W2B-RMS-0-EF-PLN-00039

# Flora Translocation Strategy

## Pacific Highway Upgrade
## Sections 3-11 excluding Early Works
## Soft Soil Treatment Areas
## Woolgoolga to Ballina

**Version 3**

**April 2017**

## EXECUTIVE SUMMARY

New South Wales Roads and Maritime Services are upgrading the Pacific Highway between Woolgoolga and Ballina on the NSW North Coast (the Project). The preparation of a translocation strategy for impacted threatened flora species i.e. listed on schedules of the *NSW Threatened Species Conservation Act* (TSC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is a requirement of the conditions of approval.

The translocation strategy is complemented by an offset strategy offset package and offset status report. Impacts to threatened species will be fully offset. The translocation management actions detailed in this report are additional to offsets.

The translocation strategy has been submitted in stages. A Translocation Strategy for Sections 1 and 2 of the Project (part of Stage 1) - was approved on 12 May 2015 and a strategy for Early Works Soft Soils Treatment Areas three waves of construction packaging making up the remainder of Stage 1 of the highway upgrade) was approved on 9 June 2015. The current strategy covers Sections 3 to 11 (excluding Early Works Soft Soils Treatment Areas.

Sixteen species of threatened flora are identified as being directly impacted by the upgrade of Sections 3 to 11 (excluding Early Works Soft Soils Treatment Areas) and twelve are assessed as feasible for translocation. They are:

Four-tailed Grevillea *Grevillea quadricauda* (Vulnerable TSC Act EPBC Act).
Green-leaved rose walnut *Endiandra muelleri* subsp. *bracteata* (Endangered TSC Act)
Hairy joint-grass *Arthraxon hispidus* (Vulnerable TSC Act EPBC Act).
Red lilly pilly *Syzygium hodgkinsoniae* (Vulnerable TSC Act EPBC Act).
Rough-shelled bush-nut *Macadamia tetraphylla* (Vulnerable TSC Act EPBC Act).
Singleton mint bush *Prostanthera cineolifera* (Vulnerable TSC Act EPBC Act).
Slender screw-fern *Lindsaea incisa* (Endangered TSC Act)
Stinking Cryptocarya *Cryptocarya foetida* (Vulnerable TSC Act EPBC Act).
Tall knotweed *Persicaria elatior* (Vulnerable TSC Act EPBC Act).
Weeping paperbark *Melaleuca irbyana* (Endangered TSC Act)
White laceflower *Archidendron hendersoni* (Vulnerable TSC Act).
Yellow-flowered king of the fairies *Oberonia complanata* (Endangered TSC Act).

Suitable receiving sites have been identified in proximity to donor populations on Roads and Maritime-owned land, National Parks estate and private land under covenant. Impacted plants will be salvaged in order to safeguard possibly unique genetic material, to enhance existing populations and avoid an overall reduction in population numbers. Trialling of translocation methods will improve knowledge of biology and management for threatened flora species.

Suitably qualified and skilled operators will be responsible for translocation including collection of material for propagation nursery procedures receiving site preparation mitigation of threats direct transplant or planting out and post-translocation care. Monitoring will be carried out for up to five years and management adapted should performance fall below specified thresholds.

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# Glossary and Abbreviations

| | |
|---|---|
| Ameliorative enhancement | An attempt to increase population size by adding individuals to an existing population to ameliorate the loss of part or all of that population due to development. |
| BOS | Biodiversity Offset Site |
| CoA | Conditions of Approval |
| Compensatory introduction | The establishment of a population to compensate for the impact of a development. In the majority of cases such translocations will meet the definition of conservation introduction. |
| Conservation introduction | Attempts to establish a taxon for the purpose of conservation at a site where it is not known to occur now or to have occurred in historical times but which is considered to provide appropriate habitat for the taxon. |
| Construction footprint | The direct area of the design alignment (also referred to as the clearance limits) |
| DECCW | NSW Department of Environment Climate Change and Water (now known as OEH) |
| Direct impact | An impact that causes direct harm within the project boundary (i.e. clearing of vegetation) |
| DoE | Commonwealth Department of the Environment (previously known as the Commonwealth Department of Sustainability Environment Water Population and Communities) |
| DP&E | NSW Department of Planning and Environment (previously known as of Planning and Infrastructure) |
| DPI | NSW Department of Primary Industries |
| EPA | NSW Environment Protection Authority |
| EP&A Act | NSW *Environmental Planning and Assessment Act 1979* |
| EPBC Act | Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* |
| Enhancement | An attempt to increase population size or genetic diversity by adding individuals to an existing population. This may be part of the process of restoration or reconstruction of a site where the taxon occurs but requires population manipulation to increase viability. Also referred to as re-enforcement re-stocking enrichment supplementation or augmentation. |
| Ex situ | Locations where plant populations would be translocated to or revegetated in a new area outside the project boundary |
| 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 |
| OEH | NSW Office of Environment and Heritage |
| Offset | An offset may be an area of land that is protected and managed to improve biodiversity values or an action that compensates for adverse impacts to biodiversity. Requirements for offsets are determined using an objective assessment of predicted loss of biodiversity at the development site and expected gain in biodiversity to be achieved at the offset site. |
| Performance threshold | This is a prescribed outcome that should it be reached an assessment as to why the objectives are not being met will be undertaken and then appropriate corrective actions implemented. |
| The Project | Refers to all the proposed works in all eleven sections which includes the construction footprint with a 10 metre construction buffer ancillary and compound sites and design changes. |
| Receival site | This is the site where plant populations would be translocated to or revegetated in a new area outside the project boundary. |

| | |
|---|---|
| Re-introduction | An attempt to establish a population in a site where it formally occurred where it is now extinct. This may be part of the process of restoration or reconstruction of a habitat where the taxon was previously known to occur. Also referred to as re-establishment. |
| 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 |
| Salvage dig | The transplantation of mature plants or soil stored seed bank to an area not affected by the development. Also referred to as transplantation or rescue dig. |
| 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 |
| Threatened species | Any organism listed as vulnerable endangered or critically endangered under State and/or Commonwealth legislation. |
| TSC Act | *Threatened Species Conservation Act 1995* |
| Translocation | Deliberate transfer of plant material from one area to another for conservation purposes |
| W2B | Woolgoolga to Ballina Pacific Highway Upgrade |
| Weeds | Plants that may threaten agricultural land adjacent to the Project have detrimental effects on the natural environment or impact human health. Includes noxious weed species under the *Noxious Weeds Act 1993* as categories W1 W2 W3 or W4. |

# 1. Background

## 1.1 Project overview

New South Wales Roads and Maritime Services are upgrading the Pacific Highway between Woolgoolga to Ballina on the NSW North Coast. The Project was approved under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) by the NSW Minister for Planning on 26 June 2014. It was also approved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 14 August 2014.

Key features of the upgrade include:

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

New South Wales Roads and Maritime Services (Roads and Maritime) has approval for the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project under Part 5.1 of the EP and A Act and the EPBC Act. In accordance with the NSW Minister's Conditions of Approval (MCoA) A8 the required translocation strategy will be submitted in stages. The Commonwealth MCoA require compliance with NSW conditions as they apply to species listed on schedules of the EPBC Act and assessed as likely to suffer a significant impact as result of the proposal.

Compliance with conditions of approval is demonstrated in Table 1. Responses to comments on a draft of this strategy are provided in Appendix 1.

The project is divided into 11 sections (Figure 1).

Translocation strategies have been prepared for two components of Stage 1 of the highway upgrade. The strategy for Sections 1 and 2 (Woolgoolga to Halfway Creek) was approved on 12 May 2015. In addition due to the presence of soft soils in the vicinity of the Clarence River and Richmond Floodplains initial works are required in advance of the main construction of the highway to consolidate the deep soft soils under the proposed highway alignment. Soft soil preload construction will be undertaken in three waves of construction packaging directly impacting on threatened flora species in Sections 4 5 and 8. Accordingly a translocation strategy for the Early Works Soft Soil Treatment Areas was approved on 9 June 2015.

This translocation strategy applies to Sections 3-11 excluding the Soft Soil Treatment Areas. Sections 3-11 extend from Halfway Creek to Ballina (153km).

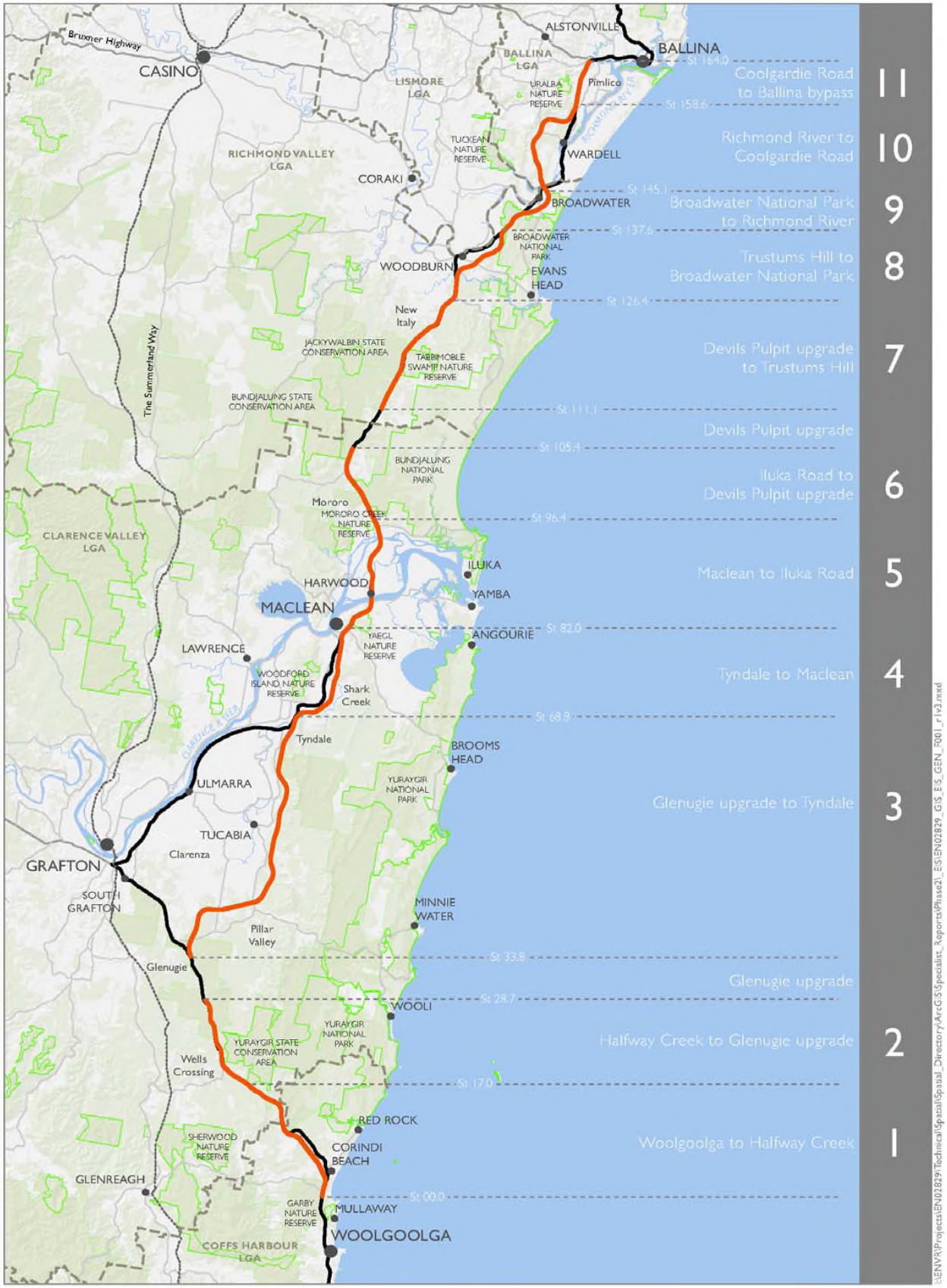


**Figure 1** Woolgoolga to Ballina Project Sections

## 1.2 Purpose of the strategy

This Translocation Strategy has been developed to meet the requirements of MCoA D7. This Translocation Strategy specifically addresses Sections 3-11 (excluding Early Works Soft Soil Treatments Works) which is due to commence construction the first half of 2016.

**Table 1** sets out the requirements of MCoA and where each has been addressed in this strategy.

**Table 1:** Project approval requirements and where addressed

| Approval requirement | | Where addressed |
|---|---|---|
| **NSW approval** | | |
| MCoA D7 | The Applicant shall prepare and implement **Flora Translocation Strategy** to determine the feasibility and potential efficacy of translocation measures (as identified in the threatened species management plans required under condition D8) prior to the commencement of construction work that would result in the disturbance of threatened flora species for which translocation is proposed. The strategy shall be prepared by a suitably qualified and experienced ecologist in consultation with the EPA and DoE and to the satisfaction of the Secretary. The Strategy shall include:<br>(a) a feasibility assessment of timeframe and staging requirements availability of expertise risk effectiveness analysis and availability/suitability of translocation sites;<br>(b) detail of species specific information on the proposed methods of and discussion of results of past recorded responses to translocations;<br>(c) a framework for the translocation process applicable to each affected species; and<br>(d) consideration of appropriate compensatory habitat in the Biodiversity Offsets Package required under condition D5 where translocation is not reasonable for feasible. | The requirements of this condition are addressed in this plan. Details on the ecologist expertise for preparation of the strategy is provided in Section 1.3. The strategy has been informed by feedback from EPA and DoE on draft Translocation Strategies prepared for Sections 1 and 2 and Early Works Soft Soil Treatment Areas.<br>(a) is addressed in Table 5, Table 7 Section 2.4 and Appendix 3.<br>(b) is addressed in Table 8 and Appendices 5 and 6.<br>(c) is addressed in Section 3 Table 8 and Appendix 6.<br>(d) is addressed in Section 1.2 below. |

The Project Area is defined by mapped boundaries broadly encompassing a corridor of approximately 1 km in width. Within the Project Area a Clearing Boundary is also defined and mapped. Vegetation and individual plants of threatened flora species within the Clearing Boundary are considered to be directly impacted by the proposal.

At the time of the preparation of this translocation strategy for Sections 3-11 (excluding Early Works Soft Soil Treatment Areas) the project design for the relevant sections had not been finalized. Compilations of survey data were available to quantify estimates of impacts on threatened flora species (see also Threatened Flora Management Plan Sections 1 -11 and Soft Soil Work Areas (Roads and Maritime 2015a).

Translocation is defined as the “deliberate transfer of plant material from one area to another for conservation purposes” (Vallee *et al.* 2004). The purpose in this project is to apply a range of translocation techniques to impacted populations of threatened species so that declines in numbers and genetic diversity can be avoided to the best extent possible. The overall objective of threatened plant translocations is to establish populations that are self-sustaining over the long-term.

Despite the potential for translocation to make valuable contributions to conservation objectives and to mitigate some of the impacts of development it is recognised that translocations are generally experimental and success cannot be guaranteed, although every effort is made to maximize the chance of success. Accordingly translocation is not considered a mitigation measure under the EPBC Act and the flora individuals to be removed/translocated are considered to be impacted for the purposes of the EPBC Act. This impact will be compensated for with the provision of suitable offsets in accordance with the EPBC Act Offsets Policy. Roads and Maritime (2015b) have prepared a Biodiversity Offset Strategy.

Translocation of threatened plants is being considered for those threatened plants that are within the clearing boundary and would be undertaken for threatened species that have suitable life history traits that make translocation a viable option with monitoring to measure success.

## 1.3 Plan authors

The Strategy was prepared by:

Barbara Stewart of Landmark Ecological Services Pty Ltd. Barbara has a Ph D in forest ecology a B Sc (Hons) in botany and more than 20 years' experience in research consultancy and land management on the NSW north coast and more widely. Her research specialisations are in seed and seedling ecology.

In addition she has authored/co-authored Recovery Plans for threatened species and has extensive survey and management planning experience for flora species of conservation significance. Barbara was formerly the proprietor of a native plant nursery.

Rhonda James - Bushland Restoration Services Pty Ltd. Rhonda has a B Business M Env Man and Cert IV Bushland Restoration. Rhonda has 15 years' experience in ecological restoration specializing in the recovery of threatened species and endangered ecological communities. Rhonda co-authored the SEQ Ecological Restoration Framework.

She has extensive experience in habitat restoration translocation and monitoring of threatened species. These projects include Hairy Joint Grass at Koala Beach and Lennox Head Green-leaved Rose Walnut at Koala Beach RTA works at Alstonville bypass Sleepy Hollow Rest Area Banora Point bypass and Murnanes Bridge OEH Coastal Fontainea and Hairy Quandong and extensive works for Gold Coast City Council and SEQWater related to translocation of threatened species during construction of the Hinze Dam.

## 1.4 Consultation and updates

This strategy provides a framework for implementation of any translocation of threatened species impacted by the Project. The plan would be updated as required during pre-construction or during the construction stage of the Project. Any updates to the strategy would be undertaken in accordance with the Project Staging Plan submitted under Ministers Condition of Approval A7.

Roads and Maritime has consulted with the NSW Environment Protection Authority and Department of Environment and Planning and the Commonwealth Department of Environment during the development of this strategy. Agencies were provided a copy of the Draft Report on 27 October 2015. Feedback received and Roads and Maritime response to issues raised have been included in **Appendix 1** of this report.

## 1.5 Previous studies

Section 2 of the Threatened Flora Management Plan includes a summary of the previous studies in the EIS, SPIR and baseline survey information since 2006.

The most recent relevant ecological studies that have been conducted for Sections 3-11, are as follows:

Surveys conducted in 2014-15 were:

| | |
|---|---|
| Section 3 | Geolink (2014a) |
| Section 4 and 5 | Geolink(2014b) |
| Section 6 | AECOM (2014) |
| Section 7 | Biosis (2014) |
| Sections 8 and 9 | Melaleuca Group (2014a) |
| Sections 10 and 11 | Australian Museum Consulting (2014) |
| Preconstruction surveys | Jacobs (2014a) |

A combined spatial database incorporating preconstruction survey data and data collected for the EIS preparation was used for the purposes of the current translocation strategy.

From these surveys it has been determined that sixteen (16) threatened flora are to be directly impacted in Sections 3-11 of the Woolgoolga to Ballina Upgrade (**Figure 1**):

- Four-tailed Grevillea *(Grevillea quadricauda)*
- Green-leaved rose walnut *(Endiandra muelleri* subsp. *bracteata)*
- Hairy joint-grass (*Arthraxon hispidus*)
- Maundia *(Maundia triglochinoides)*
- Red lilly pilly *(Syzygium hodgkinsoniae)*
- Rough-shelled bush-nut *(Macadamia tetraphylla)*
- Sandstone rough-barked apple *(Angophora robur)*
- Siah's backbone *(Streblus brunonianus)*
- Singleton mint-bush *(Prostanthera cineolifera)*
- Slender screw fern (*Lindsaea incisa*)
- Stinking Cryptocarya *(Cryptocarya foetida)*
- Tall knotweed *(Persicaria elatior)*
- Water nutgrass (*Cyperus aquatilis*)
- Weeping paperbark *(Melaleuca irbeyana)*
- White laceflower *(Archidendron hendersoni)*
- Yellow-flowered king of the fairies *(Oberonia complanata)*

Recent taxonomic changes have affected Siah's backbone *S. pendulinus* a taxon which was originally restricted to Lord Howe Island. *Streblus pendulinus* is now considered by some authorities to include Whalebone tree *S. brunonianus* which occurs on the mainland. The Royal Botanic Gardens (Plantnet website accessed 15 February 2015) considers however that *S. pendulinus* has been incorrectly included in the synonymy of *S. brunonianus.* Whalebone tree is a relatively common and widespread rainforest tree.

In NSW, *S. pendulinus* is not listed as threatened under the TSC Act. Siah's backbone *S. pendulinus* is however listed as threatened under the EPBC Act. The SPRAT profile advises that the listing status of *Streblus pendulinus* under Commonwealth legislation applies on mainland Australia.

The Federal Government's conditions of approval list threatened species requiring consideration. In addition species considered by the Australian government department responsible for administering the EPBC Act 1999 to be significantly impacted by the action require consideration. Siah's backbone/Whalebone is present in and around the project area and will suffer some direct and indirect impacts. A supplementary assessment of significance (Jacobs 2015) finds that the project is unlikely to have a significant impact on populations of Siah's Backbone.

Accordingly Siah's backbone does not require consideration in the current translocation strategy beyond measures appropriate for all rainforest trees. Siah's backbone is not considered further in this strategy though trees identified during surveys are included in some tables and mapping as noted.

**Figure 2 and 2A-D** illustrate the locations of directly impacted threatened flora species.

Not all of the threatened species are proposed for translocation. Sections 2.4 and 2.5 of this report discuss the feasibility translocation methodology and sites and justifications).


Figure 2
Threatened Flora Locations
Early Works Soft Soil Treatment Areas

Project: RMS Translocation
Date: April 2015

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0 2.5 5 Kilometers

Map Grid of Australia - Zone 56

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Phone: 02667722220, 0409244294
Email: georamb12@bigpond.com.au

Threatened flora locations shown are limited to those in close proximity to soft soils areas

Legend
major_drainage_lines
DD_SoftSoilSitesAndWaveLocations_20141217
Approved Project Boundary (date pending)
PA_PropertyAcquisition_20150201
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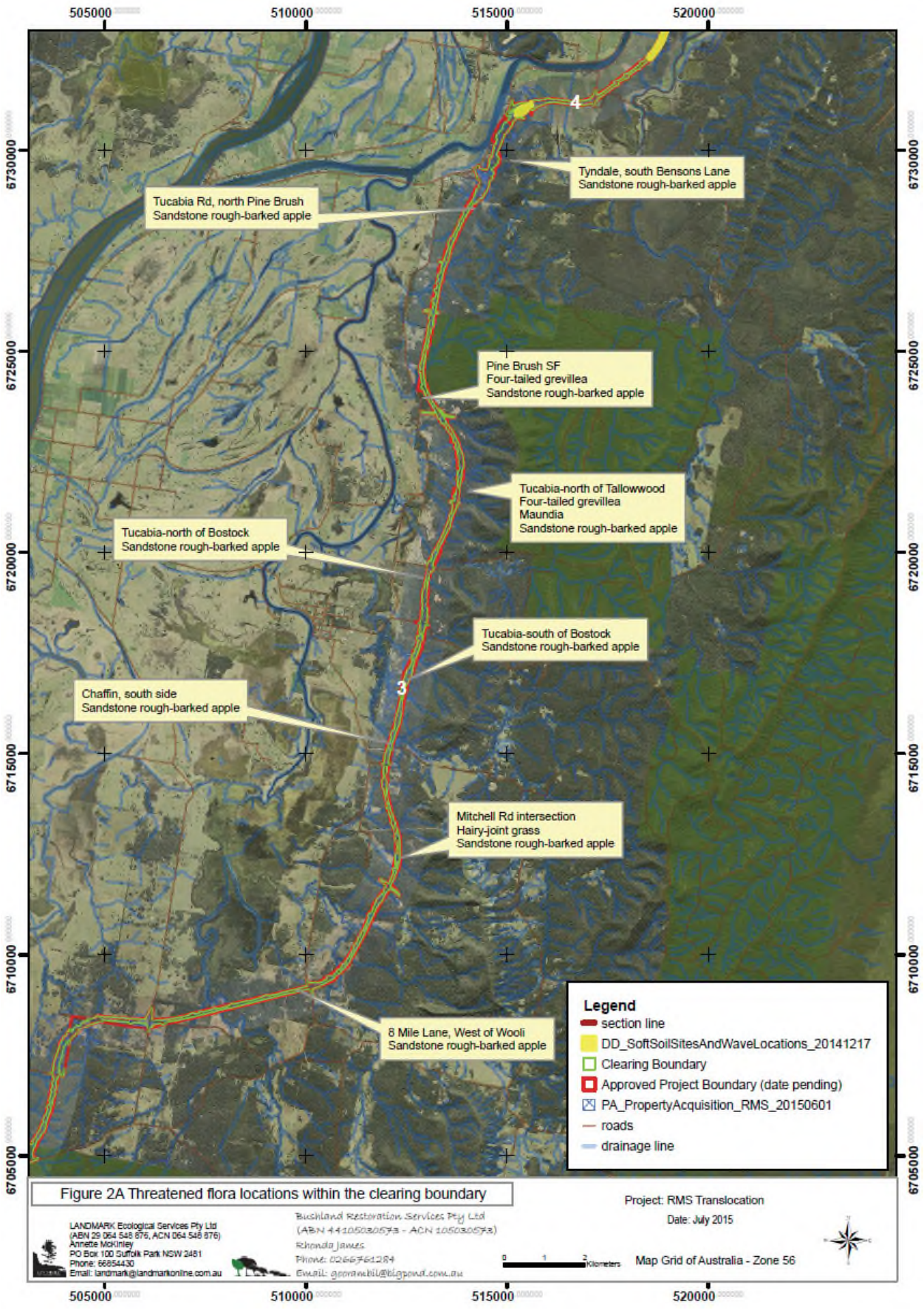
NSWStateForests
NPWS estate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4
3
Tyndale, south Bensons Lane
Sandstone rough-barked apple
Tucabia Rd, north Pine Brush
Sandstone rough-barked apple
Pine Brush SF
Four-tailed grevillea
Sandstone rough-barked apple
Tucabia-north of Tallowwood
Four-tailed grevillea
Maundia
Sandstone rough-barked apple
Tucabia-north of Bostock
Sandstone rough-barked apple
Tucabia-south of Bostock
Sandstone rough-barked apple
Chaffin, south side
Sandstone rough-barked apple
Mitchell Rd intersection
Hairy-joint grass
Sandstone rough-barked apple
8 Mile Lane, West of Wooli
Sandstone rough-barked apple
Legend
section line
DD_SoftSoilSitesAndWaveLocations_20141217
Clearing Boundary
Approved Project Boundary (date pending)
PA_PropertyAcquisition_RMS_20150601
roads
drainage line
Figure 2A Threatened flora locations within the clearing boundary
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Rhonda James
Phone: 0266761284
Email: geovanbil@bigpond.com.au
Project: RMS Translocation
Date: July 2015
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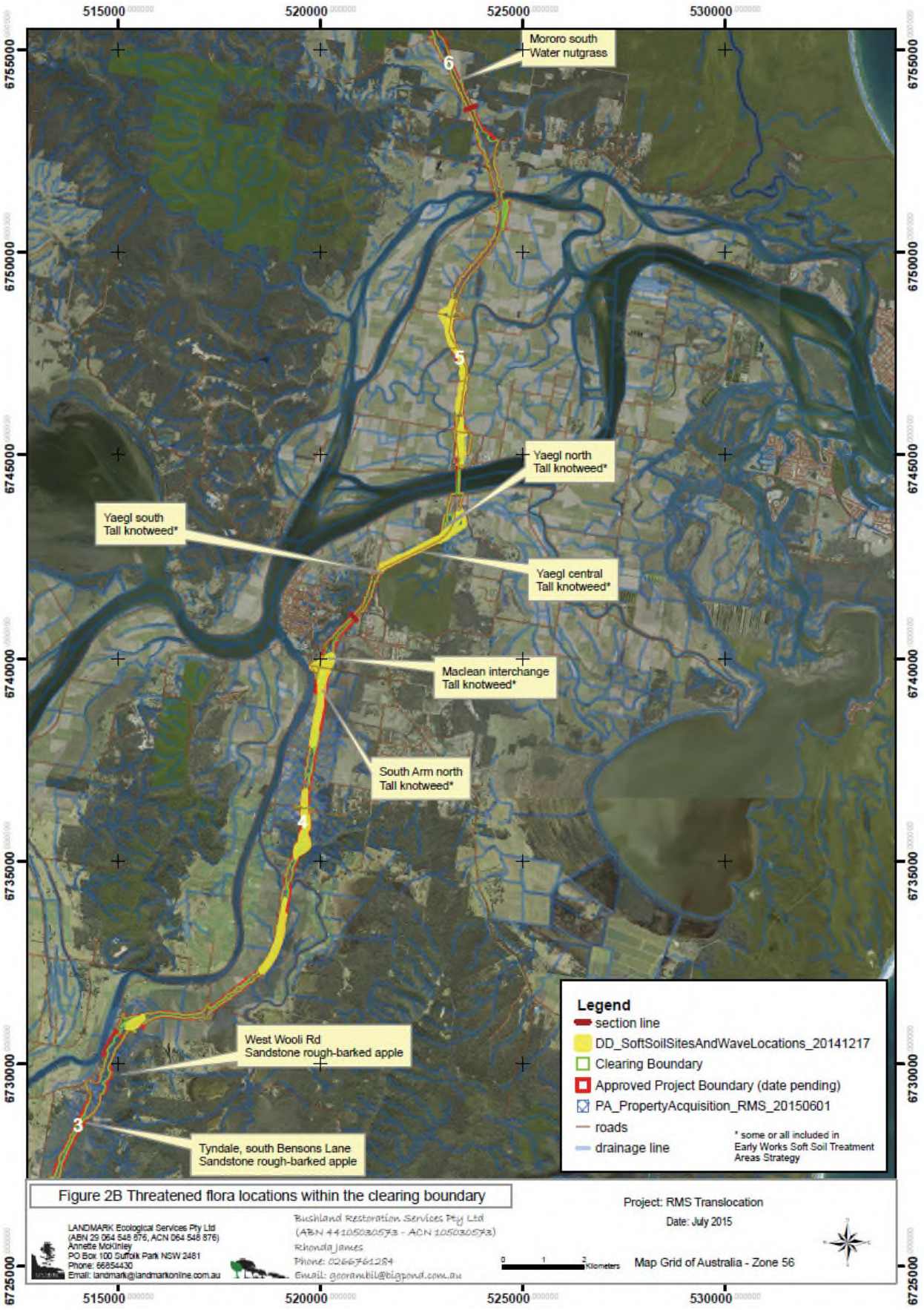
Map Grid of Australia - Zone 56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6
5
Yaegl north
Tall knotweed*
Yaegl south
Tall knotweed*
Yaegl central
Tall knotweed*
Maclean interchange
Tall knotweed*
South Arm north
Tall knotweed*
4
West Wooli Rd
Sandstone rough-barked apple
3
Tyndale, south Bensons Lane
Sandstone rough-barked apple
Legend
section line
DD_SoftSoilSitesAndWaveLocations_20141217
Clearing Boundary
Approved Project Boundary (date pending)
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roads
drainage line
* some or all included in Early Works Soft Soil Treatment Areas Strategy
Figure 2B Threatened flora locations within the clearing boundary
Project: RMS Translocation
Date: July 2015
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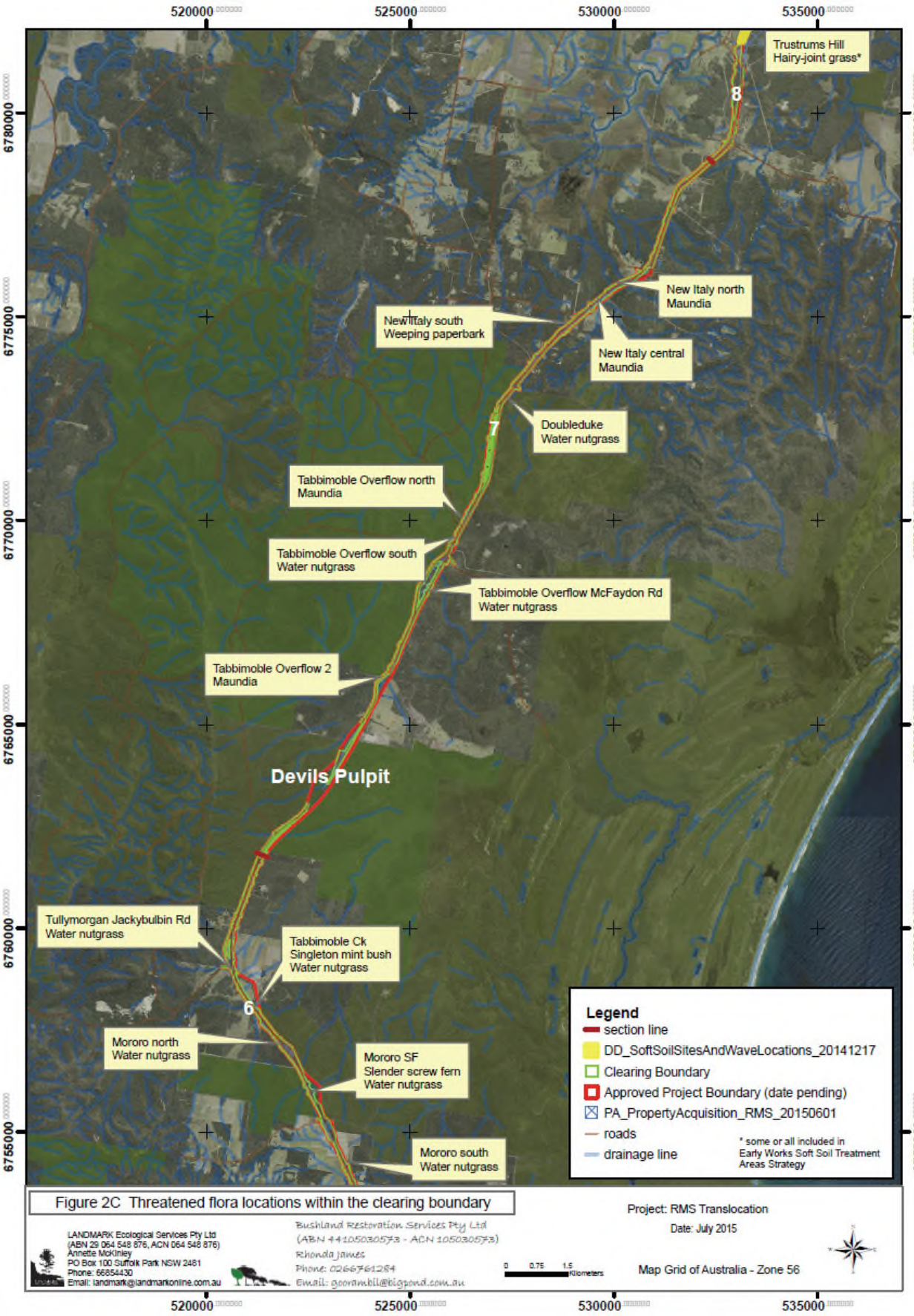
Map Grid of Australia - Zone 56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Trustrums Hill
Hairy-joint grass*
8
New Italy north
Maundia
New Italy south
Weeping paperbark
New Italy central
Maundia
7
Doubleduke
Water nutgrass
Tabbimoble Overflow north
Maundia
Tabbimoble Overflow south
Water nutgrass
Tabbimoble Overflow McFaydon Rd
Water nutgrass
Tabbimoble Overflow 2
Maundia
Devils Pulpit
Tullymorgan Jackybulbin Rd
Water nutgrass
Tabbimoble Ck
Singleton mint bush
Water nutgrass
6
Mororo north
Water nutgrass
Mororo SF
Slender screw fern
Water nutgrass
Mororo south
Water nutgrass
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section line
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Clearing Boundary
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drainage line
* some or all included in
Early Works Soft Soil Treatment
Areas Strategy
Figure 2C Threatened flora locations within the clearing boundary
Project: RMS Translocation
Date: July 2015
LANDMARK Ecological Services Pty Ltd
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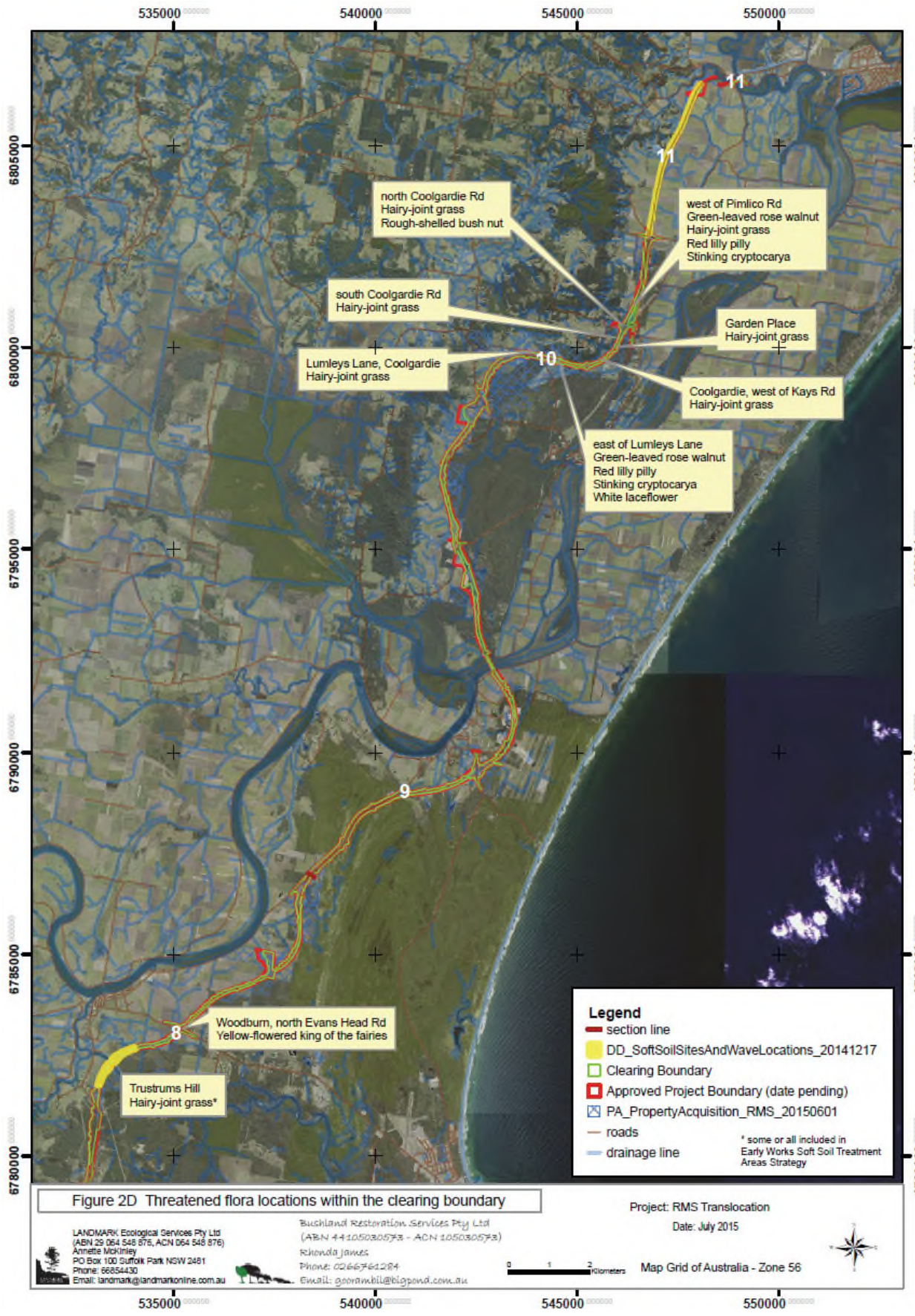
Map Grid of Australia - Zone 56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north Coolgardie Rd
Hairy-joint grass
Rough-shelled bush nut
west of Pimlico Rd
Green-leaved rose walnut
Hairy-joint grass
Red lilly pilly
Stinking cryptocarya
south Coolgardie Rd
Hairy-joint grass
Garden Place
Hairy-joint grass
Lumleys Lane, Coolgardie
Hairy-joint grass
10
Coolgardie, west of Kays Rd
Hairy-joint grass
east of Lumleys Lane
Green-leaved rose walnut
Red lilly pilly
Stinking cryptocarya
White laceflower
9
8
Woodburn, north Evans Head Rd
Yellow-flowered king of the fairies
Trustrums Hill
Hairy-joint grass*
Legend
section line
DD_SoftSoilSitesAndWaveLocations_20141217
Clearing Boundary
Approved Project Boundary (date pending)
PA_PropertyAcquisition_RMS_20150601
roads
drainage line
* some or all included in Early Works Soft Soil Treatment Areas Strategy
Figure 2D Threatened flora locations within the clearing boundary
Project: RMS Translocation
Date: July 2015
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0 1 2 Kilometers
Map Grid of Australia - Zone 56

# 2 Translocation overview

## 2.1 Translocation background

Guidelines for translocation of flora species have been developed generally and in Australia over several decades e.g. Cropper (1993) ANPC (1997) and Vallee *et al.* (2004). The latter reference recognises the increasing role that translocation is now expected to play in the amelioration of the impact of development.

Section 5.3 and 5.4 of the Threatened Flora Management Plan outline the process and management measures for this Translocation Strategy.

Types of translocation action identified by Vallee *et al.* (2004) are as follows:

Translocation action undertaken for conservation purposes

Enhancement
Re-introduction
Conservation introduction

Translocation action undertaken as an ameliorative measure for development

Salvage dig
Ameliorative enhancement
Compensatory introduction (this type is noted to in the majority of cases; meet the definition of conservation introduction as above).

In addition recent translocation planning for Roads and Maritime's projects recognise the conservation benefits that suitably planned salvage operations can make to knowledge of the biology and ecology of threatened flora species and improved management of future translocations e.g. Benwell (2013).

The decision process to precede a translocation process (Vallee *et al* 2004) is set out for species proposed for translocation (**Appendix 2**).

## 2.2 Translocation aims and objectives

The proposed translocations are guided by the overall aims set out by Vallee *et al.* (2004) as follows:

*All translocations should aim to maintain or create a self-sustaining population.*

Translocation may also lead to:

- Increased knowledge of the threatened plant species
- Development of new management techniques
- Initiation of debate on conservation policy
- Education of the public

(Pavlik 1996 quoted in Vallee *et al.* 2004)

In addition the Threatened Flora Management Plan (Roads and Maritime 2015) states that translocation should aim to achieve no net loss in local plant populations being impacted by the project.

For the proposed salvage translocation it is also appropriate to aim to make the best possible use of all plant material with potential conservation value.

## 2.3 Survey and assessment

Background information for each of the fifteen threatened flora species (Whalebone tree/Siah's backbone not included) detected within the Clearing Boundary in Sections 3-11 has been compiled and includes profiles and compilation of translocation history (**Appendix 3**). The background informed assessments of the feasibility of translocation and the risks associated with translocation.

This strategy identifies that translocation is feasible for twelve species (**Table 2**).

**Table 2:** Summary of translocation feasibility (directly impacted species only)

| Common name | Scientific name | TSC Act | EPBC Act | Section | Translocation feasibility |
|---|---|---|---|---|---|
| Four-tailed Grevillea | *Grevillea quadricauda* | V | V | 3 | feasible |
| Green-leaved rose walnut | *Endiandra muelleri* subsp. *bracteata* | E | | 10 | feasible |
| Hairy joint-grass | *Arthraxon hispidus* | V | V | 3,8,10 | feasible assuming seed and/or above ground plant material is available |
| Maundia | *Maundia triglochinoides* | V | | 3,7 | not feasible (compensatory habitat management will be conducted) |
| Red lilly pilly | *Syzygium hodgkinsoniae* | V | V | 10 | feasible |
| Rough-shelled bush-nut | *Macadamia tetraphylla* | V | V | 10 | feasible |
| Sandstone rough-barked apple | *Angophora robur* | V | V | 3,4 | not feasible |
| Singleton mint bush | *Prostanthera cineolifera* | V | V | 6 | feasible |
| Slender screw-fern | *Lindsaea incisa* | E | | 3,6 | feasible |
| Stinking Cryptocarya | *Cryptocarya foetida* | V | V | 10 | feasible |
| Tall knotweed | *Persicaria elatior* | V | V | 4,5 | feasible assuming seed and/or above ground plant material is available |
| Water nutgrass | *Cyperus aquatilis* | E | | 6,7 | not feasible (compensatory habitat management will be conducted) |
| Weeping paperbark | *Melaleuca irbyana* | E | | 7 | feasible |
| White laceflower | *Archidendron hendersoni* | V | | 10 | feasible |
| Yellow-flowered king of the fairies | *Oberonia complanata* | E | | 8 | feasible |

Note: Refer to **Table 4** for more detailed feasibility assessment.

The abundance and extent of the fifteen species has been detected during surveys and documented by way of counts of individuals and/or area of occurrence depending on the growth habit of the species and the nature of the occurrence (**Table 3**).

The detailed survey data collected for the Project Area is complemented by limited information about occurrences in immediately adjacent land. Whilst most of the corridor has been acquired by Roads and Maritime there is some remaining land within the corridor including possible translocation receiving sites for which access has not always been possible. Some broader contextual information about the occurrence of the threatened flora species is available from Atlas records.

Background information for each of the fifteen threatened flora species to be directly impacted by works in Sections 3-11 (excluding Early Works Soft Soil Treatment Areas) has been compiled and includes profiles and compilation of translocation history (**Appendix 3**). The background informed assessments of the feasibility of translocation and the risks associated with translocation.

**Table 3:** Survey results for threatened flora species within Section 3-11 project area

| Species | Clearing area | | Project area (not including clearing area) | |
|---|---|---|---|---|
| | No individuals | Area (ha) | No individuals | Area (ha) |
| Four-tailed Grevillea | 3 | 0.020 | 55 | 0.057 |
| Green-leaved rose walnut | 3 | | 16 | |
| Hairy-joint grass | 348 | 1.271 | 58 | 0.968 |
| Maundia | 20 | 0.064 | 8 | 0.194 |
| Red lilly pilly | 6 | | 4 | |
| Rough-shelled bush nut | 10 | | 4 | |
| Sandstone rough-barked apple | 6,414 | 35.369 | 2,531 | 94.821 |
| Singleton mint bush | 609 | 0.424 | 62 | 0.439 |
| Slender screw fern | 6,295 | 0.370 | 215 | 0.025 |
| Stinking Cryptocarya | 41 | | 2 | |
| Tall knotweed | 20 | 0.210 | 302 | 0.693 |
| Water nutgrass | 121 | | | |
| Weeping paperbark | 1,721 | 2.761 | | 0.002 |
| White laceflower | 1 | | 10 | |
| Yellow-flowered king of the fairies | 18 | 0.033 | | 0.000 |

The abundance and distribution data obtained from surveys require interpretation depending on growth form and survey methods. Ephemeral annuals (Hairy joint-grass and Tall knotweed) vary in their distribution and abundance within and between years depending on seasonal conditions.

- Point data for species such as Hairy joint-grass are likely to underestimate the number of individuals present since GPS points recorded in a meandering survey will have documented only a small proportion of the plants. Individuals can be difficult to distinguish and usually occur in clumps.
- Abundance data for Slender screw fern are counts of individual fronds, which will be connected by below-ground rhizomes. The counts over-estimate individual plants.
- Polygons for species such as Hairy joint-grass and Tall knotweed have usually been drawn to enclose the individual points and can be considered to represent an area where the soil stored seed density is relatively high.
- Some polygons do not include points while polygons have not always been drawn around groups of points.

Details of survey data for plants recorded within the project boundary are provided in **Appendix 4. Appendix 5** consists of maps for plants within the clearing boundary.

## 2.4 Feasibility and risk assessment

The feasibility of translocation 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)
- past translocation success

An assessment of risk considers:

- extent that mixing of populations may result in outbreeding depression
- introduction of pathogens and disease
- displacement of other species
- impacts to other species from translocation activities including site preparation and monitoring (Vallee *et al.* 2004)
- crossing of hybrids with genetically pure individuals of threatened flora species.

Appropriate sampling of propagule sources hygiene nursery protocols and vegetation management will be employed as standard practice and will mitigate against the risks. Appropriately skilled personnel will be employed.

Other risks include:

- climatic stochasticity and unpredicted extreme weather events to the species in the recipient sites (adverse impacts of newly created edges and disruption to connectivity marsupial and stock grazing)
- failure to understand the ecological requirements of the target species
- inadequate timeframes for establishment and ongoing management.

The risk to individual species depends on:

- the importance of the local population for the species
- the extent of the local population (will numbers be critically reduced?)
- the likelihood that unique genetic material may be lost
- context of the plants proposed for translocation (isolated or connected to plants on adjacent lands).

**Table 4** summarises the process of translocation feasibility assessment for threatened flora within the construction footprint of Sections 3-11 (excluding Early Works Soft Soil Treatment Areas).

**Table 4:** Translocation feasibility

| Species | Relevant biological and ecological characteristics | Seasonal constraints | Previous translocations | Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6) | Translocation feasibility | Risk assessment |
|---|---|---|---|---|---|---|
| Four-tailed Grevillea | seed production and germination likely to be reliable<br><br>cutting propagation likely to be successful | Seed collection may need multiple visits, late spring | No information but assumed to grow readily as for other Grevilleas | Road reserve adjacent to donor populations | Feasible, likely to be successful though poor condition of donor plants may be limiting | Occurrences known in the locality are small. If translocation fails numbers and genetic diversity may be reduced. |
| Green-leaved rose walnut | seeds produced only intermittently<br><br>taxonomy and identification needs resolution to guide future genetic management<br><br>slow growing | Wet conditions preferred for transplant | Limited information suggests poor success rate for cutting strike and slow growth | Wardell-Coolgardie rainforest sites | Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest. | Unique genetic material could be lost and numbers reduced if transplant and cutting propagation fails |
| Hairy joint-grass | seeds can be collected and germinated readily<br><br>Individual plants or clumps can be transplanted<br><br>seepage or swamp habitat is required | Above ground material visible during wet season dies back April-May<br>seed collection summer autumn<br>Plant out/ transplant during growing season (in wet conditions). | Nursery grown seedlings have been planted out<br>direct seeding has been successful<br>turf transplant establishment and persistence depends on site suitability management to maintain competitive biomass at low levels and recruitment microsites | Suitable sites available in the Wardell-Coolgardie area and in a section 1 receiving site. | Technically feasible though success will be dependent on management that maintains biomass reduction and habitat suitability. | Hairy joint-grass can be difficult to maintain whether natural or artificial populations. Large populations are known adjacent to northern donor you sites. Failure of translocation is not likely in itself to jeopardise the sustainability of the population in the broader locality. |

| Species | Relevant biological and ecological characteristics | Seasonal constraints | Previous translocations | Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6) | Translocation feasibility | Risk assessment |
|---|---|---|---|---|---|---|
| Maundia | seeds difficult to germinate<br><br>seeds stored in soil<br><br>lateral vegetative spread<br><br>patch extent changes with hydrology | detectable all year round but die back in dry conditions<br><br>seeds December and January | Translocations have been unsuccessful. An alternative approach to population enhancement through hydrological management at locations where soil stored seed and/or mature plants are present is preferred. | n/a | Compensatory actions other than translocation are preferred – hydrological management to enhance another existing population. | Maundia is considered to be relatively secure in the Mid North Coast region to the south of the project. Occupied habitat lies to the east of the project boundary at Tabbimobile Creek. |
| Red lilly pilly | grows and establishes from seed<br><br>cuttings and transplant will be experimental | collect seeds from August to November<br><br>wet conditions required for transplant | Regularly grown and established from seed in horticultural and rainforest restoration contexts | Wardell-Coolgardie rainforest sites | Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest | Unique genetic material could be lost and numbers reduced if translocation actions fail |
| Rough-shelled bushnut | grows and establishes from seed<br><br>transplant will be experimental | collect seeds from January to May<br><br>wet conditions required for transplant | Regularly grown and established from seed in horticultural and rainforest restoration contexts | Wardell-Coolgardie rainforest sites | Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest | Unique genetic material could be lost and numbers reduced if translocation actions fail |
| Sandstone rough-barked apple | seed propagation likely to be easy and reliable<br><br>donor populations in hybrid zone | seeds likely to be available in late spring | Angophoras in general are regularly and successfully grown from seed | n/a | Not feasible. Translocation from a hybrid phone may pose a threat to the species. Alternative management is preferred. | n/a |

| Species | Relevant biological and ecological characteristics | Seasonal constraints | Previous translocations | Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6) | Translocation feasibility | Risk assessment |
|---|---|---|---|---|---|---|
| Singleton mintbush | seed collection may be possible though viable seed probably not reliably produced<br><br>cuttings likely to be successful | seed may be available in late spring | None documented but related taxa grow and establish successfully. | Suitable sites available in the vicinity of donor population | Feasible. The cutting based translocation actions will be experimental. | Moderately abundant in the vicinity of the donor plants. Unlikely that unique genetic material will be lost should translocation be unsuccessful. |
| Slender screw-fern | lateral vegetative spread<br><br>adversely affected by disturbance | dies back in dry conditions but is claimed to be detectable<br><br>planting out of slabs/clumps requires wet conditions | Generally difficult to cultivate.<br>Short term translocation success reported from transplant conducted in wet season (recent Roads and Maritime's project).<br>Possibility for transplant. May also recommend salvage of material for nursery trials. | Receiving sites with suitable microsite conditions available. | Short term success reported for one trial but generally regarded as a difficult candidate for translocation. Trialling of value for research purposes. | Population appears to continue into adjacent State Forest in the vicinity of the donor site, but requires confirmation.<br>Unique genetic material may be lost and extent of occurrence may be reduced should translocation be unsuccessful. |
| Stinking Cryptocarya | seeds germinate reliably<br><br>naturally spreads through seed dispersal<br><br>development to maturity less reliable | collect seed june-September or as late as November<br><br>wet conditions required for transplant | Regularly grown and established from seed in horticultural and rainforest restoration contexts | Wardell-Coolgardie rainforest sites | Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest | Unique genetic material could be lost and numbers reduced if translocation actions fail. |

| Species | Relevant biological and ecological characteristics | Seasonal constraints | Previous translocations | Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6) | Translocation feasibility | Risk assessment |
|---|---|---|---|---|---|---|
| Tall knotweed | seeds can be collected and germinated readily<br><br>Individual plants or clumps can be transplanted<br><br>seepage or swamp habitat is required | seeds produced in autumn (may be variable)<br><br>cuttings possible during growing season<br><br>clump/soil transplant any time (mark plant locations before they die back)<br><br>nursery production from soil seedbank any time<br><br>transplant nursery grown stock in reliably wet conditions or provide watering | Success reported from seed grown plants in south-east Qld | Yaegl Nature Reserve adjacent and within known habitat (similar to donor site conditions) | Translocation is technically feasible and a suitable donor site is available | If translocation fails the numbers or individuals remaining may be too small to constitute a self-sustaining population. |
| Water nutgrass | ephemeral recorded sparsely and intermittently in known habitat<br><br>soil-stored seed presumed primarily water-dispersed | seasonally wet habitat conditions required for development | Limited no successful examples | n/a | It is not practically feasible to translocate a species of uncertain occurrence and extent where above ground plants are rarely observed. | Water nutgrass is sparsely distributed in the vicinity of the project area (though extensive unsurveyed suitable habitat is available). Unique genetic material may be lost. |
| Weeping paperbark | seeds retained in woody capsules<br><br>likely to develop to maturity relatively quickly | collect seeds any time | Successful establishment of a population at Tucabia – community project | Several suitable sites identified | Feasible, likely to be easy to propagate from seed and establish | Relatively large sections of the donor populations will remain adjacent to the project area. It is unlikely that unique genetic material will be lost in the event of translocation failure. Alternative seed sources will be available for back-up. |

| Species | Relevant biological and ecological characteristics | Seasonal constraints | Previous translocations | Receiving sites (see also sections 2.5 Table 5 and Appendices 5 and 6) | Translocation feasibility | Risk assessment |
|---|---|---|---|---|---|---|
| White laceflower | grows and establishes from seed, though slow growing<br><br>cuttings and transplant will be experimental | collect seeds from June to January<br><br>wet conditions required for transplant | Regularly grown and established from seed in horticultural and rainforest restoration contexts, but slow in early stages of development | Wardell-Coolgardie rainforest sites | Feasible. In the long term, the proposed translocation is likely to maintain and improve the function of a diffusely connected population in regrowth rainforest | Unique genetic material could be lost and numbers reduced if translocation actions fail |
| Yellow-flowered king of the fairies | epiphytic/lithophytic<br><br>range of host trees<br><br>vegetative expansion to form clumps<br><br>“dust” seeds produced, wind-dispersed | re-locate mature epiphytes at any time, avoiding dessicating conditions in establishment stage<br><br>seed collection likely spring | Orchids in the genus are amenable to cultivation and mature plants likely to re-locate successfully, but no specific information for translocation of the species | Suitable site with host trees of same species as donor site is available | Feasible, likely to relocate successfully as mature plants | Very rare in NSW. Loss of unique genetic material and reduction in population numbers may have serious implications for the species at State level. Research into life cycle and propagation required as back up. |

## 2.5 Receiving sites

Receiving sites have been identified on Roads and Maritime owned and public land and on land remaining within the project boundary. In addition, several of the potential Biodiversity Offset Sites are in private ownership with draft covenant configurations imminent. Multiple options are available for most species, and include alternatives in all instances where incorporating sites into the Biodiversity Offset Strategy and covenanting are not finalized. Details of the receiving sites (**Table 5),** maps (**Appendix 5**) and descriptions and management requirements and actions (**Appendix 6**) are provided.

**Table 5:** Receiving sites

| Species | Receiving Site | Translocation type | Tenure | Suitability | Threats/Risks |
|---|---|---|---|---|---|
| Four-tailed Grevillea (Tucabia north of Tallowwood) | Tucabia north of Tallowwood road reserve | Seed and cutting propagation ameliorative enhancement | Roads and Maritime | Adjacent to current occurrence of Four-tailed Grevillea | Close to new highway, edge effects. |
| Four-tailed Grevillea (Pine Brush SF) | Pine Brush SF road reserve | Seed and cutting propagation ameliorative enhancement | Roads and Maritime | Adjacent to current occurrence of Four-tailed Grevillea | Close to new highway edge effects. Poor condition of existing plants. |
| Green-leaved rose walnut | Lumleys Lane BOS 22 | Cutting and seed propagation, salvage dig, ameliorative enhancement | Roads and Maritime owned draft covenant configuration imminent | Regrowth rainforest provides suitable habitat close to current occurrence of Green-leaved rose walnut | Weed competition |
| | Meridian Drive BOS 23 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| | Buckombil BOS 17 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| Hairy joint-grass (Mitchell Road intersection) | Kangaroo Trail | Salvage dig compensatory introduction | Roads and Maritime Project area | 35km from Mitchell Road intersection donor site. Suitable habitat – drainage line provides suitable hydrological conditions. Donor material from Section 1 also to be received. | Weed competition, vehicles, motorbikes. Requires appropriate management to maintain biomass at suitable levels (grazing, slashing/raking). Maintain suitable hydrology. |
| Hairy joint-grass (Coolgardie-Wardell sites) | Lumleys Lane BOS 22 | Salvage dig compensatory introduction | Roads and Maritime owned draft covenant configuration imminent | Open grassland/sedgeland adjacent to current location of Hairy joint-grass (includes exotic grasses) | Weeds. Requires appropriate management to maintain biomass at suitable levels (grazing, slashing/raking). Maintain suitable hydrology. |

| Species | Receiving Site | Translocation type | Tenure | Suitability | Threats/Risks |
|---|---|---|---|---|---|
| Hairy joint-grass (Coolgardie-Wardell sites) | Coolgardie Road BOS 24 | Salvage dig compensatory introduction | Roads and Maritime owned draft covenant configuration imminent | Open grassland/sedgeland adjacent to current location of Hairy joint-grass | Weeds. Requires appropriate management to maintain biomass at suitable levels (grazing, slashing/raking). Maintain suitable hydrology. |
| Red lilly pilly | Lumleys Lane BOS 22 | Seed propagation salvage dig ameliorative enhancement | Roads and Maritime owned draft covenant configuration imminent | Regrowth rainforest provides suitable habitat close to current occurrence of Red lilly pilly | Weed competition |
| | Meridian Drive BOS 23 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| | Buckombil BOS 17 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| Rough-shelled bush-nut | Lumleys Lane BOS 22 | Seed propagation salvage dig ameliorative enhancement | Roads and Maritime owned draft covenant configuration imminent | Regrowth rainforest provides suitable habitat close to current occurrence of Rough-shelled bushnut | Weed competition |
| | Meridian Drive BOS 23 | | Privately owned draft covenant configuration imminent | As above | As above |
| | Buckombil BOS 17 | | Privately owned draft covenant configuration imminent | As above | As above |
| Singleton mint-bush | Tabbimobile Triangle (Priority 1) | Cutting and seed propagation, salvage dig, ameliorative enhancement | Roads and Maritime acquisition | Moist sclerophyll forest (Blackbutt dominant) within and adjacent to existing population | Inappropriate fire regime, straying cattle, weeds, edge effects from new highway edge. |
| | Jackybulbin Offset BOS 13 (Priority 2) | Cutting and seed propagation, salvage dig ameliorative enhancement | Private RMS negotiating NP | Moist sclerophyll forest (Blackbutt dominant) within and adjacent to existing population | Inappropriate fire regime, straying cattle, weeds. |

| Species | Receiving Site | Translocation type | Tenure | Suitability | Threats/Risks |
|---|---|---|---|---|---|
| | Tabbimobile Bundjalung NP (priority 3) | Cutting and seed propagation, ameliorative enhancement | NP | Moist sclerophyll forest (Blackbutt dominant) within and adjacent to existing population | Inappropriate fire regime, weeds. |
| Slender screw fern | Bundjalung NP east of Mororo SF donor site (Priority 1) | Salvage dig, ameliorative enhancement | | Effectively an extension of donor site, on same creek system. Slender screw fern likely to be already present. | Disturbance from weed invasion |
| | Mahogany Drive (BOS 25) (Priority 2). | Salvage dig, ameliorative enhancement | Roads and Maritime owned draft covenant configuration includes proposed receiving site. | ~ 50km from Mororo SF donor site. Suitable habitat present adjacent to known location of Slender screw fern | Disturbance from weed invasion |
| Stinking Cryptocarya | Lumleys Lane BOS 22 | Seed propagation salvage dig, ameliorative enhancement | Roads and Maritime owned draft covenant configuration imminent. | Regrowth rainforest provides suitable habitat close to current occurrence of Stinking Cryptocarya | Weed competition |
| | Meridian Drive BOS 23 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| | Buckombil BOS 17 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| Tall knotweed | Yaegl Nature Reserve south | Salvage dig, ameliorative enhancement | NR | Adjacent or close to donor sites where suitable low-lying conditions are present. | Disturbance from weed invasion change of hydrological conditions, close to highway |
| Weeping paperbark | Bungawalbin offset (Priority 1) | Seed propagation, compensatory introduction | Roads and Maritime owned – expected to transfer to NPWS | Large areas of floodplain swamp forest and related habitat present | Lantana, groundsel |
| | Yurringully NR (Priority 2) | Seed propagation, compensatory introduction | NR | Clearing, likely to regenerate naturally, suitable open conditions for development. Floodplain sclerophyll forest surrounding.. | Straying cattle pigs and hunting, weed competition |
| | Tabbimobile | Seed propagation, | NP | Moist sclerophyll forest (Blackbutt | Inappropriate fire regime, weeds |

| Species | Receiving Site | Translocation type | Tenure | Suitability | Threats/Risks |
|---|---|---|---|---|---|
| | Bundjalung NP (Priority 3) | compensatory introduction | | dominant) | |
| White laceflower | Lumleys Lane BOS 22 | Seed propagation salvage dig ameliorative enhancement | Roads and Maritime acquisition | Regrowth rainforest provides suitable habitat close to current occurrence of White laceflower | Weed competition |
| | Meridian Drive BOS 23 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| | Buckombil BOS 17 | As above | Privately owned draft covenant configuration imminent | As above | As above |
| Yellow-flowered king of the fairies | Gummigurrah Trail picnic area Bundjalung NP | Salvage clumps of epiphyte, compensatory introduction future augmentation with seedlings | NP | Swamp oaks present (same host species as found at donor site). Additional rainforest host trees present. | Fire (low risk), illegal collection |

## 2.6 Translocation planning

Planning for each translocation operation commences with a statement of aims for each and identification of objectives. Performance criteria to guide monitoring and the evaluation of success of the translocation are developed from the objectives and corrective actions are specified for the adaption of management (**Table 6**).

**Table 6:** Translocation planning

| Species | Four-tailed Grevillea | Green-leaved rose walnut | Hairy joint-grass |
|---|---|---|---|
| Aim | Maintain or improve the functioning and condition of existing populations | Maintain or enhance existing demographic function and genetic variability | Create a self-sustaining population (Kangaroo Trail) or augment existing populations (Coolgardie-Wardell sites) |
| Objectives | Plants improve in condition so that flowering fruiting and regeneration is successful. | Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability | Plants complete their lifecycle and regenerate successfully |
| Performance criteria | Threats identified and addressed. New growth documented on 80% of existing plants flowers and fruit observed by Year 3. Improvement maintained to Year 5. | Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained to Year 5. | At least 50 plants germinate and set seed each year |
| Threshold | New growth on <50% of existing plants no flowers nor fruit by Year 3. Improvement not maintained to Year 5.* | Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.* | Less than 30 plants germinate and set seed in any one year* |
| Corrective action | Re-assess threats and address. Consider augmentation from seed propagated plants from alternative donor sites. | Augment with nursery stock from (likely cutting grown) back up stock. | Undertake searches for suitable local donor populations (in case of isolated southern occurrence) or source from receiving site populations. Collect seed nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites. |
| Aim | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species |
| Objectives | Relevant project results and observations documented. | Relevant project results and observations documented. | Relevant project results and observations documented. |
| Performance criteria | Reporting to Include e.g. threat identification and amelioration detail of growth and seeding periods and results of nursery tasks. | Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant. | Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks. |

| Species | Four-tailed Grevillea | Green-leaved rose walnut | Hairy joint-grass |
|---|---|---|---|
| Threshold | Reporting incomplete | Reporting incomplete | Reporting incomplete |
| Corrective action | Project manager to address with sub-contractors | Project manager to address with sub-contractors | Project manager to address with sub-contractors |
| Aim | Achieve no net loss in local plant populations being impacted by the project | Achieve no net loss in local plant populations being impacted by the project | Achieve no net loss in local plant populations being impacted by the project |
| Objectives | Original number of individuals and area re-established | Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost. | Original number of individuals and area re-established |
| Performance criteria | Compare with donor site. 70% of original number of plants established in Year 1 increasing to 100% minimum by Year 5 | Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5 | Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5 |
| Threshold | >50% of original number of plants established in Year 1 or similar levels below target in subsequent years* | >50% of original number of plants established in Year 2 or similar levels below target in subsequent years* | >50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent years* |
| Corrective action | Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling | Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling | Undertake searches for suitable local donor populations collect seed nursery propagate or clump transplant. |
| Aim | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value |
| Objectives | All available cutting material and seed harvested and grown on for transplant to best extent practical. | Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation. | Soil associated with above-ground plants transplanted |
| Performance criteria | No unsalvaged material present on ground inspection | Trees translocated and cutting material collected to best extent practical for nursery propagation | No unsalvaged material present on ground inspection |
| Threshold | More than 10% of the original material present | Tree not translocated. Less than 15 cuttings transferred to nursery facilities | More than 10% of the original material present. |
| Corrective action | Project manager to address with contractors | Project manager to address with contractors | Project manager to address with contractors |

| Species | Red lilly pilly | Rough-shelled bushnut | Singleton mintbush |
|---|---|---|---|
| Aim | Maintain or enhance existing demographic function and genetic variability | Maintain or enhance existing demographic function and genetic variability | Maintain a self-sustaining population adjacent to and in the vicinity of the Tabbimobile Creek donor population. |
| Objectives | Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability | Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability | Translocated plants complete their lifecycle and regenerate successfully |
| Performance criteria | Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained through to Year 5. | Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established. | At least 30 plants establish and set seed each year from Year 3 |
| Threshold | Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.* | Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.* | Less than 20 plants establish and set seed in any one year from Year 2* |
| Corrective action | Augment with nursery stock from (likely cutting grown) back up stock. | Augment with nursery stock from (likely cutting grown) back up stock. | Augment with nursery back up stock and if required collect additional seed and cuttings from seed; nursery propagate and plant out. |
| Aim | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species |
| Objectives | Relevant project results and observations documented. | Relevant project results and observations documented. | Relevant project results and observations documented. |
| Performance criteria | Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant. | Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant. | Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks. |
| Threshold | Reporting incomplete | Reporting incomplete | Reporting incomplete |
| Corrective action | Project manager to address with sub-contractors | Project manager to address with sub-contractors | Project manager to address with sub-contractors |
| Aim | Achieve no net loss in local plant populations being | Achieve no net loss in local plant populations being | Achieve no net loss in local plant populations being |

| Species | Red lilly pilly | Rough-shelled bushnut | Singleton mintbush |
|---|---|---|---|
| | impacted by the project | impacted by the project | impacted by the project |
| Objectives | Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost. | Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost. | Original number of individuals re-established |
| Performance criteria | Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5 | Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5 | Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5 |
| Threshold | >50% of original number of plants established in Year 2 or similar levels below target in subsequent years* | >50% of original number of plants established in Year 2 or similar levels below target in subsequent years* | >50% of original number of plants established in Year 2 or similar levels below target in subsequent year* |
| Corrective action | Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling | Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling | Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed/cuttings following guidelines for sampling |
| Aim | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value |
| Objectives | Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation. | Trees and saplings is transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation. | All available seed collected cutting material harvested to an extent predicted to cover predicted requirements x 2. |
| Performance criteria | Trees translocated and cutting material collected to best extent practical for nursery propagation | Trees translocated and cutting material collected to best extent practical for nursery propagation | No seed present on ground inspection |
| Threshold | Tree not translocated. Less than 15 cuttings transferred to nursery facilities | Tree not translocated. Less than 15 cuttings transferred to nursery facilities | Uncollected seed present on 10 or more plants |
| Corrective action | Project manager to address with contractors | Project manager to address with contractors | Project manager to address with contractors |

| Species | Slender screw fern | Stinking Cryptocarya | Tall knotweed |
|---|---|---|---|
| Aim | Create a self-sustaining population | Maintain or enhance existing demographic function and genetic variability | Maintain a self-sustaining population. |
| Objectives | Maintain or create a self-sustaining population (augment an existing patch) | Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability | Plants complete their lifecycle and regenerate successfully |
| Performance criteria | Plants complete their lifecycle and regenerate successfully | Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established by Year 3 and maintained through to Year 5. | At least 30 plants germinate and set seed each year |
| Threshold | Spore production observed each year (compare with control populations). Lateral vegetative growth observed from all transplants. | Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.* | Less than 20 plants germinate and set seed in any one year.* |
| Corrective action | No spore production lateral growth from <50% of transplants | Augment with nursery stock from (seed or cutting grown) back up stock. | Undertake searches for suitable local donor populations collect seed nursery propagate or clump transplant. Re-evaluate site moisture gradients to best target suitable planting sites. |
| Aim | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species |
| Objectives | Relevant project results and observations documented. | Relevant project results and observations documented. | Relevant project results and observations documented. |
| Performance criteria | Reporting to Include e.g. detail of growth and spore production. | Reporting to include observations of new growth on translocated trees results of nursery tasks. Progress of seedling establishment as relevant. | Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks. |
| Threshold | Reporting incomplete | Reporting incomplete | Reporting incomplete |
| Corrective action | Project manager to address with sub-contractors | Project manager to address with sub-contractors | Project manager to address with sub-contractors |
| Aim | Achieve no net loss in local plant populations being impacted by the project | Achieve no net loss in local plant populations being impacted by the project | Achieve no net loss in local plant populations being impacted by the project |

| Species | Slender screw fern | Stinking Cryptocarya | Tall knotweed |
|---|---|---|---|
| Objectives | Original number of individuals and area re-established | Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost. | Original number of individuals and area re-established |
| Performance criteria | Compare with donor site: 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5 | Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5 | Compare with donor site. 70% of original cover of plants established over an area equivalent to original in Year 1 increasing to 100% cover by Year 5 |
| Threshold | >50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year.* | >50% of original number of plants established in Year 2 or similar levels below target in subsequent years.* | >50% of original cover of plants established over an area equivalent to original in Year 1 or similar levels below target in subsequent year.* |
| Corrective action | Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling | Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling | Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling |
| Aim | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value |
| Objectives | All available plants and associated soil harvested and transplanted to best extent practical | Trees and saplings transplanted. Suitable cutting material for predicted requirements x 2 harvested seeds if available for nursery propagation. | All available plants and associated soil harvested and transplanted to best extent practical |
| Performance criteria | No unsalvaged material present on ground inspection | Trees translocated no seed left unharvested. | No unsalvaged material present on ground inspection |
| Threshold | More than 10% of the original material present | Trees not translocated. Less than 15 cuttings transferred to nursery facilities | More than 10% of the original material present |
| Corrective action | Project manager to address with contractors | Project manager to address with contractors | Project manager to address with contractors |

| Species | Weeping paperbark | White laceflower | Yellow-flowered king of the fairies |
|---|---|---|---|
| Aim | Create self-sustaining populations (two sites) | Maintain or enhance existing demographic function and genetic variability | Maintain a self-sustaining population. |
| Objectives | Plants complete their lifecycle and regenerate successfully | Create or augment small sub-populations with diffuse connectivity to meta population in the Coolgardie-Wardell area conserving existing genetic variability | Translocated clumps and individuals establish on new hosts flower set seed. |
| Performance criteria | At least 50 plants germinate and set seed each year from Year 2 | Clumps of plants established numerically sufficient to replace or augment the number of affected individuals or sub-populations. Progeny from all translocated individuals is established. | At least 20 plants establish flower and set seed each year from Year 2 |
| Threshold | Less than 30 plants germinate and set seed in any one year from Year 2* | Less than 80% of no of original clumps or individuals are established. Less than 80% of impacted plants represented by established progeny.* | Less than 15 plants establish and set seed in any one year from Year 2* |
| Corrective action | Use stored seed or collect additional seed from remaining source population nursery propagate and plant out. Re-evaluate site conditions to best target suitable planting sites. | Augment with nursery stock from (likely cutting grown) back up stock. | Evaluate host sites of any plants not functioning as required and assess benefits of re-location. |
| Aim | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species | Increased knowledge of the threatened plant species |
| Objectives | Relevant project results and observations documented. | Relevant project results and observations documented. | Relevant project results and observations documented. |
| Performance criteria | Reporting to Include e.g. results of nursery tasks records of establishment and development. | Reporting to Include observations of new growth on translocated trees results of nursery tasks. progress of seedling establishment as relevant. | Reporting to Include e.g. detail of growth and seeding periods and results of nursery tasks. |
| Threshold | Reporting incomplete | Reporting incomplete | Reporting incomplete |
| Corrective action | Project manager to address with sub-contractors | Project manager to address with sub-contractors | Project manager to address with sub-contractors |
| Aim | Achieve no net loss in local plant populations being impacted by the project | Achieve no net loss in local plant populations being impacted by the project | Improve options for augmentation through seedling production |

| Species | Weeping paperbark | White laceflower | Yellow-flowered king of the fairies |
|---|---|---|---|
| Objectives | Original number of individuals re-established | Equivalent original number of individuals re-established. following guidelines for replacement of mature trees by seedlings/cuttings i.e ten seedlings established for any mature trees lost five seedlings established for any saplings lost. | Research program for seed propagation established and propagation underway. |
| Performance criteria | Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5 | Compare with donor site. 70% of original number of plants established in Year 2 increasing to 100% minimum by Year 5 | Specialist propagation facility engaged and liaison with field personnel established. Consultation with OEH SOS program. |
| Threshold | >50% of original number of plants established in Year 2 or similar levels below target in subsequent years* | >50% of original number of plants established in Year 2 or similar levels below target in subsequent years* | Insufficient understanding of seedling production techniques achieved by Year 3 production not underway |
| Corrective action | Replace with nursery back up stock. Evaluate options for sourcing more propagation material from remaining plants adjacent to donor population collect additional seed following guidelines for sampling | Replace with nursery back up stock. Evaluate options for sourcing more propagation material from neighbouring patches collect additional seed following guidelines for sampling | Consider options for alternative research partners |
| Aim | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value | Make the best possible use of all plant material with potential conservation value |
| Objectives | Available seed is harvested for nursery propagation. | Trees and saplings are transplanted. All potential cutting material (and seeds if available) harvested for nursery propagation. | All available plants translocated to new hosts |
| Performance criteria | Trees translocated and cutting material collected to best extent practical for nursery propagation (at least 20 cuttings) | Trees and saplings translocated and cutting material collected to best extent practical for nursery propagation | No unsalvaged material present on field inspection |
| Threshold | Tree not translocated. Less than 15 cuttings transferred to nursery facilities | Tree and saplings not translocated. Less than 15 cuttings transferred to nursery facilities | Plants remain on host trees |
| Corrective action | Project manager to address with contractors | Project manager to address with contractors | Project manager to address with contractors |

* where performance falls between the target and the threshold, corrective action to be at discretion of expert translocation contractor to allow for environmental variability and species specific consideration.

Corrective actions will be undertaken when any threshold is reached.

Note that monitoring is scheduled to continue over a 5 year timeframe. Should targets not be met at 5 years, the program is to be reviewed by Roads and Maritime and translocation contractors in conjunction with EPA.

## 2.7 Timeframe schedule and staging

The schedule for steps in translocation is set out in **Table 7.**

### Table 7: Translocation Schedule (part 1)

| Year | 1 | | | | | | | | | | | | 2 | | | | | | | | | | | | 3 | | | | | | | | | | | | 4 | | | | | | | | | | | | 5 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| **Four-tailed grevillea** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seed collection/cuttings*/collection of individual plants | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Germination/nursery growing on | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Receiving site preparation | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transplant seedlings/cuttings into receiving site | | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat maintenance | | | | | | | | | | | | | | | x | | | x | | | x | | | x | | | x | | | | | x | | | | x | | | x | | | | | x | | | | x | | | | | | | | | | | |
| Monitoring measurements | | x | | | x | | | x | | | x | | | x | | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| **Hairy-joint grass** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seed collection*/collection of individual plants | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Germination/nursery growing on | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Receiving site preparation | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Remove transplant slab/clump | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transplant/Plant into receiving site | | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat maintenance | | | | | x | | | x | | | x | | | | x | | | x | | | x | | | x | | | x | | | | | x | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| Monitoring measurements | | x | | | x | | | x | | | x | | | x | | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| **Singleton mint bush** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seed collection*/cuttings*/collection of individual plants | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Germination/nursery growing on | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Receiving site preparation | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transplant/Plant into receiving site | | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat maintenance | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | | | x | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| Monitoring measurements | | x | | | x | | | x | | | x | | | x | | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| **Slender screw-fern** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Receiving site preparation | | x | x | | | | | | | | | | | | | | | | | | | | | | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Remove transplant slab/clump | x | x | x | | | | | | | | | | | | | | | | | | | | | | | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transplant slab into receiving site | x | x | x | | | | | | | | | | | | | | | | | | | | | | | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat maintenance | | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | | | x | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| Monitoring measurements | | | x | | | x | | | x | | | x | | | x | | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

## Table 7: Translocation Schedule (part 2)

| Year | 1 | | | | | | | | | | | | 2 | | | | | | | | | | | | 3 | | | | | | | | | | | | 4 | | | | | | | | | | | | 5 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D |
| **Tall knotweed** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seed collection*/cuttings*/collection of individual plants | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Germination/nursery growing on | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Receiving site preparation | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Remove transplant slab/clump | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transplant/Plant into receiving site | | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat maintenance | | | | x | | | x | | | x | | | x | | x | | | x | | | x | | | x | | | x | | | | | x | | | | x | | | | x | | | | | | | | | | | | | | | | | |
| Monitoring measurements | | x | | | x | | | x | | | x | | | x | | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| **Weeping paperbark** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seed collection*/collection of individual plants | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Germination/nursery growing on | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Receiving site preparation | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transplant/Plant into receiving site | | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat maintenance | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | | | x | | | | x | | | | x | | | | | | | | | | | | | | | | | |
| Monitoring measurements | | x | | | x | | | x | | | x | | | x | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| **Yellow-flowered king of the fairies** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Collection of individual plants | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| Transplant into receiving site | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| Monitor condition of plants | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | | | | | x | | | | x | | | | | | x | | | x | | | | x | | | | | | | | | | | | |
| Monitoring measurements | x | | | x | | | x | | | x | | | x | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | |
| **Green-leaved rose walnut** Seed/cuttings/transplant | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Red lilly pilly** Seed/cuttings/transplant | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Rough-shelled bush nut** Seed/transplant | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Stinking Cryptocarya** Seed/cuttings/transplant | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **White laceflower** Seed/transplant | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seed collection*/cuttings*/Collection of individual plants | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Germination/nursery growing on | x | x | x | x | x | x | x | x | x | x | x | x | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Receiving site preparation | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Transplant/Plant into receiving site | | x | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Habitat maintenance | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | x | | | | | x | | | | x | | | | x | | | | | | | | | | | | | | | | | |
| Monitoring measurements | | x | | | x | | | x | | | x | | | x | | | | | x | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | x | | | | | | | | | | | | | | | | | | | | |
| *Seed collection/cuttings timing dependant on individual species | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scheduling dependant on timing of construction/access/season | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# 3 Translocation procedures

## 3.1 Guidelines

Florabank Guidelines and Model Code of Practice (www.florabank.org.au) will guide seed collection storage and basic germination techniques. The guidelines are designed for general revegetation and will be especially relevant to plantings required for general habitat restoration. Deviations from the guidelines may be appropriate when genetic management is required for threatened species and Vallee *et al.* (2004) s. 5.2.1 recommend greater restrictions on the percentages of seed to be collected from individual plants when dealing with threatened species. Reference is also made to RTA Seed Collection QA Specification R176 (also more appropriate for general habitat plantings).

The collection of seed of threatened flora species will also be guided by NSW OEH's Checklist For Bush Regeneration Activities in Habitats Including Threatened Species Endangered Populations and Endangered Ecological Communities.

For a salvage operation however there is no imperative to limit collection from plants proposed for destruction.

Hygiene protocols consistent with standard requirements for works in OEH sensitive areas will be employed.

Site protection protocols are required to limit the transfer of pathogens such as Myrtle rust, *Phytophthora cinnamomi* and Chytrid fungus into sensitive areas.

Footwear must be thoroughly cleaned and disinfected at the commencement of fieldwork and between sites. Any vehicles and equipment or personal effects used off road, trail or track must be thoroughly cleaned and disinfected. For Myrtle rust, disinfect further by spraying head to toe including hats and boots.

Disinfecting agents:
• Chloramine and Chlorhexidine based products such as Halamid©, Halasept© or Hexifoam© are effective against both bacteria and fungi. These products are suitable for use on hands, footwear, instruments and other equipment. Manufacturer's instructions should be followed when preparing these solutions .
• Medical standard 70% isopropyl alcohol wipes - Isowipes© can be used on hands and personal effects like sunglasses, phones, GPS etc and on hand tools, and inside vehicles.
• Bleach and alcohol (ethanol or methanol), diluted to appropriate concentrations can be effective against bacteria and fungi. However, these substances may be less practical because of their corrosive and hazardous nature.
• 70% methanol (methylated spirits).
• Fresh bleach (5% concentration), may be also effective against other frog pathogens such as Rana Virus.

## 3.2 General methods

Three methods would be employed in translocating the subject species (**Table 8)**:

- transplanting individuals clumps or slabs from the project footprint to the receiving sites; relocation of epiphytic orchids;
- propagation of individuals from locally collected seed; and
- propagation from cuttings.

Two species - Hairy joint-grass and Tall knotweed are annual species with life cycles that are driven by seasonal soil moisture variations. Accordingly seeds may not be reliably available even during documented seeding periods. Two or multiple translocation options are presented for such species for adoption depending on the availability of seed and above-ground plant material when translocation is scheduled. Generally speaking the preferred option is to slab/clump translocate those species where this is viable (Hairy-joint grass, Slender screw fern and Tall knotweed). It should also be noted that seed is available for all species suited to seed collection from other populations in proximity, except in the case of southern locations for Hairy joint-grass.

In terms of translocation schedule the work will be done in close consultation with the construction contractor with a view to prioritising actions to meet with construction timetables and species requirements.

**Table 8:** Translocation methods
(addressed for species for which translocation is assessed as feasible)

| Species | Seed | Individual or clump/slab transplant | Cuttings |
|---|---|---|---|
| Four-tailed Grevillea | Yes | Dig, pot and grow on seedlings if present, or transplant directly | Yes |
| Green-leaved rose walnut | If available | Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees | Yes |
| Hairy joint-grass | If available | Clump/slab transplant | No |
| Red lilly pilly | Yes, if available | Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees | Yes |
| Rough-shelled bush-nut | Yes | Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees | No |
| Singleton mintbush | If available | No | Yes |
| Slender screw fern | n/a | Slab transplant | n/a |
| Stinking Cryptocarya | Yes, if available | Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees | Yes |
| Tall knotweed | If available | Clump/slab transplant | Yes if suitable material available |
| Weeping paperbark | Yes | No | No |
| White laceflower | Yes | Dig, pot and grow on seedlings if present, or transplant directly. Transplant trees | Yes |
| Yellow-flowered king of the fairies | Undertake research into lifecycle and propagation, use seedlings for augmentation and back up should relocation fail | Relocate orchid individuals or clumps | No |

## 3.3 Seed collection and propagation

Seed collection will be conducted with reference to available information of likely seeding times for the target species (**Table 9**).

**Table 9:** Seed availability for threatened flora species

| Species | Time for collection | Notes |
|---|---|---|
| Four-tailed Grevillea | Oct-Nov (likely but not documented) | Likely to be shed quickly. Collection may require multiple site visits and bagging of some developing follicles |
| Green-leaved rose walnut | Nov-May also other times | Irregular within and between years |
| Hairy joint-grass | Late autumn to early winter. | Timing of seed production is poorly documented and assumed variable as life cycle depends on timing of summer rains |
| Red lilly pilly | Aug-Nov | |
| Rough-shelled bush-nut | Jan-Apr | |
| Singleton mint-bush | Not documented. Probably in Oct-Nov | Following spring flowering |
| Stinking Cryptocarya | June to September or sometimes as late as November | |
| Tall knotweed | Summer-autumn | Depending on rains |
| Weeping paperbark | Any time | Persistent capsules |
| White laceflower | Jun-Jan | |
| Yellow-flowered king of the fairies | Not documented possibly spring | Green capsules observed in July |

Individual plants or clumps for translocation should be selected from donor site. The aim should be to maximize the capture of the genetic variation from the donor site using spatial spread as a surrogate for genetic variation in absence of specific genetic studies or biological characteristics that suggest otherwise. In general no constraints to collection of seed (where available) from plants proposed for destruction are necessary. Additional seed collections from adjacent populations may be undertaken to supplement seed collected from directly impacted plants where judged necessary to achieve numbers and genetic diversity as required to meet targets.

The biology of Hairy joint-grass and Tall knotweed indicates that fine scale genetic structuring within populations and between nearby populations (e.g. on the same floodplain) is unlikely. Seeds will disperse in floodwaters (and via other dispersal mechanisms) and can be predicted to result in constant genetic mixing over short to relatively long distances. Genetic research reported by Benwell (2012) concluded that there is low genetic variation between populations in Hairy joint-grass from the Ballina-Byron region.

For Hairy joint-grass supplementary seed collection from adjacent populations can take place from available sources regardless of spacing of the source plants but should be spread to avoid local depletion of seeds. The total will be restricted to 10% of the available crop.

### Labelling

Batches of seed will be labelled to identify origin collector and date of collection (Vallee *et al.* 2004 s.5.2.3).

### Seed storage

Seeds will usually be sown fresh and no special storage arrangements are required.

### Nursery propagation from seed

Seeds will be sown in suitable commercial seed raising mix. As no specific information is available to suggest that the inoculation with soil mycorrhizae is essential for successful nursery raising of the species for which nursery propagation and growing on is proposed, natural soil from the collection site will not be added to the seed-raising and potting mix. The receiving sites are usually within or adjacent to known occurrences of the translocated plants and can be expected to contain appropriate soil fungi.

Unnecessary soil introduction may conflict with nursery hygiene protocols. Soil in seedling mixes will introduce weeds that will be difficult to distinguish from the target species when small seedlings.

- Large seeds to be sown in trays and covered to approximately the diameter of the seed.
- Medium seeds are to be sown in trays and lightly covered.
- Fine seed – use the 'saturated soil medium method' whereby the pot containing the seeds is placed into a container of water until germination occurs.

Label according to species origin and date of sowing.

In the event that translocation of epiphytic orchids require supplementation with propagated seedlings specialised techniques and facilities will be required and are well documented in e.g. Jones (1993).

## 3.4 Pre-translocation receiving site preparation

Identify the location of the sites for planting or clump/slab/tree transplant and mark with bamboo stake and flagging tape. In addition and to insure against loss of stakes and flags metal pegs will be employed for later location with a metal detector. Site preparation will include control of weeds through the whole of the mapped area and a 5m buffer area so that site is weed free when material is introduced. Identify the location of the sites for planting or slab/clump and mark with bamboo stake and flagging tape. Prior to arrival of slab or clump transplants areas slightly larger than the slab/clump to be excavated ready for receival. If undertaken during drought conditions or where recipient site is dry, a wetting agent is recommended, and will be considered regardless of conditions to assist post translocation management. Watering may be necessary depending on the season. In the case of planting seedlings the holes will be dug on the planting day.

Where impacts from stock or feral animals are likely then fine mesh fencing is to be erected around the translocation site. Individual strong plastic tree guards will be required where browsing by wallabies or kangaroos is possible.

## 3.5 Cuttings

Stem and cuttings will be rooted with hormone treatment in specialist misting facilities. Cuttings may be employed for threatened flora species Four-tailed Grevillea, Green-leaved rose walnut, Red lilly pilly, Singleton mintbush, Stinking Cryptocarya, Tall knotweed and White laceflower (depending on prospects for success using alternative methods and also availability of suitable material).

All cutting material should be labelled to indicate plant of origin (Vallee *et al.* 2004).

## 3.6 Potting and growing on

Seedlings or rooted cuttings will be transplanted to pots or tubes. All plants will be labelled with ID indicating origin.

All species (seedlings)
Transplant to pots or tubes.
Seedlings should be pricked out when 0.5 to 2 cm tall. Grow on in nursery until about 10 cm tall (herbs and grasses).
For tree and shrub species, seedlings should be potted on when 3-5cm tall.

Tree species (cuttings)
Remove from mist for one week when new leaves are produced and pot on. Grow on until plants exhibit vigorous above-ground growth and have a strong root system. Some species may be very slow growing.

Tall knotweed (cuttings)
Remove from mist for one week when new leaves are produced and pot on. Grow on until plants exhibit vigorous above-ground growth and have a strong root system.

## 3.7 Digging, potting or direct transplant of seedlings

Identify the location of the seedlings for removal and flag and number. Seedlings from donor sites to be directly transferred to receiving site if in close proximity or alternatively transported to a suitable nursery for potting. Dig around the seedling at a distance that will cause minimum disturbance to the roots system. Carefully place the seedling and soil into a tray or pot or wrap in plastic or hessian for transfer to receiving site or nursery.

## 3.8 Transplant of saplings and mature trees

Identify location of saplings and trees for translocation and flag and number. Excavate an area larger than the rootball in readiness for the translocation. Excavation should be undertaken as appropriate for the size of the plants, with hand tools or machines as small as possible for the task (bobcat) and undertaken or supervised by an ecologist or bush regenerator. Water well and keep moist. When receiving site is prepared remove the whole root ball (excavator or hand tools). Prior to transplanting (excavation), each plant needs to be lightly pruned to reduce transpiration stress.
All pruned material should be placed into a damp plastic bag and labelled as per Vallee *et al.* 2004 s.5.2.3. Bags should then be placed in a cool storage device (esky) for transport to nursery for cutting propagation.

## 3.9 Clump/slab transplant

Identify the location of the sites for clump/slab removal and flag and number. The source points for donor clumps/slabs will be identified by GPS location, abundance data recorded as appropriate for the species and a map prepared. Clumps and slabs will be dug and placed in tubs or trays for transportation. All clumps and slabs will be labelled as per Vallee *et al.* 2004 s.5.2.3, either as individuals or, where material is to be pooled, by general location. Clump and slab material will be kept moist by watering, covering with wet newspaper, enclosing in tubs and/or covering with tarpaulin during transport.

## 3.10 Relocation of epiphytic orchids

Clumps and individuals will be prised carefully from the host trees and kept moist. Clumps will be divided where there are clear divisions between individual plants and cutting with a sharp knife can separate plants without undue disturbance. Some plants may be best retained in small clumps.

Plants will be attached to the new host tree using jute ties. A host tree of the same species of the donor site tree will be chosen.

## 3.11 Transport to field and planting

Preliminary
Sun-harden all nursery stock – seedlings and established cuttings of trees, herbs and vines.

Transport to receiving site
Nursery stock to be protected from wind and desiccation during transport (well watered at starting point and in covered tubs or under secure tarpaulin).
Slabs/clumps will be transported in plastic tubs or trays manually or by utility to the site and where possible planted on the same day. In the case of large areas of Hairy joint-grass and tree transplants the clumps/trees will be transported by excavator. The transplant material is to be kept moist and protected from wind during delivery.

Planting
Place in excavated hole or depression and back fill with local soil as necessary.
The translocated species generally do not require fertiliser to be added on planting.
Weed free mulch may be required for the planted tree species to assist in retaining moisture and suppress weed.
Watering will be necessary on planting and may be ongoing depending on the season.
Consider use of wetting agent.

After transplanting individuals will be tagged with their ID code. A map of the receiving site showing the transplanted individuals identified by ID code will be prepared.

## 3.12 Post translocation management

After translocation all sites will require regular inspections to identify if plants require watering or protection from impacts such as grazing, fence repairs, drainage, exposure or weed invasion. If threats are identified they are to be rectified immediately. A regular weed control program is required for all receiving sites.

The timing of inspections, watering and weed control will vary depending on the season and time passed since the translocation. Inspection will be required on a fortnightly basis for the first month to assess if the plants require watering or other maintenance. Inspections during year one will depend on time of year and establishment of the translocations. During winter when plant growth is slow three monthly weed control is recommended whereas during

summer weed control may be required on a six-eight weekly basis. Watering should only be required during the first month of establishment unless extremely dry weather conditions are encountered. During following years inspections can be incorporated with the weed control and the period between visits extended as plants become established and weed invasion reduced.

A schedule for inspections is incorporated into **Table 7.**

# 4 Personnel expertise and resources

Personnel expertise and resources have been identified and sourced to ensure the best possible outcome from the translocations (**Table 10**).

The translocations will be managed by a restoration ecologist and supervising bush regenerator who are experienced in the translocation of threatened species within the region.

Site preparation will be undertaken by a team of experienced bush regenerators who are familiar with the native and weed species which occur on the sites.

Personnel engaged to undertake the translocations will hold:

- Certification at Levels 3-4 in Conservation and Land Management
- Licences to undertake seed collection other translocation tasks and bush regeneration (Section 132C NPW Act)
- Chemical Users Certificates.
- White card

Works will be supervised by a suitably qualified restoration ecologist.

**Table 10:** Personnel and resources

| Action | Personnel | Equipment and materials |
|---|---|---|
| Weed management at receiving sites | Supervising bush regenerator | Spray packs drills and injectors hand tools |
| Traffic control signage and protective barriers/fencing | Ecologist and Principal contractor | Signs webbing or fencing |
| Locate and identify receiving sites and access | Ecologist and Supervising bush regenerator | GPS<br>Bamboo stakes and flagging tape |
| Map access extent of receiving site and locations for transplanting | GIS operator | ArcGIS |
| Collect propagation material seed and/or cuttings | Ecologist | Secateurs bags labels esky spray bottle water spray bottle disinfectant. |
| Propagation of seed or cuttings | Certified nursery personnel and Ecologist | Nursery facilities<br>Pots containers labels |
| Receiving site preparation | Ecologist and Bush regeneration team | Bush regeneration tools and chemical<br>Fencing – pest exclusion or protective barrier – if required |
| Transplanting | Ecologist and Bush regeneration team<br>Excavator contractor<br>Principal contractor – if required | Shovels saws secateurs plastic tubs<br>Utility<br>Excavator<br>Watering system – water cell and hoses<br>Mulch and fertiliser – if required<br>Bamboo stakes and tags |
| Receiving site maintenance | Ecologist and Bush regeneration team | Bush regeneration tools<br>Watering system |
| Monitoring | Ecologist | IPad data sheets and maps |

# 5 Monitoring evaluation and reporting

## 5.1 Background

Monitoring involves detecting changes and patterns overtime. This requires identifying the parameters to be monitored gathering information and interpreting the information gathered. Monitoring will enable the identification of problems and allow early response to any problems or threats. Monitoring is also vital for evaluating translocation success (Vallee *et al.* 2004).

Translocations have been evaluated by measuring:

- vital rates (survival growth fecundity) of propagules (seeds transplants)
- completion of the life cycle through flowering fruiting dispersal and subsequent seedling recruitment
- modelling population viability of translocated populations (Menges 2008)

The monitoring data collection outlined below will serve to measure vital rates in the relatively short timeframe (5 years) generally allocated to monitoring and evaluation tasks in a typical highway construction project.

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)

Hairy joint-grass and Tall knotweed have good potential to complete their life cycles in the same timeframe and suitable monitoring data can be usefully evaluated. Menges recommends that comparisons with reference populations be incorporated into the evaluation.

Ideally Menges' recommends long-term perspectives on success and an experimental framework that can provide both practical and basic knowledge. He notes that demographic data collection and analysis in restorations has great potential to elucidate causes of translocation failure and improve the prognosis of future restorations.

In drawing conclusions about the success or failure of translocations the following factors should be considered:

- 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
-

Timeframe

Monitoring of the translocations would be conducted during and after construction for a minimum of 3 years a total of approximately 5 years.

Independent oversight

Monitoring and reporting will be conducted (or overseen) by personnel independent of those undertaking the on-ground works.

Record of translocation actions and results

- Record of collection of propagules/transplants
- Germination time and % cutting strike rate and time required
- Nursery conditions
- Growing on period
- Planting out
- Post-planting care
- Baseline measurements of translocated plants as below.

Receiving site

- Biophysical description
- Threats (e.g. weeds grazing)
- Management actions
- Regeneration/planting of habitat components

Reference populations

Identify and mark a sample of a reference population that can be used to compare growth and development of plants that have been translocated.

Monitoring data

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)

Note that for species with growth forms not suited to counts and measurements of individual stems eg Hairy joint-grass growth and development will be tracked using area- and density-based measurements.

Baseline surveys

Monitoring will commence with baseline surveys of the donor populations as an additional check on the numbers or areas of each species to be impacted and therefore to be replaced. The results will be compared with the earlier survey results and the larger of the two results adopted as the basis of numerical targets.

Monitoring frequency

Monitoring of the translocations would be conducted as follows: every 3 months for the first year; every 6 months in the second year and once a year thereafter.

Monitoring would be conducted during construction and after construction for a minimum of 3 years.

## 5.2 Performance criteria and adaptive management

The following performance criteria are derived from Vallee *et al*. (2004) with adaptation to suit the circumstances of the current project.

Propagation and record keeping

Criteria for successful propagation would include:

- the required number of transplants was available for the translocation
- correct labelling and documentation was maintained through cultivation
- techniques for successful propagation are determined
- a genetically representative collection was maintained (Vallee et al. 2004).

Salvage

All material with potential conservation value is salvaged prior to construction works having direct impact on the plants. The material is available for:

- backup in the case of failed translocation establishment
- seed banking (note additional seed can be sourced from other populations in proximity)
- trialling and research.

Short Term Criteria (to 5 years)

The translocation of each species:

- at least 70% of the transplants and enhancement introductions are surviving after the first year and 60% after five years (and arrangements for replacement from backup stock are underway in case of failure to meet this target);
- germination from freshly shed or soil-stored seed of Hairy joint-grass and Tall knotweed occurs following suitable seasonal rainfall
- flowering and seed production (or spore production) occurs in transplanted individuals (if appropriate to species timeframe and maturity of transplanted material)
- the translocated populations display similar growth development and vigour to naturally occurring populations
- regeneration occurs in transplanted individuals (if appropriate to species timeframe and maturity of transplanted material)

Habitat and threat management:

- good quality habitat restored in and surrounding the receival site;
- maintenance carried out at suitable intervals; and
- threatening processes including weed invasion controlled or eradicated.

Long Term Criteria (decades)

The timeframe of the current project will not permit the development of slow-growing species i.e. Green-leaved rose walnut to be followed to reproductive maturity. Annual plants however will complete many life cycles in timeframes of a decade or more. Details of long-term criteria are provided for information and adoption where feasible.

- translocated individuals survive to reproductive maturity;
- new seedlings or vegetative offspring are established;
- the number of individuals in the population is sustained or increased by natural recruitment;

- adequate levels of genetic fitness are maintained through generations;
- reproduction including the production of flowers and fruit (or spores) and seed viability (spore viability) is consistent with levels in naturally occurring plants;
- natural habitat conditions are restored or maintained at the receival site.

The practical difficulties in maintaining surveillance and management over ecological timeframes contribute to uncertainties in predicting translocation success. The establishment and continuing development of plants over a period of 5 years is a realistic goal for long-lived species. Species-specific performance criteria thresholds signaling the need for adaptation of management and actions to correct divergence from progress towards targets are identified in **Table 6**.

## 5.3 Translocation monitoring report

An annual translocation monitoring report will be prepared and submitted to the Environment Protection Authority, Department of the Environment and Department of Planning and Environment.

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The report will include: -

- Background and description of the translocation project (initial report)
- Translocation methods (initial report)
- Monitoring methods
- Monitoring results
- Evaluation of translocation success to date
- Identify any corrective actions required
- Recommendations for immediate and ongoing management
- General recommendations for future translocation projects

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| | |
|---|---|
| Four-tailed Grevillea | Profile last updated: 07 Sep 2012 |
| Green-leaved rose walnut | Profile last updated: 04 Aug 2014 |
| Hairy joint-grass | Profile last updated: 07 Sep 2012 |
| Maundia | Profile last updated: 30 May 2014 |
| Red lilly pilly | Profile last updated: 22 Apr 2014 |
| Rough-shelled bush-nut | Profile last updated: 22 Apr 2014 |
| Sandstone rough-barked apple | Profile last updated: 11 Aug 2014 |
| Singleton mintbush | Profile last updated: 30 May 2014 |
| Slender screw fern | Profile last updated: 07 Sep 2012 |
| Stinking Cryptocarya | Profile last updated: 05 Aug 2014 |
| Tall knotweed | Profile last updated: 31 Jan 2014 |
| Water nutgrass | Profile last updated: 07 Sep 2012 |
| Weeping paperbark | Profile last updated: 22 Apr 2014 |

White laceflower Profile last updated: 11 Aug 2014
Yellow-flowered king of the fairies Profile last updated: 07 Sep 2012

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# Appendix 1 Translocation strategy comments table

# Pacific Highway Upgrade – Woolgoolga to Ballina

Flora Translocation Strategy Sections 3-11
(excluding Early Works Soft Soil Treatment Areas)
May 2015

**AGENCY REVIEW COMMENTS –**

1) **Commonwealth Department of the Environment (DoE) 6 November 2015**
2) **Environment Protection Authority (EPA) 9 November 2015**
3) **Department of Planning and Environment (DPE) 25 November 2015**

| No. | Agency | Comments | Where addressed in report |
|---|---|---|---|
| **1.** | **DoE** | The Department has no specific comments to raise regarding this document.<br><br>Please note *Streblus* subpopulations on mainland Australia and in Melanesia, Micronesia and Polynesia have variously been included with *S. pendulinus*. More recently, *Streblus brunonianus* has been reinstated for non-Norfolk Island subpopulations. For more information see the link below.<br><br>http://www.environment.gov.au/biodiversity/threatened/nominations/comment/streblus-pendulinus | Noted |

| No. | Agency | Comments | Where addressed in report |
|---|---|---|---|
| **2.** | **EPA** | Six Translocation receiving sites are BOS sites. There are two issues of concern relating to this:<br>1) Are these sites assured of perpetual preservation considering the offset package is in its infancy. The status of these sites, and the ramifications if they are not included in the biodiversity offset package, needs to be addressed in the translocation strategy.<br>2) Any additional threatened species area generated on these sites as a result of translocations is not to be included in offset calculations | 1) Section 2.5 includes statement that alternative options are listed in all instances where covenanting of sites is not finalised. Status of sites clarified in Appendices 6.8, 6.17 and 6.18.<br>2). Noted. To be addressed in the Biodiversity Offsets Strategy. |
| **3.** | **EPA** | Table 6 contains several issues to be addressed.<br>Performance criteria, thresholds and corrective actions are often not coherent.<br>1) Performance criteria are often much higher than threshold criteria. Performance criteria reflect the literature (eg. Vallee *et al*. 2004) and are the temporal academic goals of translocation, whereas the threshold reflects the on the ground trigger for corrective action. For example for red lilly pilly 70% (of original population) is the performance criteria after 2 years whereas 50% is the threshold. The EPA suggests that when on the ground results lie within this bracket, i.e. between 70% and 50% in this example (and between performance criteria and threshold generally), the trigger for corrective action be at the discretion of the expert translocation contractor. This allows for environmental variability and species specific consideration.<br>2) Often thresholds do not include a temporal parameter. For e.g Red Lilly Pilly again, Threshold (for aim of maintaining demographic function/genetic variability) is 80% of original measure but has no time parameter for monitoring or effective corrective action. Need to include a timeframe for these type of thresholds.<br>3) There may then be a conflict between differing thresholds for corrective action for different aims for the same species. If this is the case then the EPA suggests text be included to the effect that corrective action will follow any threshold being reached. | 1) Table 6 Translocation planning.<br>Annotations to reflect EPA suggestion.<br>2) Time parameters added where required.<br>3) Statement following Table 6 |
| **4.** | **EPA** | What are the triggers for continuing/stopping monitoring after 3 years, I infer that it is the achievement of the 100% replacement figure of the original population, but this isn't mentioned anywhere. What is to happen if the 100% replacement goal isn't reached within 5 years? This possible outcome needs to be addressed in the strategy. | Table 6 adjusted to note that Year 3 achievements to be maintained though to Year 5.<br>Statement re Year 5 review, if required, follows Table 6. |
| **5.** | **EPA** | The annual monitoring report should be submitted to the EPA not OEH as stated in the strategy. | Corrected in s5.3 Translocation monitoring report, see also Comment 10. |

| No. | Agency | Comments | Where addressed in report |
|---|---|---|---|
| **6.** | **EPA** | The tables are listed erroneously, e.g. table 6 is Translocation planning not receiving sites as in table of contents etc. | Corrected in Table of Contents |
| **7.** | **DPE** | Provide list of recent ecological reports and surveys which informed the identification of the directly impacted threatened flora. | Provided, s1.5 |
| **8.** | **DPE** | The aims, objectives and performance criteria and corrective actions for the Green-leaved rose walnut individuals in section 10 are different to the actions approved for the species (individual tree) in the approved Flora Translocation Strategy Early Works Soft Soil Treatment Areas (Version 3 June 2015). Explanation of the different approach for sections 3-11 should be provided. | The risks of inbreeding depression should multiple plants be propagated and established from the isolated tree is discussed in Appendix 3 of the Soft Soils Strategy. The special case of the subject tree affected by Soft Soils Early Treatment Works required modifications to translocation objectives. |
| **9.** | **DPE** | Monitoring of translocations would be conducted during and after construction for a minimum of three years for total of approximately 5 years. Are these timeframes realistic for slow growing species (Green-leaved rose walnut) grown in a nursery (from seeds or cuttings) and when growth of the seedling is suitable for transplant to the recipient site. Will this occur within two years and allow three year monitoring period post translocation? | Rates of development are difficult to predict but are likely to be slow for Green-leaved rose walnut. A review of progress may be required at Year 5, see also Comment 4. |
| **10.** | **DPE** | Annual monitoring report to be submitted to EPA, Department of the Environment and DPE. | Section 5.3 |
| **11.** | **DPE** | Update references to Table 4.<br><br><u>Hairy joint-grass</u><br>In the section titled “Distribution” reference is made to Table 4. Table 4 describes translocation feasibility not records of the threatened species.<br><br><u>Maundia</u><br>Reference to Table 4 in paragraph 3 of the section titled “Habitat and ecology” | Corrected in Appendix 3 |

# Appendix 2 Compliance with translocation guidelines

Checklist for determining whether to translocate (Vallee *et al.* 2014)
A decision regarding whether or not to translocate should not be made until all the following questions have been answered:

| | |
|---|---|
| Have all alternative management options been attempted or considered? | Alternative route options have been investigated and design refinements have minimized impacts on threatened species |
| Is the taxonomic status of the taxon certain? | Green-leaved rose walnut has been mis-determined in the past making assessment of its conservation status and the context of any individual plant or population difficult to assess.<br>Singleton mintbush – the status of the taxon is doubtful (OEH profile) but specimens located during surveys for Roads and Maritime have been assigned to this taxon following herbarium determination.<br>Sandstone rough-barked apple. Specimens have required herbarium determination to separate hybrids and genetically pure individuals.<br>The status of other taxa is considered certain. |
| Is the distribution of the taxon adequately understood? | The study area has been surveyed intensively. Atlas records provide local context and the broader distributions of the species are adequately understood from survey and herbarium records. Green-leaved rose walnut has however been mis-determined – hence its distribution is poorly understood. Genetically pure specimens of Sandstone rough-barked apple have been incompletely separated from hybrids (translocation from hybrid zone is not proposed). |
| Are threatening processes understood and can they be controlled? | Clearing and changes to hydrology are two relevant threatening processes. Management of hydrology in particular will be a focus of management for Hairy joint grass and Tall knotweed. Weed management will be a routine management action. |
| Have potential suitable recipient sites been identified? | Yes |
| If considering population enhancement do you have evidence of population decline and have you considered or attempted alternative means of increasing population size? | Population enhancement is considered here as a component of salvage translocations. Local populations of all taxa proposed for translocation will decline at least temporarily as a result of impacts of the Project. Population enhancement is proposed in conjunction with habitat management hydrological management (where applicable) and other threat mitigation measures to increase population size. |
| Have you considered the success of any previous translocation programs? | Documented in Appendix 3. Long term success of translocation programs has rarely been demonstrated. |
| Have you determined the cost of implementing the translocation program including post translocation monitoring and management and have sufficient funds been secured? | Roads and Maritime will be responsible for funding. |

If the answer to any of the above questions is no then the benefits and risks of proceeding without that information are to be assessed prior to making a decision to translocate.

In the context of a series of salvage translocations the translocation is an alternative to destruction of plant material with conservation value and benefits will accrue even if all translocation objectives cannot be met. For example trialing of methods will provide new information about the species and improve prospects for future translocation success.

# Appendix 3 Background for threatened flora species

Species are listed alphabetically by common name. All species to be directly impacted are included excepting Whalebone tree/Siah's backbone).

## Four-tailed Grevillea

(Section 3)

**Scientific name:** *Grevillea quadricauda*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

*Photo Hugh Nicholson*

### 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 (OEH profile). Flowering is August to September (Commonwealth Conservation Advice). Probably takes about 6 weeks for fruits to ripen so that seed is likely to be available around October-November (G. Errington Australian Botanic Garden Mount Annan pers. comm. July 2015).

### Distribution

In NSW Four-tailed Grevillea 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 (OEH profile).

### Habitat and ecology

Grows in gravely loam in the understorey of dry eucalypt forest usually along or near creeks (OEH profile).

### Results of preconstruction surveys

Section 3
Geolink (2014a) found 18 Four-tailed Grevilleas associated with an area of riparian rainforest on the eastern side of the alignment (outside the clearing limits).

Small numbers of plants are now recognized as subject to direct impact in the Tucabia area. Jacobs (2014a) found Four-tailed Grevillea 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.

### Translocation history

No information specific to the species is available but Grevilleas in general grow readily from seed and cuttings and are commonly grown in horticultural or ecological restoration situations.

### Implications for translocation

It is reasonable to assume that Four-tailed Grevillea can be feasibly translocated from seed and/or cutting propagated plants. The poor condition of the donor plants may limit prospects for success.

## Green-leaved rose walnut

(Section 10)

**Scientific name:** *Endiandra muelleri* subsp*. bracteata*
**Conservation status in NSW:** Endangered
**Commonwealth status:** Not listed

*Photo Hugh Nicholson*

### Taxonomy and identification

As reported in the Recovery Plan (DECC 2004) Green-leaved rose walnut is difficult to distinguish from Rusty Rose Walnut *Endiandra hayesii* and many herbarium determinations prior to 2004 were found to be in error when re-assessed. Accordingly some background information and survey records that are not supported by recently verified herbarium specimens cannot be confidently accepted. All information provided below should be interpreted in this light.

### Description

A tree up to 30 m tall with brown bark often in 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 (OEH profile).
The characteristics of the hairs on the twigs and leaves and the presence or absence of hairs in the floral sheath distinguish Green-leaved rose walnut and Rusty rose walnut (Hyland 1989).

### Distribution

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

### Habitat and ecology

Occurs in subtropical and warm temperate rainforests and Brush box forests including regrowth and highly modified forms of these habitats.
Records are usually from poorer soils derived from sedimentary metamorphic or acid volcanic rocks.
The species is generally recorded at lower altitudes.
Flowering and fruiting has been observed from November to May (OEH profile) though other times of the year are possible (DECC 2004).

### Results of pre-construction surveys

Section 4
A tree was recorded adjacent (western edge) to the Wave 3 soft soil area (Jacobs 2014) at Maclean Interchange. The tree was assessed in the Early Works Soft Soil Treatment Areas Translocation Strategy and is excluded from consideration in the present strategy. A small number of additional plants are known from the vicinity.

Section 10
Australian Museum Consulting (2014) recorded seven individuals of Green-leaved rose walnut within the study area growing in Lowland Rainforest north of the intersection of Coolgardie Road with the Pacific Highway.

### Translocation history

Green-leaved rose walnut was translocated during the Pacific Highway Upgrading Program between Yelgun and Chinderah (DECC 2004).

An augmentation program was planned for Koala Beach in the Tweed Local Government where isolated trees were to be supplemented with plantings of cutting-grown plants from the local area in order to increase the genetic variation of the Koala Beach occurrence (Benwell 2002).

Cutting propagation was likely to be preferred (seed collection unlikely) but a low strike rate in cutting material collected during the Yelgun to Chinderah highway project (Possum Creek Nursery pers. comm. quoted in Benwell 2002).

Cuttings that successfully struck were to be grown-on in pots until at least 30cm high which may take two years in this slow growing species and inoculated with native soil mycorrhizae when potted-on (Benwell 2002). No evaluation of the effects of inoculation with mycorrhizae was conducted during this translocation.

### Implications for translocation

Trees and saplings to be transplanted seedlings potted up for growing on in nursery. If seeds are available seed propagation to be conducted together with cuttings. Plants developing through any of these methods are likely to be slow to establish and develop. The identification of all plant material should be checked given ongoing difficulty in distinguishing from Rusty rose walnut.

## Hairy joint-grass

(Sections 3,10)
**Scientific name:** *Arthraxon hispidus*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

### 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 (OEH profile). This source considers Hairy joint grass to be a perennial which tends to die down in winter. In contrast others believe that Hairy joint grass is predominantly an annual plant species on the North Coast of NSW and completes its life cycle in one year (Benwell 2012, Geolink 2007). Other detail of phenology and development is provided by Geolink (2007). Seed germinates in late winter after a short dormant period. Growth occurs mainly during the summer wet season with flowering in autumn before the whole plant dies.

### Distribution

Occurs over a wide area in south-east Queensland and on the northern tablelands and north coast of NSW. Also found from Japan to central Eurasia (OEH profile). Although the OEH source states that Hairy joint-grass is never common where found in NSW relatively large areas have been recorded within the project area (Table 3) and the grass has been found to be locally common around Lennox Head (e.g. Landmark Ecological Services 2008).

### Habitat and ecology

Moisture and shade-loving grass found in or on the edges of rainforest and in wet eucalypt forest often near creeks or swamps (OEH profile).
Benwell (2012) notes however that Hairy joint-grass now appears to have adapted to agricultural habitat occurring mainly in grazing pasture dominated by exotic grasses. Hairy joint-grass commonly persists under a grazing regime which keeps co-occurring exotic pasture grasses low in height. In forest understorey situations Hairy joint-grass appears to require high light levels and occurs under sparse canopies or forest edges.

**Results of pre-construction surveys**

Section 3
An isolated record by Jacobs in January 2014 recorded as a single plant.

Section 10
Australian Museum Consulting (2014) recorded nine individuals within the study area growing in cleared land often adjacent to Lowland Rainforest and areas prone to flooding. Jacobs (2014) recorded several additional populations within Section 10 and noted that some previously mapped populations were not present potentially due to altered management regimes and below average rainfall.

**Translocation history**
Hairy joint-grass has been the subject of a number of translocations most of which have been from pasture situations with receiving sites also in open grasslands.

Large clumps of Hairy joint-grass and exotic grasses using an excavator were successfully transplanted into a prepared receiving site at Lennox Head (B. Smeuninx pers.comm).

Benwell and Mallee (2014) report successful establishment through direct seeding (limited by the availability of required seed volume) and through transplant of nursery-raised seedlings.

Trials of grazing and or slashing regimes to reduce competitive biomass produced mixed results which were confounded by an overall reduction in abundance during the dry years experienced during the trials. As well as a recognition that biomass must be maintained at a low level the need to generate gaps in dense turf to facilitate recruitment was recognised.

**Implications for translocation**

Translocation and management of Hairy joint-grass remains experimental and approaches will vary depending on the detectability of above-ground plants. Transplant of slabs or clods is the recommended approach when feasible including the transfer of soil-stored seed from locations where plants are known to have died back. Options for seed collection and planting are also available and tested for circumstances in which transplant is not feasible or when results are not optimal.

Any management regimes will need to be site and condition specific and adapt to climatic variables.

## Maundia

(Sections 3, 7)

**Scientific name:** *Maundia triglochinoides*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Not listed

**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 - 10mm wide. Inflorescence to 10cm long and 2.5cm wide. Carpels (female parts of flower) 6 - 8mm long sessile each with a spreading beak. The fruit is 1cm long to 8mm wide (OEH profile).

**Distribution**

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

**Habitat and ecology**

Grows in swamps lagoons dams channels creeks or shallow freshwater 30 - 60 cm deep on heavy clay low nutrients (OEH profile).

- Flowers generally November to January (Benson and McDougall 2002). Northern populations rarely flower and are thought to reproduce largely vegetatively and to have limited dispersal capacity (S. Jacobs Royal Botanic Gardens quoted in Parsons Brinkerhoff 2006).
- Flowering is in November-January and flowers are thought to be wind pollinated (Benson and McDougall 2002).
- Numerous seeds are produced between December and January in a smooth shiny dehiscent capsule (Benson and McDougall 2002).
- Diaspore is the seed and root tubers which are probably dispersed by water (OEH 2014).
- 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 (OEH profile).
- Associated with wetland species e.g. *Triglochin procerum* (OEH profile).

Maundia has been reported to form dense stands rapidly and be invasive under some conditions (Romanowski 1998). The colonization and spread through a constructed drain at Port Stephens has been documented (Section 91 license application TSC Act NEHUO46) and rapid change in the distribution of Maundia has been reported in staged surveys conducted for the present highway upgrade project.

Benwell (2013) notes that recent surveys in the mid north coast have found Maundia to be more common than previously thought. The surveys investigated changes to the Maundia populations since surveys conducted by Pressey (1989) in the Lower Macleay and found local gains and losses relating largely to changes in hydrology. Craig Harré (OEH pers. comm. 8 Aug 14) advised that the sites surveyed included 30 wetlands where Maundia had been present.The surveys indicated that Maundia is apparently quite secure on the NSW Mid North Coast albeit a little south of the current project. Similar intensive targeted surveys have not been conducted in the same way in the vicinity of the current Project Area but numerous records are included in Table 3 and a large occurrence is known from adjacent land at Tabbimobile (Jacobs 2014). An additional large occurrence is adjacent to the project at Halfway Creek In Section 1.

**Implications for translocation**

The biological and ecological characteristics of Maundia would appear to facilitate translocation from seed collection and nursery propagation or transplant of clumps. However sources quoted in Benwell (2013) describe difficulties in germinating seeds and there are practical difficulties in transplanting into a swamp environment.

**Results of pre-construction surveys**

Section 3

Jacobs (2014b) 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.

Section 7

Biosis (2014) recorded two populations although additional populations had been previously documented. Differences in distribution and abundance were attributed to changes in the wet/dry cycle of suitable habitat (i.e. drainage lines) as well as dispersal of individuals throughout the area.

Jacobs (2014a) recorded Maundia in low to moderate abundance at several locations, though less than previously observed. Changes were attributed to the below average rainfall received in the study area.

### Translocation history

There is limited previous translocation experience to draw from. Practical difficulties of transplanting into aquatic environments have been used as a basis for not attempting translocation in a location where Maundia was found to be relatively abundant locally (Warrell Creek to Urunga)

Parsons Brinkerhoff (2006) prepared a translocation assessment for Maundia as part of the Pacific Highway upgrade Kempsey to Eungai. By way of background they noted that

- no translocations of this species have been successful in the past (S. Jacobs Royal Botanic Gardens personal communication 4/4/07)
- previous attempts at cultivation of *Maundia triglochinoides* have failed (Sainty and Jacobs 2003).
- previous attempts have included collection and germination of seed with subsequent death of seedlings when transplanted.
- mature plants that have been translocated have also failed to survive. germination of seed has proved difficult (S. Jacobs Royal Botanic Gardens personal communication 4/4/07).

While there have been trials including digging of rhizomes a focus on seed in soil and water dispersal has appeared more fruitful. The extent of shading has also proved to influence the distribution of Maundia. The conclusion from ongoing observations of contraction in dry periods and later expansion is that the best approach may be to design hydrology carefully rather than translocating. Local surveys may also be advisable – many of the large populations documented lie to the south of the current Project Area.

## Red lilly pilly

(Section 10)

**Scientific name:** *Syzygium hodgkinsoniae*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

*Photo Hugh Nicholson*

### 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 (OEH profile). Fruit ripe August to November (Floyd 2008).

**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 (OEH profile). Plants recorded in the vicinity of the route are a little south of the Richmond River.

**Habitat and ecology**

Usually found in riverine and subtropical rainforest on rich alluvial or basaltic soils (OEH profile).

**Pre-construction surveys**

Section 10
Australian Museum Consulting (2014) recorded five individuals within the study area growing in Lowland Rainforest north of the intersection of Coolgardie Road with the Pacific Highway and further south.

**Translocation history**

No information is available for transplant or cutting propagation. The plants is commonly and successfully grown from seed and included in rainforest plantings however. Nicholson and Nicholson (1985) note that seed germinates easily and often as multiple shoots. When very young plants go through a stage of almost zero growth coupled with bunching of the new shoots. It is worth maintaining plants in a tub for two years until the stage is passed. Syzygium species can be successfully grown from cuttings and it will be worth trialling cutting propagation of Red lilly pilly.

**Implications for translocation**

Seed propagation is expected to be reliable and transplanting existing standing plants will be appropriate for salvage and to trial techniques.

A combination of planting of seed-propagated plants together with transplanted seedlings (pot up and grow on before planting out) and direct transplant of larger stems is proposed. If seeds cannot be collected in the required timeframe cuttings should be trialled also in order to secure the genetic material, and to make best use of material trimmed from plants identified for direct transplant.

## Rough-shelled bush nut

(Section 10)

**Scientific name:** *Macadamia tetraphylla*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

*Photo Hugh Nicholson*

### 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 (OEH profile). Seeds are ripe January to April (Floyd 2008). Moderate to high genetic diversity has been recorded within the species and its populations however very low genetic differentiation between populations has been recorded at a regional scale (references cited in Southern Macadamia Species Recovery Plan, Costello *et al.* 2009).

### 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 (OEH profile). The plants reported in the Coolgardie area are a little south of the Richmond River and appear to be naturally occurring.

### Habitat and ecology

Found in subtropical rainforest usually near the coast (OEH profile).

### Pre-construction surveys

Section 10
Australian Museum Consulting (2014) recorded 10 individuals within the study area growing in Lowland Rainforest west of the intersection of Coolgardie Road with the Pacific Highway.

### Translocation history

Regularly grown from seed and used successfully in rainforest restoration for bush food and as a root stock for grafted horticultural hybrids.
Seeds germinate in two weeks and grow rapidly. Deep mulching is most beneficial. Grows moderately fast into a bushy ornamental tree to 10 m in height preferring deep rich soils with plenty of summer moisture but will tolerate slightly less favourable conditions (Nicholson and Nicholson 1985).

### Implications for translocation

Seedlings are likely to be produced and establish readily. Transplants of mature plants will be experimental.

## Sandstone rough-barked apple

(Sections 3, 4)

**Scientific name:** *Angophora robur*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

### Description

This tree is one of the 'apples' 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 (OEH profile). This species forms a lignotuber (woody swelling below or just above the ground containing adventitious buds from which new shoots develop if the top of the plant is cut or burnt) (CPBR 2006). 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 (OEH profile).

Generally *Angophora* spp. flower in late summer-early autumn but this can be variable according to the season. Seed set follows but timing can vary from season to season (G. Errington Royal Botanic Gardens Mount Annan pers. comm. July 2015).

Sandstone rough-barked apple is known to hybridise with *A. subvelutina* and *A. woodsiana.*

**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 (OEH profile).

**Habitat and ecology**

Dry open forest in sandy or skeletal soils on sandstone or occasionally granite with frequent outcrops of rock (OEH profile). During surveys for Roads and Maritime Jacobs (2014c) noted that *A. robur* was recorded on sandy slopes and ridges and to a lesser degree in some areas where sandy soils adjoined the edges of swamps drainage lines and floodplains in the localities of Pillar Valley Tucabia and Tyndale. *Angophora robur* was most abundant in elevated areas usually with deeper sandy soils and some rocky outcrops often replaced by *A. woodsiana* in higher elevated areas with skeletal soils..

**Pre-construction surveys**

Section 3

Geolink (2014a) identified an estimated 500+ individuals within an area to the north of Section 3 associated with areas of Dry Sclerophyll forest. Broad-leaved Apple *A. subvelutina* was also present and clear identification of species and hybrids was not possible.

Jacobs (2014c) undertook surveys in combination with herbarium determinations. A large proportion of hybrids were indicated.

Section 4

Geolink (2014b) recorded approximately 245 individuals within an area to the south of Section 4. associated with an area of Angophora Dry Sclerophyll forest.

Jacobs (2014) undertook surveys including herbarium determinations which indicated a large proportion of hybrids.

**Translocation history**

Angophoras are generally and reliably propagated from seed and establish easily. While rooted shoot cuttings can be used to propagate many eucalypts provided that cutting material is taken from young wood i.e. from seedlings or from young shoots from lignotubers (Ahuja 1993) information is not available for angophoras. Any attempts to propagate and angophoras from cuttings would be experimental. As for eucalypts successful cutting propagation is likely to require a dry atmosphere propagation facility in order to avoid fungal disease.

**Implications for translocation**

Transplant of seedlings saplings or conceivably lignotubers of larger trees after felling of the trunk could be trialed but vegetative propagation from individuals confirmed as pure *A. robur* will be the only way to ensure that hybrids are not included in translocated plants.

Plant conservationists working in the field suspect that hybridization is threatening a large number of rare plants with extinction (Van Dyke 2008).

It appears that the project corridor passes through a hybrid zone between *A. robur A. subvelutina* and to a more limited extent *A. woodsiana.* The presence of hybrids poses difficulties for the design of a translocation that aims to improve the status of *A. robur.* Propagation from seed of an identified pure *A. robur* will not guarantee purity in the progeny as pollination from neighbouring trees of other species is likely. Planting of further hybrids is likely to exacerbate the threats to *A. robur*.

Other propagation methods may prove impractical as suitable wood from confirmed *A. robur* may not be available for cuttings. Transplant trials will be similarly difficult in terms of locating sufficient material that can be identified with confidence.

A better alternative to attempting to collect translocation material from the clearing corridor would be to augment an existing population with greater genetic purity. Such a population is present on the BOS site 25 at Mahogany Drive Pillar Valley. *Angophora robur* is extensive across this property. *Angophora subvelutina* is not recorded and *A. woodsiana* is present in apparently low abundance and fairly localized within the property. Jacobs (2014c) provides details of habitat preferences of the three species which would help to guide selection of habitats likely to support genetically pure *A. robur*. It is proposed that population augmentation at this site using seeds collected from the same property would produced a better outcome then translocation from and within a hybrid zone.

The Mahogany Drive property would benefit from assisted natural regeneration as much of the property has a history of logging. Gaps and disturbed areas are present and management would hasten recovery to the benefit of Sandstone rough-barked apple.

## Singleton mint bush

(Section 6)

**Scientific name:** *Prostanthera cineolifera*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

### 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 (OEH profile).

### Distribution

Until recently regarded as restricted to only a few localities near Walcha Scone Cessnock and St Albans (OEH profile) but plants documented in the current project area have been confirmed as belonging to this taxon.

### Habitat and ecology

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 (OEH profile).

Probably flowers in spring with a period of six weeks for likely to be required for fruits to ripen (G. Errington Royal Botanic Gardens Mount Annan pers. comm. July 2015).

### Pre-construction surveys

Section 6
Aecom (2014) found that Singleton Mintbush was 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.
Jacobs (2014a) confirmed the location with no major changes.

### Translocation history

Specific information is not available for Singleton mintbush but generalisations from closely related taxa are informative. Most Lamiaceae are notorious for producing mostly empty seeds. Cutting propagation should be relatively easy (G. Errington Royal Botanic Gardens Mount Annan pers. comm. July 2015).

### Implications for translocation

Planting out of cutting propagated plants is predicted to be the most likely method for successful translocation. Seed collection should be undertaken if possible.

## Slender Screw Fern

(Sections 6)

**Scientific name:** *Lindsaea incisa*
**Conservation status in NSW:** Endangered
**Commonwealth status:** Not listed

*Photo by Hugh Nicholson*

### 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 (OEH profile).

Translocation could involve transplants from the field and/or propagation from spores. To collect spores for propagation place a mature frond in a folded sheet of paper and keep in a warm dry position for a few days (Jones and Clemesha 1989). The same reference provides details for germination and growing on (there are many other references and specialist nurseries or research institutions with necessary facilities must be engaged). These are general methods. No specific information for *Lindsaea* species is available.

**Distribution**

In NSW Slender screw fern is known only from a few locations between Woombah and just south of Coffs Harbour. Also occurs in north and south-east Queensland (OEH profile). The fern is fairly widely distributed though in restricted habitat being quite abundant around Glenreagh the south end of Yuraygir National Park and at Tucabia. There are scattered occurrences further north.

**Habitat and ecology**

Dry eucalypt forest on sandstone and moist shrubby eucalypt forest on metasediments. It is usually found in waterlogged or poorly drained sites along creeks where ferns sedges and shrubs grow thickly (OEH profile).

Although endangered individual populations can be very large with thousands of individuals growing amongst sedge- and grass-dominated communities close to creeks and gullies. As the species is small and grows amongst dense and taller rush and sedge communities it can be difficult to detect (Ecosure 2014). Roads and Maritime's EIS found that the species was readily detectable irrespective of season and reproductive status. Slender Screw Fern dies off during times of drought and re-grows following rain events.

**Results of pre-construction surveys**

Section 6
Aecom (2014) recorded twelve discrete sub-populations with an estimated population area of 0.37ha to be disturbed. The distribution of Slender Screw Fern was consistent with the results of previous assessments throughout the study area.

Jacobs (2014a) also recorded Slender screw fern 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.

**Translocation history**

Background references suggest that members of the genus generally do not tolerate disturbance and are difficult to cultivate (Jones and Clemesha 1989). For the Tugun bypass (SMEC 2011) translocation was attempted for *Lindsea ensifolia* – 18 plants were salvaged and grown in nursery pots for an unspecified time. Of 15 plants planted out in 2005 none were surviving in 2011.

Ecos Environmental has however recently successfully translocated Slender Screw Fern. The translocation was conducted in a very wet period and it is too early to evaluate (Craig Harré OEH pers. comm. 8 August 2014). The methods are set out in Ecos Environmental (2010) with evidence of early expansion of some transplanted clumps provided in Benchmark (2013).

### Implications for translocation

Clump/slab transplant in wet conditions is likely to produce good results on the basis of early results from recent trials.

## Stinking Cryptocarya

(Section 10)

**Scientific name:** *Cryptocarya foetida*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

*Photo Hugh Nicholson*

### 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 (OEH profile) Fruit ripe June to September or sometimes as late as November (Floyd 2008).

### Distribution

Coastal south-east Queensland and north-east NSW south to Iluka (OEH profile).

### Habitat and ecology

Found in littoral warm temperate and subtropical rainforest wet sclerophyll forest and Camphor laurel 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 (OEH profile).

**Pre-construction surveys**

Section 10
Australian Museum Consulting (2014) found 47 individuals 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.

**Translocation history**

No information is available for transplant or cutting propagation. The plants are commonly and successfully grown from seed and included in rainforest plantings, however. As Cryptocarya species have been successfully grown from cuttings, trials are recommended using standard nursery procedures.

**Implications for translocation**

Seed propagation can expected to be reliable and transplanting existing standing plants will be appropriate for salvage and to trial techniques.

A combination of planting of seed-propagated plants together with transplanted seedlings (pot up and grow on before planting out) and direct transplant of larger stems is proposed. If seeds cannot be collected in the required timeframe, cuttings should be trialled also in order to secure the genetic material and make best use of material trimmed from plants identified for direct transplant.

## Tall knotweed

(Section 4)

**Scientific name:** *Persicaria elatior*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Vulnerable

*Photo by Glenn Leiper*

**Description**

Tall knotweed is an erect herb to 90 cm tall with stalked glandular hairs (i.e. they are knobbed when seen under a lens) on most plant parts. Its leaves are up to 11 cm long and 30 mm wide. A sheath encircles the stem at the base of each leaf which is characteristic of its plant family. Its tiny flowers are in long narrow spikes to 5 cm long. The pink flower-segments are less than 4 mm long (OEH profile). Fruits are lenticular nuts 2-2.5 mm long (Wilson 1990).

### Distribution

Tall knotweed has been recorded in south-eastern NSW - Mt Dromedary (an old record) Moruya State Forest near Turlinjah the Upper Avon River catchment north of Robertson Bermagui and Picton Lakes. In northern NSW it is known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests) (OEH profile). The NSW Wildlife Atlas shows additional locations at Maclean near Wardell and in the Richmond Range. In Queensland Tall knotweed occurs in the Brisbane area and on South Stradbroke Island (SPRAT profile).

### Habitat and ecology

This species normally grows in damp places especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance (OEH profile). At a southeastern Queensland wetland Tall knotweed grows around the edge of *Melaleuca quinquenervia* communities but rarely inside these. It grows in association with dense communities of *Eleocharis equisetina Leersia hexandra Hermarthria uncinata Blechnum indicum Cyclosorus interruptus Cyperus exaltatus Juncus usitatus Echinochloa telmatophila Persicaria strigosa Persicaria orientalis and Persicaria attenuata* (Barry Fitzpatrick pers. comm. 13 Feb 2015).

Tall knotweed appears to be a short-lived herbaceous species surviving for up to two years. It germinates readily from seed on bare ground that has been wetted by rain and will grow rapidly flower and set seed within six months of germinating. The plants have been observed to succumb quickly when dry conditions follow regular rain (Leiper 2008).

At an 8 ha wetland site in southeast Queensland Tall knotweed population numbers have been observed to fluctuate annually with annual counts of mature flowering plants ranging from single digit numbers to more than 100 (Barry Fitzpatrick pers. comm. 13 Feb 2015).

Tall knotweed is relatively easy to grow from seed. It will also grow readily from cuttings. It will grow partially submerged in water (often poorly) but will not tolerate total inundation even for a short while. It appears to be highly intolerant of any hint of salinity (Barry Fitzpatrick pers. comm. 13 Feb 2015).

Swamp Wallabies will eat new shoots of some plants (Barry Fitzpatrick pers. comm. 13 Feb 2015).

### Implications for translocation

The biological and ecological characteristics of Tall knotweed would appear to facilitate translocation from seed collection and/or cuttings and nursery propagation or transplant of clumps or slabs.

A range of observations (above and within RMS survey reports) indicate fluctuating populations of the plants consistent with soil storage of seed. It seems safe to assume that seed persists in and on the soil from one growing season to the next and it is possible that soil-stored seed retains viability for longer periods (cannot rely on this without further investigation).

Selection of a suitable receiving site in terms of hydrological regime will be critical and any doubt accommodated by spreading translocated plants across moisture gradients so that at least a proportion of the plants will be placed in optimal conditions.

An advantage of clump/slab transplant will be the transfer of soil-stored seed of Tall knotweed along with above-ground plant material. In addition plants and seeds of habitat species will be carried within the clumps though weeds will inevitably accompany.

**Results of pre-construction surveys**

Section 4
Geolink (2014b) recorded approximately 157 individuals within a number of areas of Paperbark swamp (dominated by *Melaleuca quinquenervia*) along the floodplain in proximity to Maclean.

During pre-construction surveys (Jacobs 2014a) small populations of this species were recorded both within and adjacent to the construction footprint at Yaegl NR and vicinity and South Arm.

Part of the occurrences were considered as part of the translocation strategy for Stage 1 Early Works Soft Soil Treatment Areas but some of the plants lie outside the Soft Soil impact zone and require consideration in the current strategy.

**Translocation history**

Leiper (2008) recounts personal experience of finding and then growing the plant from South Stradbroke Island in 1997 and then seeing it cultivated and used in revegetation projects on the island by Couran Cove Resort staff.

**Implications for translocation**

Translocation options are to propagate from seed or cuttings and/or to clump/slab transplant to include the transplant of soil likely to contain soil-stored seed. The season of works and seasonal conditions should guide the choice of methods all of which can be predicted to be successful assuming appropriate management.

## Water nutgrass

(Section 6, 7)

**Scientific name:** *Cyperus aquatilis*
**Conservation status in NSW:** Endangered
**Commonwealth status:** Not listed

*Photo by Hugh Nicholson*

**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 (OEH profile).

**Distribution**
In NSW known only from a few sites north from Grafton. Also occurs in Queensland Northern Territory Western Australia and New Guinea (OEH profile).

**Habitat and ecology**
Grows in ephemerally wet sites such as roadside ditches and seepage areas from small cliffs in sandstone areas (OEH profile).

**Results of pre-construction surveys**
The results of surveys illustrate the variable occurrence of Water nutgrass in space and time.

Section 6
Aecom (2014) recorded 8 sub-populations with a total population size of approximately 100 individuals noting differences in numbers and distribution from previous surveys.

Jacobs (2014a) did not record Water nutgrass despite targeted surveys in areas of suitable habitat in a range of climatic conditions over the survey period.

Section 7
Biosis (2014) recorded a number of individuals and small populations in drainage lines and periodically inundated areas encompassed by the study area.

Jacobs (2014a) did not record any previously known occurrences despite targeted surveys in areas of suitable habitat in a range of climatic conditions over the survey period.

**Translocation history**

Water nutgrass was translocated during the Tugun Bypass using soil seedbank translocation techniques incorporating smoke water and/or fertiliser treatments as well as untreated controls. The translocation was unsuccessful partly attributed to run-off impacts during construction as well as weed competition (SMEC 2011).

**Implications for translocation**

The transient nature of occurrences and difficulty of translocating into aquatic habitat indicate that alternative measures such as hydrological management will be preferred to translocation.

# Weeping paperbark

**Scientific name:** *Melaleuca irbyana*
**Conservation status in NSW:** Endangered
**Commonwealth status:** Not listed


*Photos Hugh Nicholson*

### 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 (OEH profile). Seeds are retained in capsules.

### 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. Only two populations are recorded in conservation reserves in NSW these are Warragai Creek Nature Reserve and Bungawalbin National Park (OEH profile).

### Habitat and ecology

Open eucalypt forest in poorly drained usually clay sandstone or alluvial soils (OEH profile).

### Pre-construction surveys

Section 7
Biosis (2014) recorded one relatively large population within the study area just south of the New Italy Rest Area.
Jacobs (2014a) confirmed the record.

### Translocation history

A planting project for Weeping paperbark has been in progress at Tucabia. Plants propagated from seed have established and developed successfully.

### Implications for translocation

As the species can be grown easily from seed and reaches maturity relatively quickly seed propagation and planting out of nursery-grown stock is preferred to transplant of trees and saplings.

## White laceflower

(Section 10)

**Scientific name:** *Archidendron hendersonii*
**Conservation status in NSW:** Vulnerable
**Commonwealth status:** Not listed

*Photo by Hugh Nicholson*

### Description

White laceflower 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 (OEH profile). Fruit ripe June to January (Floyd 2008).

### Distribution

From north Queensland south to the Richmond River in north-east NSW (OEH profile).

### Habitat and ecology

White laceflower occurs in 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 (OEH profile).

Although White laceflower flowers and fruits well it is often represented by only single trees per stand and seedlings are rare (Scientific Committee's determination).

### Pre-construction surveys

Section 10
Australian Museum Consulting (2014) found 15 individuals of White laceflower growing in Lowland Rainforest north of the intersection of Coolgardie Road with the Pacific Highway and further south.

### Translocation history

White laceflower is grown in nurseries and regularly included in rainforest restoration plantings.
Seed germinates rapidly but seedlings in pots grow poorly. (Nicholson and Nicholson 2000).

### Implications for translocation

If seed can be collected nursery grown seedlings should be planted into suitable rainforest regrowth habitat. Cuttings and transplant of saplings and trees should be trialled.

## Yellow-flowered king of the fairies

(Section 8)

**Scientific name:** *Oberonia complanata*
**Conservation status in NSW:** Endangered
**Commonwealth status:** Not listed

### 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 (OEH profile).

### 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 (OEH profile).

### Habitat and ecology

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 (OEH profile). Jones (1993) notes its tolerance of a wide range of exposure from almost complete shade to very exposed sunny positions on trees and rocks. Melaleuca Group (2014b) provide detail of the habitat at the current donor site described as degraded Swamp oak forest.

**Preconstruction surveys**

Section 8

Melaleuca Group (2014b) identified in clumps of orchids on the southern side of three senescent swamp oak trees a total 26 individuals.

Jacobs (2014a) described the occurrence as a total of 22 individuals observed in a range of age classes.

**Translocation history**

Jones (1993) notes that Oberonias are generally easy to grow and can be long living in cultivation. Roots are very fine and rot easily if overwatered or smothered by a potting mix that is not sufficiently coarse. Plants can be grown in pots but better growth is achieved on treefern etc. hung in cool humid conditions where there is free air movement.

**Implications for translocation**

The relative ease of growing Oberonias in cultivation suggests that relocation of plants to new host trees is likely to be successful.

In view of the very small numbers of plants known to exist in NSW, additional tasks to enable seed banking propagation and further development of a translocation plan are set out by Melaleuca Group (2014b). The additional tasks include:

- investigations of the lifecycle of this species
- Liaison with OEH in regard to the Save Our Species (SOS) program for this species.

# Appendix 4 Site summary

| Section | Northing | Site/species | Clearing area | | Project area (outside clearing) | | Receiving site |
|---|---|---|---|---|---|---|---|
| | | | No individuals | Area (ha) | No individuals | Area (ha) | |
| 3 | 6708552 | **Coldstream River crossing** | | | | | |
| | | Maundia | | | | 0.07 | |
| 3 | 6709031 | **8 Mile Lane, west of Wooli** | | | | | |
| | | Sandstone rough-barked apple | 301 | 4.051523 | 96 | 1.589077 | |
| 3 | 6711960 | **Mitchell Rd intersection** | | | | | |
| | | Hairy-joint grass | 1 | | | | |
| | | Sandstone rough-barked apple | 1591 | 1.2412 | 362 | 22.367 | |
| 3 | 6715223 | **Chaffin, south side** | | | | | |
| | | Sandstone rough-barked apple | 495 | 4.5446 | 445 | 2.5267 | |
| 3 | 6717623 | **Tucabia-south of Bostock** | | | | | |
| | | Sandstone rough-barked apple | 369 | 5.7881 | 281 | 3.6961 | |
| 3 | 6718866 | **Tucabia-north of Bostock** | | | | | |
| | | Sandstone rough-barked apple | 244 | 3.0427 | 41 | 1.3365 | |
| | | Slender screw fern | | | 1 | 0.007 | |
| 3 | 6721564 | **Tucabia-north of Tallowwood** | | | | | |
| | | Four-tailed Grevillea | 1 | 0.0078 | 53 | 0.0555 | |
| | | Maundia | 3 | 0.0266 | | 0.0855 | |
| | | Sandstone rough-barked apple | 982 | 0.0266 | 264 | 19.3086 | |
| 3 | 6723624 | **Pine Brush SF** | | | | | |
| | | Four-tailed Grevillea | 2 | 0.0126 | 2 | 0.0011 | |
| | | Sandstone rough-barked apple | 124 | 1.9597 | 48 | 1.5497 | |
| | | Slender screw fern | | | 1 | | |
| 3 | 6727462 | **Tucabia Rd, north Pine Brush** | | | | | |
| | | Sandstone rough-barked apple | | 1.5966 | | 20.5222 | |
| 3 | 6727023 | **Tyndale, south Bensons Lane** | | | | | |
| | | Sandstone rough-barked apple | 1533 | 1.8518 | 926 | 20.1941 | |
| 4 | 6730163 | **West Wooli Rd** | | | | | |
| | | Sandstone rough-barked apple | 775 | 11.2665 | 68 | 1.7306 | |

| Section | Northing | Site/species | Clearing area | | Project area (outside clearing) | | Receiving site |
|---|---|---|---|---|---|---|---|
| | | | No individuals | Area (ha) | No individuals | Area (ha) | |
| 4 | 6738700 | **South Arm south** | | | | | |
| | | Tall knotweed | | | 157 | 0.4712 | |
| 4 | 6739200 | **South Arm north** | | | | | |
| | | Tall knotweed | 31 | 0.0874 | 37 | 0.0418 | |
| 4 | 6739996 | **Maclean interchange** | | | | | |
| | | Green-leaved rose walnut | | | 1 | | |
| | | Tall knotweed | 8 | 0.047 | 9 | 0.0063 | |
| 4 | 6742120 | **Yaegl south** | | | | | |
| | | Tall knotweed | 1 | 0.00049 | 11 | 0.02051 | |
| 4 | 6742600 | **Yaegl central** | | | | | |
| | | Tall knotweed | 2 | 0.013 | 2 | 0.127 | |
| 4 | 6743300 | **Yaegl north** | | | | | |
| | | Tall knotweed | 9 | 0.02 | 137 | 0.026 | |
| 6 | 6754230 | **Mororo south** | | | | | |
| | | Water nutgrass | 10 | | | | |
| 6 | 6755866 | **Mororo SF** | | | | | |
| | | Slender screw fern | 6295 | 0.3701 | 213 | 0.0176 | |
| | | Water nutgrass | 55 | | | | |
| 6 | 6757130 | **Mororo north** | | | | | |
| | | Water nutgrass | 20 | | | | |
| 6 | 6758083 | **Tabbimoble Ck** | | | | | |
| | | Singleton mint bush | 609 | 0.4238 | 62 | 0.4387 | |
| | | Water nutgrass | 11 | | | | |
| 6 | 6759117 | **Tullymorgan Jackybulbin Rd** | | | | | |
| | | Rotala | | | 2 | | |
| | | Water nutgrass | 17 | | | | |
| 7 | 6766115 | **Tabbimoble Overflow 2** | | | | | |
| | | Maundia | 4 | 0.0139 | 6 | 0.0386 | |
| 7 | 6768274 | **Tabbimoble Overflow McFaydon Rd** | | | | | |
| | | Water nutgrass | 5 | | | | |

| Section | Northing | Site/species | Clearing area | | Project area (outside clearing) | | Receiving site |
|---|---|---|---|---|---|---|---|
| | | | No individuals | Area (ha) | No individuals | Area (ha) | |
| 7 | 6769590 | **Tabbimoble Overflow south** | | | | | |
| | | Water nutgrass | 2 | | | | |
| 7 | 6769996 | **Tabbimoble Overflow north** | | | | | |
| | | Maundia | 5 | 0.0154 | | 0 | |
| 7 | 6773010 | **Doubleduke** | | | | | |
| | | Water nutgrass | 1 | | | | |
| 7 | 6774778 | **New Italy south** | | | | | |
| | | Weeping paperbark | 1721 | 2.7611 | | 0.0019 | |
| 7 | 6775379 | **New Italy central** | | | | | |
| | | Maundia | 6 | 0.0028 | 2 | 0 | |
| 7 | 6775743 | **New Italy north** | | | | | |
| | | Maundia | 2 | 0.0049 | | 0 | |
| 8 | 6781563 | **Trustums Hill** | | | | | |
| | | Hairy-joint grass | | | 2 | 0.2726 | |
| 8 | 6783155 | **Woodburn, north Evans Hd Rd** | | | | | |
| | | Yellow-flowered king of the fairies | 18 | 0.0326 | | 0 | |
| 8 | 6785073 | **Woodburn, Lang Hill** | | | | | |
| | | Rough-shelled bush nut | | | 1 | | |
| | | Whalebone tree | | | 3 | | |
| 10 | 6798430 | **Wardell Rd** | | | | | |
| | | Whalebone tree | 1 | | | | |
| 10 | 6799844 | **Lumleys Lane, Coolgardie** | | | | | |
| | | Hairy-joint grass | 20 | 0.32 | | 0 | |
| 10 | 6799694 | **east of Lumleys Lane** | | | | | |
| | | White laceflower | 1 | | 2 | | |
| | | Stinking Cryptocarya | 1 | | | | |
| | | Green-leaved rose walnut | 1 | | 1 | | |
| | | Whalebone tree | 3 | | 1 | | |
| | | Red lilly pilly | 2 | | | | |
| 10 | 6799766 | **Coolgardie, west of Kays Rd** | | | | | |

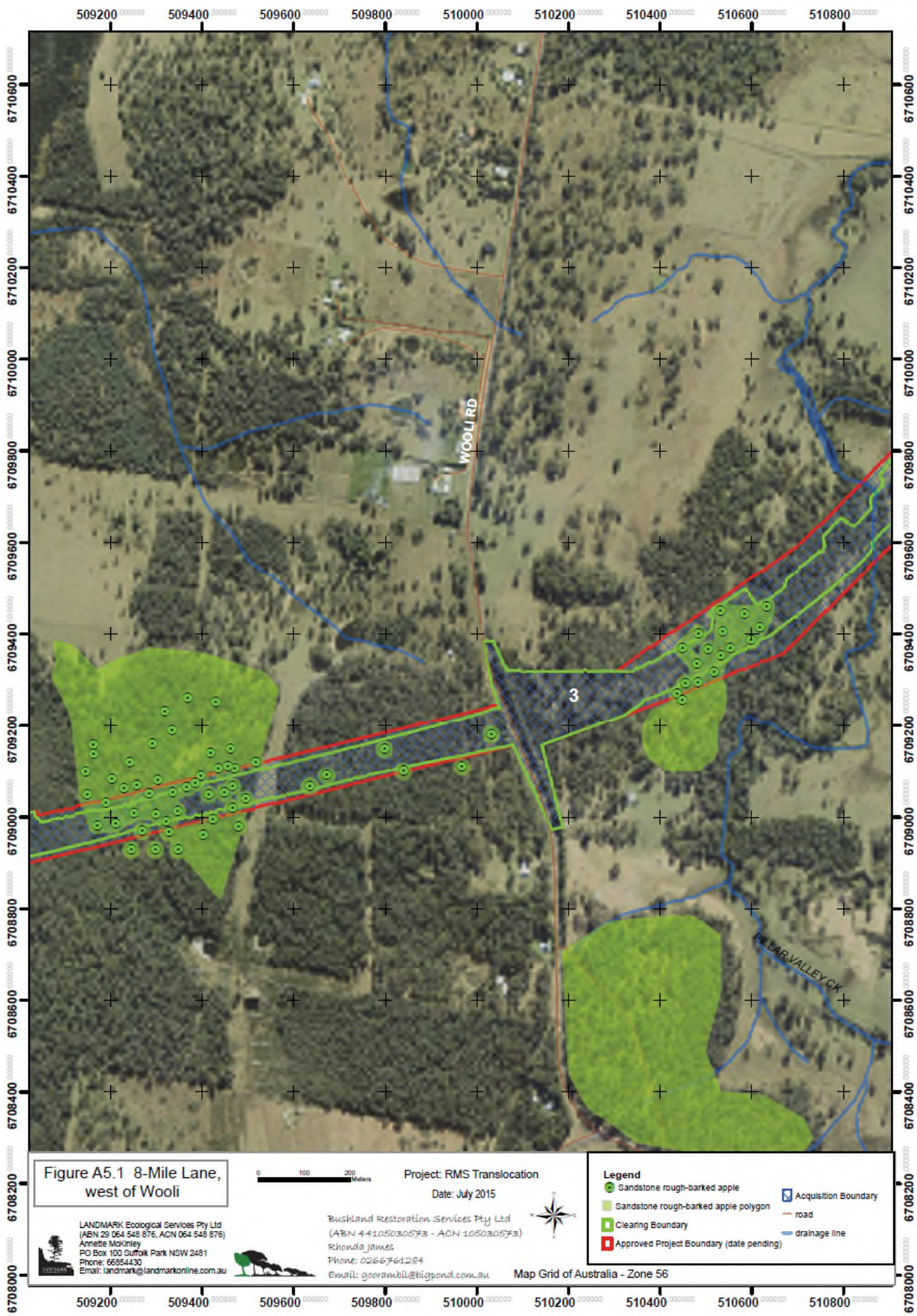
| Section | Northing | Site/species | Clearing area | | Project area (outside clearing) | | Receiving site |
|---|---|---|---|---|---|---|---|
| | | | No individuals | Area (ha) | No individuals | Area (ha) | |
| | | Hairy-joint grass | | | | | |
| 10 | 6800011 | **Garden Place** | | | | | |
| | | Hairy-joint grass | 8 | 0.1685 | 12 | 0.3515 | |
| 10 | 6800421 | south Coolgardie Rd | | | | | |
| | | Hairy-joint grass | 313 | 0.7126 | 23 | 0.1874 | |
| | | Davidsons Plum | | | 1 | | |
| 10 | 6801032 | **Coolgardie, north of Coolgardie Rd** | | | | | |
| | | Hairy-joint grass | 1 | 0.04 | 5 | 0 | |
| | | Rough-shelled bush nut | 10 | | 3 | | |
| | | Whalebone tree | | | 1 | | |
| 10 | 6800954 | **west of Pimlico Rd** | | | | | |
| | | White laceflower | | | 8 | | |
| | | Hairy-joint grass | 5 | 0.03 | 16 | 0.1768 | |
| | | Stinking Cryptocarya | 40 | | 2 | | |
| | | Green-leaved rose walnut | 2 | | 15 | | |
| | | Red lilly pilly | 4 | | 4 | | |
| 11 | 6801662 | **south of Laws Rd** | | | | | |
| | | Whalebone tree | | | 1 | | |

# Appendix 5 Maps of donor and receiving sites

Maps illustrate the occurrence of specimens (represented by points or polygons) to be directly impacted by the project i.e. within the clearing boundary. Whalebone tree/Siah's backbone and additional specimens located within the project boundary but outside the clearing boundary are shown only when they are included in the map view. Receiving sites located in the vicinity of the route are also shown (receiving sites beyond map view of the route are indicated by map or description in Appendix 6).

Maps are arranged south to north. * = some plants included in Early Works Soft Soils Treatment Areas Strategy

| Map no and site name | | Donor site | Donor species | Receiving site | Candidate species for receiving site | Other species (not to be translocated or outside clearing boundary) |
|---|---|---|---|---|---|---|
| A5.1 | 8-Mile Lane, west of Wooli | | | | | Sandstone rough-barked apple |
| A5.2 | Mitchell Rd intersection | yes | Hairy joint-grass | | | Sandstone rough-barked apple |
| A5.3 | Chaffin south side | | | | | Sandstone rough-barked apple |
| A5.4 | Tucabia north & south Bostock | | | | | Sandstone rough-barked apple |
| A5.5 | Tucabia north of Tallowwood | yes | Four-tailed Grevillea | yes | Four-tailed Grevillea | Sandstone rough-barked apple, Maundia |
| A5.6 | Pine Brush SF | yes | Four-tailed Grevillea | yes | Four-tailed Grevillea | Sandstone rough-barked apple |
| A5.7 | Tyndale, sth Bensons | | | | | Sandstone rough-barked apple |
| A5.8 | West Wooli Rd | | | | | Sandstone rough-barked apple |
| A5.9 | South Arm north* | yes | Tall knotweed | | | |
| A5.10 | Maclean Interchange* | yes | Tall knotweed | | | |
| A5.11 | Yaegl central and south* | yes | Tall knotweed | yes | Tall knotweed | |
| A5.12 | Yaegl north* | yes | Tall knotweed | | | |
| A5.13 | Mororo south | | | | | Water nutgrass |
| A5.14 | Mororo SF | yes | Slender screw fern | yes | Slender screw fern | Water nutgrass |
| A5.15 | Tabbimoble Ck & Mororo north | yes | Singleton mintbush | yes | Singleton mintbush, Weeping paperbark | Water nutgrass |
| A5.16 | Tullymorgan-Jackybulbin | | | | | Water nutgrass, Rotala |
| A5.17 | Tabbimoble overflow 2 | | | | | Maundia |
| A5.18 | Tabbimoble overflow McFaydon Rd | | | | | Water nutgrass |
| A5.19 | Tabbimoble overflow north and south | | | | | Water nutgrass, Maundia |
| A5.20 | Doubleduke | | | | | Water nutgrass |
| A5.21 | New Italy, north & south | yes | Weeping paperbark | | | Maundia |
| A5.22 | Woodburn, north Evans Head Rd | yes | Yellow-flowered king of the fairies | | | |
| A5.23 | Lumleys Rd, Coolgardie | yes | Hairy joint-grass | yes | Hairy joint-grass | |
| A5.24 | east of Lumleys Lane | yes | Green-leaved rose walnut, Red lilly pilly, White laceflower, Stinking Cryptocarya | | | |
| A5.25 | Garden Place | yes | Hairy joint-grass | | | Davidsons plum |
| A5.26 | North and South Coolgardie Rd | yes | Hairy joint-grass, Rough-shelled bushnut | yes | Hairy joint-grass | |
| A5.27 | west of Pimlico Rd | yes | Hairy joint-grass, Stinking Cryptocarya, Green-leaved rose walnut | | | Red lilly pilly, White laceflower |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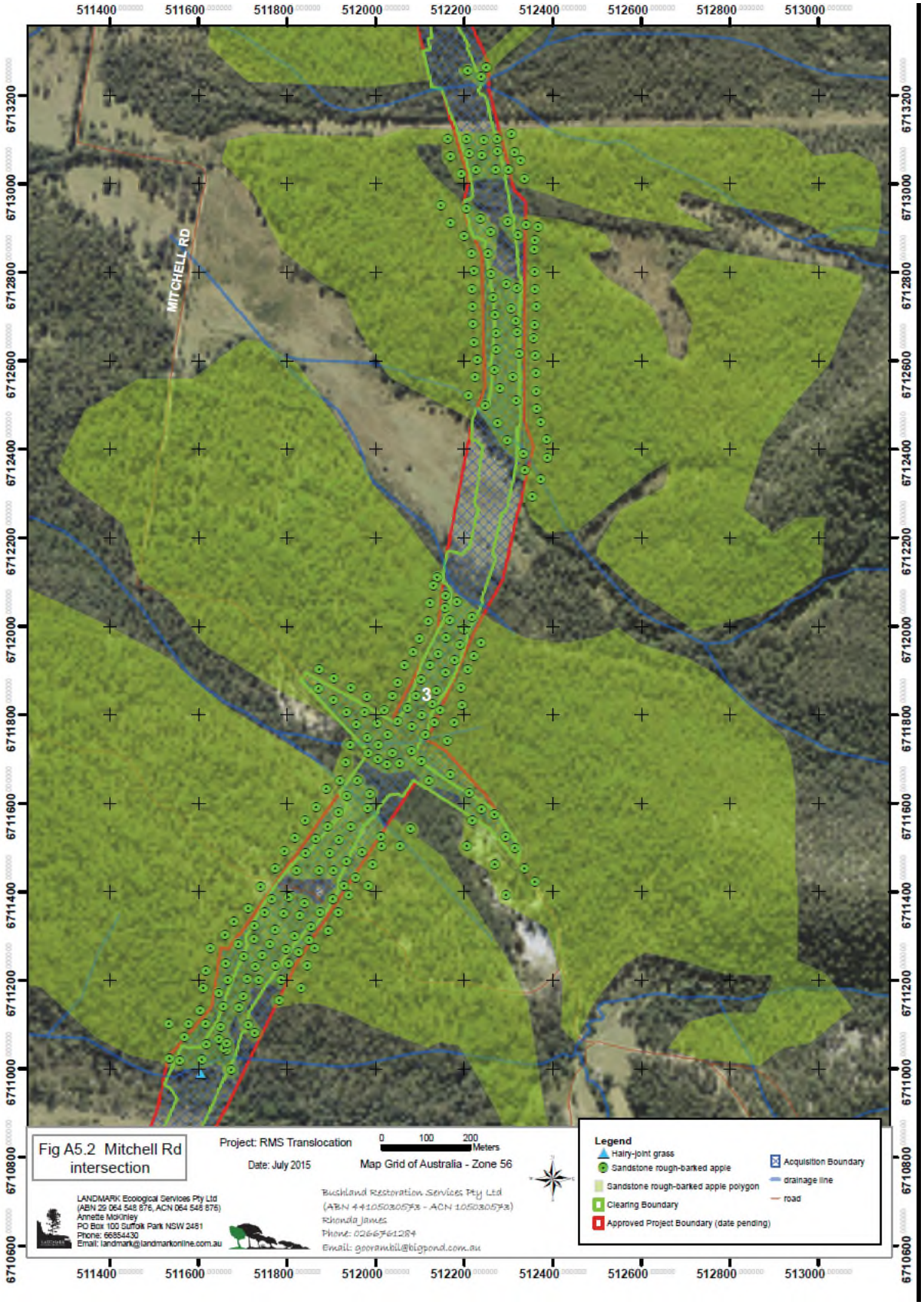
WOOLI RD
3
PALMAR VALLEY CK
Figure A5.1 8-Mile Lane, west of Wooli
Project: RMS Translocation
Date: July 2015
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
Email: georambil@bigpond.com.au
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66854430
Email: landmark@landmarkonline.com.au
Legend
Sandstone rough-barked apple
Sandstone rough-barked apple polygon
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
road
drainage line
Map Grid of Australia - Zone 56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MITCHELL RD
3
Fig A5.2 Mitchell Rd intersection
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
Map Grid of Australia - Zone 56
Legend
Hairy-joint grass
Sandstone rough-barked apple
Sandstone rough-barked apple polygon
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
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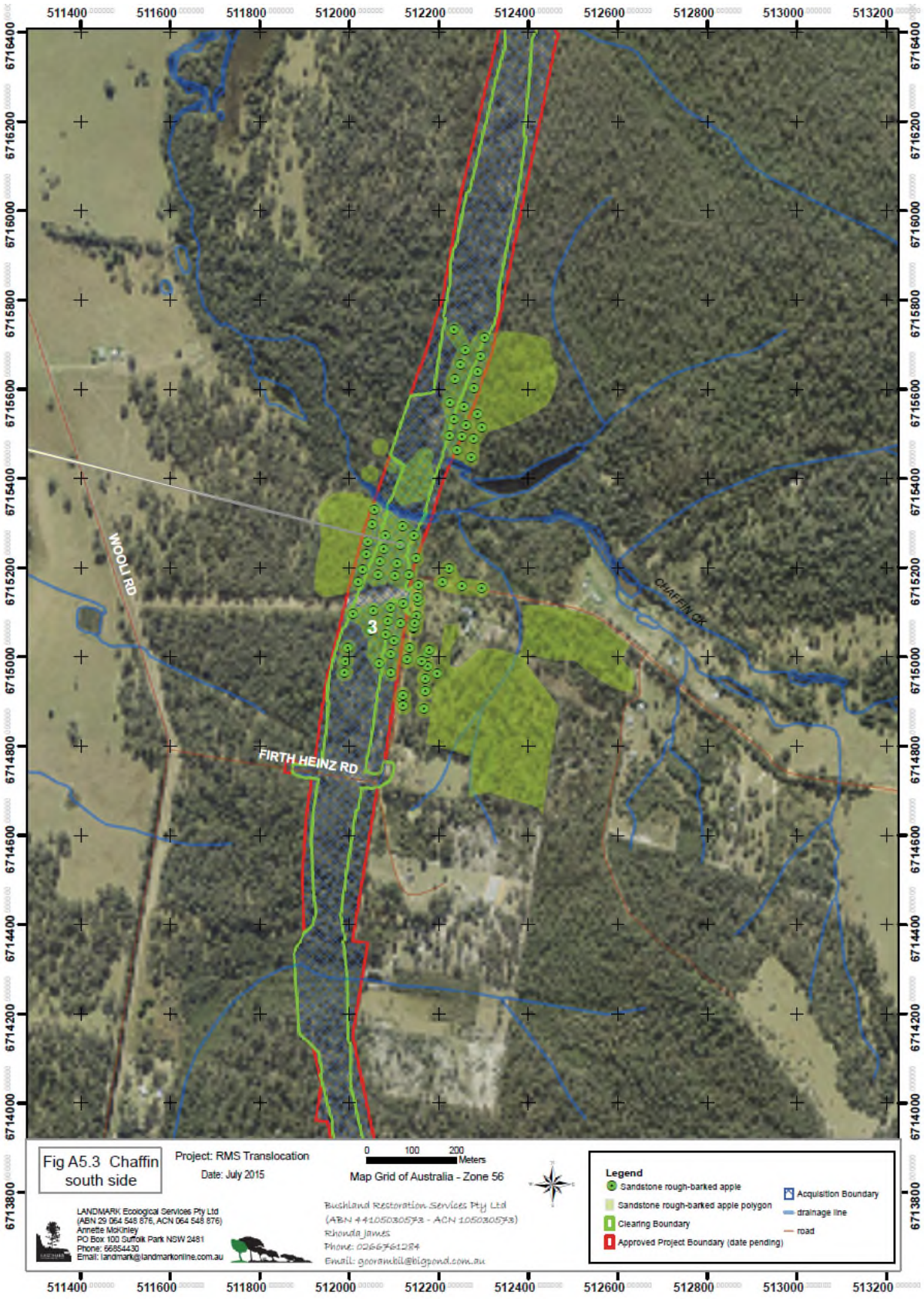
Email: georambil@bigpond.com.au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WOOLI RD
CHAFFIN CK
FIRTH HEINZ RD
3
Fig A5.3 Chaffin south side
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
Map Grid of Australia - Zone 56
Legend
Sandstone rough-barked apple
Sandstone rough-barked apple polygon
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road
LANDMARK Ecological Services Pty Ltd
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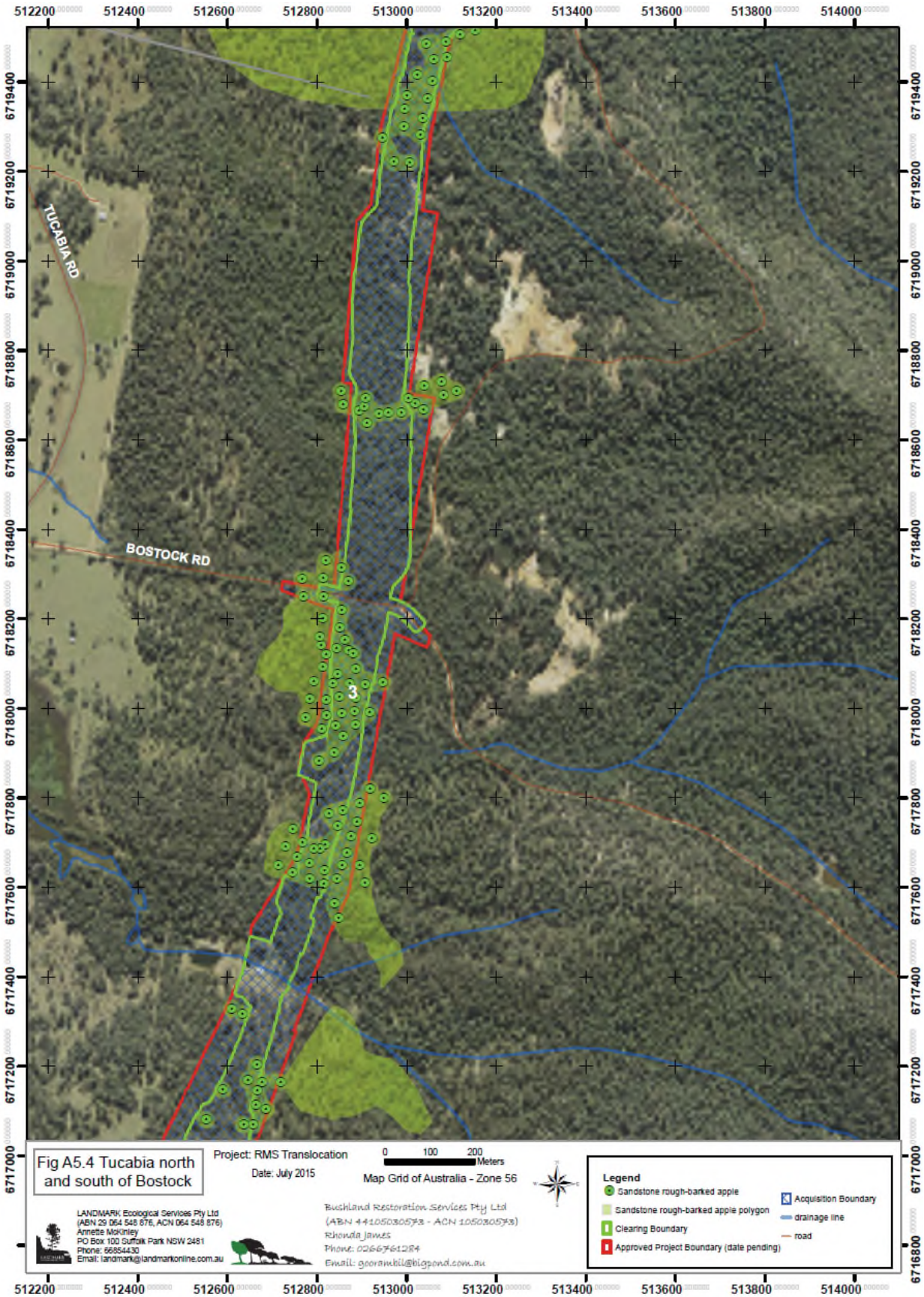
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TUCABIA RD
BOSTOCK RD
3
Fig A5.4 Tucabia north and south of Bostock
Project: RMS Translocation
Date: July 2015
0 100 200
Meters
Map Grid of Australia - Zone 56
LANDMARK Ecological Services Pty Ltd
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(ABN 44105030573 - ACN 105030573)
Rhonda James
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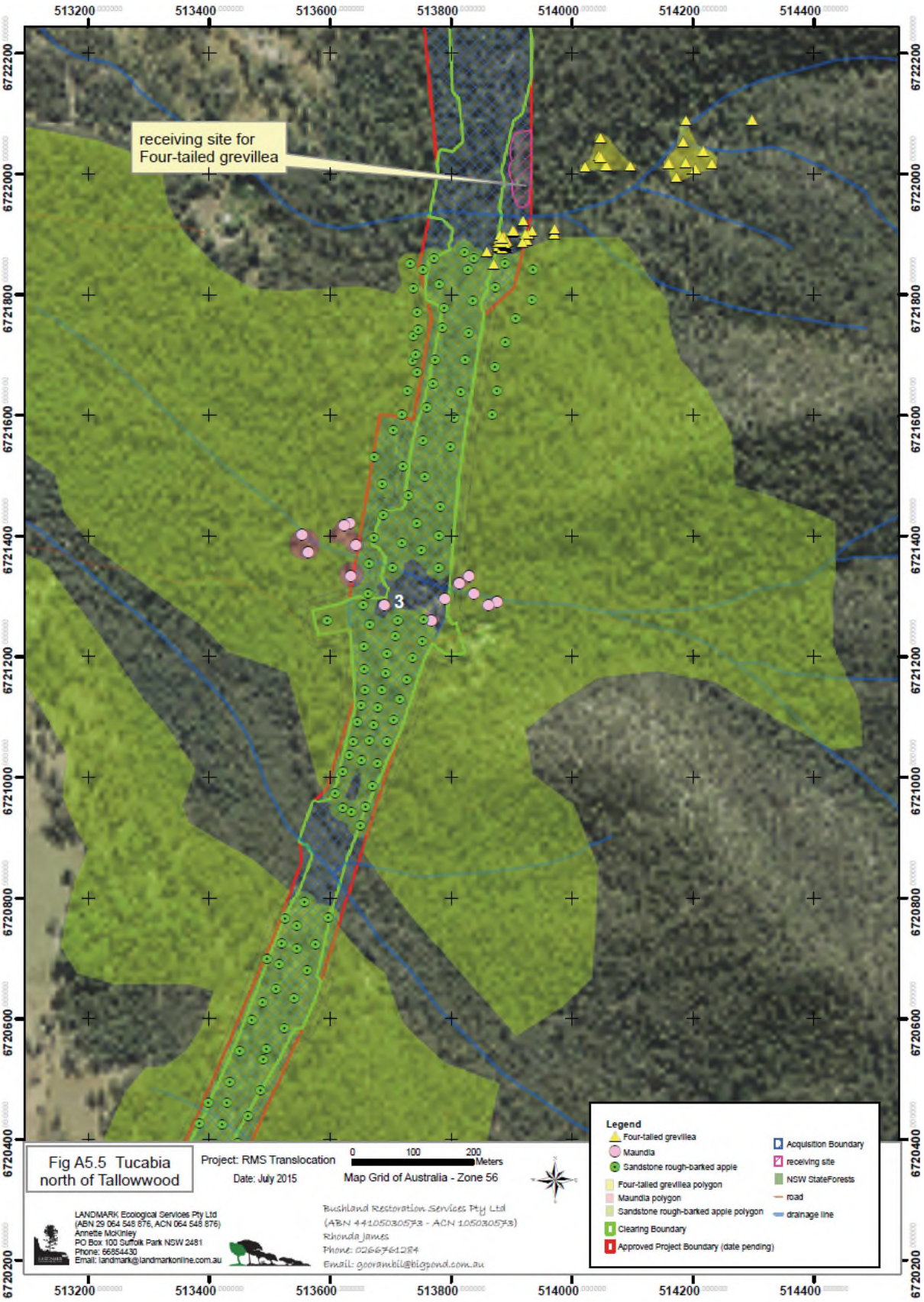
Email: goorambil@bigpond.com.au
Legend
Sandstone rough-barked apple
Sandstone rough-barked apple polygon
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road


receiving site for
Four-tailed grevillea
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Legend
Four-tailed grevillea
Maundia
Sandstone rough-barked apple
Four-tailed grevillea polygon
Maundia polygon
Sandstone rough-barked apple polygon
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
receiving site
NSW StateForests
road
drainage line
Fig A5.5 Tucabia north of Tallowwood
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
Map Grid of Australia - Zone 56
LANDMARK Ecological Services Pty Ltd
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Rhonda James
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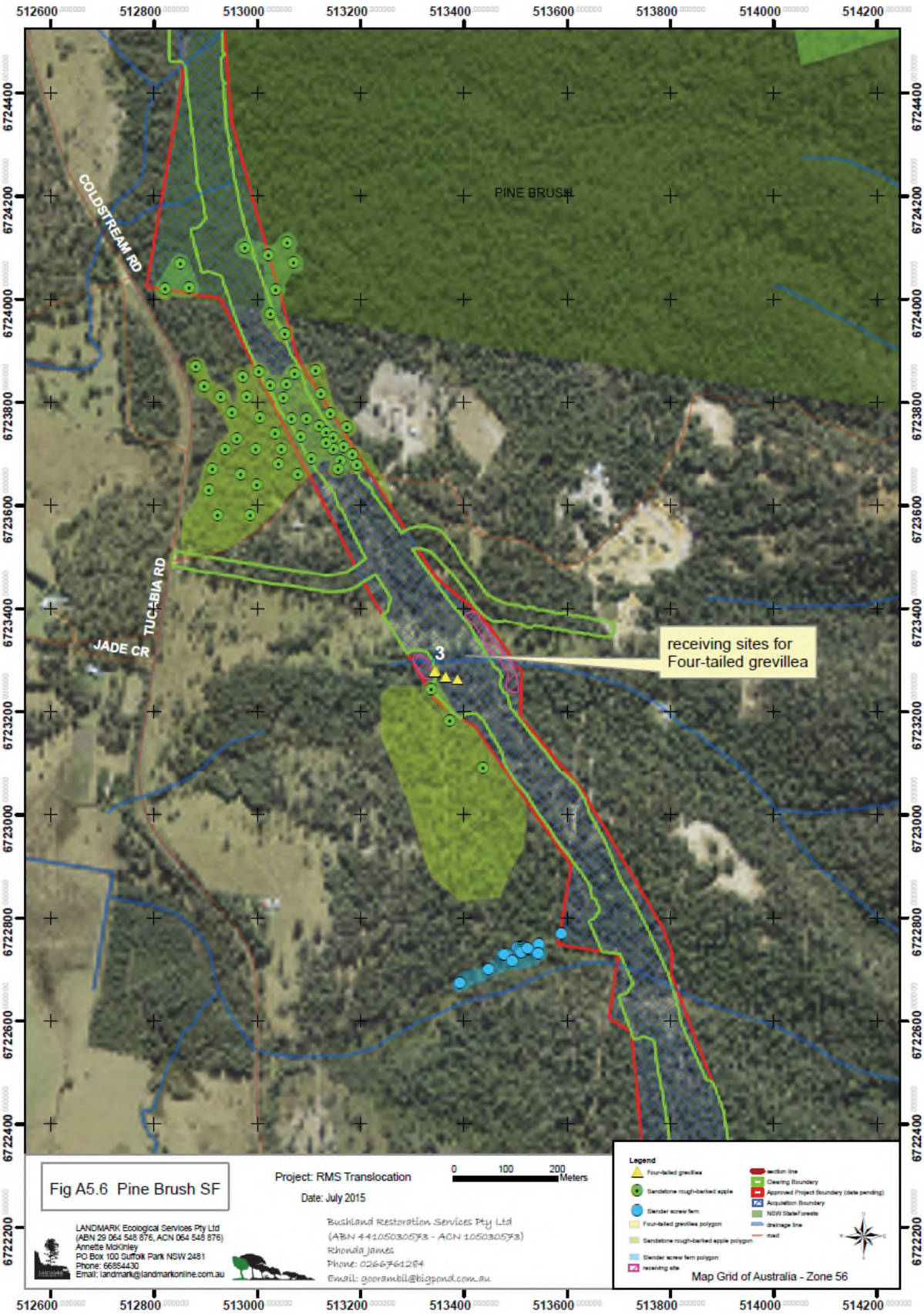
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COLDSTREAM RD
PINE BRUSH
TUCABIA RD
JADE CR
3
receiving sites for
Four-tailed grevillea
Fig A5.6 Pine Brush SF
Project: RMS Translocation
Date: July 2015
0
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Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
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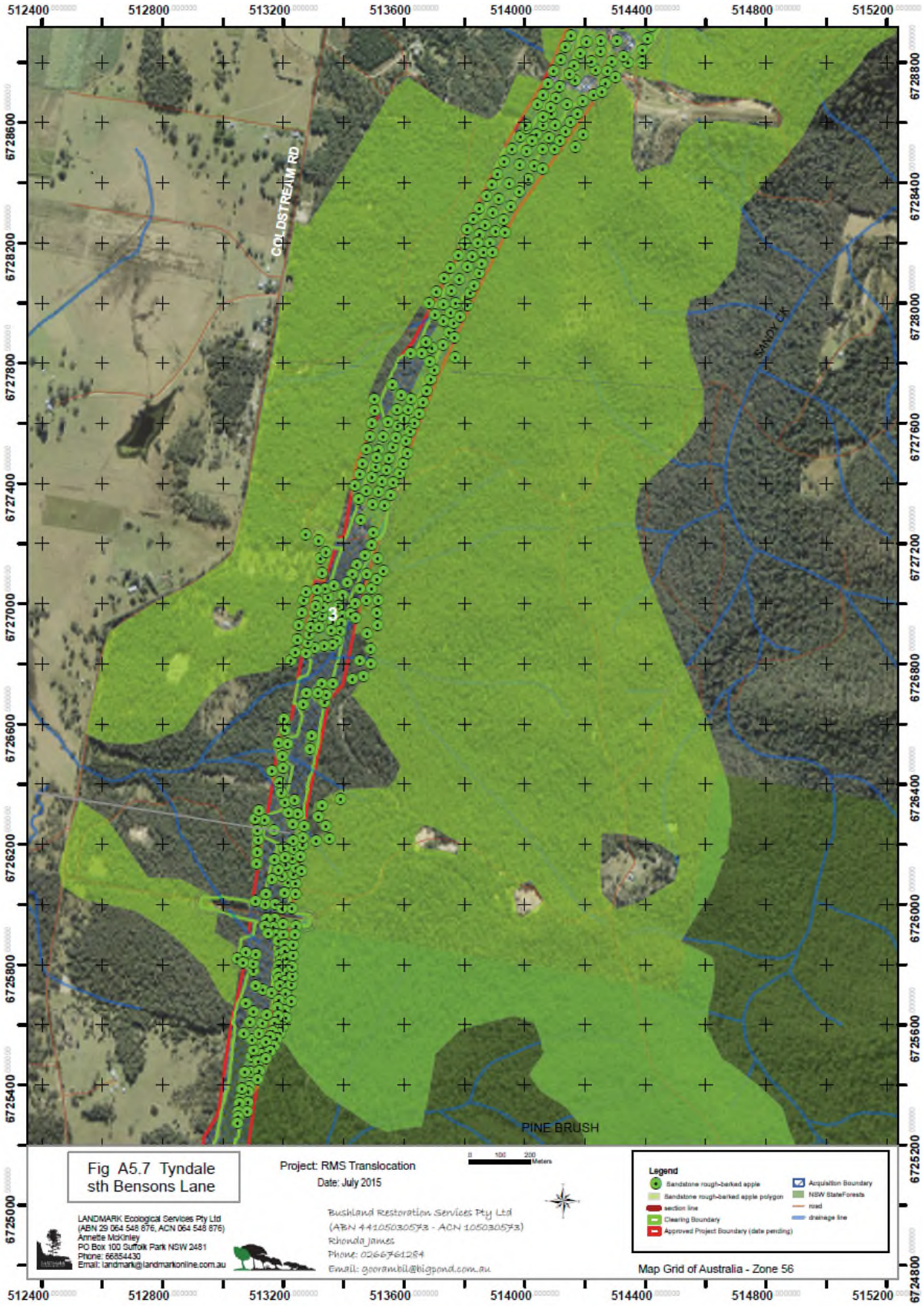
Legend
Four-tailed grevillea
Sandstone rough-barked apple
Slender screw fern
Four-tailed grevillea polygon
Sandstone rough-barked apple polygon
Slender screw fern polygon
receiving site
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
NSW StateForests
drainage line
road
Map Grid of Australia - Zone 56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COL DSTREAM RD
SANDY CK
PINE BRUSH
Fig A5.7 Tyndale sth Bensons Lane
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
Legend
Sandstone rough-barked apple
Sandstone rough-barked apple polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
NSW StateForests
road
drainage line
LANDMARK Ecological Services Pty Ltd
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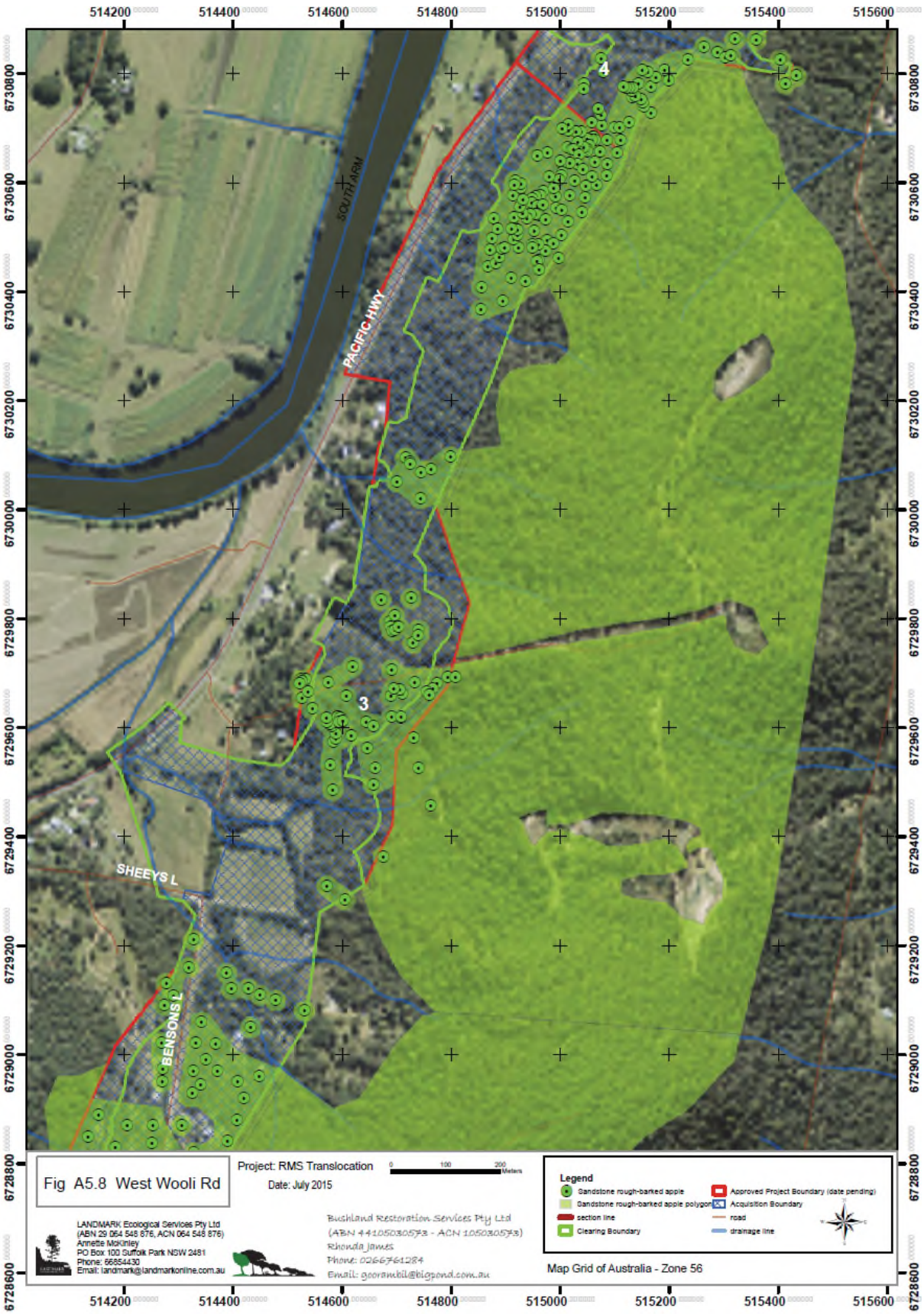
Map Grid of Australia - Zone 56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SOUTHERN
PACIFIC HWY
SHEEYS L
BENSONS L
4
3
Fig A5.8 West Wooli Rd
Project: RMS Translocation
Date: July 2015
0
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200
Meters
Legend
Sandstone rough-barked apple
Sandstone rough-barked apple polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
road
drainage line
Map Grid of Australia - Zone 56
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
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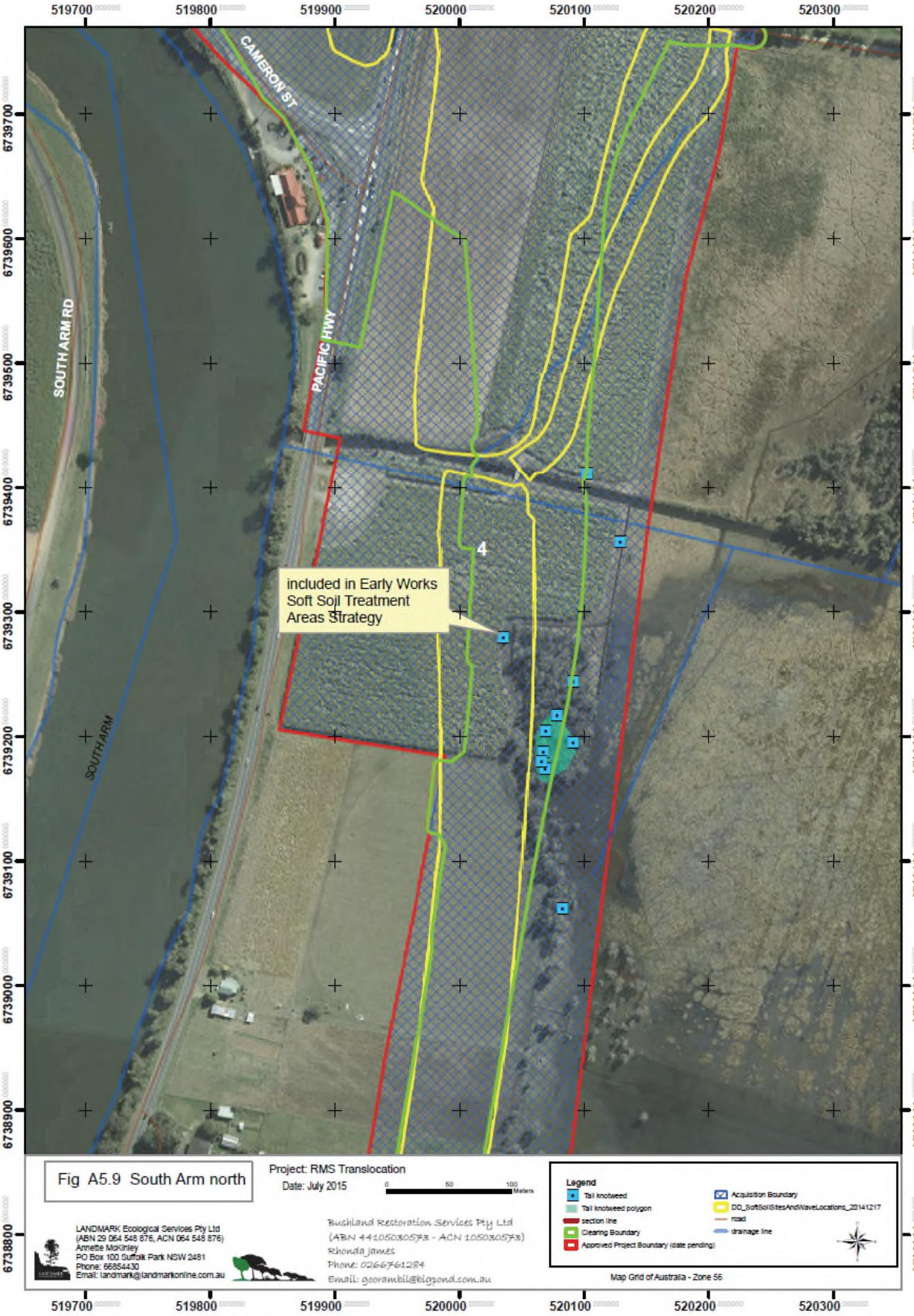
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CAMERON ST
PACIFIC HWY
SOUTH ARM RD
SOUTH ARM
4
included in Early Works Soft Soil Treatment Areas Strategy
Fig A5.9 South Arm north
Project: RMS Translocation
Date: July 2015
0 50 100 Meters
Legend
Tall knotweed
Tall knotweed polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
DO_SoftSoilSitesAndWaveLocations_20141217
road
drainage line
Map Grid of Australia - Zone 56
LANDMARK Ecological Services Pty Ltd
(ABN 29 054 548 876, ACN 054 548 876)
Annette McKinley
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Rhonda James
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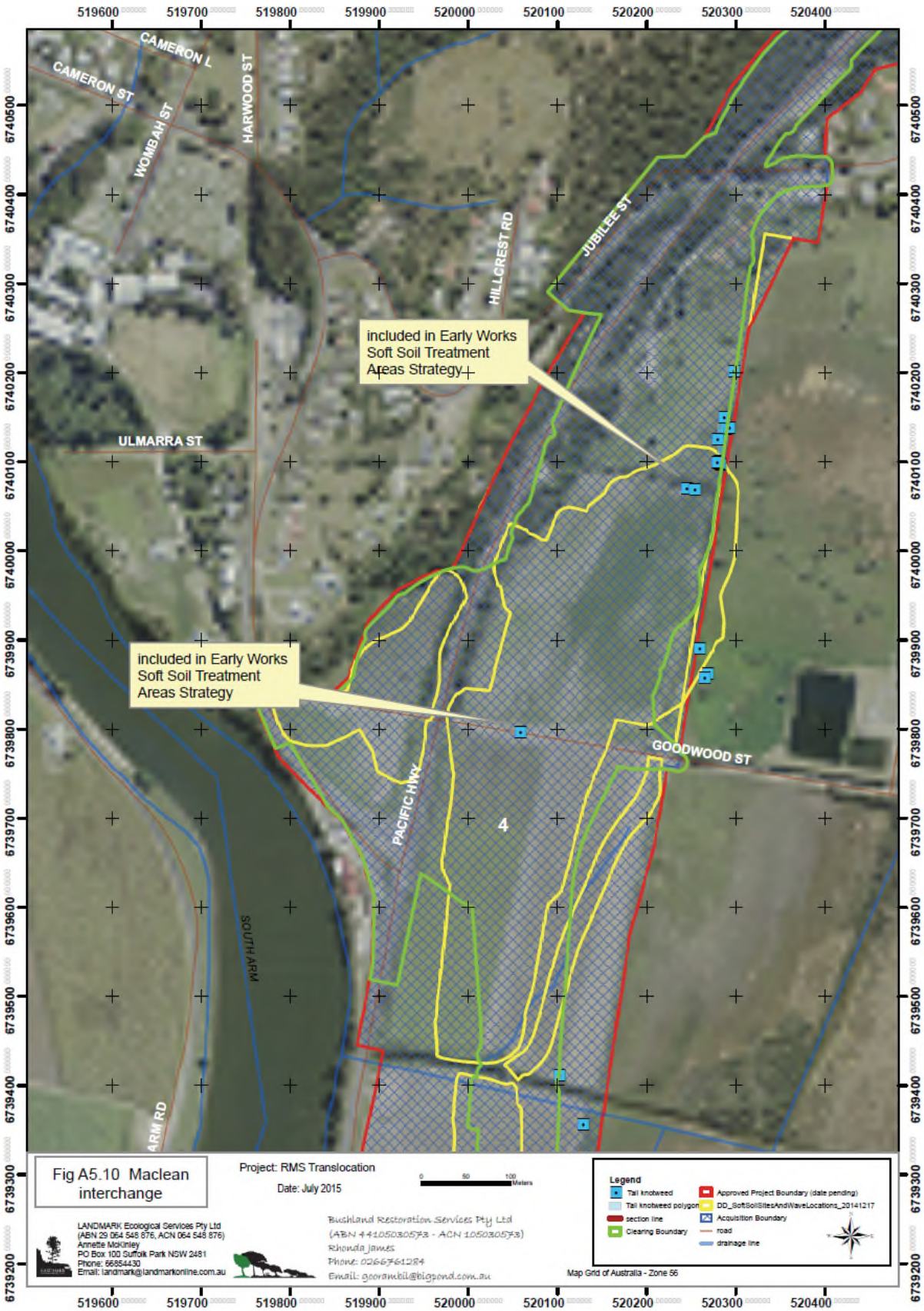
Email: goorambil@bigpond.com.au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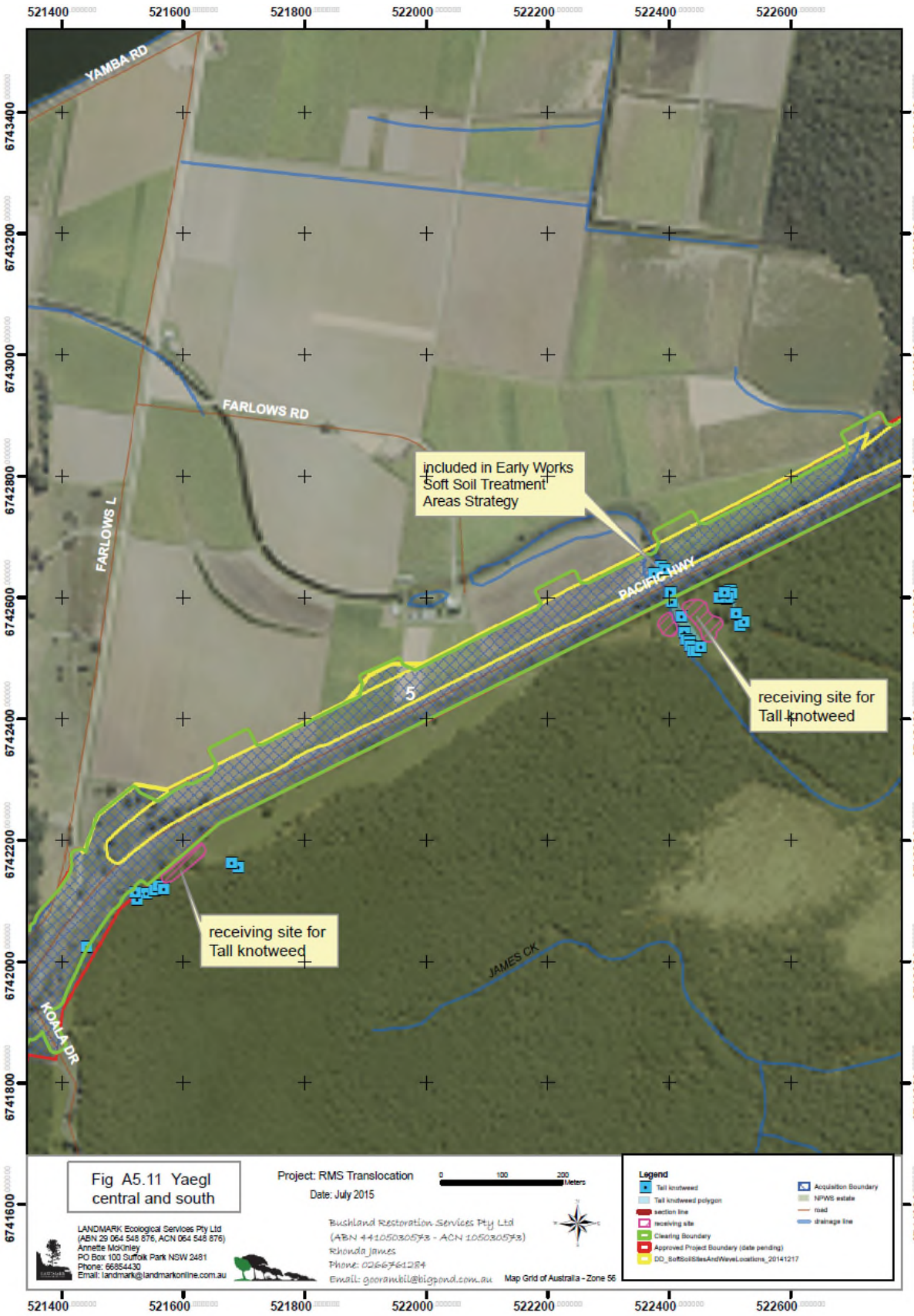
CAMERON L
CAMERON ST
WOMBAH ST
HARWOOD ST
HILLCREST RD
JUBILEE ST
ULMARRA ST
included in Early Works Soft Soil Treatment Areas Strategy
included in Early Works Soft Soil Treatment Areas Strategy
GOODWOOD ST
PACIFIC HWY
4
SOUTH ARM
ARM RD
Fig A5.10 Maclean interchange
Project: RMS Translocation
Date: July 2015
0 50 100 Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66854430
Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
Email: goorambil@bigpond.com.au
Legend
Tall knotweed
Tall knotweed polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
DD_SoftSoilSitesAndWaveLocations_20141217
Acquisition Boundary
road
drainage line
Map Grid of Australia - Zone 56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6741800
6741600
YAMBA RD
FARLOWS RD
FARLOWS L
PACIFIC HWY
JAMES CK
KOALA DR
included in Early Works Soft Soil Treatment Areas Strategy
receiving site for Tall knotweed
receiving site for Tall knotweed
Fig A5.11 Yaegl central and south
Project: RMS Translocation
Date: July 2015
0
100
200
Meters
Legend
Tall knotweed
Tall knotweed polygon
section line
receiving site
Clearing Boundary
Approved Project Boundary (date pending)
DD_SoftSoilSitesAndWeveLocations_20141217
Acquisition Boundary
NPWS estate
road
drainage line
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
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Phone: 66854430
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(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266741284
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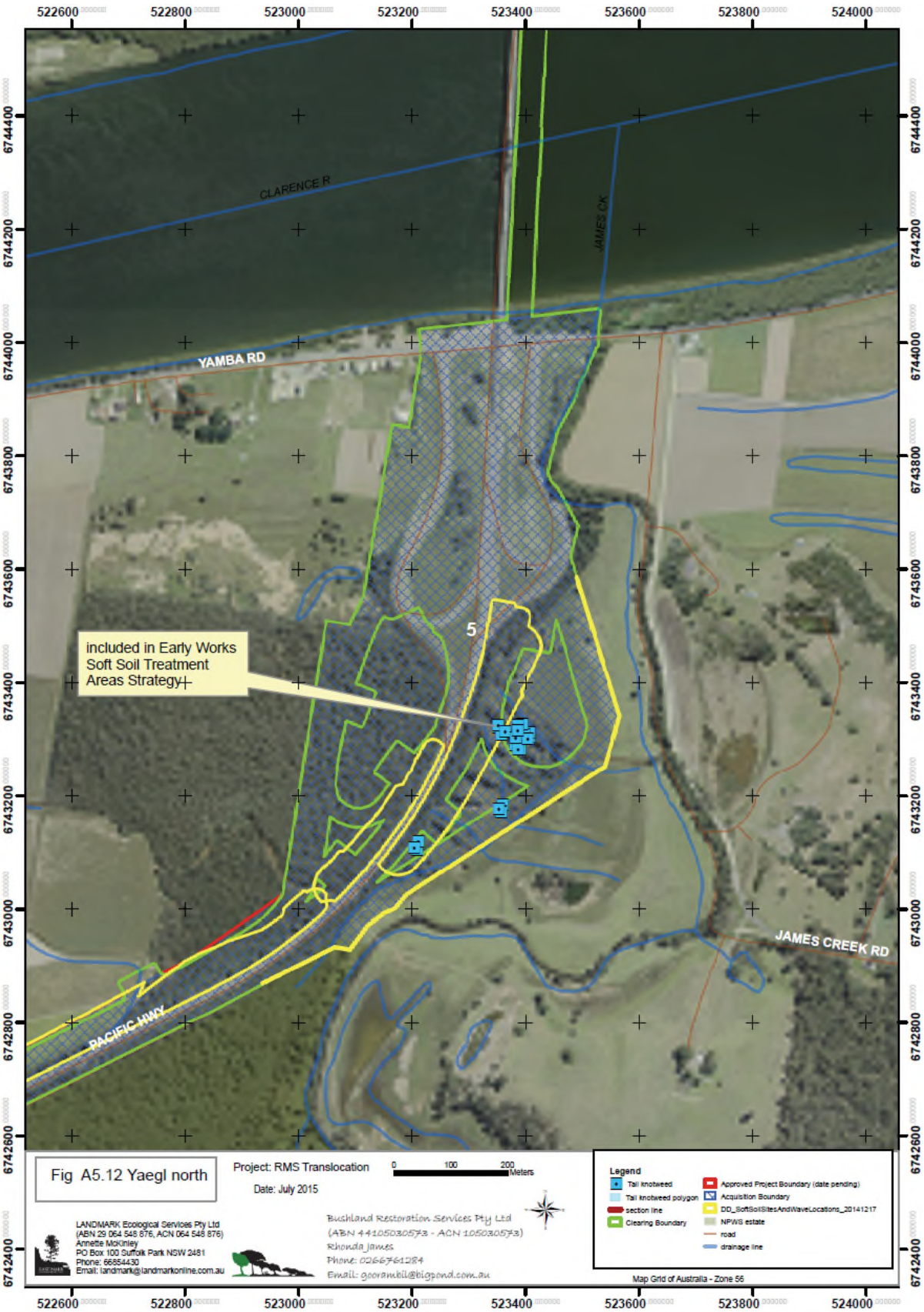
Map Grid of Australia - Zone 56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6742800
6742600
6742400
CLARENCE R
JAMES CK
YAMBA RD
JAMES CREEK RD
PACIFIC HWY
5
included in Early Works Soft Soil Treatment Areas Strategy
Fig A5.12 Yaegl north
Project: RMS Translocation
Date: July 2015
0
100
200
Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66854430
Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 02667612B4
Email: goorambil@bigpond.com.au
Legend
Tall knotweed
Tall knotweed polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
DD_SoftSoilSitesAndWaveLocations_20141217
NPWS estate
road
drainage line
Map Grid of Australia - Zone 56


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6752800
Bundjalung National Park
Bundjalung National Park
6
PACIFIC HWY
Section boundary 5-6
BANANA RD
OLD PACIFIC HWY
OLD PA
Fig A5.13 Mororo south
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 676, ACN 064 548 676)
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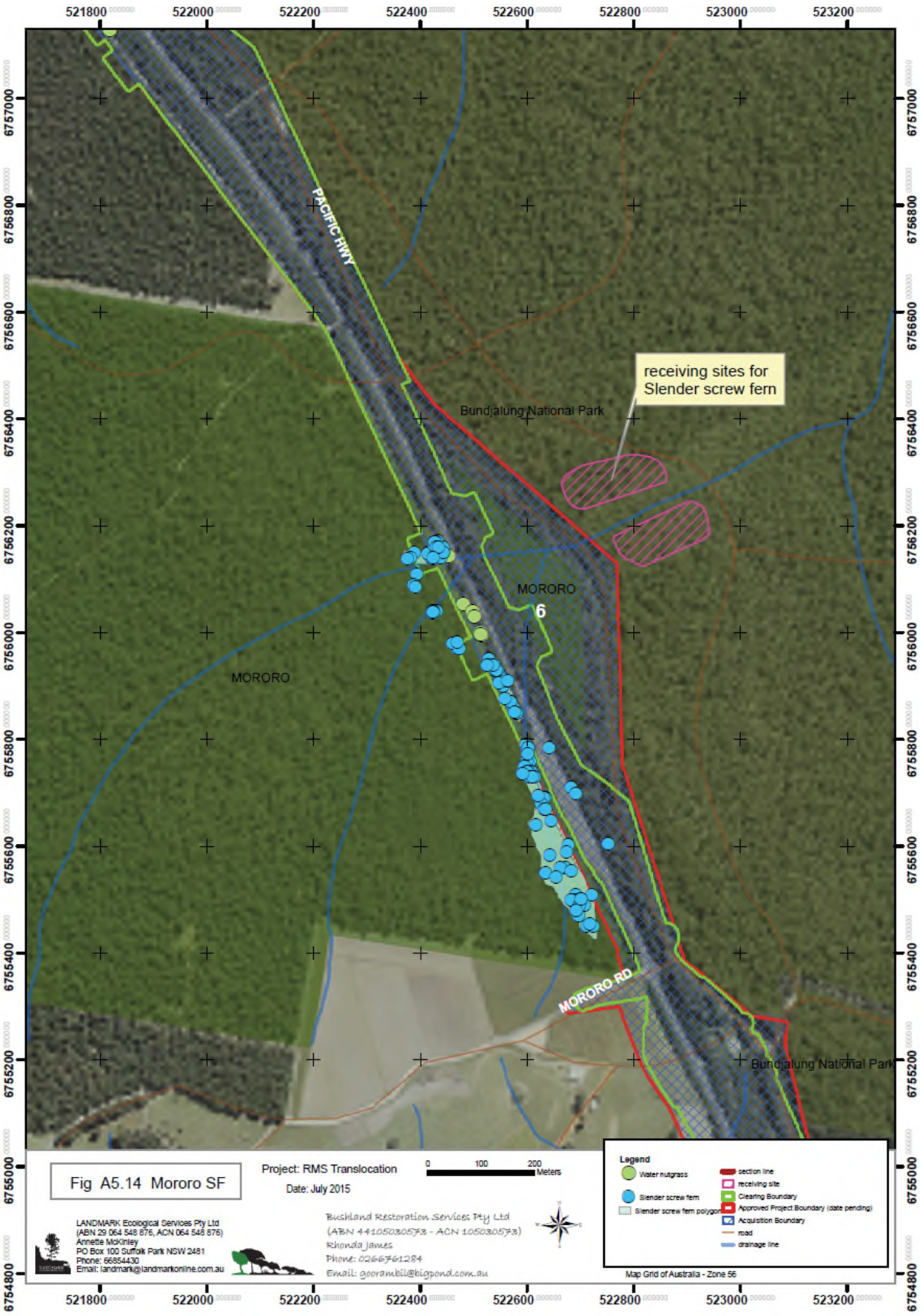
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
Email: georambil@bigpond.com.au
Legend
Water nutgrass
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
NPWS estate
road
drainage line
Map Grid of Australia - Zone 56


receiving sites for Slender screw fern
Bundjalung National Park
PACIFIC HWY
MORORO
6
MORORO
MORORO RD
Bundjalung National Park
Fig A5.14 Mororo SF
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
Legend
Water nutgrass
Slender screw fern
Slender screw fern polygon
section line
receiving site
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
road
drainage line
LANDMARK Ecological Services Pty Ltd
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Email: landmark@landmarkonline.com.au
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(ABN 44105030573 - ACN 105030573)
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Email: goorambil@bigpond.com.au
Map Grid of Australia - Zone 56
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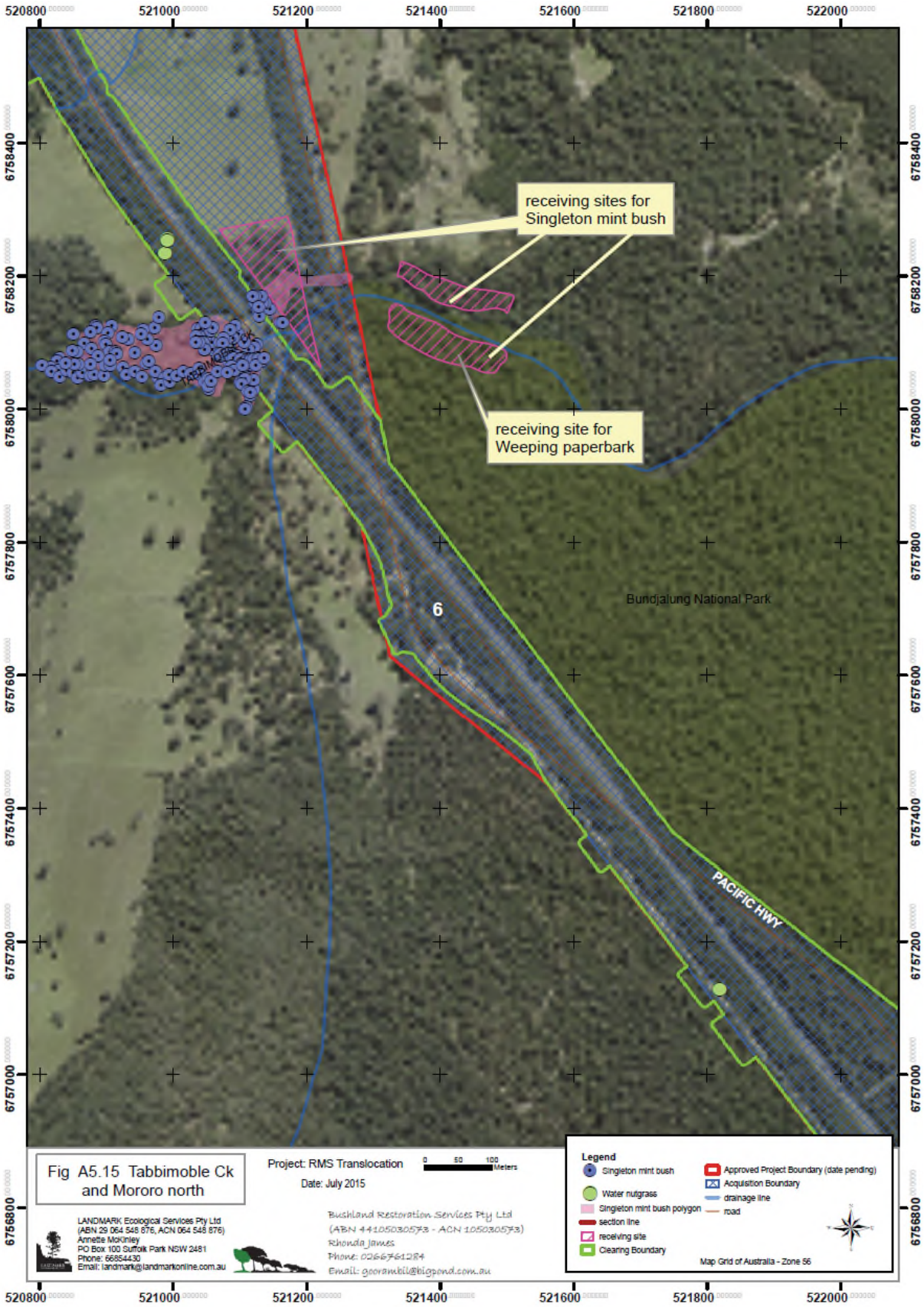
receiving sites for Singleton mint bush
receiving site for Weeping paperbark
Bundjalung National Park
PACIFIC HWY
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Fig A5.15 Tabbimoble Ck and Mororo north
Project: RMS Translocation
Date: July 2015
0 50 100 Meters
LANDMARK Ecological Services Pty Ltd
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Bushland Restoration Services Pty Ltd
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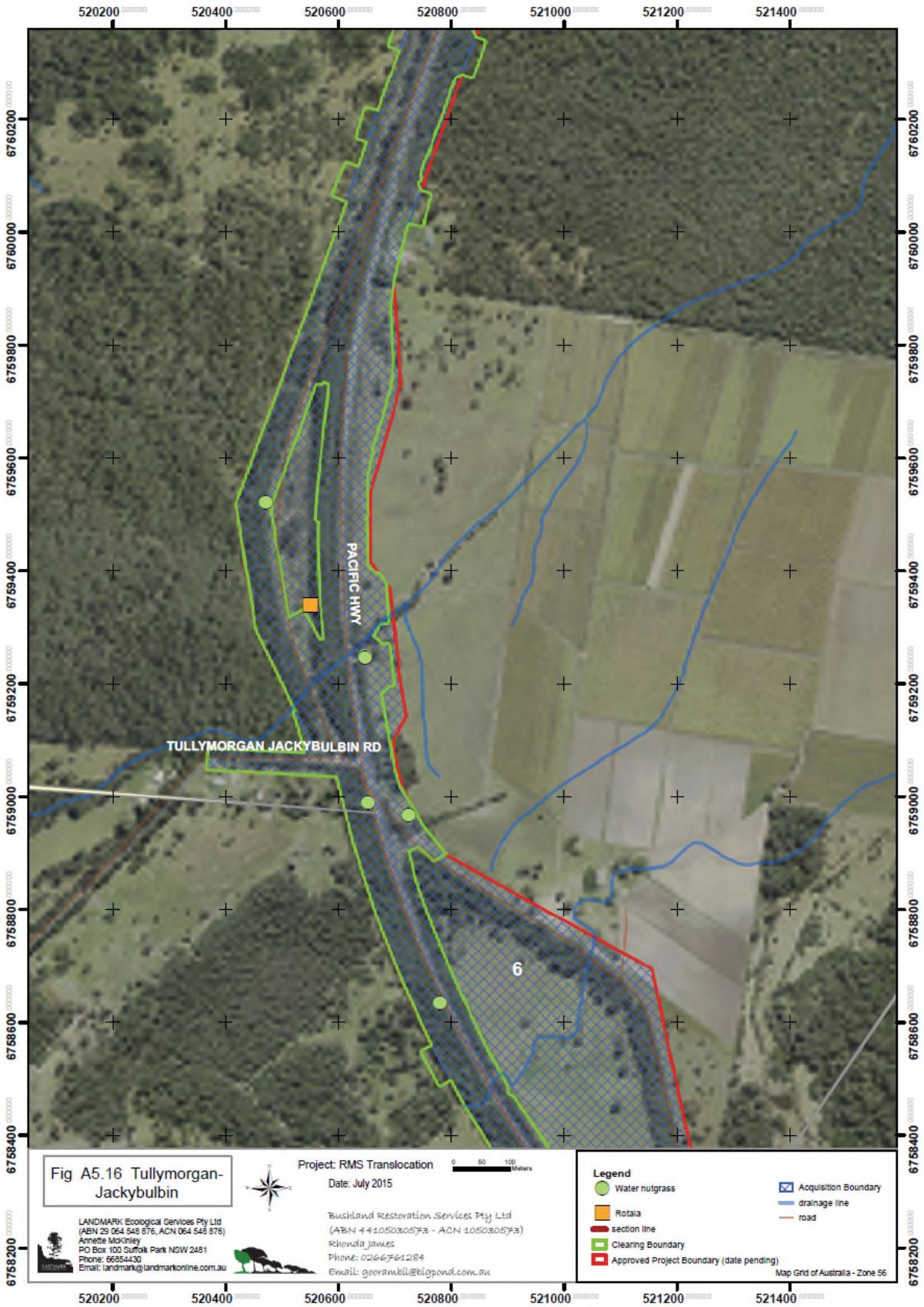
Phone: 02667612184
Email: goorambil@bigpond.com.au
Legend
Singleton mint bush
Water nutgrass
Singleton mint bush polygon
section line
receiving site
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road
Map Grid of Australia - Zone 56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PACIFIC HWY
TULLYMORGAN JACKYBULBIN RD
6
Fig A5.16 Tullymorgan-Jackybulbin
Project: RMS Translocation
Date: July 2015
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LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
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Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
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Phone: 02667761284
Email: goorambil@bigpond.com.au
Legend
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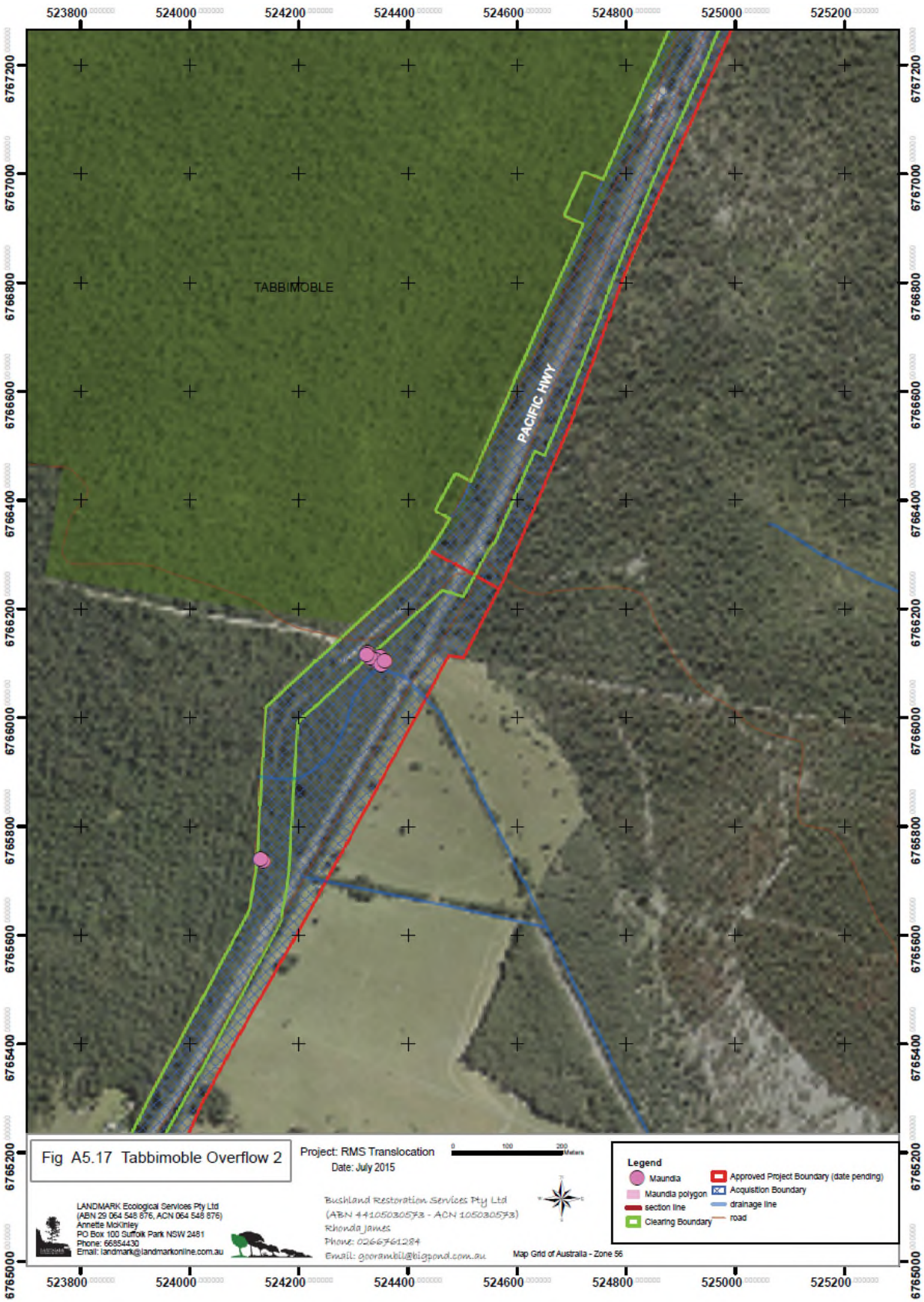
Rotala
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road
Map Grid of Australia - Zone 56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TABBIMOBLE
PACIFIC HWY
Fig A5.17 Tabbimoble Overflow 2
Project: RMS Translocation
Date: July 2015
0
100
200
Meters
Legend
Maundia
Maundia polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
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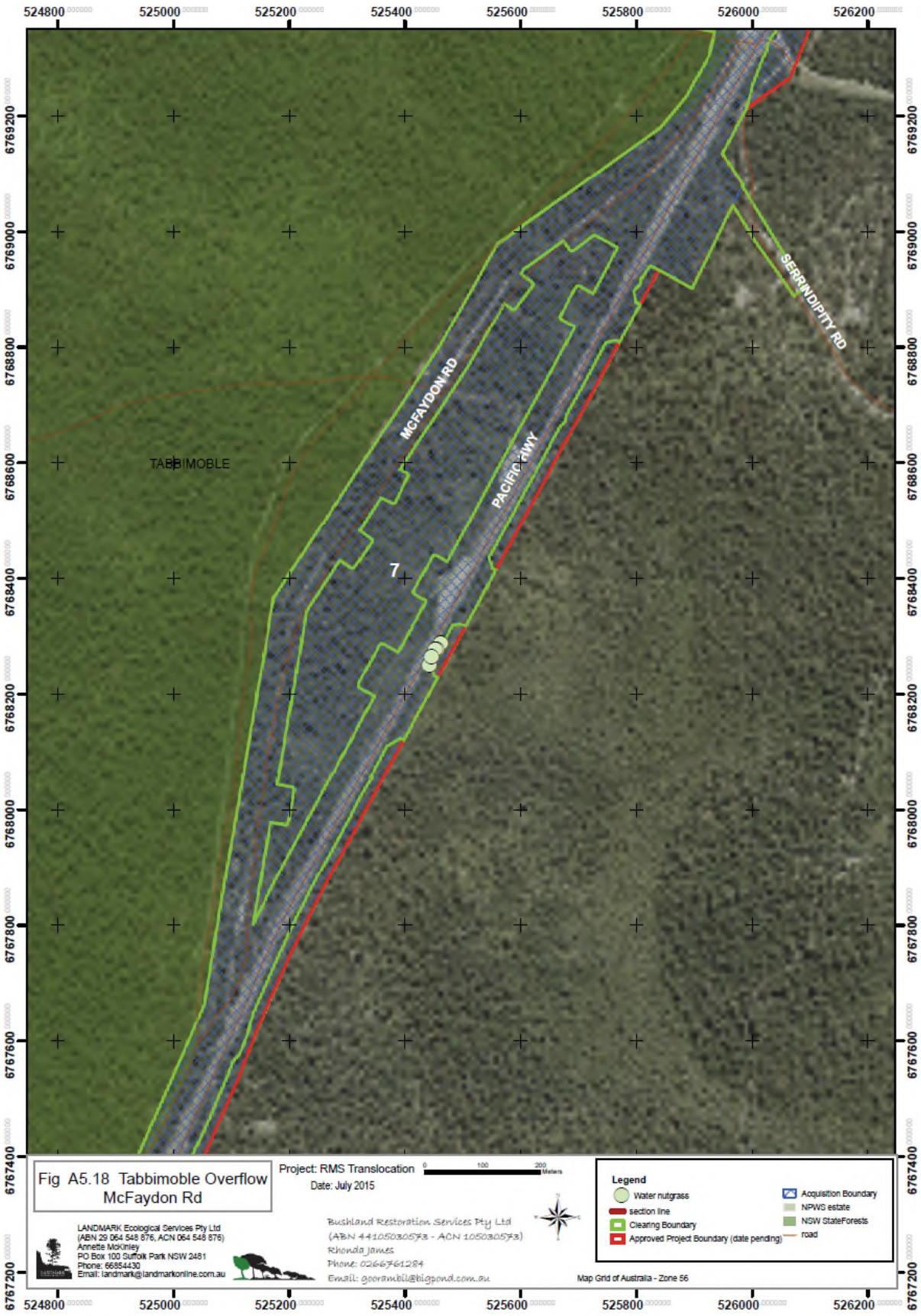
Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
Email: goorambil@bigpond.com.au
Map Grid of Australia - Zone 56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TABBIMOBLE
MCFAYDON RD
PACIFIC HWY
SERENDIPITY RD
7
Fig A5.18 Tabbimoble Overflow
McFaydon Rd
Project: RMS Translocation
Date: July 2015
0
100
200
Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 676, ACN 064 548 676)
Annette McKinley
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Email: landmark@landmarkonline.com.au
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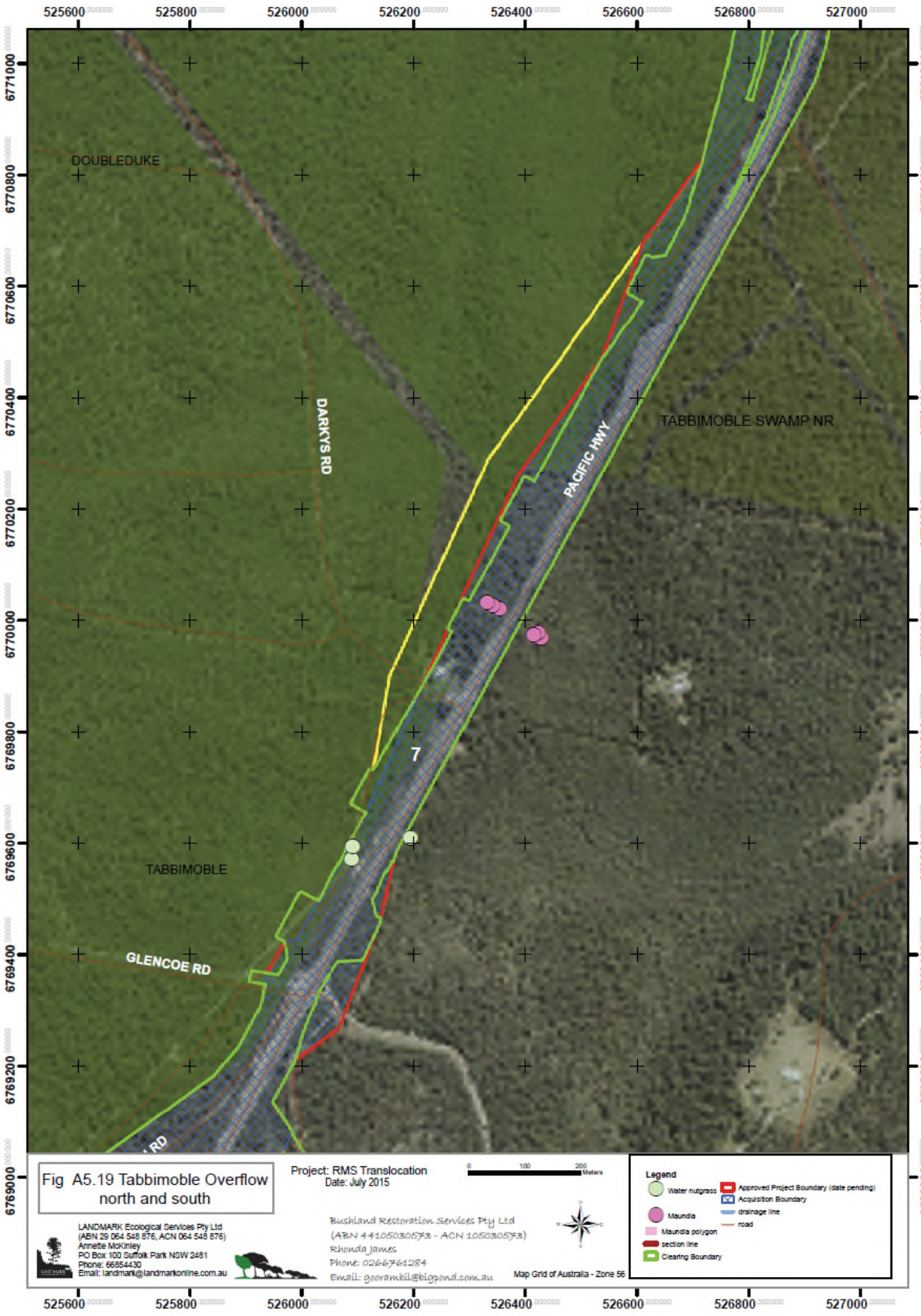
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
Email: georambil@bigpond.com.au
Legend
Water nutgrass
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
NPWS estate
NSW StateForests
road
Map Grid of Australia - Zone 56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DOUBLEDUKE
DARKYS RD
PACIFIC HWY
TABBIMOBLE SWAMP NR
7
TABBIMOBLE
GLENCOE RD
Fig A5.19 Tabbimoble Overflow north and south
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
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Email: landmark@landmarkonline.com.au
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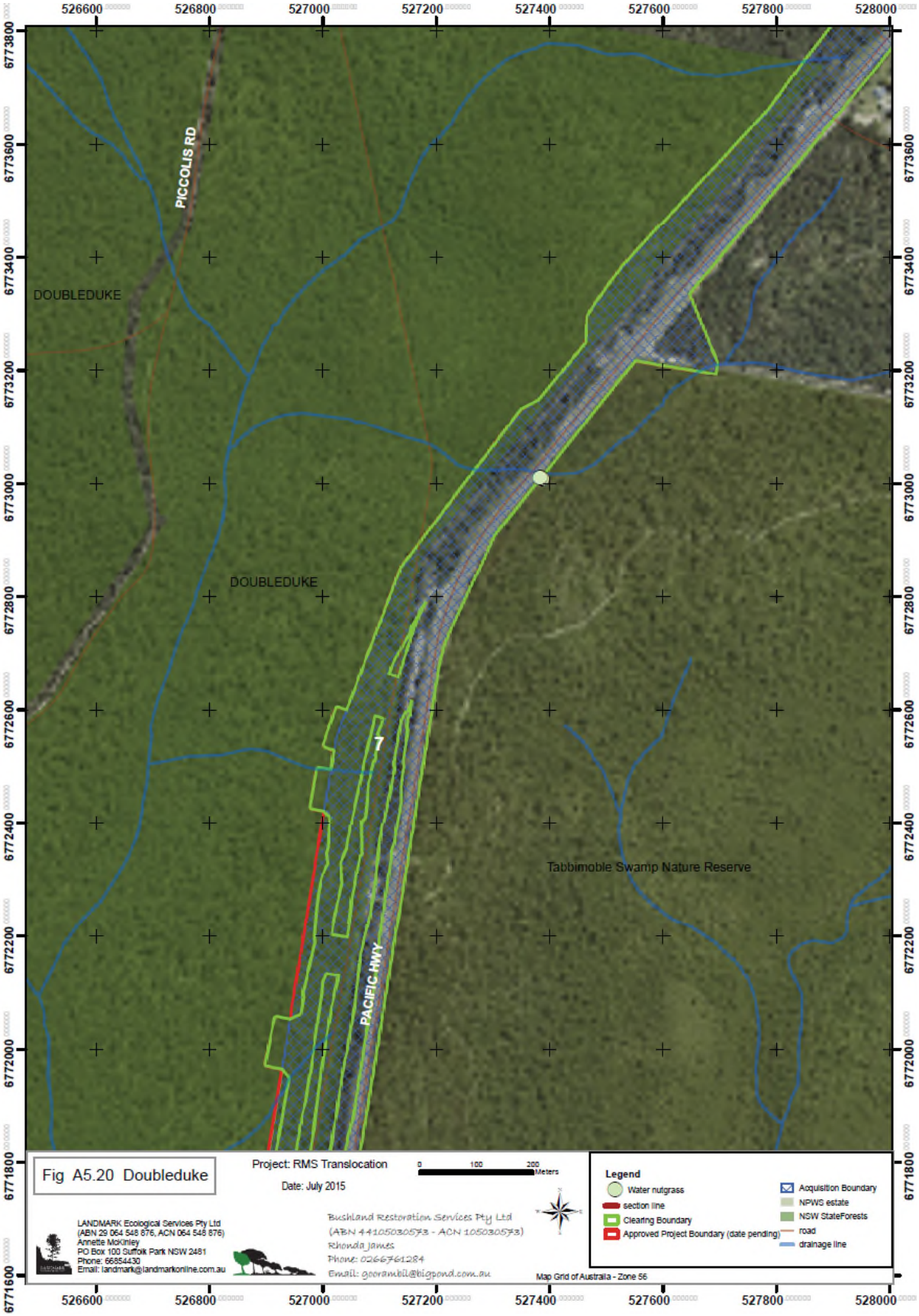
Rhonda James
Phone: 0266761284
Email: gorambil@bigpond.com.au
Map Grid of Australia - Zone 56
Legend
Water nutgrass
Maundia
Maundia polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road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PICCOLIS RD
DOUBLEDUKE
DOUBLEDUKE
7
Tabbimoble Swamp Nature Reserve
PACIFIC HWY
Fig A5.20 Doubleduke
Project: RMS Translocation
Date: July 2015
0
100
200
Meters
LANDMARK Ecological Services Pty Ltd
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Annette McKinley
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Bushland Restoration Services Pty Ltd
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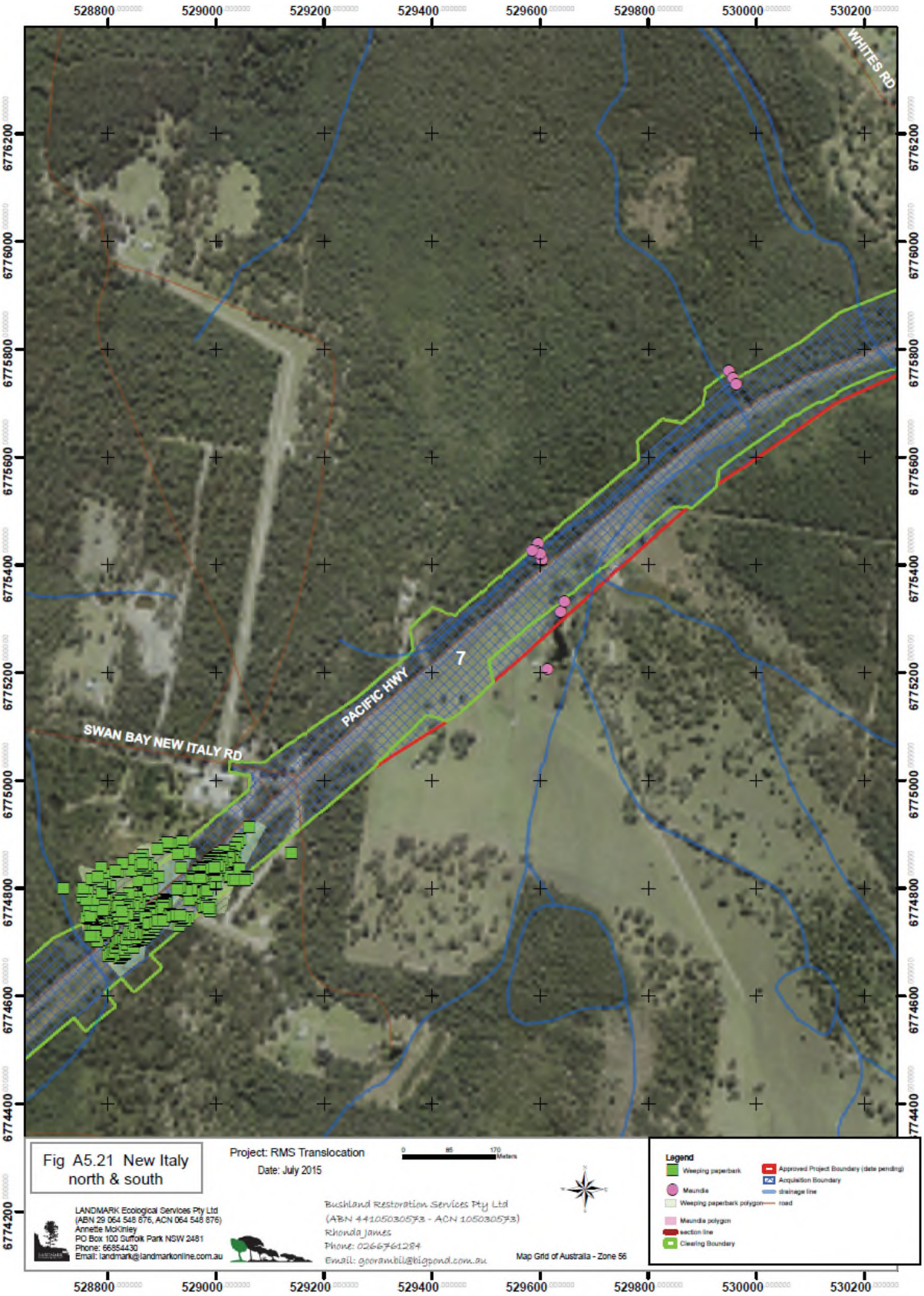
Email: goorambil@bigpond.com.au
Map Grid of Australia - Zone 56
Legend
Water nutgrass
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
NPWS estate
NSW StateForests
road
drainage line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6774200
WHITES RD
PACIFIC HWY
7
SWAN BAY NEW ITALY RD
Fig A5.21 New Italy north & south
Project: RMS Translocation
Date: July 2015
0 85 170 Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
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Email: landmark@landmarkonline.com.au
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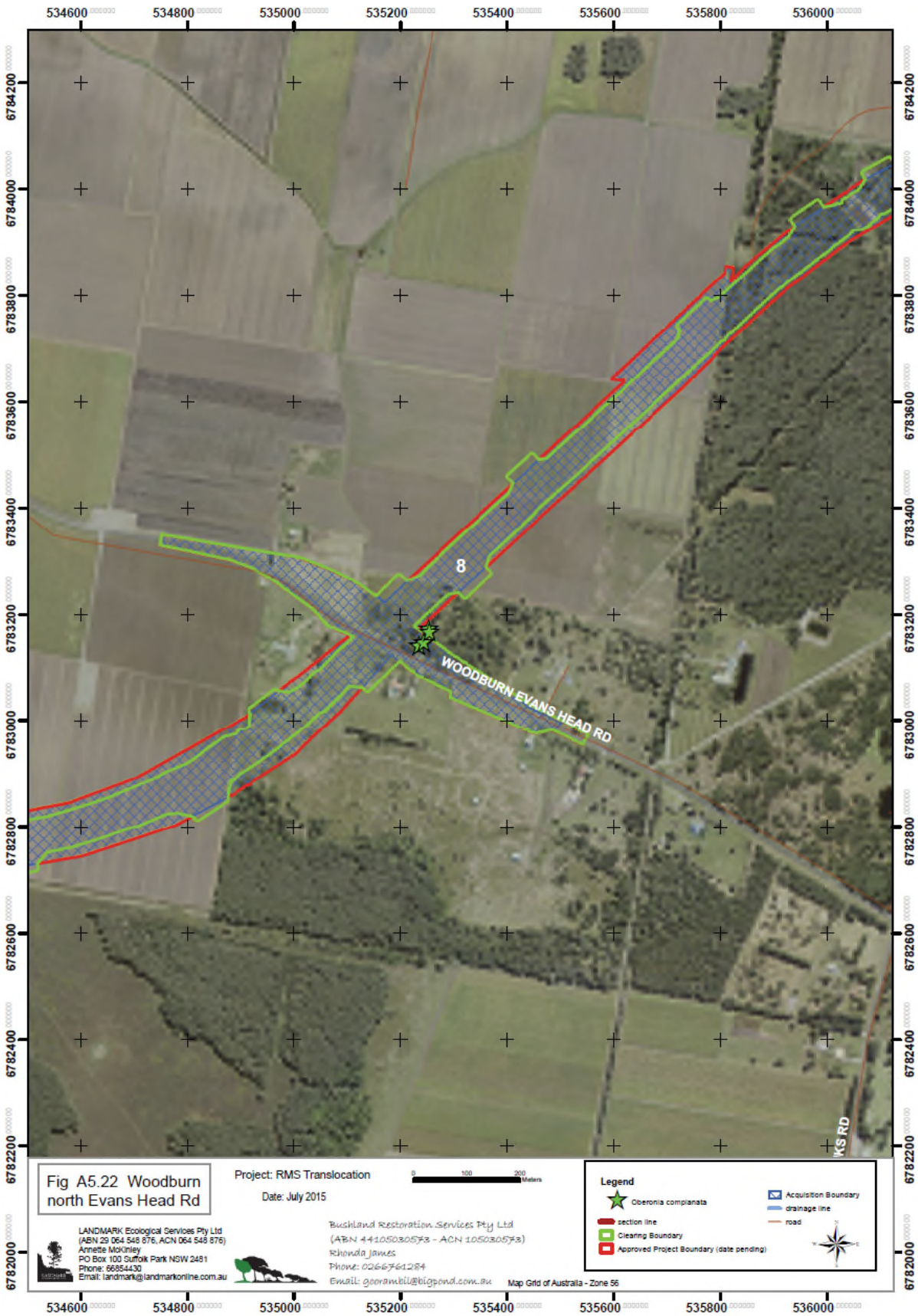
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
Email: georamb@bigpond.com.au
Map Grid of Australia - Zone 56
Legend
Weeping paperbark
Approved Project Boundary (date pending)
Acquisition Boundary
Maundie
drainage line
Weeping paperbark polygon
road
Maundie polygon
section line
Clearing Boundary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6782200
6782000
8
WOODBURN EVANS HEAD RD
Fig A5.22 Woodburn north Evans Head Rd
Project: RMS Translocation
Date: July 2015
0 100 200 Meters
Legend
Oberonia complanata
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
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(ABN 44105030573 - ACN 105030573)
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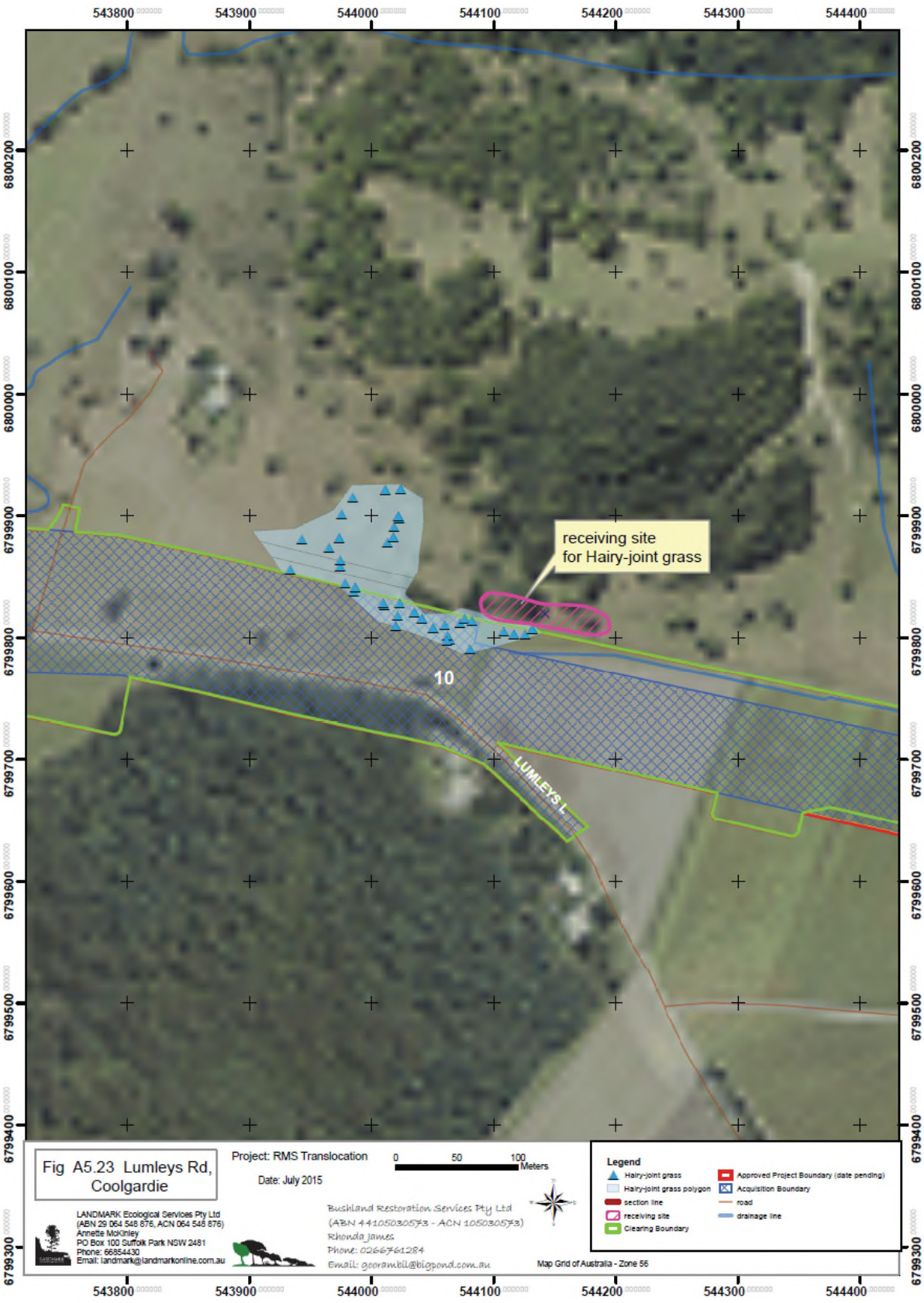
Phone: 02667641284
Email: goorambil@bigpond.com.au
Map Grid of Australia - Zone 56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6799400
6799300
receiving site
for Hairy-joint grass
10
LUMLEYS L
Fig A5.23 Lumleys Rd, Coolgardie
Project: RMS Translocation
Date: July 2015
0
50
100
Meters
Legend
Hairy-joint grass
Hairy-joint grass polygon
section line
receiving site
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
road
drainage line
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66854430
Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
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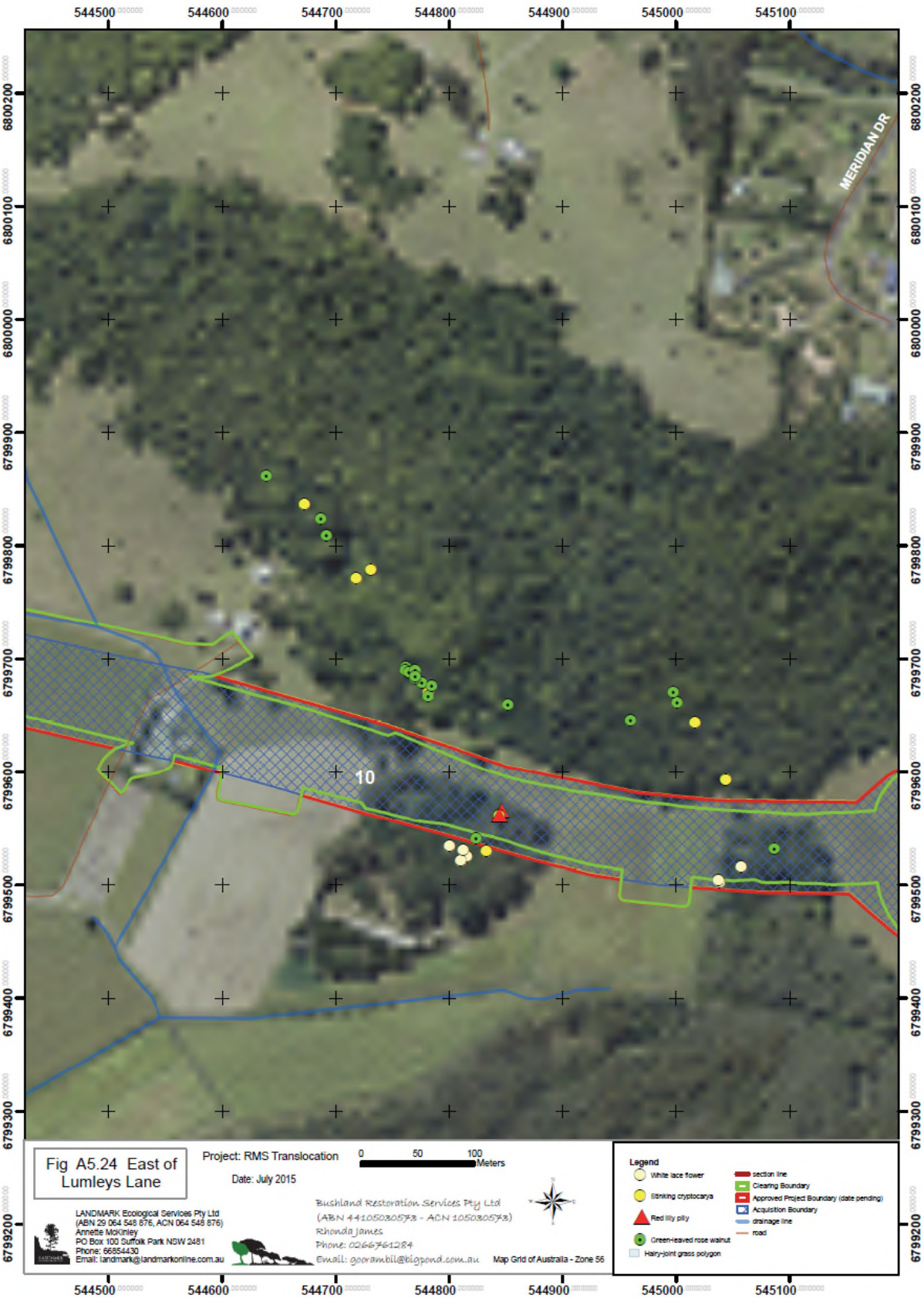
Map Grid of Australia - Zone 56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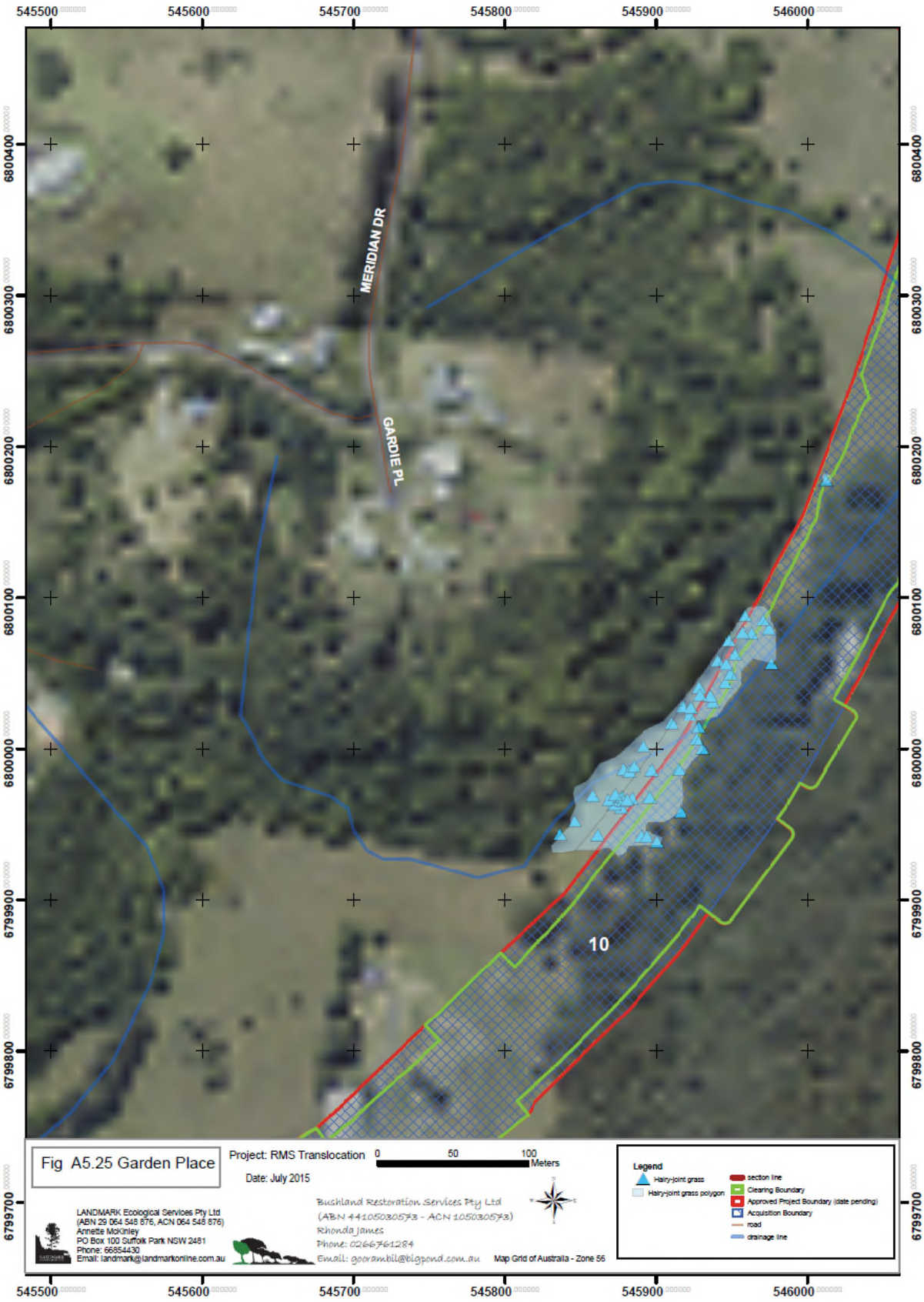
6799200
MERIDIAN DR
10
Fig A5.24 East of Lumleys Lane
Project: RMS Translocation
Date: July 2015
0
50
100
Meters
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 676, ACN 064 548 676)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66854430
Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 02667761284
Email: goorambil@bigpond.com.au
Map Grid of Australia - Zone 56
Legend
White lace flower
Stinking cryptocarya
Red lilly pilly
Green-leaved rose walnut
Hairy-joint grass polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
drainage line
road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MERIDIAN DR
GARDIE PL
10
Fig A5.25 Garden Place
Project: RMS Translocation
0
50
100
Meters
Date: July 2015
Legend
Hairy-joint grass
Hairy-joint grass polygon
section line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
road
drainage line
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 676, ACN 064 548 676)
Annette McKinley
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Bushland Restoration Services Pty Ltd
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Rhonda James
Phone: 02667761284
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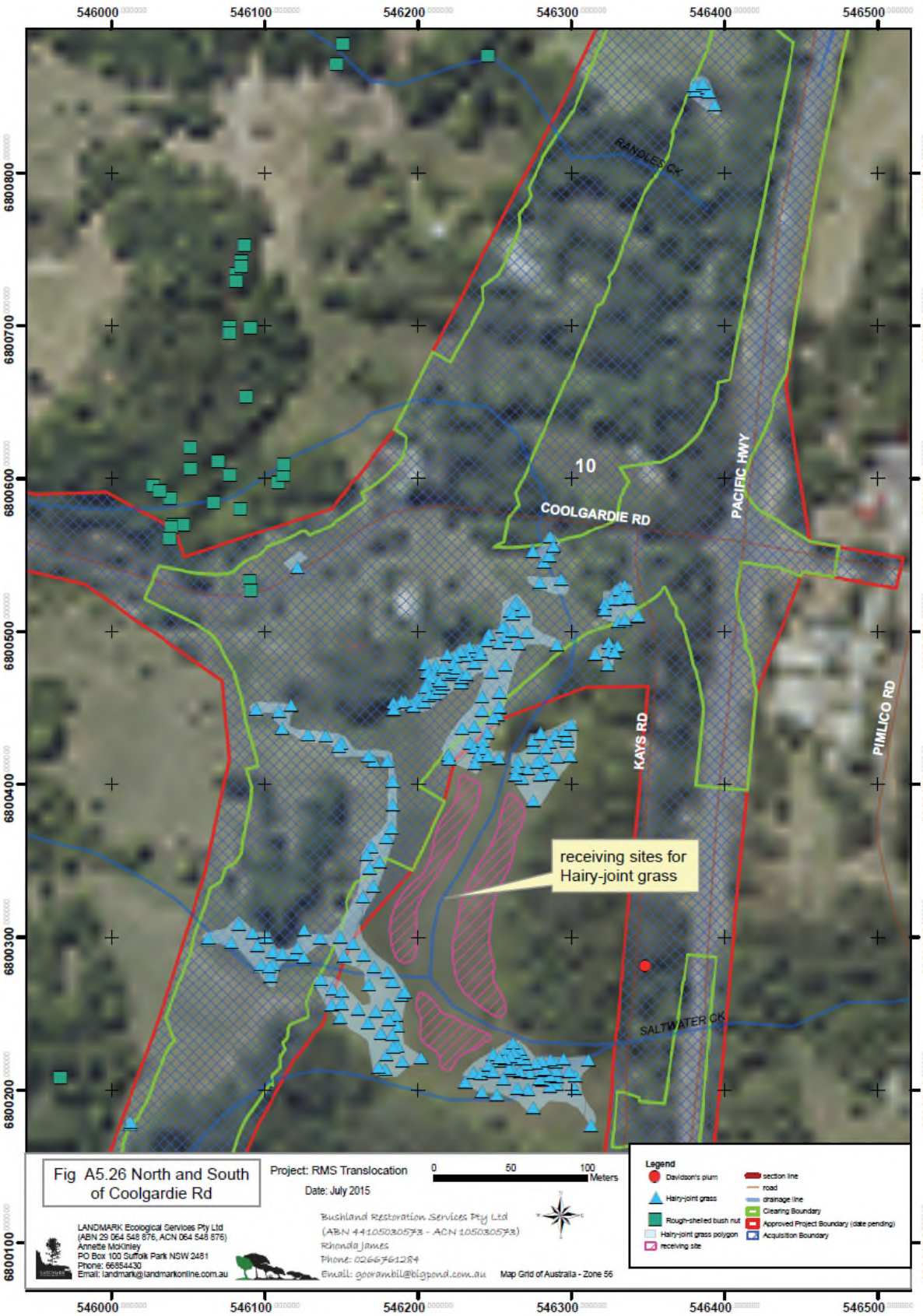
Map Grid of Australia - Zone 56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RANDLES CK
10
COOLGARDIE RD
PACIFIC HWY
KAYS RD
PIMLICO RD
SALTWATER CK
receiving sites for Hairy-joint grass
Fig A5.26 North and South of Coolgardie Rd
Project: RMS Translocation
Date: July 2015
0
50
100
Meters
Legend
Davidson's plum
Hairy-joint grass
Rough-shelled bush nut
Hairy-joint grass polygon
receiving site
section line
road
drainage line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
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Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
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Rhonda James
Phone: 0266761284
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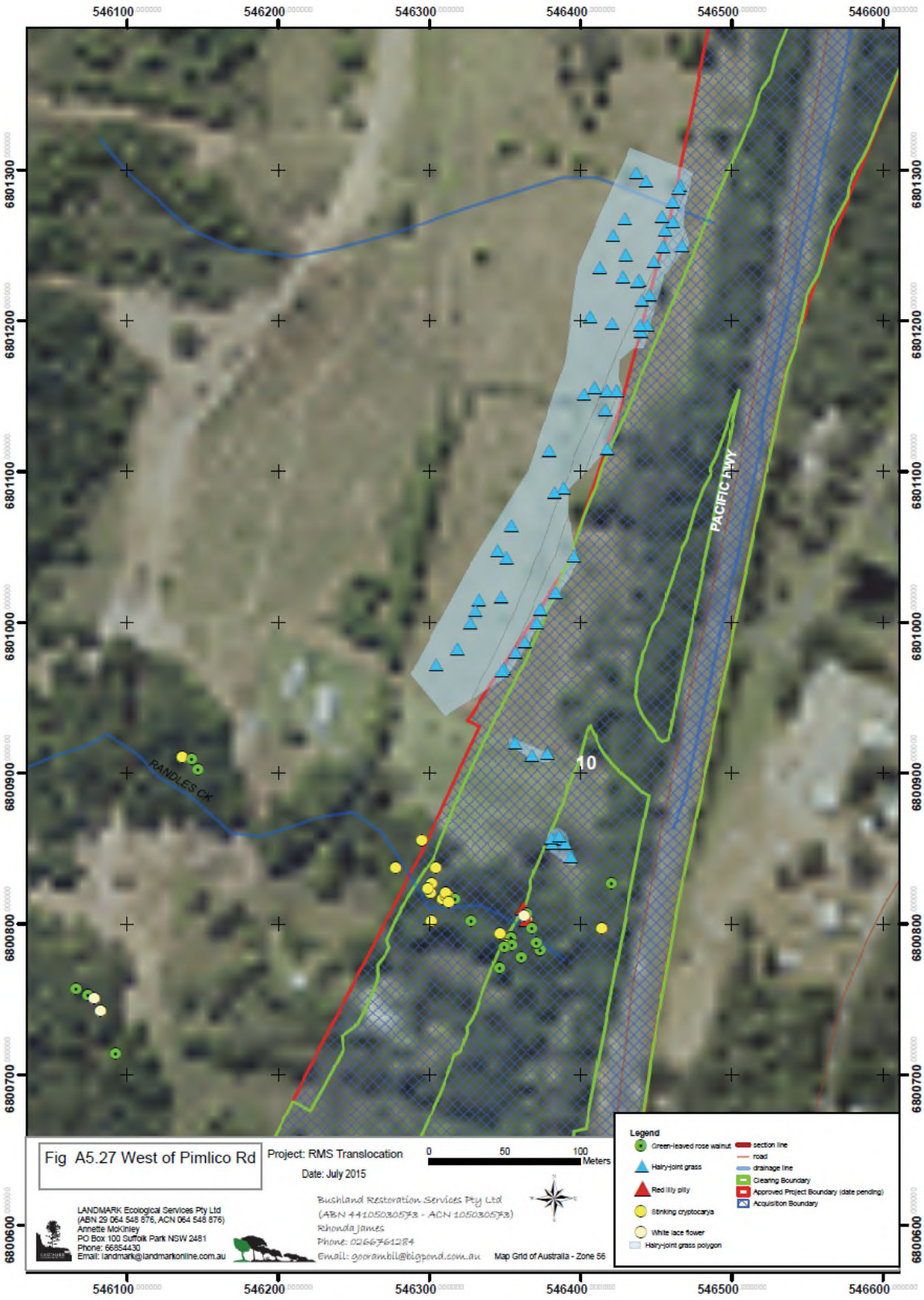
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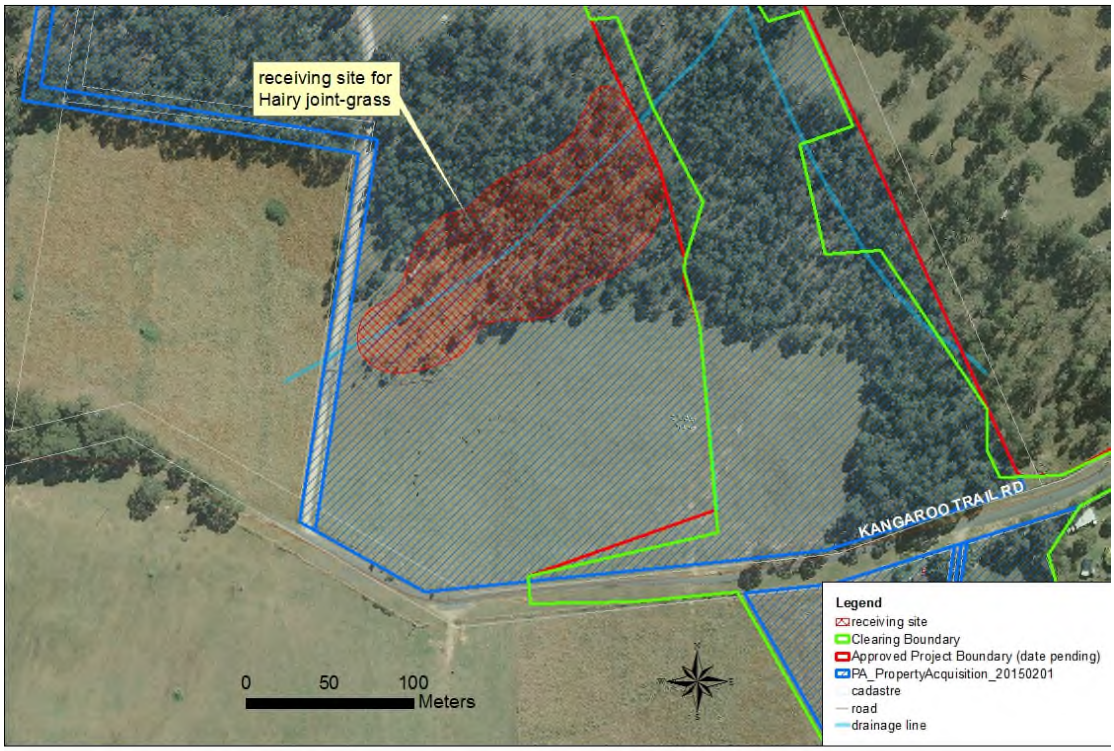
PACIFIC HWY
RANDLES CK
10
Fig A5.27 West of Pimlico Rd
Project: RMS Translocation
Date: July 2015
0
50
100
Meters
Bushland Restoration Services Pty Ltd
(ABN 44105030573 - ACN 105030573)
Rhonda James
Phone: 0266761284
Email: gorambil@bigpond.com.au
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 548 876, ACN 064 548 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66854430
Email: landmark@landmarkonline.com.au
Map Grid of Australia - Zone 56
Legend
Green-leaved rose walnut
Hairy-joint grass
Red lilly pilly
Stinking cryptocarya
White lace flower
Hairy-joint grass polygon
section line
road
drainage line
Clearing Boundary
Approved Project Boundary (date pending)
Acquisition Boundary

# Appendix 6 Receiving sites

Sites listed south to north.

## 6.1 Kangaroo Trail Road

**Donor species:** Hairy joint-grass
**Location:** Kangaroo Trail Road
The receiving site is located in Section 1, approximately 35km south of Mitchell Road intersection donor site. Additional donor material from Section 1 will also be received.




**Tenure:** Roads and Maritime
**Threats:** Weeds and unauthorised access by motor bikes and vehicles. Maintenance of existing hydrology. Appropriate management to maintain biomass at suitable level.
**Vegetation type:** The site is mapped as Swamp Box - Swamp forest and Blackbutt – Bloodwood dry open forest. Small scale variations in the vegetation depending on drainage lines have produced patches and strips of vegetation with suitable hydrological conditions.
**Weed species:** Exotic herbs and grasses
**Cover:** Sparse to common
**Site suitability**: Hairy joint-grass occurs in a range of native and exotic vegetation types. Suitable hydrological conditions are critical and have been located adjacent to a drainage line.
**Reference Site:** No local populations of Hairy joint-grass that could function as reference sites are known. Development of the translocated plants can be compared with reference sites at Trustums Hill (Early Works Soft Soil Treatment Area), but the distance between the receiving site and reference site will require consideration when observations are interpreted.

Pre Translocation management

Fence site to restrict vehicle and motorbike access.

The donor population is small and within a drainage line. Ensure that selected receiving location is suitable similar habitat within a drainage line.

Identify and mark with flagging tape the location for Hairy joint-grass within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Spot spray groundcover exotic herbs and grasses. Hand weed if site has ponded water.

Prior to translocation the site is to be weed free and prepared for receival.

After weed control excavate similar sized slab to the donor slab in preparation for receival on that day.

Drainage line at Kangaroo Trail May 2015

Translocation Management

The small donor population to be removed as one slab and taken directly to the receiving site.
Propagated seedlings to be planted in well prepared seedbed and bamboo stake placed next to individual plants.

Record and tag the slab and individual plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts. Control weeds on a regular basis.

Regular management to maintain biomass at suitable level by grazing or slashing and raking or spot spray during winter.

## 6.2 Mahogany Drive, Pillar Valley

(Biodiversity Offset Site no 25)

**Donor species:** Slender screw fern

Site 25 is also an important offset for Sandstone rough-barked apple, and provides opportunities for additional management actions to enhance a genetically fairly pure population of the species. As translocation of directly impacted trees from hybrid zones within the project corridor has been assessed as not feasible (Section 2.4, Appendix 3) the property provides opportunities for alternative measures of benefit to the species.

**Location**: 100 Mahogany Drive, Pillar Valley
Receiving site is in the north west corner of the property adjacent to a known occurrence of Slender screw fern (Jacobs 2014d). Distance from donor site at Mororo SF is 51 km.

Two suitable locations with good access were identified. In addition, the creek lines continue away from access tracks and will provide other alternatives.

Site 1 Grid reference 512099, 6705777 (care necessary to avoid damage to Moonee Creek Quassia at this location, see below)

Site 2 Grid reference 512186, 6705790

**Tenure**: Roads and Maritime
**Threats**: Close proximity to internal access track along boundary. Install protective fencing to restrict access.
**Vegetation type**: Edge of Red mahogany – Blackbutt forest and Swamp mahogany – Paperbark forest (structure below refers to Site 1 but is typical of wider area)

| Stratum | Height (m) | Crown Cover (%) | Species 1 | Species 2 | Species 3 |
|---|---|---|---|---|---|
| Upper | 15-20 | 10 | *Eucalyptus pilularis* | *E. resinifera* | |
| Mid | 5-10 | 10 | *Melaleuca quinquenervia* | *Lophostemon suaveolens* | *Melaleuca alternifolia* |
| Lower | 1-3 | 10 | *Gahnia clarkei* | *Lomandra longifolia* | |
| Ground | 0-1 | 80 | *Pteridium esculentum* | *Imperata cylindrica* | *Gahnia clarkei* |

The north west corner of property is low-lying, with altitude 20-50 m ASL, and is dissected by minor creek lines.
**Weeds**: Exotic herbs and grasses
**Cover**: Sparse
**Site suitability**: The site matches with one example of habitat described for Slender screw fern, as summarised in Appendix 3 i.e. Dry eucalypt forest on sandstone. Small scale variation within the vegetation type results from dissecting drainage lines. Slender screw fern is usually found in waterlogged or poorly drained sites along creeks, where ferns, sedges and shrubs grow thickly.
The species is already present, confirming that site characteristics suit the requirements of the taxon.

**Reference site**

The existing populations of Slender screw fern adjacent to the receiving sites will function as controls to gauge appropriate expectations for the development of translocated plants. Slender screw fern has been observed to die back in dry conditions. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations, an absence of plants at the receiving sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.


Pre translocation management

Identify and mark with flag a single stem of Moonee Creek Quassia at 512099, 6705777, trackside. Ensure that all personnel entering the area are aware of the need to avoid impacts.

Identify and mark with bamboo stakes and pink tape, any existing occurrences of Slender screw fern adjacent to the receiving locations. Ensure that all personnel entering the area are aware of the need to avoid impacts.

Identify and mark with flagging tape suitable receiving locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Due to the distance from donor site this site will be priority 2 for receival.

The donor population covers an area of 0.0127ha. As much as possible of this population will be translocated. Ensure that receiving area is suitable habitat and after weed control excavate an area in preparation for receival of slabs up to approximately 30cm x 30cm.

Weeds are sparse and if observed to be removed manually, ensuring that whole plant is removed.

Prior to translocation: the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.


Mahogany Drive July 2015

Translocation Management

The population to be removed in slabs and taken directly to the receiving site. Keep protected and moist in transit.

Record and tag the slabs with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.3 Pine Brush SF road reserve

**Donor species:** Four-tailed Grevillea
**Location:** The receiving site is adjacent to the donor site.
**Tenure:** Roads and Maritime
**Threats:** Highway edge, likely to require protective barrier
**Vegetation type:** Swamp forest on sandy soils
**Weed species:** Exotic herbs and grasses, Lantana
**Cover:** Sparse to common
**Site suitability:** The site is in close proximity to the donor site. There is a small site located to the west of donor site and larger site on the eastern side of the clearing boundary. See Figure A5.6 Pine Brush SF.
The species is already present, confirming that site characteristics suit the requirements of the taxon.
**Reference sites**
Monitoring sites Gq 3.1 and 3.2 at Tucabia north of Tallowwood (Jacobs 2015) will be employed for reference and will assist to gauge the potential for translocated plants to complete their life cycle – comparison of flowering and fruiting timing and intensity.

Pre Translocation management

Identify and mark with flagging tape a suitable location for planting within the site. The receiving site to include a buffer zone being the whole of the area between the clearing boundary and the project boundary. Within the buffer weeds are to be controlled to reduce invasion into the receiving site.

The donor population is small and located close to the upper bank of the creek. Ensure that selected receiving area is suitable habitat.
Spot spray groundcover weeds and cut, scrape and paint the woody weeds. Lop cut stems into small billets and leave on site.
Prior to translocation: the site is to be weed free and prepared for receival.
Experienced bush regeneration team to follow hygiene protocols and best practice.

Receiving site on west of clearing area. July 2015

Translocation Management

Seedlings which have been previously removed and potted on or planted and grown on from seed to be taken to the receiving site. Seedlings and cuttings to be planted in well prepared bed and bamboo stake placed next to individual plants.

Record and tag the plants with identification used in nursery on collection of seed or seedlings.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.4 Tucabia north of Tallowwood road reserve

**Donor species:** Four-tailed Grevillea
**Location:** The receiving site is adjacent to the donor site.
**Tenure:** Roads and Maritime
**Threats:** Highway edge, likely to require protective barrier. Plants impacted by disturbance prior to translocation.
**Vegetation type:** From Jacobs (2015) Gq3.1 Turpentine forest

| Stratum | Height (m) | Crown Cover (%) | Species 1 | Species 2 | Species 3 |
|---|---|---|---|---|---|
| Upper | 15-20 | 9 | *Syncarpia glomulifera* | *Eucalyptus psammitica* | *Corymbia intermedia* |
| Mid | 1.5-10 | 8 | *Allocasuarina torulosa* | *Leptospermum trinervium* | |
| Ground | 0-1.5 | 55 | *Entolasia stricta* | *Imperata cylindrica* | |

**Weed species:** Exotic herbs and grasses, Lantana
**Cover:** Sparse to common
**Site suitability:** The site is in close proximity to the donor site. The site is located to the west of donor site adjacent to remaining population.
The species is already present, confirming that site characteristics suit the requirements of the taxon. See Figure A5.5 Tucabia north of Tallowwood.
**Reference sites**
Monitoring sites Gq 3.1 and C3.1 (Jacobs 2015) will be employed for reference and will assist to gauge the potential for translocated plants to complete their life cycle – comparison of flowering and fruiting timing and intensity.

Pre Translocation management

Identify and mark with flagging tape a suitable location for planting within the site. The receiving site to include a buffer zone being the whole of the area between the clearing boundary and the project boundary. Within the buffer weeds are to be controlled to reduce invasion into the receiving site.
The donor population is small and an extension of a larger population. Ensure that selected receiving area is suitable habitat.
Spot spray groundcover weeds and cut, scrape and paint the woody weeds. Lop cut stems into small billets and leave on site.
Prior to translocation: the site is to be weed free and prepared for receival.
Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation management

Seedlings which have been previously removed and potted on or planted from seed to be taken to the receiving site. Seedlings and cuttings to be planted in well prepared bed and bamboo stake placed next to individual plants.

Record and tag the plants with identification used in nursery on collection of seed or seedlings.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.5 Yaegl Nature Reserve south

**Donor species:** Tall knotweed

**Location**: Yaegl Nature Reserve south is up to 3km from donor sites in the vicinity of Yaegl NR, also South Arm and Maclean Interchange. Suitable habitat extends along the edge of the vegetation for at least 50m north east and 20m south west of an existing population of Tall knotweed.

All donor sites and *in situ* populations are hydrologically connected to the proposed receiving site during floods. Genetic differentiation between the occurrences is unlikely and there is no impediment to mixing of material from multiple local patches in plantings proposed at the receiving site.

**Tenure**: Nature Reserve.
**Threats**: Weeds, maintenance of suitable hydrological conditions required.

**Vegetation type:** Swamp sclerophyll forest

| Stratum | Height (m) | Crown Cover (%) | Species 1 | Species 2 | Species 3 |
|---|---|---|---|---|---|
| Upper | 12 -18 | 10 (edge) | *Melaleuca quinquenervia* | | |
| Mid | | | | | |
| Lower | 0-1 | 10-50 (patchy) | *Eleocharis equisetina* | *Phragmites australis* (edge) | *Enydra fluctuans* |

**Weeds** Exotic grasses extend along adjacent edge
**Cover**: Sparse within the receiving site to dense on adjacent edges.
**Site suitability**: The site matches with the known habitat of Tall knotweed, as summarized in Appendix 3 i.e. damp places, swamp forest or associated with disturbance. Edge of *Melaleuca quinquenervia* communities. See Figure A5.11 Yaegl central and south.
Tall knotweed is already present, confirming that site characteristics suit the requirements of the species.
**Reference sites:** The existing populations of Tall knotweed adjacent to the receiving sites will function as controls to gauge appropriate expectations for the development of translocated plants. Tall knotweed is known to respond to rainfall events, which may be erratic, by developing from freshly dispersed or soil-stored seeds in a timeframe that will vary with seasonal factors. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations, an absence of plants at the donor sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.


Typical donor site February 2015


Receiving site Yaegl NR south July 2015

Pre-translocation management
Identify the extent of the receiving site and suitable locations within the site for slabs, clumps or nursery-raised plants. Mark out the locations with timber stakes and flagging tape, also metal pegs for location with metal detector if necessary. The receiving site to have a buffer zone of 5m where weeds are controlled to reduce invasion into the receiving site. Remove slabs approximately 30cm x 30cm in preparation for receival of donor slabs.

Prior to receiving the plant material the receiving sites are to be weed free. Spot spray the tall exotic grasses throughout the receival areas and extend to include the two existing populations. Do not spray over pooled water or within 5m of any patch of Tall knotweed.

Experienced bush regeneration team to follow hygiene protocols and best practice. Care to be taken in preparation to cause minimum disturbance to the site.

Post translocation management
Record and tag the plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.6 Bundjalung NP adjacent Mororo SF

**Donor species:** Slender screw fern
**Location**: Bundjalung NP
Receiving site is to the east of the donor site along the same creek line. Slender screw fern is likely to be present in the receiving site due to similarity of habitat and close proximity to existing population.
**Tenure**: National Park
**Threats**: Weed invasion
**Vegetation type:** Subtropical Coastal Floodplain Forest
**Weeds**: Exotic herbs and grasses, Lantana
**Cover**: Sparse
**Site suitability**: The site is similar habitat and located on the same creekline as donor site. The species is likely to be present in the national park. See Figure A5.14 Mororo SF.

**Reference site**
The existing populations of Slender screw fern to the west of the receiving sites will function as controls to gauge appropriate expectations for the development of translocated plants. Slender screw fern has been observed to die back in dry conditions. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations, an absence of plants at the receiving sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.

Pre translocation management

Identify and mark with bamboo stakes and pink tape, any existing occurrences of Slender screw fern adjacent to the receiving locations. Ensure that all personnel entering the area are aware of the need to avoid impacts.

Identify and mark with flagging tape suitable receiving locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

The donor population covers an area of 0.0127ha. As much as possible of this population will be translocated to this site. Ensure that receiving area is suitable habitat and after weed control excavate an area in preparation for receival of slabs up to approximately 30cm x 30cm.

Prior to translocation: the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Post translocation Management

Slabs to be transported to the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.7 Tabbimobile triangle

**Donor species:** Singleton mintbush
The receiving site is within and adjacent to a patch of Singleton mintbush, adjoining the donor site.
**Tenure:** RMS
**Threats:** Likely to be fire sensitive, weeds, cattle, edge effects from new highway construction.
**Vegetation Description:** Moist sclerophyll forest

| Stratum | Height (m) | Crown Cover (%) | Species 1 | Species 2 | Species 3 |
|---|---|---|---|---|---|
| Upper | 25 | 60 | *Eucalyptus pilularis* | *Eucalyptus propinqua* | |
| Mid | 5-15 | 20 | *Acacia* | *Melaleuca quinquenervia* | |
| Lower | 0-0.5 | 10 | *Gahnia melanocarpa* | *Panicum* sp. | *Pratia purpurascens* |

**Weeds:** Exotic herbs and grasses, Lantana, Cuphea
**Cover:** Sparse
**Site suitability:** The site is in close proximity to the donor site, to the west.
Singleton mintbush is already present, confirming that site characteristics suit the requirements of the species. See Figure A5.15 Tabbimobile.
**Reference sites:**
Monitoring site Pc 6.1C on the east of the highway (Jacobs 2015) will be employed for reference and will assist to gauge the potential for translocated plants to complete their life cycle – comparison of flowering and fruiting timing and intensity.

Pre Translocation management

Ensure fencing is installed to restrict cattle access to the site.

Identify and mark with flagging tape suitable locations within the site. Weeds to be controlled within the vegetated section of the triangle to provide a buffer to reduce impacts within the receiving site.

Cuttings, seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Larger trees may be able to be transplanted when construction machinery in vicinity of site.

Spot spray throughout the site to control groundcover weeds. Scattered Lantana can be hand pulled or cut, scrape and painted and lopped into billets and left on site.

Prior to translocation the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Tabbimobile triangle July 2015

Post translocation Management

Plants to be transported to the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.8 Jackybulbin BO Site 13

**Donor species:** Singleton mintbush
The receiving site is within and adjacent to a large population of Singleton mintbush located on the banks of Tabbimobile Creek and <0.5km from the donor site. A further population is present further east on the same creek bank. Jacobs (2014b) considers that this south west corner of the property is a revegetation option in which existing natural regeneration could be facilitated to improve condition of potential Sub-tropical Coastal Floodplain Forest.
**Tenure:** Private, candidate for Biodiversity Offset Package with conservation covenant.
**Threats:** Likely to be fire sensitive. Weeds. Edge effect from adjacent highway on western boundary of existing population and transplants.

**Vegetation Description:** Moist sclerophyll forest

| **Stratum** | **Height (m)** | **Crown Cover (%)** | **Species 1** | **Species 2** | **Species 3** |
|---|---|---|---|---|---|
| Upper | 25 | 40 | *Eucalyptus pilularis* | *Corymbia intermedia* | |
| Mid | 3-8 | 40 | *Acacia disparrima* | *Alphitonia excelsa* | *Glochidion ferdinandii* |
| Lower | 0-1 | 20 | *Gahnia melanocarpa* | *Panicum* sp. | *Pratia purpurescens* |

**Weeds:** Exotic herbs and grasses, Lantana
**Cover:** Sparse
**Site suitability**: The site matches with the known habitat of Singleton mintbush, as summarized in Appendix 3 i.e. damp places, swamp forest or associated with disturbance. Edge of *Melaleuca quinquenervia* communities.
Singleton mintbush is already present, confirming that site characteristics suit the requirements of the species. See Figure A5.15 Tabbimobile.
**Reference sites:** The existing populations of Singleton mintbush within and adjacent to the receiving site will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.

Jackybulbin receiving site June 2015

Pre Translocation management

Identify and mark with flagging tape suitable locations within the site. Weeds to be controlled to provide a minimum 10m buffer to reduce impacts within the receiving site.

Cuttings, seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Larger trees may be able to be transplanted when construction machinery in vicinity of site.

Spot spray throughout the site to control groundcover weeds. Scattered Lantana can be hand pulled or cut, scrape and painted and lopped into billets and left on site.

Prior to translocation the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Post translocation Management

Plants to be transported to the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway if located at the west of the receiving site.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.9 Bundjalung NP, Tabbimobile

**Donor species:** Singleton mintbush, Weeping paperbark
The receiving site is close to (<0.5km) to the Singleton mintbush donor site and approximately 16 km from the New Italy Weeping paperbark donor site.
**Tenure:** National Park
**Threats:** Likely to be fire sensitive
**Vegetation Description:** Moist sclerophyll forest

| Stratum | Height (m) | Crown Cover (%) | Species 1 | Species 2 | Species 3 |
|---|---|---|---|---|---|
| Upper | 25 | 40 | *Eucalyptus pilularis* | *E. acmenoides* | *Syncarpia glomulifera* |
| Mid | 8 | 40 | *Acacia disparrima* | *Melaleuca quinquenervia* | |
| Lower | 0-0.5 | 10 | *Gahnia melanocarpa* | *Entolasia stricta* | *Pratia purpurascens* |

**Weeds:** Exotic herbs and grasses, Lantana
**Cover:** Sparse
**Site suitability**: The site matches with the known habitat of Singleton mintbush on sandy banks of Tabbimobile creek in swamp forest and Weeping paperbark on coastal floodplain forest. Singleton mintbush is present on the adjacent property to the north. See Figure A5.15 Tabbimobile.
**Reference sites:** Singleton mintbush - the existing populations of Singleton mintbush on the adjoining property to the north of the receiving sites will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.
Weeping paperbark - the remaining population of Weeping paperbark at New Italy will function as controls to ascertain whether flowering and fruiting gauge appropriate expectations for the development of translocated plants.

Pre Translocation management
Identify and mark with flagging tape suitable locations within the site for both species. Weeds to be controlled to provide a minimum 10m buffer to reduce impacts within the receiving site. Seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Access would be difficult to transplant larger specimens.

Spot spray throughout the site to control groundcover weeds. Scattered Lantana can be hand pulled or cut, scrape and painted and lopped into billets and left on site.

Prior to translocation the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.


Bundjalung NP at Tabbimobile July 2015

Post translocation Management

Seedlings grown from collected seed or moved from the donor population for growing on at nursery to be carried into the site. Ensure they are protected during transit.

Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.10 1457 Myall Creek Road (Bungawalbin offset for Devil's Pulpit upgrade)

**Donor species:** Weeping paperbark
The receiving site is approximately 16km from the New Italy donor site.
**Tenure:** National Park
**Threats:** Fire in early development of plants.
**Vegetation Description:** Floodplain swamp forest
**Weeds:** Lantana, Groundsel, exotic herbs and grasses
**Cover:** Sparse to common
**Site suitability**: Benchmark (2012) describes large areas of floodplain and swamp vegetation types that will be suited to the establishment of Weeping paperbark.
**Reference sites:** No immediately local populations of Weeping paperbark that could function as reference sites are known. Development of the translocated plants can be compared with reference sites at New Italy. The distance between the receiving site and reference site will require consideration when observations are interpreted.

Pre Translocation management

Seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Access would be difficult to transplant larger specimens.

Identify and mark with flagging tape suitable locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Control woody weeds such as Lantana and Groundsel but cut, scrape and paint and spot spray groundcover weeds.

Prior to translocation the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation Management

Plants to be transported to the site on same day as planting.

Record and tag all plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

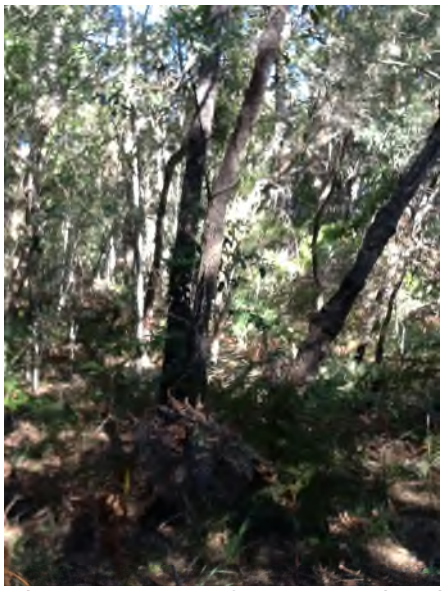
## 6.11 Bundjalung NP, Gummigurrah Trail picnic area

**Donor species:** Yellow-flowered king of the fairies

**Location:** Between the access road and river.
The receiving site is located approximately 8km from the donor site on Woodburn-Evans Head Road.
**Tenure:** National Park
**Threats:** Human visitation and possible illegal collection, fire (this strip of vegetation is protected from frequent fires that characterise vegetation on the south side of the access road).
**Vegetation Description:**
Forest dominated by Pink bloodwood with moderately dense littoral rainforest species in the mid-storey and mangroves fringing. The targeted host trees, Swamp oak, are scattered throughout, mostly on the river side but some within the adjoining forest. Patches of paperbark swamp interspersed.

Suitable trees or clumps are identified:

| Clump no | Easting | Northing | Description | Notes |
|---|---|---|---|---|
| 1 | 540454 | 6777085 | Patch of ~12 small to medium trees at turning circle | Less shelter than ideal |
| 2 | 540935 | 6777740 | Single mature tree at edge of picnic area | South-facing location on trunk will be out of sight from picnic area |
| 3 | 541239 | 6777879 | Group of ~8 medium trees on the bank of a small tributary | Distant from picnic area and tracks |
| 4 | 541387 | 6777937 | Single mature tree on edge of paperbark stand | South-facing location on trunk will be out of sight from track |


Clump 3 Group of Swamp oak July 2015


Clump 4 Swamp Oak trunk July 2015

**Weeds:** Very few exotic species, not threatening to epiphytes
**Site suitability**: Host trees of the same species as at the donor site are present, together with littoral rainforest species which are likely to suit the orchids and may be colonised in the future. The site is not subject to the frequent fires which occur in adjacent areas of the park.

Pre Translocation management
(Donor plants are located in clumps or as single plants on three Swamp oak host trees, with height ranging from 1.5 to 8m from the ground).

Identify and mark with flagging tape suitable trees and attachment points.

Translocation Management
Orchids to be placed on the south-facing side of trunks (as observed at donor site), high enough to be beyond unassisted human reach but low enough to be within the shelter of the rainforest mid-storey. Placement should be out of sight from tracks and picnic areas to best possible.

## 6.12 Yarringully NR

**Donor species:** Weeping paperbark
The receiving site is approximately 10 km from the New Italy donor site.
**Tenure:** Nature Reserve
**Threats:** Straying cattle, pig hunting. Risk of wildfire is low compared with over-burnt vegetation in the general area.
**Vegetation Description:** Clearing surrounded by Floodplain sclerophyll forest
Receiving site is located in an old house clearing where natural regeneration is now beginning, likely to require management. The site is traversed by the main fire trail, the loop track Quill Trail. Access is thus readily possible depending on soil moisture.
**Weeds**: Lantana, Groundsel
**Cover**: Sparse
**Site suitability**: Floodplain and swamp vegetation types that will be suited to the establishment of Weeping paperbark.
**Reference sites:** No immediately local populations of Weeping paperbark that could function as reference sites are known. Development of the translocated plants can be compared with reference sites at New Italy. The distance between the receiving site and reference site will require consideration when observations are interpreted.


Pre Translocation management

Seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Access would be difficult to transplant larger specimens.

Identify and mark with flagging tape suitable locations within the site. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Control woody weeds such as Lantana and Groundsel but cut, scrape and paint and spot spray groundcover weeds.

Prior to translocation the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation Management

Plants to be transported to the site on same day as planting.

Record and tag all plants with identification used on collection.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

## 6.13 Lumleys Lane BOS 22 Pasture

**Donor species:** Hairy joint-grass
The receiving sites are adjacent to the donor sites.
**Tenure:** RMS
**Threats:** Exposure to highway, weeds, grazing regime
**Vegetation Description:** Exotic grassland / edge of freshwater wetland
**Weeds:** Lantana, exotic herbs and grasses
**Cover:** Common
**Site suitability** The site is in close proximity to the donor sites. The sites are located adjacent to the donor sites.
Hairy joint-grass already present, confirm that site characteristics suit the requirements of the species. Figure A5.23
**Reference sites:** The existing populations of Hairy joint-grass within and adjacent to the receiving sites will function as controls to ascertain whether flowering and fruiting and gauge appropriate expectations for the development of translocated plants. Observations of the reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations an absence of plants at the donor sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.

Pre Translocation management

Identify and mark with flagging tape suitable locations within the site as close as possible to location of existing records. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Spot spray exotic herbs and grasses during winter when Hairy joint-grass is dormant.

Prior to translocation the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.

Translocation Management

See receiving site 1 Kangaroo Trail for Hairy joint-grass.

## 6.14 Coolgardie Road BOS 24 Pasture

**Donor species:** Hairy joint-grass
The receiving site is adjacent to and within 1km from several Hairy joint-grass donor sites in the Coolgardie-Wardell area (Figure A5.26).
**Tenure:** RMS
**Threats:** Proximity to highway, may require protective barrier
**Vegetation Description:** (Jacobs 2014h) Pasture/wetland surrounded by Floodplain sclerophyll forest
**Weeds:** Exotic herbs and grasses
**Cover:** Sparse to common
**Site suitability**: The site is in close proximity to the donor sites. The site is located to the north and south west of donor sites. Hairy joint-grass already present, confirming that site characteristics suit the requirements of the species.
**Reference sites:** The existing populations of Hairy joint-grass within and adjacent to the receiving sites will function as controls to ascertain whether flowering and fruiting and gauge appropriate expectations for the development of translocated plants. Observations of the

reference sites will guide the timing of monitoring observations and assist their interpretation i.e. if above-ground plants are not present in the reference populations an absence of plants at the donor sites will not be interpreted as a failure of translocation. Four 1 x 1 m square quadrats will be marked at known locations in the adjacent populations.

Pre Translocation management

Identify and mark with flagging tape suitable locations within the site as close as possible to location of existing records. The receiving site to include a buffer zone of 10m where weeds are controlled to reduce invasion into the receiving site.

Spot spray exotic herbs and grasses during winter when Hairy joint-grass is dormant.

Prior to translocation the site is to be weed free and prepared for receival.

Experienced bush regeneration team to follow hygiene protocols and best practice.

West of Kays Lane July 2015

Translocation Management

See receiving site 1 Kangaroo Trail for Hairy joint-grass.

## 6.15 Lumleys Lane BOS 22 Buckombil BOS 17 Meridian Drive BOS 23

**Rainforest donor and receiving sites**

Three properties provide opportunities for translocation operations for a group of rainforest tree species. The species are Green-leaved rose walnut, Red lilly pilly, Rough-shelled bush-nut, Stinking Cryptocarya and White laceflower.

General methods to be used include propagation from seed and cuttings, digging and potting of seedlings and excavation and transplant of saplings and mature trees.

All three properties include large areas of rainforest and regrowth rainforest, usually dominated by exotic species, with diverse rainforest understoreys. In combination with the weed management programs that are proposed for these areas of regrowth, planting of seed and cutting propagated plants into regenerating rainforest habitat is a recommended approach.

Cleared areas, forest or edges with machinery access will be required for transplants of mature trees. Such areas are present on the lower slopes of the escarpment, where soils are of intermediate to high fertility, as a result of basalt substrate or the influence of basalt from the ridge tops, and are well suited to the rainforest species.

**Reference sites:** Rainforest species - the existing populations of rainforest species on the properties adjacent to the receiving sites will function as controls to ascertain whether flowering and fruiting and gauge appropriate expectations for the development of translocated plants.

## 6.16 Lumleys Lane BOS 22 Rainforest

**Donor species:** Rainforest trees
The receiving site is up to 1km from a number of donor sites for all species in the Coolgardie-Wardell area.
**Tenure:** RMS
**Threats:** Exposure to highway, weeds
**Vegetation Description:**
Jacobs (2014e) classify the rainforest as Biometric type White Booyong – Fig subtropical rainforest of the North Coast.
Dominant canopy species: *Aphananthe philippinensis, Livistona australis, Cryptocarya obovata, Guioa semiglauca, Endiandra pubens, Diploglottis cunninghamii*
Dominant mid storey species: *Wilkiea huegeliana, Streblus pendulinus, Breynia oblongifolia, Maclura cochinchinensis, Pittosporum multiflorum*
Dominant lower storey species: *Cissus antarctica, Alpinia caerulea, Doodia aspera, Trophis scandens, Calamus, muelleri, Cordyline petiolaris*
**Weeds:** Camphor Laurel, Large-leaved Privet, Lantana, exotic herbs and grasses
**Cover:** Sparse to common
**Site suitability** The site is in close proximity to the donor sites. The site is located to the north and south west of donor sites.
Rainforest species already present, confirm that site characteristics suit the requirements of the species. Figure A5.23

Lumleys Lane July 2015

## 6.17 Buckombil BOS 17 Rainforest

**Donor species:** Rainforest species
The receiving site is up to 4km from several donor sites in the Coolgardie-Wardell area to the north.
**Tenure:** Private, candidate for Biodiversity Offset Package with conservation covenant.
**Threats:** Weeds
**Vegetation Description:** Subtropical rainforest White Booyong -Fig subtropical rainforest of the North Coast (Jacobs 2014f).
Canopy dominants:
*Argyrodendron trifoliolatum, Ficus macrophylla, Flindersia schottiana, Ficus obliqua, Araucaria cunninghamii, Dendrocnide excelsa*
Mid storey dominants:
*Sloanea australis, Archontophoenix cunninghamiana, Cryptocarya obovata, Endiandra pubens, Dysoxylum fraserianum*
Lower storey dominants:
*Trophis scandens, Cissus hypoglauca, Calamus muelleri, Alpinia caerulea, Alocasia brisbanensis, Maclura cochinchinensis.*
**Weeds:** Lantana, Mistflower, Large and small-leaved Privet, exotic herbs and grasses.
**Cover:** Sparse to dense
**Site suitability**: Areas of subtropical rainforest present on the site.

## 6.18 Meridian Drive BOS 23 rainforest

**Donor species:** Rainforest species
The receiving site is up to 2km from several donor sites in the Coolgardie-Wardell area.
**Tenure:** Private, candidate for Biodiversity Offset Package with conservation covenant.
**Threats:** Weeds
**Vegetation Description:** Subtropical rainforest
**Weeds:** Lantana, Large-leaved privet
**Cover:** Sparse to dense
**Site suitability**: Areas of subtropical rainforest present on the site.

Pre Translocation management

Install protective barrier if translocated species to be placed in close proximity to the edge of clearing zone.

Identify and mark with flagging tape suitable locations within the site. Weeds to be controlled to provide a minimum 10m buffer to reduce impacts within the receiving site. Select sites within gaps or on the edge of existing rainforest.

Cuttings, seedlings grown from collected seed or moved from the donor population for growing on at nursery will be transplanted to the site. Larger trees to be transplanted on forest edges or easily accessible gaps in the forest.

Spot spray throughout the site to control groundcover weeds. Woody weeds such as Lantana and Privet to be cut, scrape and painted and lopped into billets and left on site. Larger woody weeds and Camphor Laurel to be drill and injected and left in situ.

Prior to translocation the site is to be weed free and prepared for receival.
Experienced bush regeneration team to follow hygiene protocols and best practice.

Post translocation Management

Plants to be transported to the sites. Ensure they are protected during transit.
Record and tag all plants with identification used on collection. Plants may require protective barrier fencing to reduce impacts from highway.

Water well on planting. Water as required depending on weather. Monitor plants and site for occurrence of weeds and other impacts.

# Appendix 7 Change of Translocation Receival Sites for *Melaleuca irbyana* (Weeping Paperbark) for Portion C

| | | | |
|---|---|---|---|
| **To:** | Peter Higgs (EPA), Murray Curtis (ERM), Scott Lawrence (RMS), Woods, Mark (Pacific Complete), Jason Sheehan (RMS), Brian Tolhurst (EPA), Matthew Stephens (RMS) | Date: | 18/04/17 |
| **From:** | Tom St Vincent Welch (Pacific Complete) | | |
| **cc:** | Mathew Neeson (Pacific Complete), Jasmine Walden (PC) | | |
| **Subject:** | Change of translocation receival sites for Melaleuca irbyana (Weeping Paperbark) on Portion C. | | |

As part of the approved Woolgoolga to Ballina (W2B) Pacific Highway Upgrade Translocation Strategy, the translocation of *Melaleuca irbyana* (Weeping Paperbark) is required.

Dr Andrew Benwell, who is contracted to undertake translocation works on W2B, has identified the receival sites listed within the Translocation Strategy as not suitable for receival of this species due to access difficulties and inundation of floodwaters. Below is a statement from Andrew Benwell regarding the proposed changes:

> *"I inspected prospective Melaleuca irbyana (Weeping Paperbark) receival sites on 8/4/17and found a suitable area in the Biobanking property at Tabbimoble Creek on the western side of the highway. Access to the other two sites at Bungalwalbin is still blocked by floodwater so they are probably much too wet for planting.*
>
> *The larger paddock areas on the Tabbimoble Creek land are all still waterlogged but the sites shown on the attached plan have drained sufficiently to be able to plant. Floodwater has been over the sites but they drain a bit faster. The sites are on the western side of a small creek which has a good crossing underlain with stones so there should be no problems with access. The sites are large open clearings surrounded by floodplain forest of Swamp Box, Forest Red Gum, Broad-leaved Paperbark, Casuarina glauca and White Stringybark, which will make the site more sheltered. I inspected cleared areas at the northern end of the land but they were too waterlogged.*
>
> *Melaleuca irbyana grows in floodplain situations as well as on relatively dry rises such as at New Italy. The site identified is on a slight dome so in between wet and dry. Two areas have been selected with slightly different drainage, soil texture and exposure."*

The proposed translocation sites within the above Roads and Maritime owned property are located within areas that will be protected by an in-perpetuity BioBanking agreement.

To increase the likelihood of a successful translocation of the species and the provision of safe and reliable access for monitoring and maintenance at the site, the proposal from Andrew Benwell as above is recommended to be implemented. If agreed, the W2B Translocation Strategy would be updated to reflect the changed location.