate condition of approval.
DoE18.	Page 45, table	The actions within this table need to be time bound for example, the term	Timeframes for corrective actions have been allocated where applicable. Exclusion

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	6.1	<p>“regularly” needs to be defined. Please ensure all corrective actions have timeframes attached to them.</p> <p>Please justify proposed timing in this table, as required by the conditions of approval. For example, please demonstrate that monthly monitoring of exclusion fencing would be sufficient, or propose more frequent monitoring.</p> <p>A corrective action of securing additional offsets (for EPBC Act listed flora in accordance with the EPBC Act Offsets Policy) is required if the threatened flora have not survived.</p>	<p>fencing inspections will form part of the weekly environmental site inspections during construction.</p> <p>In regards to offsets, if there is a residual impact on a threatened flora species outside of what has already been estimated, additional offsets will be required.</p>
DoE19.	Page 47, section 7.3.1	In accordance with the requirements of the conditions, monitoring must occur until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring periods	Section 7.3.1 has been amended to state that ongoing mitigation for in situ threatened flora species/populations would be undertaken until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring events.
DoE20.	Page 49, table 7.3	<p>Unless further justification can be provided, a 20% decline of threatened plants is considered too high prior to corrective actions being implemented. Please review this figure and provide justification regarding the value chosen.</p> <p>Corrective actions need to be time bound, and result in actions being implemented to reverse the decline that is recorded. For example, further monitoring is not an action in itself. Please review and amend corrective actions in this table.</p> <p>Please confirm that the surveys undertaken to date a sufficient to determine baseline conditions and natural variability, as is required to meet the requirements of the actions in this table.</p>	<p>It is noted that the performance objective is divided into phases. Phase 1 performance objective is that there are no mortalities of in situ threatened plants during construction and for three consecutive monitoring periods post construction. This is to say that should there be any mortalities during this time from the pre-clearance baseline (which could be for over three years taking into account how long construction may go for) corrective actions will be assessed and applied if appropriate.</p> <p>The Phase 2 performance objective is then to take into account that there may be some natural attrition of threatened flora over the longer term due to natural seasonal conditions. Populations may go up or down. Therefore it is proposed that if there is a decline in species numbers >20% from the baseline over one monitoring event then corrective action will be assessed and applied if appropriate. This is considered reasonable as if the population baseline was 20 individuals, then the death of 5 individuals would trigger a corrective action.</p> <p>We have updated the wording in Table 7.3 to make this clearer.</p> <p>Baseline threatened flora surveys have been extensive. They have occurred over various seasonal conditions and timeframes both during the EIS, SPIR and targeted baseline surveys in 2014. Some areas have even been surveyed twice in 2014 at different times. Each threatened species found has been recorded with GPS and observations taken regarding number of individuals, habitat, condition etc. An additional pre-clearance survey will also be undertaken prior to clearing to confirm these threatened species locations, mark them, put up exclusion zones and ensure no additional individuals are present due to changes in climatic conditions etc.</p>
DoE21.	Page 50	Please confirm that monitoring would also cover threatened flora directly adjacent to the proposed action, as is implied in other parts of the plan.	Monitoring of threatened flora species is detailed throughout the management plan. RMS is not monitoring areas adjacent or outside the approved Project Boundary with the exception of identified control sites.

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 2.1)
DoE22.	Page 50, section 8.2.1	Please provide justification, in accordance with the requirements of the approval conditions, that biannual monitoring would be sufficient, and that the timing proposed is ecologically appropriate for the targeted threatened flora species, or amend as necessary.	The monitoring periods proposed will allow for threatened flora species to be monitored in consideration of seasonal variations and flowering/fruitleting. Frequency is also based on the likely risks to species. It is currently proposed that monitoring is to be conducted: <ul style="list-style-type: none"> • 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)).
DoE23.	Page 50-51	Please ensure that the information to be monitored covers all the identified threats and issues to be monitored in the plan. For example, monitoring of impacts from water quality and erosion/sedimentation and dust do not currently appear to be proposed. Please provide the performance thresholds and corrective actions for the monitoring program. For example, control and impact sites are mentioned for the first time on this page, however no performance threshold table in the entire document includes a performance threshold relating to control and impacts sites. Please amend table 7.3 to reflect the information on this page.	Reference has been included to monitoring of threats from erosion and sedimentation, dust and water quality. Further, information concerning the measures to be implemented to avoid, minimise and mitigate impacts from dust, soil and water quality has been included in Section 6.3.6 and Section 6.4. Monitoring during construction and operation for in situ plant populations, mitigation goals and corrective actions are described in Section 6.4 and Section 7.4. Section 8.2 also identifies frequency of monitoring and performance thresholds.
DoE24.	Ecosure surveys	The Department notes and welcomes the surveys that have now been undertaken to determine the offset quality scores under the EPBC Act Offsets calculator and the results provided. The Department has the following comments to assist in progressing this assessment for the provision of suitable offsets for these species: <ul style="list-style-type: none"> • Please ensure that sufficient information regarding the methodology and results of how polygons were scored is available to ensure repeatability of surveys in remaining sections of the proposal, and within the offsets. • Page 81 – fauna habitat quality scores: The Department notes that average scores have been provided for each threatened species. As the EPBC Act offsets calculator cannot consider decimals, the Department recommends that the areas of habitat is provided separately for each score recorded (e.g. x ha of score 7, y hectares of score 9 etc.) No information is provided regarding flora species and habitat scores/counts for these.	GIS analysis of field survey data was undertaken to determine counts and areas of threatened flora species impacted by the Project. Tables 4.1 and 4.2 in this report outline these impacts. The methodology to be applied for the calculations of offsets will be outlined in the Biodiversity Offsets Strategy and will consider these comments in its finalisation.
DoE25.	Ecosure surveys	Please clarify how the description of koala habitat in this document compares to the EPBC Act koala guidelines. This document implies that 150ha + of	Areas determined within the report are for all potential koala habitat. Koala habitat in the Ecosure report was determined through consideration of nesting/sheltering,

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 2.1)
		critical habitat occurs within sections 1 and 2. In accordance with the conditions of approval, the maximum clearance across the whole project of critical habitat for the koala is 375 ha.	foraging, habitat features, connectivity, patch size and vegetation condition requirements. Additional information concerning koala habitat determinations will be outlined in the Biodiversity Offsets Strategy.
DoE26.	Ecosure surveys	Page 10 - slender screw fern is described as endangered under the EPBS Act, however is not an EPBC Act listed species	Noted. This version of the TFMP uses the correct status, Endangered under the <i>Threatened Species Conservation Act 1995</i> .
DoE27.	Biosis Report Page 21	The EPBC Act Offsets Policy and Calculator ranks habitat quality on the basis of the subject species ecological requirements, rather than general vegetation condition, as is suggested on this page. Therefore the same area of vegetation can have different condition scores for different species. Please confirm how this is addressed in these calculations.	Blanket condition scores for each vegetation community were determined using biometric methodologies which then adjusted the condition score for each species based on factors that may influence the quality of the habitat for a specific species. Using the Regent Honeyeater as an example, an area of dry sclerophyll forest may have been scored as being in good condition overall, but may have been dropped to moderate or low if preferred feed trees were present in low densities or completely absent.
DoE28.	Biosis Report Page 21	The Department seeks confirmation that the methodology applied in this report is the same as what was applied in the Ecosure report – to ensure consistency across the whole project, the same scoring methodology needs to be applied for each species. Sufficient information also needs to be provided to demonstrate that this is the case. For example, the quality scores outlined in this document for the Regent Honeyeater and Swift Parrot differ substantially from those in the Ecosure report. While this may be due to different habitat types present between section 1 and 2, insufficient information is available to demonstrate consistency between the two reports.	The methodology for determining offset requirements was conducted in accordance with EPBC Offsets Policy by experienced ecologists. RMS has adopted a conservative approach and intends to provide offsets for identified impacts, not just residual significant impacts. The extent of impacts to each MNES have been calculated based on detailed information from threatened species surveys and habitat quality mapping undertaken in 2014.
DoE29.	Biosis Report	Comment 24 above is also relevant to this report	As per comment 24.
DoE30.	Jacobs Report	The Report states that Stage 1 is the only stage covered by this report, however other parts of the report state that it covers whole highway. Please clarify. Please confirm that proposed monitoring is sufficient for BACI design and determining natural variability, as is required by the conditions of approval. Also please clarify that control sites 50m away from the proposal will not be indirectly impacted by the proposal (and therefore not suitable as control sites) Section 2.4 – will other aspects, such as erosion and sedimentation and dust be monitored? Please include the results of initial monitoring, in accordance with the monitoring criteria provided in the report.	Control site locations were selected based on their relative proximity to impacted populations to help ensure suitability as a representative population of affected populations within the construction footprint, within similar environmental conditions (e.g. soils, hydrology and humidity). Further, control site locations were also selected in consideration of being a minimum of 50m from the project, availability of land access and where the flora populations occurred. It is expected that the control sites will not be impacted by the proposed works due to the separation distance and the control measures to mitigate environmental impacts outlined in the project CEMP. As some species were not able to be identified during the Jacobs survey additional BACI sites will need to be established in the future prior to clearing commencing. The number of BACI sites established for each species to date are considered adequate to establish natural variability in the populations within the local area and compare what

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 2.1)
			may be occurring at the in-situ populations versus control site populations. Erosion, sedimentation and dust will be monitored as per the CEMP.
DoE31.	Appendix G – species profiles	If these profiles are to be provided as part of EWMS or other documents for contractors, please update these to include a description of known occurrences within the proposal boundary, including supporting maps.	The profiles have been provided to supplement the report as background information on each of the threatened flora species assessed. Profiles and maps will remain as part of this document with the entire TFMP. Further, GIS information on threatened flora locations will also be provided to the contractor so they can prepare their own more detailed maps for use in construction which could include EWMS for specific activities in the construction period e.g. creek realignments, sediment basin management etc.
DoE32.	All documents	Moonee Quassia Please clarify how the information in these documents relates to the information provided on this species in the memo dated 16 August 2012 provided by Arup Parsons Brinckerhoff. Please clarify the final design proposed in this area.	The targeted threatened flora surveys conducted by Biosis and Jacobs in 2014 were undertaken to compliment information collected during the preparation of the environmental impact assessment. The occurrence of Moonee Quassia within Section 1 is the same locality of that previously identified in the memo dated 16 August 2012 provided by Arup Parsons Brinckerhoff JV. Project design has now been finalised and impacts for Moonee Quassia are presented in Section 4.

Summary of comments and amendments from DoE (received 17 April 2015)

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 2.1)
Department of the Environment			
DoE1	General	Condition 12 - Develop a Threatened Flora Management Plan as per NSW condition D8 for each relevant stage for EPBC listed species. This plan has been prepared to address mainly Section 1 and Section 2 including soft work areas; from Woolgoolga to Glenugie.	Noted. This version of the plan now addresses all sections of the Project.
DoE2	General	It is unclear why figures illustrating habitat quality for fauna species have been included in this plan. It would be useful if the Plan included Sensitive Area Plans for threatened flora species.	As part of the consultants' scope, Roads and Maritime required they assess flora and fauna habitat quality for offset purposes. Therefore there is additional information in these technical reports not relevant to the TFMP. For the most up to date mapping of threatened flora species please refer to Appendix C. The Sensitive Area Plans (SAPs) need to include all project constraints such as Aboriginal and non-Aboriginal cultural heritage, noise sensitive receiver locations, groundwater monitoring locations, waterways, threatened frog habitats, threatened fish habitat and threatened flora, to name a few. To ensure these plans specifically address threatened flora, Roads & Maritime have developed a GIS spatial file that has captured all threatened flora species recorded to sub-metre accuracy (used to produce the mapping provided in Appendix C of this plan). This data will be provided to Roads & Maritime construction contractors to enable the development of their SAPs required by RMS contract specifications and overlaid with other project specific constraints/sensitive areas. Details on the SAPs will be provided with each section/stage of the CEMP.
DoE3	General	The plan is designed to address issues generally for the overall project and lacks specific information for Sections 1 and 2 except on surveys undertaken and areas impacted for each species.	The structure of this version of the TFMP is to address the whole Project and establish a framework as to how impacts to threatened plants will be avoided, mitigated and monitored. Management measures detailed in this plan for pre-construction, construction and operation will apply to all impacted threatened flora species, such as exclusion zones, weed management, dust monitoring etc as it is considered these measures are relevant to all species. i.e. there are no specific measures required for specific threatened flora species beyond those detailed in Translocation Strategy.
DoE4	Section 2.1	Condition 12 – Plan must minimise impacts to EPBC listed flora species to the satisfaction of the Minister. Targeted surveys undertaken for Section 1 found 2 EPBC listed flora species; Hairy Joint Grass (v) and Moonee Quassia (v). Land between chainage 7000 and 7500 and 9000 (14 ha) of Section 1 have not been surveyed due to restrictions to land access. TFMP will be updated	The life history attributes of each species being monitored were considered when determining the number of <i>in situ</i> monitoring and control sites for each species. The distribution of the species and extent of impact was also considered. Smaller wetland species that are potentially more susceptible to indirect impacts and climatic/seasonal conditions have a larger number of in situ and control sites where possible and larger trees and shrubs less susceptible to indirect impacts and climatic variability have less sites established particularly control sites.

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 2.1)
		<p>with new survey information should any threatened species be found.</p> <p>EPBC listed flora species found within Section 2 include Square-fruited Ironbark (<i>Eucalyptus tetrapleura</i>) (v) and Square-stemmed Olax (<i>Olax angulata</i>) (v).</p> <p>EPBC listed species found within soft soil work areas include <i>Persicaria elatior</i> (v), <i>Angophora robur</i> (v) and <i>Streblus pendulinus</i> (E).</p> <p>Potential impacts are identified under Section 4.1 and detailed in Tables 4.1 and 4.2 which provide areas to be impacted for each species. This information is also in Appendix D including habitat quality scores.</p> <p>There are 13 control sites established for monitoring and determining natural variability. These sites include 5 species of which only one EPBC listed species has been included (Moonee Quassia). Please explain why control sites for other EPBC listed species, in particular for <i>Streblus pendulinus</i> have not been included.</p>	<p>In summary the in-situ and control sites established are for:</p> <ul style="list-style-type: none"> • <i>Eleocharis tetraquetra</i> – 2 control sites, 5 in situ sites • <i>Eucalyptus tetrapleura</i> (Vulnerable under EPBC Act) – 1 control site, 3 in situ sites • <i>Lindernia alsinoides</i> – 3 control sites, 4 in situ sites • <i>Lindsaea incisa</i> – 1 control site, 3 in situ sites • <i>Maundia triglochinosoides</i> – 4 control sites, 6 in situ sites; and • <i>Quassia</i> sp. Moonee Creek (Endangered) – 2 control sites, 2 in situ sites. <p>Given the substantial resources involved in establishing and monitoring control sites, consideration to the level of project impact was also a key factor in selecting control sites. For example, <i>Persicaria elatior</i> and <i>Streblus pendulinus</i> have been determined as not having a 'significant' impact from the project and accordingly control site monitoring was not deemed necessary.</p>
DoE5	General	<p>Condition 12 - Mitigation and monitoring</p> <p>This plan does not provide detailed information on mitigation and monitoring relevant to species identified in Sections 1 and 2. Whilst it refers to the CEMP and FFMP, under CEMP information relating to mitigation and monitoring must be included in this plan.</p> <p>E.g. exclusion fencing, translocation etc. – which species would these measures apply to in Sections 1 and 2? Does exclusion fencing apply to all those identified for <i>in situ</i> monitoring in Figures A-1, A-2 etc.? Which species are proposed to be translocated?</p>	<p>The Translocation Strategy required by NSW MCoA and developed in consultation with DoE details which species will be translocated. Draft of the Translocation Strategy for Sections 1 and 2 was provided to DoE 02/12/14. Translocation strategy/ies for other sections of the Project will be produced prior to works commencing in the relevant sections.</p> <p>Management responses have been detailed in the TFMP in Sections 5, 6 and 7 and Tables 5.4, 6.1 and 7.3. These management responses are considered appropriate for all impacted threatened flora species which is why species are not singled out. For example exclusion fencing during clearing will apply to all in-situ plants.</p> <p>Additional information on translocation has been added to Section 8.3. However for the most detail on translocation proposed and methods please refer to the Translocation Strategy. Aside from the translocation methodologies (detailed in the Translocation Strategy) there are no additional specific management responses based on species specific requirements.</p>
DoE6	Section 2, Appendix D	<p>NSW D8(a) - Demonstration of adequate surveys</p> <p>The level of surveys undertaken for Sections 1 and 2 appears reasonable.</p>	Noted.
DoE7	Section 8, Table 9	<p>NSW D8(d) - Monitoring program to assess the use of mitigation measures - include monitoring periods, performance parameters and criteria against which effectiveness will be measured.</p> <p>Please include monitoring frequency under 8.2 – weed management around in situ populations during construction.</p>	<p>Monitoring of in situ threatened flora species to be retained and protected throughout construction of the Project is to be conducted:</p> <ul style="list-style-type: none"> - Every three months during the first year of construction; - Every six months during the second year of construction; and

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		The relationship between numbering on Figure A (overview of threatened flora locations) to figures A-1, A-2 etc. is unclear. Does no 1 on Figure A correspond to Figure A-1? Please mark the relevant figures for sections 1 and 2.	<ul style="list-style-type: none"> - Every 12 months thereafter for a minimum of three years post-construction (subject to achieving three consecutive monitoring periods as per MCoA D8 (k)). <p>Weed monitoring will be conducted at the same intervals during monitoring of in situ plants. Timing is outlined in Section 8.2.1.</p> <p>Management responses, performance parameters and corrective actions have been detailed in the TFMP in Sections 5, 6 and 7 and Tables 5.4, 6.1 and 7.3.</p> <p>Weed management is outlined in Sections 5.3.6, 6.3.8 and 7.3.3. Monitoring of weeds will be undertaken as per the Weed Management Plan and CEMP. Section 8.2 has been amended to provide further information and references relevant plans, such as the CEMP and Weed Management Plan, and Sections of the report that discuss weed management.</p>
DoE8	Section 6.4 and Table 6.1	NSW D8(e) - Monitoring methodology Table 6.1 provides general performance goals, mitigation measures, performance targets etc. Given the management plan is required to specifically address those flora species in Sections 1 and 2, this table should be amended to reflect each species relevant to Sections 1 and 2 as identified in Tables 4.1 and 4.2. A column should also be added to include the responsible party for the implementation of management measures, monitoring and corrective actions.	<p>This version of the TFMP addresses all sections of the Project. Management responses have been detailed in the TFMP in Sections 5, 6 and 7 and Tables 5.4, 6.1 and 7.3. These management responses are appropriate for all impacted threatened flora species. Aside from the translocation methodologies (detailed in the Translocation Strategy) there are no additional specific management responses based on species specific requirements.</p> <p>Tables 5.4, 6.1 and 7.3 have been amended to include responsible parties in consideration of Table 9.1.</p>
DoE9	General	NSW D8(f) - Goals and performance indicators As above, relevant tables need to be updated to clearly distinguish between performance goal, performance criteria and performance triggers.	<p>Management responses have been detailed in the TFMP in Sections 5, 6 and 7 and Tables 5.4, 6.1 and 7.3. These tables distinguish between the main goal for mitigations, the proposed mitigation measures, monitoring frequency/timing, the trigger for when corrective actions are required and the corrective actions to be implemented.</p> <p>Responsibilities have also been included as requested by comment DoE8.</p>
DoE10	General	D8(h) - Provision for assessment of monitoring data to identify changes attributable to the project - Not specifically addressed.	<p>Section 7.3.1 specifies ongoing mitigation and monitoring for <i>in situ</i> threatened flora species/populations would be undertaken until mitigation measures, including corrective actions, are found to be effective for three consecutive monitoring events. 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 8 for the <i>in situ</i> and translocation monitoring requirements.</p> <p>Table 7.3 identifies goals of: Zero mortality of retained in situ threatened plant populations during construction and for three consecutive monitoring periods post-construction. Post the above period 80 per cent survival of tree, shrub and herbaceous perennials after three years.</p> <p>Threatened species may differ in resilience, longevity and sensitivity to disturbance.</p>

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			<p>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, particularly for <i>Arthraxon hispidus</i> and <i>Maundia triglochoides</i>.</p> <p>Therefore monitoring results will be assessed after each monitoring period to identify if there is a reduction or impact to threatened plant populations and likely causes.</p> <p>Further, the proposed monitoring program would capture and provide data to determine the success of mitigation measures proposed.</p>
DoE11	General	D8(i) - Details of contingency measures in the event of changes to habitat usage patterns, distribution and movement patterns attributable to the project - Not specifically addressed.	Management responses for mitigating impacts on threatened flora have been detailed in the TFMP in Sections 5, 6 and 7 and Tables 5.4, 6.1 and 7.3. These tables clearly identify the proposed mitigation measures and corrective actions for when mitigation measures are not deemed to be performing as required.
DoE12	Section 1.3	D8(j) Mechanism for monitoring, review, and amendment of the plans - Not specifically addressed to include adaptive management.	Section 4.5 (Also Section 8.4.2 in relation to habitat revegetation) outlines the adaptive management approach and is 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. Tables 5.4, 6.1 and 7.3 provide the detail of how adaptive management is being applied.
DoE13	Section 9	<p>D8(k) – Provision for ongoing monitoring during operation until the success of mitigation measures are demonstrated</p> <p>See comments under 12 and D(8)d in relation to the Department's expectation on specific species based information for mitigation and monitoring.</p>	Management responses have been detailed in the TFMP in Sections 5, 6 and 7 and Tables 5.4, 6.1 and 7.3. These management responses are appropriate for all impacted threatened flora species. Aside from the translocation methodologies (detailed in the Translocation Strategy) there are no additional specific management responses based on species specific requirements.
DoE14	Section 7.5	<p>D8(l) - Annual reporting of monitoring results</p> <p>Please see EPBC approval condition 21 requirement for publication of annual reports. These reports should include results of monitoring as part of the implementation of the plans.</p>	Monitoring results will be incorporated into annual reports as outlined in Section 8.4. All reports prepared will be published as required under MCoA and EPBC approval requirements.

Summary of comments and amendments from agencies (received 16 July 2015)

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
Department of the Environment			
DoE1	-	TFMP for sections 1 and 2 was previously approved under the EPBC Act. This plan includes the overall project from 1 – 11.	Noted.
DoE2	-	Please submit the final version in hard copy for consideration of approval by the Minister/delegate.	RMS is happy to submit the final version in hard copy to DoE.
DoE3	-	Condition D8 applies to both threatened flora and fauna. EPBC condition 12 specifically relates to threatened flora species.	Noted.
DoE4	Section 2	Compliant- information provided in section 2 indicates that adequate surveys have been undertaken by suitably qualified and experienced persons.	Noted.
DoE5	4.1, Table 4-1, Table 4-2, Section 5.1 and 6.1	Section 4 provides details on direct and indirect impacts on identified threatened flora species (20) within and adjacent to the project footprint.	Noted.
DoE6	Section 4, 5 and 6	<p>5.3.1 – reference made to TIMP needs clarification.</p> <p>Mitigation and management measures are satisfactorily addressed.</p> <p>Detailed site specific information for mitigation and management measures during construction is to be included in the CEMP/s and FFMP/s. Table 5.4 states that in situ conservation of species is to be identified during pre-construction targeted surveys and will be addressed in CEMP/s and FFMP/s. However, this information is inconsistent with information in section 8.2 and Jacobs 2014.</p> <p>These documents are yet to be submitted for sections 3-11.</p>	<p>This has been amended to TFMP. The sentence now reads “Updated figures illustrating the location of threatened plants is included in Appendix C of this TFMP”.</p> <p>Noted.</p> <p>In Table 5-4 we have stated “targeted surveys of threatened plants to be completed to identify threatened plants for retention in situ, translocation and seed collection”. In Section 8.2 we have stated that “targeted surveys have been undertaken to collect comprehensive up-to-date data on the location and number of threatened plants within the project”. Table 5-4 is considered relevant as undertaking targeted surveys is a key mitigation to identify populations to inform impacts and required management. Both statements require that the project CEMP incorporate information on these populations to inform management during construction.</p> <p>Noted.</p>
DoE7	Table 5-4	<p>Has translocation strategy completed and approved by NSW for sections 1 and 2?</p> <p>If all targeted surveys have been completed, it is unclear why the species that have been identified in sections 3 – 11 for translocation have not been listed in the TFMP.</p>	A Translocation Strategy has been prepared and submitted for approval that addresses Sections 1 and 2. Targeted surveys have now been completed for Sections 1-11. The results of these targeted surveys are now informing preparation of a separate Translocation Strategy for Sections 3-11. The Translocation Strategy for Sections 3-11 will be submitted for approval to relevant agencies at a later date prior to construction commencing in these sections.

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
			Therefore this TFMP has only been able to confirm those threatened flora species to be translocated for Sections 1 and 2. It is not proposed to update the TFMP post finalisation of the next Translocation Strategy as all relevant detail for translocation will be in that report. The TFMP currently references that report where applicable.
DoE8	Section 8, Table 9	Table 9 provides for monthly monitoring for the first year for maintenance of revegetated areas by the contractor. Information in Table 9 (summary) does not appear to be consistent with Tables 7-1 and 7-2. Could a map illustrating revegetation areas be included in the TFMP?	Table 7-1 provides maintenance requirements for Year 1. Plant health, weed control, plant replacement and stake and tree guards are all monthly monitoring and maintenance activities proposed in Year 1. This is considered consistent with Table 9-1. It is proposed that areas to be revegetated will be included in the project Urban Design and Landscape Plan and CEMP. Mapping will be provided in those documents at a more detailed scale.
DoE9	Section 8	Section 8.2 and Jacobs 2014 indicates all targeted surveys and baseline surveys to satisfy pre construction survey requirements have been completed. It is unclear whether there will be further pre-clearing surveys proposed to be undertaken by contractors as part of CEMPs and FFMPs. Further, in situ threatened flora locations have been identified as per Jacobs 2014a. The Jacobs surveys submitted with the TFMP is titled Rev02, 8 October 2014 and it is unclear if this is the correct version referred to as Jacobs 2014a in section 8.2. The figures in Jacobs document are unclear and difficult to locate proposed monitoring sites and control sites. The relevant Jacobs document must be provided as an Appendix to the TFMP and appropriately referenced within the TFMP.	Pre-clearing surveys as part of the CEMP and FFMPs are proposed to occur prior to clearing to confirm presence and to ensure that in-situ flora populations are tagged and marked in the field prior to clearing. These surveys are summarised in Section 6.3.3. Flora surveys have been undertaken by a range of ecological consultants including Jacobs. GIS data has been collated and updated figures showing the location of threatened flora recorded during targeted surveys are provided in Appendix C of this document. These figures represent the data collected by all ecological consultants with the latest project footprint. The Jacobs report has been included as an Appendix.
DoE10	Section 4.5 and 6	Please clarify, if main goals for mitigation are considered same as performance goals (e.g. Tables 5.4, 6.4 and 7.4). We suggest that these should be considered as the performance goals.	Essentially main goals for mitigation have the same meaning as mitigation performance goals. These headings have been amended to performance goals.
DoE11	-	This condition is applicable to fauna only.	Noted.
DoE12	Section 8.2	Impact and control sites have been identified for in situ flora species. There is insufficient information in regard to evaluating success of revegetation areas.	Information regarding the location of revegetation areas will be provided in detail in the Urban Design and Landscape Plan. In this TFMP Table 7-3 details performance goals for revegetation. These include "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".
DoE13	Section 5.4, 6.4 and 7.4	Review of management measures and monitoring regimes are proposed with additional offsets in the event of failure.	Noted.
DoE14	Section 1.3 and 8.4	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 TFMP, the updated plan will need to be re submitted for the Minister's	Noted.

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
		consideration of approval.	
DoE15	Section 8	Monitoring is proposed only up to 5 years following completion of construction. This is not considered as meeting the condition requirement.	<p>Section 8 states that proposed monitoring for translocated plants is for a minimum of 5 years. Section 8 also states that monitoring is to be conducted:</p> <ul style="list-style-type: none"> • 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)). <p>As per the statement above, monitoring timeframes are subject to achieving performance goals over three consecutive monitoring periods as per MCoA D8 (k). To avoid confusion, the period of 5 years has been removed from Section 8.</p> <p>The proposed monitoring schedule is consistent with approval condition MCoAD8.</p>
DoE16	Section 8.4	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.	Noted. The annual reports will include information on implementation of management plans.
Department of Planning and Environment			
DPE1	Chapter 1.3	<p>Plan updates – 2nd dot point Version 2 update. State that the Version 2 TFMP for Stage 1 was approved by the Secretary on 30 April 2015.</p> <p>State that once Version 3 is approved, it will replace the approved Version 2 TFMP.</p> <p>This version (2.2) is the third update of the TFMP, also referred to as Version 3. For clarity and to avoid confusion this TFMP should be referred to as Version 3.0 on the title page rather than version 2.2.</p>	<p>Section 1.3 has been amended to state that “Version 2 of the TFMP was approved by the Secretary on 30 April 2015”.</p> <p>Section 1.3 has been amended to state that “once Version 3 of the TFMP has been approved by the Secretary it will supersede Version 2”.</p> <p>Noted. This suggestion has been incorporated.</p>
DPE2	Chapter 1.5	Consultation – Table 1-3 summarises key issues raised by agencies on the draft Version 2 TFMP. This chapter will need to be updated to refer to comments made on Version 3 by agencies.	Agreed. Comments on Version 3 will be incorporated once received.
DPE3	Chapter 2.1.1	Biosis (2014a) – the final paragraph notes that 13.99ha or 5% of the survey area, was unable to be accessed. Remote assessment of the vegetation communities in adjoining accessible areas was extended to these inaccessible areas. Targeted flora surveys will be conducted in these areas once property acquisition has been finalised. RMS has committed to undertake flora surveys prior to construction and update the TFMP should threatened flora species be observed.	Noted.
DPE4	Chapter 2.4.1	Geolink (2014a) – Chapter 1.3 of the report discusses survey limitations and	The access limitations identified in the GeoLink (2014a) report are noted in Section

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
		noted access to a number of properties (8 in total) was unavailable. Please advise the status of these properties and will they be surveyed by an ecologist prior to construction commencing.	2.4.1 and a commitment has been made to carry out a risk based assessment and survey properties identified with having a higher risk and likelihood to contain threatened plant species. RMS will update the TFMP should any additional threatened flora species be identified during these future surveys. Surveys on these properties will be completed by a suitably qualified ecologist prior to construction commencing on that property.
DPE5	Chapter 2.5.1 and 2.6.1	Geolink (2014b) – Chapter 2.6 of the report noted that access to a number of areas was unavailable at the time of the surveys. Most of these areas were under sugar cane cultivation however, a number of areas contain native vegetation. Will these areas be subject to further targeted survey?	The access limitations identified in the GeoLink (2014b) and Jacobs (2014a) report are noted in Section 2.6.1 and a commitment has been made to carry out a risk based assessment and survey properties identified with having a higher risk and likelihood to contain threatened plant species. RMS will update the TFMP should any additional threatened flora species be identified during these future surveys. Surveys on these properties will be completed by a suitably qualified ecologist prior to construction commencing on that property.
DPE6	Chapter 2.7.1	AECOM (2014) – Chapter 1.4 notes the survey limitations, in particular access to three properties was unavailable. The report considers that re-survey of these properties is not necessary. As a precautionary approach will RMS survey these properties prior to construction commencing?	As discussed in Section 2.7.1, although it has been recommended by AECOM that no further surveys are required in these areas, the project ecologist will assess the risk of threatened flora occurring prior to clearing. If there is considered to be a high risk, additional surveys will be commissioned.
DPE7	Chapter 2.8.1	Biosis (2014b) – Chapter 1.2 states that due to landholder access issues approximately 17.88 ha or 8% of the study area, was not included in the surveys carried out. The vegetation communities in these areas were able to be identified remotely, however, surveys for cryptic/ephemeral species should be undertaken once land access had been resolved. Will these areas be subject to further targeted survey?	The access limitations identified in the Biosis (2014b) report are noted in Section 2.8.1 and a commitment has been made to carry out a risk based assessment and survey properties identified with having a higher risk and likelihood to contain threatened plant species. RMS will update the TFMP should any additional threatened flora species be identified during these future surveys. Surveys on these properties will be completed by a suitably qualified ecologist prior to construction commencing on that property.
DPE8	Chapter 2.11.1	Australian Museum Consulting (2014) – Chapter 1.3 noted that access to a number of properties was not available. Table 1.1 has recommended further investigation of the vegetation on these properties. Will these areas be subject to further targeted survey?	The access limitations identified in the Australian Museum Consulting (2014) report are noted in Section 2.11.1 and a commitment has been made to carry out a risk based assessment and survey properties identified with having a higher risk and likelihood to contain threatened plant species. RMS will update the TFMP should any additional threatened flora species be identified during these future surveys. Surveys on these properties will be completed by a suitably qualified ecologist prior to construction commencing on that property.
DPE9	Table 5-1	The table lists the optimal period for seed collection of 13 threatened species. Table 3-1 lists 25 threatened flora species impacted by the project. Are the species listed in Table 5-1 those species which are suitable for translocation? Chapter 5.3.4 should discuss/justify the threatened species listed in Table 5-1. See comment 10 below.	The list provided in Table 5-1 has been amended to be representative of threatened flora species identified in Sections 1 and 2 from pre-clearance surveys and provides flowering and optimal seed collection periods. Table 3-1 represents species previously identified in the EIS prior to the undertaking of pre-clearance surveys. This table is provided for context and does not represent species impacted. Table 4-1 and 4-2 provides a list of species impacted by the proposed works. According to these tables a total of 22 threatened flora species are

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
			likely to be directly or indirectly impacted by the project. Currently the Translocation Strategy prepared for the project provides an assessment of translocation suitability for eight species located in Sections 1 and 2. As a result, the TFMP only includes these species. A Translocation Strategy for Sections 3–11 is currently being prepared and will be finalised and approved by relevant agencies prior to construction commencing in these sections. It is not intended that the TFMP will be updated post approval of the Translocation Strategy. The TFMP refers to this document where applicable for relevant details.
DPE10	Chapter 8.3	It is noted that the species to be assessed for translocation in sections 3-11 will be assessed at a future date. The TFMP will need to be updated and submitted for approval once this information is available. Table 5-1 lists the optimal period for seed collection. Is this list indicative of the species to be considered for translocation? Cross referencing needs to be made with Chapter 5.3.4 and Table 5-1.	The primary purpose of Chapter 8.3 (Translocation) of this report is to outline the characteristics of the translocation strategy and how it contributes to the objectives of the TFMP. The inclusion of the species suitable for translocation within Sections 1 and 2 has been included due to the availability of this information at the time of writing. The Translocation Strategy is the primary document where information on translocation requirements should be gained. Therefore, references to the translocation strategies made throughout this document are considered sufficient and the finalisation of the Translocation Strategy for Sections 3-11 will not trigger an update to this plan. Section 5.3.3 discusses the Translocation Strategy and has been amended to cross reference Table 5-1. In addition, Section 5.3.4 has been updated to include justification for species listed in Table 5-1.
DPE11	Appendix D	Technical Reports – please provide the status of the conclusions and recommendations made by the following reports: <ul style="list-style-type: none"> Jacobs (2014a) recommended threatened flora species and populations identified in the study area during detailed design should be subject to targeted surveys and incorporated into the baseline monitoring and identified in an updated TFMP. Geolink (2014a) in Chapter 6.1 made 4 recommendations, including #3 about additional searches for Maundia. 	A summary of the status of recommendations is provided below: The species identified in the Jacobs (2014a) study area have been incorporated into this TFMP which also outlines monitoring requirements. Further, pre-clearing surveys are proposed to confirm presence and to ensure that populations are tagged and marked in the field prior to clearing. Several recommendations were made in the Geolink (2014a) report. Comments on the status of these conditions is provided below: <ul style="list-style-type: none"> Several studies of Rough-barked Apple (<i>Angophora robur</i>) populations have been undertaken throughout the Project area, such as the Jacobs Rough-barked Apple (<i>Angophora robur</i>) assessment undertaken Nov 2014. Further, genetic testing was undertaken for some occurrences of Rough-barked Apple (<i>Angophora robur</i>) in proximity to soft soil work areas in Section 3. However, due to the complexity and time associated with genetic testing the Project has adopted a precautionary approach and assumed that all potential Rough-barked Apple (<i>Angophora robur</i>)

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
		<ul style="list-style-type: none"> Geolink (2014b) in Chapter 7 made 3 recommendations. 	<p>are in fact Rough-barked Apple (<i>Angophora robur</i>) (outside those confirmed as hybrids by NSW Herbarium).</p> <ul style="list-style-type: none"> Roads and Maritime will assess and maximise the reuse of timber resources. Any salvage of valuable timber will be outlined in the CEMP. Reuse may include for bridge timbers, glider poles etc. Extensive targeted surveys have now been completed for all sections of the Project over various seasonal conditions. Subsequent to GeoLink's survey of Section 3 an additional survey was completed by Jacobs for threatened plants. Jacobs recorded Maundia (<i>Maundia triglochinos</i>) within the alignment of Section 3 and it was observed in low to moderate abundance at several locations in comparison to previous observations, most likely due to the below average rainfall received in the study area. There were no major changes from previous surveys in terms of distribution and abundance. A pre-clearance survey will also be undertaken prior to any clearing to confirm the threatened plant populations, ensure in-situ species are tagged and marked and exclusion fencing constructed. Weed control will be undertaken as per the CEMP. <p>Several recommendations were made in the Geolink (2014b) report. Comments on the status of these conditions is provided below:</p> <ul style="list-style-type: none"> The species identified in the Geolink (2014b) surveys have been incorporated into this TFMP which also outlines monitoring requirements. A significant impact assessment was completed for Knotweed (<i>Persicaria elatior</i>) and it was found the project is unlikely to have a significant impact on the species. Several studies of Rough-barked Apple (<i>Angophora robur</i>) populations have been undertaken throughout the Project area, such as the Jacobs Rough-barked Apple (<i>Angophora robur</i>) assessment undertaken Nov 2014. Further, genetic testing was undertaken for some occurrences of Rough-barked Apple (<i>Angophora robur</i>). However, due to the complexity and time associated with genetic testing the Project has adopted a precautionary approach and assumed that all potential Rough-barked Apple (<i>Angophora robur</i>) are in fact Rough-barked Apple (<i>Angophora robur</i>) (outside those confirmed as hybrids by NSW Herbarium).
		<ul style="list-style-type: none"> Melaleuca Group (2014) in Chapter 5 noted the occurrence of between 25-30 individuals of the endangered Yellow-flowered King of the Fairies within the project area (approximately 443 sq. m, with an additional 700 sq. m of the same vegetation unit outside the study area). The report concluded that further investigation of the population is warranted to determine appropriate mitigation measures. 	

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
			<ul style="list-style-type: none"> Weed control and management requirements will be outlined in the Project CEMP. It will be the responsibility of the Contractor to manage and treat weed outbreaks in the Project area during construction. A population of Yellow-flowered King of the Fairies (<i>Oberonia complanata</i>) occurs in Section 8. 18 individuals have been confirmed as occurring inside the construction footprint and will be directly impacted. Another population of 7 individuals occurs within 20m of the construction footprint and will be retained as in-situ populations.
Environment Protection Authority			
EPA1	2.3	It is unclear what is proposed for sect 4/ wave 3 with respect to <i>E. robur</i> . The implication is that all specimens in section 4 that are also part of wave 3 have been tested genetically and determined to be hybrids (except 1)? but the other parts of section 4 (in the south?) and not part of wave 3 works are not to be genetically tested, and treated conservatively, as all being potentially <i>E. robur</i> ? If this is correct then 2.5.2 needs to be clarified, as it implies that all <i>Angophora</i> in sect 4 are being treated as potential <i>E. robur</i>	Section 2.5.2 has been updated to state: "Due to the large number of potential Rough-barked Apple (<i>Angophora robur</i>) in the Project area, and the complexity and lengthy timeframes associated with genetic testing, Roads and Maritime are proposing to take a conservative approach and have assumed all potential Rough-barked Apple (<i>Angophora robur</i>) as being Rough-barked Apple (<i>Angophora robur</i>), other than species where genetic testing has confirmed otherwise".
EPA2	2.3	The soft soil works are now proposed as 4 waves. Will RMS incorporate/update this and its ramifications to the TFMP?	The first version of the TFMP addressed Sections 1 and 2 and soft soil works. At that time there were 3 waves proposed. Amendments have been made by Roads and Maritime and Wave 2 has now been split into two separate waves. This change has not resulted in any change to potential impacts on threatened flora. As the TFMP has been updated to include all sections of the Project (including soft soil works), and there is no change to threatened flora no further amendments are required to the TFMP. Roads and Maritime will update the Staging Report to reflect the four waves and the extent of those waves.
EPA3	5.3.4	Seed collection/propagation. Is there some way to track this? It is a good policy that may get lost in the rest of works.	Seed collection and propagation and timing of relevant actions will be outlined in the applicable Translocation Strategy. Progress will be tracked by Roads and Maritime and audited through regular reporting by contractors involved.
EPA4	5.3.5/6.4	Exclusion zones: The EPA supports a hold point on these. Meaning they are to be under the control of Project EM or Environment Officers only. Fencing/access/removing fencing etc. all to be signed off by above only	The hold point related to the establishment of exclusion zones will be provided in the Project CEMP with responsibilities for their control/management noted within.
EPA5	General	Within the technical reports (appendix D) are many suggestions/recommendations that don't appear to be addressed anywhere. Additionally there are often areas that have remained unsurveyed due to landowner issues. These have obvious relevance to Biodiversity Offset calculations as well as this management plan and need to be undertaken	An update on the recommendations of the technical reports is provided against comment DPE 11.

ID No	Chapter or Section	Comment / Recommendation	How recommendation has been addressed (Version 3)
		and results incorporated. Of particular relevance is the unsurveyed areas of sect 1 (13.99ha) as clearing has commenced and is well progressed already.	

Appendix B – Dr Andrew Benwell CV

CURRICULUM VITAE

Name: Andrew Samuel Benwell

Date of Birth: 11.1.55

Residential Address: 3 Short Street New Brighton NSW 2483

Postal Address: PO Box 641 Mullumbimby NSW 2482

Telephone: 0266 804817

Email: andrewbenwell@bigpond.com

Qualifications

Diploma of Horticulture

Victorian College of Agriculture and Horticulture, Burnley 1978

Bachelor of Arts with Honours (Biogeography)

Department of Geography and Planning, University of New England 1995

Doctor of Philosophy (Plant Ecology)

University of New England 2004

Selected Project Experience

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

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

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

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

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

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

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

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

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

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

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

Translocation Plan, implementation and monitoring for the threatened species Rough-shelled Bush Nut (*Macadamia tetraphylla*), Arrow-head Vine (*Tinospora tinoporoides*) and Ball Nut (*Floydia praealta*), for the Ballina Bypass Alliance. 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 (Dorrroughby), 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 – Location of threatened plants in proximity to the project

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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans LEGEND LOCATION DIAGRAM

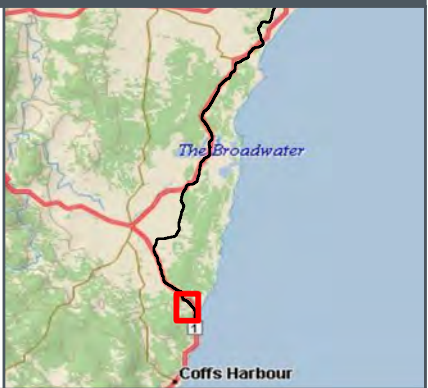
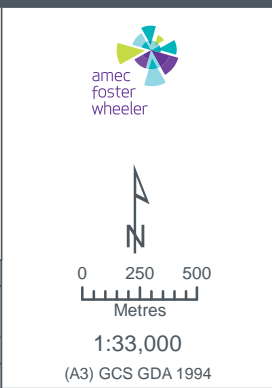
Appendix C

Project Sections and Soft Soil Work Areas

WORK REQUEST NUMBER: RMS

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

<div><div>○ Chainage (metres)</div><div>— Alignment</div><div>▭ Section boundary</div></div>						
ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE	
26/03/2015	JH	NG	BE	0	Issued for Use	
24/03/2015	JH	NG	BE	A	Issued for Review	



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Legend

Cyperus aquatilis

Eleocharis tetraquetra

Eucalyptus tetrapleura

Lindernia alsinoides

Lindsaea incisa

Maundia triglochinos

Olax angulata

Angophora subvelutina

Cyperus aquatilis

Eleocharis tetraquetra

Eucalyptus tetrapleura

Lindsaea incisa

Maundia triglochinos

ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

LEGEND

LOCATION DIAGRAM

Appendix C

Project Sections and Soft Soil Work Areas

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia
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○ Chainage (metres)

— Alignment

□ Section boundary

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
26/03/2015	JH	NG	BE	0	Issued for Use
24/03/2015	JH	NG	BE	A	Issued for Review

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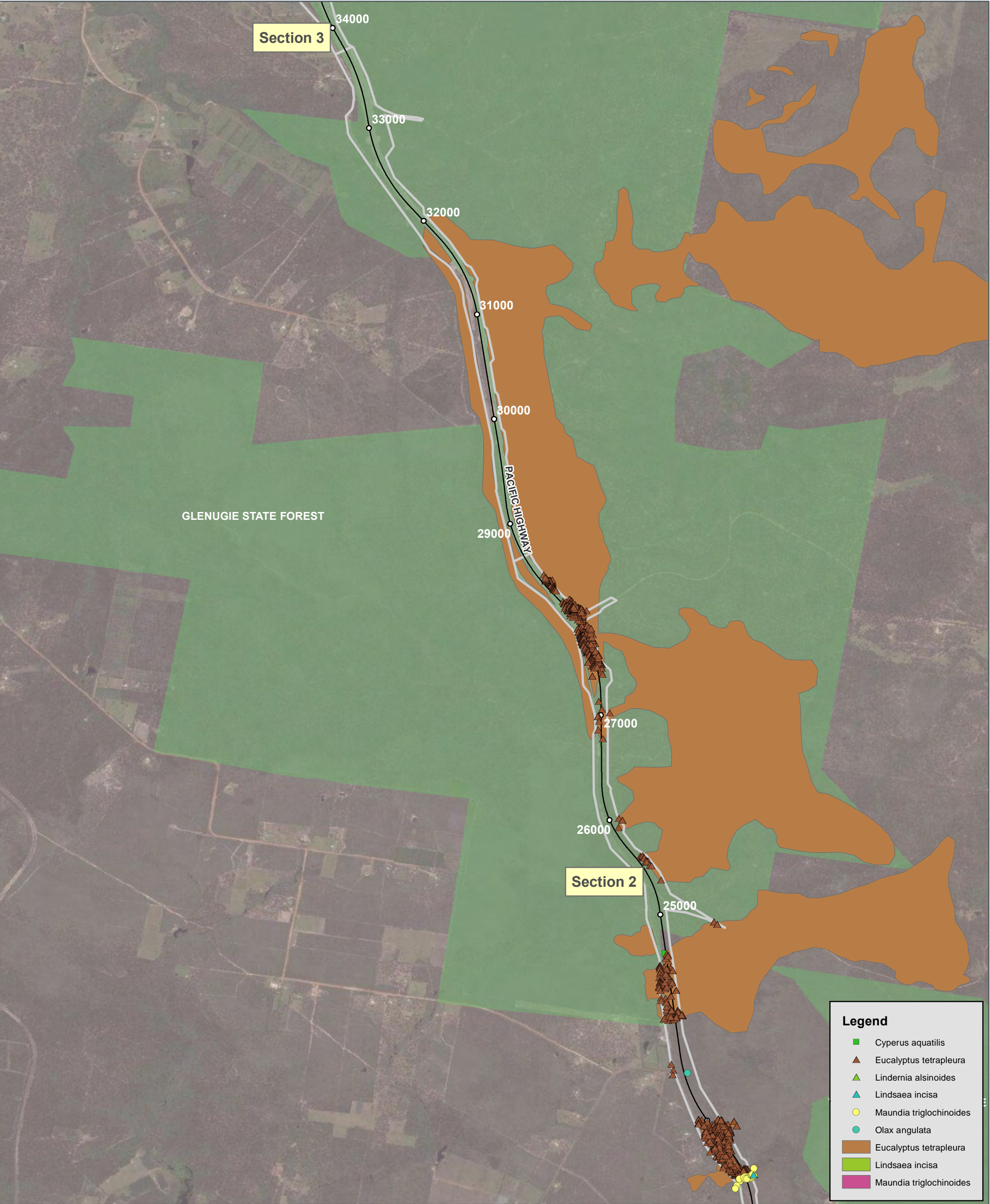
(A3) GCS GDA 1994

The Broadwater

Coffs Harbour

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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

LEGEND

LOCATION DIAGRAM

Appendix C

Project Sections and Soft Soil Work Areas

WORK REQUEST NUMBER: RMS

DATA SOURCES:
Topographic Vector Series 3 © Commonwealth of Australia
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○ Chainage (metres)

— Alignment

□ Section boundary

ISSUE DATE	AUTHOR	QA CHECK	APPROVED	MAP REV.	REVISION NOTE
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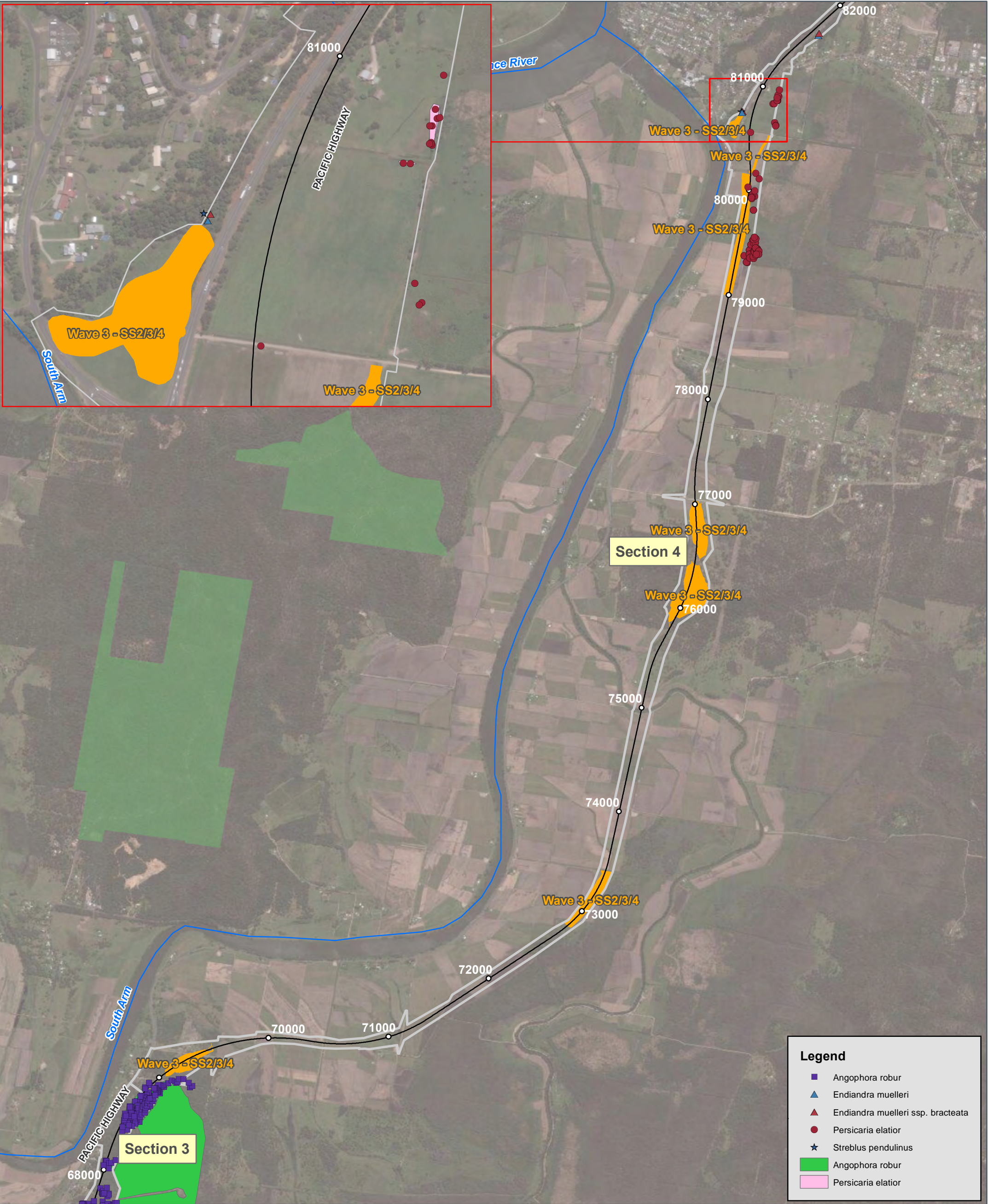
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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

LEGEND

LOCATION DIAGRAM

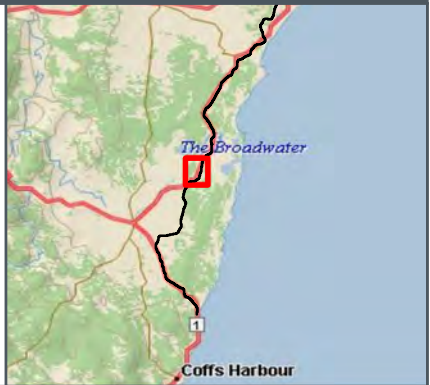
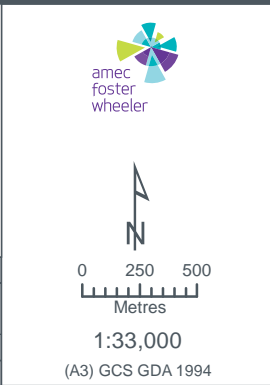
Appendix C

Project Sections and Soft Soil Work Areas

WORK REQUEST NUMBER: RMS

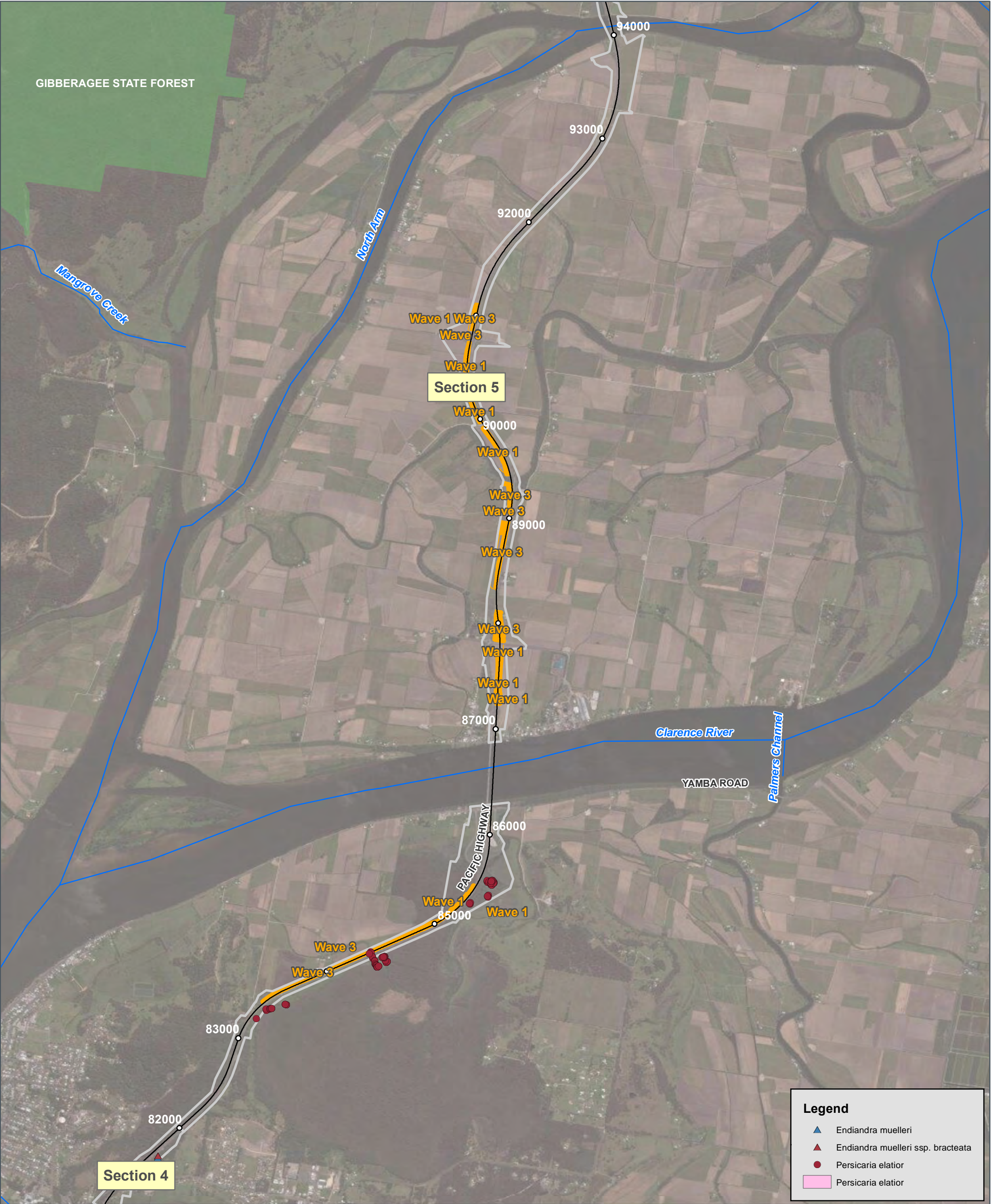
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Chainage (metres)						
Alignment						
Section boundary						
Soft soil work area						
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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

LEGEND

LOCATION DIAGRAM

Appendix C

Project Sections and Soft Soil Work Areas

WORK REQUEST NUMBER: RMS

DATA SOURCES:
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Chainage (metres)

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Alignment

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Section boundary

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Soft soil work area

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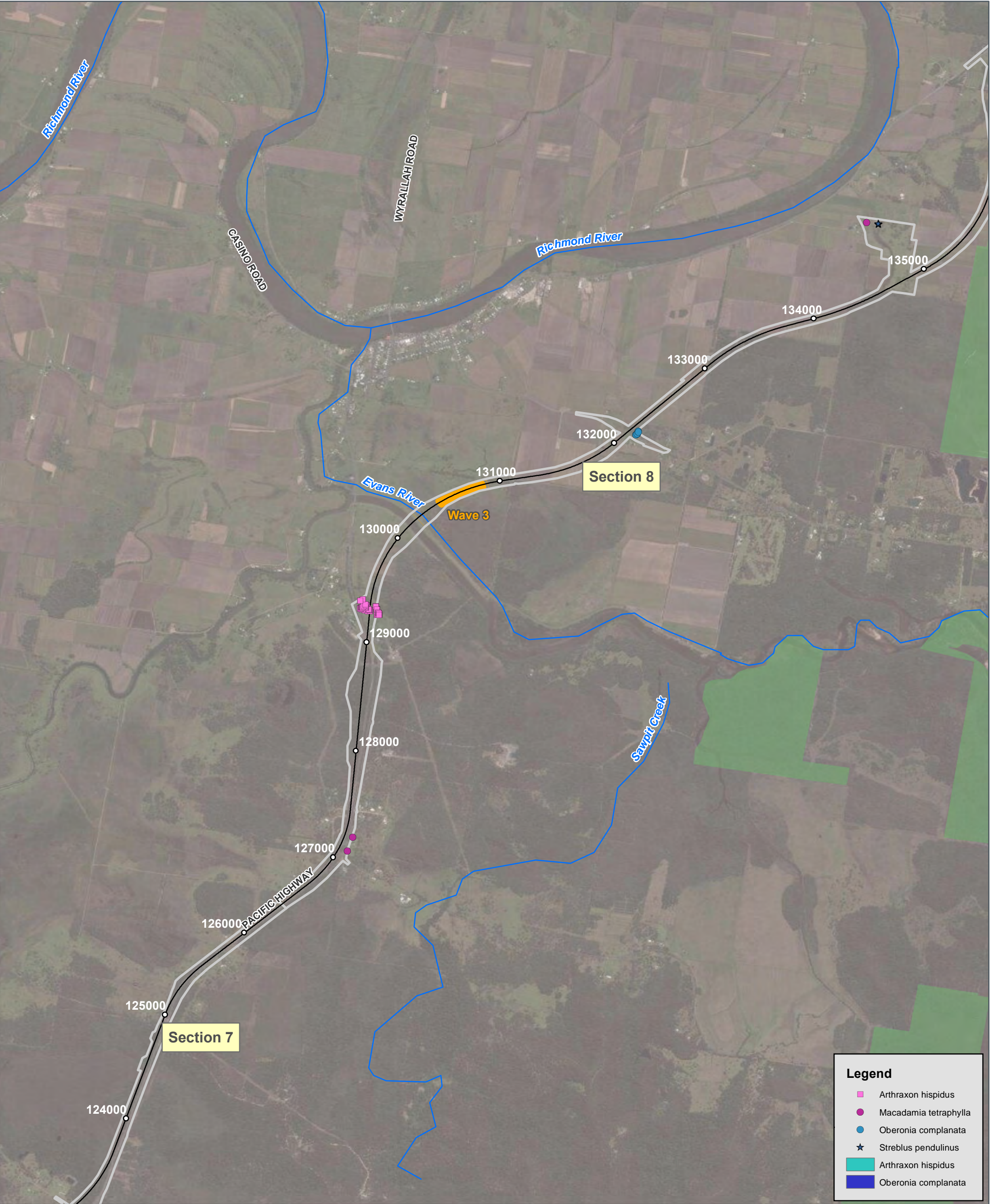
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ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

LEGEND

LOCATION DIAGRAM

Appendix C

Project Sections and Soft Soil Work Areas

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DATA SOURCES:
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○ Chainage (metres)

— Alignment

▭ Section boundary

▭ Soft soil work area

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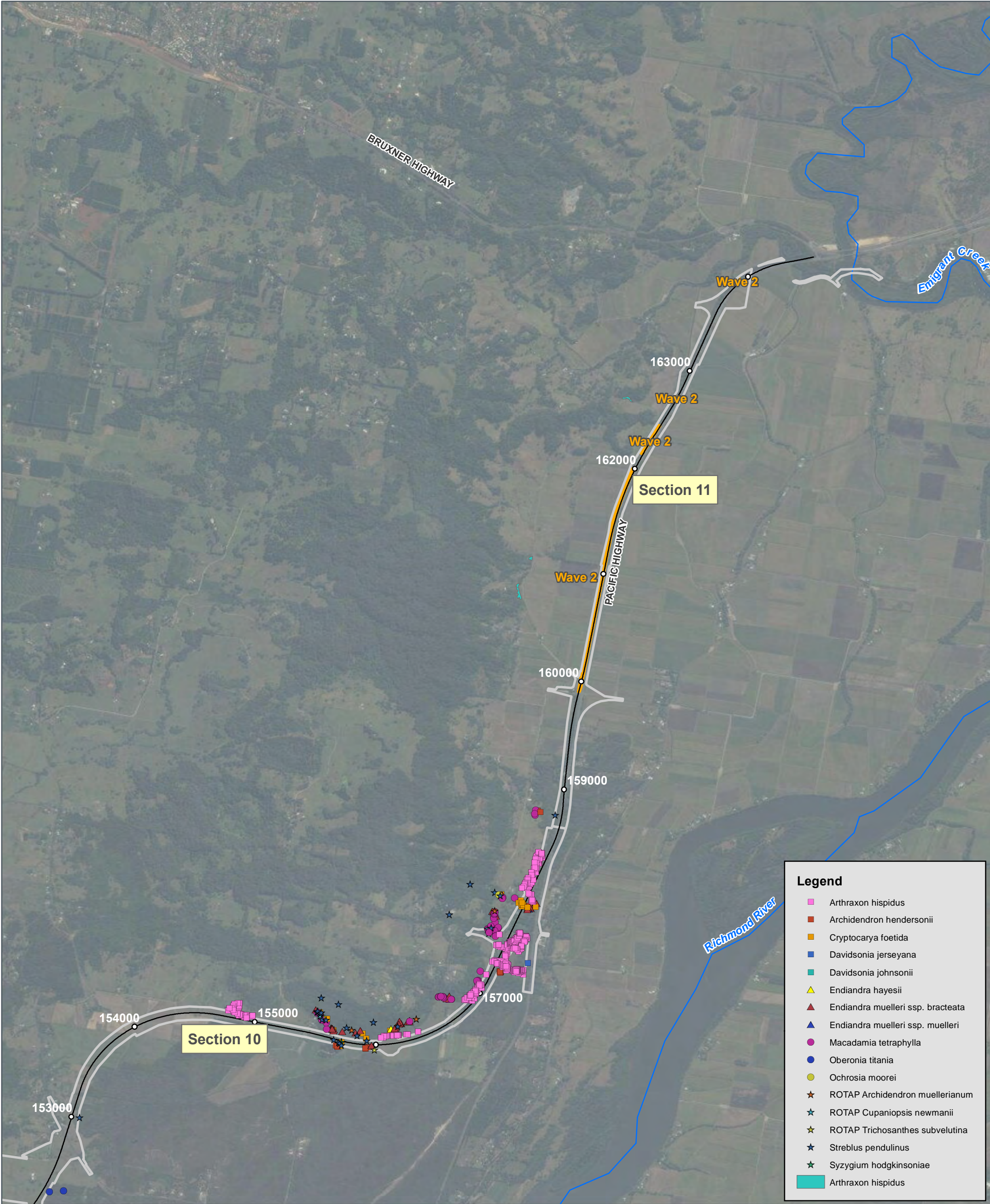
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- Legend**
- Arthraxon hispidus
 - Archidendron hendersonii
 - Cryptocarya foetida
 - Davidsonia jerseyana
 - Davidsonia johnsonii
 - Endiandra hayesii
 - Endiandra muelleri ssp. bracteata
 - Endiandra muelleri ssp. muelleri
 - Macadamia tetraphylla
 - Oberonia titania
 - Ochrosia moorei
 - ROTAP Archidendron muellerianum
 - ROTAP Cupaniopsis newmanii
 - ROTAP Trichosanthes subvelutina
 - Streblus pendulinus
 - Syzygium hodgkinsoniae
 - Arthraxon hispidus

ROADS & MARITIME SERVICES - 651570 - W2B Species Management Plans

LEGEND

LOCATION DIAGRAM

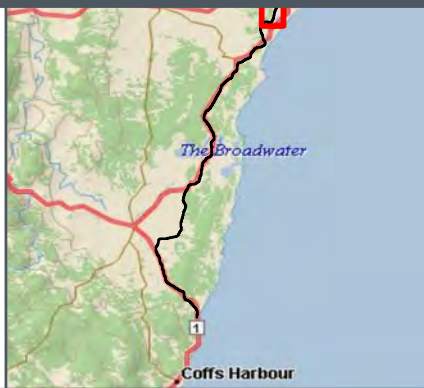
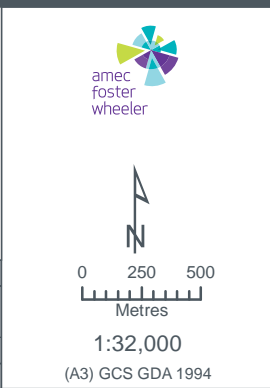
Appendix C

Project Sections and Soft Soil Work Areas

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Chainage (metres)						
Alignment						
Section boundary						
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Appendix D – Technical reports

Woolgoolga to Ballina Pacific Highway Upgrades

NSW ROADS AND MARITIME SERVICES

Threatened Flora Pre-construction Surveys

Rev02

13.2544.0919

08 October 2014



JACOBS®

Woolgoolga to Ballina Pacific Highway Upgrades Threatened Flora Pre-construction Surveys

Project no: EN04383
Document title: Threatened Flora Pre-construction Surveys
Document no: Document No.
Revision: Rev01
Date: 30 May 2014
Client name: NSW Roads and Maritime Services
Client no: 13.2544.0919
Project manager: Andrew Carty
Author: Andrew Carty
File name: I:\ENVR\Projects\EN04383\Deliverables\Reports\Jacobs_W2B_ThreatFloraBaselineSurveys_DRAFT_25July2014.docx

Sinclair Knight Merz Pty Ltd (Jacobs)
ABN 37 001 024 095
Level 5, 33 King William Street
Adelaide SA 5000 Australia
PO Box 8291
T +61 8 8424 3800
F +61 8 8424 3810
www.jacobs.com

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Document history and status

Revision	Date	Description	By	Approved
1	18/07/2014	Practice and Quality	C.Thomson	A.Carty

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4.	Conclusions and recommendations	17
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Appendix A. Threatened Flora and Monitoring Locations (Figures)**Appendix B. Threatened Flora Monitoring Baseline Data****Appendix C. Threatened Flora Monitoring Proforma**

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to undertake targeted surveys and baseline monitoring of threatened flora species potentially impacted by the Woolgoolga to Ballina Pacific Highway upgrades in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

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1. Introduction

1.1 Background

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

Eighteen non-rainforest threatened flora species have been identified in the project area (refer to Table 2-1), and three threatened rainforest flora species have been identified outside of Section 10 which have also been included in the threatened flora pre-construction surveys. Seventeen of these species have been addressed by the Woolgoolga to Ballina EIS and associated Threatened Flora Management Strategy, and an additional four species were identified during the targeted surveys for this project. Each of these species is the focus of the monitoring program.

Roads and Maritime engaged Jacobs to undertake the threatened flora targeted surveys and baseline monitoring to satisfy the preconstruction survey requirements for the threatened flora as specified in the draft Threatened Flora Management Plan. Targeted surveys are primarily to be undertaken to collect baseline data to inform ongoing monitoring, confirm location and number of threatened plants within the project, mark plants within and surrounding the project and to inform the development of a translocation strategy. These surveys are necessary to enable the commencement of preparation works at various locations along the Woolgoolga to Ballina Pacific Highway upgrade.

The W2B Threatened Flora Management Plan (Roads and Maritime Services 2013b) identifies management and monitoring objectives for threatened plant species listed under the EPBC Act and NSW *Threatened Species Conservation Act 1995* (TSC Act) which were considered to be directly impacted or at greatest risk from the project. This plan does not include threatened rainforest plant species which are addressed in the *Rainforest Communities and Threatened Rainforest Plants Management Plan*. This plan identifies the proposed mitigation measures to be implemented for threatened plants and a program for monitoring the effectiveness of these measures. The plan provides:

- A summary of the locations where threatened plants have been identified and would be impacted by the project and the extent of that impact.
- Details of further targeted surveys that are required for some species, to specify the exact locations and numbers of threatened plants potentially impacted.
- A description of the management and mitigation measures that would be implemented pre- construction, during construction and during operation, to ensure the protection of *in-situ* threatened flora.
- A description of corrective actions to be used, should mitigation measures not be implemented successfully.
 - Reference to, and contents for, the design of a detailed translocation strategy for impacted threatened plants, where translocation could be considered to be a feasible management option.

1.2 Aims and objectives

The W2B Threatened Flora Management Plan (the Plan) aims to address the impacts of the upgrade and proposed mitigation measures on threatened flora populations. A critical objective of the Plan is to determine monitoring requirements to measure the effectiveness of the proposed mitigation measures and provide adaptive management actions where required. To achieve the objectives of the Plan, a valid and adaptable approach to targeted surveys and monitoring is required, this will require surveys to be conducted pre-construction, during construction and post-construction using performance criteria and an adaptive management approach.

The Plan identifies monitoring would provide reliable information such that sound conclusions can be drawn in relation to the management of threatened plants. The overall monitoring objectives include evaluating the success of the mitigation measures and to further understand the propagation and translocation requirements of individual threatened plants. The Plan includes an adaptive management approach based on firstly identifying specific goals for management, implementation of management actions followed by monitoring of the performance of these measures against the goals and identified thresholds. As a final step the monitoring would evaluate the effectiveness of the management measures using identified thresholds for performance and implementing corrective actions to improve mitigation where required. To ensure the success of this approach the management goals presented in the plan were based on the following SMART principles:

- **Specific.**
- **Measurable.**
- **Achievable.**
- **Results-based.**
- **Time-based.**

This report details the results of the stage 1 pre-construction surveys for threatened flora populations (non-rainforest species). The surveys aimed to refine and record the distribution and abundance of threatened flora populations within and adjacent to the proposed project clearing boundary to provide a baseline for monitoring potential impacts during construction and operation of the project. The aim of the baseline surveys comprised two main components 1) conduct targeted surveys to identify, mark and map the threatened flora populations adjacent to the corridor reporting on baseline population and habitat condition; and 2) establish permanent sites for ongoing monitoring during construction and operation. The following objectives were implemented to achieve these aims:

- Where practical mark individual plants in and adjacent to the project boundary and collect geographic coordinates (GPS waypoints) to assist on-ground identification of threatened flora for detailed survey and management purposes.
- Ground-truth and build on existing detailed data collected for the EIA and provide accurate mapping of the distribution and abundance of threatened flora species within and adjacent to the project construction corridor.
- Undertake targeted surveys for additional flora species or populations considered to potentially occur.
- Establish *in-situ* monitoring locations for each species/population adjacent to the project clearing boundary and collect pre-construction baseline data to be used as a basis for ongoing monitoring during construction and operation.
- Establish control monitoring locations for each species/population where practical in areas of habitat greater than 50 metres from the project boundary where there has been limited disturbance and are there are minimal existing threatening processes.

This report represents the first in the development of the threatened flora monitoring program. Future reports will address ongoing monitoring of potential impacts to threatened flora to measure performance during construction and operation as part of the adaptive management program.

2. Methodology

2.1 Background

The threatened flora species listed in Table 2-1 occur in a variety of different habitats across the entire project area, with some species occurring as several disjunct sub-populations in different project sections. These species were subject to targeted surveys and baseline monitoring during the field surveys conducted between the 18 March 2014 and 7 May 2014, and 1-5 September 2014.

Table 2-1 Threatened plant species targeted in the pre-construction (baseline) surveys

Species	Common name	Status EPBC Act	Status TSC Act	Project section where surveys undertaken
<i>Angophora robur</i>	Sandstone Rough Barked Apple	V	V	3
<i>Arthraxon hispidus</i>	Hairy Joint Grass	V	V	8, 9, 10
<i>Cyperus aquatilis</i>	Water Nutgrass	-	E	1, 2, 3, 6, 7
<i>Eleocharis tetraquetra</i>	Square-stemmed Spike-rush	-	E	1, 2, 3
<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	Green-leaved Rose Walnut	-	E	4
<i>Eucalyptus tetrapleura</i>	Square-fruited Ironbark	V	V	2
<i>Grevillea quadricauda</i>	Four-tailed Grevillea	V	V	3
<i>Lindernia alsinoides</i>	-	-	E	1, 2, 3
<i>Lindsaea incisa</i>	Slender Screw Fern	-	E	1, 2, 3, 6
<i>Macadamia tetraphylla</i>	Rough-shelled Bush Nut	V	V	7, 8
<i>Maundia triglochinosoides</i>	-	-	V	1, 2, 3, 6, 7
<i>Melaleuca irbyana</i>	Weeping Paperbark	-	E	7
<i>Oberonia complanata</i>	-	-	E	8
<i>Oberonia titania</i>	-	-	V	10
<i>Olx angulata</i>	Square-stemmed Olx	-	V	2
<i>Persicaria elatior</i>	Tall Knotweed	V	V	4, 5
<i>Phaius australis</i>	Southern Swamp Orchid	E	E	9
<i>Prostanthera cineolifera</i>	Singleton Mint Bush	V	V	6
<i>Quassia</i> sp. <i>Moonee Creek</i>	Moonee Quassia	E	E	1, 3
<i>Rotala tripartita</i>	-	-	E	6
<i>Streblus pendulinus</i>	Siah's Backbone	E	-	4, 8

Note: E – endangered and V- vulnerable.

The methodology comprised two main components, comprising:

- Targeted surveys, including recording GPS locations and physically marking plants in the field in and directly surrounding the clearing boundary.
- Collection of baseline data, including the establishment of permanent monitoring locations to be used for ongoing monitoring during construction and operation.

2.2 Timing and conditions

Field surveys were conducted over a five-week period in autumn 2014 (between the 18 March 2014 and 7 May 2014) and a single week in early spring (1-5 September 2014). The timing of the surveys (autumn) was relatively sufficient for identifying the majority of threatened flora species in the study area, with the presence of

aquatic/wetland species being more dependent on preceding climatic conditions. Only one species could not be relocated during the surveys (*Cyperus aquatilis*) and some species were in relatively poor condition and low abundance (*Rotala tripartita*). During surveys in early spring several species were found to have died back due to the dry and cold conditions experienced over winter including *Arthraxon hispidus* in Section 8, *Persicaria elatior* in Section 4 and *Eleocharis tetraquetra* in Section 1.

The climate conditions (rainfall and temperature) within the study area at the time of the survey period is an important component of the threatened flora monitoring considering the high number of threatened flora species occurring in permanent and ephemeral wetland habitats. The health, distribution and abundance of these wetland species are closely associated with the preceding climate conditions. The health and condition of larger shrubs and trees growing in drier habitats is also closely associated with climatic conditions, however large fluctuations in distribution and abundance are not expected. The rainfall received (from north to south) at Coffs Harbour, Grafton, Yamba Evans Head and Ballina between January 2014 and August 2014 is illustrated in Figure 2-1.

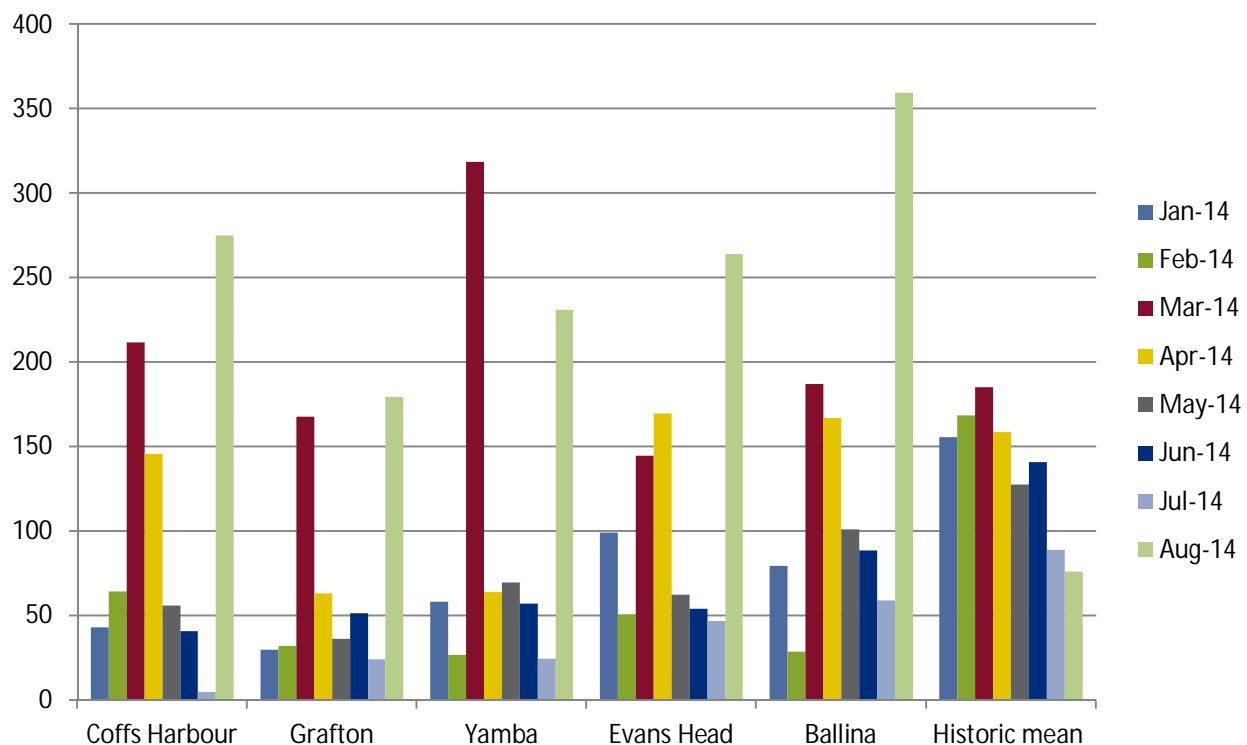


Figure 2-1: Monthly rainfall totals (mm) recorded in the study area (2014) and the historic mean (averaged across all locations). Source: BOM 2014.

The rainfall received at these points (Figure 2-1) along the study area was reviewed prior to and during surveys being undertaken so surveys could be undertaken during optimal wetter conditions (ie following favourable rainfall in March). Reconnaissance of some areas was undertaken to observe ground conditions and if conditions were poor than these were revisited where possible. As can be seen in Figure 2-1 rainfall was below average in the study area during summer (Jan-Feb) followed by above average or average rainfall during the survey period (March and April). As can be seen in Figure 2-1 rainfall was below average in the study area during late autumn and winter (May-July) followed by above average rainfall in August preceding the second survey period at the start of September 2014. Cold temperatures were also experienced in some areas of the study area over winter with frosts recorded in several areas and evidence of frost-related dieback.

2.3 Targeted surveys

Targeted surveys were conducted within the vicinity of known locations of threatened flora populations as well as other areas of suitable habitat where threatened flora could potentially occur. In particular, areas of suitable habitat for cryptic threatened flora species that are only detectable during suitable climatic and seasonal conditions were targeted, including *Lindsaea incisa*, *Cyperus aquatilis*, *Arthraxon hispidus*, *Rotala tripartita*, *Lindernia alsinoides*, *Persicaria elatior* and *Maundia triglochinoides*. The list of threatened flora species and populations that were targeted are shown in Table 2.1.

Where practical to do so, threatened flora populations were physically flagged in and adjacent to the project boundary. Flagging tape was used to identify individual plants and/or the boundaries of populations, and surveyors spray paint was used to mark larger trees (ie *Eucalyptus tetrapleura*). The geographic coordinates of plants was recorded using a Trimble Yuma handheld GPS with ArcPad software, as was data on the abundance of plants and where relevant health attributes and dimensions of the plants. Standard hand-held GPS units were also used to waypoint threatened flora.

The data collected in the field was then collated into a spatial database for each threatened flora species in or adjacent to the project boundary to inform detailed design and construction and the ongoing monitoring of plant health and performance during construction. Observations of threatened rainforest flora were also made and referred to the Roads and Maritime for inclusion in the threatened rainforest flora monitoring program.

2.4 Monitoring locations and methodology

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. Control monitoring plots were also established for each species/population where possible greater than 50 metres from the project clearing boundary. The baseline surveys are consistent with the methods described in the Plan and the brief. The locations of monitoring locations are mapped in Appendix A.

A total of 82 monitoring locations were established which covers 92 threatened flora occurrences, with some plots supporting two or three threatened species. The placement of monitoring locations were approximated prior to field surveys based on a range of factors including:

- The location and distribution of threatened flora populations relative to the clearing boundary, with *in situ* plots established in retained threatened populations adjacent to the clearing boundary and control plots established greater than 50 metres from the clearing boundary and preferentially upstream/upslope remote from potential impacts.
- Land tenure, within *in situ* plots established within the project boundary but outside of the clearing boundary where possible and control plots were established where possible on land currently owned by Roads and Maritime, as well as state forests, flora reserves and crown land to due access permissions on these lands.
- The distribution and abundance of threatened flora populations along the project corridor, with small populations (ie *Oberonia titania*) or spatially restricted populations (ie *Prostanthera cineolifera*) requiring only one or two monitoring locations, and larger populations occurring over a large area (ie *Angophora robur*) or occurring as several widely disjunct populations (ie *Maundia triglochinoides*, *Lindsaea incisa*) requiring a greater number of monitoring locations along the length of the specie's distribution.
- 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, with smaller wetland species potentially more susceptible to indirect impacts and climatic/seasonal conditions having 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.

- Areas downslope of the construction corridor and other areas where habitat changes are likely to occur from indirect impacts were also targeted particularly for larger trees (ie *Angophora robur*, *Eucalyptus tetrapleura*).
- Several threatened flora populations surveyed in early spring were found to have died back, however monitoring locations were still established within these populations for future assessment.

A 20 x 20 metre plot size with a central 20 metre transect was used at each site (refer Figure 2-2). Where possible transects were aligned from north to south and a photograph point established at the northern end of the transect (refer to Figure 2-2) facing away from direct sunlight to the north. GPS locations at the start and end point of the transect were recorded and marked in the field using double flagging tape tied to the nearest tree in forested areas, and in grassland areas metal star pickets were used to indicate the location of the plot area. A tape measure was laid out along transects to indicate the boundaries of the plot area, record vegetation cover and to use as a reference for plant locations.

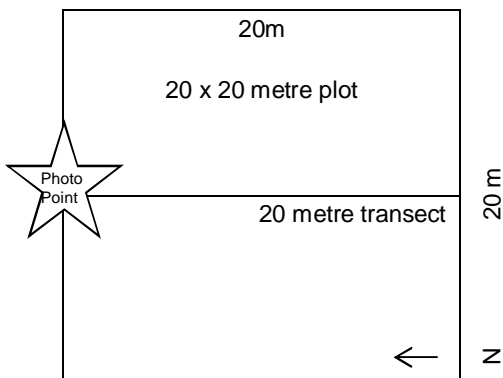


Figure 2-2: Plot layout used for each of the monitoring locations

Field pro-forma (refer to Appendix C) were developed for the collection of data. This included quantitative measurements and qualitative descriptors which provide a summary of plant health and habitat condition factors to be recorded. Individuals and/or clusters of threatened flora within the 20 x 20 metre plot area were identified in the field and assigned a unique code and flagged wherever practical. Plant health attributes for each individual/cluster were recorded including distribution and abundance, leaf condition, dieback, insect attack, height, width, diameter at breast height (DBH), number of trunks and habitat conditions. Photographs of individual plants/clusters were also taken and photograph numbers recorded. Refer to Appendix B for an example of the data and information collected at each monitoring location.

Habitat condition parameters recorded were consistent with the methods identified in the Plan (Roads and Maritime Services 2013b), including but not limited to:

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

Other information recorded included dominant flora species in each structural layer, prevailing site conditions and (ie soil moisture, climate, and water levels and flow) and landscape parameters (ie landform, drainage, slope and aspect). The cover of vegetation layers was recorded using the central 20 metre transect (refer to Figure 2-2) with the canopy and midstorey (greater than one metre high) cover was recorded as percentage foliage cover every five metres (four points) along the transect and groundcover attributes were recorded at every metre (20 points) as either forb, grass, shrub (less than one metre high), bare/water, litter or exotic. The central transect was also used to describe the distribution of threatened flora within the plot.

Numerous photographs were taken at each location including photographs of the plot area, individual plants and/or clusters of plants, insect attack, dieback and habitat conditions. For some monitoring locations a rough diagram was used to indicate the presence of threatened flora within the plot area, as well as other prominent features to assist with repeatability.

3. Results

3.1 Monitoring locations

A total of 82 monitoring locations were established which covers 92 threatened flora occurrences, with some plots supporting two or three threatened species. The number of plots undertaken for each species is summarised in Table 3-1, comprising in total 23 control plots and 69 *in situ* plots. The location of monitoring locations and threatened flora populations is shown in Appendix A and the full results of the baseline monitoring are provided in Appendix B.

Table 3-1 Monitoring locations established

Species	Section	In situ	Control	Total
<i>Angophora robur</i>	3	11	2	13
<i>Arthraxon hispidus</i>	10	7	2	8
<i>Eleocharis tetraquetra</i>	1	5	2	6
<i>Endiandra muelleri</i> subsp <i>bracteata</i>	4	2	0	2
<i>Eucalyptus tetrapleura</i>	2	3	1	4
<i>Grevillea quadricauda</i>	3	1	1	2
<i>Lindernia alsinoides</i>	1, 2	4	3	7
<i>Lindsaea incisa</i>	1, 2, 3, 6	7	2	9
<i>Macadamia tetraphylla</i>	8	1	0	1
<i>Maundia triglochinosoides</i>	1, 2, 3, 7	13	4	17
<i>Melaleuca irbyana</i>	7	2	1	3
<i>Oberonia complanata</i>	8	1	0	1
<i>Oberonia titania</i>	10	1	1	2
<i>Persicaria elatior</i>	4, 5	4	1	4
<i>Phaius australis</i>	9	1	0	1
<i>Prostanthera cineolifera</i>	6	2	1	3
<i>Quassia</i> sp. Moonee Creek	1	2	2	4
<i>Streblus pendulinus</i>	4, 8	2	0	2
Total		69	23	89

The results of the baseline monitoring are summarised in Table 3-2, and the full results including plot attributes, location, habitat conditions and a selection of photographs is provided for each location in Appendix B.

Table 3-2 Details of monitoring location, status, and abundance of threatened species in the plot

Species	ID Code	Section	Type	Abundance	Side of project	Location
<i>Angophora robur</i>	Ar-3.1	3	In situ	7 trees	North	West of Woolli Road, Pillar Valley
<i>Angophora robur</i>	Ar-C3.1	3	Control	6 trees,	North	West of Woolli Road, Pillar Valley
<i>Angophora robur</i>	Ar-3.2	3	In situ	18 plants	East	Mitchell Road intersection, Pillar Valley
<i>Angophora robur</i>	Ar-3.3	3	In situ	17 plants	West	North of the Mitchell Road, Pillar Valley
<i>Angophora robur</i>	Ar-3.4	3	In situ	30 plants	East	North of the Mitchell Road, Pillar Valley
<i>Angophora robur</i>	Ar-3.5	3	In situ	13 plants	West	South of Chaffin Creek, Tucabia
<i>Angophora robur</i>	Ar-3.6	3	In situ	10 plants	East	North of Bostock Road, Tucabia
<i>Angophora robur</i>	Ar-3.7	3	In situ	36 plants	West	North of Tallowwood Lane, Tucabia

Species	ID Code	Section	Type	Abundance	Side of project	Location
<i>Angophora robur</i>	Ar-3.8	3	In situ	9 trees	West	Pine Brush State Forest, Pillar Valley
<i>Angophora robur</i>	Ar-C3.2	3	Control	7 trees	East	Crown Land, Tyndale
<i>Angophora robur</i>	Ar-3.9	3	In situ	12 plants	West	North of Pine Brush State Forest, Tyndale
<i>Angophora robur</i>	Ar-3.10	3	In situ	20 plants	West	Bensons Lane, Tyndale
<i>Angophora robur</i>	Ar-3.11	3	In situ	3 trees	East	North of Bensons Lane, Tyndale
<i>Arthraxon hispidus</i>	Ah-8.1	8	In situ	dead	East	North of the Gap Road, Trustums Hill
<i>Arthraxon hispidus</i>	Ah-10.1	10	In situ	Low	North	Near fauna overpass, Coolgardie
<i>Arthraxon hispidus</i>	Ah-10.2	10	In situ	High	West	North of Kay's Road, Coolgardie
<i>Arthraxon hispidus</i>	Ah-C10.1	10	Control	High	East	Kay's Road Intersection, Coolgardie
<i>Arthraxon hispidus</i>	Ah-10.3	10	In situ	Low	East	West of Kay's Road, Coolgardie
<i>Arthraxon hispidus</i>	Ah-10.4	10	In situ	Moderate	East	West of Kay's Road, Coolgardie
<i>Arthraxon hispidus</i>	Ah-C10.2	10	Control	High	East	West of Kay's Road, Coolgardie
<i>Arthraxon hispidus</i>	Ah10.5	10	In situ	Moderate	East	West of Kay's Road, Coolgardie
<i>Arthraxon hispidus</i>	Ah10.6	10	In situ	Moderate	East	North of Coolgardie Road, Coolgardie
<i>Eleocharis tetraquetra</i>	Elt-1.1	1	In situ	Low-Moderate	East	Redbank Creek, Corindi Beach
<i>Eleocharis tetraquetra</i>	Elt-1.2	1	In situ	Low	East	North of Redbank Creek, Corindi Beach
<i>Eleocharis tetraquetra</i>	Elt-C1.1	1	Control	Low	East	North of Redbank Creek, Corindi Beach
<i>Eleocharis tetraquetra</i>	Elt-C1.2	1	Control	Moderate-High	West	North of Redbank Creek, Corindi Beach
<i>Eleocharis tetraquetra</i>	Elt-1.3	1	In situ	Low	East	North of Redbank Creek, Corindi Beach
<i>Eleocharis tetraquetra</i>	Elt-1.4	1	In situ	Moderate-High	West	North of Redbank Creek, Corindi Beach
<i>Eleocharis tetraquetra</i>	Elt-1.5	1	In situ	dead	East	Northwest of Newfoundland Road
<i>Endiandra muelleri</i> subsp <i>bracteata</i>	Emb-4.1	4	In situ	1 plant	East	North of Schwonberg Street, Townsend
<i>Endiandra muelleri</i> subsp <i>bracteata</i>	Emb-4.2	4	In situ	1 plant	West	South of Jubilee Street, Maclean
<i>Eucalyptus tetrapleura</i>	Et-2.1	2	In situ	7 trees	East	Wells Crossing Flora Reserve
<i>Eucalyptus tetrapleura</i>	Et-2.2	2	In situ	9 trees	East	Wells Crossing Flora Reserve
<i>Eucalyptus tetrapleura</i>	Et-C2.1	2	Control	8 trees	East	Glenugie State Forest
<i>Eucalyptus tetrapleura</i>	Et-2.3	2	In situ	8 trees	East	Glenugie State Forest
<i>Grevillea quadricauda</i>	Gq-3.1	3	In situ	27 plants	East	North of Tallowwood Lane, Tucabia
<i>Grevillea quadricauda</i>	Gq-C3.1	3	Control	10 plants	East	North of Tallowwood Lane, Tucabia
<i>Lindernia alsinoides</i>	La-C1.1	1	Control	Low	East	On Redbank Creek, Corindi Beach
<i>Lindernia alsinoides</i>	La-1.1	1	In situ	Low	East	North of Redbank Creek, Corindi Beach
<i>Lindernia alsinoides</i>	La-C1.2	1	Control	Moderate	East	North of Redbank Creek, Corindi Beach
<i>Lindernia alsinoides</i>	La-1.2	1	In situ	Low	East	North of Redbank Creek, Corindi Beach
<i>Lindernia alsinoides</i>	La-C1.3	1	Control	High	West	North of Redbank Creek, Corindi Beach
<i>Lindernia alsinoides</i>	La-1.3	1	In situ	High	West	North of Redbank Creek, Corindi Beach
<i>Lindernia alsinoides</i>	La-2.1	2	In situ	Low	East	On Halfway Creek
<i>Lindsaea incisa</i>	Li-1.1	1	In situ	Moderate	East	Post Office Lane, Corindi Beach
<i>Lindsaea incisa</i>	Li-C2.1	2	Control	High-Moderate	West	Halfway Creek rest area
<i>Lindsaea incisa</i>	Li-2.1	2	In situ	High-Moderate	West	Halfway Creek rest area
<i>Lindsaea incisa</i>	Li-2.2	2	In situ	High-Moderate	East	On Halfway Creek
<i>Lindsaea incisa</i>	Li-3.1	3	In situ	Low-Moderate	East	North of Bostock Road, Tucabia
<i>Lindsaea incisa</i>	Li-3.2	3	In situ	High	West	North of Tallowwood Lane, Tucabia
<i>Lindsaea incisa</i>	Li-C6.1	6	Control	High	West	Mororo State Forest

Species	ID Code	Section	Type	Abundance	Side of project	Location
<i>Lindsaea incisa</i>	Li-6.1	6	In situ	Low-Moderate	West	Mororo State Forest
<i>Lindsaea incisa</i>	Li-6.2	6	In situ	Low	West	Mororo State Forest
<i>Macadamia tetraphylla</i>	Mac-8.1	8	In situ	1 plant	West	Lang Hill, Woodburn
<i>Maundia triglochinos</i>	Mt-1.1	1	In situ	Low	West	Post Office Lane, Corindi Beach
<i>Maundia triglochinos</i>	Mt-C1.1	1	Control	Low-Moderate	East	Post Office Lane, Corindi Beach
<i>Maundia triglochinos</i>	Mt-1.2	1	In situ	Low-Moderate	East	On Redbank Creek, Corindi Beach
<i>Maundia triglochinos</i>	Mt-C1.2	1	Control	Low	East	On Redbank Creek, Corindi Beach
<i>Maundia triglochinos</i>	Mt-C2.1	2	Control	Low-Moderate	East	On Halfway Creek
<i>Maundia triglochinos</i>	Mt-2.1	2	In situ	Low-Moderate	East	On Halfway Creek
<i>Maundia triglochinos</i>	Mt-2.2	2	In situ	Low-Moderate	West	Wells Crossing
<i>Maundia triglochinos</i>	Mt-2.3	2	In situ	Low-Moderate	East	Wells Crossing
<i>Maundia triglochinos</i>	Mt-2.4	2	In situ	Moderate-High	East	Wells Crossing
<i>Maundia triglochinos</i>	Mt-C2.2	2	Control	Moderate-High	East	Wells Crossing
<i>Maundia triglochinos</i>	Mt-3.1	3	In situ	Low	South	Coldstream River, Glenugie
<i>Maundia triglochinos</i>	Mt-3.2	3	In situ	Moderate-High	East	South of Bostock Road, Tucabia
<i>Maundia triglochinos</i>	Mt-C3.1	3	Control	Moderate	West	North of Tallowwood Lane, Tucabia
<i>Maundia triglochinos</i>	Mt-3.3	3	In situ	Low	West	North of Tallowwood Lane, Tucabia
<i>Maundia triglochinos</i>	Mt-7.1	7	In situ	High-Moderate	West	Tabbimoble Overflow 1
<i>Maundia triglochinos</i>	Mt-7.2	7	In situ	High	East	Tabbimoble Overflow 2
<i>Maundia triglochinos</i>	Mt-7.3	7	In situ	Moderate-High	East	Tabbimoble Overflow 2
<i>Melaleuca irbyana</i>	Mi-7.1	7	In situ	24 plants	West	New Italy
<i>Melaleuca irbyana</i>	Mi-C7.1	7	Control	8 plants	West	New Italy
<i>Melaleuca irbyana</i>	Mi-7.2	7	In situ	34 plants	West	New Italy
<i>Oberonia complanata</i>	Oc-8.1	8	In situ	22 plants	East	Evans Head Road, Woodburn
<i>Oberonia titania</i>	Ot-10.1	10	In situ	1 plant	East	Wardell Road, Wardell
<i>Oberonia titania</i>	Ot-C10.1	10	Control	17+ plants	East	Wardell Road, Wardell
<i>Persicaria elatior</i>	Pe-C4.1	4	Control	89 Plants	East	Maclean
<i>Persicaria elatior</i>	Pe-4.1	4	In situ	13 plants	East	Maclean
<i>Persicaria elatior</i>	Pe-4.2	4	In situ	dead	East	Maclean
<i>Persicaria elatior</i>	Pe-5.1	5	In situ	39 plants	East	Yaegl Nature Reserve
<i>Persicaria elatior</i>	Pe-5.2	5	In situ	9 plants	East	Yamba intersection
<i>Phaius australis</i>	Pa-9.1	9	In situ	18 plants	East	Broadwater National Park
<i>Prostanthera cineolifera</i>	Pc-6.1	6	In situ	20 plants	West	Tabbimoble Creek
<i>Prostanthera cineolifera</i>	Pc-6.2	6	In situ	23 plants	East	Tabbimoble Creek
<i>Prostanthera cineolifera</i>	Pc-C6.1	6	Control	34 plants	East	Tabbimoble Creek
<i>Quassia sp. Moonee Creek</i>	QM-C1.1	1	Control	19 stems	West	Dirty Creek
<i>Quassia sp. Moonee Creek</i>	QM-1.1	1	In situ	54 stems	West	Dirty Creek
<i>Quassia sp. Moonee Creek</i>	QM-C1.2	1	Control	26 stems	West	Dirty Creek
<i>Quassia sp. Moonee Creek</i>	QM-1.2	1	In situ	78 stems	West	Dirty Creek
<i>Streblus pendulinus</i>	Sp-4.1	4	In situ	1 plant	West	South of Jubilee Street, Maclean
<i>Streblus pendulinus</i>	Sp-8.1	8	In situ	3 plants	West	Lang Hill, Woodburn

The full results of the baseline monitoring are provided in Appendix B. Considering the below average rainfall preceding the monitoring surveys many of the aquatic and semi-aquatic species were in poor condition and/or were not present during the surveys. However some areas of the study area particularly in Section 1 had received higher rainfall and therefore had ideal conditions for aquatic and semi-aquatic species during the survey period, resulting in an abundance of healthy wetland flora particularly smaller species in ephemeral environments (ie *Lindsaea incisa*, *Lindernia alsinoides*, *Eleocharis tetraquetra*). During early spring some species had died back over winter (ie *Arthraxon hispidus*, *Persicaria elatior*, *Eleocharis tetraquetra*) with very dry and cold climatic conditions experienced across much of the study area. Monitoring locations were still established within these populations for future assessment.

3.2 Distribution and abundance of target species

The results of the targeted surveys are summarised in Table 3-3, and the location of threatened flora populations and targeted survey data collected for the project is mapped in Appendix A (Figure A-1 to Figure A-40) along with established monitoring locations. The distribution and abundance of threatened flora populations has been collated from recent and past data into a single spatial database including a polygon layer indicating threatened species distribution and a point layer including abundance data (refer to Appendix A).

Table 3-3 Summary of results of distribution and abundance of target species in and adjacent to the project area

Species (Figure reference Appendix A)	Results summary	Approximate abundance	
		Individuals in Clearing area (area)	Individuals in situ (20 m buffer) and area
<i>Angophora robur</i> (Figure A-12 to Figure A-23)	<ul style="list-style-type: none"> No major changes to previous surveys in terms of distribution and abundance. The abundance of trees within 20 to 40 metres of the majority of the alignment was also surveyed and added to the spatial database (Figure A-12 to A-23). Considering the large number of plants in and surrounding the clearing boundary it was impractical to mark plants in the field. 	6473 (93 ha)	2360 (43 ha)
<i>Arthraxon hispidus</i> (Figure A-34, Figure A-39 and Figure A-40)	<ul style="list-style-type: none"> Several additional polygons of the species were mapped in Section 10. Some previously mapped populations are not currently present most likely due to altered management regimes. Rainfall has been below average which is likely to have restricted the distribution of the species during the current survey period. The current distribution based on survey data collected has been mapped and added to the spatial database (Figure A-34, Figure A-39 and Figure A-40). Flagging tape was used to mark the presence of plants where possible (i.e. on fences, trees, shrubs). 	1.5 ha	1.61 ha
<i>Cyperus aquatilis</i> (Figure A-1, Figure A-27, Figure A-28, Figure A-30 and Figure A-31)	<ul style="list-style-type: none"> No individuals of this species were recorded despite targeted surveys in areas of suitable habitat in a range of climatic conditions over the survey period. Specimens of all <i>Cyperus</i> species were collected for later identification with many specimens sent to the National Herbarium of New South Wales for confirmation. The dry climatic conditions were unsuitable for detecting the species and the cooler season (autumn) may have restricted the germination of any soil-stored seed following rainfall during the survey period. The location of previously recorded <i>Cyperus aquatilis</i> is shown in Figure A-1, Figure A-27, Figure A-28, Figure A-30 and Figure A-31. 	12	1
<i>Eleocharis tetraquetra</i> (Figure A-1 and Figure A-3)	<ul style="list-style-type: none"> Additional locations of this species were identified during the current survey (Figure A-1 and Figure A-3). Habitat conditions in Section 1 were optimal for the species during the survey period (April 2014) with relatively large areas of swampy habitat shallowly inundated along Red Bank Creek and tributaries. Flagging tape was used to indicate the presence of the species in and adjacent to the project area. The current distribution based on survey data collected has been mapped and added to the spatial database (Figure A-1 and Figure A-3). 	56 (0.79 ha)	277 (0.26 ha)

Species (Figure reference Appendix A)	Results summary	Approximate abundance	
		Individuals in Clearing area (area)	Individuals in situ (20 m buffer) and area
<i>Endiandra muelleri</i> subsp. <i>bracteata</i> (Figure A-24)	<ul style="list-style-type: none"> Two individuals of this species were recently recorded adjacent to the Project Area in Section 4 comprising a juvenile plant and mature medium sized tree occurring separate areas at Maclean A monitoring location was established at each individual (refer to Figure A-24) 	0	2
<i>Eucalyptus tetrapleura</i> (Figure A-6 to Figure A-9).	<ul style="list-style-type: none"> No major changes to previous surveys in terms of spatial distribution and abundance. Trees were marked with pink paint and flagging tape and GPS locations recorded (Figure A-6 to Figure A-9). 	764 (22 ha)	1795 (15 ha)
<i>Grevillea quadricauda</i> (Figure A-18 and Figure A-19)	<ul style="list-style-type: none"> No major changes from previous surveys. Plants in the southern population have been damaged in the project area and are regenerating (refer to Appendix B, Gq-3.1). Only one individual of the northern population could be found (Figure A-19). Flagging tape was used to indicate the presence of the species in and adjacent to the project area. 	1	29
<i>Lindernia alsinoides</i> (Figure A-1 and Figure A-6)	<ul style="list-style-type: none"> This is an additional species not previously identified in the project area. Habitat conditions in Section 1 were optimal for the species during the survey period (April 2014) with relatively large areas of swampy habitat shallowly inundated along Red Bank Creek and tributaries. Flagging tape was used to indicate the presence of the species in and adjacent to the project area. The distribution and abundance of this species has been mapped and added to the spatial database (Figure A-1 and Figure A-6). 	0.73 ha	0.22 ha
<i>Lindsaea incisa</i> (Figure A-1, Figure A-4, Figure A-6, Figure A-17, Figure A-19 and Figure A-27)	<ul style="list-style-type: none"> An additional population of this species was identified in and surrounding the clearing boundary in Section 1 (refer to Figure A-1). Habitat conditions in Section 1 were optimal for the species during the survey period (April 2014) with numerous plants regenerating from underground rhizomes. Habitat conditions were not ideal for the species recorded at Mororo State Forest (Figure A-27) until the end of the survey period (May 2014) with no/very few plants recorded in March 2014. Flagging tape was used to indicate the presence of the species in and adjacent to the project area. The current distribution based on survey data collected at populations has been mapped and added to the spatial database (Figure A-1, Figure A-4, Figure A-6, Figure A-17, Figure A-19 and Figure A-27). 	0.41 ha	0.22 ha
<i>Macadamia tetraphylla</i> (Figure A-33 and Figure A-36)	<ul style="list-style-type: none"> This species has not previously identified in the project area outside of Section 10. A single mature tree is present in Section 8 in an open paddock adjacent to the proposed ancillary site at Lang Hill. Several other plants are also present on residential properties at Trustums Hill (Section 8) as shown in Figure A-33 The distribution and abundance of this species has been mapped and added to the spatial database (Figure A-33 and Figure A-36). 	0	3
<i>Maundia triglochinoides</i> (Figure A-1, Figure A-5, Figure A-6, Figure A-11, Figure A-15, Figure A-16, Figure A-18, Figure A-20, Figure A-21, Figure A-29, Figure A-31,	<ul style="list-style-type: none"> No major changes from previous surveys in terms of distribution and abundance. The species was observed in low to moderate abundance at several locations in comparison to previous observations, most likely due to the below average rainfall received in the study area. Some populations were in better condition than others. Flagging tape was used to indicate the presence of the species in and adjacent to the project area. Access was not granted to private property supporting this species at Tucabia (Figure A-18). The locations of populations subject to ongoing monitoring and other are shown in (Figure A-1, Figure A-5, Figure A-6, Figure A-11, Figure A-15, Figure A-16, Figure A-18, Figure A-20, Figure A-21, Figure A-29, Figure A-31, and Figure A-32). 	0.24 ha	0.29 ha

Species (Figure reference Appendix A)	Results summary	Approximate abundance	
		Individuals in Clearing area (area)	Individuals in situ (20 m buffer) and area
Figure A-32)			
<i>Melaleuca irbyana</i> (Figure A-10 and Figure A- 32)	<ul style="list-style-type: none"> No major changes from previous surveys. Trees in and surrounding the project area at New Italy were flagged and GPS locations recorded (Figure A-32). Trees recorded well outside of the project area in Section 3 are shown in Figure A-10. 	1487	148
<i>Oberonia complanata</i> (Figure A-35)	<ul style="list-style-type: none"> This is an additional species not previously identified in the project area. recorded on three separate host trees with a total of 22 individuals observed in a range of age classes Flagging tape was used to flag host trees to indicate the presence of the species in and adjacent to the project area. The distribution and abundance of this species has been mapped and added to the spatial database (Figure A-35). 	0	22
<i>Oberonia titania</i> (Figure A-38)	<ul style="list-style-type: none"> No major changes from previous surveys. Comprises one plant near the edge of the clearing boundary in Section 10. Plants were flagged and GPS locations recorded (Figure A-38). 	0	13
<i>Olex angulata</i> (Figure A-6)	<ul style="list-style-type: none"> No major changes from previous surveys. One individual present within the project area, has died back due to being smothered by a fallen tree, with only 1- 2 shoots regenerating. Plant flagged. (Figure A-6) 	1	0
<i>Persicaria elatior</i> (Figure A-24 to Figure A-26)	<ul style="list-style-type: none"> This is an additional species not previously identified in the project area. Habitat conditions in Section 4 and 5 were suitable for the species during the survey period (March 2014). Plants had died back during supplementary surveys in September 2014. Flagging tape was used to indicate the presence of the species in and adjacent to the project area. The distribution and abundance of this species has been mapped and added to the spatial database (Figure A-24 to Figure A2-6). 	59	90
<i>Phaius australis</i> (Figure A-37)	<ul style="list-style-type: none"> No major changes from previous surveys. Plants are well outside proposed clearing boundary (Figure A-37). 	0	0
<i>Prostanthera cineolifera</i> (Figure A-28)	<ul style="list-style-type: none"> No major changes from previous surveys. Plants in and surrounding the project area were flagged and GPS locations recorded (Figure A-28). 	408 (0.42 ha)	343 (0.42 ha)
<i>Quassia sp.</i> <i>Moonee Creek</i> (Figure A-2)	<ul style="list-style-type: none"> No major changes from previous surveys. Plants in and surrounding the project area were flagged and GPS locations recorded (Figure A-2). 	136 stems	363 stems
<i>Rotala tripartita</i> (Figure A-28)	<ul style="list-style-type: none"> This is an additional species not previously identified in the project area in the EIS. Only two individuals that were in poor condition were seen in an area of wetland habitat in Section 6. Surveys during more favourable conditions are required to understand the distribution and abundance of the species in the study area. Specimens were confirmed by the National Herbarium of NSW (Figure A-28). 	0	2
<i>Streblus pendulinus</i> (Figure A-24 and Figure A- 36)	<ul style="list-style-type: none"> This is an additional species not previously identified in the project area. Recent taxonomic changes in this species has resulted in the mainland form of this species being included under the EPBC Act listing for this species which was originally restricted Lord Howe Island Three specimens were recorded in Section 8, adjacent to the proposed excavation site Lang Hill, including one small tree and two juvenile plants (Figure A-36) A single tree of this species was recorded in Section 4 at the Maclean intersection, co-occurring with the threatened <i>Endiandra muelleri subsp. bracteata</i> (Figure A-24) 	0	3

4. Conclusions and recommendations

The findings of the pre-construction (baseline) survey are briefly summarised as:

- A total of 21 threatened flora species were subject to targeted surveys and/or baseline monitoring.
- Threatened flora species were mapped and marked on the ground where practical.
- A total of 82 monitoring locations were established covering 92 threatened flora populations/occurrences.
- The climatic conditions preceding the baseline surveys were very dry in some locations which limited the distribution and abundance of some threatened flora populations associated with wetland habitats.

The recommended W2B Threatened Flora Management Plan states that monitoring locations should be monitored every 6 months (spring and autumn) during construction and annually (autumn) during post construction until the mitigation measures have been proven successful for three consecutive monitoring periods. Additional threatened flora species and new populations identified in the study area during detailed design or should be subject to targeted surveys and incorporated into the baseline monitoring and identified in the updated threatened flora management plan.

5. References

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Roads and Traffic Authority (2011) Biodiversity Guidelines – Protecting and managing biodiversity on RTA projects. Roads and Traffic Authority, NSW.

Appendix A. Threatened Flora and Monitoring Locations (Figures)

Figure A Overview of threatened flora locations

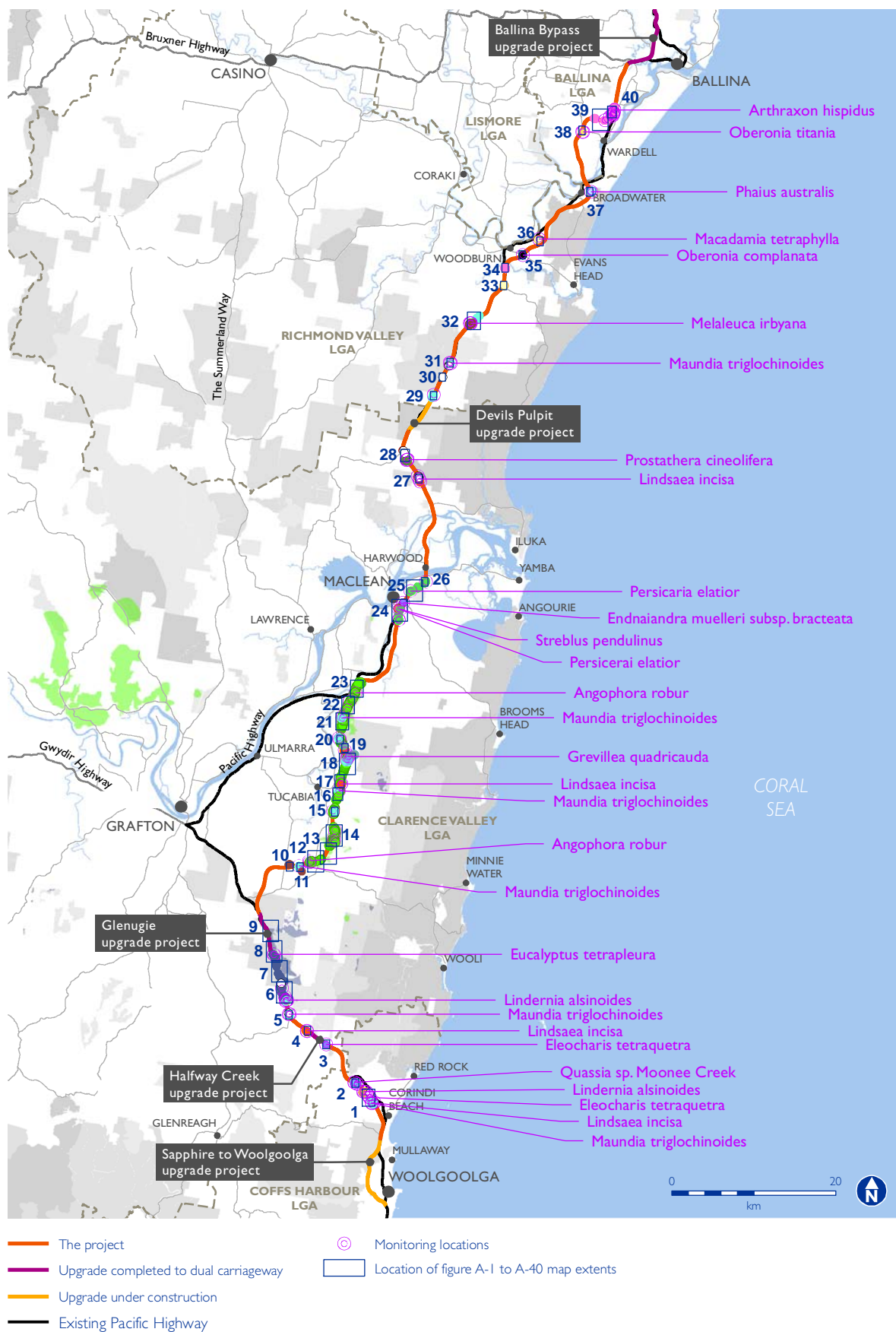
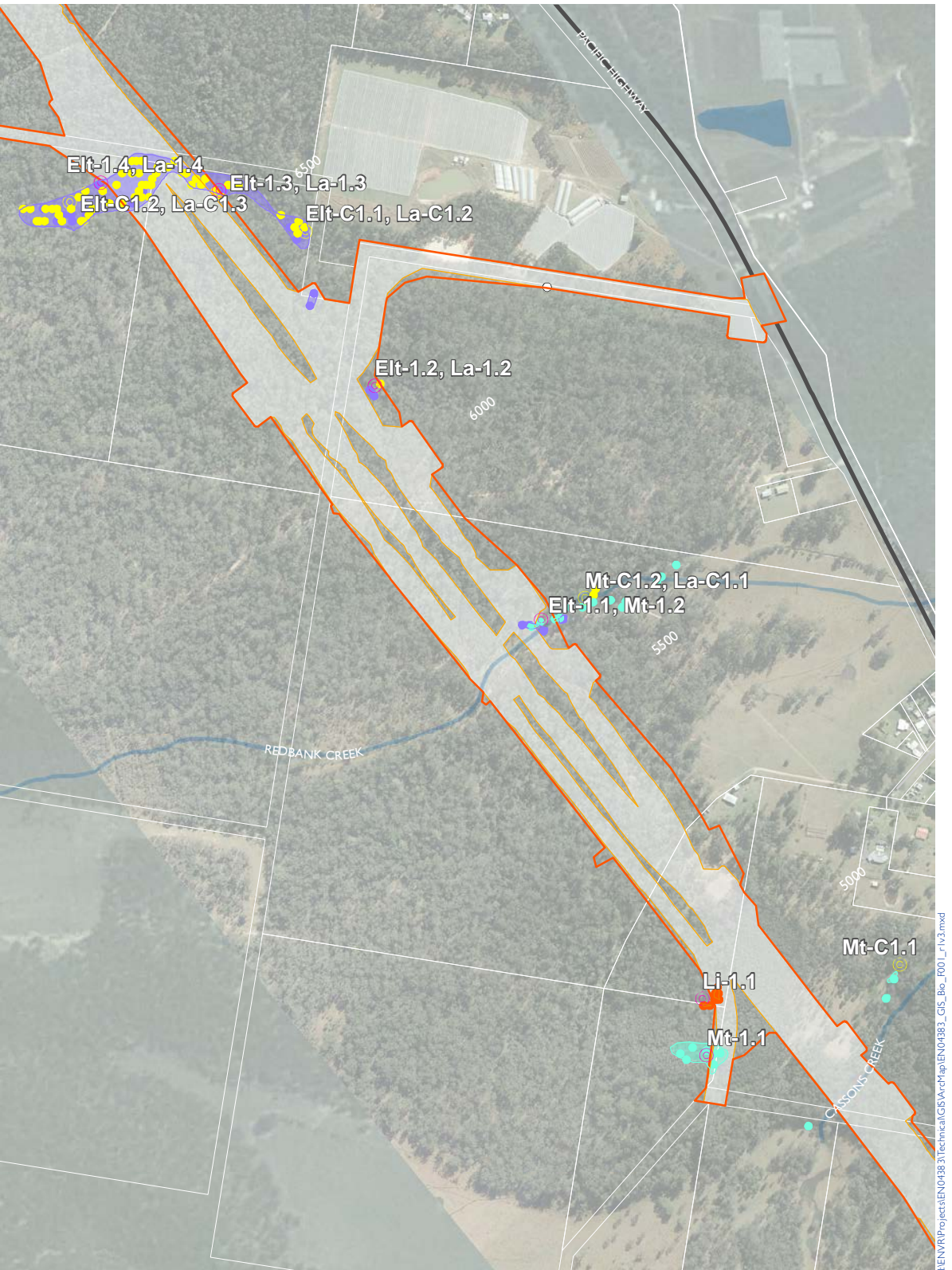


Figure A-1 Threatened flora and monitoring locations

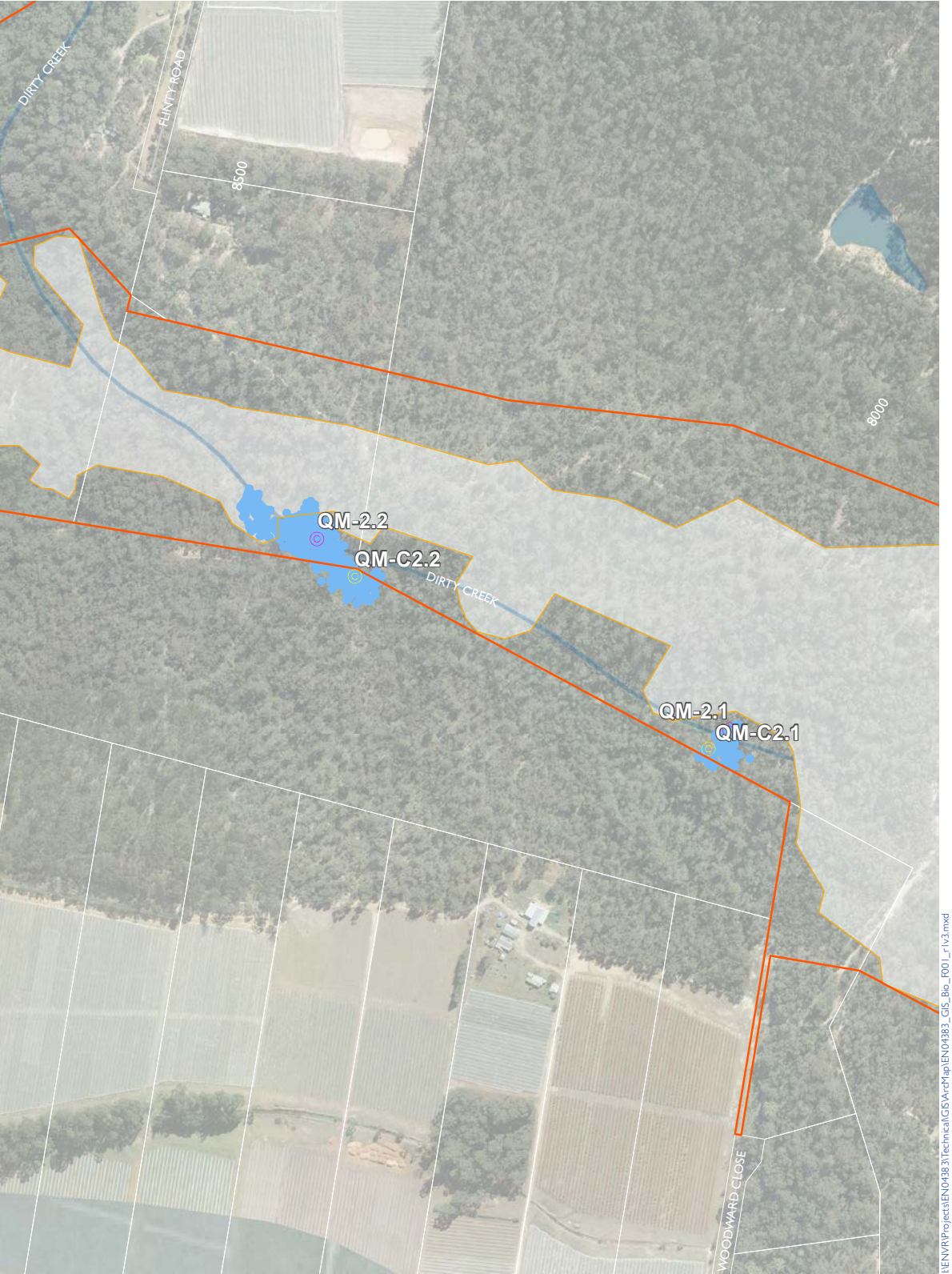


- | | | |
|-------------------------------|------------------------|------------------------|
| Project boundary | Cyperus aquatilis | Eleocharis tetraquetra |
| Clearing boundary | Eleocharis tetraquetra | Lindsaea incisa |
| Existing Pacific Highway | Lindernia alsinoides | Maundia triglochinos |
| Monitoring location - Control | Lindsaea incisa | |
| Monitoring location - In situ | Maundia triglochinos | |



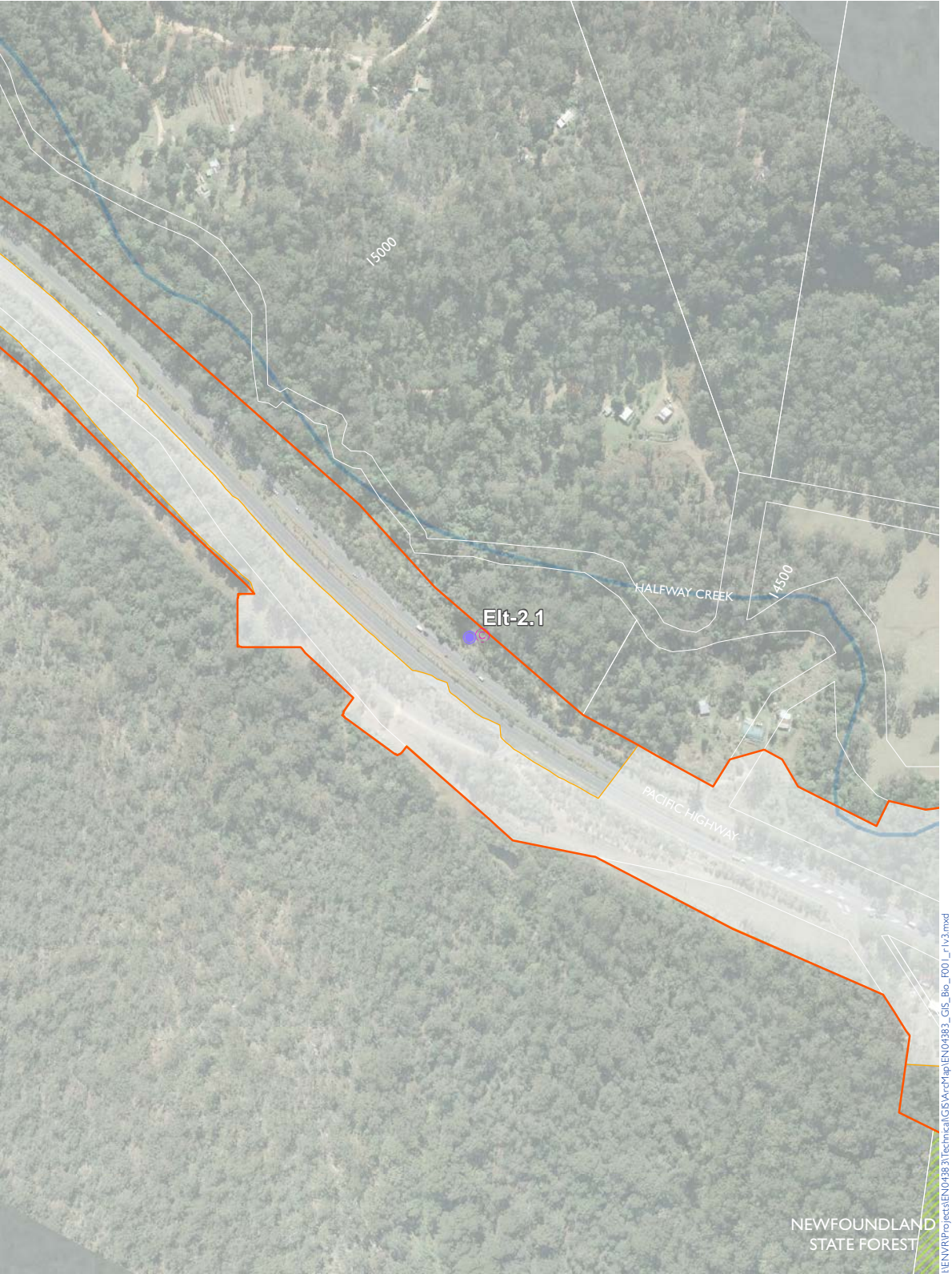
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Figure A-2 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Monitoring location - Control
- Monitoring location - In situ
- Quassia sp. Moonee Creek

Figure A-3 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - In situ
- Eleocharis tetraquetra*
- Eleocharis tetraquetra*



Figure A-4 Threatened flora and monitoring locations

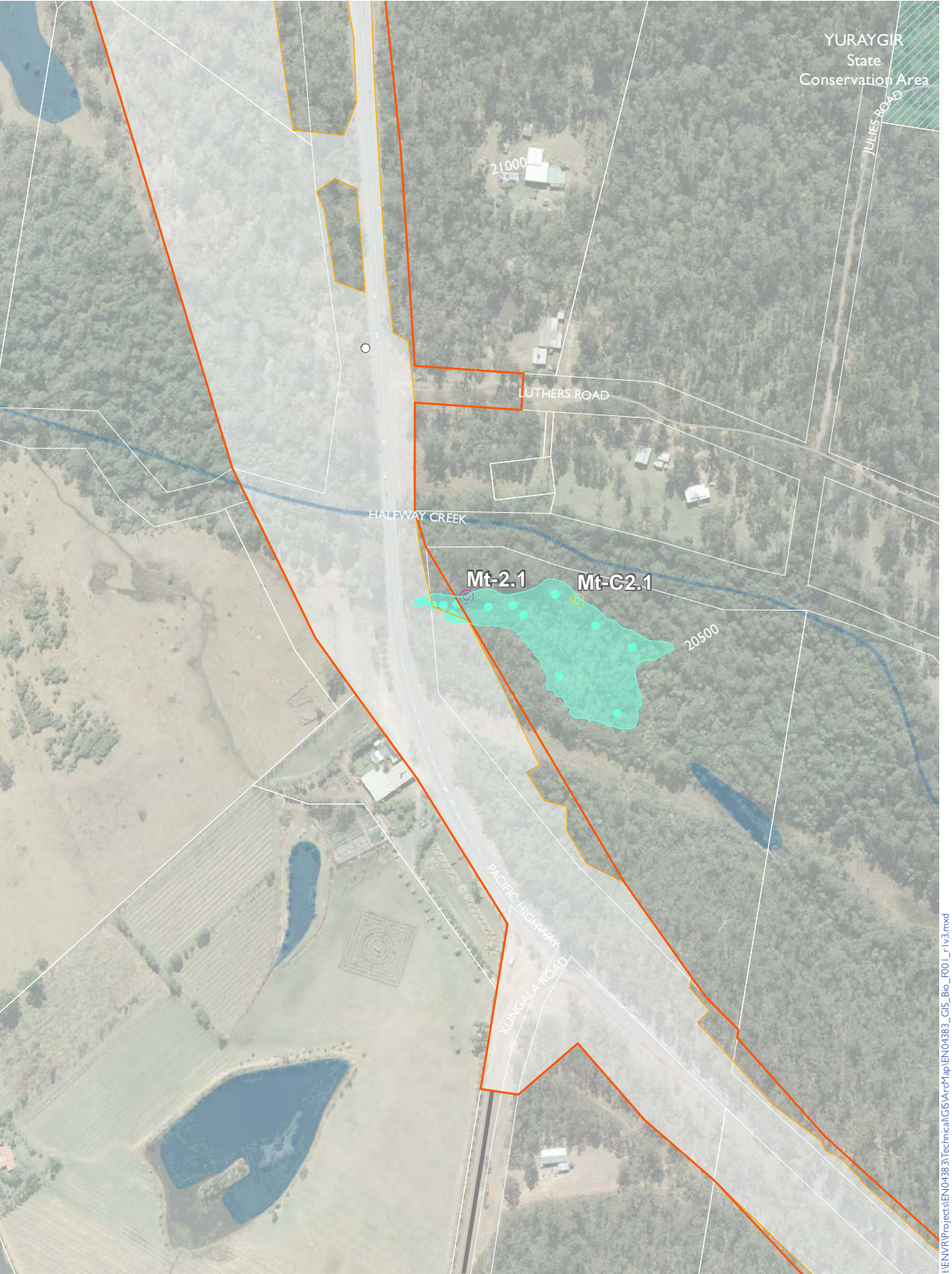


- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - Control
- Monitoring location - In situ
- Lindsaea incisa*
- Lindsaea incisa*



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Figure A-5 Threatened flora and monitoring locations



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- | | | |
|-------------------------------|--------------------------------|--------------------------------|
| Project boundary | <i>Cyperus aquatilis</i> | <i>Maundia triglochynoides</i> |
| Clearing boundary | <i>Maundia triglochynoides</i> | |
| Existing Pacific Highway | | |
| Monitoring location - Control | | |
| Monitoring location - In situ | | |



Figure A-6 Threatened flora and monitoring locations



Figure A-7 Threatened flora and monitoring locations

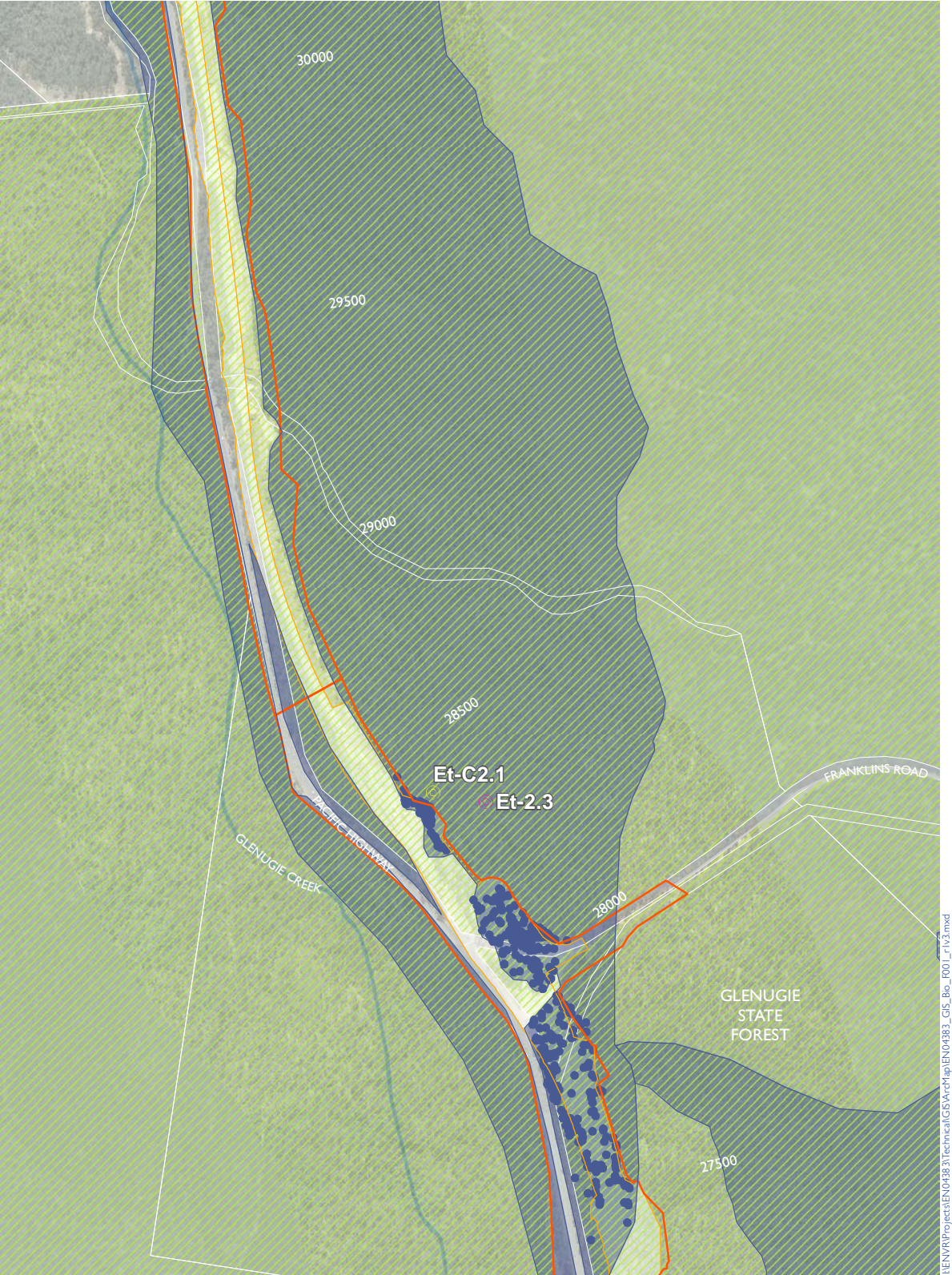


- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Eucalyptus tetrapleura
- Eucalyptus tetrapleura



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Figure A-8 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - Control
- Monitoring location - In situ
- Eucalyptus tetrapleura*
- Eucalyptus tetrapleura*



Figure A-9 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway

Eucalyptus tetrapleura



Figure A-10 Threatened flora and monitoring locations



Project boundary ● *Melaleuca irbyana*
Clearing boundary



Figure A-11 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Monitoring location - In situ
- Maundia triglochinoides
- Melaleuca irbyana
- Maundia triglochinoides



Figure A-12 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Monitoring location - Control
- Monitoring location - In situ
- Angophora robur*
- Angophora robur*

Figure A-13 Threatened flora and monitoring locations



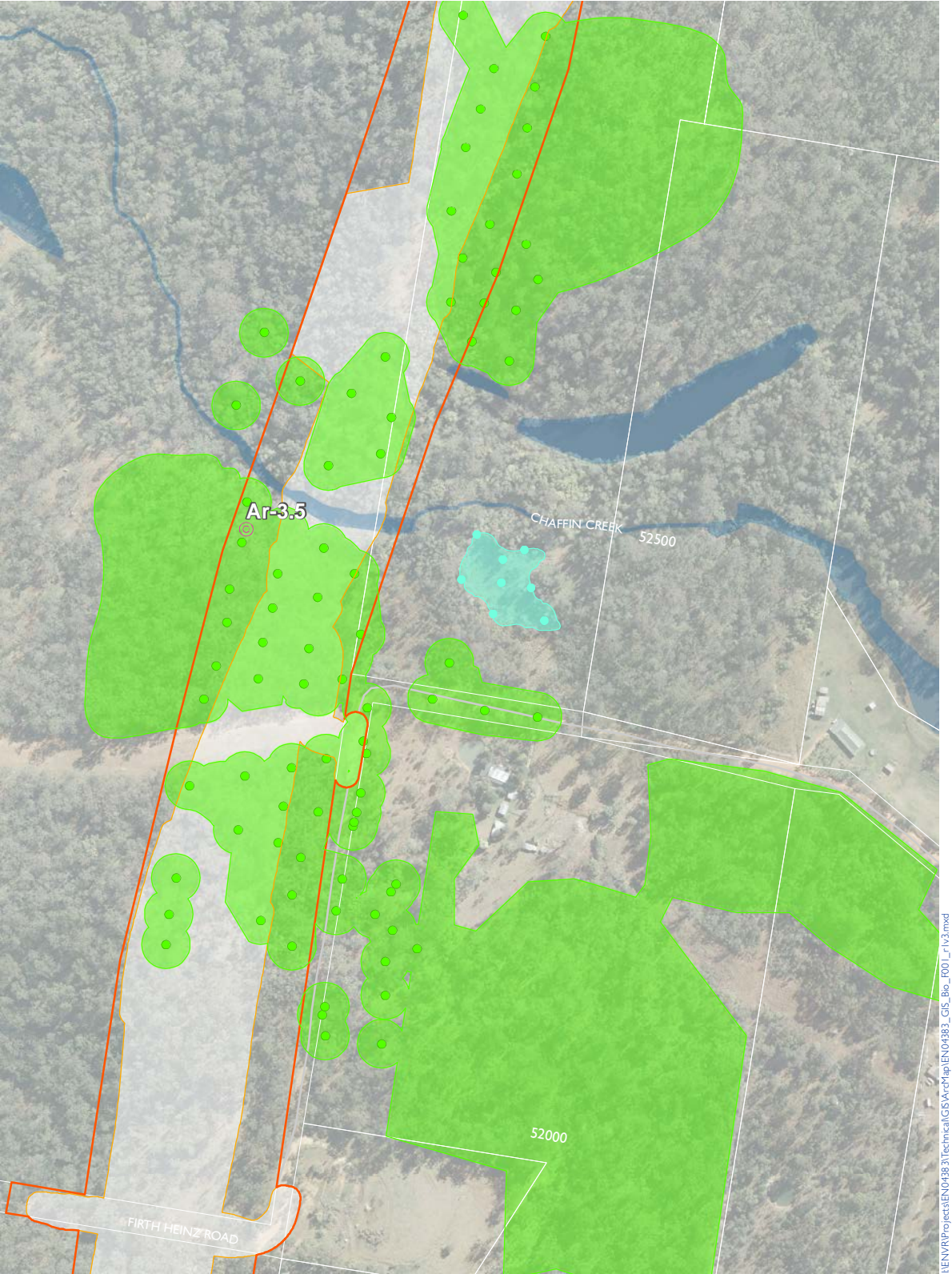
Figure A-14 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Monitoring location - In situ
- Angophora robur
- Angophora robur



Figure A-15 Threatened flora and monitoring locations










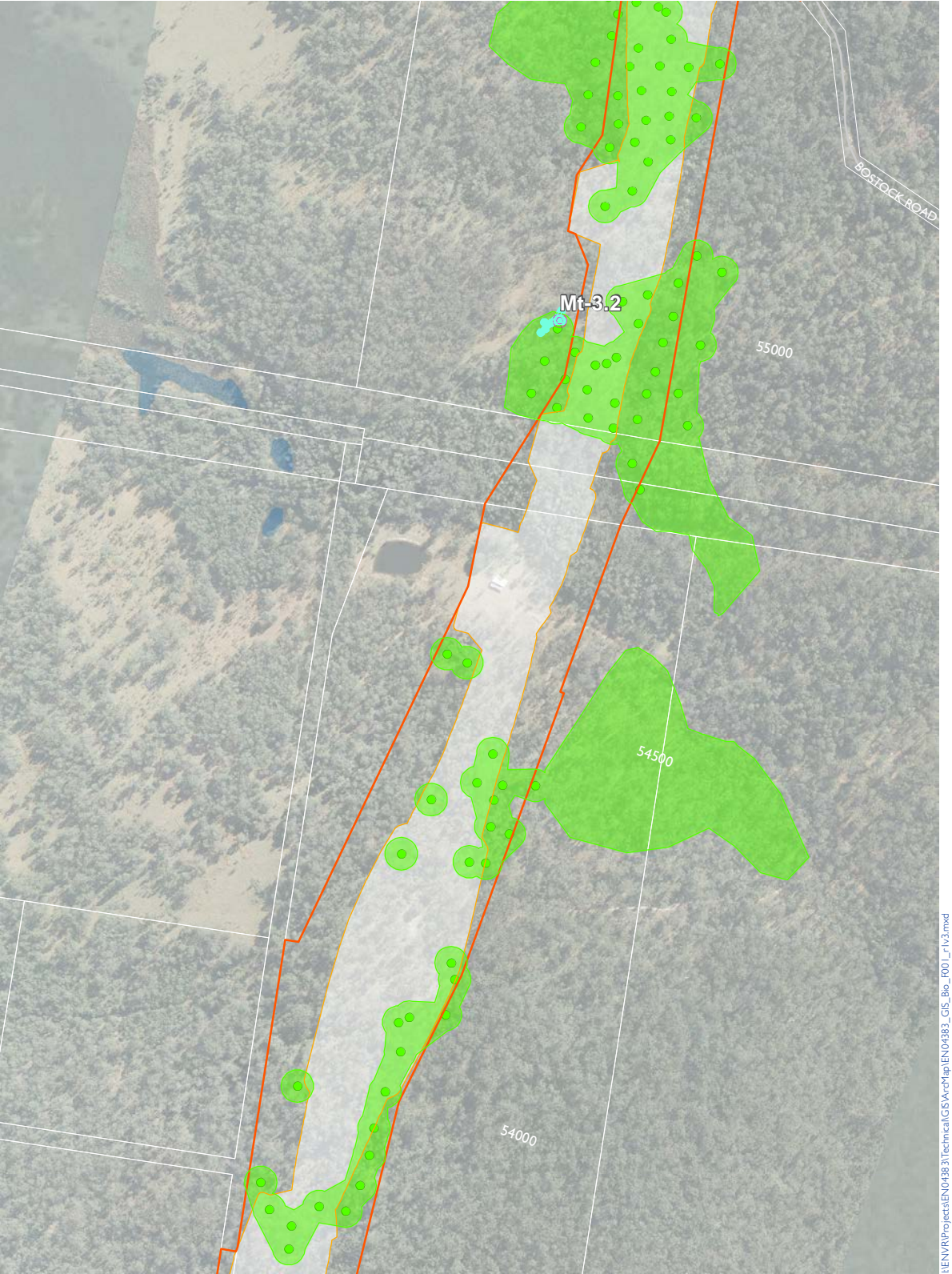







- | | | |
|---|---|---|
|  Project boundary |  <i>Angophora robur</i> |  <i>Angophora robur</i> |
|  Clearing boundary |  <i>Maundia triglochinos</i> |  <i>Maundia triglochinos</i> |
|  Monitoring location - In situ | | |



Figure A-16 Threatened flora and monitoring locations

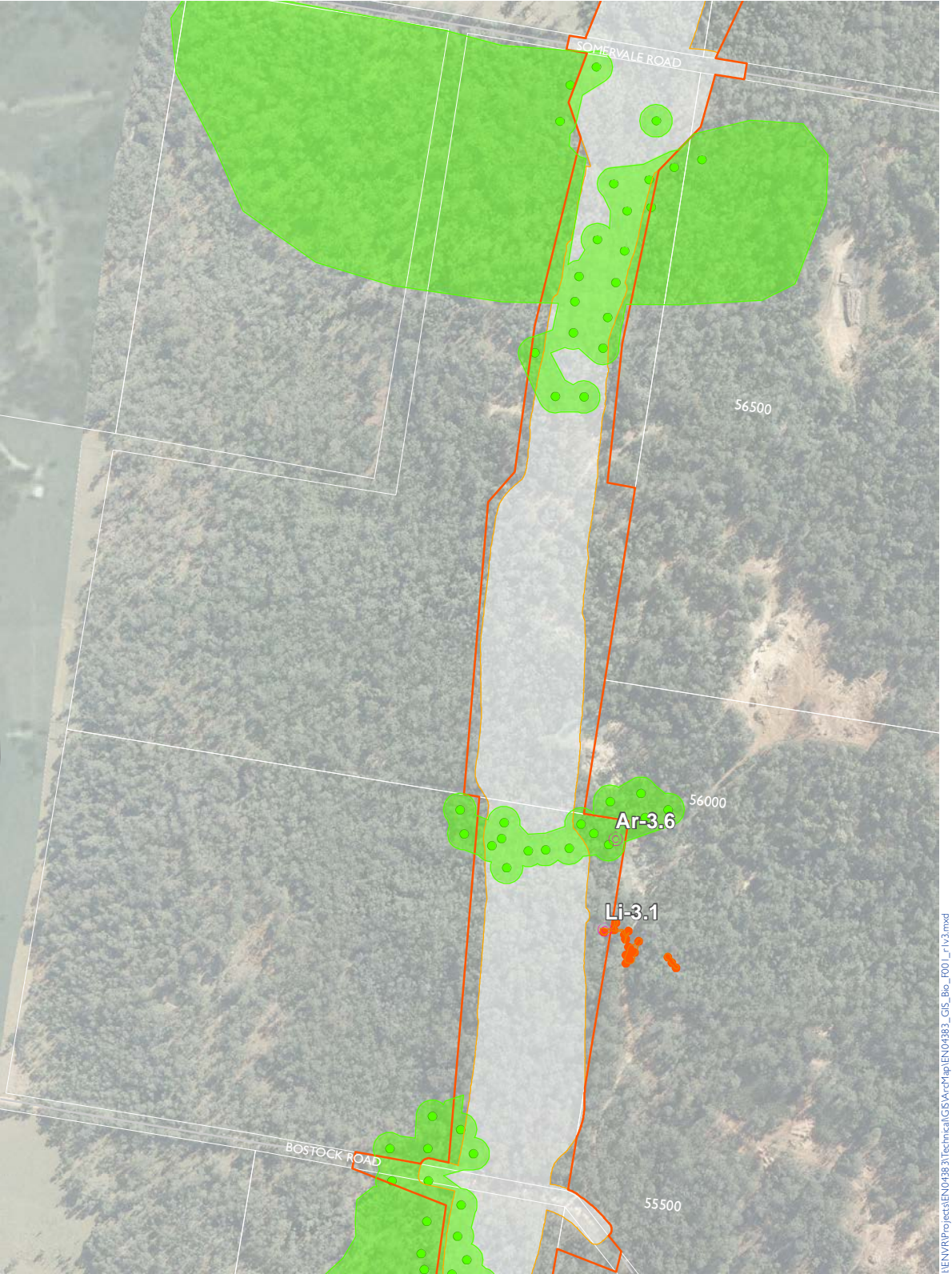


- | | | |
|---|---|---|
|  Project boundary |  <i>Angophora robur</i> |  <i>Angophora robur</i> |
|  Clearing boundary |  <i>Maundia triglochinos</i> |  <i>Maundia triglochinos</i> |
|  Monitoring location - In situ | | |



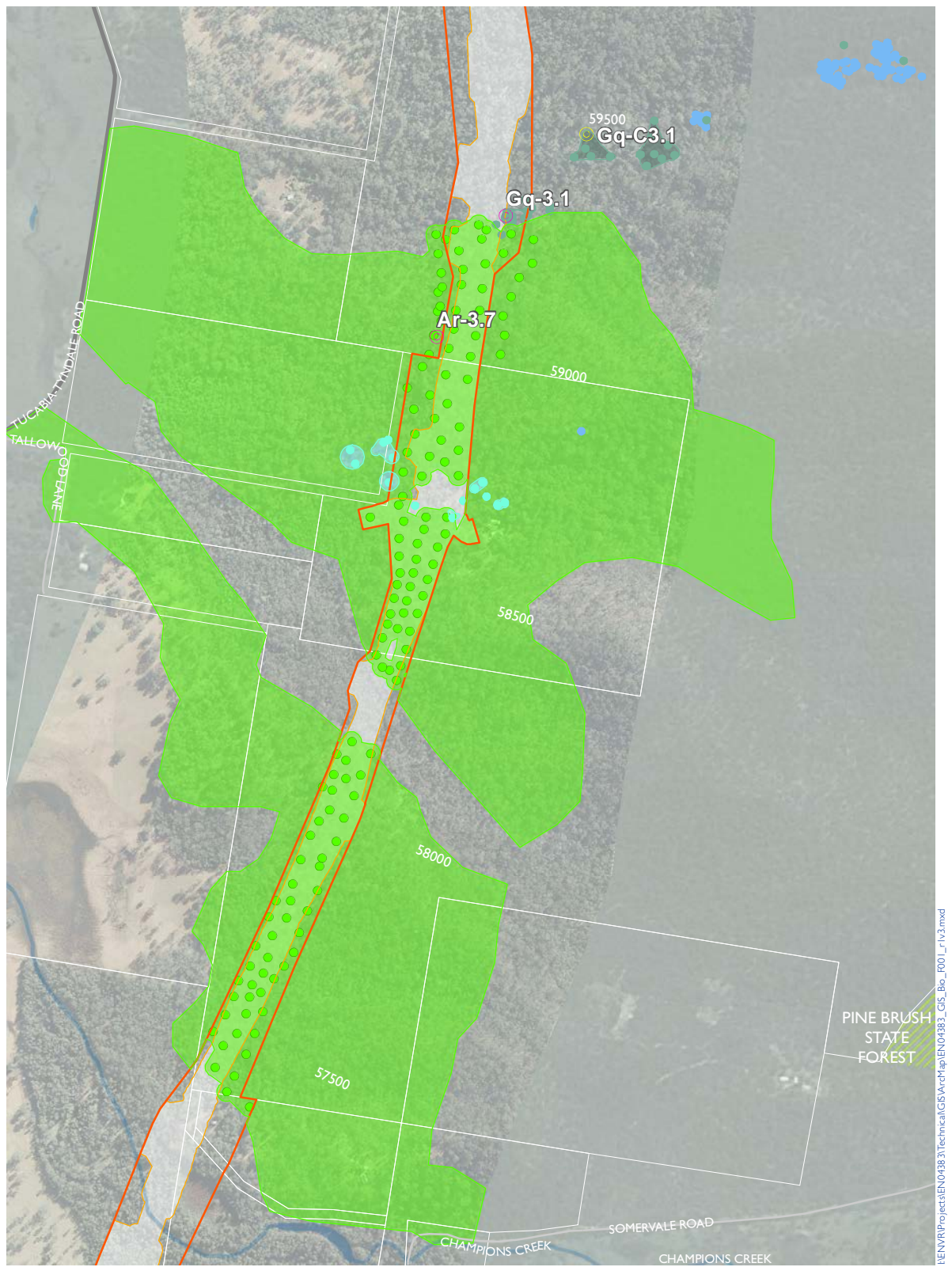
0 250
m

Figure A-17 Threatened flora and monitoring locations



- | | | |
|-------------------------------|-----------------|-----------------|
| Project boundary | Angophora robur | Angophora robur |
| Clearing boundary | Lindsaea incisa | Lindsaea incisa |
| Monitoring location - In situ | | |

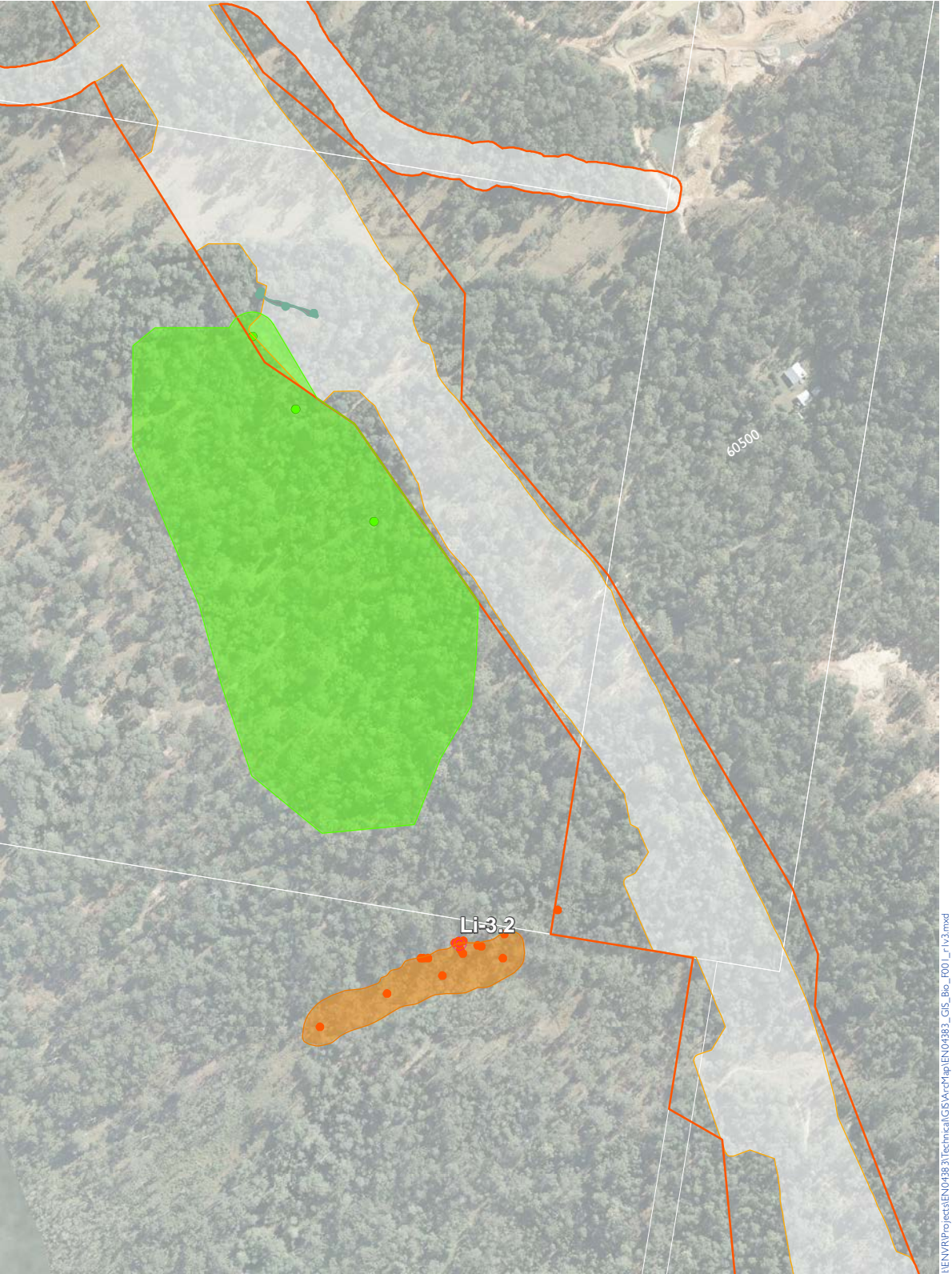
Figure A-18 Threatened flora and monitoring locations



- | | | |
|-------------------------------|---------------------------|---------------------------|
| Project boundary | Angophora robur | Angophora robur |
| Clearing boundary | Grevillea quadricauda | Grevillea quadricauda |
| Monitoring location - Control | Maundia triglochinosoides | Maundia triglochinosoides |
| Monitoring location - In situ | Quassia sp. Moonee Creek | |



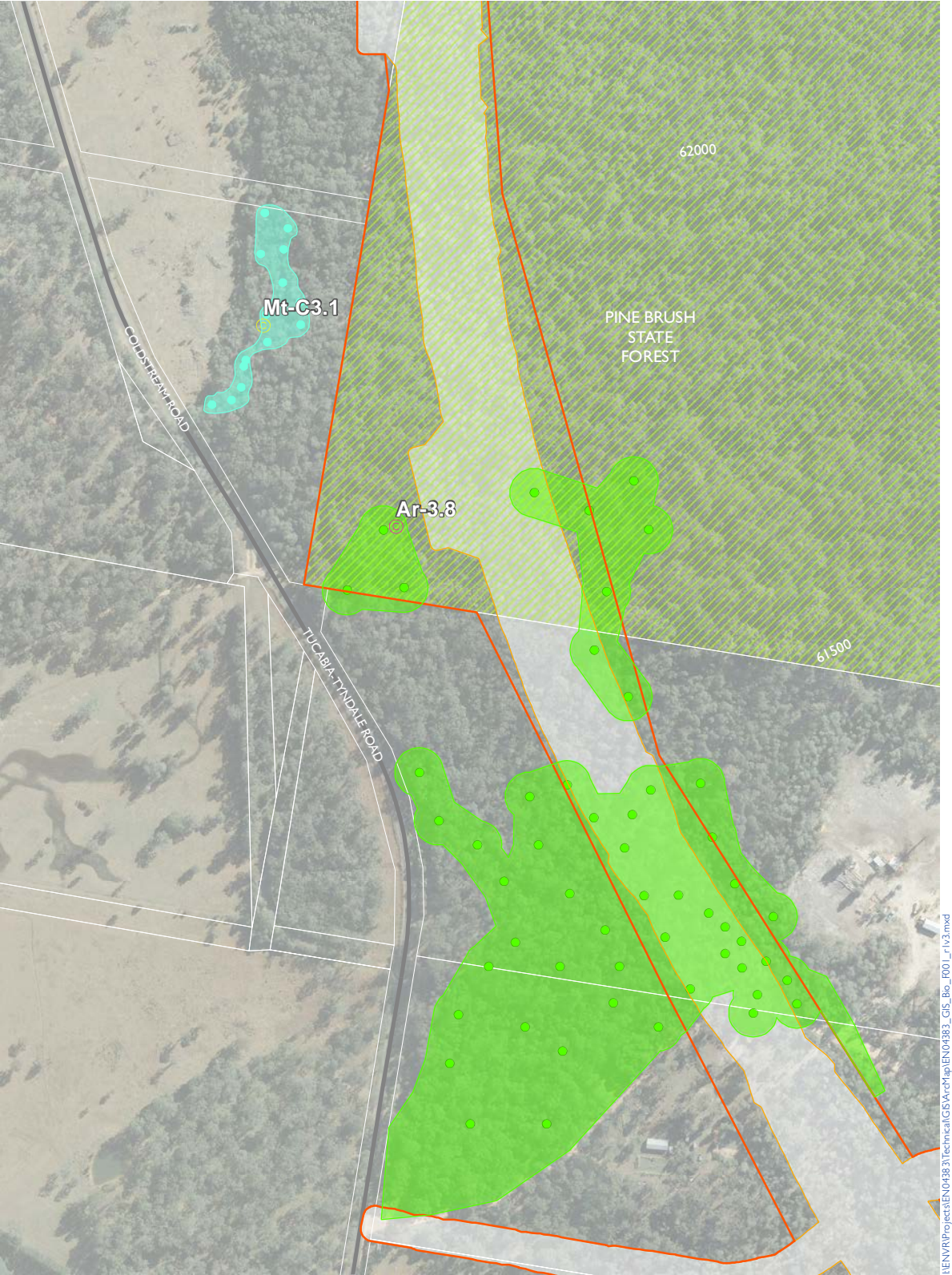
Figure A-19 Threatened flora and monitoring locations



- | | | |
|-------------------------------|-----------------------|-----------------------|
| Project boundary | Angophora robur | Angophora robur |
| Clearing boundary | Grevillea quadricauda | Grevillea quadricauda |
| Monitoring location - In situ | Lindsaea incisa | Lindsaea incisa |



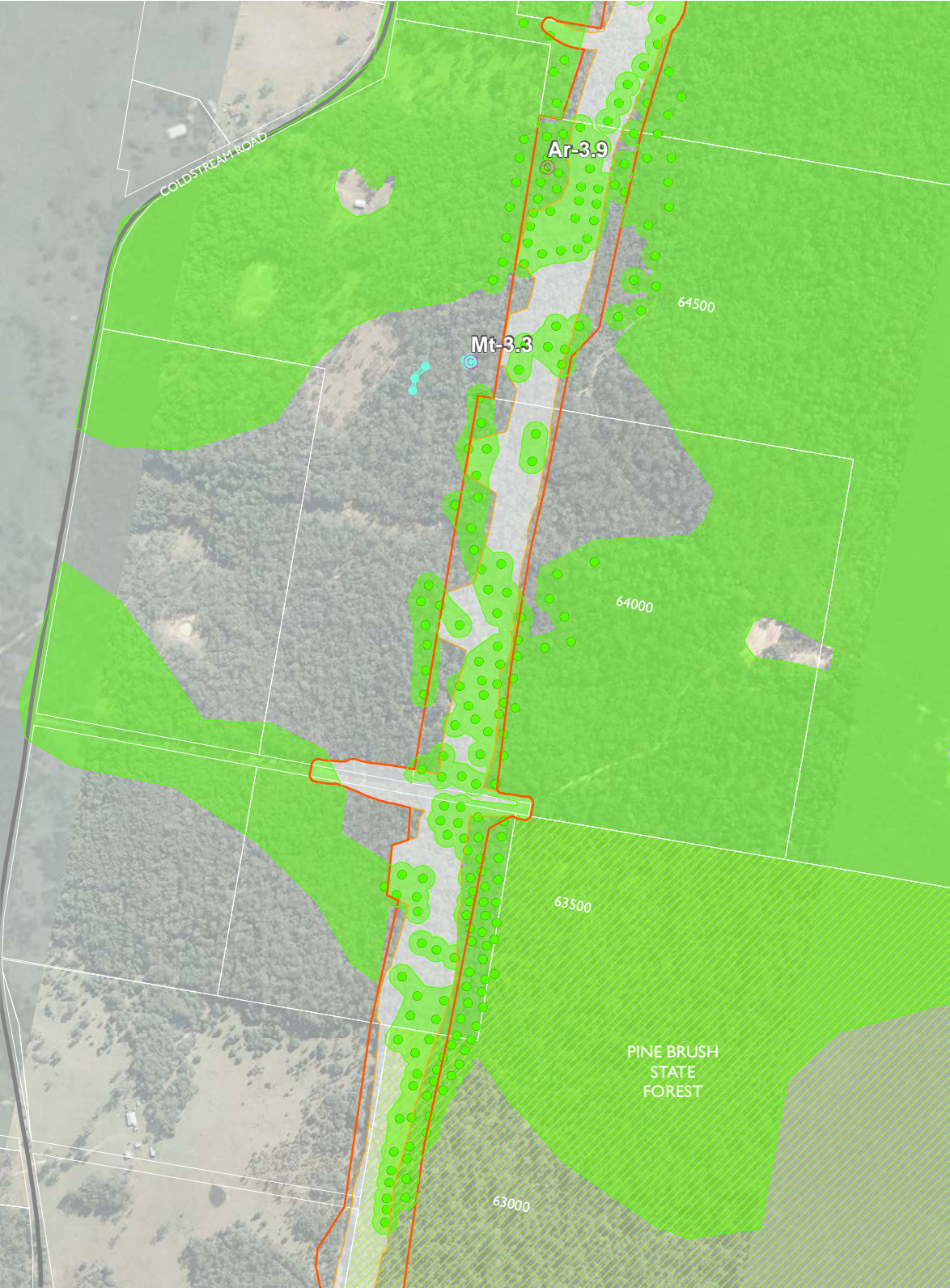
Figure A-20 Threatened flora and monitoring locations



- | | | |
|-------------------------------|-----------------------------|-----------------------------|
| Project boundary | <i>Angophora robur</i> | <i>Angophora robur</i> |
| Clearing boundary | <i>Maundia triglochinos</i> | <i>Maundia triglochinos</i> |
| Monitoring location - Control | | |
| Monitoring location - In situ | | |



Figure A-21 Threatened flora and monitoring locations

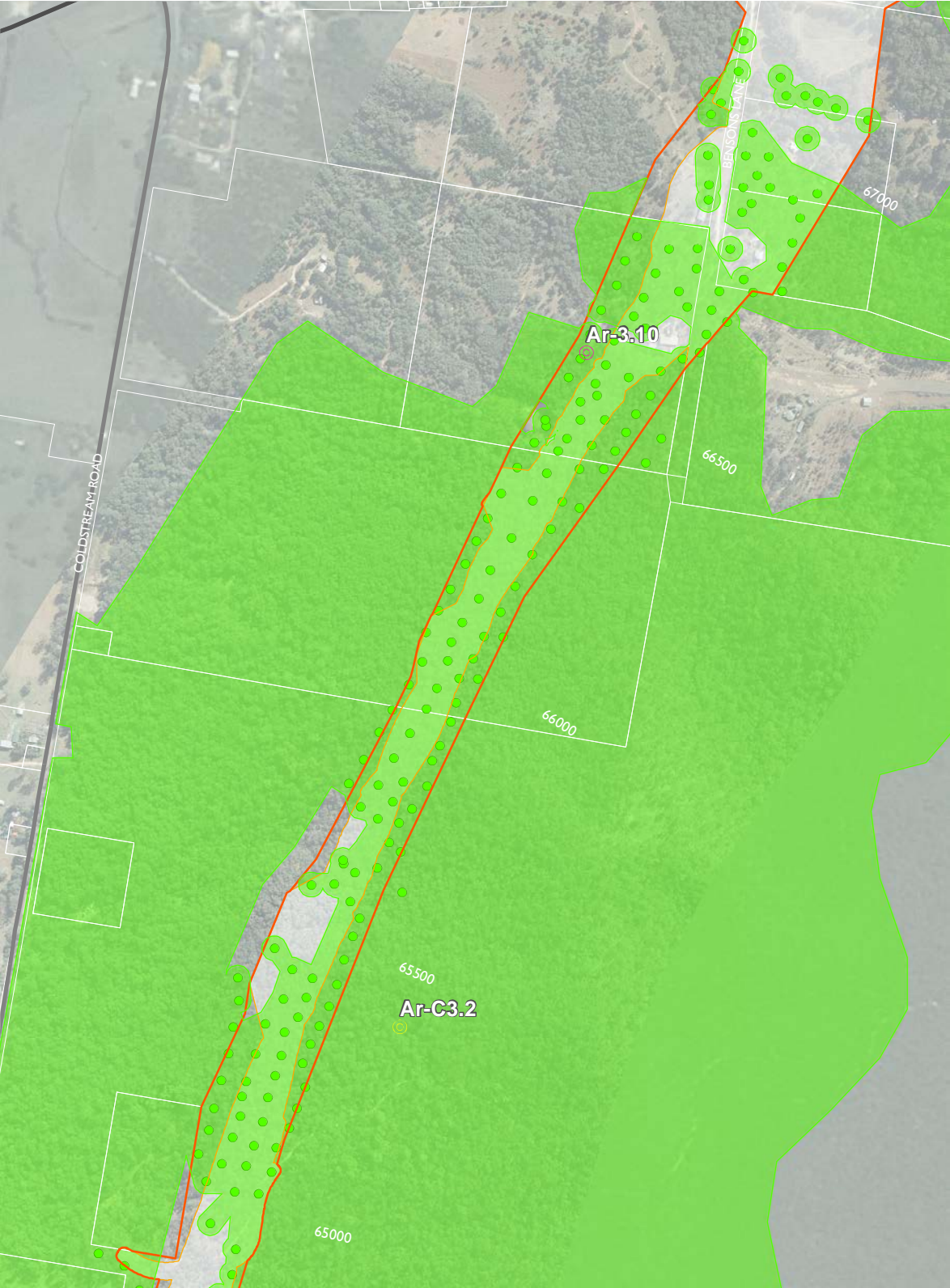


- | | | |
|-------------------------------|----------------------|----------------------|
| Project boundary | Angophora robur | Angophora robur |
| Clearing boundary | Maundia triglochinos | Maundia triglochinos |
| Monitoring location - In situ | | |



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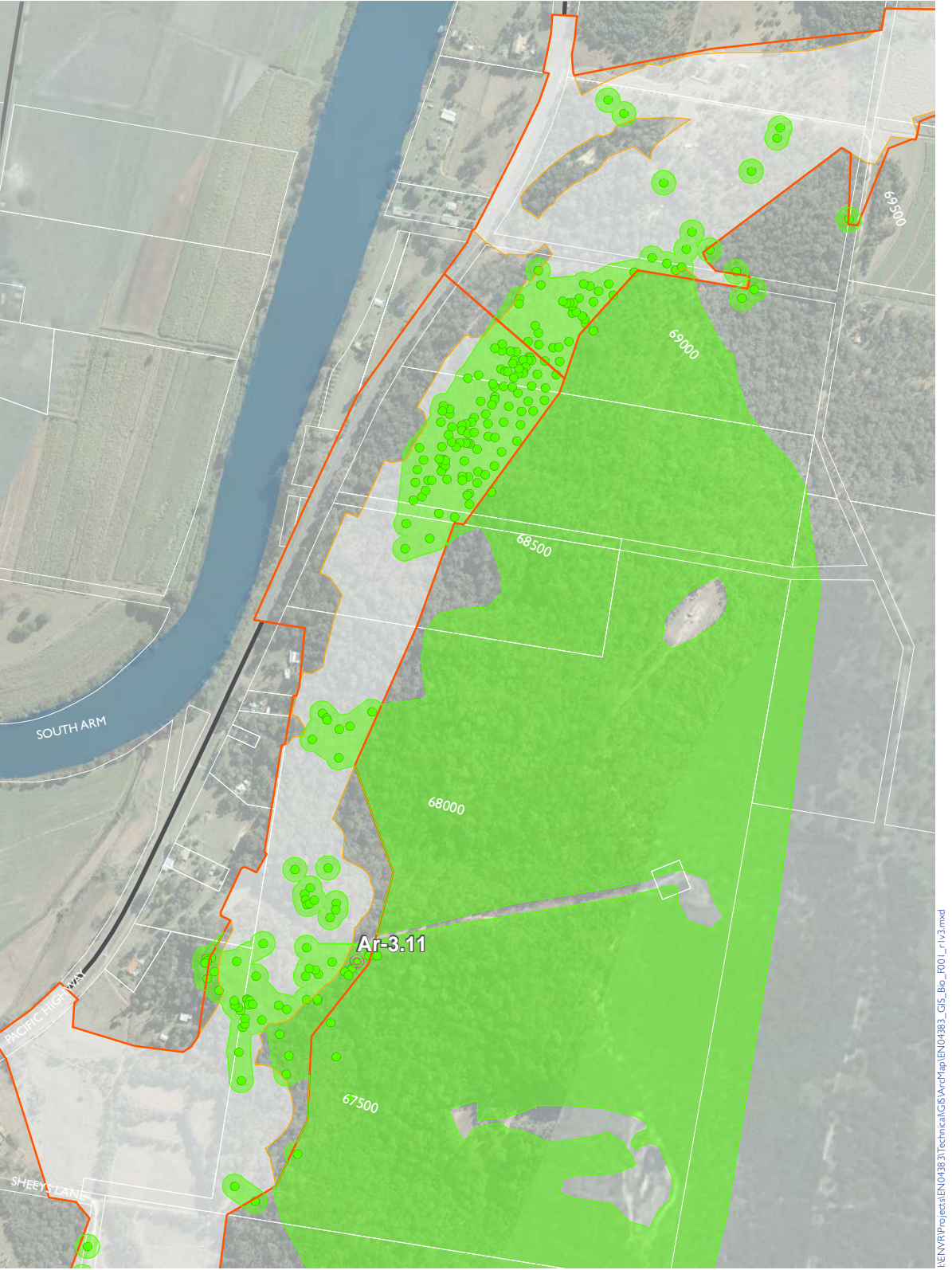
Figure A-22 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - Control
- Monitoring location - In situ
- *Angophora robur*
- Angophora robur*












Figure A-23 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - In situ
- Angophora robur*
- Angophora robur*

Figure A-24 Threatened flora and monitoring locations

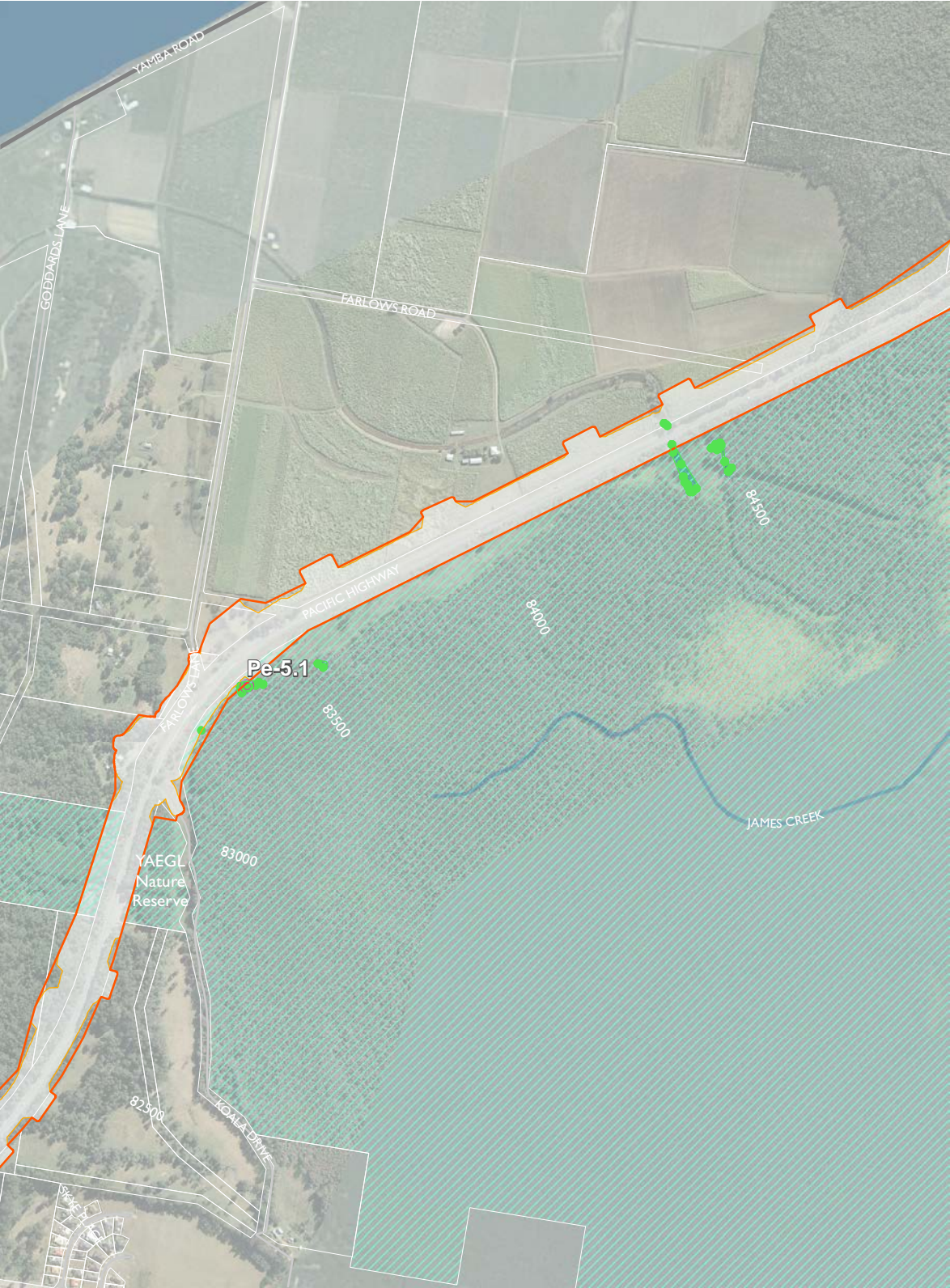


- | | | |
|---|---|---|
|  Project boundary |  <i>Endiandra muelleri</i> subsp. <i>bracteata</i> |  <i>Persicaria elatior</i> |
|  Clearing boundary |  <i>Persicaria elatior</i> | |
|  Existing Pacific Highway |  <i>Streblus pendulinus</i> | |
|  Monitoring location - Control | | |
|  Monitoring location - In situ | | |



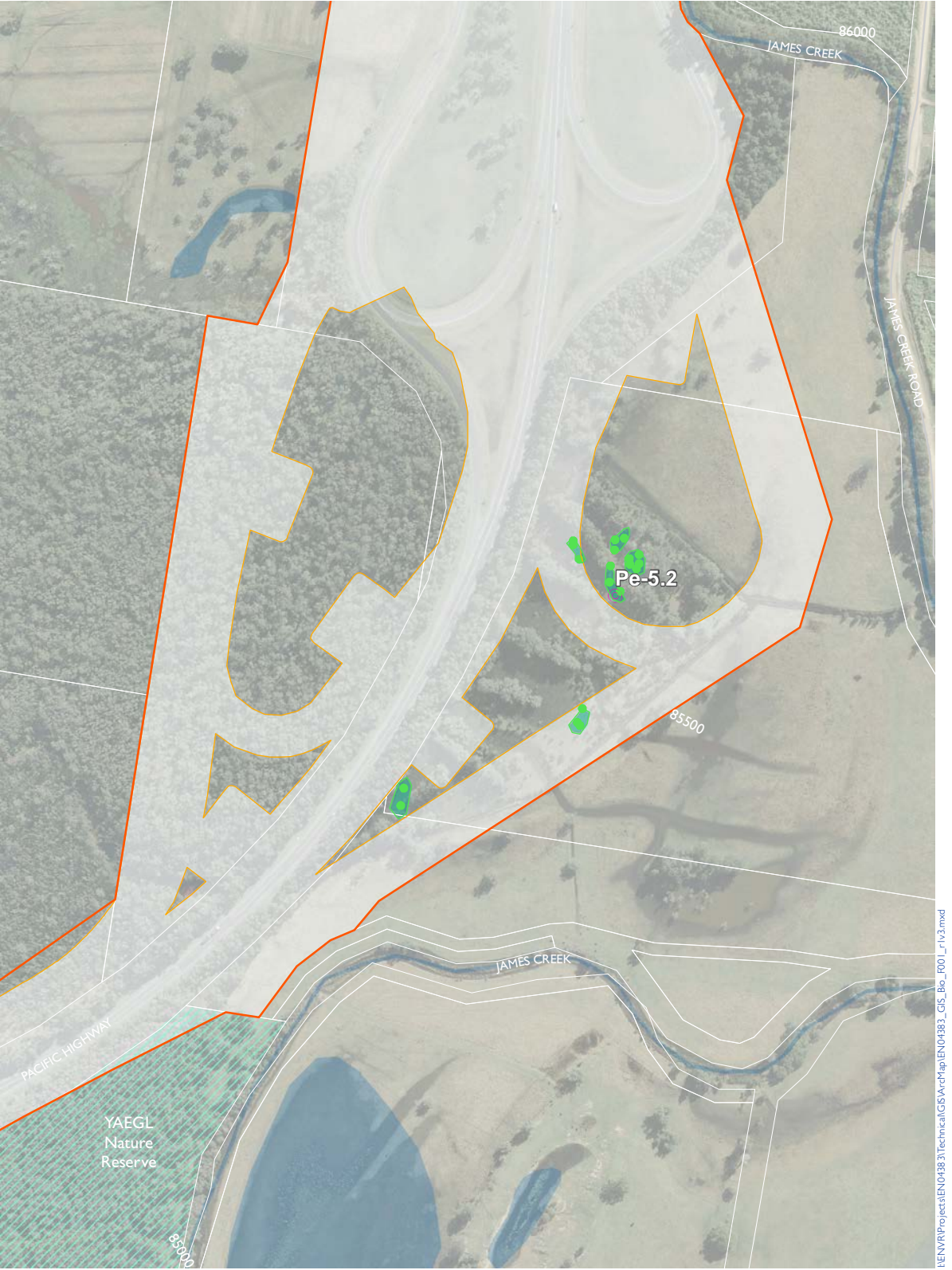
0 250
m

Figure A-25 Threatened flora and monitoring locations



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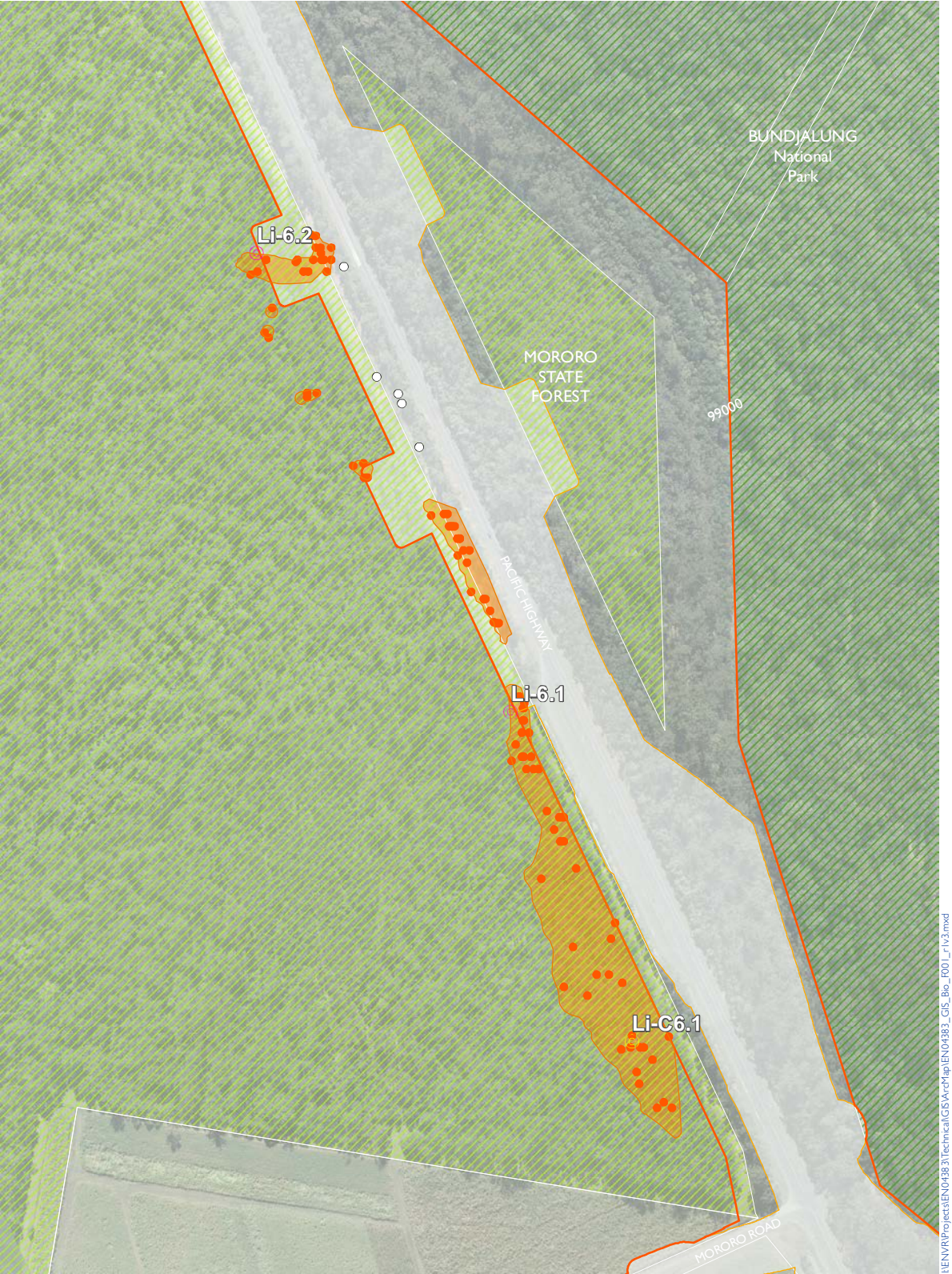
Figure A-26 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - In situ
- Persicaria elatior
- Persicaria elatior



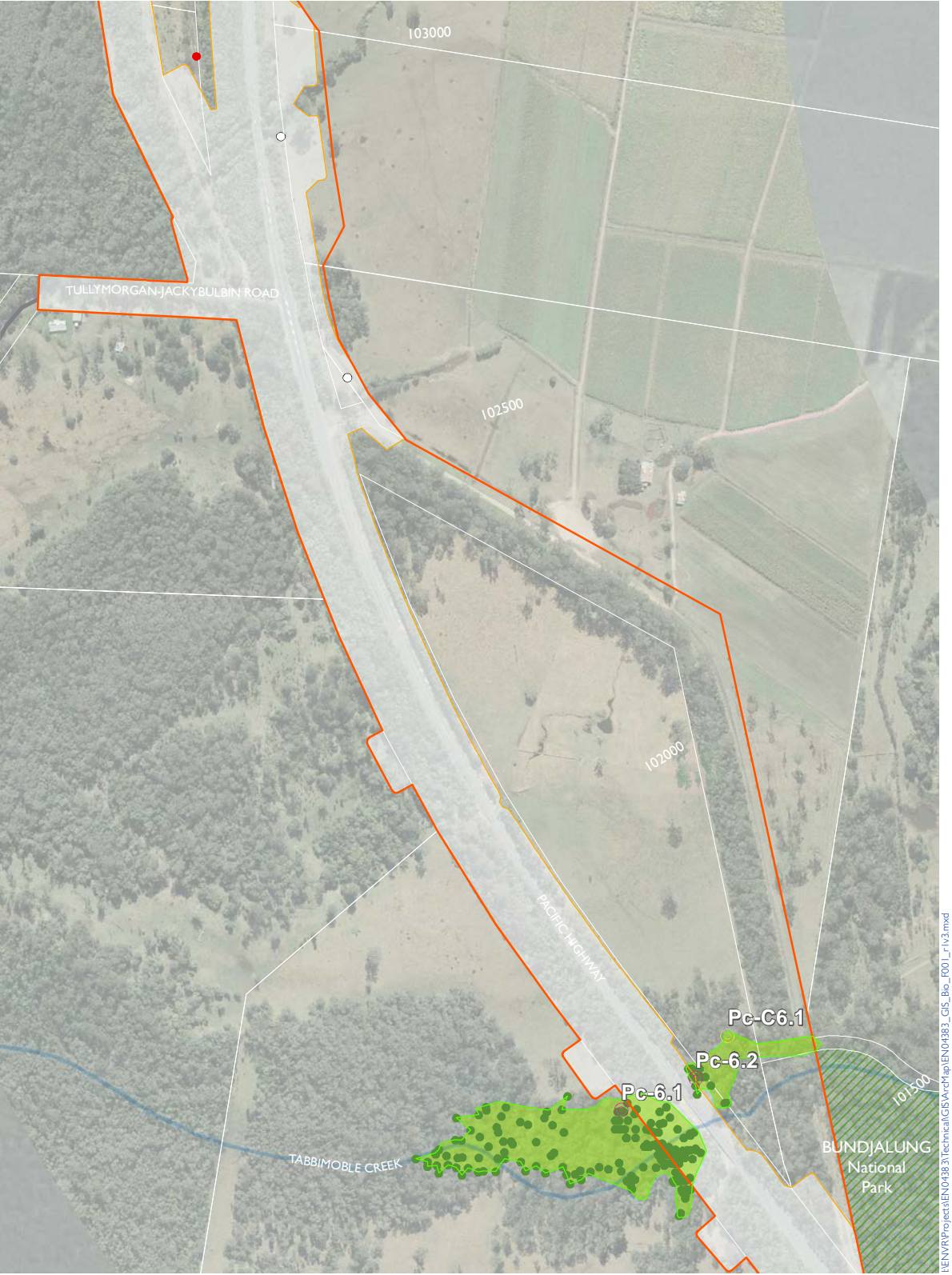
Figure A-27 Threatened flora and monitoring locations



- | | | |
|-------------------------------|--------------------------|------------------------|
| Project boundary | <i>Cyperus aquatilis</i> | <i>Lindsaea incisa</i> |
| Clearing boundary | <i>Lindsaea incisa</i> | |
| Existing Pacific Highway | | |
| Monitoring location - Control | | |
| Monitoring location - In situ | | |



Figure A-28 Threatened flora and monitoring locations



- | | | |
|-------------------------------|---------------------------------|---------------------------------|
| Project boundary | <i>Cyperus aquatilis</i> | <i>Prostanthera cineolifera</i> |
| Clearing boundary | <i>Prostanthera cineolifera</i> | |
| Existing Pacific Highway | <i>Rotala tripartita</i> | |
| Monitoring location - Control | | |
| Monitoring location - In situ | | |



Figure A-29 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - In situ
- Maundia triglochinos*
- Maundia triglochinos*

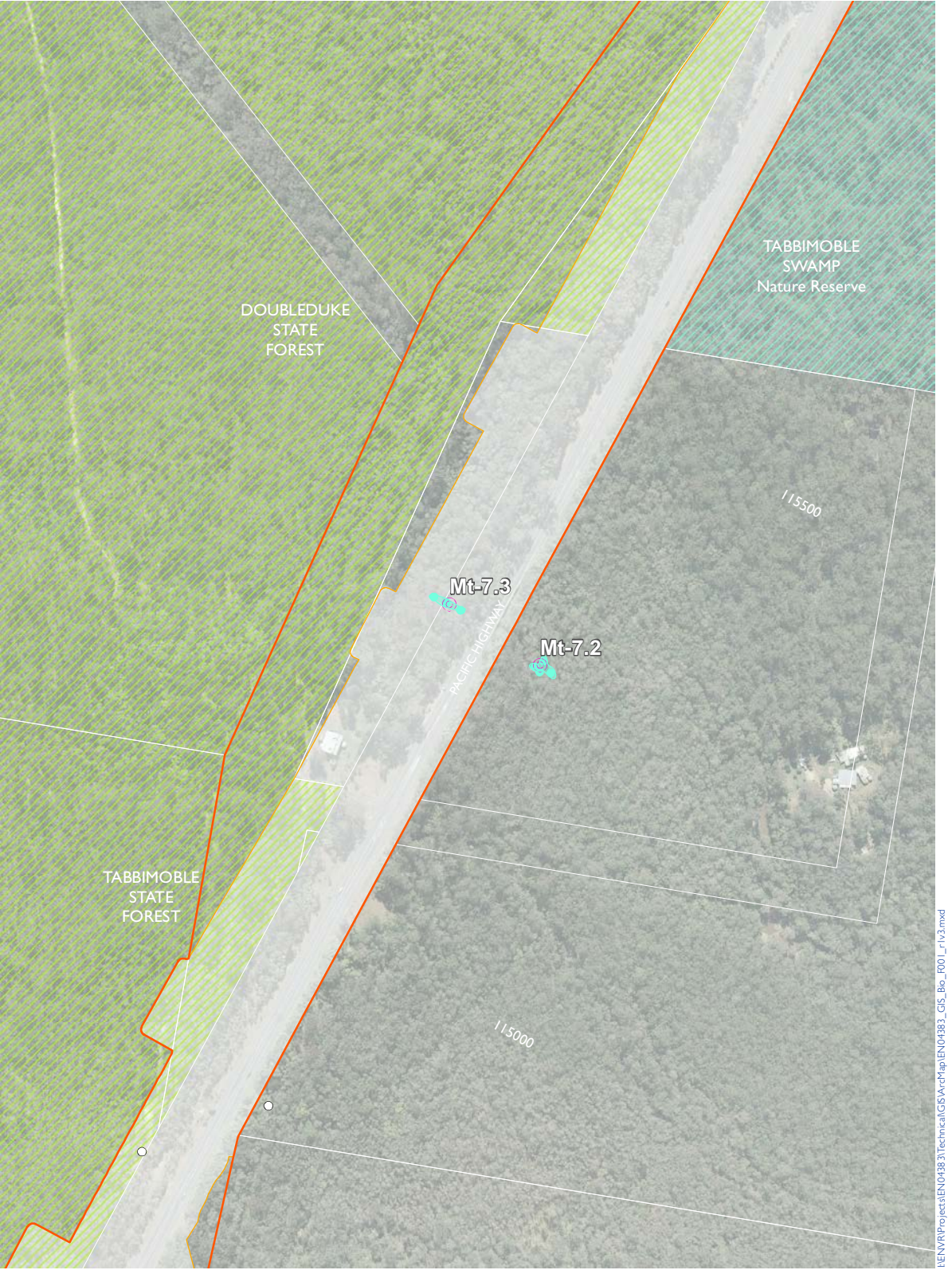
Figure A-30 Threatened flora and monitoring locations



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Figure A-31 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Monitoring location - In situ
- Cyperus aquatilis
- Maundia triglochinos
- Maundia triglochinos



Figure A-32 Threatened flora and monitoring locations



- | | | |
|-------------------------------|-----------------------------|-----------------------------|
| Project boundary | <i>Maundia triglochinos</i> | <i>Maundia triglochinos</i> |
| Clearing boundary | <i>Melaleuca irbyana</i> | <i>Melaleuca irbyana</i> |
| Existing Pacific Highway | | |
| Monitoring location - In situ | | |



Figure A-33 Threatened flora and monitoring locations

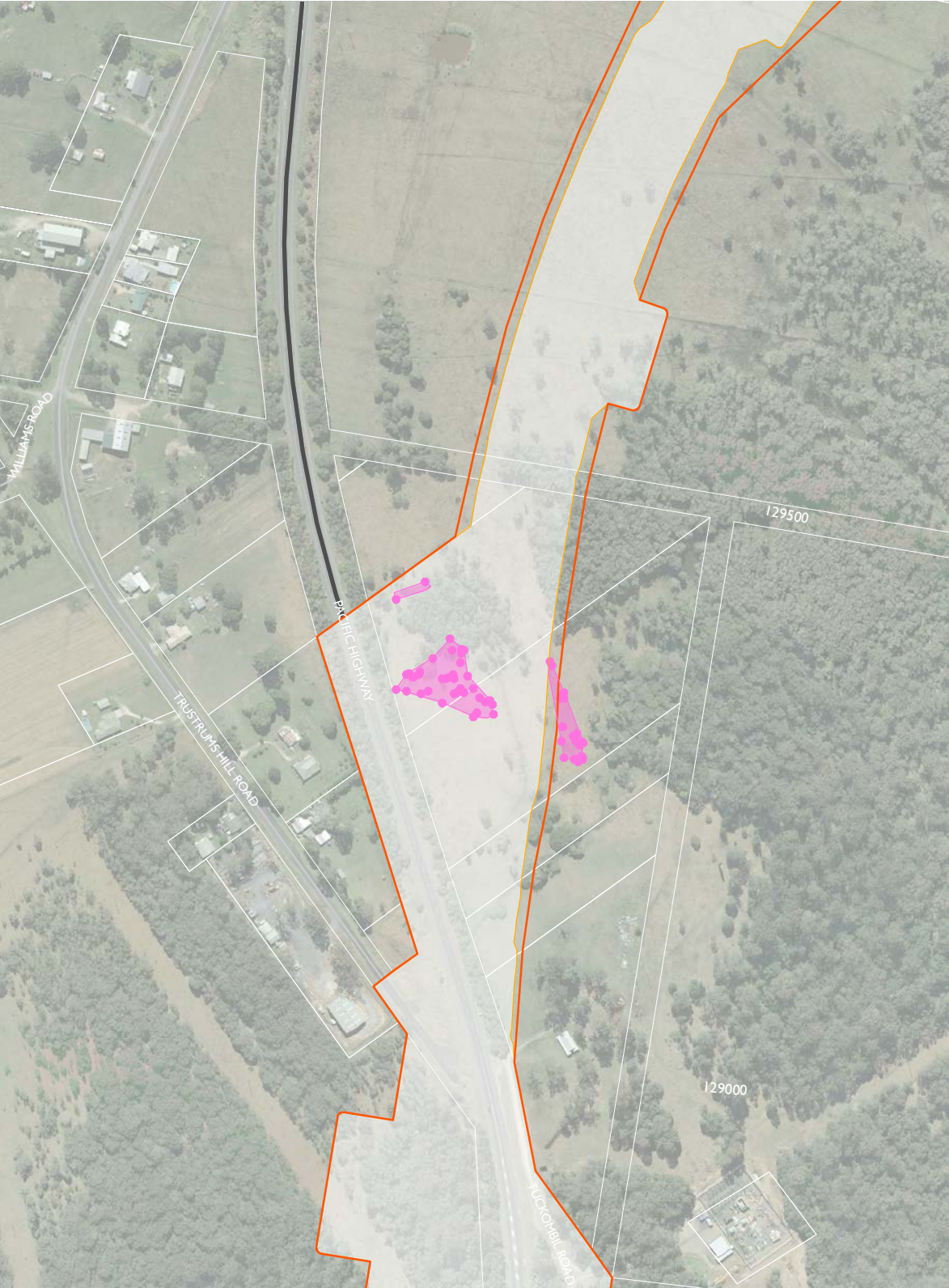


- Project boundary
- Clearing boundary
- Existing Pacific Highway
- Macadamia tetraphylla



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Figure A-34 Threatened flora and monitoring locations



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Figure A-35 Threatened flora and monitoring locations



Figure A-36 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Macadamia tetraphylla
- Streblus pendulinus
- Monitoring location - In situ



Figure A-37 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Monitoring location - In situ
- Phaius australis



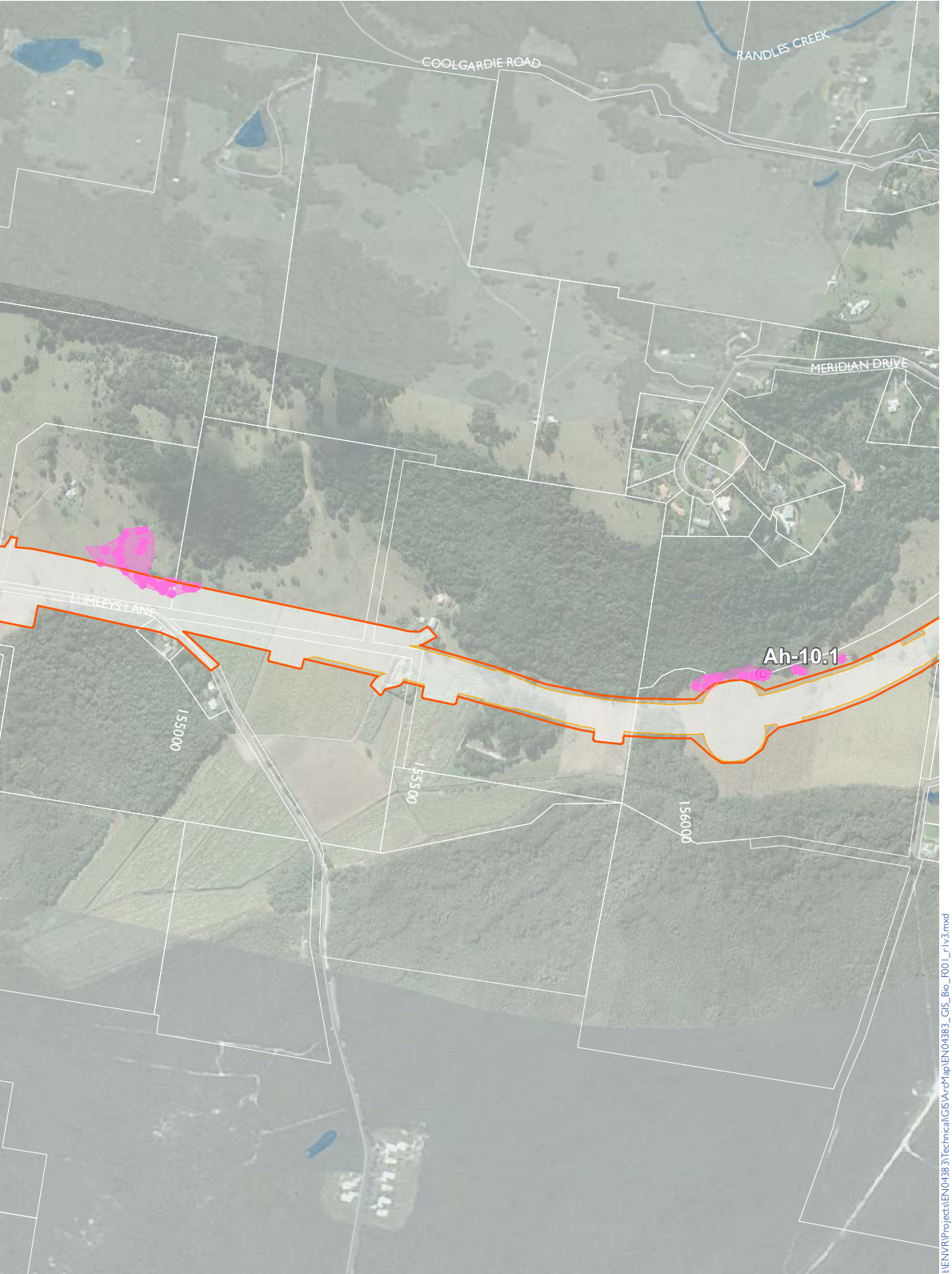
Figure A-38 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Monitoring location - Control
- Monitoring location - In situ
- Oberonia titania

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Figure A-39 Threatened flora and monitoring locations



- Project boundary
- Clearing boundary
- Arthroxon hispidus
- Arthroxon hispidus
- Monitoring location - In situ

This aerial map illustrates the proposed Coolgardie Road and its proximity to various heritage sites. The road is outlined in orange, and the heritage sites are marked with pink dots and labels. The map includes the following labels:

- Randles Creek
- Meridian Drive
- Gandie Place
- Ah-10.2
- Ah-10.3
- Ah-10.4
- Ah-10.5
- Ah-C10.1
- Ah-C10.2
- Ah-10.6
- Pacific Highway
- Kays Road
- Coolgardie Road
- Saltywater Creek
- 157000
- 158000



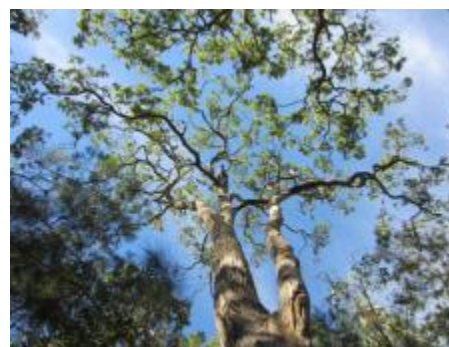
Appendix B. Threatened Flora Monitoring Baseline Data

ID Code	Species	ID Code	Species
Ar-3.1	<i>Angophora robur</i>	Li-2.1	<i>Lindsaea incisa</i>
Ar-C3.1	<i>Angophora robur</i>	Li-2.2	<i>Lindsaea incisa</i>
Ar-3.2	<i>Angophora robur</i>	Li-3.1	<i>Lindsaea incisa</i>
Ar-3.3	<i>Angophora robur</i>	Li-3.2	<i>Lindsaea incisa</i>
Ar-3.4	<i>Angophora robur</i>	Li-C6.1	<i>Lindsaea incisa</i>
Ar-3.5	<i>Angophora robur</i>	Li-6.1	<i>Lindsaea incisa</i>
Ar-3.6	<i>Angophora robur</i>	Li-6.2	<i>Lindsaea incisa</i>
Ar-3.7	<i>Angophora robur</i>	Mac-8.1	<i>Macadamia tetraphylla</i>
Ar-3.8	<i>Angophora robur</i>	Mt-1.1	<i>Maundia triglochinoides</i>
Ar-C3.2	<i>Angophora robur</i>	Mt-C1.1	<i>Maundia triglochinoides</i>
Ar-3.9	<i>Angophora robur</i>	Mt-1.2	<i>Maundia triglochinoides</i>
Ar-3.10	<i>Angophora robur</i>	Mt-C1.2	<i>Maundia triglochinoides</i>
Ar-3.11	<i>Angophora robur</i>	Mt-C2.1	<i>Maundia triglochinoides</i>
Ah-8.1	<i>Arthraxon hispidus</i>	Mt-2.1	<i>Maundia triglochinoides</i>
Ah-10.1	<i>Arthraxon hispidus</i>	Mt-2.2	<i>Maundia triglochinoides</i>
Ah-10.2	<i>Arthraxon hispidus</i>	Mt-2.3	<i>Maundia triglochinoides</i>
Ah-C10.1	<i>Arthraxon hispidus</i>	Mt-2.4	<i>Maundia triglochinoides</i>
Ah-10.3	<i>Arthraxon hispidus</i>	Mt-C2.2	<i>Maundia triglochinoides</i>
Ah-10.4	<i>Arthraxon hispidus</i>	Mt-3.1	<i>Maundia triglochinoides</i>
Ah-C10.2	<i>Arthraxon hispidus</i>	Mt-3.2	<i>Maundia triglochinoides</i>
Ah-10.5	<i>Arthraxon hispidus</i>	Mt-C3.1	<i>Maundia triglochinoides</i>
Ah-10.6	<i>Arthraxon hispidus</i>	Mt-3.3	<i>Maundia triglochinoides</i>
Elt-1.1	<i>Eleocharis tetraquetra</i>	Mt-7.1	<i>Maundia triglochinoides</i>
Elt-1.2	<i>Eleocharis tetraquetra</i>	Mt-7.2	<i>Maundia triglochinoides</i>
Elt-C1.1	<i>Eleocharis tetraquetra</i>	Mt-7.3	<i>Maundia triglochinoides</i>
Elt-C1.2	<i>Eleocharis tetraquetra</i>	Mi-7.1	<i>Melaleuca irbyana</i>
Elt-1.3	<i>Eleocharis tetraquetra</i>	Mi-C7.1	<i>Melaleuca irbyana</i>
Elt-1.4	<i>Eleocharis tetraquetra</i>	Mi-7.2	<i>Melaleuca irbyana</i>
Elt-1.5	<i>Eleocharis tetraquetra</i>	Oc-8.1	<i>Oberonia complanata</i>
Emb-4.1	<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	Ot-10.1	<i>Oberonia titania</i>
Emb-4.2	<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	Ot-C10.1	<i>Oberonia titania</i>
Et-2.1	<i>Eucalyptus tetrapleura</i>	Pe-C4.1	<i>Persicaria elatior</i>
Et-2.2	<i>Eucalyptus tetrapleura</i>	Pe-4.1	<i>Persicaria elatior</i>
Et-C2.1	<i>Eucalyptus tetrapleura</i>	Pe-4.2	<i>Persicaria elatior</i>
Et-2.3	<i>Eucalyptus tetrapleura</i>	Pe-5.1	<i>Persicaria elatior</i>
Gq-3.1	<i>Grevillea quadricauda</i>	Pe-5.2	<i>Persicaria elatior</i>
Gq-C3.1	<i>Grevillea quadricauda</i>	Pa-9.1	<i>Phaius australis</i>
La-C1.1	<i>Lindernia alsinoides</i>	Pc-6.1	<i>Prostanthera cineolifera</i>
La-1.1	<i>Lindernia alsinoides</i>	Pc-6.2	<i>Prostanthera cineolifera</i>
La-C1.2	<i>Lindernia alsinoides</i>	Pc-C6.1	<i>Prostanthera cineolifera</i>
La-1.2	<i>Lindernia alsinoides</i>	QM-C1.1	<i>Quassia</i> sp. Moonee Creek
La-C1.3	<i>Lindernia alsinoides</i>	QM-1.1	<i>Quassia</i> sp. Moonee Creek
La-1.3	<i>Lindernia alsinoides</i>	QM-C1.2	<i>Quassia</i> sp. Moonee Creek
La-2.1	<i>Lindernia alsinoides</i>	QM-1.2	<i>Quassia</i> sp. Moonee Creek
Li-1.1	<i>Lindsaea incisa</i>	Sp-4.1	<i>Streblus pendulinus</i>
Li-C2.1	<i>Lindsaea incisa</i>	Sp-8.1	<i>Streblus pendulinus</i>

Identification Code	Ar-3.1	Date	5/05/2014
Species	Angophora robur	Type	In situ
Location	North of project boundary, west of Woolli Road	Field marker	Pink Tape
Easting	509191	Section	3
Northing	6709050	Photo no. start	9020
Transect aspect	South	Photo no. finish	9022
Landform	Lower-mid slope	Slope	Low
Climate history	Rain end of March and during April, dry preceding	Aspect	South
Survey conditions	Clear, cool, sunny	Drainage	Good, sandy
Water levels/If flow	n/a	Soil moisture	High-moderate
Vegetation Community	Scribbly Gum sandy dry forest	Canopy cover (%)	26
Canopy species	Eucalyptus bancroftii, Angophora robur, Lophostemon suaveolens	Midstorey (%)	16
Midstorey species	Alphitonia excelsa, Allocasuarina littoralis	Forb cover (%)	5
Understorey species	Vernonia cinerea, Digitaria diffusa, Imperata cylindrica, Microlaena stipoides	Grass cover (%)	50
Weed species	Axonopus fissifolius	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	30
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, Clearing/underscrubbing, pasture improvement	Exotic (%)	15
Leaf condition	Appear healthy	Plant condition score	4 to 5
Dieback	Yes, Refer to table	Height (m)	Refer to table
Disease/Insect Attack	Yes, holes in some leaves	Width (m)	Refer to table
New shoot length	No access	Recruitment	No



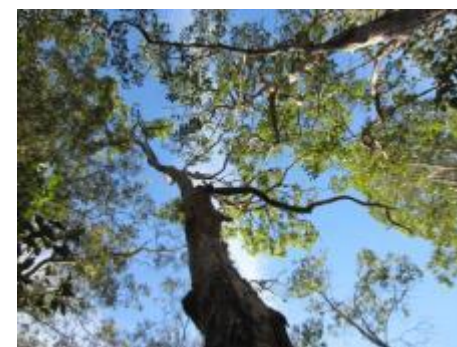
Plot Location



Tree 5




Tree 4




Tree 7

Tree No. Ar-3.1	Height (m)	Width (m)	DBH (cm)	Photo No.	Dieback/Comments
1	16	4	35	9023	3 x large and 2 x medium
2	10	3	15	9024	1 x medium and 2 x small branches
3	15	9	36	9025	1 x large, 1 s medium and 3 x small branches
4	15	7	33	9026	8 x large, plus several medium branches
5	17	10	42	9027	5 x medium and several small branches
6	16	8	27	9028	2 x large and 5 x medium branches (Appx.)
7	15	8	37	9029	6 large and 1 x medium branches
Mean	15	7	32		


Identification Code	Ar-C3.1	Date	5/05/2014
Species	<i>Angophora robur</i>	Type	Control
Location	North of project boundary, west of Wooli Road	Field marker	Pink Tape
Easting	509163	Section	3
Northing	6709180	Photo no. start	9007
Transect aspect	South	Photo no. finish	9009
Landform	Mid/lower slope	Slope	Low
Climate history	0	Aspect	South
Survey conditions	0	Drainage	Good, sandy
Water levels/flow	n/a	Soil moisture	High-moderate
Vegetation Community	Scribbly Gum sandy dry forest	Canopy cover (%)	14
Canopy species	<i>Eucalyptus signata</i> , <i>Angophora robur</i> , <i>Corymbia intermedia</i>	Midstorey (%)	16
Midstorey species	<i>Banksia integrifolia</i> , <i>Alphitonia excelsa</i> , <i>Lophostemon suaveolens</i>	Forb cover (%)	15
Understorey species	<i>Pratia</i> , <i>Gahnia aspera</i> , <i>Echinopogon caespitosus</i> , <i>Microlaena stipoides</i> , <i>Imperata cylindrica</i> , <i>Hibbertia aspera</i> , <i>Digitaria diffusa</i>	Grass cover (%)	55
Weed species	<i>Paspalum mandiocanum</i> , <i>Gomphocarpus fruticosus</i> , <i>Axonopus fissifolius</i>	Shrub cover (%)	5
Weed abundance	Moderate	Litter (%)	15
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, Clearing/underscrubbing, pasture improvement	Exotic (%)	10
Leaf condition	Juveniles, dark green leaves, generally healthy, some insect attack	Plant condition score	4 to 5
Dieback	Yes, see below	Height (m)	Refer to table
Disease/Insect Attack	Yes, holes in some leaves	Width (m)	Refer to table
New shoot length	5 to 10 cm shoots on juvenile plants	Recruitment	Yes, 10x juvs




Plot Location



Tree 4




Tree 6




Juvs

Tree No. Ar-C3.1	Height (m)	Width (m)	DBH (cm)	Photo No.	Dieback/Comments
1	14	4	26	9014	6 x small branches
2	4	1	13	9013	1 x large trunk
3	11	10	36	9015	6 x medium and 8 x small branches (Appx.). Lots of fruit
4	7	2	18	9016	2 x small branches
5	7	3	13	9017	3 x small branches
6	15	8	47	9018	10 larger, 10 medium and lots of small (Appx.)
Juvs	0.5	0.5	0.5	9010-12	None
Mean	8	4	22		

Identification Code	Ar-3.2	Date	27/03/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Mitchell Road intersection	Field marker	Pink Tape
Easting	512180	Section	3
Northing	6711660	Photo no. start	8008
Transect aspect	South	Photo no. finish	8010
Landform	Lower slope	Slope	Low
Climate history	Dry previous	Aspect	South
Survey conditions	Clear, recent rain	Drainage	Good to moderate
Water levels/flow	n/a	Soil moisture	High
Vegetation Community	Dry sandy forest / Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	8
Canopy species	<i>Eucalyptus signata</i> , <i>Angophora robur</i> , <i>Lophostemon suaveolens</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	4
Midstorey species	<i>Lophostemon suaveolens</i> , <i>Leptospermum polygalifolium</i> , <i>Banksia oblongifolia</i>	Forb cover (%)	20
Understorey species	<i>Pomax umbellata</i>	Grass cover (%)	0
Weed species	<i>Axonopus fissifolius</i> , <i>Andropogon virginicus</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	60
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Clearing, underscrubbing, grazing, weed invasion	Exotic (%)	20
Leaf condition	Healthy, some insect damage	Plant condition score	5 to 5
Dieback	Yes, Trees 4 and 5	Height (m)	Refer to table
Disease/Insect Attack	Some chewed leaves	Width (m)	Refer to table
New shoot length	n/a	Recruitment	No




Plot Location



Insect damage Tree 14 (seedling)

Tree No. Ar-3.2	Height (m)	DBH (cm)
1	11	24
2	11	21
3	14	35
4	6	22
5	11	14
6	5	12
7	14	26
8	11	27
9	11	23
10	10	21
11	10	16
12	10	18
13	12	18
14	0.1	n/a (seedling)
15	0.4	n/a (seedling)
16	0.5	n/a (seedling)
17	0.1	n/a (seedling)
18	0.1	n/a (seedling)
Mean	8	21


Identification Code	Ar-3.3	Date	27/03/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Pillar Valley -north of Mitchell Road intersection	Field marker	Pink Tape
Easting	512160	Section	3
Northing	6712080	Photo no. start	8003
Transect aspect	South	Photo no. finish	8005
Landform	Lower slope	Slope	Low to moderate
Climate history	Dry previous	Aspect	North
Survey conditions	Clear, recent rain	Drainage	Good to moderate
Water levels/flow	n/a	Soil moisture	High
Vegetation Community	Dry sandy forest	Canopy cover (%)	35
Canopy species	<i>Eucalyptus microcorys</i> , <i>Eucalyptus signata</i> , <i>Corymbia intermedia</i>	Midstorey (%)	8
Midstorey species	<i>Glochidion ferdinandi</i> , <i>Alphitonia excelsa</i>	Forb cover (%)	10
Understorey species	<i>Imperata cylindrica</i> , <i>Pteridium esculentum</i>	Grass cover (%)	70
Weed species	<i>Lantana camara</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	20
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Lantana invasion, frequent burning, cattle grazing	Exotic (%)	0
Leaf condition	Healthy, some insect damage	Plant condition score	4 to 5
Dieback	Yes, Trees 10, 11, 13 and 14	Height (m)	Refer to table
Disease/Insect Attack	Some chewed leaves	Width (m)	Refer to table
New shoot length	n/a	Recruitment	Seedlings present



Plot Location

Tree No. Ar-3.3	Height (m)	DBH (cm)
1	10	12
2	13	16
3	10	12
4	12	18
5	5	8
6	12	12
7	9	12
8	6	8
9	14	20
10	5	10
11	5	12
12	6	12
13	5	8
14	8	16
15	8	10
16	0.15	n/a (seedling)
17	0.5	n/a (seedling)
Mean	8	12


Identification Code	Ar-3.4	Date	27/03/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Pillar Valley -north of Mitchell Road intersection	Field marker	Pink Tape
Easting	512324	Section	3
Northing	6712920	Photo no. start	7999
Transect aspect	South Southeast	Photo no. finish	8001
Landform	Lower slope	Slope	Low
Climate history	Dry previous	Aspect	West Northwest
Survey conditions	Clear, recent rain	Drainage	Good-moderate
Water levels/flow	n/a	Soil moisture	High
Vegetation Community	Sandy dry forest	Canopy cover (%)	26
Canopy species	<i>Eucalyptus signata</i> , <i>Angophora robur</i> , <i>Corymbia intermedia</i> , <i>Angophora woodsiana</i> ,	Midstorey (%)	30
Midstorey species	<i>Banksia aemula</i> , <i>Endiandra sieberi</i> , <i>Leucopogon lanceolatus</i>	Forb cover (%)	10
Understorey species	<i>Entolasia stricta</i> , <i>Imperata cylindrica</i> , <i>Hibbertia vestita</i>	Grass cover (%)	50
Weed species	<i>Lantana camara</i>	Shrub cover (%)	5
Weed abundance	Low	Litter (%)	35
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Grazing, burning off	Exotic (%)	0
Leaf condition	Healthy, some insect damage	Plant condition score	4 to 5
Dieback	Yes, Trees 15, 16 and 29	Height (m)	Refer to table
Disease/Insect Attack	Some chewed leaves	Width (m)	Refer to table
New shoot length	n/a	Recruitment	Yes, appx. 10 seedlings present




Plot Location

Tree No. Ar-3.4	Height (m)	DBH (cm)
1	14	20
2	5	10
3	15	32
4	15	26
5	10	10
6	13	22
7	15	28
8	10	16
9	10	14
10	15	24
11	8	20
12	10	12
13	12	20
14	16	32
15	14	26
16	10	12
17	0.05	n/a
18	0.15	n/a
19	0.15	n/a
20	0.25	n/a
21	0.1	n/a
22	0.1	n/a
23	0.25	n/a
24	0.1	n/a
25	13	30
26	11	13
27	0.1	n/a
28	0.1	n/a
29	4	8
30	14	22
Mean	8	20

Identification Code	Ar-3.5	Date	26/03/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Chaffin Creek-Southside	Field marker	Pink Tape
Easting	512054	Section	3
Northing	6715310	Photo no. start	7984
Transect aspect	South	Photo no. finish	7986
Landform	Lower slope	Slope	Moderate
Climate history	Dry previous	Aspect	North
Survey conditions	Clear, recent rain	Drainage	Good
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Spotted Gum - Ironbark Forest / Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	20
Canopy species	<i>Eucalyptus siderophloia</i> , <i>Eucalyptus tereticornis</i> , <i>Corymbia intermedia</i>	Midstorey (%)	9
Midstorey species	<i>Angophora robur</i>	Forb cover (%)	0
Understorey species	<i>Imperata cylindrica</i>	Grass cover (%)	25
Weed species	<i>Lantana camara</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	75
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, regular burning off - dense <i>Imperata cylindrica</i>	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	Few dead branches	Height (m)	Refer to table
Disease/Insect Attack	Some chewed leaves	Width (m)	Refer to table
New shoot length	None obvious	Recruitment	No



Plot Location





A caterpillar found on *Angophora robur* nearby in Chaffin Creek

Tree No. Ar-3.5	Height (m)	DBH (cm)	Comment
1	7	11	Lots of fruit
2	7	9	Lots of fruit
3	3	6	Dieback
4	0.1	n/a	
5	10	17	Insect damage
6	15	30	Lots of fruit
7	11	18	Lots of fruit
8	6	16	Broken trunk
9	6	13	Lots of fruit
10	12	16	Lots of fruit
11	14	21	Lots of fruit
12	5	11	Lots of fruit
13	0.2	n/a	
Mean	7	15	



Identification Code	Ar-3.6	Date	26/03/2014		Tree No. Ar-3.6	Height (m)	DBH (cm)	Comment
Species	<i>Angophora robur</i>	Type	In situ		1	15	22	Lots of fruit
Location	Tucabia - north of Bostock Road	Field marker	Pink Tape		2	15	35	Lots of fruit
Easting	513046	Section	3		3	12	20	Dieback
Northing	6718670	Photo no. start	7965		4	10	21	
Transect aspect	South	Photo no. finish	7967		5	15	23	Insect damage
Landform	Sandy Slope	Slope	Low		6	12	22	Lots of fruit
Climate history	Dry previous	Aspect	West		7	15	28	Lots of fruit
Survey conditions	Clear, recent rain	Drainage	Good, sandy		8	14	30	Broken trunk
Water levels	n/a	Soil moisture	High		9	14	25	Lots of fruit
Water flow	n/a			Plot Location	10	16	37	Lots of fruit
Vegetation Community	Turpentine - Red Mahogany Forest	Canopy cover (%)	16		Mean	14	26	
Canopy species	<i>Syncarpia glomulifera</i> , <i>Eucalyptus resinifera</i> , <i>Angophora robur</i> , <i>Corymbia intermedia</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	13					
Midstorey species	<i>Banksia integrifolia</i> , <i>Leucopogon lanceolatus</i> ,	Forb cover (%)	25					
Understorey species	<i>Lomandra longifolia</i> , <i>Pteridium esculentum</i>	Grass cover (%)	15					
Weed species	None	Shrub cover (%)	10					
Weed abundance	0	Litter (%)	50					
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0					
Impacts/disturbance/threats	0	Exotic (%)	0					
Leaf condition	Healthy, bright green	Plant condition score	4					
Dieback	Some dieback	Height (m)	Refer to table					
Disease/Insect Attack	Mistletoe-dead, Some chewed leaves	Width (m)	Refer to table	Angophora robur trees in the plot				
New shoot length	n/a	Recruitment	No					

Identification Code	Ar-3.7	Date	24/03/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Tucabia - north of Tallowood Lane	Field marker	Pink Tape
Easting	513734	Section	3
Northing	6721640	Photo no. start	7889
Transect aspect	Southwest	Photo no. finish	7891
Landform	Sandy hill	Slope	Moderate
Climate history	Dry previous	Aspect	North
Survey conditions	Clear, recent rain	Drainage	Good, sandy
Water levels	n/a	Soil moisture	Moderate
Water flow	n/a		
Vegetation Community	Sandy dry forest	Canopy cover (%)	19
Canopy species	<i>Eucalyptus signata</i> , <i>Angophora robur</i> , <i>Eucalyptus planchoniana</i> , <i>Corymbia intermedia</i>	Midstorey (%)	4
Midstorey species	0	Forb cover (%)	25
Understorey species	0	Grass cover (%)	30
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	45
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Fire 9 months ago	Exotic (%)	0
Leaf condition	Bright green, limited insect damage	Plant condition score	4
Dieback	Yes, some dead branches	Height (m)	Refer to table
Disease/Insect Attack	Some chewed leaves	Width (m)	Refer to table
New shoot length	n/a	Recruitment	Regrowth from small lignotuber following fire

Plot Location

Tree 1 and 8 – dieback evident






Tree 27 – healthy seedling

Tree 30 – insect damage

Tree No. Ar-3.7	Mean height (m)	Mean DBH (cm)	Comment	Photos
1 to 10	15	20	Mature	7894: Tree 1 and 8; 7893: Tree 10
11 to 36	0.3	n/a	Juvenile plants	7892: Tree 22; 7895 to 7896 insect damage Tree 29; 7897 insect damage Tree 30

Identification Code	Ar-3.8	Date	5/05/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Pine brush State Forest, in road boundary	Field marker	Pink Tape
Easting	512862	Section	3
Northing	6724070	Photo no. start	9030
Transect aspect	South	Photo no. finish	9032
Landform	Lower slope/floodplain	Slope	Flat to slight
Climate history	Rain end of March and during April, dry preceding	Aspect	West
Survey conditions	Clear, cool, sunny	Drainage	Moderate-poor, sandy soils
Water levels	n/a	Soil moisture	High-moderate
Water flow	n/a		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	16
Canopy species	<i>Lophostemon suaveolens</i> , <i>Eucalyptus robusta</i> , <i>Melaleuca quinquenervia</i>	Midstorey (%)	23
Midstorey species	<i>Banksia integrifolia</i> , <i>Angophora robur</i> , <i>Trochocarpa laurina</i> , <i>Leucopogon lanceolatus</i> , <i>Banksia serrata</i> , <i>Acacia disparrima</i>	Forb cover (%)	80
Understorey species	<i>Baloskion tetraphyllum</i> , <i>Lomandra longifolia</i>	Grass cover (%)	0
Weed species	<i>Solanum mauritianum</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	20
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Past logging, state forest	Exotic (%)	0
Leaf condition	Appear healthy, dark green	Plant condition score	4 to 5
Dieback	Yes, Refer to table	Height (m)	Refer to table
Disease/Insect Attack	Yes, holes in some leaves	Width (m)	Refer to table
New shoot length	No access	Recruitment	No






Plot Location

Tree 9 – dieback evident

Tree No. Ar-3.1	Height (m)	Width (m)	DBH (cm)	Photo No.	Dieback/Comments
1	12	5	22	9033	1 x large and 2 x medium branches
2	10	2	17	9034	2 x large and 2 x medium branches
3	15	5	34	9035	3 x large and 2 x medium branches
4	3	1.5	7	9036	1 large trunk
5	14	5	27	9037	2 x large and 2 x medium branches
6	11	5	15	9041	1 x large and 2 x medium branches, lots of fruit
7	8	4	20	9040	1 x very large and 4 x medium branches, insect damage
8	10	4	25	9038	1 x very large and 10 x small branches
9	11	8	45	9039	1 x very large and 4 x medium branches, mistletoe
Mean	11	4	24		

Identification Code	Ar-C3.2	Date	5/05/2014
Species	Angophora robur	Type	Control
Location	Crown land, Tucabia Road, east of project boundary	Field marker	Pink Tape
Easting	512752	Section	3
Northing	6724240	Photo no. start	9058
Transect aspect	South	Photo no. finish	9060
Landform	Mid slope	Slope	Moderate
Climate history	Rain end of March and during April, dry preceding	Aspect	Northwest
Survey conditions	Clear, cool, sunny	Drainage	Good, sandy
Water levels	n/a	Soil moisture	Moderate
Vegetation Community	Tallowwood Forest	Canopy cover (%)	30
Canopy species	Angophora robur, Corymbia intermedia, Acacia disparrima	Midstorey (%)	0
Midstorey species	Acacia disparrima, Alphitonia excelsa, Glochidion ferdinandi, Breynia oblongifolia	Forb cover (%)	15
Understorey species	Pteridium esculentum, Glycine clandestina, Billardiera scandens, Digitaria diffusa, Microlaena stipoides, Imperata cylindrica	Grass cover (%)	55
Weed species	Lantana camara	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	30
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, weed invasion	Exotic (%)	0
Leaf condition	Appear healthy, dark green	Plant condition score	4 to 5
Dieback	Yes, Refer to table	Height (m)	Refer to table
Disease/Insect Attack	Yes, holes in some leaves	Width (m)	Refer to table
New shoot length	No access	Recruitment	No







Plant No. Ar-C3.2	Height (m)	Width	DBH	Photo No.	Dieback
1	14	3	18	9061	2 large branches
2	13	5	33	9062	4 large branches - trunk damaged
3	4	2	10	9064	1 x large trunk
4	15	1	44	9065	1 x very large low branch, 4 large and 5 medium branches
5	15	6	32	9066	4 large branches difficult to see
6	15	8	32	9067	3 x very large low branch, 4 large branches
7	17	11	60	9063	3 x medium branches, some mistletoe
Mean	13	5	33		

Identification Code	Ar-3.9	Date	28/03/2014	No photos due to heavy rain during survey			
Species	<i>Angophora robur</i>	Type	In situ				
Location	Tucabia - north of Pine Brush State Forest	Field marker	Pink Tape				
Easting	513314	Section	3				
Northing	6726990	Photo no. start	8022				
Transect aspect	South	Photo no. finish	8024				
Landform	Mid slope	Slope	Moderate				
Climate history	Dry previous	Aspect	South				
Survey conditions	Raining	Drainage	Good, sandy				
Water levels	n/a	Soil moisture	High				
Water flow	n/a						
Vegetation Community	Sandy dry forest	Canopy cover (%)	5	Tree No. Ar-3.9	Height (m)	DBH (cm)	Dieback/Comments (Heavy rain - no photos)
Canopy species	<i>Angophora robur</i> , <i>Corymbia gummifera</i>	Midstorey (%)	4	1	12	16	Bark condition possible disease, some dieback
Midstorey species	<i>Alphitonia excelsa</i> , <i>Glochidion ferdinandi</i> , <i>Endiandra sieberi</i> , <i>Acacia disparrima</i>	Forb cover (%)	10	2	14	56	Several large dead limbs, tree senescent, sap flow, possible hollows
Understorey species	<i>Lepidosperma laterale</i> , <i>Oplismenus imbecillis</i>	Grass cover (%)	15	3	17	64	Little dieback, some burls, large tree, sthn edge plot
Weed species	<i>Lantana camara</i>	Shrub cover (%)	0	4	15	28	Some dieback appears healthy, wstn edge plot
Weed abundance	Low	Litter (%)	75	5	12	28	Some dieback, smaller twisted tree
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0	6	15	50	Some dieback, sap flow, burls
Impacts/disturbance/threats	Cattle grazing	Exotic (%)	0	7 to 12	n/a	n/a	Seedlings 0.15-0.3 m high on rocky outcrop
Leaf condition	Healthy, some dieback, insect attack	Plant condition score	3 to 4	Mean	14	40	
Dieback	Yes	Height (m)	Refer to table				
Disease/Insect Attack	Yes, chewed leaves	Width (m)	Refer to table				
New shoot length	n/a	Recruitment	Yes 4x seedlings				

Identification Code	Ar-3.10	Date	25/03/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Tyndale- South of Bensons Lane	Field marker	Pink Tape
Easting	514071	Section	3
Northing	6728700	Photo no. start	7920
Transect aspect	South	Photo no. finish	7922
Landform	Mid slope, sandy	Slope	Moderate
Climate history	Dry previous	Aspect	Southwest
Survey conditions	Clear, recent rain	Drainage	Good, sandy
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Turpentine forest	Canopy cover (%)	13
Canopy species	<i>Corymbia intermedia</i> , <i>Angophora robur</i> , <i>Eucalyptus microcorys</i> , <i>Eucalyptus psammitica</i>	Midstorey (%)	16
Midstorey species	<i>Trochocarpa laurina</i> , <i>Acacia disparrima</i> , <i>Banksia integrifolia</i>	Forb cover (%)	10
Understorey species	<i>Lepidosperma laterale</i> , <i>Imperata cylindrica</i>	Grass cover (%)	50
Weed species	<i>Lantana camara</i>	Shrub cover (%)	5
Weed abundance	Moderate	Litter (%)	30
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Logging, Lantana invasion, too frequent fires, grazing	Exotic (%)	5
Leaf condition	Healthy, some minor insect damage	Plant condition score	4 to 5
Dieback	Few dead branches	Height (m)	Refer to table
Disease/Insect Attack	Some chewed leaves	Width (m)	Refer to table
New shoot length	n/a	Recruitment	No



Plot Location



Lantana camara in plot

Tree No. Ar-3.10	Height (m)	DBH (cm)
1	12	25
2	5	7
3	12	17
4	12	21
5	10	15
6	15	21
7	10	15
8	11	15
9	12	15
10	15	20
11	10	15
12	12	21
13	11	15
14	0.1	n/a
15	5	8
16	6	20
17	0.1	n/a
18	0.1	n/a
19	0.1	n/a
20	0.1	n/a
Mean	8	17

Identification Code	Ar-3.11	Date	25/03/2014
Species	<i>Angophora robur</i>	Type	In situ
Location	Tyndale- north of Bensons Lane	Field marker	Pink Tape
Easting	514775	Section	3
Northing	6729680	Photo no. start	7925
Transect aspect	South	Photo no. finish	7927
Landform	Upper slope, sandy	Slope	Steep
Climate history	Dry previous	Aspect	South Southwest
Survey conditions	Clear, recent rain	Drainage	Good, sandy
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Turpentine forest	Canopy cover (%)	35
Canopy species	<i>Eucalyptus microcorys</i> , <i>Corymbia intermedia</i> , <i>Angophora robur</i>	Midstorey (%)	15
Midstorey species	<i>Trochocarpa laurina</i>	Forb cover (%)	35
Understorey species	<i>Calochlaena dubia</i> , <i>Doodia aspera</i>	Grass cover (%)	45
Weed species	<i>Lantana camara</i>	Shrub cover (%)	0
Weed abundance	Low-Moderate	Litter (%)	20
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Lantana invasion	Exotic (%)	0
Leaf condition	Bright green, some insect damage	Plant condition score	5
Dieback	Yes, some bare limbs	Height (m)	Refer to table
Disease/Insect Attack	Some chewed leaves	Width (m)	Refer to table
New shoot length	n/a	Recruitment	No



Plot Location

Lantana camara in plot area

Tree No. Ar-3.11	Height (m)	DBH (cm)	Dieback/Comments
1	14	20	Appears healthy, canopy 5 m wide
2	18	35	Appears healthy, canopy 5 m wide
3	17	34	Appears healthy, canopy 5 m wide
Mean	16	30	

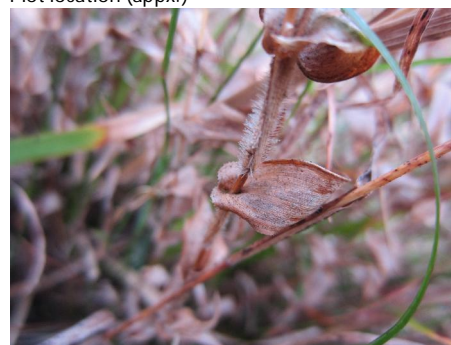
Identification Code	Ah-8.1	Date	2/09/2014
Species	<i>Arthraxon hispidus</i>	Type	In situ
Location	Trustums Hill - north of The Gap Road	Field marker	Not marked yet
Easting	0	Section	8
Northing	0	Photo no. start	9974
Transect aspect	South	Photo no. finish	9985
Landform	Floodplain	Slope	Flat
Climate history	Heavy rain previous week	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor-moderate
Water levels	Moderate-low	Soil moisture	High
Water flow	n/a		
Vegetation Community	Exotic grassland/pasture	Canopy cover (%)	0
Canopy species	<i>Casuarina glauca</i>	Midstorey (%)	0
Midstorey species	<i>Casuarina glauca</i>	Forb cover (%)	0
Understorey species	<i>Arthraxon hispidus</i> , <i>Centella asiatica</i>	Grass cover (%)	0
Weed species	<i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Weeds, grazing	Exotic (%)	0
Leaf condition	Brown, plants dead	Plant condition score	0
Dieback	Yes, all plants dead	Height (m)	0
Disease/Insect Attack	None obvious	Width (m)	0
New shoot length	n/a	Recruitment	No



Plot location (appx.)




Dead plants observed during September

Dead *Arthraxon hispidus*Dead *Arthraxon hispidus*


Comment

All plants have died back transect location yet to be established once extant of remaining population adjacent to the clearing boundary is known. Targeted surveys required in summer/autumn.

Identification Code	Ah-10.1	Date	1/04/2014
Species	Arthraxon hispidus	Type	In situ
Location	Coolgardie, adjacent to proposed fauna overpass	Field marker	Pink Tape
Easting	545301	Section	10
Northing	6799630	Photo no. start	8094
Transect aspect	South	Photo no. finish	8096
Landform	Floodplain edge	Slope	Slight
Climate history	Dry previous	Aspect	South
Survey conditions	Clear, recent rain	Drainage	Poor-moderate
Water levels	Moderate-low	Soil moisture	High-moderate
Water flow	None/little		
Vegetation Community	Exotic grassland/pasture	Canopy cover (%)	0
Canopy species	Lophostemon suaveolens, Corymbia intermedia	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	0
Understorey species	0	Grass cover (%)	0
Weed species	Setaria sphacelata, Paspalum mandiocanum	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Weeds, altered grazing regime	Exotic (%)	100
Leaf condition	Healthy green, some yellow/brown leaves	Plant condition score	4 to 5
Dieback	None/little	Height (m)	up to 50 cm
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	n/a	Recruitment	Possible





Plot Location



Ah206


Field code	No. of stems	Photo	Comments
Ah-10.1			
Ah206	8	8097	Low abundance, western end of plot, southern edge of drainage channel
Ah207	25	8098	Moderate abundance, mid-western area of plot
Ah208	15		Starting to flower, difficult to detect in dense exotic grassland
Total	48		

Identification Code	Ah-10.2	Date	1/04/2014
Species	<i>Arthraxon hispidus</i>	Type	In situ
Location	Coolgardie, north of Kay's Road	Field marker	Metal Star Picket
Easting	545899	Section	10
Northing	6800020	Photo no. start	8102
Transect aspect	South	Photo no. finish	8104
Landform	Floodplain	Slope	Slight
Climate history	Dry previous	Aspect	Southeast
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Water in drainage channel	Soil moisture	High
Water flow	None/little		
Vegetation Community	Exotic grassland/pasture	Canopy cover (%)	0
Canopy species	0	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	5
Understorey species	<i>Centella asiatica</i> , <i>Commelina cyanea</i> , <i>Cynodon dactylon</i> , <i>Oplismenus aemulus</i> , <i>Hypolepis muelleri</i> , <i>Juncus usitatus</i> , <i>Cyperus polystachyos</i> , <i>Dichondra repens</i>	Grass cover (%)	10
Weed species	<i>Axonopus fissifolius</i> , <i>Paspalum dilatatum</i> , <i>Ageratina adenophora</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Weeds, altered grazing regime	Exotic (%)	85
Leaf condition	Healthy green, some yellow/brown leaves	Plant condition score	4 to 5
Dieback	None/little	Height (m)	up to 50 cm
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	n/a	Recruitment	Possible

Plot Location

Ah1 –slight yellowing on some leaves






Ah2

Ah3



Field code	Abundance	Photo	Comments
Ah-10.2			
Ah1	High-Moderate	8105-8111	North end of transect, westside, edge of forest
Ah2	High-Moderate	8112-8113	Northwest area of plot, edge of forest
Ah3	High	8114-8115	Northeast corner of plot

Identification Code	Ah-C10.1	Date	3/04/2014
Species	<i>Arthraxon hispidus</i>	Type	Control
Location	Coolgardie, west of Kay's Road intersection	Field marker	Metal star pickets both ends
Easting	546254	Section	10
Northing	6800230	Photo no. start	8269
Transect aspect	South	Photo no. finish	8271
Landform	dry previous	Slope	Flat
Climate history	Dry previous	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	None/little		
Vegetation Community	Exotic grassland / freshwater wetland	Canopy cover (%)	0
Canopy species	0	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	35
Understorey species	<i>Juncus usitatus</i> , <i>Commelina cyanea</i> , <i>Paspalum vaginatum</i> , <i>Paspalum distichum</i> , <i>Cyperus polystachyos</i> , <i>Carex appressa</i> , <i>Ludwigia peploides</i> , <i>Carex appressa</i> , <i>Eleocharis acuta</i>	Grass cover (%)	45
Weed species	<i>Paspalum urvillei</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	0
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Lack of grazing, trampling	Exotic (%)	20
Leaf condition	Healthy, green, some yellow spots	Plant condition score	4 to 5
Dieback	Some yellow spots plants on island	Height (m)	Up to 1.2 m
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	Up to 1.2 m	Recruitment	Possibly

Plot Location

Ah1 –slight yellowing on some leaves





Ah2

Ah3

Field code	Abundance	Photo	Comments
Ah-C10.1			
Ah1	High	8272-8274	Northwest corner of the plot, small rise surrounded by swamp habitat
Ah2	High	8275-8276	Mid western area of plot south of drainage channel
Ah3	High	8278-79	Mid eastern area of plot south of drainage channel

Occurs on the edges of two drainage channels that cross the plot area drainage areas too wet for the species



Identification Code	Ah-10.3	Date	1/04/2014
Species	Arthraxon hispidus	Type	In situ
Location	Coolgardie, west of Kay's Road	Field marker	Metal Star Picket, Telstra pole at 10 m mark
Easting	546170	Section	10
Northing	6800340	Photo no. start	8128
Transect aspect	South	Photo no. finish	8130
Landform	Lower slope/floodplain	Slope	Moderate to flat
Climate history	Dry previous	Aspect	East to flat
Survey conditions	Clear, recent rain	Drainage	Poor-moderate
Water levels	Water in wetland area	Soil moisture	High
Water flow	Stagnant		
Vegetation Community	Exotic grassland/pasture	Canopy cover (%)	0
Canopy species	0	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	0
Understorey species	Paspalum distichum	Grass cover (%)	35
Weed species	Cinnamomum camphora, Lantana camara, Gomphocarpus fruticosus	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Weeds, altered grazing regime	Exotic (%)	65
Leaf condition	Healthy green, minor yellow/brown parts, some leaves purple	Plant condition score	4 to 5
Dieback	None/little	Height (m)	up to 1 m
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	n/a	Recruitment	Possible





Field code	Abundance	Photo	Comments
Ah-C10.3			
Ah1	Low-Moderate	8132	North central area of plot. Edge of wetland
Ah2	Low	8133-8135	Central area of plot. Some smaller plants present
Ah3	Moderate	8136-8138	Southern end west of central transect
Ah4	Low-Moderate	8139-8140	Southern end east of central transect. Edge of wetland

Mostly low abundance. Occurs on edges of wetland and wet spots on adjacent slope. Telstra easement in plot. Shaded from afternoon sun.



Identification Code	Ah-10.4	Date	3/04/2014
Species	<i>Arthraxon hispidus</i>	Type	In situ
Location	Coolgardie, west of Kay's Road	Field marker	Pink Tape
Easting	546253	Section	10
Northing	6800430	Photo no. start	8252
Transect aspect	South	Photo no. finish	8254
Landform	Floodplain, raised mound	Slope	Flat
Climate history	Dry previous	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor-moderate
Water levels	Moderate-low	Soil moisture	High-moderate
Water flow	None/little		
Vegetation Community	Exotic grassland / freshwater wetland	Canopy cover (%)	0
Canopy species	0	Midstorey (%)	15
Midstorey species	<i>Acacia melanoxylon</i>	Forb cover (%)	10
Understorey species	<i>Persicaria hydropiper</i> , <i>Juncus usitatus</i> , <i>Centella asiatica</i> , <i>Cynodon dactylon</i> , <i>Paspalum distichum</i>	Grass cover (%)	0
Weed species	<i>Lantana camara</i> , <i>Cinnamomum camphora</i> , <i>Ipomoea indica</i> , <i>Ageratum houstonianum</i> , <i>Ligustrum sinense</i> , <i>Sida rhombifolia</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Lack of grazing, trampling	Exotic (%)	75
Leaf condition	Healthy, green, some yellow spots, browned leaves	Plant condition score	4 to 5
Dieback	Some yellow spots, browned leaves	Height (m)	Up to 1.3 m
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	Up to 1.3 m	Recruitment	Possibly



Plot Location			Ah1
Field code Ah-10.4	Abundance	Photo	Comments
Ah1	High	8255-8258	Flagged Juncus culms
Ah2	High	8259-8261	Just outside plot. Plants fallen over with large daisys
Ah3	High	8262-8264	1.3 metres high
Ah4	Very High	8265-8267	Dying back yellow leaves, lots of flowers
Ah5	Low	8268	
Ah6	Moderate		Edge of mound
Creek/drainage area along eastern edge of plot, constructed mound along central area of plot.			

Identification Code	Ah-C10.2	Date	3/04/2014	 			
Species	<i>Arthraxon hispidus</i>	Type	Control				
Location	Coolgardie, west of Kay's Road	Field marker	Pink Tape and stake at end				
Easting	546283	Section	10				
Northing	6800440	Photo no. start	8241				
Transect aspect	South	Photo no. finish	8243				
Landform	Floodplain	Slope	Flat				
Climate history	Dry previous	Aspect	Flat				
Survey conditions	Clear, recent rain	Drainage	Poor				
Water levels	Moderate	Soil moisture	High				
Water flow	Low			Plot Location			
Vegetation Community	Exotic grassland	Canopy cover (%)	0	 			
Canopy species	0	Midstorey (%)	0				
Midstorey species	0	Forb cover (%)	15				
Understorey species	<i>Paspalum distichum</i> , <i>Juncus usitatus</i> , <i>Arthraxon hispidus</i> , <i>Hypolepis muelleri</i>	Grass cover (%)	65				
Weed species	<i>Cinnamomum camphora</i> , <i>Ipomoea indica</i> , <i>Ageratina adenophora</i>	Shrub cover (%)	0				
Weed abundance	Moderate	Litter (%)	0				
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0				
Impacts/disturbance/threats	Lack of grazing, trampling	Exotic (%)	21.25				
Leaf condition	Healthy, green, some yellow spots	Plant condition score	4 to 5				
Dieback	Some yellow spots	Height (m)	Up to 1 m				
Disease/Insect Attack	No	Width (m)	n/a	Ah2			
New shoot length	Up to 1 m	Recruitment	Possibly	Ah3			
				Field code	Abundance	Photo	Comments
				Ah1	High	8244-8245	Northeast corner of the plot
				Ah2	High-Very High	8246-8247	Southeast corner of the plot. High abundance 200+ stems
				Ah3	Moderate	8248-8251	West of plot. Crofton Weed flagged

Identification Code	Ah-10.5	Date	3/04/2014
Species	<i>Arthraxon hispidus</i>	Type	In situ
Location	Coolgardie, west of Kay's Road	Field marker	Pink Tape
Easting	546330	Section	10
Northing	6800490	Photo no. start	8232
Transect aspect	South	Photo no. finish	8234
Landform	Floodplain	Slope	Flat
Climate history	Dry previous	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Low		
Vegetation Community	Exotic grassland on edges of rainforest	Canopy cover (%)	0
Canopy species	0	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	15
Understorey species	<i>Hypolepis muelleri</i> , <i>Paspalum distichum</i> , <i>Persicaria hydropiper</i>	Grass cover (%)	25
Weed species	<i>Cinnamomum camphora</i> , <i>Ligustrum sinense</i> , <i>Lantana camara</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	None	Bare/Water (%)	0
Impacts/disturbance/threats	Lack of grazing, trampling	Exotic (%)	81.25
Leaf condition	Healthy, green, some brown yellow spots	Plant condition score	4 to 5
Dieback	Some yellow/brown spots	Height (m)	up to 70 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	up to 70 cm	Recruitment	Possibly

Plot Location		Ah2	
Field code	Abundance	Photo	Comments
Ah-10.5			
Ah1	Low-Moderate		Southern area of plot, west of central transect. Appx. 25 stems
Ah2	Moderate	8235-8238	South western corner of plot. Appx. 40 per square metre
Ah3	High	8239-8240	West of centre of plot appx. 6-7 m from 11m mark on central transect. 100+ stems per square metre
Ah4	Low		Southern end of transect. Low abundance appx. 10 stems


Creek adjoins western edge of plot. Rainforest in eastern portion of plot

Identification Code	Ah-10.6	Date	31/03/2014
Species	<i>Arthraxon hispidus</i>	Type	In situ
Location	Coolgardie, north of Coolgardie Road	Field marker	Metal Star Picket
Easting	546397	Section	10
Northing	6800850	Photo no. start	8053
Transect aspect	South	Photo no. finish	8055
Landform	Floodplain	Slope	Flat
Climate history	Dry previous	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor to moderate
Water levels	None	Soil moisture	High
Water flow	n/a		
Vegetation Community	Exotic grassland/pasture	Canopy cover (%)	10
Canopy species	<i>Lophostemon suaveolens</i> , <i>Corymbia intermedia</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	0
Understorey species	<i>Paspalum distichum</i>	Grass cover (%)	35
Weed species	<i>Axonopus fissifolius</i> , <i>Paspalum mandiocanum</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Weeds, grazing regime	Exotic (%)	65
Leaf condition	Yellow patches on most leaves	Plant condition score	2 to 4
Dieback	Some dieback brown/yellow leaves	Height (m)	up to 50 cm
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	n/a	Recruitment	Possible





Plot Location		Ah3 – 14 metre mark on transect	
Field code	Abundance	Photo	Comments
Ah-10.6			
Ah1	Moderate	8056-8062	East of centre of plot area, appx. 60 to 70 stems
Ah2	Moderate		Western central area of plot, appx. 50 stems
Ah3	Moderate	8063-8068	South eastern area of plot, appx. 80 stems
Ah4	Moderate		South eastern area of plot, appx. 40 stems
Ah5	Low		1 stem, south eastern edge
Ah6	Low		1 plant, southeastern area
Ah7	Low		South central area, 1 stem on edge of channel
Ah8	Low		Centre of plot, 4 stems on edge of channel
Ah9	Low		North central area, appx. 10-20 stems
Ah10	Moderate		North western area of plot, appx. 30 stems in long grass, flowering
Ah11	Moderate		Central area of plot, appx 50 stems
Ah12	High	8069-8070	Western edge of plot, 100 plus stems


Identification Code	Elt-1.1	Date	29/04/2014
Species	<i>Eleocharis tetraquetra</i>	Type	In situ
Location	Redbank Creek downstream of project	Field marker	Yellow Tape
Easting	516531	Section	1
Northing	6680300	Photo no. start	8498
Transect aspect	South	Photo no. finish	8500
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	East
Survey conditions	Raining	Drainage	Poor, moderate on banks
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus pilularis</i> , <i>Corymbia intermedia</i> , <i>Lophostemon suaveolens</i> , <i>Angophora costata</i> , <i>Eucalyptus resinifera</i>	Midstorey (%)	6
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Leptospermum polygalifolium</i>	Forb cover (%)	35
Understorey species	<i>Lomandra longifolia</i> , <i>Triglochin procerum</i> , <i>Imperata cylindrica</i>	Grass cover (%)	30
Weed species	<i>Axonopus fissifolius</i>	Shrub cover (%)	5
Weed abundance	Low	Litter (%)	20
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	10
Impacts/disturbance/threats	Trail formation, trail crosses creek downstream, pasture improvement and cattle grazing, altered hydrology	Exotic (%)	0
Leaf condition	Healthy, green	Plant condition score	4 to 5
Dieback	None obvious	Height (m)	Up to 60 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	Up to 60 cm	Recruitment	Possible



Plot Location




Elt101 – flowers




Elt101 - habitat

Field code	Abundance	Photo	Comments
Elt-1.1			
Elt101	Moderate-High	8501-8507, 8510-8514	Appx. 150 plants present. Occurs in northeast area of plot on edge of pond.
Elt102	Moderate		Appx 20 plants outside western edge of plot on edge of pond, near surveyors post


Identification Code	Elt-1.2	Date	6/05/2014
Species	<i>Eleocharis tetraquetra</i>	Type	In situ
Location	Tributary of Redbank Creek	Field marker	Pink Tape
Easting	516256	Section	1
Northing	6680690	Photo no. start	9078
Transect aspect	South	Photo no. finish	9080
Landform	Creek	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Northeast
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	None/little		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	30
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Corymbia intermedia</i> , <i>Eucalyptus siderophloia</i> , <i>Eucalyptus pilularis</i>	Midstorey (%)	3
Midstorey species	<i>Glochidion ferdinandi</i> , <i>Lophostemon suaveolens</i>	Forb cover (%)	65
Understorey species	<i>Carex sp.</i> , <i>Lomandra longifolia</i> , <i>Imperata cylindrica</i>	Grass cover (%)	20
Weed species	<i>Cinnamomum camphora</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	15
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, not trampled as much as other creek flats	Exotic (%)	0
Leaf condition	Mostly healthy, some dieback observed	Plant condition score	4 to 5
Dieback	Minor	Height (m)	Up to 50 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	Mostly 20 cm	Recruitment	Possible



Plot Location




Elt101 - flowers




Elt101 – habitat

Field code	Abundance	Photo	Comments
Elt-1.2			
Elt101	Low	9074-9077	Appx. 15 plants present. Occurs in southwest area of plot on edge of riffle, in small depression.


Identification Code	Elt-C1.1	Date	29/04/2014
Species	<i>Eleocharis tetraquetra</i>	Type	Control
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	516141	Section	1
Northing	6680940	Photo no. start	8535
Transect aspect	South	Photo no. finish	8540
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	Southeast
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	15
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Lophostemon suaveolens</i> , <i>Eucalyptus pilularis</i> , <i>Corymbia intermedia</i> , <i>Eucalyptus resinifera</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	3
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	75
Understorey species	<i>Triglochin procerum</i> , <i>Philydrum lanuginosum</i> , <i>Hygrophila angustifolia</i>	Grass cover (%)	25
Weed species	<i>Senecio madagascariensis</i> , <i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	0
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	0
Leaf condition	Healthy in general, some dieback	Plant condition score	4 to 5
Dieback	Yes some dieback (see photos)	Height (m)	Up to 50 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	Up to 50 cm	Recruitment	Possible



Plot Location



Elt3-some dieback, brown stems



Elt2 - Mature flowers/fruit and dead stem


Field code	Abundance	Photo	Comments
Elt1	Low-Moderate	8547	In centre of plot near tree
Elt2	Low-Moderate	8541-8543	In central east of plot, near log
Elt3	Low-Moderate	8548-8550	Northern end of plot, east of transect
Elt4	Low-Moderate	8552-8554	Central area, plants in riffle in deep muddy cattle tracks
Elt5	Low-Moderate	8555	Dieback

Difficult to count amongst other sedges, appx. 150 plants


Identification Code	Elt-C1.2	Date	1/05/2014
Species	<i>Eleocharis tetraquetra</i>	Type	Control
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	515750	Section	1
Northing	6680990	Photo no. start	8670
Transect aspect	South	Photo no. finish	8672
Landform	Swampy creek line	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	3
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	65
Understorey species	<i>Eleocharis</i> spp., <i>Carex</i> sp., <i>Imperata cylindrica</i>	Grass cover (%)	25
Weed species	<i>Paspalum urvillei</i> , <i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Low-Moderate	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	10
Leaf condition	Healthy, dark green	Plant condition score	4 to 5
Dieback	Minor	Height (m)	20 to 50 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	n/a	Recruitment	Likely



Plot Location



Elt1-flowers




Elt2 - Flowering plants


Field code	Abundance	Photo	Comments
Elt-C1.2			
Elt1	Moderate	8679-8680	Plants at 2 metre mark on transect
Elt2	Moderate	8681-8683	In northeast corner of plot

Habitat deep sinking mud, difficult to survey. Survey limited to avoid trampling. Approximately 54 plants counted but likely many more estimated 100+ plants dispersed throughout majority of plot


Identification Code	Elt-1.3	Date	29/04/2014
Species	<i>Eleocharis tetraquetra</i>	Type	In situ
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	515998	Section	1
Northing	6681010	Photo no. start	8557
Transect aspect	East	Photo no. finish	8559
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	Southeast
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	26
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	4
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	60
Understorey species	<i>Triglochin procerum</i> , <i>Philydrum lanuginosum</i> , <i>Hygrophila angustifolia</i> , <i>Eleocharis species</i>	Grass cover (%)	20
Weed species	<i>Axonopus fissifolius</i> , <i>Baccharis halimifolia</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	10
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	10
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	0
Leaf condition	Healthy, green, minor dieback	Plant condition score	3 to 4
Dieback	Yes, minor	Height (m)	Up to 40 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	n/a	Recruitment	Possible



Plot Location




Elt07 - dieback brown culms



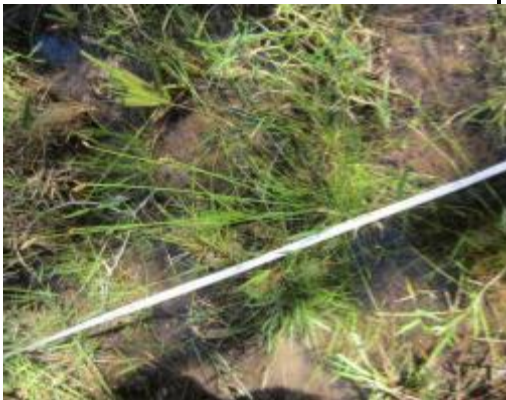
Elt08 - habitat

Field code	Abundance	Photo	Comments
Elt-1.3			
Elt07	Low	8560-8562	Appx. 6 plants, dieback on two plants, on cattle pock mark between 8 and 9 metre mark on central transect
Elt08	Low	8563-8566	Appx. 6 plants, dieback on one plant


Identification Code	Elt-1.4	Date	1/05/2014
Species	<i>Eleocharis tetraquetra</i>	Type	In situ
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	515801	Section	1
Northing	6681020	Photo no. start	8657
Transect aspect	South	Photo no. finish	8659
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Southeast
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	11
Canopy species	<i>Melaleuca quinquenervia</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	60
Understorey species	<i>Eleocharis tetraquetra</i> , <i>Eleocharis philippensis</i> , <i>Isachne globosa</i>	Grass cover (%)	30
Weed species	<i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	10
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	Minor	Height (m)	Up to 50 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	n/a	Recruitment	Likely



Plot Location



Elt101-plants at 5 metre mark on transect



Elt101 – Flowering plants

Field code	Abundance	Photo	Comments
Elt-1.4			
Elt101	Moderate	8660-8663	Near 5 metre mark on central transect

Habitat deep sinking mud, difficult to survey. Survey limited to avoid trampling. Approximately 70 plants counted but likely many more estimated 100+ plants dispersed throughout majority of plot

Identification Code	Elt-1.5	Date	5/09/2014
Species	<i>Eleocharis tetraquetra</i>	Type	0/01/1900
Location	Halfway Creek	Field marker	Pink Tape
Easting	0	Section	1
Northing	0	Photo no. start	352
Transect aspect	Southwest	Photo no. finish	357
Landform	Drainage swale, man-made	Slope	Low
Climate history	Heavy rain previous week	Aspect	North
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	High
Water flow	n/a		
Vegetation Community	Freshwater wetland	Canopy cover (%)	0
Canopy species	n/a	Midstorey (%)	11
Midstorey species	<i>Callistemon salignus</i> , <i>Acacia fimbriata</i>	Forb cover (%)	60
Understorey species	<i>Lomandra longifolia</i> , <i>Hemarthria uncinata</i> , <i>Baumea rubiginosa</i>	Grass cover (%)	10
Weed species	<i>Andropogon virginicus</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	5
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	15
Impacts/disturbance/threats	Urban runoff, weeds	Exotic (%)	10
Leaf condition	Plants dead	Plant condition score	0
Dieback	0	Height (m)	0
Disease/Insect Attack	None obvious	Width (m)	0
New shoot length	n/a	Recruitment	No



Plot location



Dead plants present only



Habitat/groundcover



Culvert of the Pacific Highway upstream of the monitoring location

Comment

Dead plants present in drainage swale adjacent to the existing highway with a large culvert up stream. Potential for indirect impacts from works on western side of the highway. Targeted surveys required during suitable conditions.

Identification Code	Emb-4.1	Date	4/09/2014
Species	<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	Type	0/01/1900
Location	Maclean, south of Jubilee Street	Field marker	Pink Tape
Easting	0	Section	4
Northing	0	Photo no. start	189
Transect aspect	South	Photo no. finish	191
Landform	Lower slope / gully	Slope	Moderate
Climate history	Heavy rain previous week	Aspect	South
Survey conditions	Clear, recent rain	Drainage	Good to moderate
Water levels	Low	Soil moisture	Moderate-high
Water flow	n/a		
Vegetation Community	Flooded Gum/Brushbox with rainforest understorey	Canopy cover (%)	34
Canopy species	<i>Eucalyptus grandis</i>	Midstorey (%)	41
Midstorey species	<i>Elaeocarpus obovatus</i> , <i>Endiandra sieberi</i> , <i>Notelaea longifolia</i>	Forb cover (%)	35
Understorey species	<i>Tripladenia cunninghamii</i> , <i>Geitonoplesium cymosum</i> , <i>Smilax australis</i> , <i>Stephania japonica</i> , <i>Doodia aspera</i>	Grass cover (%)	0
Weed species	<i>Ochna serrulata</i> , <i>Lantana camara</i> , <i>Aristolochia elegans</i> , <i>Asparagus plumosus</i>	Shrub cover (%)	0
Weed abundance	0	Litter (%)	55
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance	Weeds, edge effects	Exotic (%)	10
Leaf condition	Healthy some insect damage	Plant condition score	4 to 5
Dieback	Main stem broken but still attached, healed and regrowing	Height (m)	1 metre
Disease/Insect Attack	Yes, caterpillars, webbing and cocoons	Width (m)	1 metre
New shoot length	10 to 15 cm	Recruitment	No



Plot location



Insect damage from caterpillars




Whole plant (sapling)




Broken main stem on sapling

Comment
Single small damaged sapling on edge of clearing boundary


Identification Code	Emb-4.2	Date	4/09/2014
Species	<i>Endiandra muelleri</i> subsp. <i>bracteata</i>	Type	0/01/1900
Location	Townsend, north of Schwonberg Street	Field marker	Pink Tape
Easting	0	Section	4
Northing	0	Photo no. start	246
Transect aspect	South	Photo no. finish	248
Landform	Lower slope/floodplain	Slope	Low
Climate history	Heavy rain previous week	Aspect	South
Survey conditions	Clear, recent rain	Drainage	Good to moderate
Water levels	Low	Soil moisture	Moderate-high
Water flow	n/a		
Vegetation Community	Flooded Gum/Brushbox with rainforest understorey	Canopy cover (%)	13
Canopy species	<i>Lophostemon confertus</i> , <i>Eucalyptus grandis</i> , <i>Cinnamomum camphora</i>	Midstorey (%)	13
Midstorey species	<i>Acacia disparrima</i> , <i>Trophis scandens</i>	Forb cover (%)	10
Understorey species	<i>Adiantum hispidulum</i> , <i>Oplismenus imbecillis</i> , <i>Microlaena stipoides</i> , <i>Doodia aspera</i> , <i>Geitonoplesium cymosum</i>	Grass cover (%)	45
Weed species	<i>Lantana camara</i> , <i>Ochna serrulata</i> , <i>Ipomoea cairica</i> , <i>Senna pendula</i> var. <i>glabrata</i> , <i>Cinnamomum camphora</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	35
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance	Weeds, edge effects	Exotic (%)	5
Leaf condition	Healthy some insect damage	Plant condition score	4 to 5
Dieback	None obvious	Height (m)	10 metres
Disease/Insect Attack	Yes, caterpillars, webbing and cocoons	Width (m)	4 metres
New shoot length	1 to 10 mm	Recruitment	No




Plot location




Trunk of *Endiandra muelleri* subsp. *bracteata*



Insect damage from caterpillars



Canopy of tree



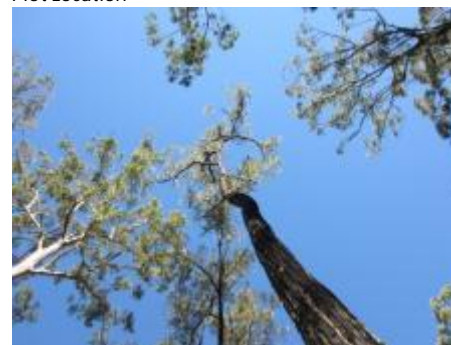
Foliage

Comment
Small healthy tree on edge of the clearing boundary. Starting to flower.

Identification Code	Et-2.1	Date	3/05/2014
Species	<i>Eucalyptus tetrapleura</i>	Type	In situ
Location	Wells Crossing Flora Reserve	Field marker	Green Tape
Easting	506152	Section	2
Northing	6692700	Photo no. start	8832
Transect aspect	South	Photo no. finish	8834
Landform	Mid slope	Slope	Low
Climate history	Rain end of March and during April, dry preceding	Aspect	Southwest
Survey conditions	Raining yesterday and earlier in week	Drainage	Poor
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Spotted Gum-Ironbark Forest	Canopy cover (%)	20
Canopy species	<i>Corymbia henryi</i> , <i>Eucalyptus tetrapleura</i> , <i>Eucalyptus fibrosa</i>	Midstorey (%)	11
Midstorey species	<i>Acacia disparrima</i> , <i>Pultenaea villosa</i>	Forb cover (%)	30
Understorey species	<i>Ptilothrix deusta</i> , <i>Entolasia stricta</i> , <i>Lepidosperma laterale</i>	Grass cover (%)	50
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	20
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Limited	Exotic (%)	0
Leaf condition	Appear healthy, limited access	Plant condition score	4
Dieback	Yes, dead small branches	Height (m)	Up to 20 m
Disease/Insect Attack	Some chewed leaves	Width (m)	5 to 7 m
New shoot length	n/a	Recruitment	Saplings present, Tree 4



Plot Location





Tree 7





Tree 4 - juvenile

Tree No. Et-2.1	Height (m)	Width (m)	DBH (cm)	Photo No.	Dieback/Comments
1	20	5	35	8835	1 x medium and 4 x small branches
2	20	4	32	8836	3 x medium and 2 x small branches
3	20	7	37	8837	4 x medium and 2 x small branches
4	4.5	1	5	8838	3 x small branches, juvenile tree
5	8	2	15	8839	1 x large and 7 x small branches
6	16	7	32	8840	2 x large, 1 x medium and 1 small branch
7	20	5	35	8841	2 x medium and 2 x small branches
Mean	16	4	27		



Identification Code	Et-2.2	Date	3/05/2014
Species	<i>Eucalyptus tetrapleura</i>	Type	In situ
Location	Sandy Hill, north of Wells Crossing	Field marker	Green Tape
Easting	505836	Section	2
Northing	6693690	Photo no. start	8858
Transect aspect	South	Photo no. finish	8860
Landform	Upper slope	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Southeast
Survey conditions	Raining yesterday and earlier in week	Drainage	Poor-moderate, clay/sand mixed soil
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Sandy swamp woodland/ Sandy Dry Forest	Canopy cover (%)	15
Canopy species	<i>Angophora woodsiana</i> , <i>Eucalyptus resinifera</i> , <i>Eucalyptus tetrapleura</i> , <i>Corymbia gummifera</i> , <i>Eucalyptus bancroftii</i>	Midstorey (%)	6
Midstorey species	<i>Melaleuca sieberi</i> , <i>Pultenaea tuberculata</i> , <i>acacia complanata</i>	Forb cover (%)	55
Understorey species	<i>Ptilothrix deusta</i> , <i>Lomandra sp.</i> , <i>Lepidosperma laterale</i> , <i>Entolasia stricta</i> , <i>Aristida vagans</i>	Grass cover (%)	20
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	25
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/ threats	Limited	Exotic (%)	0
Leaf condition	Appear healthy, limited access	Plant condition score	3 to 4
Dieback	Yes	Height (m)	15 to 18 m
Disease/Insect Attack	Insect galls	Width (m)	n/a
New shoot length	n/a	Recruitment	Yes, 1 x juvenile present (Tree 8)

Tree No. Et-2.2	Height (m)	Width (m)	DBH (cm)	Photo No.	Dieback/Comments
1	12	2	16	8861	1 x medium and 8 x small branches
2	15	7	45	8862	7 x large, 2 x medium and 4 small branches
3	10	4	20	8863	3 x medium and 2 x small branches
4	7	2	7	8864	1 x trunk and 3 x small branches
5	15	4	6	8865	5 x large and 6 x small branches
6	10	2	16	8866	2 x large and 3 x small branches
7	5	2	6	8867	7 x small branches
8	1	1	2	8868	3 x small branches
9	3	1	3	8869	6 x small branches
Mean	9	3	13		

Identification Code	Et-C2.1	Date	3/05/2014	 		
Species	<i>Eucalyptus tetrapleura</i>	Type	Control			
Location	Glenugie, north of Franklins Road	Field marker	Green Tape			
Easting	504886	Section	2			
Northing	6697790	Photo no. start	8886			
Transect aspect	South	Photo no. finish	8888			
Landform	0	Slope	Moderate			
Climate history	Rain end of March and during April, dry preceding	Aspect	Southwest			
Survey conditions	Raining yesterday and earlier in week	Drainage	0			
Water levels	n/a	Soil moisture	Moderate			
Water flow	n/a			Plot Location		
Vegetation Community	Spotted Gum-Ironbark Forest	Canopy cover (%)	16	Tree No. Et-C2.1	Height (m)	Dieback/Comments
Canopy species	<i>Corymbia henryi</i> , <i>Eucalyptus tetrapleura</i> , <i>Eucalyptus seeana</i>	Midstorey (%)	5	1	15	2 x large and 1 x small branches
Midstorey species	<i>Acacia disparrima</i> , <i>Melaleuca nodosa</i>	Forb cover (%)	10	2	20	4 x large, 2 x medium and few small branches
Understorey species	<i>Gahnia aspera</i> , <i>Entolasia stricta</i> , <i>Entolasia marginata</i> , <i>Themeda australis</i>	Grass cover (%)	40	3	20	1 x large and 4 x small branches
Weed species	None	Shrub cover (%)	0	4	16	4 medium branches
Weed abundance	None	Litter (%)	50	5	20	2 x large and 2 x medium branches
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0	6	18	3 x large and 4 x medium branches
Impacts/disturbance/threats	Feral horses	Exotic (%)	0	7	18	4 x medium branches
Leaf condition	Appear healthy, limited access	Plant condition score	4	8	19	2 x large and 2 x small branches
Dieback	Yes	Height (m)	0	Mean	18	
Disease/Insect Attack	Insect galls	Width (m)	0		5	
New shoot length	No access to canopy	Recruitment	One juvenile suspected (base of Tree 8)		32	

Identification Code	Et-2.3	Date	3/05/2014
Species	<i>Eucalyptus tetrapleura</i>	Type	In situ
Location	Glenugie, north of Franklins Road	Field marker	Green Tape
Easting	504777	Section	2
Northing	6697810	Photo no. start	8874
Transect aspect	South	Photo no. finish	8876
Landform	Mid to upper slope	Slope	Low
Climate history	Rain end of March and during April, dry preceding	Aspect	North
Survey conditions	Raining yesterday and earlier in week	Drainage	Poor, clay soils, in drainage area
Water levels	n/a	Soil moisture	High
Water flow	Little/None		
Vegetation Community	Spotted Gum-Ironbark Forest	Canopy cover (%)	21
Canopy species	<i>Corymbia henryi</i> , <i>Eucalyptus tetrapleura</i> , <i>Corymbia intermedia suaveolens</i> , <i>Eucalyptus seeana</i> , <i>Lophostemon</i>	Midstorey (%)	24
Midstorey species	<i>Acacia disparrima</i> , <i>Melaleuca nodosa</i> , <i>Hakea silaifolia</i> , <i>Breynia oblongifolia</i>	Forb cover (%)	20
Understorey species	<i>Goodenia paniculata</i> , <i>Centella asiatica</i> , <i>Hydrocotyle tripartita</i> , <i>Eragrostis brownii</i> , <i>Imperata cylindrica</i>	Grass cover (%)	35
Weed species	None, some in road easement	Shrub cover (%)	0
Weed abundance	None	Litter (%)	45
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Runoff from road, feral horses	Exotic (%)	0
Leaf condition	Appear healthy, limited access	Plant condition score	4
Dieback	Yes	Height (m)	0
Disease/Insect Attack	Insect galls	Width (m)	0
New shoot length	No access to canopy	Recruitment	No

Plot Location					Tree 5 – dieback evident
Tree No. Et-2.3	Height (m)	Width (m)	DBH (cm)	Photo No.	Dieback/Comments
1	19	5	32	8877	4 x large and 3 x medium branches
2	17	7	32	8878	3 x large, 5 x medium and several small branches
3	18	6	32	8879	2 x large and 5 x smaller
4	17	4	32	8880	2 x large, 1 x medium and 5 smaller
5	14	3	22	8881 and 8884	5 x large, 2 x medium and few small branches
6	20	7	39	8882	3-4 x medium and several small branches
7	19	8	41	8883	2 x large, 4 x medium and 2 small branches
8	15	4	25	8885	2 x large, 2 x medium and 2 small branches
Mean	17	6	32		

Eucalyptus tetrapleura



Eucalyptus tetrapleura was in full flower at Wells Crossing Flora Reserve. Limited flowers were present on trees at Glenugie State Forest to the north



Evidence of insect damage on *Eucalyptus tetrapleura* leaves at Wells Crossing Flora Reserve



Insect galls on *Eucalyptus tetrapleura* leaves at Wells Crossing Flora Reserve

Identification Code	Gq-3.1	Date	24/03/2014	Plant No.	Height (m)	Width (m)	Photo No.	Dieback/Comments
Species	<i>Grevillea quadricauda</i>	Type	In situ	G1	3	1	7853	1 x flower present. On trail has been knocked over
Location	Tucabia - north of Tallowood Lane	Field marker	Metal star pickets	G2	2	3	7854	On trail has been knocked over
Easting	513878	Section	3	G3	3	1.5	7855	Upright and spreading on trail
Northing	6721890	Photo no. start	Tucabia - Kratz	G4	1.3	0.5	7856	Upright juvenile on trail
Transect aspect	Southwest	Photo no. finish	7885	G5	1	0.5	7857	Upright juvenile on trail
Landform	Sandy gully	Slope	Low	G6	1	2	7858	Mostly dead, was a large plant, one branch still alive
Climate history	Dry previous	Aspect	Southwest	G7	0.8	0.3	7859	Edge trail. Small juvenile
Survey conditions	Clear, recent rain	Drainage	Good sandy alluvium	G8	0.8	0.3	7860	Edge trail. Small juvenile. 1 x old fruit
Water levels	Moderate	Soil moisture	High	G9	0.3	1	7861	Edge trail. Knocked over only one smaller roots still in ground
Water flow	Low			G10	1.3	0.8	7862	Western edge trail. Upright, 1 branch broken
Vegetation Community	Swamp Sclerophyll Forest (EEC)/Rainforest/Turpentine Forest	Canopy cover (%)	5	G11	0.5	2	7863	Large plant knocked over on edge of trail
Canopy species	<i>Syncarpia glomulifera</i> , <i>Melaleuca quinquenervia</i> , <i>Pinus elliotii</i>	Midstorey (%)	33	G12	1	0.2	7864	Mostly dead, wilted on edge of trail. 1 x old fruit
Midstorey species	<i>Syzygium oleosum</i> , <i>Backhousia myrtifolia</i> , <i>Trochocarpa laurifolia</i>	Forb cover (%)	5	G13	0.2	1	7865	Knocked over, now regrowing on edge of trail
Understorey species	<i>Entolasia stricta</i> , <i>Imperata cylindrica</i> , <i>Oplismenus imbecillis</i> , <i>Lomandra longifolia</i>	Grass cover (%)	20	G14	1	1	7866	Knocked over, slightly wilted on edge of trail
Weed species	<i>Axonopus fissifolius</i> on trail, <i>Pinus elliotii</i> , <i>Richardia brasiliensis</i> , <i>Lantana camara</i>	Shrub cover (%)	0	G15	0.5	2	7867	Knocked over, slightly wilted on edge of trail
Weed abundance	Low	Litter (%)	30	G16	0.2	0.2	7868	Knocked over know regrowing on edge of trail
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	10	G17	0.2	0.2	7869	Knocked over know regrowing on edge of trail
Impacts/disturbance/threats	Vehicle access and trails, logging, weeds and surveyors clearing	Exotic (%)	30	G18	1	4	7870	Damaged, knocked over, on edge of trail
Leaf condition	0	Plant condition score	0 to 5	G19	2	1	7871	Upright healthy plant with new shoots on the edge of trail
Dieback	Yes on some plants	Height (m)	0	G20	0.7	0.4	7872	Healthy on trail
Disease/Insect Attack	None obvious	Width (m)	0	G21	1.8	1	7873	Upright healthy plant with new shoots on the eastern edge of trail
New shoot length	1 to 3 cm	Recruitment	Yes, few juveniles on trails	G22	0.6	0.2	7874	Upright plant in middle of trail on trail to west
				G23	0.3	0.2	7875	Seedling that is slightly wilted. Upright plant in middle of trail on trail to west
				G24	0.2	0.2	7876	Seedling, healthy in centre of trail
				G25	0.2	0.2	7877	Seedling damaged
				G26	1.5	2	7878	New shoots healthy plant
				G27	1.5	1	7879	New shoots, little dieback
				Mean	1.03	1.03		

Gq-3.1 (cont.)



Plot location Gq-3.1 – *Grevillea quadricauda* growing on existing trail adjacent to the project



G24 – Healthy juvenile growing in centre of trail




G1-on trail has been knocked over.



G13- knocked over, now regrowing on edge of trail


Identification Code	Gq-C3.1	Date	24/03/2014
Species	<i>Grevillea quadricauda</i>	Type	Control
Location	Tucabia - north of Tallowood Lane	Field marker	Pink Tape
Easting	514047	Section	3
Northing	6722060	Photo no. start	7886
Transect aspect	South	Photo no. finish	7888
Landform	Mid slope sandy	Slope	Moderate
Climate history	Dry previous	Aspect	Southwest
Survey conditions	Clear, recent rain	Drainage	Good, sandy
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Turpentine Forest	Canopy cover (%)	9
Canopy species	<i>Syncarpia glomulifera</i> , <i>Eucalyptus psammitica</i> , <i>Corymbia intermedia</i>	Midstorey (%)	8
Midstorey species	<i>Allocasuarina torulosa</i> , <i>Leptospermum trinervium</i>	Forb cover (%)	5
Understorey species	<i>Entolasia stricta</i> , <i>Imperata cylindrica</i>	Grass cover (%)	50
Weed species	<i>Lantana camara</i>	Shrub cover (%)	0
Weed abundance	Low-moderate	Litter (%)	45
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	0	Exotic (%)	0
Leaf condition	Healthy, but some dieback	Plant condition score	3 to 5
Dieback	Yes on some plants	Height (m)	1 to 2 m
Disease/Insect Attack	None obvious	Width (m)	up to 1 m
New shoot length	1 to 2 cm most branches with new shoots	Recruitment	Some juveniles present




Plot Location

Plant No. Gq-C3.1	Height (m)	Width (m)	Dieback/Comments
G1	1.5	2	
G2	1.5	2	Appx 25% dieback
G3	1.5	1.5	Dieback, older plant
G4	1	2	Fallen over, relatively healthy
G5	1.5	1.5	Appx 50% dieback
G6	2	1	
G7	2	3	Lots of old fruit
G8	1	0.3	Juvenile, healthy
G9	0.4	0.3	Juvenile, healthy
G10	2	2	Good condition
Mean	1.44	1.56	


Identification Code	La-C1.1	Date	29/04/2014
Species	<i>Lindernia alsinoides</i>	Type	Control
Location	Redbank Creek downstream of project	Field marker	Yellow Tape
Easting	516605	Section	1
Northing	6680330	Photo no. start	8468
Transect aspect	South	Photo no. finish	8670
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	East
Survey conditions	Raining	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	16
Canopy species	<i>Eucalyptus microcorys</i> , <i>Melaleuca quinquenervia</i> , <i>Lophostemon suaveolens</i> , <i>Eucalyptus resinifera</i> , <i>Eucalyptus pilularis</i> , <i>Syncarpia glomulifera</i> , <i>Corymbia intermedia</i>	Midstorey (%)	4
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Leptospermum polygalifolium</i> , <i>Banksia spinulosa</i> , <i>Pultenaea retusa</i>	Forb cover (%)	35
Understorey species	<i>Philydrum lanuginosum</i> , <i>Baumea juncea</i> , <i>Eleocharis philippensis</i>	Grass cover (%)	20
Weed species	<i>Axonopus fissifolius</i> , <i>Lepidium africanus</i>	Shrub cover (%)	15
Weed abundance	Low	Litter (%)	5
Recruitment	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Trail formation, trail crosses creek downstream, pasture improvement and cattle grazing, altered hydrology	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	No	Height (m)	10 to 20 cm
Disease/Insect Attack	No	Width (m)	Up to 50 cm
New shoot length	10 to 20 cm	Recruitment	Possible



Plot Location



La1




La1


Plant No.	Abundance	Photo	Comment
La-C1.1			
La1	Appx. 10 clusters	9068-9073	Directly downstream (to the east) of plot area in riffle, may expand into plot in future

Occurs with *Maundia triglochinoides* (Vulnerable, TSC Act)


Identification Code	La-1.1	Date	6/05/2014
Species	<i>Lindernia alsinoides</i>	Type	In situ
Location	Tributary of Redbank Creek	Field marker	Pink Tape
Easting	516256	Section	1
Northing	6680690	Photo no. start	9078
Transect aspect	South	Photo no. finish	9080
Landform	Creek	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Northeast
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	None/little		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	30
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Corymbia intermedia</i> , <i>Eucalyptus siderophloia</i> , <i>Eucalyptus pilularis</i>	Midstorey (%)	3
Midstorey species	<i>Glochidion ferdinandi</i> , <i>Lophostemon suaveolens</i>	Forb cover (%)	65
Understorey species	<i>Carex</i> sp., <i>Lomandra longifolia</i> , <i>Imperata cylindrica</i>	Grass cover (%)	20
Weed species	<i>Cinnamomum camphora</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	15
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, not trampled as much as other creek flats	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	No	Height (m)	10 to 20 cm
Disease/Insect Attack	No	Width (m)	Up to 50 cm, sprawling
New shoot length	10 to 20 cm	Recruitment	Possible



Plot Location



La1 – larger sprawling plant




La1 – small plant


Plant No.	Abundance	Photo	Comment
La-1.1			
La1	Appx. 6 clusters	9085-9089	Directly downstream (to the north east) of plot area in riffle, may expand into plot in future

Occurs with *Eleocharis tetraquetra* (Endangered, TSC Act)


Identification Code	La-C1.2	Date	29/04/2014
Species	<i>Lindernia alsinoides</i>	Type	Control
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	516141	Section	1
Northing	6680940	Photo no. start	8535
Transect aspect	South	Photo no. finish	8540
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	Southeast
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	15
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Lophostemon suaveolens</i> , <i>Eucalyptus pilularis</i> , <i>Corymbia intermedia</i> , <i>Eucalyptus resinifera</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	3
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	75
Understorey species	<i>Triglochin procerum</i> , <i>Philydrum lanuginosum</i> , <i>Hygrophila angustifolia</i> , <i>Eleocharis species</i>	Grass cover (%)	25
Weed species	<i>Senecio madagascariensis</i> , <i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	0
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	No	Height (m)	10 to 20 cm
Disease/Insect Attack	No	Width (m)	Up to 50 cm, sprawling
New shoot length	10 to 20 cm	Recruitment	Possible



Plot Location



La4-fruit




La4

Plant No.	Abundance	Photo No.	Comment
La-C1.2			
La1	2 plants		Directly north of plot in riffle habitat up stream of pond
La2	20 plants		Upstream of plot, flagged
La3	5 plants		Within plot central area
La4	High abundance	8635-8641	Upstream to west of plot in broad riffle area


Downstream of project. Disturbance regime from cattle grazing/trampling and flooding and drying may facilitate the species through reduced competition and creating muddy germination niches

Occurs with *Eleocharis tetraquetra* (Endangered, TSC Act)


Identification Code	La-1.2	Date	29/04/2014
Species	<i>Lindernia alsinoides</i>	Type	In situ
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	515998	Section	1
Northing	6681010	Photo no. start	8557
Transect aspect	East	Photo no. finish	8559
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	Southeast
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	26
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	4
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	60
Understorey species	<i>Triglochin procerum</i> , <i>Philydrum lanuginosum</i> , <i>Hygrophila angustifolia</i> , <i>Eleocharis species</i>	Grass cover (%)	20
Weed species	<i>Axonopus fissifolius</i> , <i>Baccharis halimifolia</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	10
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	10
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	No	Height (m)	10 to 25 cm
Disease/Insect Attack	No	Width (m)	Up to 50 cm, sprawling
New shoot length	10 to 25 cm	Recruitment	Possible, small plants present




Plot Location



La7



La7




La7


Plant No.	Abundance	Photo No.	Comment
La-1.2			
La7	5 plants	8686-8689	In riffle not abundant cluster 3 and 2 other plants up stream, fern flagged
La8	15 plants		Upstream of plot, flagged, in broad swale edge of project
La43	Low		Within plot central area

Directly downstream of project. Disturbance regime from cattle grazing/trampling and flooding and drying may facilitate the species through reduced competition and creating muddy germination niches
Occurs with *Eleocharis tetraquetra* (Endangered, TSC Act)


Identification Code	La-C1.3	Date	1/05/2014
Species	<i>Lindernia alsinoides</i>	Type	Control
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	515750	Section	1
Northing	6680990	Photo no. start	8670
Transect aspect	South	Photo no. finish	8672
Landform	Swampy creek line	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	3
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	65
Understorey species	<i>Eleocharis</i> spp., <i>Carex</i> sp., <i>Imperata cylindrica</i>	Grass cover (%)	25
Weed species	<i>Paspalum urvillei</i> , <i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Low-Moderate	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	10
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	Minor	Height (m)	Up to 20 cm
Disease/Insect Attack	No	Width (m)	Up to 50 cm, sprawling
New shoot length	10 to 20 cm	Recruitment	Likely




Plot Location



Muddy habitat



Flower




Abundant throughout plot, appx 5% cover abundance across total area. Upstream of the project. Disturbance regime from cattle grazing/trampling and flooding and drying may facilitate the species through reduced competition and creating muddy germination niches.

Habitat deep sinking mud, difficult to survey. Survey limited to avoid trampling.


Photos 8673 - 8678 (2m mark)

Occurs with *Eleocharis tetraquetra* (Endangered, TSC Act)



Identification Code	La-1.3	Date	1/05/2014
Species	<i>Lindernia alsinoides</i>	Type	In situ
Location	Northern tributary of Redbank Creek	Field marker	Yellow Tape
Easting	515801	Section	1
Northing	6681020	Photo no. start	8657
Transect aspect	South	Photo no. finish	8659
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Southeast
Survey conditions	Clear, raining yesterday	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	11
Canopy species	<i>Melaleuca quinquenervia</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	60
Understorey species	<i>Eleocharis tetraquetra</i> , <i>Eleocharis philippensis</i> , <i>Isachne globosa</i> ,	Grass cover (%)	30
Weed species	<i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	10
Impacts/disturbance/threats	Cattle grazing and pasture improvement	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	Minor	Height (m)	Up to 30 cm, mostly 10 cm
Disease/Insect Attack	No	Width (m)	Up to 50 cm, sprawling
New shoot length	Up to 30 cm, mostly 10 cm	Recruitment	Likely



Plot Location



Juvenile plant


Abundant throughout plot, appx 5% cover abundance across total area. Upstream of the project. Disturbance regime from cattle grazing/trampling and flooding and drying may facilitate the species through reduced competition and creating muddy germination niches.

Habitat deep sinking mud, difficult to survey. Survey limited to avoid trampling.


Photos 8664 - 8667 (North west area of plot)

Occurs with *Eleocharis tetraquetra* (Endangered, TSC Act)


Identification Code	La-2.1	Date	2/05/2014
Species	<i>Lindernia alsinoides</i>	Type	In situ
Location	Wells Crossing upstream of project	Field marker	Pink Tape
Easting	506418	Section	2
Northing	6692190	Photo no. start	8795
Transect aspect	South	Photo no. finish	8797
Landform	Creek	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Raining today and earlier in week	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Eucalyptus robusta</i>	Midstorey (%)	23
Midstorey species	<i>Melaleuca alternifolia</i> , <i>Acacia floribunda</i> , <i>leptospermum juniperinum</i>	Forb cover (%)	80
Understorey species	<i>Eleocharis sphacelata</i> , <i>Maundia triglochinosoides</i> , <i>Isachne globosa</i>	Grass cover (%)	5
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	15
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Grazing and trampling by wild horses and pigs evident	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	None obvious	Height (m)	Mostly to 10 cm
Disease/Insect Attack	None obvious	Width (m)	Up to 50 cm, sprawling
New shoot length	Mostly to 10 cm	Recruitment	Possible




Plot Location



Habitat



Juvenile plant



Juvenile plant

Approximately 50 plants

Photos 8824 - 8829 (mid western area of plot)

Occurs with *Lindsaea incisa* (Endangered, TSC Act) and *Maundia triglochinosoides* (Vulnerable, TSC Act)

Identification Code	Li-1.1	Date	28/04/2014
Species	<i>Lindsaea incisa</i>	Type	In situ
Location	Corindi Creek, west of Post Office Lane	Field marker	Pink Tape
Easting	516799	Section	1
Northing	6679670	Photo no. start	8438
Transect aspect	South	Photo no. finish	8440
Landform	Swamp edges	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	South
Survey conditions	Raining	Drainage	Poor to moderate
Water levels	Moderate	Soil moisture	High
Water flow	n/a		
Vegetation Community	Swamp Sclerophyll Forest (EEC), Blackbutt Forest	Canopy cover (%)	9
Canopy species	<i>Corymbia intermedia</i> , <i>Eucalyptus pilularis</i> , <i>Syncarpia glomulifera</i> , <i>Lophostemon suaveolens</i> , <i>Melaleuca quinquenervia</i> , <i>Eucalyptus resinifera</i>	Midstorey (%)	8
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Leptospermum polygalifolium</i> , <i>Lophostemon suaveolens</i>	Forb cover (%)	30
Understorey species	<i>Ptilothrix deusta</i> , <i>Pteridium esculentum</i> , <i>Lindsaea incisa</i> , <i>Themeda australis</i> , <i>Imperata cylindrica</i> , <i>Entolasia stricta</i>	Grass cover (%)	40
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	30
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Trail maintenance, logging, grazing	Exotic (%)	0
Leaf condition	Healthy, green, lots of regenerating plants on trail area following recent rainfall	Plant condition score	4 to 5
Dieback	No	Height (m)	Up to 60 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	10 to 50 cm	Recruitment	Possibly



Plot Location



LI502



LI501

Plant No. Li-1.1	Abundance	Photo No.	Comment
L500	Appx. 250 plants	8444-8446	On edge of trail, mid-eastern area of plot south of fence
L501	Appx. 130 plants	8447-8448	Larger plants along fenceline (30 plants) and smaller regrowth on trail (100 plants). Central area of plot.
L502	Appx. 200 plants	8441-8443	Plants on old trail at 3.5 metre mark on transect. North of fence.

Identification Code	Li-C2.1	Date	1/05/2014
Species	<i>Lindsaea incisa</i>	Type	Control
Location	Halfway Creek rest area	Field marker	Pink Tape
Easting	508904	Section	2
Northing	6688360	Photo no. start	8690
Transect aspect	South	Photo no. finish	8695
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Northeast
Survey conditions	Clear, raining yesterday	Drainage	Poor-moderate on sandy soils edges of wetland
Water levels	Moderate	Soil moisture	High
Water flow	Low		
Vegetation Community	Swamp Sclerophyll Forest (EEC)/ Scribbly Gum Forest	Canopy cover (%)	15
Canopy species	<i>Eucalyptus robusta</i> , <i>Melaleuca quinquenervia</i>	Midstorey (%)	1
Midstorey species	<i>Leptospermum juniperinum</i> , <i>Banksia oblongifolia</i>	Forb cover (%)	85
Understorey species	<i>Baumea</i> sp., <i>Dampiera stricta</i> , <i>Gahnia clarkei</i> , <i>Balioskion tetraphyllum</i> , <i>Pteridium esculentum</i>	Grass cover (%)	0
Weed species	None	Shrub cover (%)	5
Weed abundance	None	Litter (%)	10
Recruitment (canopy/midstorey)	Mid-storey species only (<i>Pultenaea retusa</i>), resprouting <i>Banksia oblongifolia</i>	Bare/Water (%)	0
Impacts/disturbance/threats	Fire in last 1 to 2 years, entire area burnt	Exotic (%)	0
Leaf condition	All healthy green, resprouting plants following fire and dry summer	Plant condition score	5
Dieback	No	Height (m)	Up to 20 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	1 to 20 cm, mean 10 cm	Recruitment	Re-sprout from rhizome



Plot Location



Juvenile plants and/or re-sprout from rhizomes



Larger plants (appx. 20 cm high)

Plant No.	Abundance	Photo No.	Comment
Li-C2.1	High-Moderate	8696-8700	New growth following fire. Plants 1-20 cm high. Most likely regrowth from rhizome

Occurs along edge of swampy drainage line. Distribution restricted.

Fire in last 1 to 2 years, entire area burnt, resprouting *Banksia oblongifolia*. Open swamp habitat with sparse canopy, possibly previously cleared

Identification Code	Li-2.1	Date	1/05/2014
Species	<i>Lindsaea incisa</i>	Type	In situ
Location	Halfway Creek rest area	Field marker	Pink Tape
Easting	508856	Section	2
Northing	6688430	Photo no. start	8707
Transect aspect	South	Photo no. finish	8709
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Northeast
Survey conditions	Clear, raining yesterday	Drainage	Poor-moderate on sandy soils edges of wetland
Water levels	Moderate	Soil moisture	High
Water flow	Low		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	16
Canopy species	<i>Eucalyptus robusta</i> , <i>Eucalyptus resinifera</i>	Midstorey (%)	0
Midstorey species	<i>Melaleuca alternifolia</i> , <i>Leptospermum juniperinum</i> , <i>Banksia oblongifolia</i>	Forb cover (%)	55
Understorey species	<i>Baumea</i> sp., <i>Empodisma minus</i> , <i>Isachne globosa</i> , <i>Imperata cylindrica</i>	Grass cover (%)	15
Weed species	None	Shrub cover (%)	15
Weed abundance	None	Litter (%)	15
Recruitment (canopy/midstorey)	Mid-storey species only (<i>Pultenaea retusa</i>), resprouting <i>Banksia oblongifolia</i>	Bare/Water (%)	0
Impacts/disturbance/threats	Fire in last 1 to 2 years, entire area burnt	Exotic (%)	0
Leaf condition	All healthy green, resprouting plants following fire and dry summer	Plant condition score	5
Dieback	No	Height (m)	Up to 20 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	2 to 20 cm, mean 10 cm	Recruitment	Re-sprout from rhizome



Plot Location



Larger plants (appx. 20 cm high)



Re-sprouting from rhizomes following fire



Juvenile plants and/or re-sprout from rhizomes

Plant No. Li-2.1	Abundance	Photo No.	Comment
Li501-Li512	High-Moderate	8701-8706 and 8710-8713	New growth following fire. Plants 1-20 cm high. Most likely regrowth from rhizome. This population cluster is larger than the control population cluster

Occurs along edge of swampy drainage line. Distribution restricted.

Fire in last 1 to 2 years, entire area burnt, resprouting *Banksia oblongifolia*. Open swamp habitat with sparse canopy, possibly previously cleared

Identification Code	Li-2.2	Date	2/05/2014
Species	<i>Lindsaea incisa</i>	Type	In situ
Location	Wells Crossing upstream of project	Field marker	Pink Tape
Easting	506418	Section	2
Northing	6692190	Photo no. start	8795
Transect aspect	South	Photo no. finish	8797
Landform	Creek	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Raining today and earlier in week	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Eucalyptus robusta</i>	Midstorey (%)	23
Midstorey species	<i>Melaleuca alternifolia</i> , <i>Acacia floribunda</i> , <i>leptospermum juniperinum</i>	Forb cover (%)	80
Understorey species	<i>Eleocharis sphacelata</i> , <i>Maundia triglochinosides</i> , <i>Isachne globosa</i>	Grass cover (%)	5
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	15
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Grazing and trampling by wild horses and pigs evident	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	4 to 5
Dieback	Minor, on larger plants	Height (m)	Up to 70 cm
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	Mostly 15 cm	Recruitment	Possible



Plot Location



Li1



Li2

Occurs in an elevated area between two drainage lines along the eastern boundary of the plot and crosses the central transect at the 14 metre mark. Distribution restricted

Plant No. Li-2.2	Abundance	Photo No.	Comment
Li1	High-Moderate	8819-21	Near log on eastern boundary of plot
Li2	High-Moderate	8816-8818	Eastern boundary of plot
Li3	High-Moderate	8814-8815	Edge of pool
Li4	High-Moderate	8823	Centre of population
Li5	High-Moderate	8808-809	Central transect 14 metre mark

Identification Code	Li-3.1	Date	26/03/2014
Species	<i>Lindsaea incisa</i>	Type	In situ
Location	Tucabia - north of Bostock Road	Field marker	Pink Tape
Easting	513033	Section	3
Northing	6718560	Photo no. start	7962
Transect aspect	West southwest	Photo no. finish	7964
Landform	Drainage line	Slope	Low
Climate history	Dry previous	Aspect	West
Survey conditions	Clear, recent rain	Drainage	Good, sandy soils
Water levels	Low	Soil moisture	High
Water flow	Low		
Vegetation Community	Turpentine Forest/Sandy dry forest	Canopy cover (%)	25
Canopy species	<i>Syncarpia glomulifera</i> , <i>Eucalyptus signata</i> , <i>Corymbia intermedia</i>	Midstorey (%)	9
Midstorey species	<i>Leptospermum polygalifolium</i> , <i>Ceratopetalum gummifera</i> , <i>Banksia spinulosa</i> , <i>Acacia complanata</i>	Forb cover (%)	70
Understorey species	<i>Gahnia clarkei</i> , <i>Empodisma minus</i> , <i>Austrostipa sp.</i>	Grass cover (%)	5
Weed species	None	Shrub cover (%)	5
Weed abundance	0	Litter (%)	20
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Surveyors trampled/cut shrubs	Exotic (%)	0
Leaf condition	Healthy, bright green	Plant condition score	5, no dieback, yellowing
Dieback	None	Height (m)	5 to 70 cm
Disease/Insect Attack	None obvious	Width (m)	2 cm
New shoot length	5 to 70 cm	Recruitment	Possible



Plot Location



Li5

Plant No. Li-3.1	Abundance	Photo No.	Comment
Li1	Moderate	7946-7947	At base of fagged tree. In southeast area of plot
Li2	Moderate	7948-7949	Regrowth from rhizome?
Li3	Low-Moderate	7950-7951	Larger plants surrounding falline timber, Northwest area of plot
Li4	Low-Moderate	7952-7953	Western edge of distribution
Li5	Moderate	7954-7956	Southwest area of plot, on edge of drainage line dense Gahnia
Li6	Moderate	7957-7959	8 metre mark near drainage line
Li7	Low-Moderate	7960-7961	South eastern area of plot edge of drainage line

Identification Code	Li-3.2	Date	24/03/2014
Species	<i>Lindsaea incisa</i>	Type	In situ
Location	Tucabia - north of Tallowood Lane	Field marker	Pink Tape
Easting	513510	Section	3
Northing	6722744	Photo no. start	7915
Transect aspect	West	Photo no. finish	7917
Landform	Sandy swampy swale	Slope	Slight
Climate history	Dry previous	Aspect	West
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	Boggy
Water flow	None		
Vegetation Community	Swamp Sclerophyll Forest (EEC) / Turpentine Forest	Canopy cover (%)	23
Canopy species	<i>Syncarpia glomulifera</i> , <i>Eucalyptus robusta</i> , <i>Melaleuca quinquenervia</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	1
Midstorey species	<i>Breynia oblongifolia</i>	Forb cover (%)	60
Understorey species	<i>Baloskion tetraphyllum</i> , <i>Gahnia clarkei</i> , <i>Epacris paludosa</i>	Grass cover (%)	35
Weed species	<i>Andropogon virginicus</i>	Shrub cover (%)	5
Weed abundance	Low	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Trail grading, clearing, underscrubbing, livestock grazing/trampling, burning off	Exotic (%)	0
Leaf condition	Healthy, bright green, little dieback in dryer spots	Plant condition score	5
Dieback	Little/none	Height (m)	mean 0.5 m, up to 1 m
Disease/Insect Attack	No	Width (m)	2 cm
New shoot length	fronds to 1 m	Recruitment	Possible





Plot Location



Li6-taller plants

Plant No. Li-3.2	Abundance	Photo No.	Comment
Li1	Moderate	7906-7907	Base of tree at north eastern end of plot, higher on slope in moist sclerophyll forest
Li2	Low	7908	Smaller plants, mid north eastern area of plot, higher on slope
Li3	Moderate	7909	Larger plants surrounding fallen timber, Northwest area of plot
Li4	Moderate	7910	Western edge of distribution
Li5	High	7911-7912	Southwest area of plot, on edge of drainage line dense Gahnia
Li6	High	7913	South central area of plot edge of drainage line
Li7	Moderate	7914	South eastern area of plot edge of drainage line

Identification Code	Li-C6.1	Date	4/05/2014
Species	<i>Lindsaea incisa</i>	Type	Control
Location	Mororo State Forest	Field marker	Pink Tape
Easting	522691	Section	6
Northing	6755500	Photo no. start	8932
Transect aspect	South	Photo no. finish	8934
Landform	Depression on mid slope	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Northeast
Survey conditions	Clear, cool, sunny	Drainage	Poor-moderate
Water levels	Moderate-high	Soil moisture	High
Water flow	None/little		
Vegetation Community	Turpentine Forest	Canopy cover (%)	31
Canopy species	<i>Syncarpia glomulifera</i> , <i>Corymbia variegata</i> , <i>Eucalyptus resinifera</i>	Midstorey (%)	9
Midstorey species	<i>Acacia disparrima</i> , <i>Melaleuca nodosa</i> , <i>Leptospermum polygalifolium</i>	Forb cover (%)	15
Understorey species	<i>Entolasia stricta</i> , <i>Hibbertia aspera</i> , <i>Lindsaea incisa</i>	Grass cover (%)	50
Weed species	Low	Shrub cover (%)	5
Weed abundance	lantana camara	Litter (%)	30
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Limited disturbance. Lack of fire?, litter building up and smothering plants, drought	Exotic (%)	0
Leaf condition	Healthy, bright green, new shoots. Dieback of fronds on older plants	Plant condition score	4 to 5
Dieback	Minor	Height (m)	5 to 20 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	5 to 20 cm, mean 15 cm	Recruitment	Possibly, most probably regrowth from rhizome

Plot Location

Li522

Plant No. Li-C6.1	Abundance	Photo No.	Comment
Li201	Appx. 200 stems	8941-8944	Appx. 20 plants observed in March 2014
Li520	Appx. 200 stems	8946-8948	Mid east of plot
Li521	Appx. 400 stems	8935-8937	Near 5 metre mark on central transect
Li522	Appx. 300 stems	8938-8940	13 metre mark on central transect
Li523	Appx. 30 stems		Northeast boundary
Li524	Appx. 50 stems	8945	Southeast boundary
Li525	Appx. 80 stems	8951-8952	Mid west area of plot
Li526	Appx. 150 stems		Northwest corner of plot

Occurs on edges of a broad swale/drainage area

Identification Code	Li-6.1	Date	4/05/2014
Species	<i>Lindsaea incisa</i>	Type	In situ
Location	Mororo State Forest	Field marker	Pink Tape
Easting	522591	Section	6
Northing	6755780	Photo no. start	8913
Transect aspect	South	Photo no. finish	8915
Landform	Gully	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Northeast
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	Moderate-high	Soil moisture	High
Water flow	None/little		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	23
Canopy species	<i>Eucalyptus resinifera</i> , <i>Syncarpia glomulifera</i> , <i>Corymbia intermedia</i>	Midstorey (%)	25
Midstorey species	<i>Melaleuca sieberi</i> , <i>Melaleuca nodosa</i> , <i>Leptospermum polygalifolium</i>	Forb cover (%)	10
Understorey species	<i>Lepidosperma laterale</i> , <i>Entolasia stricta</i> , <i>Hibbertia aspera</i>	Grass cover (%)	30
Weed species	None	Shrub cover (%)	20
Weed abundance	None	Litter (%)	35
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	5
Impacts/disturbance/threats	Lack of fire?, litter building up and smothering plants, drought	Exotic (%)	0
Leaf condition	Healthy, bright green, new shoots. Some minor browning	Plant condition score	4 to 5
Dieback	Minor	Height (m)	5 to 20 cm, mean 15 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	5 to 15 cm, mean 10 cm	Recruitment	Possibly, most probably regrowth from rhizome



Plot Location

Li1008

Plant No. Li-6.1	Abundance	Photo No.	Comment
Li1006	Appx. 59 stems	8916-8918	Near 2 metre mark on central transect
Li1007	Appx. 61 stems	8919-8920	North east boundary of plot, edge of easement
Li1008	>50 stems	8925-28	Mid east of plot
Li1009	>100 stems	8921-8924	Mid east of plot

Occurs on edges of a broad swale/drainage area. Within road boundary

Identification Code	Li-6.2	Date	3/05/2014
Species	<i>Lindsaea incisa</i>	Type	In situ
Location	Mororo State Forest	Field marker	Pink Tape
Easting	522381	Section	6
Northing	6756160	Photo no. start	8905
Transect aspect	South	Photo no. finish	8907
Landform	Gully	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	East
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	Moderate-high	Soil moisture	High
Water flow	None/little		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	33
Canopy species	<i>Eucalyptus resinifera</i> , <i>Lophostemon suaveolens</i> , <i>Syncarpia glomulifera</i>	Midstorey (%)	26
Midstorey species	<i>Callistemon salignus</i> , <i>Melaleuca sieberi</i> , <i>Leptospermum polygalifolium</i>	Forb cover (%)	5
Understorey species	<i>Gahnia clarkei</i> , <i>Entolasia stricta</i> , <i>Hibbertia aspera</i>	Grass cover (%)	45
Weed species	None	Shrub cover (%)	10
Weed abundance	None	Litter (%)	40
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Limited disturbance. Lack of fire?, litter building up and smothering plants, drought	Exotic (%)	0
Leaf condition	Healthy, bright green, new shoots	Plant condition score	4 to 5
Dieback	No	Height (m)	10 to 15 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	10 to 15 cm	Recruitment	Possibly, most probably regrowth from rhizome



Plot Location

Li502

Plant No. Li-6.2	Abundance	Photo No.	Comment
Li502	Appx. 8 stems	8908-8910	North east of plot
Li503	Appx. 10 stems	8911-8912	South of centre

Occurs on edges of a broad swale/drainage area.

Identification Code	Mac-8.1	Date	3/09/2014
Species	<i>Macadamia tetraphylla</i>	Type	In situ
Location	Woodburn, Lang Hill	Field marker	Not marked
Easting	0	Section	8
Northing	0	Photo no. start	173
Transect aspect	South	Photo no. finish	188
Landform	Floodplain	Slope	Low
Climate history	Heavy rain previous week	Aspect	Northeast
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	Moderate-high
Water flow	Low		
Vegetation Community	Exotic pasture	Canopy cover (%)	0
Canopy species	n/a	Midstorey (%)	10
Midstorey species	<i>Macadamia tetraphylla</i>	Forb cover (%)	0
Understorey species	<i>Solanum prinophyllum</i> , <i>Centella asiatica</i>	Grass cover (%)	0
Weed species	<i>Senecio madagascariensis</i> , <i>Pennisetum clandestinum</i> , <i>Cinnamomum camphora</i> , <i>Cirsium vulgare</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	0
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	30
Impacts/disturbance	Weeds, grazing	Exotic (%)	70
Leaf condition	Mostly healthy	Plant condition score	3 to 4
Dieback	Top branches have die back	Height (m)	6 metres
Disease/Insect Attack	Yes, caterpillars, webbing and cocoons	Width (m)	7 metres
New shoot length	5 to 10 cm	Recruitment	Yes, one juvenile present



Macadamia tetraphylla tree



Leaves and flowers





Dieback on top emergent branches



Comment
Single tree well outside clearing boundary, however included with nearby monitoring location for *Streblus pendulinus*

Identification Code	Mt-1.1	Date	28/04/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Corindi Creek, west of Post Office Lane	Field marker	Pink Tape
Easting	516806	Section	1
Northing	6679580	Photo no. start	8460
Transect aspect	South	Photo no. finish	8462
Landform	Swamp	Slope	Flat
Climate history	Rain end of March and start of April, dry preceding	Aspect	Flat
Survey conditions	Raining	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	None/little		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	31
Canopy species	<i>Melaleuca quinquenervia</i>	Midstorey (%)	16
Midstorey species	<i>Melaleuca quinquenervia</i>	Forb cover (%)	45
Understorey species	<i>Baumea</i> sp., <i>Persicaria praetermissa</i> , <i>Enydra fluctuans</i> , <i>Blechnum indicum</i>	Grass cover (%)	0
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	55
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	None	Exotic (%)	0
Leaf condition	Green small plants	Plant condition score	1 to 2
Dieback	None obvious, likely plants have died back during previous dry conditions	Height (m)	Up to 10 cm
Disease/Insect Attack	Some leaves chewed	Width (m)	n/a
New shoot length	Up to 10 cm	Recruitment	Possibly

Plot Location

Mt3

Plant No. Mt-1.1	Abundance	Photo No.	Comment
Mt1	Low	8452-8452	19 metre mark on central transect
Mt2	Low	8911-8912	South west area of plot
Mt3	Low	8463-8464	North east area of plot
Mt4	Low	8965-66	Mid eastern area of plot

Small stunted plants and/or seedlings. Occurs in small depressions along swampy drainage swale

Identification Code	Mt-C1.1	Date	6/05/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Corindi Creek, west of Post Office Lane	Field marker	Pink Tape
Easting	517126	Section	1
Northing	6679730	Photo no. start	9090
Transect aspect	South	Photo no. finish	9092
Landform	Creek/pond	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	South flowing
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	Moderate-Low	Soil moisture	High
Water flow	Low		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	35
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Melaleuca alternifolia</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	60
Understorey species	<i>Carex appressa</i> , <i>Parsonsia straminea</i> , <i>Lobelia alata</i> , <i>Persicaria praetermissa</i> , <i>Entolasia marginata</i>	Grass cover (%)	10
Weed species	<i>Baccharis halimifolia</i> , <i>Axonopus fissifolius</i> , <i>Pinus elliotii</i> , <i>Crassocephalum crepidioides</i> , <i>Paspalum dilatatum</i>	Shrub cover (%)	0
Weed abundance	Low-Moderate	Litter (%)	5
Recruitment	Minor	Bare/Water (%)	25
Impacts/disturbance/threats	Weed invasion, cattle grazing, clearing, water extraction	Exotic (%)	0
Leaf condition	Small plants in moderate condition, no large healthy plants	Plant condition score	1 to 3
Dieback	None obvious no dead plants seen, but likely	Height (m)	Up to 30 cm, mostly to 20cm
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	10 to cm	Recruitment	Possible, smaller plants present



Plot Location





Mt2

Plant No. Mt-C1.1	Abundance	Photo No.	Comment
Mt1	Low-Moderate	9093-9095	19 metre mark on central transect
Mt2	Low-Moderate	9100-9101	Plants in central area of plot edge of pond
Mt3	Low-Moderate	9102	Larger plants
Mt4	Low-Moderate	9104	15 metre mark on central transect

No large healthy plants present. Smaller plants in good to moderate condition. No dead plants seen

Identification Code	Mt-1.2	Date	29/04/2014
Species	<i>Maundia triglochoides</i>	Type	In situ
Location	Redbank Creek downstream of project	Field marker	Yellow Tape
Easting	516531	Section	1
Northing	6680300	Photo no. start	8498
Transect aspect	South	Photo no. finish	8500
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	East
Survey conditions	Raining	Drainage	Poor, moderate on banks
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus pilularis</i> , <i>Corymbia intermedia</i> , <i>Lophostemon suaveolens</i> , <i>Angophora costata</i> , <i>Eucalyptus resinifera</i>	Midstorey (%)	6
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Leptospermum polygalifolium</i>	Forb cover (%)	35
Understorey species	<i>Lomandra longifolia</i> , <i>Triglochin procerum</i> , <i>Imperata cylindrica</i>	Grass cover (%)	30
Weed species	<i>Axonopus fissifolius</i>	Shrub cover (%)	5
Weed abundance	Low	Litter (%)	20
Recruitment	Yes	Bare/Water (%)	10
Impacts/disturbance/threats	Trail formation, trail crosses creek downstream, pasture improvement and cattle grazing, altered hydrology	Exotic (%)	0
Leaf condition	Healthy	Plant condition score	3 to 4
Dieback	Dead plants floating and some dieback on plants	Height (m)	Up to 1 m
Disease/Insect Attack	Yes (see photos)	Width (m)	n/a
New shoot length	Up to 1 m	Recruitment	Possible

Plot Location

Mt2

Plant No. Mt-1.2	Abundance	Photo No.	Comment
Mt1	Low-Moderate	8519-8521	North west area of plot in pool
Mt2	Low-Moderate	8522-8524	Near post outside of plot area

Estimated 800 stems present in pool adjacent to construction footprint

Identification Code	Mt-C1.2	Date	29/04/2014
Species	<i>Maundia triglochinoides</i>	Type	Control
Location	Redbank Creek downstream of project	Field marker	Yellow Tape
Easting	516605	Section	1
Northing	6680330	Photo no. start	8468
Transect aspect	South	Photo no. finish	8476
Landform	Swampy creek line	Slope	Slight
Climate history	Rain end of March and start of April, dry preceding	Aspect	East
Survey conditions	Raining	Drainage	Poor, moderate on banks
Water levels	Moderate	Soil moisture	High
Water flow	Moderate		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	16
Canopy species	<i>Eucalyptus microcorys</i> , <i>Melaleuca quinquenervia</i> , <i>Lophostemon suaveolens</i> , <i>Eucalyptus resinifera</i> , <i>Eucalyptus pilularis</i> , <i>Syncarpia glomulifera</i> , <i>Corymbia intermedia</i>	Midstorey (%)	4
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Leptospermum polygalifolium</i> , <i>Banksia spinulosa</i> , <i>Pultenaea retusa</i>	Forb cover (%)	35
Understorey species	<i>Philydrum lanuginosum</i> , <i>Baumea juncea</i> , <i>Eleocharis philippensis</i>	Grass cover (%)	20
Weed species	<i>Axonopus fissifolius</i> , <i>Lepidium africanus</i>	Shrub cover (%)	15
Weed abundance	Low	Litter (%)	5
Recruitment	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Trail formation, trail crosses creek downstream, cattle grazing, altered hydrology	Exotic (%)	0
Leaf condition	Healthy, green, some dieback on leaf tips	Plant condition score	3 to 4
Dieback	Some browning of leaf tips	Height (m)	Up to 1 m
Disease/Insect Attack	Some chewed leaves (grasshoppers)	Width (m)	n/a
New shoot length	Up to 1 m	Recruitment	Possible



Plot Location



Mt1



Mt2



Mt2

Plant No. Mt-C1.2	Abundance	Photo No.	Comment
Mt1	Appx. 200 stems	8477-8479	South central area of plot in pool
Mt2	Appx. 300 stems	8480-8482	South eastern area of plot in pool

Water levels are high-moderate with tops of plants only out of water and plants can also be seen under water

Identification Code	Mt-C2.1	Date	2/05/2014
Species	Maundia triglochinoides	Type	Control
Location	Halfway Creek, up stream of project, northern side of drainage line	Field marker	Pink Tape
Easting	506768	Section	2
Northing	6690440	Photo no. start	8747
Transect aspect	South	Photo no. finish	8749
Landform	Swampy creek line	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Recent rainfall, however soils not very moist and water levels relatively low considering recent rainfall	Drainage	Poor
Water levels	Low-Moderate	Soil moisture	Moderate
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC) / Freshwater Wetland (EEC)	Canopy cover (%)	14
Canopy species	<i>Melaleuca alternifolia</i> , <i>Angophora floribunda</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	100
Understorey species	<i>Carex inversa</i> , <i>Persicaria pratensis</i> , <i>Sparganium subglobosum</i> , <i>Eleocharis sphacelata</i> , <i>Triglochin microtuberosum</i>	Grass cover (%)	0
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	0
Recruitment (canopy/midstorey)	None	Bare/Water (%)	0
Impacts/disturbance/threats	Drought	Exotic (%)	0
Leaf condition	0	Plant condition score	2 to 3
Dieback	None obvious, but likely	Height (m)	Up to 50 cm
Disease/Insect Attack	Limited	Width (m)	n/a
New shoot length	Up to 50cm, mean 40cm	Recruitment	Possible



Plot Location



Mt1



Mt3



Mt4

Plant No. Mt-C2.1	Abundance	Photo No.	Comment
Mt1	Moderate	8740-8745	Plants near logs south east area of plot
Mt2	Low	8746	Eastern boundary
Mt3	Moderate	8750-8753	Northwest area of plot
Mt4	Moderate	8754-8755	Healthier plants in central area of plot

Water levels low-moderate, dense vegetation in wetland

Identification Code	Mt-2.1	Date	2/05/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Halfway Creek crossing	Field marker	Pink Tape
Easting	506677	Section	2
Northing	6690450	Photo no. start	8729
Transect aspect	South	Photo no. finish	8732
Landform	Swampy creek line	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Recent rainfall, however soils not very moist and water levels relatively low considering recent rainfall	Drainage	Poor
Water levels	Low-Moderate	Soil moisture	Moderate
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	33
Canopy species	<i>Melaleuca alternifolia</i> , <i>Eucalyptus resinifera</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	85
Understorey species	<i>Blechnum indicum</i> , <i>Baumea</i> sp., <i>Sparganium subglobosum</i>	Grass cover (%)	0
Weed species	<i>Pinus elliotii</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	15
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Drought	Exotic (%)	0
Leaf condition	Plants stunted, limited large healthy plants present, dead plants not obvious	Plant condition score	0 to 3
Dieback	Yes, some plants have completely died back	Height (m)	Up to 50 cm
Disease/Insect Attack	Yes some chewed leaves	Width (m)	n/a
New shoot length	Up to 50cm, mean 20cm	Recruitment	Possible, small plants



Plot Location



Mt1



Mt1



Mt2

Plant No. Mt-2.1	Abundance	Photo No.	Comment
Mt1	Low-Moderate	8721-8728, 8737	Edges of pond in north west area of plot
Mt2	Low	8733-8736	Small and dead plants in slight depression running west to east through plot

Water levels low-moderate, population should expand with greater creek flows

Identification Code	Mt-2.2	Date	2/05/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Wells Crossing, downstream of the project, private property	Field marker	Pink Tape
Easting	506288	Section	2
Northing	6692080	Photo no. start	8756
Transect aspect	South	Photo no. finish	8759
Landform	Creek	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Raining today and earlier in week	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	15
Canopy species	<i>Eucalyptus robusta</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	8
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	20
Understorey species	<i>Myriophyllum</i> sp., <i>Eleocharis</i> spp., <i>Isachne globosa</i>	Grass cover (%)	15
Weed species	<i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	15
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	25
Impacts/disturbance/threats	Cattle grazing, trampling evident	Exotic (%)	25
Leaf condition	Healthy, bright green, smaller upright plants, no larger upright plants present	Plant condition score	3 to 4
Dieback	None obvious	Height (m)	Up to 50 cm, mean 30 cm
Disease/Insect Attack	Some chewed leaves	Width (m)	n/a
New shoot length	Up to 50 cm, mean 30 cm	Recruitment	Possible



Plot Location



Mt1



Mt2



Habitat

Plant No. Mt-2.2	Abundance	Photo No.	Comment
Mt1	Low-Moderate	8756-8760	Smaller 5 metre mark on central transect plants 3 to
Mt2	Moderate	8761-8762	Larger plants in northeast area of plot in pool

Small billabong of main channel open to cattle (private property)

Identification Code	Mt-2.3	Date	2/05/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Wells Crossing, in 'island' between bridges	Field marker	Pink Tape
Easting	506320	Section	2
Northing	6692140	Photo no. start	8764
Transect aspect	South	Photo no. finish	8766
Landform	Creek	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Raining today and earlier in week	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	60
Canopy species	<i>Eucalyptus robusta</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	40
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	0
Understorey species	<i>Baumea</i> sp., <i>Eleocharis</i> sp., <i>Lobelia alata</i> , <i>Isachne globosa</i> , <i>Imperata cylindrica</i>	Grass cover (%)	0
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Limited	Exotic (%)	0
Leaf condition	Healthy, bright green, smaller plants, no larger upright plants present	Plant condition score	3 to 4
Dieback	None obvious	Height (m)	Up to 20cm, mean 15 cm
Disease/Insect Attack	Some chewed leaves	Width (m)	n/a
New shoot length	Up to 20cm, mean 15 cm	Recruitment	Possible



Plot Location



Mt1



Mt2



Mt4

Plant No. Mt-2.3	Abundance	Photo No.	Comment
Mt1	Low-Moderate	8767-8768	Plants at 5 metre mark on central transect
Mt2	Low-Moderate	8769	Plants at 11 metre mark on central transect
Mt3	Low-Moderate	8770	Small plants at 14 metre mark on central transect
Mt4	Low-Moderate	8771-8772	Plants at 20 metre mark on central transect

Small waterhole with dense sedges

Identification Code	Mt-2.4	Date	2/05/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Wells Crossing upstream of project	Field marker	Pink Tape
Easting	506418	Section	2
Northing	6692190	Photo no. start	8795
Transect aspect	South	Photo no. finish	8797
Landform	Creek	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Raining today and earlier in week	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Eucalyptus robusta</i>	Midstorey (%)	23
Midstorey species	<i>Melaleuca alternifolia</i> , <i>Acacia floribunda</i> , <i>leptospermum juniperinum</i>	Forb cover (%)	80
Understorey species	<i>Eleocharis sphacelata</i> , <i>Maundia triglochinoides</i> , <i>Isachne globosa</i>	Grass cover (%)	5
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	15
Recruitment	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Grazing and trampling by wild horses and pigs evident	Exotic (%)	0
Leaf condition	Healthy, bright green, moderate dieback, yellowing evident	Plant condition score	1 to 4
Dieback	Yes, dead/dying plants evident on edges	Height (m)	Up to 1 m
Disease/Insect Attack	Some chewed leaves	Width (m)	n/a
New shoot length	Up to 1 m	Recruitment	Possible, small plants



Plot Location



Mt1



Mt2



Mt4

Plant No. Mt-2.4	Abundance	Photo No.	Comment
Mt1	High	8793-8794	Plants at 5 metre mark on central transect in pool
Mt2	Low-Moderate	8801-8803	Small plants on muddy bank
Mt3	High	8804-8806	Plants at 9 metre mark on central transect in pool
Mt4	Moderate-High	8798-8800	Second pool at southern end

Two waterholes with elevated area between

Identification Code	Mt-C2.2	Date	2/05/2014
Species	<i>Maundia triglochinoides</i>	Type	Control
Location	Wells Crossing upstream of project	Field marker	Pink Tape
Easting	506448	Section	2
Northing	6692210	Photo no. start	8774
Transect aspect	South	Photo no. finish	8776
Landform	Creek	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flat
Survey conditions	Raining today and earlier in week	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Little/None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	5
Canopy species	<i>Eucalyptus robusta</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	14
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	60
Understorey species	<i>Eleocharis sphacelata</i> , <i>Philydrum lanuginosum</i> , <i>Isachne globosa</i>	Grass cover (%)	5
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	20
Recruitment (canopy/midstorey)	None	Bare/Water (%)	15
Impacts/disturbance/threats	Grazing and trampling by wild horses and pigs evident	Exotic (%)	0
Leaf condition	Healthy, bright green, lots of dieback, yellowing evident	Plant condition score	0 to 4
Dieback	Yes, dead/dying plants evident	Height (m)	Up to 1 m
Disease/Insect Attack	Some chewed leaves	Width (m)	n/a
New shoot length	Up to 1 m	Recruitment	Possible, small plants on muddy edges



Plot Location



Mt1



Mt2-dead plants



Mt3

Plant No. Mt-C2.2	Abundance	Photo No.	Comment
Mt1	Low-Moderate	8777	Small plants regenerating in drainage swale, north west area of plot
Mt2	Low-Moderate	8778, 8785-8787	Dead plants in drainage swale and edges of pool, north west area of plot
Mt3	High	8781-8782	Larger plants in pool

Identification Code	Mt-3.1	Date	5/05/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Coldstream River crossing	Field marker	Yellow Tape
Easting	507915	Section	3
Northing	6708620	Photo no. start	8999
Transect aspect	South	Photo no. finish	9001
Landform	River, Floodplain	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Drains northwest
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Low		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC) and Swamp Oak Floodplain Forest (EEC)	Canopy cover (%)	11
Canopy species	<i>Eucalyptus tereticornis</i>	Midstorey (%)	17
Midstorey species	<i>Casuarina glauca</i>	Forb cover (%)	55
Understorey species	<i>Ludwigia peploides</i> , <i>Eleocharis spp.</i> , <i>Cyperus spp.</i>	Grass cover (%)	40
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	5
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, sedimentation	Exotic (%)	0
Leaf condition	Small leaves, regrowth	Plant condition score	3
Dieback	No	Height (m)	10 to 15 cm
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	10 to 15 cm (8 shoots in total)	Recruitment	Possible



Plot Location




Mt1




Mt1

Plant No. Mt-3.1	Abundance	Photo No.	Comment
Mt1	Low	9002-9004	8 plants are at the 7 to 8 m mark on the central transect.
Coldstream River bank. Appears to be a high level of sedimentation. Previously observed plants may have been buried by sediment			

Identification Code	Mt-3.2	Date	26/03/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Tucabia - south of Bostock Road	Field marker	Pink Tape
Easting	512751	Section	3
Northing	6717737	Photo no. start	7979
Transect aspect	West	Photo no. finish	7981
Landform	Gully, drainage line	Slope	Low
Climate history	Dry previous	Aspect	Southwest
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	No flow, dry patches		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	5
Canopy species	<i>Eucalyptus tereticornis</i> , <i>Lophostemon suaveolens</i> , <i>Eucalyptus robusta</i> , <i>Eucalyptus microcorys</i> , <i>Melaleuca quinquenervia</i> , <i>Eucalyptus signata</i>	Midstorey (%)	13
Midstorey species	<i>Acacia floribunda</i>	Forb cover (%)	10
Understorey species	<i>Oplismenus imbecillis</i>	Grass cover (%)	25
Weed species	<i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	10
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Grazing, livestock trampling and pasture improvement	Exotic (%)	55
Leaf condition	Poor, yellow, brown, dead	Plant condition score	1 to 2
Dieback	Yes most plants dieback	Height (m)	0.05 to 0.4 m
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	None	Recruitment	Possible



Plant No. Mt-3.2	Abundance	Photo No.	Comment
Mt1	Appx. 15-20 plants	7970	Low abundance in small drainage swale. Yellow and dead leaves.
Mt2	Appx. 30 plants	7971-7972	Low abundance in small drainage swale. Yellow and dead leaves.
Mt3	Appx. 30 plants	7973-7974	Pond edges. Low abundance
Mt4	Appx. 100 plants	7975-7978	Downstream of pond, higher abundance. Yellow and dead leaves.

Possibly very dry prior to recent rain and will recover

Identification Code	Mt-C3.1	Date	5/05/2014
Species	<i>Maundia triglochinoides</i>	Type	Control
Location	Tucabia Road, north of Tallowwood Lane	Field marker	Pink Tape
Easting	512862	Section	3
Northing	6724090	Photo no. start	9042
Transect aspect	South	Photo no. finish	9045
Landform	Creek, swamp	Slope	Flat
Climate history	Rain end of March and during April, dry preceding	Aspect	Flows west
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	None/little		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	31
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Eucalyptus robusta</i>	Midstorey (%)	8
Midstorey species	<i>Melaleuca alternifolia</i>	Forb cover (%)	65
Understorey species	<i>Gahnia clarkei</i> , <i>Blechnum indicum</i> , <i>Carex sp.</i> , <i>Lepironia articulata</i>	Grass cover (%)	0
Weed species	<i>Axonopus fissifolius</i> , <i>Cinnamomum camphora</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	0
Recruitment	Minor	Bare/Water (%)	35
Impacts/disturbance/threats	Cattle grazing, weed invasion	Exotic (%)	5
Leaf condition	Mostly healthy, some dieback observed, no large robust plants	Plant condition score	3 to 4
Dieback	Yes, in deeper water upright dead plants	Height (m)	Up to 1 metre
Disease/Insect Attack	None	Width (m)	n/a
New shoot length	Up to 1 metre	Recruitment	Possible



Plot Location



Mt3



Mt4



Mt5

Plant No. Mt-C3.1	Abundance	Photo No.	Comment
Mt1	Moderate	9046, 9056	0-1 m mark of central transect
Mt2	Moderate	9047, 9055, 9057	16-18 m mark of central transect
Mt3	Moderate	9047-9050	16-17 m mark of central transect
Mt4	Moderate	9051	12-13 m mark of central transect
Mt5	Moderate	9052-9053	12-13 m mark of central transect
Mt6	Moderate	9054	9 m mark of central transect

Edges of larger pool

Identification Code	Mt-3.3	Date	28/03/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Tucabia Road, north of Tallowood Lane	Field marker	Pink Tape
Easting	513188	Section	3
Northing	6726680	Photo no. start	8016
Transect aspect	West	Photo no. finish	8018
Landform	Sandy gully/creek line	Slope	Low
Climate history	Dry previous	Aspect	Southwest
Survey conditions	Raining	Drainage	Poor
Water levels	Moderate	Soil moisture	High
Water flow	Low		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	15
Canopy species	<i>Eucalyptus robusta</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	24
Midstorey species	<i>Melaleuca alternifolia</i> , <i>Acacia disparrima</i>	Forb cover (%)	90
Understorey species	<i>Gahnia clarkei</i>	Grass cover (%)	0
Weed species	<i>Lantana camara</i> , <i>Axonopus fissifolius</i> , <i>Cinnamomum camphora</i> , <i>Setaria sphacelata</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	10
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Cattle grazing, clearing, burning, weed invasion/pasture improvement	Exotic (%)	0
Leaf condition	New plants healthy, old plants poor condition/dieback	Plant condition score	1 to 5
Dieback	Yes, plants dried out	Height (m)	Up to 0.8 m
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	0.3 to 0.8 m	Recruitment	Possible



Plot Location



Mt1



Mt1

Plant No. Mt-3.3	Abundance	Photo No.	Comment
Mt1	Appx. 20 plants	8019-8021	Yellow and dead leaves
In small depression amongst dense Gahnia			

Identification Code	Mt-7.1	Date	21/03/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Tabbimoble Overflow 2	Field marker	Pink Tape
Easting	524341	Section	7
Northing	6766110	Photo no. start	7008
Transect aspect	East	Photo no. finish	7819
Landform	Pond/dam	Slope	Flat
Climate history	Extended dry period	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low-moderate there is dieback upstream where dried out	Soil moisture	Boggy
Water flow	None		
Vegetation Community	Open Wetland with surrounding Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	0
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	75
Understorey species	<i>Maundia triglochinoides</i> , <i>Philydrum lanuginosum</i> , <i>Eleocharis sp.</i>	Grass cover (%)	0
Weed species	<i>Paspalum mandiocanum</i> , <i>Paspalum urvillei</i> , <i>Panicum maximum</i>	Shrub cover (%)	0
Weed abundance	0	Litter (%)	0
Recruitment (canopy/midstorey)	No	Bare/Water (%)	25
Impacts/disturbance/threats	Dumping	Exotic (%)	0
Leaf condition	Bright green in dam, brown/yellow in stream	Plant condition score	0 to 5
Dieback	Yes upstream	Height (m)	0-60cm above water
Disease/Insect Attack	no	Width (m)	n/a
New shoot length	None obvious - mostly to 65 cm	Recruitment	Possible



Plot Location



Mt1



Mt1




Mt2


Plant No. Mt-7.1	Abundance	Photo No.	Comment
Mt1	High	7808-7819	High abundance of larger plants in the pool area
Mt2	Low-Moderate	7805-7807	In channel area feeding into main pool

Medium-sized pool

Identification Code	Mt-7.2	Date	21/03/2014
Species	<i>Maundia triglochinoides</i>	Type	In situ
Location	Tabbimoble Overflow 1 - downstream	Field marker	Pink Tape
Easting	526419	Section	7
Northing	6769980	Photo no. start	7831
Transect aspect	East	Photo no. finish	7835
Landform	Constructed drainage channel	Slope	Flat
Climate history	Extended dry period	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	High
Water flow	Low		
Vegetation Community	Open Wetland with surrounding Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	10
Canopy species	<i>Lophostemon suaveolens</i> , <i>Melaleuca quinquenervia</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	50
Understorey species	<i>Maundia triglochinoides</i>	Grass cover (%)	0
Weed species	<i>Setaria sphacelata</i> on edges of drainage lines	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	15
Recruitment (canopy/midstorey)	No	Bare/Water (%)	10
Impacts/disturbance/threats	No minor weed invasion	Exotic (%)	25
Leaf condition	Some yellow, browning at leaf tips	Plant condition score	0 to 4
Dieback	Yes most leaves browning at tips	Height (m)	0.6 to 0.7 m
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	60 to 70 cm, appx. 5 to 10% new shoots	Recruitment	Possible



Plot Location



Mt1

Plant No. Mt-7.2	Abundance	Photo No.	Comment
Mt1	High	7831-7840	High abundance of larger plants in the pool area

Medium sized pool downstream of the project

Identification Code	Mt-7.3	Date	21/03/2014
Species	<i>Maundia triglochoides</i>	Type	In situ
Location	Tabbimoble Overflow 2	Field marker	Pink Tape
Easting	526344	Section	7
Northing	6770030	Photo no. start	7820
Transect aspect	West	Photo no. finish	7830
Landform	Constructed drainage channel	Slope	Flat
Climate history	Extended dry period	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	High
Water flow	None		
Vegetation Community	Open Wetland with surrounding Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	23
Canopy species	<i>Eucalyptus tereticornis</i> , <i>Eucalyptus siderophloia</i> , <i>Lophostemon suaveolens</i>	Midstorey (%)	0
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Acacia disparrima</i>	Forb cover (%)	40
Understorey species	<i>Cyperus flaccidus</i> , <i>Myriophyllum</i> sp., <i>Isolepis inundatus</i> , <i>Cyperus</i> sp., <i>Philydrum lanuginosum</i>	Grass cover (%)	0
Weed species	<i>Senna pendula</i> var. <i>glabrata</i> , <i>Paspalum mandiocanum</i> , <i>Sonchus oleraceus</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	30
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	30
Impacts/disturbance/threats	None	Exotic (%)	0
Leaf condition	Browning off, some green and yellow leaves as well	Plant condition score	0-2 dying back
Dieback	Yes	Height (m)	0-40 cm
Disease/Insect Attack	Few leaves with minor damage	Width (m)	n/a
New shoot length	40 to 50 cm, appx.. 10% new shoots	Recruitment	Possible



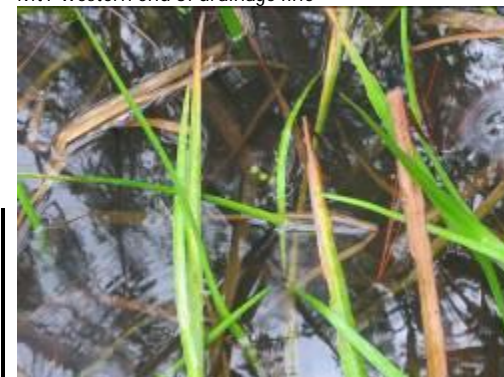
Plot Location



Mt1-western end of drainage line



Mt1



Mt1-free floating fruit/seed

Plant No. Mt-7.3	Abundance	Photo No.	Comment
Mt1	Moderate-High	7820-7830	

Drainage channel in project area

Identification Code	Mi-7.1	Date	20/03/2014
Species	<i>Melaleuca irbyana</i>	Type	In situ
Location	New Italy	Field marker	Pink Tape
Easting	528802	Section	7
Northing	6774779	Photo no. start	7790
Transect aspect	South	Photo no. finish	7792
Landform	Clay Hill	Slope	Low
Climate history	Extended dry period	Aspect	Southwest
Survey conditions	Clear, recent rain	Drainage	Poor-moderate
Water levels	n/a	Soil moisture	High to moderate
Water flow	n/a		
Vegetation Community	Spotted Gum - Ironbark Forest	Canopy cover (%)	29
Canopy species	<i>Corymbia henryi</i> , <i>Eucalyptus siderophloia</i> , <i>Eucalyptus resinifera</i> ,	Midstorey (%)	14
Midstorey species	<i>Melaleuca irbyana</i> , <i>Acacia disparrima</i> , <i>Melaleuca nodosa</i>	Forb cover (%)	5
Understorey species	<i>Entolasia stricta</i> , <i>Imperata cylindrica</i>	Grass cover (%)	55
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	40
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Limited - past clearing	Exotic (%)	0
Leaf condition	Good - Little/no dieback	Plant condition score	4
Dieback	Little bit dieback	Height (m)	0
Disease/Insect Attack	None obvious	Width (m)	Refer to table
New shoot length	5 to 10 cm	Recruitment	Yes, some plants in Telstra easement, seedlings and suckering



Plot Location



Trees in plot

Plant No. Mi-7.1	Abundance	Appx. height (m)	Trunks
Mi17	8 individuals	5	Several trunks on some
Mi18	2 individuals	6	Several trunks on some
Mi34	8 individuals	6	Several trunks on some
Mi39	6 individuals	6	Several trunks on some

Identification Code	Mi-C7.1	Date	4/05/2014
Species	<i>Melaleuca irbyana</i>	Type	Control
Location	New Italy	Field marker	Pink Tape
Easting	528781	Section	7
Northing	6774810	Photo no. start	8958
Transect aspect	South	Photo no. finish	8960
Landform	Lower slope	Slope	Slight
Climate history	Rain end of March and during April, dry preceding	Aspect	Southwest
Survey conditions	Clear, cool, sunny	Drainage	Poor
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	3
Canopy species	<i>Eucalyptus tereticornis</i> , <i>Melaleuca quinquenervia</i>	Midstorey (%)	5
Midstorey species	<i>Callistemon salignus</i> , <i>Melaleuca irbyana</i>	Forb cover (%)	5
Understorey species	<i>Carex</i> sp., <i>Imperata cylindrica</i> , <i>Cymbopogon refractus</i> ,	Grass cover (%)	70
Weed species	<i>Baccharis halimifolia</i> , <i>Axonopus fissifolius</i>	Shrub cover (%)	0
Weed abundance	Low-moderate	Litter (%)	25
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Clearing/logging, weed invasion,	Exotic (%)	0
Leaf condition	Healthy, green	Plant condition score	4 to 5
Dieback	Yes, some trees	Height (m)	mostly to 6 metres
Disease/Insect Attack	No	Width (m)	Refer to table
New shoot length	1 to 10 cm, mean 5 cm	Recruitment	No



Plot Location

Mi4-Mi5

Plant No.	Abundance	Height (m)	Width (m)	DBH (cm)	Trunks	Fruit	Photos	Dieback
Mi-C7.1								
Mi2	1 individual	6	2	10	1	Low		1 medium and 2 small branches
Mi3	1 individual	6	4	10	2	High		5 small branches at base
Mi4-Mi5	1 individual	5	1	10	1	Low-Moderate	8964	Several small
Mi6	1 individual	5	1	7	1	Low-Moderate		3 small branches at base
Mi7	1 individual	4.5	1	9	1	None		Minor
Mi8	1 individual	4	1	7	1	Low	8962	Minor
Mi9	1 individual	6	2	12	1	Low	8963	3 small branches
Mi10	1 individual	6	2	7	2	Moderate		7 small branches at base

Identification Code	Mi-7.2	Date	21/03/2014
Species	<i>Melaleuca irbyana</i>	Type	In situ
Location	New Italy	Field marker	Pink Tape
Easting	528877	Section	7
Northing	6774840	Photo no. start	7841
Transect aspect	South	Photo no. finish	7843
Landform	Clay Hill	Slope	Low
Climate history	Extended dry period	Aspect	Southwest
Survey conditions	Clear, recent rain	Drainage	Poor-moderate
Water levels	n/a	Soil moisture	High to moderate
Water flow	n/a		
Vegetation Community	Spotted Gum - Ironbark Forest	Canopy cover (%)	19
Canopy species	<i>Corymbia henryi</i> , <i>Eucalyptus resinifera</i> ,	Midstorey (%)	1
Midstorey species	<i>Melaleuca irbyana</i> , <i>Acacia disparrima</i> , <i>Melaleuca nodosa</i>	Forb cover (%)	0
Understorey species	<i>Entolasia stricta</i> , <i>Imperata cylindrica</i> , <i>Oplismenus imbecillis</i>	Grass cover (%)	25
Weed species	<i>Baccharis halimifolia</i> in adjoining cleared areas and exotic grasses <i>Setaria sphacelata</i>	Shrub cover (%)	0
Weed abundance	None	Litter (%)	75
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Past clearing	Exotic (%)	0
Leaf condition	Healthy, little dieback	Plant condition score	4
Dieback	Little	Height (m)	0
Disease/Insect Attack	None obvious	Width (m)	Refer to table
New shoot length	5 to 10 cm, 25% new shoots	Recruitment	Yes, plants in easement, seedlings and suckering





Plot Location



Mi11 and Mi12-juvenile plants in easement



Plant No. Mi-7.2	Abundance	Height (m)	Trunks
Mi10	1 individual	4	11 trunks/suckers
Mi11	2 individuals	1.5	Juveniles
Mi12	1 individual	1.5	Juvenile
Mi15	5 individuals	5	4 single stems and 1 with 3 stems
Mi42	4 individuals	5	3 single stems and 1 with 2 stems
Mi43	3 individuals	2 to 5	Single stems
Mi44	9 individuals	3 to 6	8 single stems and 1 with 3 stems
Mi45	5 individuals	4 to 6	4 single stems and 1 with 2 stems
Mi46	4 individuals	3 to 7	3 single stems and 1 with 3 stems

Identification Code	Oc-8.1	Date	2/09/2014
Species	<i>Oberonia complanata</i>	Type	In situ
Location	Woodburn- north of Evans Head Road	Field marker	Pink Tape
Easting	0	Section	8
Northing	0	Photo no. start	9986
Transect aspect	South	Photo no. finish	9989
Landform	Floodplain	Slope	Flat
Climate history	Heavy rain previous week	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	Low
Water flow	n/a		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	24
Canopy species	<i>Casuarina glauca</i> , <i>Melaleuca quinquenervia</i>	Midstorey (%)	20
Midstorey species	<i>Lophostemon suaveolens</i> , <i>Melaleuca styphelioides</i> , <i>Callistemon salignus</i> , <i>Maclura cochinchinensis</i>	Forb cover (%)	0
Understorey species	<i>Dendrobium linguiforme</i> , <i>Parsonsia stramineum</i>	Grass cover (%)	0
Weed species	<i>Paspalum mandiocanum</i> , <i>Ipomoea cairica</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	10
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Past clearing, dense weeds, pasture improvement	Exotic (%)	90
Leaf condition	Healthy, some dead plants present	Plant condition score	3 to 5
Dieback	Minor	Height (m)	2 to 12 cm
Disease/Insect Attack	Minor	Width (m)	2 to 15 cm
New shoot length	n/a	Recruitment	Yes, small plants present (see photos)

Plot location

Mature fruits

Habitat (host tree)

Juvenile plant

Tree No. Oc-8.1	Plants present	Photo No.	Dieback/Comments
Host tree 1	6 plants (2 x large, 2 x medium, 2 x juvenile, 1 x dead)	9990-9995	1 x dead plant, healthy otherwise
Host tree 2	15 plants (10 x large, 2 x medium, 3 x juvenile, 1 x dead)	9997-0005	1 x dead plant Edge of clearing boundary, good plants for translocation if not avoided
Host tree 3	1 x large plant	0007-0011	Edge of clearing boundary, good plants for translocation if not avoided

Comment
Occurs on three host trees on edge of clearing boundary.

Identification Code	Ot-10.1	Date	2/04/2014
Species	<i>Oberonia titania</i>	Type	In situ
Location	Wardell Road	Field marker	Pink Tape
Easting	542491	Section	10
Northing	6798210	Photo no. start	8178
Transect aspect	South	Photo no. finish	8180
Landform	Floodplain	Slope	Flat
Climate history	Dry previous	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	n/a	Soil moisture	Moderate
Water flow	n/a		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	50
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Lophostemon suaveolens</i> , <i>Ficus macrophylla</i>	Midstorey (%)	11
Midstorey species	<i>Archontophoenix cunninghamiana</i> , <i>Callistemon salignus</i>	Forb cover (%)	15
Understorey species	<i>Morinda jasminoides</i> , <i>Blechnum indicum</i> , <i>Oplismenus imbecillis</i>	Grass cover (%)	15
Weed species	<i>Lantana</i> , <i>Ochna serrulata</i> , <i>Paspalum mandiocanum</i>	Shrub cover (%)	0
Weed abundance	Low-moderate	Litter (%)	70
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Weed invasion	Exotic (%)	0
Leaf condition	Healthy, green and pink/red	Plant condition score	5
Dieback	No	Height (m)	n/a
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	n/a	Recruitment	Yes, small plants present (see photos)



Plot Location



Ot1 and host tree



Ot1



Ot1-Juveniles plants

Plant No. Ot-10.1	Abundance	Photo	Comment
Ot1	3 adult plants appx. 10 juveniles	8181-8203	At 11 metre mark on central transect at base of Bangalow palm

Identification Code	Ot-C10.1	Date	3/04/2014
Species	<i>Oberonia titania</i>	Type	Control
Location	Wardell Road	Field marker	Pink Tape
Easting	542602	Section	10
Northing	6798210	Photo no. start	8281
Transect aspect	South	Photo no. finish	8286
Landform	Floodplain edge	Slope	Flat-slight
Climate history	Dry previous	Aspect	South
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	n/a	Soil moisture	Moderate
Water flow	n/a		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	33
Canopy species	<i>Lophostemon confertus</i> , <i>Callicoma serratifolia</i>	Midstorey (%)	38
Midstorey species	<i>Archontophoenix cunninghamiana</i> , <i>Trochocarpa laurina</i> , <i>Acmena smithii</i>	Forb cover (%)	45
Understorey species	<i>Gahnia clarkei</i> , <i>Alpinia caerulea</i>	Grass cover (%)	10
Weed species	<i>Paspalum mandiocanum</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	45
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Limited	Exotic (%)	0
Leaf condition	Healthy, green and pink/red, some dieback-dead plants	Plant condition score	1 to 5
Dieback	Yes	Height (m)	Growing 0.2 to 4 m from ground
Disease/Insect Attack	No	Width (m)	n/a
New shoot length	n/a	Recruitment	Yes



Plot Location



Host tree 2- dieback evident



Host tree 2



Host tree 3

Plant No. Ot-C10.1	Abundance	Photo	Comment
Host tree 1	7 plants plus juveniles		Dieback on large plants, one plant half dead and 7 dead plants observed
Host tree 2	8 plants plus juveniles	8287-8296, 8300-8303	One plant at base. Dieback on larger plants. Appx 64 juvenile plants
Host tree 3	1 larger plant	8297-8299	3 to 4 metres high on trunk

Identification Code	Pe-C4.1	Date	19/03/2014
Species	<i>Persicaria elatior</i>	Type	Control
Location	Maclean - cane paddock areas	Field marker	Pink Tape
Easting	520112	Section	4
Northing	6738630	Photo no. start	7775
Transect aspect	South	Photo no. finish	7777
Landform	Floodplain	Slope	Flat
Climate history	Extended dry period	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	High
Water flow	None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	28
Canopy species	<i>Melaleuca quinquenervia</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	35
Understorey species	<i>Cynodon dactylon</i> , <i>Persicaria spp.</i>	Grass cover (%)	40
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	25
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Limited, possibly grazing	Exotic (%)	0
Leaf condition	Good - Little/no dieback	Plant condition score	4 to 5
Dieback	Little/none	Height (m)	up to 10 1.2 m
Disease/Insect Attack	No	Width (m)	up to 1.5 m
New shoot length	n/a	Recruitment	Yes, some smaller plants present



Plot Location

Plant No. Pe-C4.1	Abundance
Pe39	44
Pe40	4
Pe41	29
Pe42	1
Pe43	10
Pe44	1


Identification Code	Pe-4.1	Date	19/03/2014
Species	<i>Persicaria elatior</i>	Type	In situ
Location	Maclean - cane paddock areas	Field marker	Pink Tape
Easting	520069	Section	4
Northing	6738690	Photo no. start	7778
Transect aspect	South	Photo no. finish	7780
Landform	Floodplain	Slope	Flat
Climate history	Extended dry period	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	High
Water flow	None		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	15
Canopy species	<i>Melaleuca quinquenervia</i>	Midstorey (%)	1
Midstorey species	0	Forb cover (%)	15
Understorey species	<i>Cynodon dactylon</i> , <i>Paspalum vaginatum</i> , <i>Juncus usitatus</i> , <i>Cyperus polystachyos</i>	Grass cover (%)	65
Weed species	<i>Bidens pilosa</i> , <i>Conyza sp.</i> , <i>Cirsium vulgare</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	20
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	0	Exotic (%)	0
Leaf condition	Some yellowing, dieback	Plant condition score	3 to 4 some dieback
Dieback	Yes from recent dry period	Height (m)	up to 1.2 m
Disease/Insect Attack	Possibly some scale-type insects	Width (m)	up to 2 m
New shoot length	n/a	Recruitment	Yes, some smaller plants present




Plot Location

Plant No. Pe-4.1	Abundance	Comment
Pe23	7	Large spreading plants fallen over
Pe24	4	
Pe30	1	
Pe31	1	


Identification Code	Pe-4.2	Date	4/09/2014
Species	<i>Persicaria elatior</i>	Type	0/01/1900
Location	Townsend	Field marker	Yellow Tape
Easting	0	Section	4
Northing	0	Photo no. start	277
Transect aspect	East	Photo no. finish	279
Landform	Floodplain	Slope	Flat
Climate history	Heavy rain previous week	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	High
Water flow	n/a		
Vegetation Community	Freshwater wetland	Canopy cover (%)	0
Canopy species	n/a	Midstorey (%)	0
Midstorey species	n/a	Forb cover (%)	35
Understorey species	<i>Persicaria spp.</i>	Grass cover (%)	5
Weed species	<i>Sonchus oleraceus</i> , <i>Plantago lanceolata</i> , <i>Conyza spp.</i> , <i>Bidens pilosa</i> , <i>Crotalaria incana</i> , <i>Solanum nigrum</i> , <i>Verbena bonariensis</i> , <i>Cirsium vulgare</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	40
Recruitment	Yes	Bare/Water (%)	0
Impacts/disturbance	Weeds, cropping	Exotic (%)	25
Leaf condition	Plants dead	Plant cond. score	0
Dieback	0	Height (m)	0
Disease/Insect Attack	None obvious	Width (m)	0
New shoot length	n/a	Recruitment	No



Plot location



Habitat



Dead plants present only

Comment
Dead plants present in power line easement adjacent to the clearing boundary. Targeted surveys required during suitable conditions.

Identification Code	Pe-5.1	Date	25/03/2014
Species	<i>Persicaria elatior</i>	Type	In situ
Location	Yaegl Nature Reserve	Field marker	Pink Tape
Easting	521535	Section	5
Northing	6742120	Photo no. start	7933
Transect aspect	South	Photo no. finish	7935
Landform	Swamp, floodplain	Slope	Flat
Climate history	Dry previous	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Moderate	Soil moisture	Boggy, pools of water
Water flow	Stagnant		
Vegetation Community	Swamp Sclerophyll Forest (EEC)	Canopy cover (%)	30
Canopy species	<i>Melaleuca quinquenervia</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	10
Understorey species	0	Grass cover (%)	40
Weed species	<i>Echinochloa crus-galli</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	30
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	10
Impacts/disturbance/threats	Weed invasion	Exotic (%)	10
Leaf condition	Healthy, some insect attack	Plant condition score	4 to 5
Dieback	Yes, from insect damage, not from drying out	Height (m)	1 to 1.5 m
Disease/Insect Attack	Yes, some leaves cocoons present (see photos)	Width (m)	up to 1 m
New shoot length	None obvious, flowering	Recruitment	Minor



Plot Location



Insect damage, insect cocoons ?



Plant No.	Abundance	Comment
Pe-5.1		
Pe403	10	
Pe404	20	2 x juveniles
Pe405	9	2 x juveniles

Identification Code	Pe-5.2	Date	19/03/2014
Species	<i>Persicaria elatior</i>	Type	In situ
Location	Yamba intersection	Field marker	Pink Tape
Easting	523385	Section	5
Northing	6743270	Photo no. start	7772
Transect aspect	West	Photo no. finish	7774
Landform	Floodplain	Slope	Flat
Climate history	Extended dry period	Aspect	Flat
Survey conditions	Clear, recent rain	Drainage	Poor
Water levels	Low	Soil moisture	High
Water flow	None		
Vegetation Community	Pasture with regrowth swamp forest	Canopy cover (%)	0
Canopy species	<i>Melaleuca quinquenervia</i> , <i>Casuarina glauca</i>	Midstorey (%)	0
Midstorey species	0	Forb cover (%)	5
Understorey species	<i>Centella asiatica</i> , <i>Alternanthera denticulata</i> , <i>Cynodon dactylon</i> , <i>Paspalum vaginatum</i> , <i>Cyperus polystachyos</i> , <i>Juncus usitatus</i>	Grass cover (%)	75
Weed species	<i>Cynodon dactylon</i> present treated as a native	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	0
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	20
Impacts/disturbance/threats	Cattle grazing/trampling	Exotic (%)	0
Leaf condition	Poor to moderate	Plant condition score	3 - lots of dieback
Dieback	Yes from extended dry period	Height (m)	up to 1.3 metres
Disease/Insect Attack	Yes, minor stem damage, very small brown sucker insect seen	Width (m)	up to 0.5 metres
New shoot length	n/a	Recruitment	None



Plot Location



Pe7

Plant No.	Abundance	Comment
Pe-5.2		
Pe7	9	Large clump. Plants connected under/along ground stems

Identification Code	Pa-9.1	Date	2/04/2014
Species	<i>Phaius australis</i>	Type	In situ
Location	Broadwater National Park - south of the Richmond River	Field marker	Pink Tape
Easting	543554	Section	9
Northing	6790890	Photo no. start	8146
Transect aspect	South	Photo no. finish	8149
Landform	Sand mass	Slope	Slight
Climate history	Dry previous	Aspect	East
Survey conditions	Clear, recent rain	Drainage	Good to moderate
Water levels	n/a	Soil moisture	High
Water flow	n/a		
Vegetation Community	Littoral Rainforest	Canopy cover (%)	15
Canopy species	<i>Ficus fraseri</i> , <i>Archontophoenix cunninghamiana</i>	Midstorey (%)	59
Midstorey species	<i>Litsea reticulata</i> , <i>Cissus hypoglaucua</i> , <i>Cissus antarctica</i>	Forb cover (%)	65
Understorey species	<i>Histiopteris incisa</i> , <i>Hypolepis muelleri</i>	Grass cover (%)	0
Weed species	<i>Lantana</i> , <i>Solanum mauritianum</i>	Shrub cover (%)	0
Weed abundance	Moderate-high	Litter (%)	30
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Quarry edge effects, dense <i>Lantana</i> cover in areas	Exotic (%)	15
Leaf condition	Dark green, some yellowing	Plant condition score	4 to 5
Dieback	Little, some yellow leaves	Height (m)	up to 0.6 m
Disease/Insect Attack	None obvious	Width (m)	n/a
New shoot length	n/a	Recruitment	Possible, some smaller stems present



Plot Location



Pa1

Plant No. Pa-9.1	Abundance	Photo	Comment
Pa1	9	8150	21 stems, 3 partially dead at 10 metre mark on central transect
Pa2	2	8151	7 stems (3 and 4), mid west of plot area
Pa3	1	8152	3 stems, 2 stems dying back, northwest area of plot
Pa4	2	8153	10 stems, 2 stems dying back, northwest area of plot
Pa5	2	8154	12 stems, 3 dying back, mid north of plot
Pa6	1	8155	3 stems, 1 juvenile stem in north east of plot
Pa7	1	8155	6 stems, 1 died back, mushrooms at base, in north east of plot

Identification Code	Pc-6.1	Date	18/03/2014
Species	<i>Prostanthera cineolifera</i>	Type	In situ
Location	Tabbimoble Creek - Westside highway	Field marker	Metal star picket
Easting	521041	Section	6
Northing	6758120	Photo no. start	7736
Transect aspect	South	Photo no. finish	7738
Landform	Creek, floodplain	Slope	Slight
Climate history	Extended dry period	Aspect	East
Survey conditions	Clear, recent storms	Drainage	Good, sandy
Water levels	Low	Soil moisture	Low
Water flow	None		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	18
Canopy species	<i>Eucalyptus acmenoides</i> , <i>Corymbia intermedia</i> , <i>Eucalyptus microcorys</i>	Midstorey (%)	14
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Acacia disparrima</i>	Forb cover (%)	0
Understorey species	<i>Oplismenus imbecillis</i>	Grass cover (%)	50
Weed species	<i>Lantana camara</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	50
Recruitment (canopy/midstorey)	No	Bare/Water (%)	0
Impacts/disturbance/threats	Grazing	Exotic (%)	0
Leaf condition	Some plants wilting	Plant condition score	2 to 4
Dieback	Yes on most plants some level of dieback	Height (m)	0.5 to 5 m
Disease/Insect Attack	Yes, insect attack around stem (see photos)	Width (m)	0.5 to 6 m
New shoot length	None obvious - mostly to 20 cm	Recruitment	Yes, several juveniles no seedlings



Plot Location



Wilting leaves from dry conditions

Plant No. Pc-6.1	Abundance
Pc137-Pc142	7
Pc148-Pc155	8
Pc158-159	2
Pc164	1
Pc220-Pc221	2
Total	20



Insect activity



Insect damage

Identification Code	Pc-6.2	Date	18/03/2014
Species	<i>Prostanthera cineolifera</i>	Type	In situ
Location	Tabbimoble Creek - Eastside highway	Field marker	Metal star picket
Easting	521127	Section	6
Northing	6758160	Photo no. start	7731
Transect aspect	North	Photo no. finish	7735
Landform	Drainage swale, man-made	Slope	Slight
Climate history	Extended dry period	Aspect	East
Survey conditions	Recent storms	Drainage	Good, sandy
Water levels	Low	Soil moisture	Low
Water flow	None		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	13
Canopy species	<i>Eucalyptus tereticornis</i> , <i>Eucalyptus resinifera</i> , <i>Lophostemon suaveolens</i> , <i>Eucalyptus propinqua</i>	Midstorey (%)	21
Midstorey species	<i>Melaleuca quinquenervia</i> , <i>Callistemon salignus</i> , <i>Acacia disparrima</i>	Forb cover (%)	0
Understorey species	<i>Oplismenus imbecillis</i> , <i>Parsonsia straminea</i>	Grass cover (%)	5
Weed species	<i>Setaria sphacelata</i> , <i>Lantana camara</i>	Shrub cover (%)	5
Weed abundance	Low-Moderate	Litter (%)	80
Recruitment (Yes	Bare/Water (%)	0
Impacts/disturbance/ threats	Road runoff, moderate weed, No livestock access invasion	Exotic (%)	10
Leaf condition	Some plants wilting	Plant condition score	2 to 4
Dieback	Yes on most plants some level of dieback	Height (m)	0.5 to 3 m
Disease/Insect Attack	Yes, insect attack around stem (see photos)	Width (m)	0.5 to 2 m
New shoot length	None obvious - mostly to 20 cm	Recruitment	Yes, several juveniles no seedlings



Plot Location



Insect activity on plants in area

Plant No. Pc-6.2	Abundance	Comments
Pc102-Pc103	2	Trampled Pc103 broken at base Pc102 partially broken, appx. 0.2 metres from each other
Pc104-pc107	4	Numerous stems possibly part of the same individual. Few dead branches present
Pc108-Pc111	4	On road embankment. Pc109 branches trailing under litter. Up to 3 metres high (Pc111)
Pc115-Pc117	3	On road embankment. Pc115 is wilted and dying, Pc117 (5 metres high) is wilted, p116 healthy looking plant
Pc118-Pc120	3	Eastern side of drainage swale away from road
Pc121	1	In open area on edge of vegetation in the road reserve
Pc122	1	
Pc123	1	
Pc124, Pc125	2	Spreading stems along ground, some insect damage
Pc126, Pc127	2	Eastern side of drainage swale away from road. Pc126 juvenile. Pc127 wilted

Identification Code	Pc-C6.1	Date	19/03/2014
Species	<i>Prostanthera cineolifera</i>	Type	Control
Location	Tabbimoble Creek - Eastside highway	Field marker	Wooden stake
Easting	521164	Section	6
Northing	6758210	Photo no. start	7750
Transect aspect	South	Photo no. finish	7752
Landform	Creek, floodplain	Slope	Slight
Climate history	Extended dry period	Aspect	East
Survey conditions	Raining	Drainage	Good, sandy
Water levels	High	Soil moisture	High-mod
Water flow	High		
Vegetation Community	Subtropical Coastal Floodplain Forest (EEC)	Canopy cover (%)	15
Canopy species	<i>Eucalyptus siderophloia</i> , <i>Eucalyptus resinifera</i> , <i>Corymbia intermedia</i>	Midstorey (%)	16
Midstorey species	<i>Callistemon salignus</i>	Forb cover (%)	10
Understorey species	<i>Oplismenus imbecillis</i>	Grass cover (%)	20
Weed species	<i>Axonopus</i>	Shrub cover (%)	0
Weed abundance	Low	Litter (%)	70
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Grazing	Exotic (%)	0
Leaf condition	Healthy, no wilting plants as seen on Westside of highway	Plant condition score	4 to 5
Dieback	Minor, some plants	Height (m)	0.1 to 3 m
Disease/Insect Attack	No	Width (m)	up to 4 m
New shoot length	None obvious - mostly to 20 cm	Recruitment	Yes, 4x seedlings (0.1-0.2 m high), plus juveniles (>0.2 m high)



Plot Location

Plant No. Pc-6.2	Abundance	Comments
Pc1-Pc34	34	All healthy looking plants, not wilting as seen as western side of highway

Identification Code	QM-C1.1	Date	30/04/2014
Species	<i>Quassia</i> sp. Moonee Creek	Type	Control
Location	Dirty Creek Range, southern population	Field marker	Yellow Tape
Easting	514990	Section	1
Northing	6681980	Photo no. start	8570
Transect aspect	Southeast, parallel to property boundary	Photo no. finish	8572
Landform	Lower to mid slope	Slope	Steep
Climate history	Rain end of March and start of April, dry preceding	Aspect	Northeast
Survey conditions	Rain developing	Drainage	Good
Water levels	No water in drainage line	Soil moisture	Moderate-High
Water flow	None		
Vegetation Community	Large-fruited Blackbutt Forest	Canopy cover (%)	9
Canopy species	<i>Eucalyptus pyrocarpa</i> , <i>Angophora woodsiana</i> , <i>Corymbia gummifera</i>	Midstorey (%)	4
Midstorey species	<i>Acacia terminalis</i> , <i>Hakea sericea</i> ,	Forb cover (%)	5
Understorey species	<i>Entolasia stricta</i>	Grass cover (%)	25
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	70
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Graded trail and clearing for fence construction, plants have regenerated on trail	Exotic (%)	0
Leaf condition	Healthy, dark green	Plant condition score	4 to 5
Dieback	Some minor yellowing on some plants, one dead plant present	Height (m)	0.1 to 0.6 m
Disease/Insect Attack	None	Width (m)	0.1 to 0.3 m
New shoot length	None	Recruitment	Possible



Plot Location



Q1



Q255



Q257- soil erosion on old cutting, roots exposed

Plant No.	Abundance	Photo	Comments
QM-C1.1			
Q1-Q9	9	8579-8582 (Q1), 8578 (Q9)	Plants flagged during current survey
Q148-Q151	4	8587 (Q50)	
Q255	1	8573-8574	Plant dead
Q256-Q260	5	8583-8585 (Q257), 8575-8577	Soil erosion up on old cutting, roots exposed
Total	19		

In a disturbed area along the fence line, old trails either side with small cuttings

Identification Code	QM-1.1	Date	30/04/2014
Species	<i>Quassia</i> sp. Moonee Creek	Type	In situ
Location	Dirty Creek Range, southern population	Field marker	Yellow Tape
Easting	515007	Section	1
Northing	6681990	Photo no. start	8588
Transect aspect	South	Photo no. finish	8590
Landform	Lower slope / gully	Slope	Steep
Climate history	Rain end of March and start of April, dry preceding	Aspect	Northeast
Survey conditions	Rain developing	Drainage	Good
Water levels	No water in drainage line	Soil moisture	Moderate-High
Water flow	None		
Vegetation Community	Large-fruited Blackbutt Forest	Canopy cover (%)	14
Canopy species	<i>Eucalyptus pyrocarpa</i> , <i>Syncarpia glomulifera</i> , <i>Angophora woodsiana</i> , <i>Corymbia gummifera</i>	Midstorey (%)	15
Midstorey species	<i>Acacia complanata</i> , <i>Hakea sericea</i> , <i>Pultenaea tuberculata</i>	Forb cover (%)	20
Understorey species	<i>Lepidosperma laterale</i> , <i>Patersonia sericea</i> , <i>Microlaena stipoides</i>	Grass cover (%)	5
Weed species	None	Shrub cover (%)	0
Weed abundance	None	Litter (%)	75
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	Trail construction upslope	Exotic (%)	0
Leaf condition	Healthy, dark green	Plant condition score	4 to 5
Dieback	Some minor yellowing on some plants	Height (m)	Mostly to 0.5 m
Disease/Insect Attack	None	Width (m)	Mostly to 0.5 m
New shoot length	None	Recruitment	Possible




Plot Location

Q188-Q194


Plant No. QM-1.1	Abundance	Photo	Comments
Q10-Q14	5		Plants flagged during current survey
Q19-Q21	7	8597-8600 (Q19)	Plants flagged during current survey
Q153-Q156	4		
Q165-Q167	3		
Q178, Q175	7		Photos of lignotuber (Q175), 5x plants not numbered
Q180-Q184	5		
Q188-Q194	3	8595-8596	Single individual with 5 stems
Q195-Q198	1		Log fallen on plant, and now multiple stems regrowing
Q209-Q216	9		
Q240-Q247	6	8601-8603	
Q260-Q263	4		
Total	54		

Some plants resprouting after being smothered with leaf litter

Identification Code	QM-C1.2	Date	30/04/2014
Species	<i>Quassia sp. Moonee Creek</i>	Type	Control
Location	Dirty Creek Range, northern population	Field marker	Yellow Tape
Easting	514698	Section	1
Northing	6682120	Photo no. start	8614
Transect aspect	South	Photo no. finish	8616
Landform	Lower slope / gully	Slope	Steep
Climate history	Rain end of March and start of April, dry preceding	Aspect	North
Survey conditions	Rain developing	Drainage	Good
Water levels	Moderate	Soil moisture	Moderate-High
Water flow	Moderate		
Vegetation Community	Large-fruited Blackbutt Forest	Canopy cover (%)	14
Canopy species	<i>Eucalyptus pyrocarpa, Angophora woodsiana</i>	Midstorey (%)	14
Midstorey species	<i>Leptospermum trinervium, Ceratopetalum gummifera, Acacia oshanesii</i>	Forb cover (%)	5
Understorey species	<i>Caustis flexuosa, Entolasia stricta, Themeda australis</i>	Grass cover (%)	20
Weed species	None	Shrub cover (%)	15
Weed abundance	None	Litter (%)	55
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	0
Impacts/disturbance/threats	0	Exotic (%)	0
Leaf condition	Healthy, dark green, new red shoots	Plant condition score	4 to 5
Dieback	Minor	Height (m)	0.1 to 1.5 m
Disease/Insect Attack	Yes, caterpillars (see photos)	Width (m)	Mostly to 0.5 m
New shoot length	5 to 10 cm red leaves (see photos)	Recruitment	Possible



Plot Location



Q25-flower buds present

Plant No. QM-C1.2	Abundance	Photo	Comments
Q25	1	8618-8621	Flowering
Q27	1		
Q324-Q329	6	8625	New shoots present, Q329 has caterpillars present
Q340-Q346	7		
Q826-Q828	1		One individual several stems
Q829	1		Fallen over, stood back up
Q830-Q831	1		One individual several stems
Q835-Q838	4		Downslope of large log
Q841-Q842	1	8623-8624	One individual several stems. Caterpillar observed feeding on leaves, photos
Q843-Q845	3	8613	
Total	26		

Quassia sp. Moonee Creek



Quassia sp. Moonee Creek and webbing from caterpillars in Plot QM-C1.2



Caterpillar feeding on *Quassia* sp. Moonee Creek in Plot QM-C1.2



Q175 (Plot QM-1.1) - two stems arising from a single lignotuber / storage organ

Identification Code	QM-1.2	Date	30/04/2014
Species	<i>Quassia</i> sp. <i>Moonee Creek</i>	Type	In situ
Location	Dirty Creek Range, northern population	Field marker	Yellow Tape
Easting	514667	Section	1
Northing	6682150	Photo no. start	8604
Transect aspect	South	Photo no. finish	8606
Landform	Lower slope / gully	Slope	Steep
Climate history	Rain end of March and start of April, dry preceding	Aspect	South
Survey conditions	Rain developing	Drainage	Good
Water levels	Moderate	Soil moisture	Moderate-High
Water flow	Moderate		
Vegetation Community	Large-fruited Blackbutt Forest	Canopy cover (%)	14
Canopy species	<i>Eucalyptus pyrocarpa</i> , <i>Angophora woodsiana</i>	Midstorey (%)	3
Midstorey species	<i>Acacia oshanesii</i> , <i>Leptospermum polygalifolium</i> , <i>Bursaria spinosa</i> , <i>Epacris pulchella</i> , <i>Pultenaea tuberculata</i>	Forb cover (%)	15
Understorey species	<i>Gahnia clarkei</i> , <i>Entolasia stricta</i> , <i>Aotus ericoides</i>	Grass cover (%)	10
Weed species	None	Shrub cover (%)	10
Weed abundance	None	Litter (%)	45
Recruitment (canopy/midstorey)	Yes	Bare/Water (%)	25
Impacts/disturbance/threats	0	Exotic (%)	0
Leaf condition	Healthy, dark green, new red shoots	Plant condition score	4 to 5
Dieback	Very minor	Height (m)	Mostly to 0.5 m
Disease/Insect Attack	None	Width (m)	Mostly to 0.5 m
New shoot length	10 cm red leaves (see photos)	Recruitment	Possible



Plot Location



Q522

Plant No. QM-1.2	Abundance	Photo	Comments
Q11-Q22	12		Northern area of plot
Q23	4	8611-8612	Marked on existing tape
Q24	1	8613	
Q26	1	8610	
Q27	1	8609	New shoots present
Q39-Q46	8		Plants flagged during current survey
Q522	3	8607	2 x plants flagged during current survey just outside western boundary
Q46-Q50	5		At 5 to 6 metre mark on central transect
Q51-Q93	43		On creek
Total	78		

Identification Code	Sp-4.1	Date	4/09/2014
Species	<i>Streblus pendulinus</i>	Type	In situ
Location	Maclean, south of Jubilee Street	Field marker	Pink Tape
Easting	0	Section	4
Northing	0	Photo no. start	246
Transect aspect	South	Photo no. finish	248
Landform	Lower slope/floodplain	Slope	Low
Climate history	Heavy rain previous week	Aspect	South
Survey conditions	Clear, recent rain	Drainage	Moderate
Water levels	Moderate	Soil moisture	Moderate-High
Water flow	Low		
Vegetation Community	Flooded Gum/Brushbox with rainforest understorey	Canopy cover (%)	13
Canopy species	<i>Lophostemon confertus</i> , <i>Eucalyptus grandis</i> , <i>Cinnamomum camphora</i>	Midstorey (%)	13
Midstorey species	<i>Acacia disparrima</i> , <i>Trophis scandens</i>	Forb cover (%)	10
Understorey species	<i>Adiantum hispidulum</i> , <i>Oplismenus imbecillis</i> , <i>Microlaena stipoides</i> , <i>Doodia aspera</i> , <i>Geitonoplesium cymosum</i>	Grass cover (%)	45
Weed species	<i>Lantana camara</i> , <i>Ochna serrulata</i> , <i>Ipomoea cairica</i> , <i>Senna pendula</i> var. <i>glabrata</i> , <i>Cinnamomum camphora</i>	Shrub cover (%)	0
Weed abundance	Moderate	Litter (%)	35
Recruitment	Minor	Bare/Water (%)	0
Impacts/disturbance	Weeds, edge effects	Exotic (%)	5
Leaf condition	Healthy, dark green	Plant cond. score	5
Dieback	Minor	Height (m)	9 metres
Disease/Insect Attack	Yes	Width (m)	3 metres
New shoot length	1 to 20 mm	Recruitment	No
Comments	Single tree on edge of clearing boundary		



Plot Location

Trunk of *Streblus pendulinus*

Foliage



Insect damage and small cocoon



Insect damage and webbing

Identification Code	Sp-8.1	Date	3/09/2014
Species	<i>Streblus pendulinus</i>	Type	In situ
Location	Woodburn, Lang Hill	Field marker	Yellow Tape
Easting	0	Section	8
Northing	0	Photo no. start	156
Transect aspect	South	Photo no. finish	160
Landform	Lower slope/floodplain	Slope	Low
Climate history	Heavy rain previous week	Aspect	West southwest
Survey conditions	Clear, recent rain	Drainage	Moderate
Water levels	Moderate	Soil moisture	Moderate-High
Water flow	n/a		
Vegetation Community	Pasture with regrowth dry rainforest and sclerophyll forest	Canopy cover (%)	10
Canopy species	<i>Casuarina glauca</i>	Midstorey (%)	40
Midstorey species	<i>Maclura cochinchinensis</i> , <i>Gossia acmenoides</i> , <i>Elaeocarpus obovatus</i> , <i>Cupaniopsis laurina</i> , <i>Hodgkinsonia ovatifolia</i>	Forb cover (%)	20
Understorey species	<i>Sigesbeckia orientalis</i> , <i>Oplismenus imbecillis</i>	Grass cover (%)	35
Weed species	<i>Lantana camara</i> , <i>Cinnamomum camphora</i>	Shrub cover (%)	0
Weed abundance	High	Litter (%)	30
Recruitment (canopy/midstorey)	Minor	Bare/Water (%)	0
Impacts/disturbance/threats	Weeds, grazing	Exotic (%)	15
Leaf condition	Healthy, dark green	Plant condition score	5
Dieback	Minor	Height (m)	0.4 to 6 metres
Disease/Insect Attack	None obvious	Width (m)	0.4 to 2 metres
New shoot length	1 to 2 cm	Recruitment	Yes



Plot Location



Foliage (Sp2)



Juvenile plant (Sp3)



Flower buds (sp1)

Tree No. Sp-8.1	Height (m)	Width (m)	DBH (cm)	Photo No.	Dieback/Comments
Sp1	6	2	8	161-165, 170	Minor
Sp2	1.5	0.5	1	166-169	None obvious
Sp3	0.4	0.4	1	171-172	None obvious

Comment

One larger plant and two juveniles in isolated patch of weeds and native trees on edge of clearing boundary in open paddock area

Appendix C. Threatened Flora Monitoring Proforma

W2B - THREATENED FLORA PRO-FORMA						
SPECIES						in-situ control
LOCATION				WAYPOINT		
PLANT ID CODE				MARKER		
PHOTO NUMBER (location, aspect)						
CLIMATIC CONDITIONS				LANDFORM		
				DRAINAGE		
SOIL MOSITURE				SLOPE		
WATERWAYS (water levels, flow, stagnant water)				ASPECT		
PLANT CONDITION (score 0-5, where 0 is dead and 5 is excellent)				Score		
Height			DBH			
Width			No. of trunks			
LEAF CONDITION (healthy/unhealthy, colour, vigour.)						
FLOWERS						
FRUIT						
LENGTH OF NEW SHOOTS						
(average length of new shoots (estimate) and abundance of new shoots (counts or basic scale))						
DISEASE / INSECT ATTACK						
RECRUITMENT						
OTHER (DAMAGE/DISTURBANCE)				DIEBACK		
VEGETATION COMMUNITY				20m TRANSECT		
CANOPY COVER (4 points c/a)						
MID-STOREY COVER (4 points c/a)						
GROUND-LAYER COVER (20 points presence/absence)						
forb						
grass						
shrub						
litter						
bare						
exotic						
Weeds species and abundance						
RECRUITMENT (canopy, midstorey)						
IMPACTS/DISTURBANCE (fire, logging, grazing, runoff, edge effects)						
COMMENTS/INDIVIDUALS						
DRAFT						

Appendix E – Species profiles

Sandstone Rough-barked Apple

(*Angophora robur*)



Source: <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10054>

DESCRIPTION

Sandstone Rough-barked Apple is an, eucalypt-like trees with paired leaves and, often, gnarled limbs. It grows up to 10 m tall, and is smaller and more twisted than most angophoras. It has rough grey bark and is distinguished by its unusually large leaves, up to 18 cm long and 7.5 cm wide. The leaves may be rather bristly and are paler below. The white, clustered flowers are followed by large, ribbed fruits up to 1.6 cm long and wide

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

Occurs in a band from around Glenreagh, north-west of Coffs Harbour, to the Coaldale area north-west of Grafton, with an isolated occurrence farther west near Nymboida. It can be locally common

HABITAT

Dry open forest in sandy or skeletal soils on sandstone, or occasionally granite, with frequent outcrops of rock.

THREATS

- Clearing of habitat for development or agriculture.
- Too-frequent fires, which may suppress successful regeneration.
- Widening of roads.
- Timber harvesting in water quality, from sedimentation or pollution.

White Lace Flower

(*Archidendron hendersonii*)



Source: <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10062#>

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; EPBC Act: NOT LISTED.

DISTRIBUTION

From north Queensland south to the Richmond River in north-east NSW.

HABITAT

Riverine and lowland subtropical rainforest, littoral rainforest, coastal cypress pine forest and their ecotones.

It is found on a variety of soils including coastal sands and those derived from basalt and metasediments.

THREATS

- Fragmentation and loss of habitat for agriculture.
- Fragmentation and loss of habitat for development.
- Habitat degradation through weed invasion and disturbance.
- Illegal collection of seeds for horticulture.
- Trampling by domestic stock.
- Coastal locations are likely to be exposed to saltwater intrusion, and increased intensity of storms/winds.
- Current or potential future land management practices do not support conservation.
- Disturbance from road and track maintenance activities.
- Inappropriate fire regimes.

Hairy Joint Grass

(*Arthraxon hispidus*)



Source: <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10066>

DESCRIPTION

Hairy Joint Grass is a creeping grass with branching, erect to semi-erect purplish stems. Leaf-blades are 2–6 cm long, broad at the base and tapering abruptly to a sharp point. Long white hairs project around the edge of the leaf. The seed-heads are held above the plant on a long fine stalk. This grass is considered to be a perennial but it tends to die down in winter

LEGISLATIVE STATUS

TSC Act: VULNERABLE, EPBC Act: VULNERABLE.

DISTRIBUTION

Occurs over a wide area in south-east Queensland, and on the northern tablelands and north coast of NSW, but is never common. Also found from Japan to central Eurasia.

HABITAT

Moisture and shade-loving grass, found in or on the edges of rainforest and in wet eucalypt forest, often near creeks or swamps.

THREATS

- Clearing of habitat for agriculture and development.
- Inappropriate fire regimes.
- Over-grazing by domestic stock.
- Competition from introduced grasses such as *Paspalum* and *Kikuyu*.
- Slashing or mowing of habitat.

Stinking Cryptocarya

(*Cryptocarya foetidai*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10186>

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, warm temperate and subtropical rainforest, wet sclerophyll forest and Camphor laural forest 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 development.
- Clearing and fragmentation of habitat for agriculture.
- Infestation of habitat by weeds.
- Clearing and disturbance as a result of roadworks and track maintenance.
- Inappropriate fire regime.
- Trampling by visitors when accessing beach areas through littoral rainforest.
- Trampling by domestic stock.
- Inappropriate fire regime altering habitat and destroying individuals.

Water Nutgrass

(*Cyperus aquatilis*)



Source: <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10197>

DESCRIPTION

Sedge that appears as an annual during the wet summer period. It grows to 10 – 30 cm tall, and has weak triangular stems. The leaves are 1 – 3 mm wide and shorter than the flowering stem. The flower- and seed-head is made up of several branches radiating from the top of the stem. Each branch has one to eight flattened spikelets 3 mm wide with 10 – 30 green flowers. The seeds are three-sided nuts, whitish to pale brown.

LEGISLATIVE STATUS

TSC Act: ENDANGERED.

DISTRIBUTION

In NSW, known only from a few sites north from Grafton. Also occurs in Queensland, Northern Territory, Western Australia and New Guinea.

HABITAT

Grows in ephemerally wet sites, such as roadside ditches and seepage areas from small cliffs, in sandstone areas.

THREATS

- Clearing for agriculture or development.
- Browsing and trampling by stock.
- Damage to plants and habitat during road-works.

Davidson's Plum

(*Davidsonia jerseyana*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10208>

DESCRIPTION

Davidson's Plum grows to 10 m tall, either with a single unbranched stem or several stems arising from the base. The large, hairy leaves are bunched towards the top of the trunk, and are divided into 7 - 17 large, toothed leaflets. Small pinkish flowers are borne directly from the main stem in long, loose clusters. The plum-like fruits are prized as bush food.

LEGISLATIVE STATUS

TSC Act: ENDANGERED, EPBC Act: ENDANGERED

DISTRIBUTION

Restricted to north-east NSW to as far south as Wardell.

HABITAT

Lowland subtropical rainforest and wet eucalypt forest at low altitudes (below 300m).

Many trees are isolated in paddocks and on roadsides in former rainforest habitats.

THREATS

- Clearing and fragmentation of habitat.
- Grazing by domestic stock.
- Roadworks.
- Invasion of habitat by weeds.
- Fire.
- Collection of fruit for bush food, and seeds for horticulture.

Square-stemmed Spike-rush

(*Eleocharis tetraquetra*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10265>

DESCRIPTION

A tufted perennial plant distinguished by its slender four-angled stem and broad spikelet on top of the stem. Stems grow 30 to 100 cm tall and are 1 – 1.5 mm in diameter. The leaves are at the base of the stem and are not very conspicuous, being reduced to tubular sheaths. The spikelet is 10 – 20 mm long and 3.5 – 5mm in diameter. The seeds are contained within the spikelet and are a shining yellow or brown colour, approximately 1.5 mm long and 1 mm wide.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

Thought to be extinct in NSW until it was rediscovered in 1997 at Boambee near Coffs Harbour. It has since been found in other north coast localities near Grafton and Murwillumbah. The species also occurs in south-east Queensland.

HABITAT

Found in damp locations on stream edges and in and on the margins of freshwater swamps.

THREATS

- Clearing of habitat for development and agriculture.
- Invasion of habitat by weeds and pasture grasses.
- Changes to the natural disturbance patterns such as grazing, fire and flooding.
- Degradation of habitat by intensive grazing by stock.

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

Square-fruited Ironbark

(*Eucalyptus tetrapleura*)



Source: http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&photo=26&file=28/169/Eucalyptus_tetrapleura_0.jpg

DESCRIPTION

This tree may grow to over 30 m tall but is usually smaller than other ironbarks. The deeply furrowed bark is dark brown or black and extends to the small branches. It is more flaky than the typically hard bark of other ironbarks. Adult leaves are up to 20 cm long, curved and dull green on both sides. The four-angled buds have distinctively small caps that protrude at the end. The 1 cm long, conical or pear-shaped fruits also have four angles.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

Restricted to the coastal lowlands and foothills of northern NSW around Casino and Grafton.

HABITAT

Dry or moist eucalypt forest on moderately fertile soil, often in low areas with poor drainage.

THREATS

- Loss of habitat through clearing for agriculture.
- Timber harvesting activities.
- Road construction and maintenance.
- Grazing of young plants by domestic stock.
- Too-frequent fires, which inhibit regeneration.

Four-tailed Grevillea

(*Grevillea quadricauda*)



Source: <http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&photo=28&file=67/012/Grevillea%20quadricauda.jpg>

DESCRIPTION

This is a bushy shrub with yellow-green foliage, growing to 2 m in height and spread. New growth is pink or purple, especially on the tips of the leaves, and the branchlets are matted with hairs. The leaves are up to 1.8 cm long, tapered at both ends and often rolled under along the sides. Silky white hairs are sparse on the upper side and denser on the lower side. The hairy flowers are in groups of two to four, and are pink or red with a green base. Each 'petal' bears a distinct pointed 'tail' at its tip. The dry fruit has a long projection bent sharply backwards.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

In NSW it is found to the north-west of Whiporie in Mount Belmore State Forest and Mount Neville Nature Reserve, and at Tucabia east of Grafton. It also occurs near Toowoomba in south-east Queensland in damp locations on stream edges and in and on the margins of freshwater swamps.

HABITAT

Grows in gravelly loam, in the understorey of dry eucalypt forest, usually along or near creeks

THREATS

- Timber harvesting activities.
- Too-frequent fire.
- Road widening and maintenance.
- Clearing for development and agriculture.
- Risk of local extinction because populations are small.

Lindernia

(*Lindernia alsinoides*)



Source: <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10922>

DESCRIPTION

Lindernia is a small diffuse or erect herb growing to 15cm tall. Oval shaped leaves grow to approximately 5-10 cm long and 1.5-5 mm wide and are arranged in opposite pairs along the length of the stem. Leaves growing closer to a flower are thinner being almost linear in shape. The leaf stalk is approximately 3 mm long and three veins can be observed extending from juncture of the stem and the base of the leaf. Lindernia flower throughout spring and autumn presenting 1-8 blue and white hooded and lobed flowers.

LEGISLATIVE STATUS

TSC Act: ENDANGERED

DISTRIBUTION

In NSW Lindernia has been primarily recorded along coastal areas between Buladelah and Coopernook. Additional records also exist from Shannon Creek, west of Coutts Crossing, and Bungawalbyn.

HABITAT

Lindernia occurs in areas of swampy forest and wetlands along coastal and hinterland creek systems.

THREATS

- Land development and clearing.
- Vulnerability due to population size.
- Lack of knowledge surrounding management requirements for the species.
- Fire frequency.
- Grazing and trampling by domestic stock, particularly during drought.
- Competition with *Melaleuca quinquenervia* as a result of irregular slashing and grazing regimes.
- Competition from weed species within habitat areas.

Slender Screw Fern

(*Lindsaea incisa*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10482>

DESCRIPTION

Slender Screw Fern is a delicate-looking ground fern with a creeping underground root. The light-green fronds are slender, up to 30 cm long, and stand erect or tangled through other vegetation. Divided fan-shaped leaflets are spaced along the stems, often in pairs. The leafless part of the stem is straw-coloured, darker at the base, and is much shorter than the frond length. The spores are produced under membranous flaps on the lobes of some of the leaflets.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

In NSW it is found to the north-west of Whiporie in Mount Belmore State Forest and Mount Neville Nature Reserve, and at Tucabia east of Grafton. It also occurs near Toowoomba in south-east Queensland in damp locations on stream edges and in and on the margins of freshwater swamps.

HABITAT

Grows in gravely loam, in the understorey of dry eucalypt forest, usually along or near creeks.

THREATS

- Land development and clearing.
- Frequent fire.
- Alterations to drainage of creeks.
- Recreation, including camping, near creeks.
- Grazing and trampling by domestic stock.
- Risk of local extinction because numbers are low.
- Broad leaved Paspalum, Crofton weed and soil nutrification (from agriculture and urban run-off).

Rough-shelled Bush Nut

(*Macadamia tetraphylla*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10482>
<http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10499>

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 north of the Richmond River in north-east NSW, extending just across the border into Queensland. Many records, particularly those further south, are thought to be propagated.

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.
- Reduction of genetic diversity as a result of fragmentation

Maundia

(*Maundia triglochinoides*)



Source: <http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&photo=26&file=66/708/Maundia%20triglochinoides%20in%20Windmill%20Dam.%20Clybucca.JPG>

DESCRIPTION

Perennial with rhizomes about 5mm thick and emergent tufts of leaves arising along their length. Leaves are spongy, inflated and triangular in cross section, to 80 cm long, sometimes longer, 5 – 10 mm wide. Inflorescence to 10 cm long and 2.5 cm wide. Carpels (female parts of flower) 6 – 8 mm long, sessile, each with a spreading beak. The fruit is 1cm long to 8mm wide.

LEGISLATIVE STATUS

TSC Act: VULNERABLE

DISTRIBUTION

Restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong; former sites around Sydney are now extinct.

HABITAT

- Grows in swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients.
- Flowering occurs during warmer months.
- Associated with wetland species e.g. Triglochin procerum.
- Probably wind pollinated.
- Diaspore is the seed and root tubers, which are probably dispersed by water.
- Spreads vegetatively, with tufts of leaves arising along rhizome. Populations expand following flood events and contract to more permanent wetlands in times of low rainfall.
- Flowers November-January. Grows in gravelly loam, in the understorey of dry eucalypt forest, usually along or near creeks.

THREATS

- Further loss and fragmentation of habitat.
- Changes in hydrology and water quality.
- Weed invasion.

Weeping Paperbark

(*Melaleuca irbyana*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10518>

DESCRIPTION

Weeping Paperbark (formerly *Melaleuca tamariscina* subsp. *irbyana*) has thick, spongy, papery bark and grows to about 8 m tall. It has a dense, rounded canopy of very fine, weeping foliage. The tiny, stalkless, pointed leaves are less than 4 mm long, smaller than any other NSW *Melaleuca* species, and are pressed close to the branchlets, wrapping around them slightly. In summer profuse white brushes, made up of groups of flowers in threes, appear and are followed by tight clusters of woody fruits.

LEGISLATIVE STATUS

TSC Act: ENDANGERED, EPBC Act: NOT LISTED

DISTRIBUTION

Found in only a few places in north-east NSW, including near Coraki, Casino and Coutts Crossing south of Grafton. Also occurs in near Ipswich in south-east Queensland

HABITAT

Open eucalypt forest in poorly drained, usually clay, soils

THREATS

- Fire, particularly when too frequent to allow regeneration.
- Clearing of habitat for agriculture and development.
- Grazing by domestic stock.
- Invasion of habitat by weeds particularly introduced grasses.
- Road-works, including grading and slashing.
- Timber harvesting activities.
- Risk of local extinction because populations are small and may also lack genetic diversity.

Yellow-flowered King of the Fairies

(*Oberonia complanata*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10570>

DESCRIPTION

Yellow-flowered King of the Fairies is a small orchid which grows on trees or rocks. Each plant possesses one to many shoots in a tight, iris-like clump. There are 3-8 leaves per shoot. The leaves are spear- to oblong-shaped, 3-15 cm long, 10-15 mm wide, and yellow-green in colour. About 150 to 300 tiny cream to yellowish flowers are borne on erect to drooping stems up to 20 cm long in spring and summer.

LEGISLATIVE STATUS

TSC Act: ENDANGERED, EPBC Act: NOT LISTED

DISTRIBUTION

Within NSW, there are several historical collections (all pre 1917) of this species from Byron Bay and Lismore, and a collection from Coffs Harbour from 1961. More recent observations of this species have been made from Lismore and Wollumbin.

HABITAT

This species grows on trees and rocks in littoral rainforest, subtropical rainforest, dry rainforest, wet or dry eucalypt forests, dunes (including stabilised sands), stream-side areas, swampy forests and mangroves.

THREATS

- Loss of habitat through clearing, degradation and fragmentation of native vegetation.
- Collection by orchid enthusiasts.
- The species is susceptible to extinction via stochastic processes due to its small known population size and restricted distribution.

Red-flowered King of the Fairies Orchid

(*Oberonia titania*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10571>

DESCRIPTION

King of the Fairies is a small orchid which grows on trees and rocks. Each plant possesses one to several shoots in a tight, iris-like clump. There are 4-10 leaves per shoot. The leaves are narrowly oval- to spear-shaped, 1-8 cm long, 2-8 mm wide, and green to greenish pink in colour. About 50-350 tiny red flowers are borne on erect to drooping stems 5-17 cm long in autumn and spring.

LEGISLATIVE STATUS

TSC Act: VALNERABLE, EPBC Act: NOT LISTED

DISTRIBUTION

King of the Fairies occurs on the NSW north coast north from Kendall, and also in in Queensland and Norfolk Island. It is known from 10 locations in NSW, two of which occur within Dorrigo National Park and Washpool National Park.

HABITAT

King of the Fairies occurs in littoral and subtropical rainforest and paperbark swamps, but it can also occur in eucalypt-forested gorges and in mangroves.

THREATS

- Loss of habitat through clearing, degradation and fragmentation of native vegetation.
- Collection by orchid enthusiasts.

Square-stemmed Olax

(*Olax angulata*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10574>

DESCRIPTION

Square-stemmed Olax is an upright shrub, which may be parasitic on the roots of other plants. Its stiff branches are often yellowish in colour, with prominent U-shaped ridges. The branchlets are square in cross-section and are yellow-green or blue-green like the leaves. The leaves are stalkless, arranged alternately, and are smooth, brittle and oval-shaped with a tiny point at the end. Small white flowers are often present with the fleshy, egg-shaped, one-seeded fruits.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

Known from a small area east of Grafton, near Minnie Water and Wooli, mainly in Yuraygir National Park and on nearby leasehold land. Locally common. Also known from an area north of Grafton in Banyabba Nature Reserve, Fortis Creek National Park and adjoining freehold land.

HABITAT

Low-lying coastal heaths and heathy woodlands on sandy soils near swamps, often in association with Wallum Banksia (*Banksia aemula*).

THREATS

- Clearing of habitat for urban development.
- Frequent fire.
- Trampling by visitors.
- Track widening and maintenance, and road maintenance.
- Weed invasion of habitat, particularly Bitou Bush.
- Risk of local extinction because populations are small.
- Eutrophication from urban run-off increasing weed threat - localised impacts
- Do not know extent of the population throughout the reserve.

Tall Knotweed

(*Persicaria elatior*)



Source: <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10590>

DESCRIPTION

Tall Knotweed is an erect herb growing to 90 cm tall. Distinctive stalked, glandular hairs are present on most parts of the plant. Mature leaves grow up to 11 cm long and 30 mm wide with a sheath encircling the stem at the base of each leaf. Tall Knotweed flowers appear in long, narrow spikes growing to 5 cm long. Each pink flower-segment along the spike is less than 4 mm long.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

In NSW Tall Knotweed has been recorded in the South-east in Mt Dromedary, Moruya State Forest, Upper Avon River catchment north of Robertson, Bermagui and Picton Lakes. Additional records also exist from northern NSW around Raymond Terrace and Grafton. The species also occurs in parts of South-east Queensland.

HABITAT

This species is known to grow in damp habitats, primarily found beside streams and lakes. It is also known to occasionally occur in swampy forests or similarly swampy areas that have undergone historical disturbance.

THREATS

- Clearing or disturbance of habitat areas.
- Damage to populations occurring in the vicinity of roads due to maintenance activities.
- Competition with weeds such as *Ludwigia longifolia* and *Solanum nigrum*.
- Grazing and trampling by domestic stock.
- Small population sizes and a restricted distribution.

Southern Swamp Orchid

(*Phaius australis*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10610>

DESCRIPTION

This orchid has flower stems up to 2 m tall and large broad leaves with a pleated appearance, both arising from a fleshy bulb near ground level. The large, showy flowers, with up to 20 per stem, have four petals which are white on the outside and brown with white or yellow veins on the inside. The central tongue of the flower is pink and yellow with lobes slightly curved inwards

LEGISLATIVE STATUS

TSC Act: ENDANGERED; EPBC Act: ENDANGERED.

DISTRIBUTION

Occurs in Queensland and north-east NSW as far south as Coffs Harbour. Historically, it extended farther south, to Port Macquarie.

HABITAT

Swampy grassland or swampy forest including rainforest, eucalypt or paperbark forest, mostly in coastal areas.

THREATS

- Illegal collection for horticulture or cut flowers. This showy species is highly sought after.
- Small population size.
- Drainage of swamps, or pollution from nutrient run-off.
- Frequent fire
- Grazing and trampling by domestic stock and feral pigs.
- Invasion of habitat by introduced weeds.
- Trail bike riders disturbing substrate and destroying plants.
- Rubbish dumping and other disturbance due vehicles and/or people.
- Clearing and fragmentation of habitat for development, agriculture and roadworks.

Singleton Mint Bush

(*Prostanthera cineolifera*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10672>

DESCRIPTION

Erect shrub, 1 - 4 m high, strongly aromatic; branches moderately to densely covered with short, curled hairs and more or less sessile glands. Leaves more or less narrow-ovate, 12 - 50 mm long, 4 - 12 mm wide; apex obtuse; base cuneate to obtuse; margins entire; surfaces light green, mostly hairless, sparsely to densely hairy on midrib on lower surface, densely glandular with more or less sessile glands. Flowers clustered at the ends of branches; bracteoles not persistent, 1 - 2 mm long. Sepals 3 - 4 mm long; tube 2 - 2.5 mm long; upper lobe 1 - 2 mm long, not enlarged in fruit. Petals 8 - 11 mm long, pale mauve to dark purple-mauve, darker in throat. The taxonomic status of this species is uncertain.

LEGISLATIVE STATUS

TSC Act: VULNERABLE; EPBC Act: VULNERABLE.

DISTRIBUTION

Restricted to only a few localities near Walcha, Scone, Cessnock and St Albans.

HABITAT

Grows in open woodlands on exposed sandstone ridges.

Usually found in association with shallow or skeletal sands.

Fire response is unknown, but other *Prostanthera* species are fire sensitive, with recruitment occurring from the soil seed bank following a fire.

Life span is unknown but is expected to be in the vicinity of 10-20 years while the estimated minimum time to produce seed is approximately 3-4 years.

THREATS

- Frequent fire may threaten some populations given it is fire sensitive.
- The known populations are small and therefore highly susceptible to demographic and environmental stochasticity.

Moonee Quassia

(*Quassia* sp. Moonee Creek)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10723>

DESCRIPTION

Moonee Quassia can be a slender or bushy shrub growing to 1.5 m tall. Stems are often kinked and show signs of periodic halts in growth. The tough, narrow leaves of this species are a glossy dark green above and pale below, growing to 10 cm long and arranged alternately along the stems. Numerous veins are visible on each leaf, extending at a wide angle to the midrib. Flowers are small and reddish with a slight green tinge. These flowers develop into distinctive fruits, covered in fine hairs, and composed of up to 5 radiating segments which turn red once mature.

LEGISLATIVE STATUS

TSC Act: ENDANGERED; EPBC Act: ENDANGERED.

DISTRIBUTION

Records for this species are scattered, extending from the Moonee Creek area north of Coffs Harbour to north-east of Grafton.

HABITAT

This species primarily occurs in the shrub layer of tall moist eucalypt forests and tall dry eucalypt forests, mostly at lower altitudes. This species is also known to occur along forest edges.

THREATS

- Small size of populations.
- Timber harvesting in habitat areas.
- Drainage of swamps, or pollution from nutrient run-off.
- Frequent fire.
- The invasion of habitat by weed species such as Lantana.

(*Rotala tripartita*)

Source: <http://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=20087>

DESCRIPTION

Rotala tripartita is an annual or short-lived perennial herb up to 40 cm tall, with branched stems that are often shortly creeping at the base of the plant and erect above. Leaves are up to 20 mm long and 5 mm wide with the lower surface paler than the upper surface. Flowers are sessile, solitary and occur within the axils of bracts and scattered along stems. Flowers have three (or rarely four) sepals with appendages longer than sepals, three (or rarely four) elliptic, colourless petals and three (or rarely four) stamens inserted near the base of the hypanthium. The style is c. 0.5 mm long.

LEGISLATIVE STATUS

TSC Act: ENDANGERED, EBPC: NOT LISTED

DISTRIBUTION

Rotala tripartita occurs in New South Wales, Queensland and the Northern Territory. In New South Wales the species is currently known from only two locations, one in the Casino district and one in the South Grafton area, in the northern part of the North Coast bioregion. These locations are separated by a distance of less than c. 100 km. The geographic distribution of the species in New South Wales is therefore highly restricted. There are no records of *Rotala tripartita* in any reserve or State Forest.

HABITAT

Rotala tripartita is a riparian species that grows in free-standing water with sedges. There appear to be extreme fluctuations in abundance of the species, with plants observed to germinate prolifically and establish in large numbers after substantial rainfall. Individuals disappear above-ground during dry periods and may only persist during these times in the soil seed-bank.

Surveys in the South Grafton area located two populations of *Rotala tripartita* growing in exposed silty clay on the edges of farm dams that were about 150m apart.

Also known from Melaleuca freshwater coastal wetland.

THREATS

- *Rotala tripartita* is threatened in New South Wales by chance adverse environmental events due to its highly restricted geographic distribution and small number of locations.
- At Black Swamp the species is further threatened by the construction and maintenance of an access road and a cleared alignment for a pipeline and powerline to a water supply dam. This infrastructure may result in sedimentation and changes to downstream swampland.
- Weed invasion of wetland sites.
- Grazing and trampling by domestic stock.

Siah's Backbone

(*Streblus pendulinus* syn. *S. brunonianus*)



Source: BAAM

DESCRIPTION

The Siah's Backbone 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

Siah's Backbone 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 Lilly Pilly

(*Syzygium hodgkinsoniae*)



Source: <http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10792>

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, EBPC 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