APPENDIX F

MAULES CREEK TYLOPHORA LINEARIS OFFSET PACKAGE

AND

TYLOPHORA LINEARIS PROPAGATION AND TRANSLOCATION PROGRAM

Maules Creek Coal Mine

Tylophora linearis Offset Package

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EXECUTIVE SUMMARY

Tylophora linearis is a small twining plant that is listed as 'Vulnerable' in the schedules of the New South Wales (NSW) *Biodiversity Conservation Act 2016* (BC Act) and as 'Endangered' in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species was identified within the Maules Creek Coal Mine (MCCM) Project Boundary during pre-clearing flora surveys by Niche Environment and Heritage (Niche) in 2014.

This report describes the offset package being undertaken for *Tylophora linearis*. An offsets package is a suite of actions that a proponent undertakes in order to compensate for the residual significant impact of a project. It can comprise a combination of direct offsets and other compensatory measures.

Whitehaven established the following direct and other compensatory measures for the species as part of the offsets package:

1. Conservation of existing habitat for *Tylophora linearis* within offset areas;
2. Revegetation of woodland/forest within areas of former *Tylophora linearis* habitat;
3. Implementation of a root architecture and growth study for *Tylophora linearis*;
4. Seed production monitoring for *Tylophora linearis*;
5. Collection and storage of seed;
6. *Tylophora linearis* propagation;
7. Translocation trials; and
8. Regional surveys.

The *Approved Conservation Advice for Tylophora linearis* recognises the following directly relevant priorities for *Tylophora linearis:*

- *Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants;*
- *Determine the distribution and viability of surviving populations;*
- *Investigate seed viability, germination, dormancy, and longevity in storage and the natural environment, to determine the requirements for successful establishment;*
- *Conduct research to determine ecological requirements and undertake field studies to monitor seedling establishment and survivorship;*
- *Undertake appropriate seed collection and storage for NSW Seedbank and develop collection program of multiple provenances of Tylophora linearis in collaboration with the Botanic Gardens Trust;* and
- *Implement national translocation protocols if establishing additional populations is considered necessary and feasible.*

While loss at an approved mine site may be unavoidable, the above compensatory measures have led to:

1. Conservation of existing habitat for *Tylophora linearis* within land-based offset areas (approximately 3,707.5 hectares [ha]) satisfies 107.63 percent (%) of the offset requirement according to the *Offsets Assessment Guide*.
2. Active revegetation of woodland/forest in areas of former *Tylophora linearis* habitat.
3. A greater understanding of the regional occurrence of the species. Targeted surveys initiated by Whitehaven confirmed the presence of the species in six National Parks and Wildlife Service reserves and six State Forests (Bibblewindi State Forest; Pilliga East State Forest; Pilliga National Park; Pilliga Nature Reserve; Pilliga State Conservation Area; Timallallie National Park; Breeza State Forest; Boonalla Aboriginal Area; Kerringle State Forest; Baradine State Forest; Euligal State Forest; and Trinkey State Conservation Area).
4. A greater understanding of the habitat types in which the species occurs in the region – a range of woodland at elevation range 200 metres (m) to > 600 m; slope of flat to > 8 degrees; seven Australian Soil Classification types; seven geological ages; and rainfall from 500 to 800 millimetres per year.
5. Germination and translocation trials have demonstrated that this is a feasible option for increasing the number of *Tylophora linearis* populations.
6. Root architecture studies have demonstrated that *Tylophora linearis* has in part a clonal growth habit which provides protection from fire and the capacity to conserve resources by losing surface stems during times of environmental stress.
7. A greater understanding of the life history of the species:
    - Vegetative growth studies have shown the species to have variable responses to environmental conditions to the extent that it is not possible to predict from month to month or from one year to the next when the plant becomes detectable by its above-ground stems, or how many stems might appear.
    - The species has been shown to remain dormant for several months and in one case a translocated stem remained dormant for in excess of three years.
    - The number of stems present at any particular time and location are only a portion of the entire population.
    - The species is predominantly present above ground as short leafy stems often twining on small grass stems and small shrubs.
    - Infrequently a stem will develop into a fertile plant.
    - The process of flowering and fruiting appears to also be dependent upon environmental conditions with buds, flowers or fruiting follicles often aborting.
    - Flowering to seed follicle development and seed release can occur over one month or take three or four months.

It is concluded that the *Tylophora linearis* offset package meets the EPBC Act *Environmental Offset Policy and Guide*. *Tylophora linearis* was recognised as a little known and cryptic species and the direct and compensatory measures have led to a greater understanding of the species and how it can be managed for conservation purposes. The *Tylophora linearis* offset package provides a significant addition to the reserved *Tylophora linearis* habitat (including additional confirmed records).

1 INTRODUCTION

1.1 Background

Tylophora linearis is a small twining plant that is listed as 'Vulnerable' in the schedules of the New South Wales (NSW) *Biodiversity Conservation Act 2016* (BC Act) and as 'Endangered' in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The species was identified within the Maules Creek Coal Mine (MCCM) Project Boundary during pre-clearing flora surveys by Niche Environment and Heritage Pty Ltd (Niche) (2014a) in 2014. Condition 32 of the MCCM EPBC Act Approval (EPBC 2010/5566) states:

> *In the event that any additional matters of national environmental significance are recorded with the project area and a significant impact on the matter/s is likely, the department must be notified in writing within 14 days of the matter/s being recorded. In accordance with Condition 37, the Minister may request that the person taking the action revise any relevant plans to ensure better protection of the relevant matter/s.*

The Commonwealth Department of the Environment (now Department of Agriculture, Water and Environment [DAWE]) was notified in 2014 that *Tylophora linearis* had been found and Whitehaven was requested to revise the Offset Management Plan (referred to as the Biodiversity Management Plan) to reflect the compensatory measures being undertaken for *Tylophora linearis.*

Hunter Eco prepared the *Tylophora linearis Management Recommendations Report* (Hunter Eco, 2014), which provided recommendations for the implementation of a propagation and translocation programme for *Tylophora linearis*. In a letter to Whitehaven (dated 18 July 2014), the Department states:

> …
>
> *the Department will accept, on a precautionary basis, a 3:1 ratio of known Tylophora linearis habitat. Alternatively, Whitehaven may apply the EPBC Act Environmental Offset Policy and Guide. Should you apply the offset policy, the Department recognises that this is a little known and cryptic species and that as such, compensatory measures may be appropriate.*
>
> …

The MCCM Biodiversity Management Plan (Offset Management Plan) was subsequently updated to reflect the recommendations.

1.2 Purpose of this Report

This report describes the offset package being undertaken for *Tylophora linearis*. An offsets package is a suite of actions that a proponent undertakes in order to compensate for the residual significant impact of a project (Department of Sustainability, Environment, Water, Population and Communities [DSEWPaC], 2012b). It can comprise a combination of direct offsets and other compensatory measures (DSEWPaC, 2012b).

Whitehaven established the following direct and other compensatory measures for the species as part of the offsets package:

1. Conservation of existing habitat for *Tylophora linearis* within offset areas;
2. Revegetation of woodland/forest within areas of former *Tylophora linearis* habitat;
3. Implementation of a root architecture and growth study for *Tylophora linearis*;
4. Seed production monitoring for *Tylophora linearis*;
5. Collection and storage of seed;
6. *Tylophora linearis* propagation;
7. Translocation trials; and
8. Regional surveys.

The measures outlined in this document constitute a significant addition to the reserved *Tylophora linearis* habitat (including additional confirmed records), and provide a body of knowledge about the biology of the species along with the utility of a variety of translocation measures.

1.3 Description of *Tylophora Linearis*

1.3.1 Morphology and Taxonomy

Tylophora linearis P.I. Forst (family Apocynaceae, sub-family Asclepiadoideae) is a slender twining plant to over 2 metres (m) tall, although more commonly it is seen singly or as groups of short stems to around 20 centimetres (cm) tall. Cut stems exude clear latex. Leaves are opposite, glabrous or with occasional hairs on the margins. Lamina linear-lanceolate to 5 cm long and 3 millimetres (mm) wide; tip acute, base cuneate; extra floral nectaries absent from lamina base. Petiole 1-2 mm long, grooved along top.

Flowers in umbels of 3-8, 6-7 mm diameter, dark purple inside, moderately to densely hairy, dark olive green on the outside with some hairs at the tip of corolla lobes. Follicles fusiform, 95-100 mm long, c. 5 mm diameter, glabrous[1].

Tylophora linearis was first described by Forster (1992) as part of a taxonomic revision of the *Tylophora* genus and at that stage was known from only three records in NSW and one in Queensland, all herbarium specimens. Subsequently, Forster *et al.,* (2004) reported on several plants from three additional NSW locations and revised the description of the species including that the species was capable of resprouting from underground stems following fire and was likely to be clonal. Population structure consisted of often numerous small leafy stems with occasional elongated stems twining a shrub or some other structure. These larger plants frequently produced flowers and fruiting follicles.

1.3.2 Distribution

NSW BioNet Atlas (NSW Department of Planning, Industry and Environment [DPIE], 2021a) holds 1,125 *Tylophora linearis* records (Figure 1) distributed from West Wyalong in the south to Yetman in the north, and the Pilliga region in the west to Murrurundi in the east; there is also one historic record from near Glenmorgan, west of Dalby, in southern Queensland. Figure 1 also indicates areas where the most concentrated surveys have occurred which represent 77 percent (%) of the BioNet Atlas records.

[1] Description summarised from NSW PlantNET (2021) http://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&search=yes&namesearch=tylophora+linearis&dist=

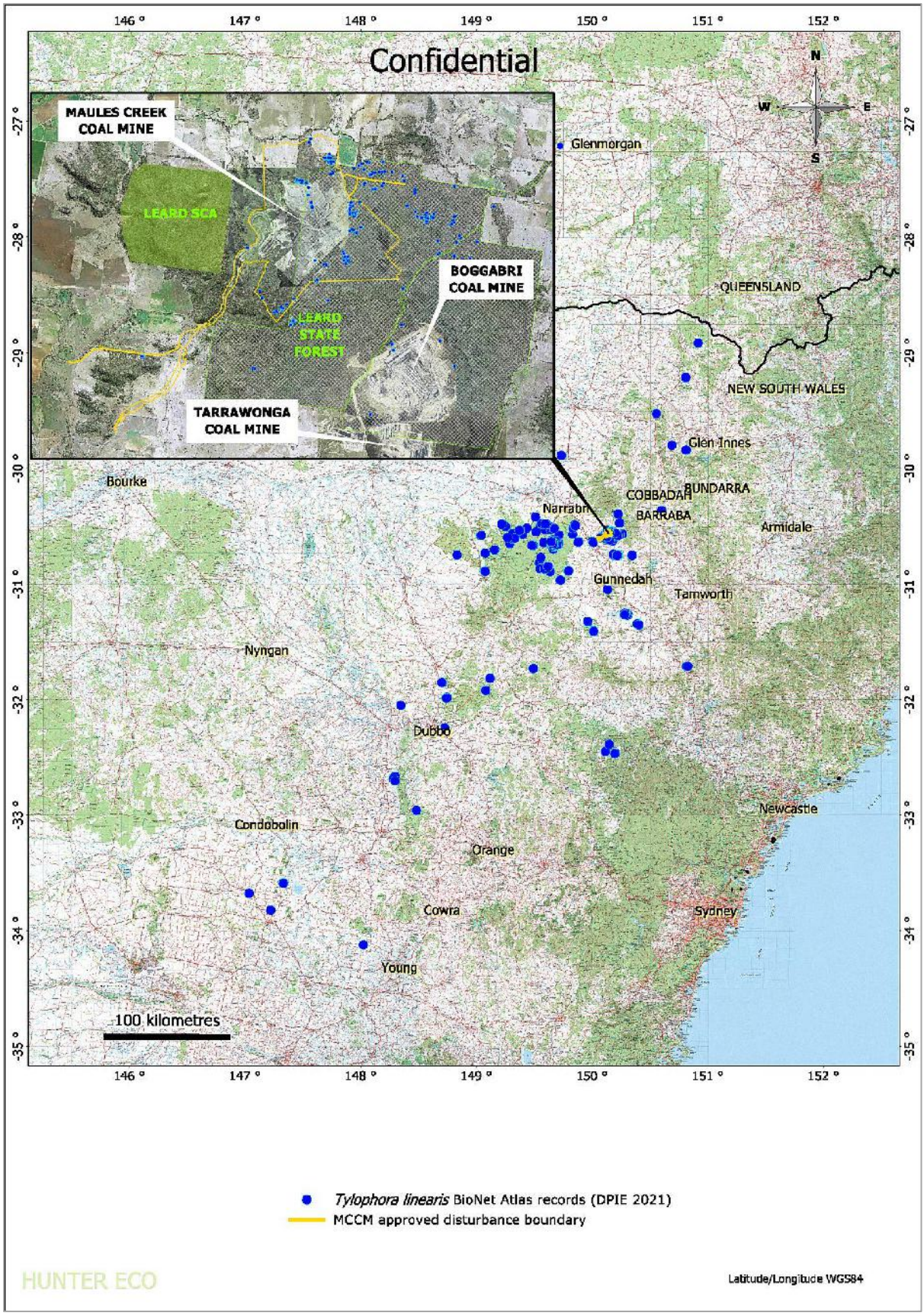

Figure 1 ***Tylophora linearis*** **Regional Extent**

1.3.3 Abundance

Records are simply the geographic location where the species was found, and at any one location there can be one-to-many stems. As mentioned above, *Tylophora linearis* was first described by Forster (1992) when there were only four herbarium specimens, three from NSW and one from Queensland. Forster *et al.* (2004) subsequently reported the rediscovery of the species adding 390 stems from three new locations in NSW.

The NSW Scientific Committee (2008) conducted a review of current *Tylophora linearis* information and concluded that there were 10 confirmed populations in NSW consisting of 250 to 500 mature individuals in total. The NSW Scientific Committee (2008) assumed that half the number of stems would be mature individuals, or genets as a consequence of the species being clonal.

Eco Logical Australia (ELA) (2012) reporting on results of surveys for the Narrabri Santos Coal Seam gas exploration project modelled the population of *Tylophora linearis* in the Pilliga region at approximately 180,000 individuals.

The most contemporary data from BioNet Atlas (DPIE, 2021a) shows that the species has been recorded from 13 National Parks and Wildlife Service (NPWS) reserves (129 records) and 12 NSW State Forests (542 records) with the balance from freehold land. From all records it is deduced that there are now approximately 45 populations. This estimate has been made assuming that areas of high concentration of records such as NSW conservation reserves and NSW State Forests each consist of one population.

1.3.4 Habitat

Forster *et al.* (2004) describe the species as occurring in dense shrubland overtopped on occasion with eucalypts. Examples of reported associated species were *Melaleuca uncinata*, *Allocasuarina luehmannii*, *Callitris glaucophylla*, *Dodonaea viscosa*, *Acacia doratoxylon*, *Eucalyptus crebra*, *Eucalyptus albens* and *Eucalyptus populnea* subsp. *bimbil*. The list of associated species provided by Forster *et al.* (2004) is much larger and indicates that *Tylophora linearis* can occur in a wide range of habitats.

The BioNet Threatened Biodiversity Data Collection (DPIE, 2021b) recognises that *Tylophora linearis* is known or likely to be associated with 163 different plant community types (Attachment A). This indicates that the species is a habitat generalist rather than specialist which reduces the impact of habitat clearing on the species over its wide geographic range.

This is consistent with results of a state-wide analysis of selected environmental conditions from which the species has been recorded:

- elevation range 200 m to > 600 m;
- slope of flat to > 8 degrees;
- seven Australian Soil Classification types (Chromosols, Ferrosols, Kurosols, Rudosols and Tenosols, Sodosols, Vertosols, Kurosols Natric);
- seven geological ages (Carboniferous, Cretaceous, Devonian, Jurassic, Permian, Quaternary and Tertiary); and
- rainfall from 500 to 800 mm per year.

1.3.5 Habitat Modelling

A probability of occurrence model was conducted across the State-wide records for *Tylophora linearis* using the methods described in Attachment B. The results of this model were used to estimate the amount of habitat within the approved MCCM footprint as well as the habitat within land-based offset areas. The model output has a probability of occurrence from 0 to 90% in steps of 10%. Probability was simplified to low (10% – 30%), medium (40% - 60%) and high (70% - 90%).

Attachment B describes that 1,894 *Tylophora linearis* records were available (published and unpublished records) from which 90 were drawn as model input. The outcome was that 90% of the 1,894 records occurred in high, 5% in medium and 5% in low probability habitat. The woodland area within the MCCM approved footprint modelled predominantly as high probability habitat with a small amount of medium probability habitat. The distribution of habitat in the land-based offsets is discussed in section 3.1.

1.3.6 Lifecycle

Tylophora linearis is a perennial plant but it is not known whether the vegetative phenology includes reduction in above ground biomass during winter months, or during extended dry periods.

Forster *et al.* (2004) describe an underground rhizome from which the plant can re-sprout following fire, a feature that would also accommodate seasonal reduction and re-sprouting of above-ground biomass.

Flowering is reported as occurring during November, and several weeks after at least 20 mm of rain following a lengthy dry period (Forster *et al.,* 2004), or Spring (PlantNET, 2021). The species may exhibit synchronous flowering over large areas (Forster *et al.,* 2004) and the flowering period is thought to be positively correlated with light, rainfall and availability of support for climbing (Forster *et al.,* 2004).

Pollinators for *Tylophora linearis* or other species of *Tylophora* are unknown (Forster *et al.,* 2004). It is thought that insect-mediated transfer of pollen between flowers is necessary for pollination to occur in this species, as with most Apocynaceae (Forster *et al.,* 2004). This species may also be partially or exclusively clonal (Forster *et al.,* 2004), with several above ground stems arising from a common rhizome.

2 *TYLOPHORA LINEARIS* HABITAT CLEARANCE

The extent of *Tylophora linearis* habitat in the indicative extent of the MCCM surface disturbance area has been modelled using the methods described in Attachment B. All records of *Tylophora linearis* are included in the extent of *Tylophora linearis* habitat.

There are approximately 1,495 hectares (ha) of *Tylophora linearis* habitat in the indicative extent of Project surface disturbance (Figure 2). This habitat encompasses all of the woodland/forest vegetation mapped by Cumberland Ecology (2011).

The presence of *Tylophora linearis* within the MCCM surface disturbance area was not identified until after the commencement of the approved vegetation clearing and so it is not possible to quantify the number of plants in the indicative extent of the MCCM surface disturbance area. Further, the propagation and translocation programme (Section 3.2) has shown the species to be very responsive to environmental conditions to the extent that it is not possible to predict from month to month or from one year to the next when the plant becomes detectable by its above-ground stems, or how many stems might appear. For the above reasons, it is appropriate to quantify the clearance and offsets in relation to the species habitat.

The vegetation to be cleared, predominantly in Leard State Forest, consists of low eucalypt forest with a varied shrubby to grassy ground cover. Ground cover is highly variable both in species content and density depending on rainfall. The dominant canopy species are *Eucalyptus albens, Eucalyptus crebra, Eucalyptus pilligaensis, Eucalyptus melanophloia* and *Callitris glaucophylla*. Predominant shrubs are *Beyeria viscosa* subsp*. angustifolia, Denhamia cunninghamii, Dodonaea viscosa, Eremophila mitchellii, Notelaea microcarpa* and *Acacia decora*. Ground cover grasses include *Leptochloa asthenes, Aristida ramosa, Paspalidium distans* and *Rytidosperma fulvum*. Ground cover herbs include *Calotis lappulacea, Brunoniella australis, Glossocardia bidens, Abutilon oxycarpum, Einadia hastata* and *Sida corrugata.* Vines and twiners include *Marsdenia viridiflora, Oxytes brachypoda, Glycine clandestina, Jasminum suavissimum* and *Tylophora linearis*.

The habitat is in good condition with no evidence of recent logging and few weeds (C. Driscoll *pers obs*.).

The cleared areas (mapped by Cumberland Ecology [2011] as plains grassland, derived native grassland, exotic grassland, wheat field and crop land) are not considered to be potential habitat for *Tylophora linearis.* No records of *Tylophora linearis* were found in these vegetation types.

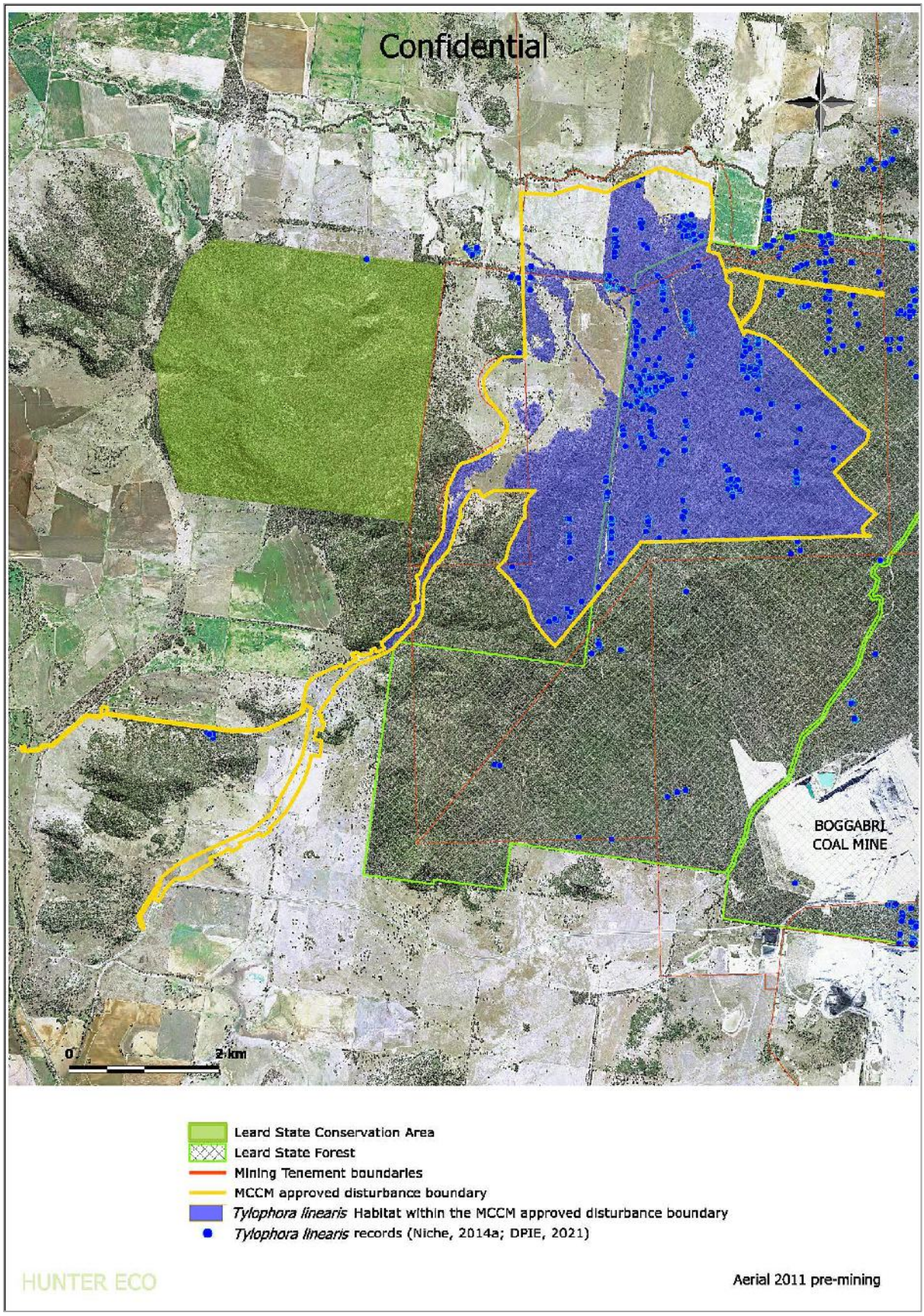

Figure 2 *Tylophora linearis* Habitat within the MCCM Approved Disturbance Boundary

3 OFFSET PACKAGE FOR *TYLOPHORA LINEARIS*

The offset package for *Tylophora linearis* includes:

- conservation of existing habitat for *Tylophora linearis* within offset areas (Section 3.1);
- revegetation of woodland/forest within areas of former *Tylophora linearis* habitat (Section 3.1.2);
- implementation of a root architecture and growth study (Section 3.2.1);
- seed production monitoring for *Tylophora linearis* (Section 3.2.2);
- collection and storage of *Tylophora linearis* seed (Section 3.2.3);
- *Tylophora linearis* propagation (Section 3.2.4);
- translocation trials for *Tylophora linearis* (Section 3.2.5); and
- regional surveys for *Tylophora linearis* (Section 3.3).

3.1 Land-based Offset Areas

Figures 3 to 6 show the distribution of modelled habitat across woodland/forest areas in the 15 offset areas grouped into Eastern, Western, Northern and Southern offsets. Across these offsets there is a total of 3,707.5 ha of existing habitat for *Tylophora linearis* (Table 1), consisting of 2,508.4 ha 'high/medium probability' of occurrence habitat and 1,199 ha of 'low probability' of occurrence habitat[2]. In addition, 1,580 ha of cleared former *Tylophora linearis* habitat has been revegetated. This represents a 3.5:1 ratio for the *Tylophora linearis* habitat in the indicative extent of Project surface disturbance.

Similar to the mine site (Section 2), the extent of *Tylophora linearis* habitat in the MCCM offset areas has been modelled using the methods in Attachment B. All records of *Tylophora linearis* within the offset areas are included in the extent of *Tylophora linearis* habitat.

The Mt Lindesay, Neranghi North and Coonoor, Triangle and Wirradale and Wongala South offset areas were predominantly modelled as low probability habitat. Given that 5% of all *Tylophora linearis* records occurred in low probability habitat, the habitat on these offsets was reduced to 20% of the total (the median of the low probability range) to reflect a lower likelihood of occurrence.

The Long Gully Offset Area is located outside of the eastern boundary of the model and is in a higher rainfall area than that which the species prefers. The probability of occurrence for Long Gully is assumed to be zero.

[2] Note: this area is a total of 5,995.1 ha of low probability habitat, discounted by 80%.

Table 1: Modelled Habitat for *Tylophora linearis* in Offset Areas

Offset Area	Offset Area (ha)	Area of Existing Habitat for *Tylophora linearis* (ha)	Area of Revegetation within Former Potential Habitat for *Tylophora linearis* (ha)	Total Existing and Future Habitat for *Tylophora linearis* (ha)
Bimbooria	622.5	374.6	146.2	520.8
Coonoor	574.1	82.7[A]	0	82.7
Kelso	489.4	268.3	151	419.3
Long Gully	352.9	0[B]	0	0
Louenville	213.1	178.5	26.2	204.7
Mt Lindesay	2,337.1	379.9[C]	12.6[D]	392.5
Neranghi North	567.1	107.9[E]	0	107.9
Onavale	557.7	101.8	79.5	181.3
Roseglass	1,465.3	1,039.4	132.7	1,172.1
Teston South	336.2	234.1	57.5	291.6
Thornfield	171.3	31.8	68	99.8
Triangle	665.9	39.9[F]	0	39.9
Velyama	702.6	55.8	474.8	530.6
Wollandilly	804.4	224.1	315.5	539.6
Wirradale & Wongala South	4,469.2	588.7[G]	116[H]	704.7
Total Area (ha)	**14,328.8**	**3,707.5**	**1,580**	**5,287.5**
			Ratio Offset to Clearance	**3.5:1**

[A] Includes 413.4 ha low probability habitat discounted by 80% (Coonoor).
[B] Offset lies outside model bounds and in high rainfall area. Probability of occurrence assumed to be zero (Long Gully).
[C] Includes 1,899.3 ha low probability habitat discounted by 80% (Mt Lindesay).
[D] Includes 62.8 ha low probability revegetation habitat discounted by 80% (Mt Lindesay).
[E] Includes 539.4 ha low probability habitat discounted by 80% (Neranghi North).
[F] Includes 199.5 ha low probability habitat discounted by 80% (Triangle).
[G] Includes 2,943.5 ha low probability habitat discounted by 80% (Wirradale & Wongala South).
[H] Includes 580 ha low probability revegetation habitat discounted by 80% (Wongala South).

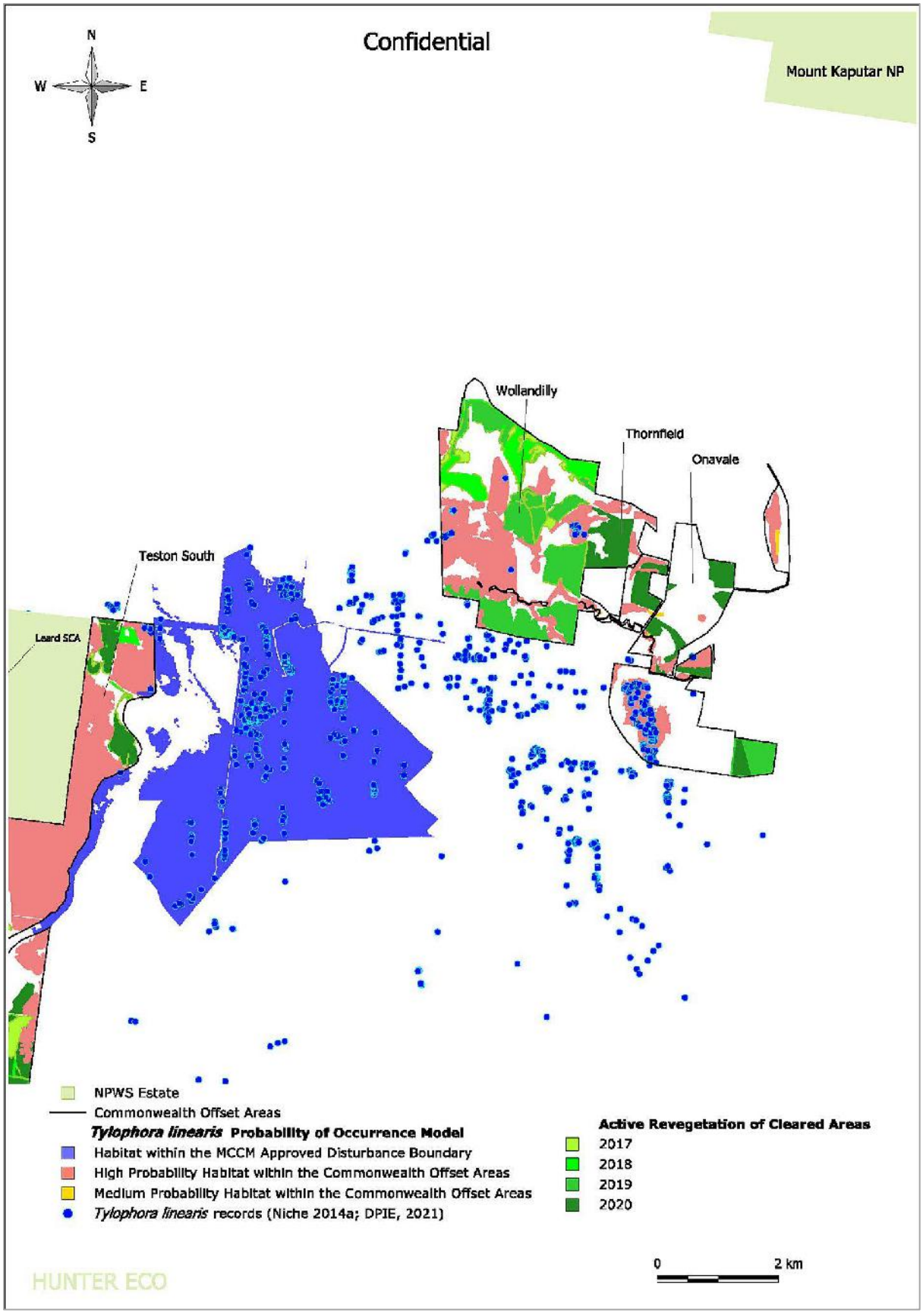

Figure 3 ***Tylophora linearis*** **Habitat within the Eastern Commonwealth Offset Areas**

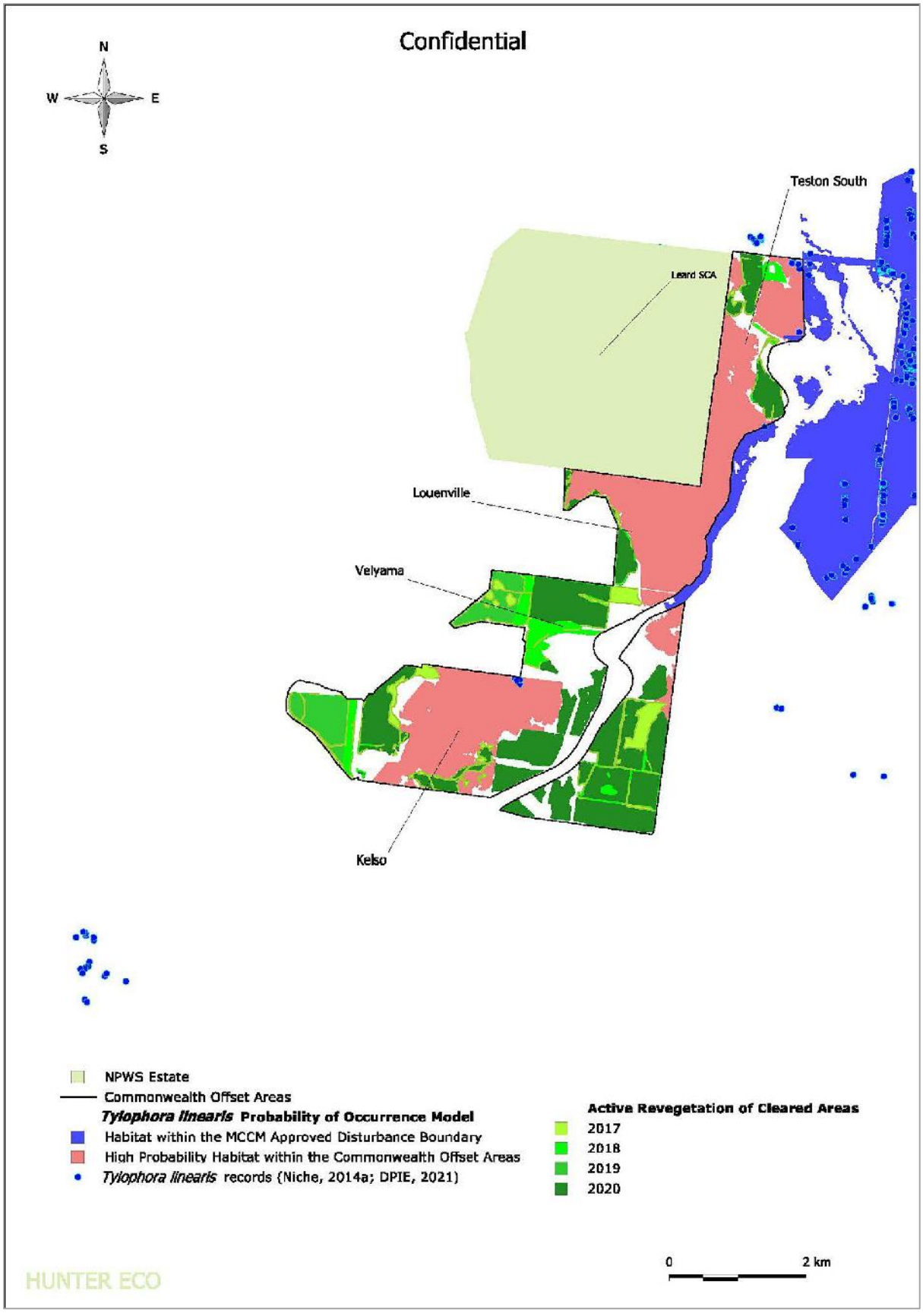

Figure 4 ***Tylophora linearis*** **Habitat within the Western Commonwealth Offset Areas**

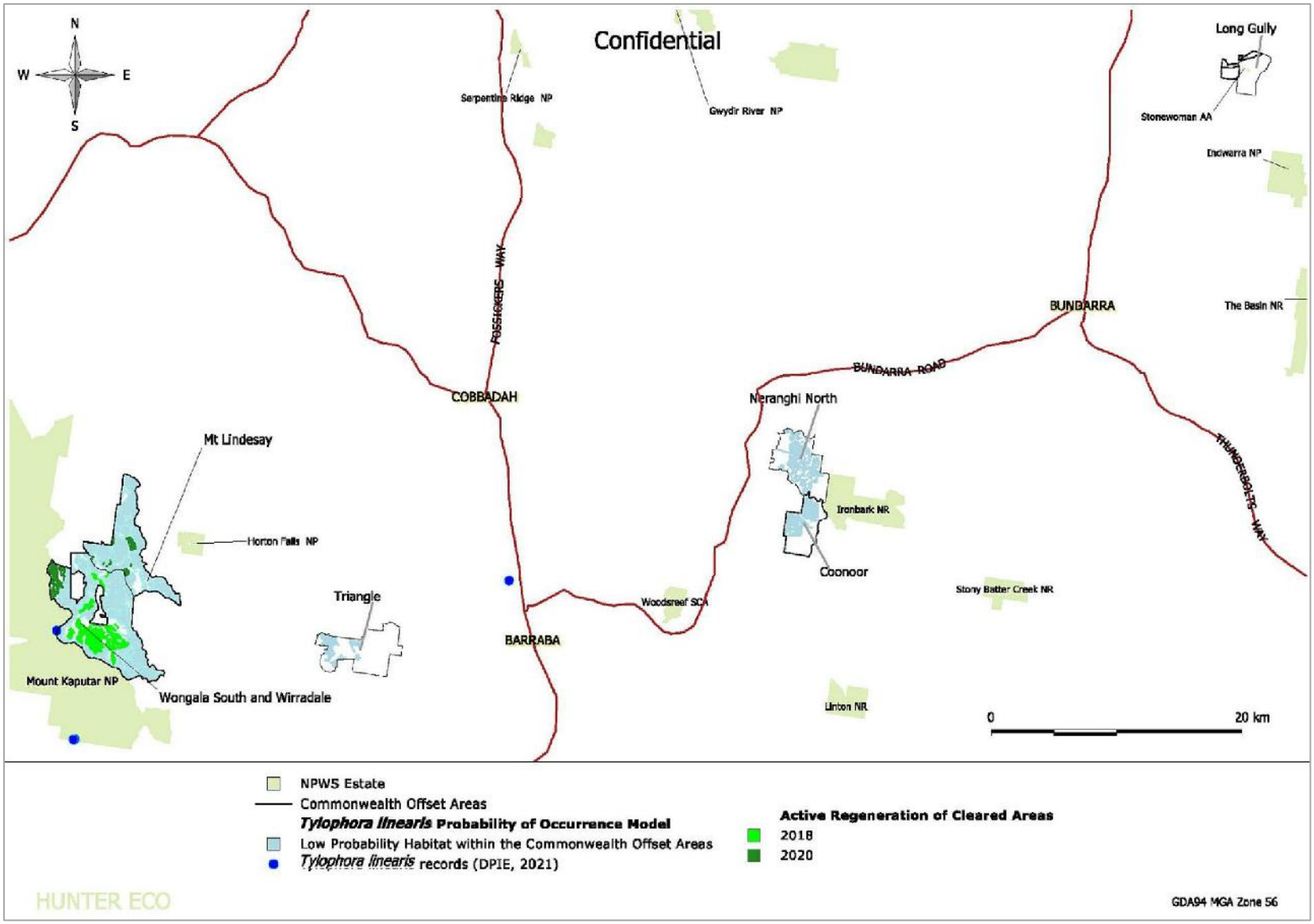

Figure 5 ***Tylophora linearis*** **Habitat within the Northern Commonwealth Offset Areas**

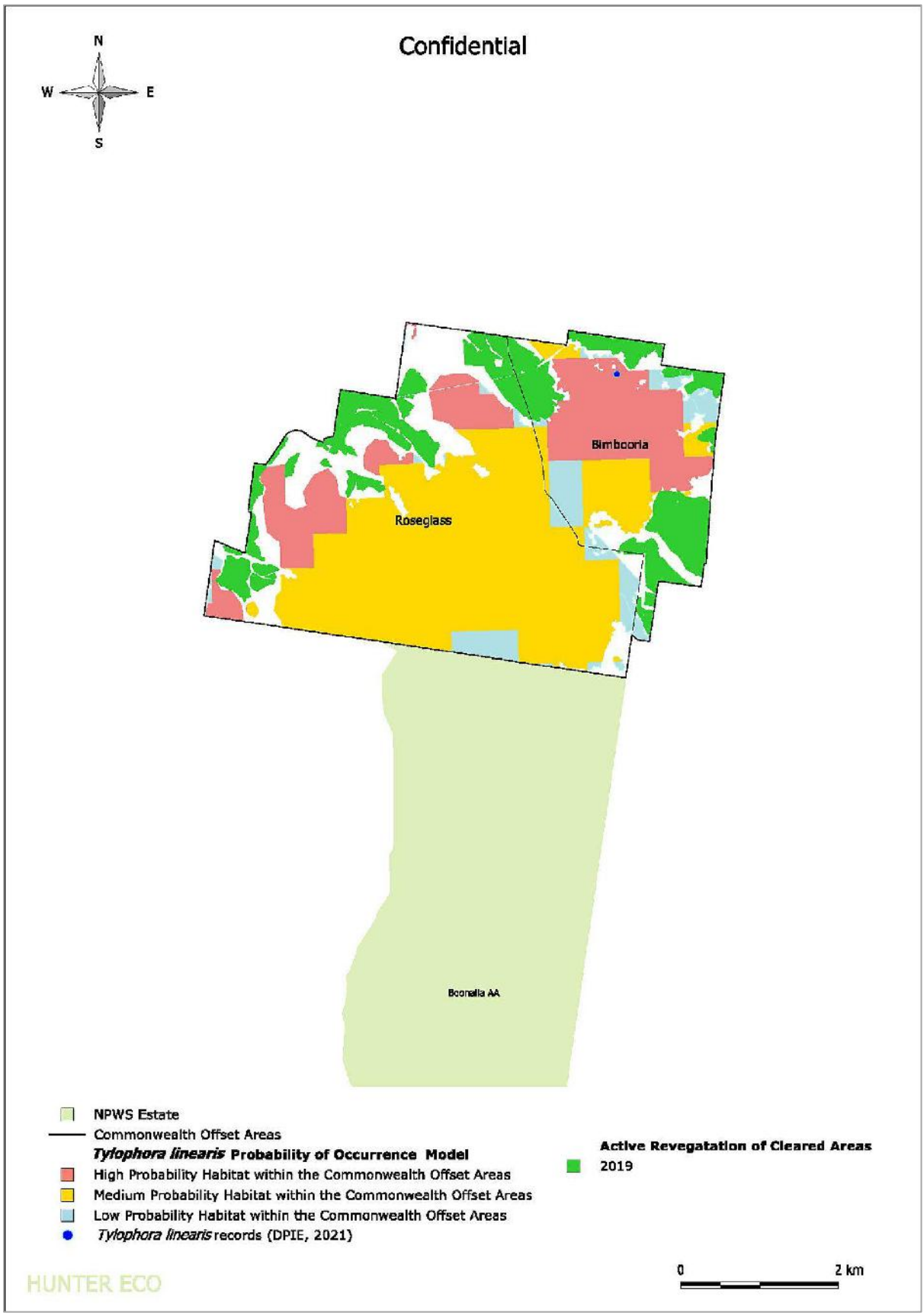

Figure 6 ***Tylophora linearis*** **Habitat within the Southern Commonwealth Offset Areas**

3.1.1 Plant Community Type Associations

AMBS (2020) mapped 30 PCTs across the MCCM Commonwealth offset areas. *Tylophora linearis* is listed as associated with five of these PCTs (DPIE, 2021b):

- PCT 435, White Box - White Cypress Pine shrub grass hills woodland;
- PCT 589, White Box - White Cypress Pine - Silver-leaved Ironbark grassy woodland;
- PCT 590, White Box grassy woodland on the Inverell basalts;
- PCT 592, Narrow-leaved Ironbark - cypress pine - White Box shrubby open forest; and
- PCT 599, Blakely's Red Gum - Yellow Box grassy tall woodland.

Other than for PCT 589 and 590, the species has been recorded in each of these PCTs within the offset areas. In addition, there are nine records representing 437 stems from PCT 413, Silver-leaved Ironbark – White Cypress Pine – box dry shrub grass woodland, a PCT not listed in the BioNet Threatened Biodiversity Data Collection (DPIE, 2021b) as associated with *Tylophora linearis* (which is a good finding meaning that the species occurs in a greater range of PCTs than recognised by DPIE [2021b]).

3.1.2 Area of Revegetation within Former Potential Habitat for *Tylophora linearis*

A revegetation programme has commenced within the offset areas, and includes revegetation of cleared land that was former potential habitat for *Tylophora linearis*. Figure 4 shows the distribution of modelled former habitat across woodland/forest areas in the offset areas and the location of the revegetation works. Plate 1 shows an example of the growing trees.

Across these offsets there is a total of 1,580 ha of former potential habitat for *Tylophora linearis* that is undergoing active revegetation (Table 1). This represents a 1.1:1 ratio for the *Tylophora linearis* habitat in the indicative extent of Project surface disturbance.

The revegetation programme activities carried out since 2015 in the areas identified as former potential habitat for *Tylophora linearis* have included:

- In 2016;
  - Understorey seeding and sowing within the Eastern Offset Area.
- In 2017 and 2018;
  - Understorey seeding and sowing within the Western Offset Area and Northern Offset Area; and
  - Overstorey planting within the Northern Offset Area, Eastern Offset Area and Western Offset Area.
- In 2019 and 2020;
  - Understorey seeding and planting of Southern Offset area;
  - Additional overstorey planting within the Northern Offset Area, Eastern Offset Area and Western Offset Area.

Plate 1 Example of Revegetation in the Offset Areas

3.2 Propagation and Translocation Programme

As a consequence of its relatively recent description as a species (Forster, 1992) and even more recent discovery during development assessments, *Tylophora linearis* had been a poorly researched species with the majority of information on the biology of the species only available from Forster *et al.* (2004). Plate 2 shows *Tylophora linearis* at various stages of propagation and translocation.

Following the identification of *Tylophora linearis* within the MCCM Project Boundary, a propagation and translocation program was prepared for the species with the aim of developing a greater understanding of the biology of the species in order to facilitate better management. The propagation and translocation program is provided in the MCCM Biodiversity Management Plan (Offset Management Plan).

There are multiple stages to the propagation and translocation program:

- Stage 1 – Root Architecture and Growth Study (Section 3.2.1);
- Stage 2 – Seed Production Monitoring (Section 3.2.2);
- Stage 3 – Seed Collection and Storage (Section 3.2.3);
- Stage 4 – Seed Propagation (Section 3.2.4); and
- Stage 5 – Translocation Trials (Section 3.2.5).

The *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008) recognises a research priority for *Tylophora linearis* is to investigate seed viability, germination, dormancy, and longevity in storage and the natural environment, to determine the requirements for successful establishment.

3.2.1 Stage 1 – Root Architecture and Growth Study

Forster *et al*. (2004) reported finding that individual *Tylophora linearis* stems had sprouted from a common rhizome. Whitehaven commissioned Niche (2014b) to conduct a more detailed examination of root structure excavating 27 individual rhizomes from several different groups of stems across the MCCM area approved for clearing (Plate 1). Niche (2014b) found that one third of these stems were connected to other stems (up to four connected stems) by a single rhizome. Rhizome length ranged from 3 cm to 145 cm and they did not appear to have a common origin such as from a larger plant. Rhizome depth was shallow, being only 4 cm on average.

The 27 individual rhizomes represented unique genetic plants (genets) that would have originated from germinating seed. Nine of these rhizomes had two or more sprouting stems which would be genetically identical (ramets) to the originating rhizome. In total there were 39 stems sprouting from the 27 excavated rhizomes indicating that approximately 70% of stems are genetically individual plants. This is higher than the 50% estimate of the NSW Scientific Committee (2008).

Understanding the genetic makeup of groups of plants/stems is important for conservation purposes. It would appear that groups of *Tylophora linearis* stems consist of a majority of genetic individual plants along with a significant number of clonal stems. This combination indicates the occurrence of genetic refreshment along with clonality that confers longevity not afforded to non-clonal species. It also indicates a possible translocation pathway from habitat approved for clearing by way of excavating soil containing rhizomes and relocating that to an appropriate conservation area.

Root architecture studies have demonstrated that *Tylophora linearis* has in part a clonal growth habit which provides protection from fire and the capacity to conserve resources by losing surface stems during times of environmental stress.

Plate 2: ***Tylophora linearis*** **(Note: above ground [top left], root system [top right], seeds [middle left], seed pod [middle right], germination trial [bottom left] and propagated plants [bottom right])**

3.2.2 Stage 2 - Seed Production Monitoring

Niche (2014b) monitored 19 flowering plants over eight weeks in late May to early July 2014. There were four monitoring occasions: 22 May; 18 and 19 June; 23 and 24 June; and 8 July. Budding generally did not progress into open flowers, however 11 immature follicles were recorded with only one maturing. Niche (2014b) also reported that what they referred to as mature plants (i.e. flowering), subsequently termed *fertile plants*, accounted for only 1% of the stems recorded. On account of the rarity of flowering plants and the very low fecundity of these plants they concluded that translocation by way of seed collection and germination might not be productive. Figure 5 shows the flowering records over time that were recorded by Niche (2014b).

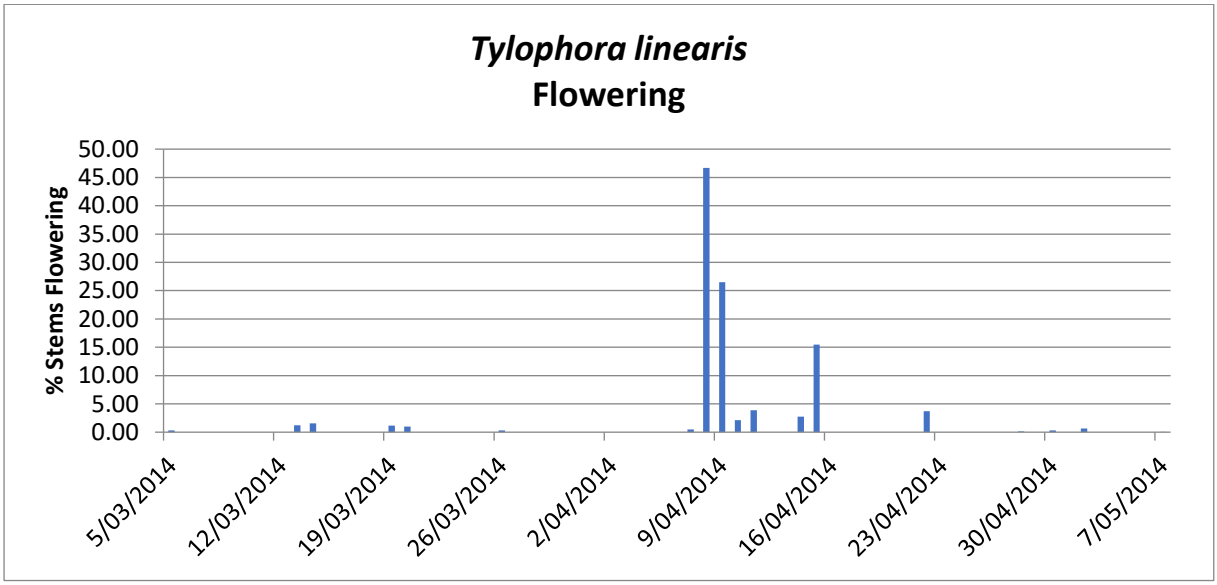

Figure 7 *Tylophora linearis* Flowering

Hunter Eco (2019) monitored a single fertile *Tylophora linearis* plant for over two years from January 2017. The plant was located at a permanent monitoring site in Leard State Forest, Site TL01. This plant produced a single fruiting follicle twice in 2017 both of which successfully shed seed. In March 2018 a further three follicles had developed and all had shed seeds. Then in December 2018 this plant was carrying 11 follicles, three of which were shedding seeds with the others yet to mature. In June 2019 there were 10 follicles (Plate 3) and in December 2019 a single follicle was shedding seed (Plate 4). The 10 follicles recorded in June 2019 were then monitored weekly by a Whitehaven staff member until they commenced shedding seed in late September 2019. At approximately 40 seeds per follicle this plant will have shed over 1000 seeds in the two years of being monitored.

On the other hand, two other fertile plants at monitoring sites in Leard State Forest commencing in January 2017 developed flowers with no resulting fruiting follicles and by the end of 2017 both plants were dead (C. Driscoll *pers obs).*

Plate 3: The Eleven Fruiting Follicles on The TL01 Fertile Plant June 2019

Plate 4: The Fruiting Follicle Shedding Seeds on The TL01 Fertile Plant December 2019

3.2.3 Stage 3 - Seed Collection and Storage

Niche (2014b) collected the one follicle in August 2014 that had been observed during the fruiting monitoring study. Whitehaven staff also collected six follicles from one plant on 20 August 2014. Following collection, seed were stored dry at 2^0C for three months prior to the germination trial.

3.2.4 Stage 4 - Seed Propagation

The germination trial was conducted by Max Elliott of Grow Local Nurseries at Ellalong, NSW Hunter Valley. The trial consisted of six different combinations of pre-treatment and planting media as described in Table 2. There were insufficient seeds for replicate treatments, the intention being that at the end of the trial the balance of seeds would be treated by the most productive method and then sown. A control (T1) consisted of no seed pre-treatment. Close examination of the seeds showed an apparent difference between fertile (fuller and darker colour) and infertile (thinner and lighter colour) seeds. Ten of the possibly infertile seeds were tested (T6) under the same conditions as the control (T1).

Table 2: Seed Germination Trial Matrix

Treatment	Seeds	Planting Medium	Watering	Application
T1	10	Potting mix with sand bed and perlite	1/day	None
T2	10	Potting mix with sand bed and perlite plus smoked vermiculite	1/day	Smoked Vermiculite
T3	10	As for T1	1/day	Seed soaked in 100ppm Gibberellic Acid overnight
T4	10	As for T2	1/day	Combination of 2 and 3
T5	10	As for T1 but with a very light perlite covering to allow more light penetration	1/day or more temp. dependent	None
T6	10	As for T1	1/day	None

The aim of the trial was to test whether the seeds held some form of dormancy that needed to be broken before germination could occur. Two possible dormancy breaking methods were tested: the application of smoke chemicals simulating the effects of bushfire; and the use of Gibberellic Acid (Gibberellin) which is naturally produced in seed triggering germination under a variety of environmental conditions.

Figure 8 shows the germination rate for each treatment including any losses (attrition). Taking attrition into account, the most productive treatments were T2 and T3. Figure 8 shows a more consistent response over time for T3 than for T2. The common component of these two treatments was Gibberellic Acid, consequently treatment T3 was selected for germinating the remaining seed.

The fact that Gibberellic Acid treatment resulted in 60% higher germination than untreated seed suggests the presence of a dormancy mechanism. The fact that there was 50% germination of untreated seed suggests either that dormancy is weak or had been partially broken. Following collection, seed were stored dry at 2^0C for three months prior to the germination trial and this cold storage may have lowered dormancy. It is reasonable to speculate that on release *Tylophora linearis* seed have a dormancy mechanism that prevents immediate germination prior to winter when it appears that the young plants would be most vulnerable. Passing through cold winter months into warmer spring is known to release dormancy in seed of other species (Probert, 2000).

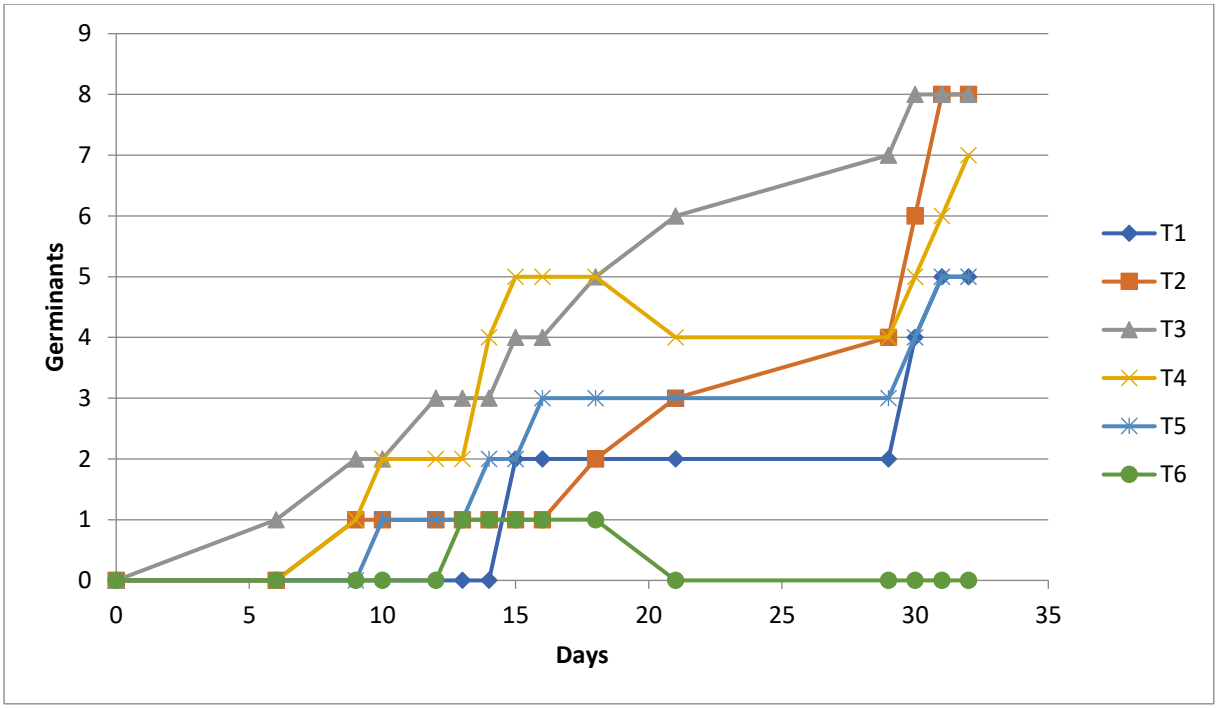

Figure 8 Germination Trial Rate of Germination

3.2.5 Stage 5 - Translocation Trials

Translocation is the process of moving an organism to a new location. Common ways translocation of plants can be achieved are: direct excavation of mature plants; collection and germination of seed with seedlings planted at a recipient site; direct seeding; tissue culture; or rooting of stem cuttings.

Direct excavation poses several problems. It can be relatively straight forward if the plant is small with a simple shallow root structure. However, for large shrubs or rhizomatous plants with complex root structure, excavation generally involves using large machinery. Consequently, transporting the excavated plant without breaking up the soil around the roots is difficult, and at the recipient site considerable collateral damage can occur to existing vegetation.

Germination of seed (or direct seeding) presupposes that the target species produces sufficient fruit and that there are no seed dormancy issues to be overcome before germination can be successful. However, if germination is successful, translocation of seedlings does not have the risk of collateral damage associated with whole plant removal.

The best tissue culture results come from using seedling tissue so this can be used to generate more stock for planting than would otherwise be available where seeds are in short supply. However, tissue culture results in genetic clones thus limiting the genetic diversity in the target population.

Not all species respond well to stem cutting rooting techniques.

Of the aforementioned translocation options, seed germination was selected primarily because an investigation of the root structure of *Tylophora linearis* (Niche, 2014b) has shown that it is rhizomatous, thus necessitating the use of an excavator for removal of whole plants. Also, if seeds could be successfully germinated, tissue culture would be a later option for production of large numbers of plants.

3.2.5.1 Translocation

Translocation encompasses a range of actions (Commander *et al*., 2018) involving movement of plant species from one location to another. The source material can be from *ex situ* locations, natural populations, regenerative material such as seeds or cuttings, or whole plants.

In 2014, 157 *Tylophora linearis* seeds were obtained, 60 were used to determine the most appropriate germination method that was ultimately used on the balance (Hunter Eco, 2015). Initially 86 germinants were placed in 50 mm tubes in January 2015. The seedlings reached a suitable size for translocation by November 2015, and with some attrition, 77 tubestock were available.

Translocation was carried out on 3 December 2015 with 10 plants each placed in enclosures A to F and 17 in G with plants tagged from A1 to G17. Because the plants are twining vines, they had entangled themselves as they grew in the nursery and so required careful separation.

Planting was conducted by loosening the soil beside a small shrub (generally a Cypress pine) or another object such as a stump or fallen branch. Where the plant was tall enough it was loosely tied to its support. Each plant was given 1 Litre (L) of water.

The tubestock plants had a height range of 2 cm to 62 cm and a reasonably successful attempt was made to distribute heights evenly in each enclosure.

Plants were monitored and regularly watered every two to five days by Whitehaven staff up to January 2016 and then monitored monthly by Hunter Eco to December 2017 then quarterly to June 2020.

Figure 9 shows the number of plants recorded on each monitoring occasion and Table 3 details the presence/absence periods for each plant. Note that only one plant (G8) has not died back over the monitoring period.

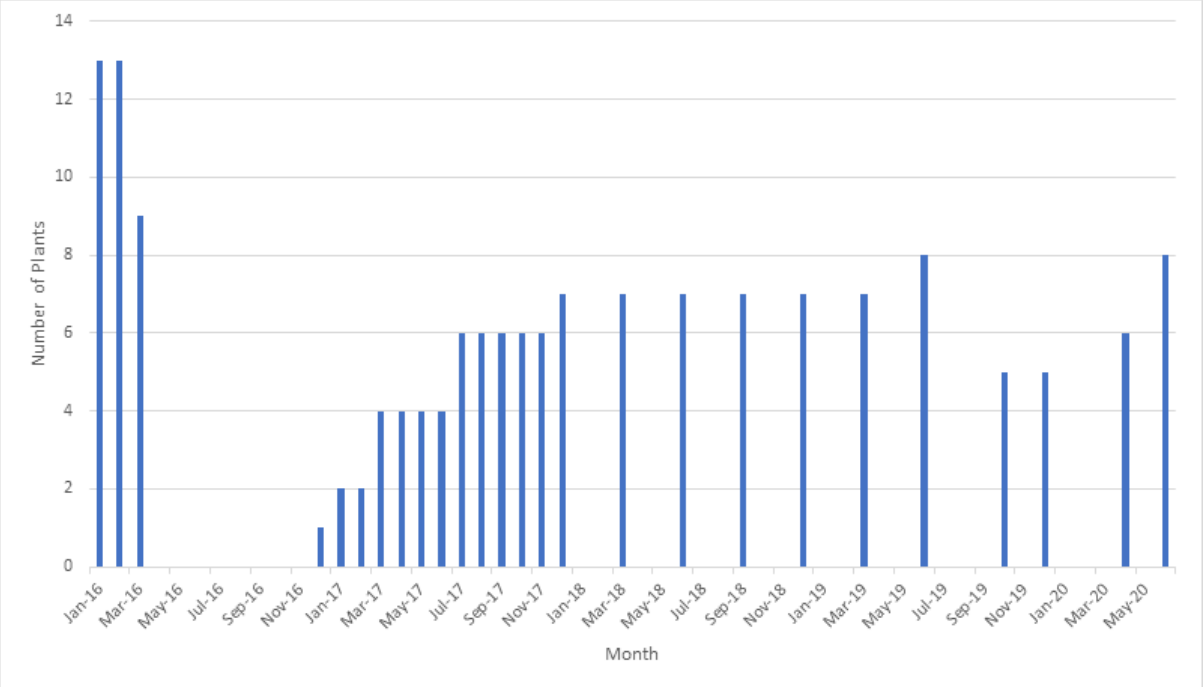

Figure 9 The Number of Surviving Translocated Plants over Time

Plant A2 rapidly grew from 48 cm tall when planted to 120 cm in two months and developed buds, becoming a fertile plant. However, its condition deteriorated and it was subsequently absent for 13 months. Plant G8 has developed into a fertile plant and has released approximately 200 seeds. Plant A4 has developed a second sprout approximately 5 cm from the initial planted stem and Plant G13, as of June 2020, has sprouted a new stem approximately 15 cm from the initial planted stem. Both of these examples indicate that the rhizomes are extending underground.

Table 3: Periods when Translocated Plant Stems Had Died Back

Plant	Last seen	Next seen	Months absent
A2	3/03/2016	19/04/2017	13
A4	7/12/2016	20/07/2017	7
A7	3/03/2016	20/03/2017	12
B5	3/03/2016	23/01/2017	10
F5	4/02/2016	20/03/2017	13
G8	3/12/2015	-	0
G12	3/03/2016	5/06/2019	39
G13	3/03/2016	20/12/2017	21

3.2.5.2 Transplantation

Transplantation is a subset of translocation and is used here to distinguish between translocation of *ex situ* material such as germinated seedlings and the direct removal and relocation of plants or plant material.

Commonly, transplantation involves excavating mature plants, either individually or *en masse*, and relocating them to suitable habitat. In the case of *Tylophora linearis*, because the plant sprouts from a network of underground rhizomes which have the capacity to store resources before re-sprouting, it was proposed to remove the topsoil layer entirely from discreet areas found during pre-clearing surveys to contain *Tylophora linearis* plants. That soil would then be spread in suitable habitat in a selected MCCM biodiversity offset area with the expectation that rhizomes within the soil would ultimately sprout. This methodology is in part supported by opportunistic observation of *Tylophora linearis* sprouting from rhizomes in topsoil piled beside roads or cleared areas as noted in Niche (2014b).

Transplantation occurred on 27 February 2019. The following steps were followed:

1. eleven donor sites found to contain groups of *Tylophora linearis* stems during pre-clearing surveys were flagged;
2. these areas were excluded from mulching;
3. approximately 20 cm of topsoil including shrubs and ground cover vegetation was excavated;
4. the excavated topsoil was trucked to the selected recipient site;
5. the topsoil was transferred to five sites and spread to approximately 20 cm depth; and
6. each site was immediately watered so that the soil was fully wet but not soaked.

Recipient site selection criteria were:

- MCCM biodiversity offset areas having modelled suitable habitat;
- MCCM biodiversity offset areas having previous *Tylophora linearis* records nearby;
- natural woodland with proximity to existing tracks for delivery, management and monitoring access; and
- reasonable proximity to the donor sites.

Following these criteria, Teston South offset area was selected as the recipient site location. An area of similar habitat to that at the donor sites was identified and five locations were flagged for topsoil placement. Following spreading of the topsoil, each area was fenced to exclude herbivores. Sites were signposted as Enclosures 1 to 5 (E1 to E5 for brevity).

The following items are being monitored and managed where appropriate:

- Soil moisture levels: while the species adapts to dry periods this adaptation involves the rhizomes remaining dormant, and the aim of this trial is to encourage plant growth, keeping the soil lightly moist but not saturated. Following the initial saturation, it is aimed to keep moisture at around level 3, the mid-point, on the provided soil moisture meter;
- *Tylophora linearis* stems will be recorded quarterly (or otherwise as deemed necessary) with individual stems flagged, numbered, measured and dated; and
- Monitor and control weeds, with any weeds to be removed by hand.

As of June 2020, no emerging stems have been recorded. This is unsurprising, in fact expected, given the long periods of time the rhizomes can remain dormant as demonstrated in the plant growth studies (Section 3.2.6) and the translocation trial (Section 3.2.5.1) where stems can be absent for months or years.

3.2.6 Plant Growth

The *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008) recognises a research priority for *Tylophora linearis* is to determine the distribution and viability of surviving populations.

Hunter Eco has conducted a longitudinal study of *Tylophora linearis* vegetative growth patterns in natural populations. The study commenced in December 2016 and concluded in June 2020 and has involved three separate components:

- Wollandilly offset area monitoring total stems present;
- Leard State Forest monitoring the presence/absence of individual stems in five populations without stem location mapping; and
- Leard State Forest monitoring the presence/absence of individual stems in five populations with stem location mapping.

Wollandilly Offset Area

This study was conducted in parallel with monitoring the translocated plants described in Section 3.2.5. On each occasion, the total number of stems present was recorded. The population occupied a small, approximately 2 m radius, area facilitating discovery and counting of all stems. Monitoring was monthly up to and including December 2018 and quarterly thereafter. Figure 8 shows the number of stems present on each monitoring occasion.

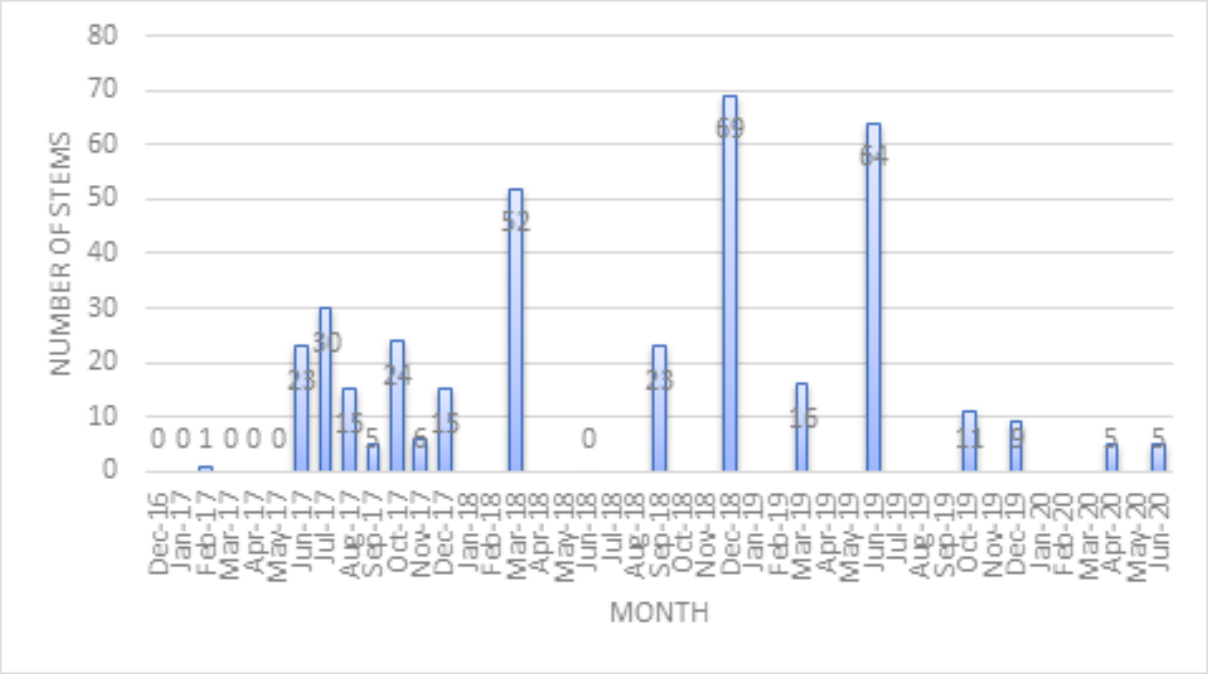

Figure 10 Stem Count over time in the Wollandilly Natural Population

Leard State Forest without Stem Location Mapping

Five widely spaced natural populations were monitored monthly from December 2016 to December 2017. Four corners of a portion of each population were permanently pegged within which all stems present were flagged and sequentially numbered with different coloured flags for each month. The presence/absence of each previously flagged stem was recorded on each monitoring occasion with any new stems flagged.

Leard State Forest with Stem Location Mapping

At each of the five populations a 1 m square quadrat was permanently pegged around a representative group of stems. The position of each stem within the quadrat was triangulated from two corner pegs with stems flagged and numbered. Monitoring was quarterly from March 2018 to June 2020.

Vegetative growth studies have shown the species to be responsive to environmental conditions to the extent that it is not possible to predict from month to month or from one year to the next when the plant becomes detectable by its above-ground stems, or how many stems might appear. The same applies to locality where populations even a short distance apart can differ markedly in the proportion of the population present. The species has been shown to remain dormant for several months and in one case a translocated stem remained dormant for in excess of three years. Furthermore, the number of stems present at any particular time and location are only a portion of the entire population. These attributes suggest that *Tylophora linearis* is considerably more abundant than records have indicated and that the species exhibits the characteristics of *pseudo rarity* (Schoener, 1987; Blackburn and Gaston, 1997).

3.3 *Tylophora linearis* Surveys in NSW

The *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008) recognises a research priority for *Tylophora linearis* is to undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants.

Following the identification of *Tylophora linearis* in the MCCM Project Boundary, Whitehaven engaged Niche to undertake regional targeted surveys for *Tylophora linearis* within seven NPWS reserves and six State Forests within northern NSW. The study area was approximately 371,629 ha (Niche, 2014a). Figure 11 shows the regional occurrence of *Tylophora linearis* prior to and after surveys. The purpose of these works was to gain an understanding of the regional extent of *Tylophora linearis to* inform regional habitat modelling for this species (Niche, 2014a).

Transect surveys, conducted over 15 days by seven people, were of varying lengths (between 1.2 km and 3.8 km) based on the quality of habitat being surveyed. A total transect length of 280 km was sampled during the survey resulting in an estimated survey area of 112 ha (Niche, 2014a).

These surveys confirmed the presence of *Tylophora linearis* in six NPWS reserves and six State Forests, all of which were modelled as containing suitable habitat, namely: Bibblewindi State Forest; Pilliga East State Forest; Pilliga National Park; Pilliga Nature Reserve; Pilliga State Conservation Area; Timallallie National Park; Breeza State Forest; Boonalla Aboriginal Area; Kerringle State Forest; Baradine State Forest; Euligal State Forest; and Trinkey State Conservation Area.

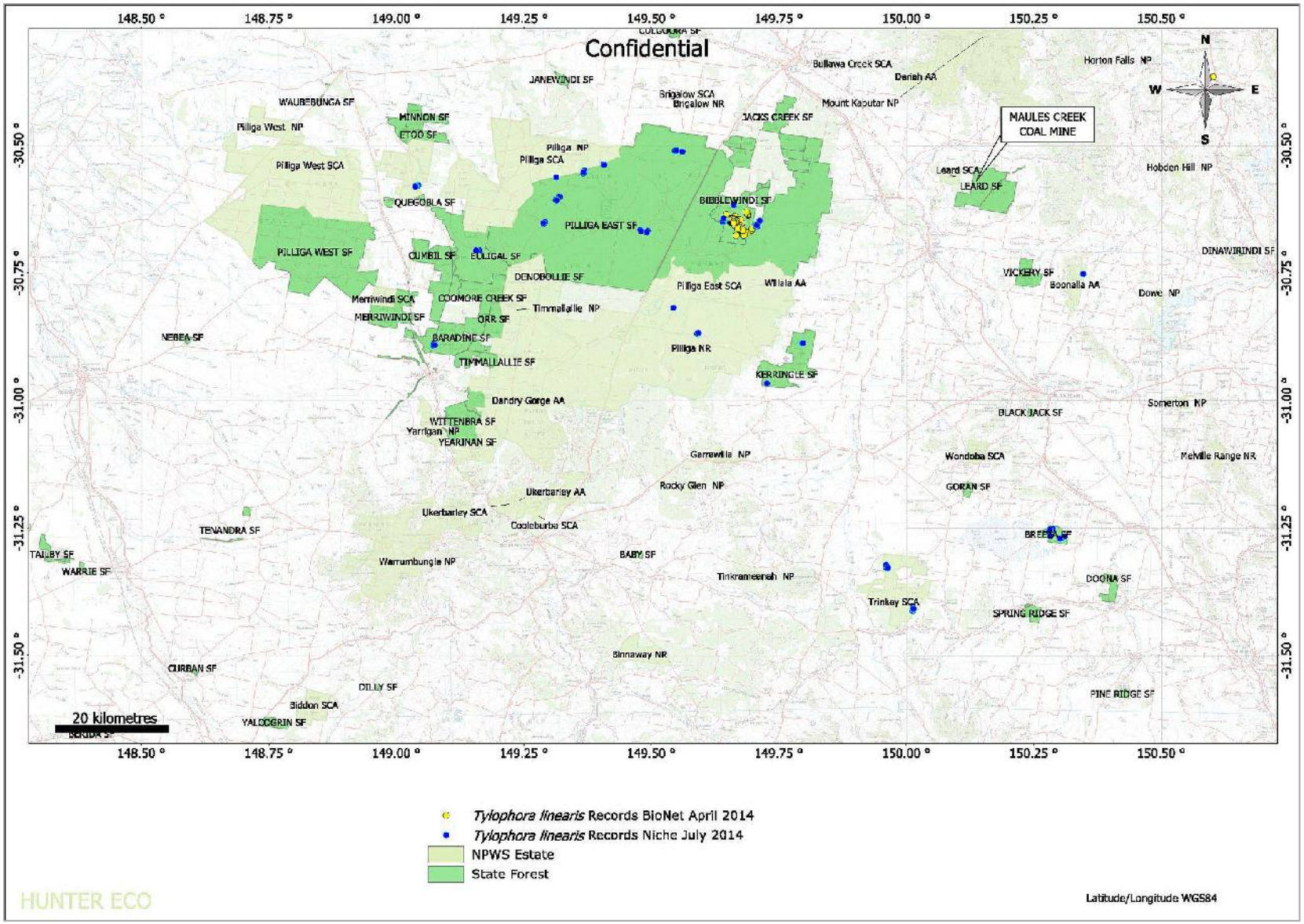

Figure 11 ***Tylophora linearis*** **Regional Occurrence Prior to and After Surveys**

4 COMMONWEALTH OFFSET POLICY AND OFFSET ASSESSMENT GUIDE

A reconciliation of the *Tylophora linearis* offset package against the Commonwealth offset principles (DSEWPaC, 2012b) is presented in Table 4. Table 5 provides an assessment of the land-based offset areas against the *Offsets Assessment Guide* (DSEWPaC, 2012a). The land-based offset areas satisfy 107.63% of the offset requirement according to the *Offsets Assessment Guide* (DSEWPaC, 2012a), and the other compensatory measures (Sections 3.2 and 3.3) have led to a greater understanding of the species and how it can be managed for conservation purposes.

Table 4: Reconciliation of the *Tylophora linearis* Offset Package against the Commonwealth Offset Principles

Offset Principles[1]	Elements of the Offset Package that Address these Requirements
Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environmental law and affected by the action.	The offset package is specifically tailored to offset the impacts on *Tylophora linearis* and its habitat. It would deliver a conservation outcome that improves or maintains the viability of the species as compared to what is likely to have occurred under the status quo, that is if neither the action nor the offset had taken place. The offset package is consistent with the *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008). A conservation gain would be achieved by improving existing *Tylophora linearis* habitat.
Be built around direct offsets but may include other compensatory measures.	The offset package is built around the following measures that directly benefit the species: • conservation of existing habitat for *Tylophora linearis* within offset areas (Section 3.1); • revegetation of woodland/forest within areas of former *Tylophora linearis* habitat; • collection and storage of *Tylophora linearis* seed (Section 3.2.3); and • translocation trials for *Tylophora linearis* resulting in the establishment of a new population of *Tylophora linearis* (Section 3.2.5). These are consistent with the following measures in the *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008)*:* • *Undertake appropriate seed collection and storage for NSW Seedbank and develop collection program of multiple provenances of Tylophora linearis in collaboration with the Botanic Gardens Trust* • *Implement national translocation protocols (Vallee et al., 2004) if establishing additional populations is considered necessary and feasible.* The offset package includes other compensatory measures that provide a greater understanding of the species: • implementation of a root architecture and growth study (Section 3.2.1); • seed production monitoring for *Tylophora linearis* (Section 3.2.2); • *Tylophora linearis* propagation trials (Section 3.2.4); and • regional surveys for *Tylophora linearis* (Section 3.3). These are consistent with the following measures in the *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008)*:* • *Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants* • *Determine the distribution and viability of surviving populations* • *Investigate seed viability, germination, dormancy, and longevity in storage and the natural environment, to determine the requirements for successful establishment* • *Conduct research to determine ecological requirements and undertake field studies to monitor seedling establishment and survivorship*

Offset Principles[1]	Elements of the Offset Package that Address these Requirements
Be in proportion to the level of statutory protection that applies to protected matters.	*Tylophora linearis* is endangered under the EPBC Act. The land-based offset areas satisfy 107.63% of the offset requirement according to the Offsets Assessment Guide (DSEWPaC, 2012a) (Table 5), and the other compensatory measures (Sections 3.2 and 3.3) have led to a greater understanding of the species and how it can be managed for conservation purposes.
Be of a size and scale proportionate to the impacts on the protected matter.	The land-based offset areas satisfy 107.63% of the offset requirement according to the Offsets Assessment Guide (DSEWPaC, 2012a), and the other compensatory measures (Sections 3.2 and 3.3) have led to a greater understanding of the species and how it can be managed for conservation purposes.
Effectively account for and manage the risks of the offset not succeeding.	The *Tylophora linearis* in the MCCM Project Boundary is part of a larger population that extends further into Leard State Forest and adjoining offset areas. The offset package would be able to compensate for the impact on the species as the impacts would not result in the loss of the population. Active management of the majority of offset areas (except Triangle, Thornfield, Neranghi North and Coonoor) has been undertaken for a number of years.
Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs.	The offset package for *Tylophora linearis* is part of the Commonwealth offset for the MCCM and it is additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs.
Be efficient, effective, transparent, proportionate, scientifically robust and reasonable.	The *EPBC Act Environmental Offset Policy* (DSEWPaC, 2012b) describes that '*efficient and effective offsets are those that maintain or improve the viability of a protected matter through the sound allocation of resources'*. The offset package includes a range of measures that are consistent with the following measures in the *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008). The offset package has been implemented over a number of years. *Tylophora linearis* was identified within the MCCM Project Boundary in 2014. In 2014, the following was undertaken: • implementation of a root architecture and growth study (Section 3.2.1); • seed production monitoring for *Tylophora linearis* (Section 3.2.2); • collection and storage of *Tylophora linearis* seed (Section 3.2.3); and • *Tylophora linearis* propagation trials (Section 3.2.4); and • regional surveys for *Tylophora linearis* (Section 3.3). In 2015, the following was commenced: • translocation trials for *Tylophora linearis* resulting in the establishment of a new population of *Tylophora linearis* (Section 3.2.5). In 2016, the following was commenced: • management of existing habitat for *Tylophora linearis* within offset areas (Section 3.1); and This offset package is consistent with the *EPBC Act Environmental Offset Policy* (DSEWPaC, 2012b) that describes '*offsets must be based on both scientifically robust and transparent information that sufficiently analyses and documents the benefit to a protected matter's ecological function or values. This includes undertaking desktop modelling of offset benefits and conducting relevant field work as appropriate'.*
Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.	The offset package for *Tylophora linearis* is part of the MCCM Biodiversity Management Plan (Offset Management Plan) as required by the EPBC Act approval.

[1] DSEWPaC, 2012b.

Table 5: Offset Assessment Guide Calculator Inputs and Output

Aspect	Input	Justification
Impact		
Species Status	Endangered	Section 1.3.
Area of Habitat (ha) to be Impacted	1,495	There are approximately 1,495 ha of *Tylophora linearis* habitat in the indicative extent of Project surface disturbance (Figure 2). This habitat encompasses all of the woodland/forest vegetation.
Quality (0 to 10)	7	There are three components that contribute to the calculation of habitat quality, namely site condition, site context, and species stocking rates (DSEWPaC, 2012c). The site condition for *Tylophora linearis* prior to mining is good with no evidence of recent logging and few weeds (C. Driscoll *pers. obs.*), but there were some recognized threats present, namely being in Leard State Forest there was always the threat from logging activities. The site context was good as the habitat to be cleared was part of a larger area of continuous habitat, however, survey work by Niche (2014a) demonstrated that *Tylophora linearis* is widespread and in other State Forests and Protected Areas in the region as described earlier in this report. The species stocking rates in the habitat to be impacted is illustrated in Figure 2. The species stocking rates in the habitat to be cleared (and adjacent habitat) is likely to be similar to other sites in other State Forests (Section 3.3). The overall habitat quality is considered to be good (7/10).
Offset		
Time over which loss is averted (max. 20 years)	20	A legally binding conservation covenant will be established over the offset areas. Although the offsets are in perpetuity, 20 years is the maximum time able to be entered into the *Offsets Assessment Guide* (DSEWPaC, 2012a).
Time (years) until ecological benefit	10	Management of the offset areas would include management of threats relevant to this species, namely exclusion of livestock, fire and weeds. Management of the offset areas is expected to improve the quality and composition of habitat for *Tylophora linearis* over 10 years as natural regeneration and active revegetation advance.
Start area (ha) (Size of the offset)	5,287.5	Consisting of 3,707.5 ha 'high/medium/low probability' of occurrence habitat and 1,580 ha revegetation.

Aspect	Input	Justification
Start Quality (0 to 10)	5	*The quality score for area of habitat or area of community is a measure of how well a particular site supports a particular threatened species or ecological community and contributes to its ongoing viability*. *There are three components that contribute to the calculation of habitat quality, namely site condition, site context, and species stocking rates… It is important to note that the assessment of quality for threatened species habitat and ecological communities is not simply a scoring of vegetation 'pristineness'.* (DSEWPaC, 2012c). The site condition for *Tylophora linearis* is good in areas of 'high/medium probability' of occurrence habitat (high quality) and 'low probability' of occurrence habitat (but there were some recognized threats present, namely long-term grazing pressure and weeds) (low quality) (Section 3.1). Areas undergoing active revegetation have a current low site condition. The site context is moderate to good as some habitat is fragmented and other habitat adjoins larger areas of continuous habitat. The species stocking rates in the habitat in the various offset areas is described in Section 3.1. The species density is similar to other sites in areas of 'high/medium probability' of occurrence habitat, but absent in areas undergoing active revegetation. The overall habitat quality, on balance, is considered to be moderate to good (5/10) for this species.
Risk of loss (%) without offset	0	Within the next 20 years, without the offset, it is conservatively assumed that there is a 0% risk that the ecological values will be lost (i.e. completely gone). However, it is noted that if the offsets were not to go ahead, grazing pressure would have continued.
Future quality without offset (scale of 0-10)	4	Without the offset, the habitat quality for this species would likely have been further degraded by agricultural land use given agricultural land use is associated with threats to the species. Prior to acquisition by Whitehaven, the offsets were actively used for grazing and/or cropping. A 1-point decline from the current condition is considered reasonable given this species is susceptible to grazing.
Risk of loss (%) with offset	0	Within the next 20 years, with the offset, there is a 0% risk that the ecological values will be lost.
Future quality with offset (scale of 0-10)	7	A quality value of 7 is considered appropriate because the starting quality is 5 and management of the offset areas would include management of threats relevant to this species, namely exclusion of livestock, fire and weeds. The site condition for *Tylophora linearis* is expected to improve. Areas undergoing active revegetation that have a current low site condition, have a large capacity to provide additional habitat and better buffer and link areas of existing habitat (Figures 3 to 6). Based on the proposed offset areas and the proposed management measures, it is highly likely that the offset sites would reach a future quality with offset score of at least 7 (i.e. equivalent to the quality score entered for the impact site) in consideration of the site condition, site context, and species stocking rates. A 2-point increase from the current condition is considered reasonable and achievable given the objectives of the offset areas. The MCCM Offset Management Plan will contain performance and completion criteria to ensure that the revegetation works occurs. A quality value of 7 would be realised once the completion criteria for the revegetation works are met.
Confidence (%) in the result	80	There is a high level of confidence that loss of habitat values in the offset areas would be averted because a legally binding conservation covenant will be established over the offset areas. Further, it is noted that the land on which the offset area is proposed is freehold land owned by Whitehaven and as a result, there is certainty regarding the management commitments.

Aspect	Input	Justification
% of Impact Offset		**107.63%** **Note, the measures under the translocation and propagation program are additional to the calculated 107.63%, meaning that the offset package well exceeds minimum requirements.**

5 CONCLUSION

This report describes the offset package being undertaken for *Tylophora linearis*. An offsets package is a suite of actions that a proponent undertakes in order to compensate for the residual significant impacts of a project. It can comprise a combination of direct offsets and other compensatory measures.

Whitehaven established the following direct and other compensatory measures for the species as part of the offsets package:

1. Conservation of existing habitat for *Tylophora linearis* within offset areas;
2. Revegetation of woodland/forest within areas of former *Tylophora linearis* habitat;
3. Implementation of a root architecture and growth study for *Tylophora linearis*;
4. Seed production monitoring for *Tylophora linearis*;
5. Collection and storage of seed;
6. *Tylophora linearis* propagation;
7. Translocation trials; and
8. Regional surveys.

The *Approved Conservation Advice for Tylophora linearis* (DEWHA, 2008) recognises the following directly relevant priorities for *Tylophora linearis:*

- *Undertake survey work in suitable habitat and potential habitat to locate any additional populations/occurrences/remnants;*
- *Determine the distribution and viability of surviving populations;*
- *Investigate seed viability, germination, dormancy, and longevity in storage and the natural environment, to determine the requirements for successful establishment;*
- *Conduct research to determine ecological requirements and undertake field studies to monitor seedling establishment and survivorship;*
- *Undertake appropriate seed collection and storage for NSW Seedbank and develop collection program of multiple provenances of Tylophora linearis in collaboration with the Botanic Gardens Trust;* and
- *Implement national translocation protocols if establishing additional populations is considered necessary and feasible.*

While loss at an approved mine site may be unavoidable, the above direct and compensatory measures have led to:

1. Conservation of existing habitat for *Tylophora linearis* within offset areas (approximately 3,707.5 ha) (the land-based offset areas satisfy 107.63% of the offset requirement according to the *Offsets Assessment Guide* [DSEWPaC, 2012a]).
2. Active revegetation of woodland/forest in areas of former *Tylophora linearis* habitat.
3. A greater understanding of the regional occurrence of the species targeted surveys initiated by Whitehaven confirmed the presence of the species in six NPWS reserves and six State Forests (Bibblewindi State Forest; Pilliga East State Forest; Pilliga National Park; Pilliga Nature Reserve; Pilliga State Conservation Area; Timallallie National Park; Breeza State Forest; Boonalla Aboriginal Area; Kerringle State Forest; Baradine State Forest; Euligal State Forest; and Trinkey State Conservation Area).

4. A greater understanding of the habitat types that the species occurs in within the region – a range of woodland at elevation range 200 m to > 600 m; slope of flat to > 8 degrees; seven Australian Soil Classification types; seven geological ages; and rainfall from 500 to 800 mm per year.
5. Discovery of *Tylophora linearis* occurring in the previously unrecognised PCT 413.
6. Germination and translocation trial have demonstrated that this is a feasible option for increasing the number of *Tylophora linearis* populations.
7. Root architecture studies have demonstrated that *Tylophora linearis* has in part a clonal growth habit which provides protection from fire and the capacity to conserve resources by losing surface stems during times of environmental stress.
8. A greater understanding of the life history of the species:
    - Vegetative growth studies have shown the species to be responsive to environmental conditions to the extent that it is not possible to predict from month to month or from one year to the next when the plant becomes detectable by its above-ground stems, or how many stems might appear.
    - The species has been shown to remain dormant for several months and in one case a translocated stem remained dormant for in excess of three years.
    - The number of stems present at any particular time and location are only a portion of the entire population.
    - The species is predominantly present above ground as short leafy stems often twining on small grass stems and small shrubs.
    - Infrequently a stem will develop into a fertile plant generally twining vigorously on a small shrub.
    - The process of flowering and fruiting appears to also be dependent upon environmental conditions with buds, flowers or fruiting follicles often aborting.
    - Flowering to seed follicle development and seed release can occur over one month or take three or four months.

It is concluded that the *Tylophora linearis* offset package meets the EPBC Act *Environmental Offset Policy and Guide*. *Tylophora linearis* was recognised as a little known and cryptic species and the measures have led to a greater understanding of the species and how it can be managed for conservation purposes. The *Tylophora linearis* offset package provides a significant addition to the reserved *Tylophora linearis* habitat (including additional confirmed records).

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ATTACHMENT A: PLANT COMMUNITY TYPES ASSOCIATED WITH *TYLOPHORA LINEARIS*

Sourced from BioNet Threatened Biodiversity Data Collection 5 May 2021

PCT	PCT Name	PCT Status
54	Buloke – White Cypress Pine woodland in the NSW South Western Slopes Bioregion	Complete
70	White Cypress Pine woodland on sandy loams in central NSW wheatbelt	Complete
88	Pilliga Box – White Cypress Pine – Buloke shrubby woodland in the Brigalow Belt South Bioregion	Complete
90	Red Ironbark – Brown Bloodwood shrubby woodland of the Brigalow Belt South Bioregion	Complete
141	Broombush – wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion	Complete
148	Dirty Gum – Buloke – White Cypress Pine – ironbark shrubby woodland on deep sandy soils in the Liverpool Plains region of the Brigalow Belt South Bioregion	Complete
179	Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, Brigalow Belt South Bioregion	Complete
202	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South Bioregion (including Pilliga) and Nandewar Bioregion	Complete
217	Mugga Ironbark – Western Grey Box – cypress pine tall woodland on footslopes of low hills in the NSW South Western Slopes Bioregion	Complete
235	Yelarbon Buloke – Western Grey Box – spinifex low open woodland / hummock grassland on sandy sodic soils	Complete
255	Mugga Ironbark – Buloke – Pilliga Box – White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western Brigalow Belt South Bioregion	Complete
272	White Box – Black Cypress Pine – red gum +/- Mugga Ironbark shrubby woodland in hills of the NSW central western slopes	Complete
435	White Box – White Cypress Pine shrub grass hills woodland in the Brigalow Belt South Bioregion and Nandewar Bioregion	Complete
480	Black Cypress Pine – ironbark +/- Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	Complete
673	Black Cypress Pine – Narrow-leaved Stringybark heathy woodland of the southern Brigalow Belt South Bioregion	Complete
676	Black Cypress Pine shrubby woodland of the Brigalow Belt South Bioregion	Complete

PCT	PCT Name	PCT Status
713	Blue-leaved Ironbark heathy woodland of the southern part of the Brigalow Belt South Bioregion	Complete
714	Blue-leaved Ironbark woodland on sandy uplands and slopes of the Darling Riverine Plains Bioregion	Complete
746	Brown Bloodwood – cypress – ironbark heathy woodland in the Pilliga region of the Brigalow Belt South Bioregion	Complete
791	Cypress pine – Bulloak shrubby woodland of northern Brigalow Belt South Bioregion	Complete
955	Mugga Ironbark – Black Cypress Pine woodland on hillslopes and ridges of the Central Lachlan region of the NSW South Western Slopes Bioregion	Complete
956	Mugga Ironbark – Inland Grey Box shrubby woodland of the Brigalow Belt South Bioregion	Complete
1176	Slaty Box – Grey Gum shrubby woodland on footslopes of the upper Hunter Valley, Sydney Basin Bioregion	Complete
1307	White Box – White Cypress Pine – Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion	Complete
1308	White Box – White Cypress Pine shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion	Complete
1313	White Cypress Pine – Narrow-leaved Ironbark shrub/grass open forest of the western Nandewar Bioregion	Complete
1314	White Cypress Pine – Silver-leaved Ironbark – Tumbledown Red Gum shrubby open forest of the Nandewar Bioregion and Brigalow Belt South Bioregion	Complete
1317	White Cypress Pine – White Box – Silver-leaved Ironbark shrubby open forest of the Nandewar Bioregion	Complete
1381	Narrow-leaved Ironbark shrubby woodland of the Brigalow Belt South bioregion	Complete
1383	White Box grassy woodland of the Nandewar Bioregion and Brigalow Belt South Bioregion	Complete
1384	White Cypress Pine – Bulloak – ironbark woodland of the Pilliga area of the Brigalow Belt South Bioregion	Complete
1387	Narrow-leaved Ironbark grassy woodland of the Brigalow Belt South bioregion	Complete

ATTACHMENT B: *TYLOPHORA LINEARIS* HABITAT MODELLING

The Modelling Tool

Maxent (Maximum Entropy modelling) has been developed as a habitat suitability modelling tool over several years and has been widely used (Phillips *et. al*., 2006 and 2008). The version used was Maxent 3.4.1.

Maxent compares the environmental conditions (Environmental Variables [EV]) prevailing around known occurrence locations (samples) with a random selection of 10,000 unoccupied locations from the model area. These unoccupied locations are treated as pseudo absences. Environmental conditions across the entire model area are then graded for degree of habitat similarity when compared with those around the known occurrence locations. In this context the use of 'around' has specific meaning whereby environmental conditions are examined in a wider context than an exact occurrence location. The degree of 'around-ness' can be varied during modelling through the *regularisation* parameter. This provides some control of the degree of fit of the model to known occurrences. A model is overfitted when habitat suitability lies tightly around known occurrences, and underfitted when habitat suitability is too widespread. Generally, the default regularisation parameter suffices.

Maxent uses the principle of *entropy* or disorder. A condition of complete disorder would be when the entire model area is determined to have equal suitability. This condition is then assessed against the constraints of a suite of environmental conditions which restrict the amount of disorder as described above. The model area is divided into a grid, in this case with 500 metres (m) square cells resulting in excess of 1.35 million cells. This means that the model is predicting the probability of *Tylophora linearis* occurring somewhere in each 25 hectares (ha) cell but gives no indication of exact location or potential abundance.

Samples Bias and Samples Selection

Bias in collection of species occurrence records comes in several forms: ease of access where species are recorded near easy points of access such as roads or tracks; records from opportunistic encounters compared with records from intense targeted surveys; or records from surveys driven by development requirements rather than random surveys intended to cover a variety of habitat types. Most regional collections of occurrence records will include each of these to varying degrees and the output from any model using all of these records is likely to be biased in some way. For example, suppose a large proportion of records were from beside roads or tracks, the resulting model would be of the environmental conditions along these access points rather than conditions preferred by the target species.

In the case of the compiled set of *Tylophora linearis* records for NSW all of these biases were apparent. In particular there are dense collections of records from areas targeted for intense survey. These were: Leard State Forest and immediate surrounds, Bibblewindi State Forest, Doona State Forest, Breeza State Forest and several smaller areas. Combined these clusters of records are 84% of the NSW total.

There are several methods available to address bias:

1. Eliminate multiple records lying within a grid cell. Environmental conditions within a grid cell do not vary so one record per occupied grid cell is sufficient. This is conveniently achieved by using the centroid of each occupied grid cell. This is an essential first step irrespective of which subsequent bias control method is used.

2. Create a bias file that Maxent can use to factor out the bias. This is a grid file in the same dimensions as the environmental layers with cells scored according the abundance of records.
3. Restrict the model to an area that contains the majority of records and then project the resulting model into the remainder of the overall target area.
4. Select a subset of all occurrence records that results in a model that most closely describes the environment of all records (Driscoll, 2013). Using a grid approximately 10 times larger than the model grid (e.g. a 5 kilometre [km] grid for a 0.5 km grid model) one record is selected at random from the records occurring within each large grid cell. This is repeated so that 100 random occurrence sets are created. This procedure ensures that occurrences are always selected from across the full geographic/environmental range. Models are then created for each of the 100 random sample sets, using the raw output option and 1000 iterations with all other settings being defaults. The 100 models are then each tested for degree of fit against the full set of occurrences using ENMTools (Warren *et al.,* 2010). The Akaike Information Criteria metric constrained for small samples (AIC)(Akaike, 1974) is computed for each model. The set of samples that resulted in the lowest AIC value (i.e. which best predicted the original combined occurrences) is then selected as input for a final model.

Of these options, the fourth proved to be the most successful. The process resulted in a set of 90 samples being selected from the total 1864 records across NSW.

Environmental Variables

The wide geographic range of the model means that climate variables along with physical variables could be drivers of the model (Guisan and Thuiller, 2005). Climate variables were explored using the 19 Bioclim variables (WorldClim, 2020), along with variables selected from the Australian Bureau of Meteorology (BoM) (BoM, 2020). Maxent will accept EV in either categorical (whole numbers each representing a particular condition) or continuous (actual values) form.

While a Maxent model is tolerant of some degree of correlation between EV, for understanding which variables influence distribution, it is better to avoid EV that are clearly correlated. Correlated EV exist where one variable has some form of relationship with another, meaning that the presence of one could be a surrogate for the other. ENMTools was used to determine the amount of correlation between each EV pair. The output matrix was examined and pairs having r^2 of $\geq \pm 0.8$ were assessed to determine which EV would be the most biologically appropriate to use.

Categorical grids originated from primary data sources that were in vector polygon format where each polygon represented a particular type or condition. To develop the categorical grids the various attributes (e.g. soil type) were given a sequential number and this number was transferred to each overlying cell of the 500 m grid. Continuous grids were prepared from raster grids such as a Digital Terrain Model (DTM) with the values of each grid cell being passed to the master vector grid. The final input grids were created by converting the vector cells into raster grids without interpolation. The following table lists the EV prepared and their source.

Table B-1: Environmental Variables and Their Source

Code	Variable	Type	Format	Source
ELEV	Elevation	Raster	Continuous	A 25 m DTM (NSW Digital Topographic Database) was resampled in GIS to 500 m resolution using bicubic interpolation.
ASPECT	Aspect	Raster	Categorical	Extracted in Manifold GIS from the 500 m DTM then partitioned into 8 categories 22.5^0 either side of N, NE, E etc. An additional category 9, of flat was created for all areas where slope $<1^0$ i.e. flat ground.
SLOPE	Slope	Raster	Continuous	Extracted in GIS from the 500 m DTM.
SOIL	Australian Soil Classification	Vector	Categorical	Digital data from OEH digital data download.
GEOLITH	Lithology	Vector	Categorical	Data from the NSW Department of Mineral Resources.
GEOPER	Geological Period	Vector	Categorical	Data from the NSW Department of Mineral Resources.
BIO1	Annual Mean Temperature	Raster	Continuous	Bioclim.
BIO2	Mean Diurnal Range (Mean of monthly (max temp - min temp))	Raster	Continuous	Bioclim.
BIO3	Isothermality (BIO2/BIO7) (* 100)	Raster	Continuous	Bioclim.
BIO4	Temperature Seasonality (standard deviation *100)	Raster	Continuous	Bioclim.
BIO5	Max Temperature of Warmest Month	Raster	Continuous	Bioclim.
BIO6	Min Temperature of Coldest Month	Raster	Continuous	Bioclim.
BIO7	Temperature Annual Range (BIO5-BIO6)	Raster	Continuous	Bioclim.
BIO8	Mean Temperature of Wettest Quarter	Raster	Continuous	Bioclim.
BIO9	Mean Temperature of Driest Quarter	Raster	Continuous	Bioclim.
BIO10	Mean Temperature of Warmest Quarter	Raster	Continuous	Bioclim.
BIO11	Mean Temperature of Coldest Quarter	Raster	Continuous	Bioclim.
BIO13	Precipitation of Wettest Month	Raster	Continuous	Bioclim.
BIO14	Precipitation of Driest Month	Raster	Continuous	Bioclim.
BIO15	Precipitation Seasonality (Coefficient of Variation)	Raster	Continuous	Bioclim.
BIO16	Precipitation of Wettest Quarter	Raster	Continuous	Bioclim.
BIO17	Precipitation of Driest Quarter	Raster	Continuous	Bioclim.
BIO18	Precipitation of Warmest Quarter	Raster	Continuous	Bioclim.
BIO19	Precipitation of Coldest Quarter	Raster	Continuous	Bioclim.
RAIN	Mean annual rainfall	Raster	Continuous	Australian Bureau of Meteorology.

Code	Variable	Type	Format	Source
RAINAUT	Mean Autumn rainfall	Raster	Continuous	Australian Bureau of Meteorology.
RAINSPR	Mean Spring rainfall	Raster	Continuous	Australian Bureau of Meteorology.
RAINSUM	Mean Summer rainfall	Raster	Continuous	Australian Bureau of Meteorology.
RAINWIN	Mean Winter rainfall	Raster	Continuous	Australian Bureau of Meteorology.
EVAPT	Mean annual evaporative transpiration	Raster	Continuous	Australian Bureau of Meteorology.

A large number of the Bioclim variables were found to be highly correlated as were annual rainfall and elevation. Several models were run with a selection of Bioclim variables along with other variables with the outcome being that only BIO1, Annual Mean Temperature, was selected with the others only having a small influence on the final model. Slope and Aspect also proved to have negligible influence over the final model so these were also excluded. Ultimately the most parsimonious model was achieved using only three EV: SOIL, GEOLITH and RAIN.

As mentioned earlier, the model indicates the probability of *Tylophora linearis* occurring anywhere in a 500 m grid cell (25 ha). This could be any amount of the plant from a single individual to hundreds. The range of probabilities can be conveniently simplified to: 10% to 30% **Low**; 40% to 60% **Moderate**; and 70% to 90% **High**.

Model Validation

Maxent provides a *threshold independent* version of area under the curve (AUC) of the receiver-operating characteristic (ROC) (Fielding and Bell, 1997). The curve is the plot of sensitivity (proportion of presences correctly predicted; omission error) and 1 - specificity (proportion of correctly predicted absences; commission error) across the full range of possible thresholds. In other words, it is a plot of true positives vs false positives across the threshold range of 0 to 1 where, at a threshold of 0 all of the model area is predicted as suitable. The AUC statistic is best obtained using independent test data. Partitioning species presence data is a commonly used method whereby the model is trained on a proportion of the data then tested on the withheld balance. The amount withheld for testing depends on the total number of samples available but is commonly 10 – 25% of the total. For the current model 20% (18) of the 90 samples were used for testing with the remaining 72 used for model training.

The following plot shows the AUC curves for the selected model indicating that the result is well away from being a random prediction and that the training and test data are closely aligned. Broadly, this plot indicates that a randomly selected sample will have a higher predicted value than any randomly selected background point.

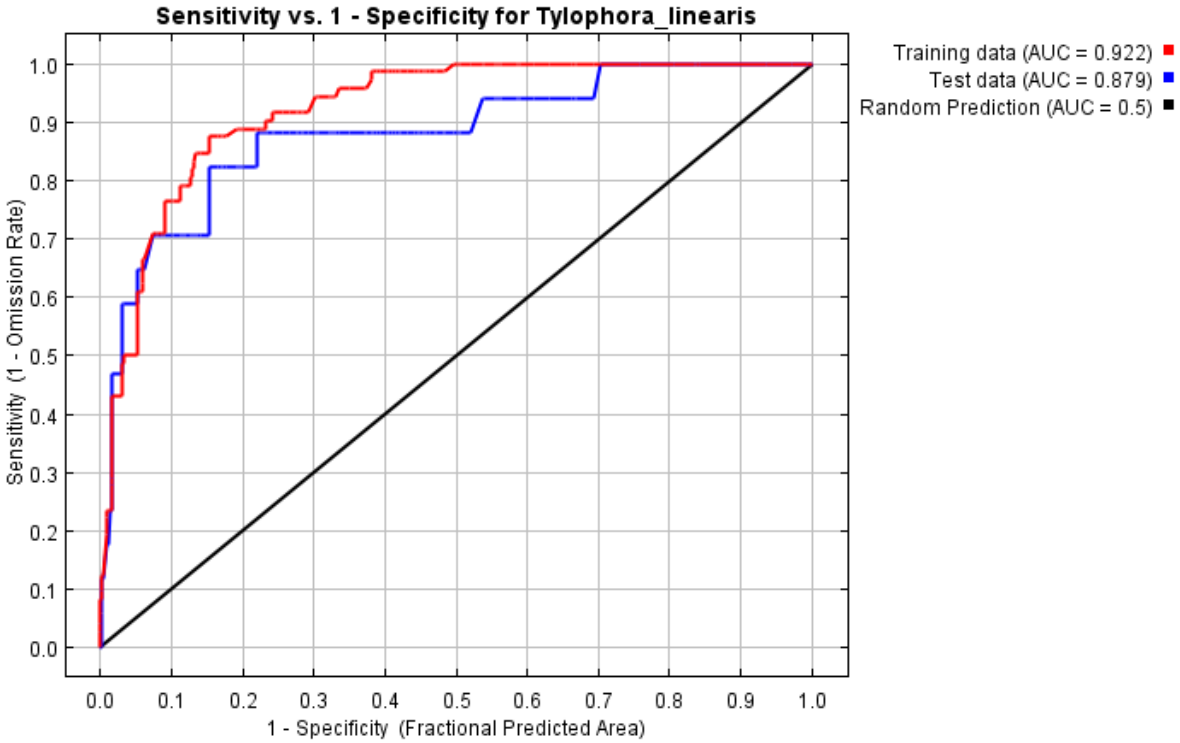

Figure B-1 AUC Curves

The next plot shows the omission levels (false prediction of unsuitable habitat) for varying threshold levels for both training and test data. The training and test data omission levels are closely aligned indicating that the two sets of samples were independent. Both are closely aligned with the predicted omission rate indicating a valid model.

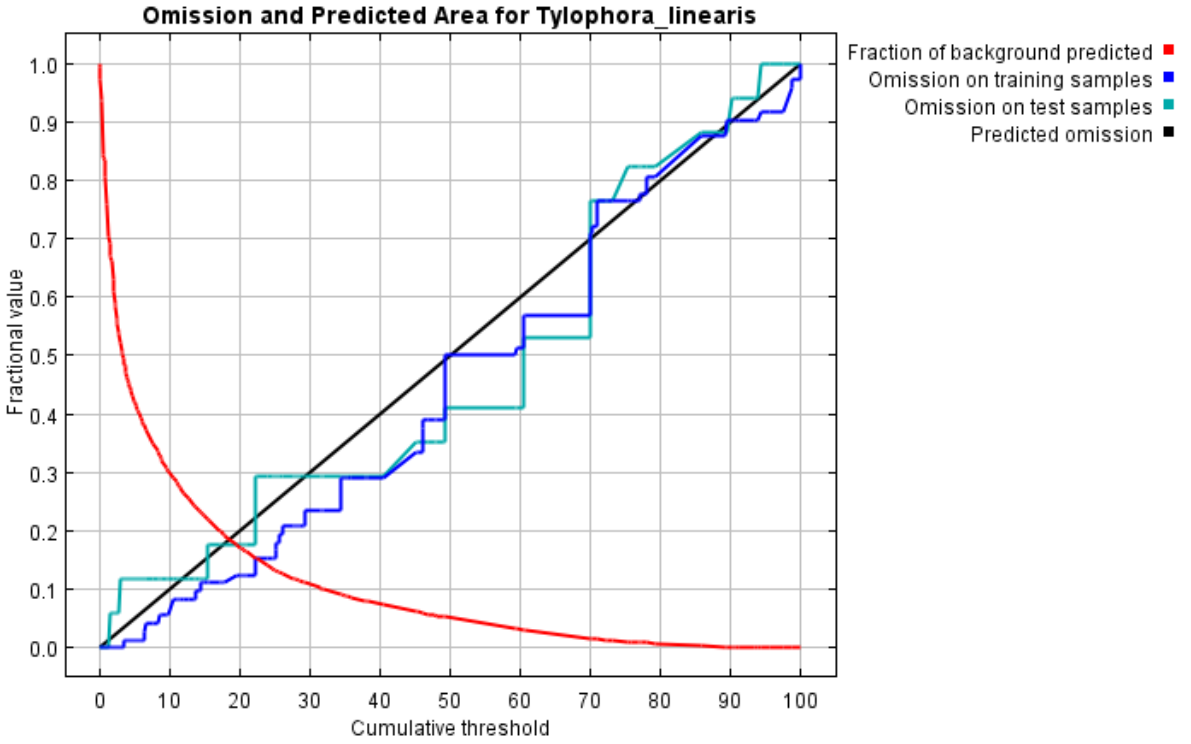

Figure B-2 Omission Levels

Model Drivers

As noted, only three EV were needed to produce the model: Rainfall, Soil Type and Lithology.

Rainfall

This was the primary driver with the species preferring average annual rainfall from 500 millimetres (mm) to 900 mm, with the 600 mm to 700 mm annual rainfall band being clearly dominant.

Soil Type

Four soil types were preferred: Chromosols, Ferrosols, Rudosols/Tenosols and Sodosols. The latter two were dominant.

Lithology

There were 104 lithology types in the model and of these 14 were important although, compared with rainfall and soil, lithology had much reduced influence on the model. Summarising, the species is likely to be found in lithology derived from both sedimentary and igneous rock types.

While Rainfall is the primary model driver, it does not influence the model in isolation of the others, there are interactions between all three EV.

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Propagation and Translocation Program

Tylophora linearis

Maules Creek Coal Mine

Prepared for: Whitehaven Coal

12 June 2024 Version: 1.0

PROJECT NUMBER	2023-160-06			
PROJECT NAME	Propagation and Translocation Program			
PROJECT ADDRESS	Maules Creek Coal Mine			
PREPARED FOR	Whitehaven Coal			
AUTHOR/S	Brian Towle, Tammy Paartalu			
REVIEW	**Technical**	**QA**	**Version**	**Date to client**
	Brian Towle		1.0	12 June 2024
LICENCES	**Scientific Licence**		SL101557 & C0005930	
	Bionet Sensitive Species Data Licence		1115	
	Animal Research Authority Ethics Licence		Fauna Surveys and Monitoring (16/346)	
	Scientific Collection - Aquatic		P19/0009-1.0 & OUT19/2602	

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Glossary and abbreviations

Acronym	Description
BC Act	*Biodiversity Conservation Act 2016*
BCS	Biodiversity, Conservation and Science Directorate within the NSW DCCEEW
BMP	Biodiversity Management Plan
Cth. DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water (formerly DotE)
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DEWHA	Former Commonwealth Department of Environment, Water, Heritage and the Arts, now Cth. DCCEEW
DotE	Former Commonwealth Department of the Environment, now Cth. DCCEEW
DPHI	NSW Department of Planning, Housing and Infrastructure
DPIE	Former NSW Department of Planning, Industry and the Environment now DPHI or NSW DCCEEW
DSEWPAC	Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities, now Cth. DCCEEW
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
MCCM	Maule Creek Coal Mine
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	Office of Environment and Heritage
PAC	Planning Assessment Commission
SCA	State Conservation Area

Acronym	Description
TFPP	Threatened Flora Project Plan
TSC Act	*Threatened Species Conservation Act 1995* (repealed; now BC Act)
WHC	Whitehaven Coal

1 Introduction

In accordance with Project Approval (PA 10_0138) Schedule 3, Condition 52, a Biodiversity Management Plan (BMP) has been prepared by Whitehaven Coal Pty Ltd (WHC) for the Maules Creek Coal Mine (MCCM; WHC 2017). A revision to this BMP is currently underway (WHC In prep.) and Section 3.1.2 of the revised BMP, states that:

> "*Prior to clearing, a pre-clearing flora survey will be conducted to search for threatened plant species that have potential to occur, based on habitat available. If a threatened plant species is identified, the numbers of plants will be counted and/or the population estimated/mapped. A review of translocation methods, collection of propagules, and propagation from seeds or cuttings from plants within the MCCM disturbance area and/or surrounds will be undertaken. Following this review, a translocation/propagation program will be developed and implemented where appropriate in consultation with BCS, DPHI and Cth DCCEEW (for Matters of National Environmental Significance [MNES]).*"

Tylophora linearis is a herbaceous twiner or subshrub which is listed as vulnerable under the NSW *Biodiversity Conservation Act 2016* (BC Act) and as endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The species was identified at Maules Creek Coal Mine (MCCM) during pre-clearing surveys in 2014 and 2015. A propagation and translocation program for *Tylophora linearis* was previously prepared in consultation with Dr Colin Driscoll (Hunter Eco), the former Office of Environment and Heritage (OEH) and the former NSW Department of Planning and Environment, and was included in Appendix C of the BMP (WHC 2017). In 2020 and 2021, an updated Threatened Flora Project Plan ('TFPP'; Ecoplanning 2021a) and *Tylophora linearis* Restoration and Translocation Strategy (Ecoplanning 2020a) were prepared to support the propagation and translocation program (WHC – 2017 Appendix D), pending the next revision of the BMP.

Management actions undertaken by WHC to date for *Tylophora linearis* have been documented annually in the MCCM Annual Reviews (Hunter Eco 2015a - 2017; WHC 2019; Ecoplanning 2020b-2024).

This propagation and translocation program has been prepared for inclusion in a revised BMP (WHC In prep.) and reviews, updates, and supersedes the previous *Tylophora linearis* Propagation and Translocation Plan (WHC 2017) and the *Tylophora linearis* Restoration and Translocation Strategy (Ecoplanning 2020a). This program has been prepared to fulfil the ongoing requirements of revised BMP (WHC In prep.). Further, this propagation and translocation program is integrated as part of WHCs TFPP (Ecoplanning 2021a) which provides overarching guidance on the management habitat for threatened flora species within and adjacent to WHC mining operations and Biodiversity Offset Areas (hereafter referred to as WHC managed areas).

This program adopts the definition of 'translocation' as included in the third version of the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018), which is:

> *"… the deliberate transfer of plants or regenerative plant material from an ex situ collection or natural population to a new location, usually in the wild. It includes reintroduction, introduction, reinforcement, assisted migration and assisted colonization.*

Translocations involve a diverse range of methods including: seed collection and propagation; propagation via cuttings or tissue culture; planting of containerised plants; direct seeding; transplantation of whole plants from one site to another; and the transfer of soil, leaf litter, brush or pollen."

1.1 Nomenclature

Recent studies of the *Tylophorinae* (Liedde-Schumann et al. 2016; Liedde-Schumann and Meve 2018) found the previously unrelated genera *Tylophora* and *Vincetoxicum* to be intermingled and all species within the *Tylophora* genus were renamed as members of the *Vincetoxicum* genus. As part as these studies, *Tylophora linearis* was renamed *Vincetoxicum fosteri* (Liedde-Schumann and Meve 2018). While this name change has been adopted by the Council of Heads of Australasian Herbaria and the Commonwealth Department of Climate Change, Energy, the Environment and Water (Cth. DCCEEW), it has not yet been adopted by the BC Act, PlantNet (2023) or the documentation of the NSW Department of Climate Change, Energy, the Environment and Water (NSW DCCEEW). Naming throughout this report follows the current listing of the species under the BC Act, as *Tylophora linearis*, although all information presented applies equally to the synonymous *Vincetoxicum fosteri*, as listed under the EPBC Act.

1.2 Aims and objectives

The overall aim of this propagation and translocation program is to directly support the conservation of *Tylophora linearis,* and to maintain a self-sustaining, genetically diverse population of the species within the WHC managed areas, which is capable of surviving in the long term. To ensure long-term survival, research suggests that populations of around 200 to 250 plants are required to minimise reduced genetic and demographic outcomes associated with small populations (Young and Brown 1999). Across WHC managed lands various naturally occurring sub-populations of *Tylophora linearis* are present, with the size of these sub-populations variable between seasons and individual sub-populations. Therefore, success of the translocation program would be achieved by maintaining these existing sub-populations, including translocated populations, and where possible reinforcing these populations with genetic diversity from sub-populations within the approved MCCM disturbance areas. Specific objectives of this program include the following:

- Guide the successful translocation of *Tylophora linearis* individuals, grown from seed, stem cuttings, or whole turve translocations, to suitable habitat within the protected areas that form part of the WHC managed lands.
- Provide clear management and monitoring measures to ensure the long-term success of the program.

This program primarily represents a 'Salvage' and 'Reinforcement' translocation according to the definitions of Commander et al. (2018). That is, the translocation aims to transfer seedlings grown under ex situ conditions and/or seed to locations where there is an existing population of *Tylophora linearis*. The source of regenerative material is to include individuals within the approved MCCM disturbance areas ('salvage') and material from natural populations across WHC managed lands and State Forests.

1.3 Ecology of *Tylophora linearis*

1.3.1 Distribution and population size

Tylophora linearis was first described by Forster (1992) when there were only four records, three in NSW and one in Queensland. The species was listed as 'Endangered' in NSW at the commencement of the NSW *Threatened Species Conservation Act 1995* (TSC Act). Forster *et al.* (2004) then reported the rediscovery of the species adding 390 stems from three new locations in NSW. In 2008 the NSW Scientific Committee conducted a review of current *Tylophora linearis* information which concluded that there were 10 confirmed populations in NSW consisting of 250 to 500 mature individuals (NSW Scientific Committee 2008). In early 2009 the listing of the species under the TSC Act was downgraded from 'Endangered' to 'Vulnerable'. The species was listed as 'Endangered under the EPBC Act in October 2008, having previously been listed as Endangered under the *Threatened Flora Amendment* (June 1994) to the previous Commonwealth *Endangered Species Protection Act 1992.*

NSW BioNet Atlas (NSW DCCEEW 2024) holds 1,625 *Tylophora linearis* records distributed from West Wyalong in the south to Yetman in the north, and the Pilliga region in the west to Murrurundi in the east (**Figure 1.1**). Very large populations of the species have been detected in multiple locations across NSW with population density extrapolations used to estimate the number of stems, or individuals. Eco Logical Australia (2012) recorded populations of *Tylophora linearis* within Pilliga East State Forest, Pilliga State Conservation Area (SCA), Pilliga East SCA, Pilliga Nature Reserve and Bibblewindi State Forest and estimated the total population of *Tylophora linearis* within the Pilliga and Pilliga Outwash Catchment Management Authority subregions as 183,908 stems (Eco Logical Australia 2012). Hunter Eco (2014) estimated that the median *Tylophora linearis* population in an area taking in the Pilliga region, Leard State Forest, Leard State Conservation Area and the Mt Kaputar area was in excess of one million stems. Hunter Eco (2015b) also estimated a median population of 9,360 stems in 720 ha of Doona State Forest. Records of *Tylophora linearis* across the region are shown in **Figure 1.2**.

Occurrence within WHC managed lands

The presence of *Tylophora linearis* within the MCCM disturbance area was not identified until pre-clearance surveys in 2014 and 2015, after the commencement of the approved vegetation clearing. Therefore, it is impossible to quantify the exact number of individuals of *Tylophora linearis* within the MCCM Project Boundary. Since the species was recorded within the approved MCCM disturbance area, *Tylophora linearis* has been recorded across multiple WHC managed lands. A summary of occurrences of *Tylophora linearis* and modelled habitat for the species (Hunter Eco 2021) across WHC managed lands is summarised in **Table 1.1** with recorded locations shown in **Figure 1.2**.

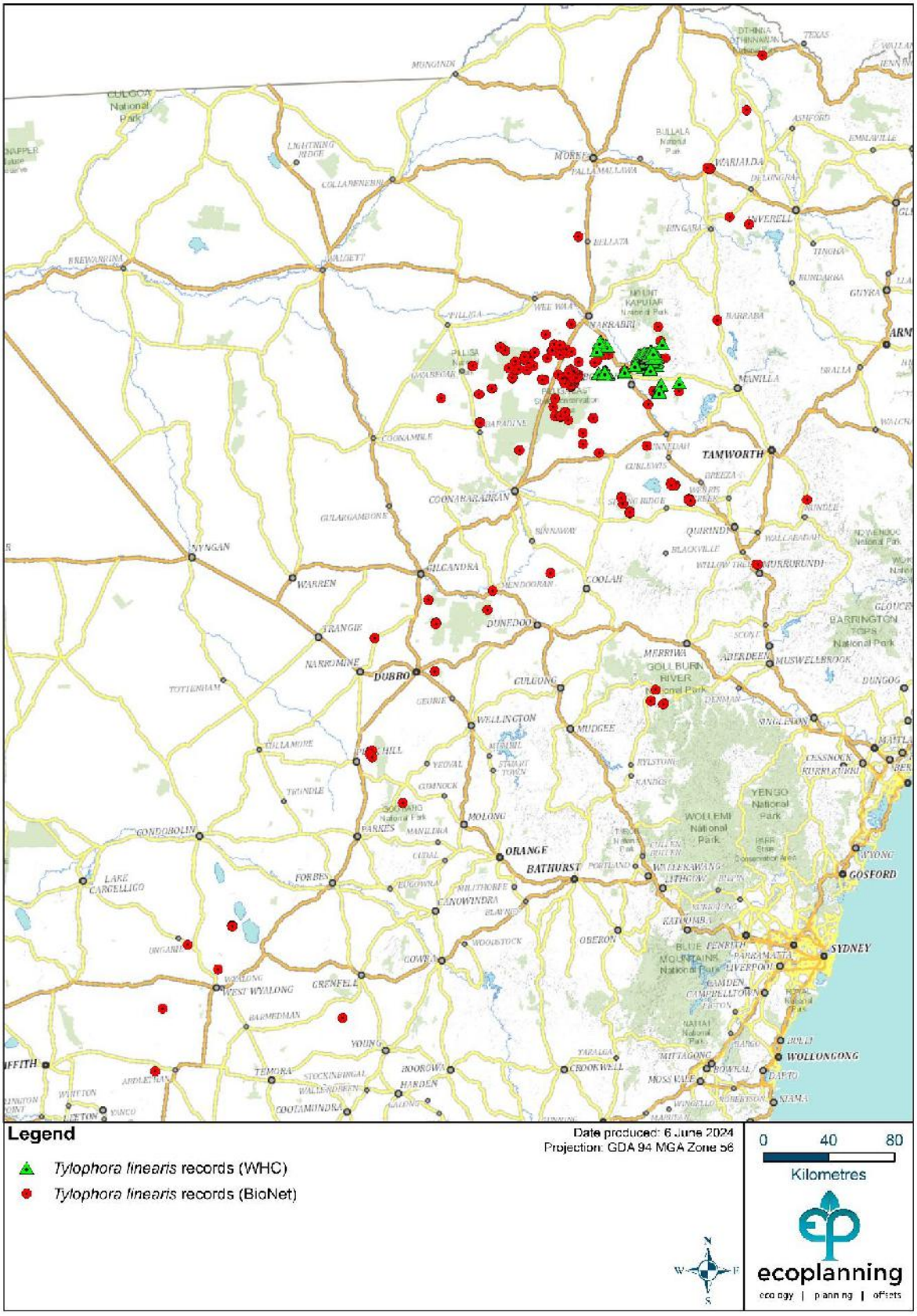

Figure 1.1: Occurrence of *Tylophora linearis* across NSW

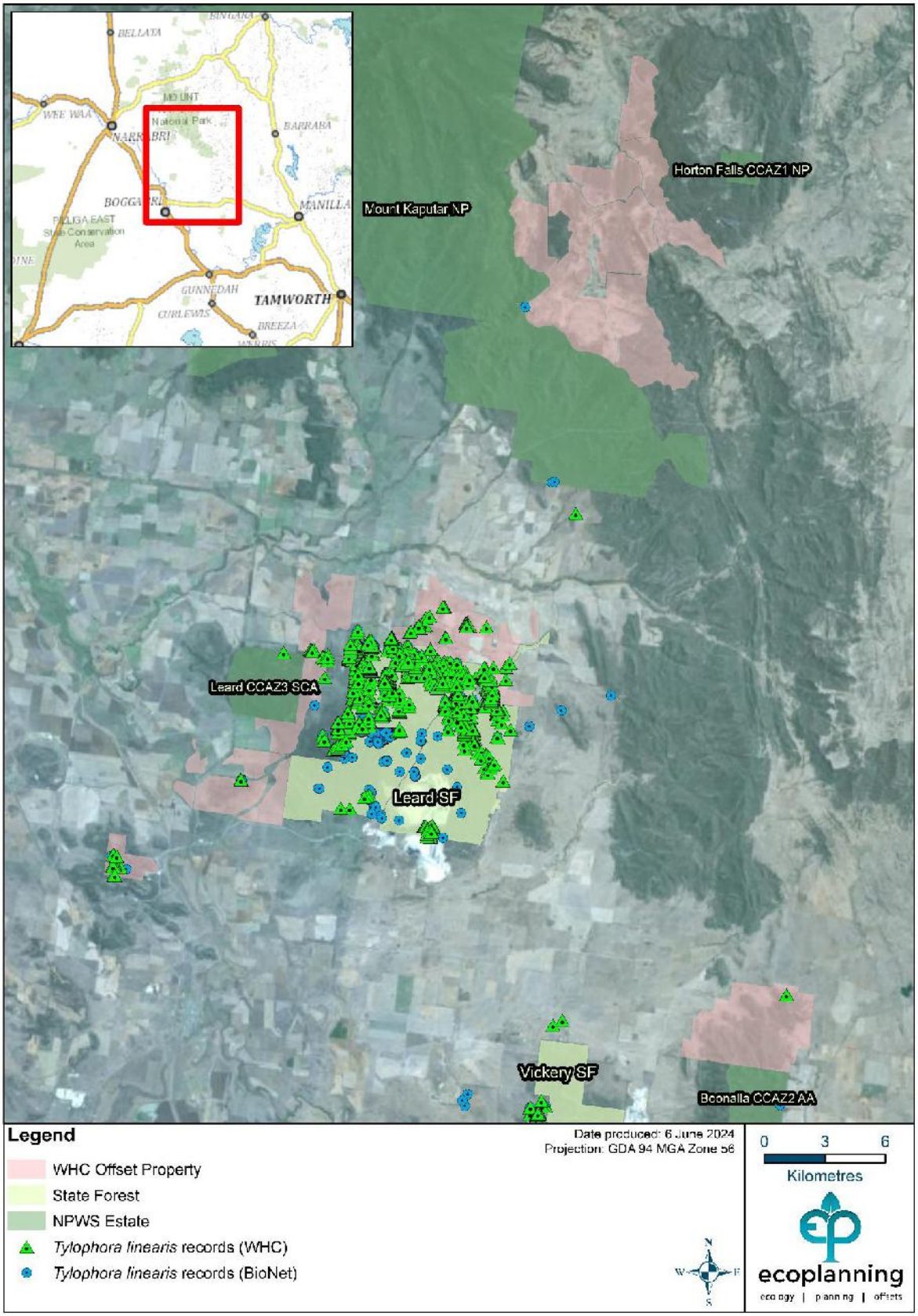

Figure 1.2: Occurrences of *Tylophora linearis* across the region

Table 1.1: The habitat for *Tylophora linearis* across the MCCM Offset Areas (after the *Tylophora linearis* Offset Package, Hunter Eco 2021)

Offset Area	Offset Area (ha)	Area of Existing Habitat for *T. linearis* (ha)	Area of Revegetation within Former Potential Habitat for *T. linearis* (ha)	Total Existing and Future Habitat for *T. linearis* (ha)
Bimbooria	622.5	374.6	146.2	520.8
Coonoor	574.1	82.7[A]	0	82.7
Kelso	489.4	268.3	151	419.3
Long Gully	352.9	0[B]	0	0
Louenville	213.1	178.5	26.2	204.7
Mt Lindesay	2337.1	379.9[C]	12.6[D]	392.5
Neranghi North	567.1	107.9[E]	0	107.9
Onavale	557.7	101.8	79.5	181.3
Roseglass	1465.3	1039.4	132.7	1172.1
Teston South	336.2	234.1	57.5	291.6
Thornfield	171.3	31.8	68	99.8
Triangle	665.9	39.9[F]	0	39.9
Velyama	702.6	55.8	474.8	530.6

Offset Area	Offset Area (ha)	Area of Existing Habitat for *T. linearis* (ha)	Area of Revegetation within Former Potential Habitat for *T. linearis* (ha)	Total Existing and Future Habitat for *T. linearis* (ha)
Wollandilly	804.4	224.1	315.5	539.6
Wirradale & Wongala South	4469.2	588.7[G]	116[H]	704.7
Total Area (ha)	**14328.8**	**3707.5**	**1580**	**5287.5**
Ratio Offset to Clearance				**3.5:1**

[A] Includes 413.4 ha low probability habitat discounted by 80% (Coonoor).

[B] Offset lies outside model bounds and in high rainfall area. Probability of occurrence assumed to be zero (Long Gully).

[C] Includes 1,899.3 ha low probability habitat discounted by 80% (Mt Lindesay).

[D] Includes 62.8 ha low probability revegetation habitat discounted by 80% (Mt Lindesay).

[E] Includes 539.4 ha low probability habitat discounted by 80% (Neranghi North).

[F] Includes 199.5 ha low probability habitat discounted by 80% (Triangle).

[G] Includes 2,943.5 ha low probability habitat discounted by 80% (Wirradale & Wongala South).

[H] Includes 580 ha low probability revegetation habitat discounted by 80% (Wongala South).

1.3.2 Habitat associations

Habitat for *Tylophora linearis* has been variously described as dense shrublands over-topped by Eucalypts, *Callitris glaucophylla* or *Allocasuarina luehmannii* (Forster et al. 2004; NSW Scientific Committee 2008; PlantNet 2023). The BioNet Threatened Biodiversity Data Collection (NSW DCCEEW 2024) recognises that *Tylophora linearis* is known or likely to be associated with 162 different plant community types. This indicates that the species is a habitat generalist rather than specialist. Hunter Eco (2021) identifies that the species occupies a broad range of habitats across multiple environment variables, as follows:

- elevation range 200 m to > 600 m;
- slope of flat to > 8 degrees;
- seven Australian Soil Classification types (Chromosols, Ferrosols, Kurosols, Rudosols and Tenosols, Sodosols, Vertosols, Kurosols Natric);
- seven geological ages (Carboniferous, Cretaceous, Devonian, Jurassic, Permian, Quaternary and Tertiary); and
- rainfall from 500 to 800 mm per year.

A review of habitat descriptions associated with records of *Tylophora linearis* on BioNet (NSW DCCEEW 2024) identified a number of records as occurring within regrowth *Callitris glaucophylla* or within areas described as open woodlands. Eco Logical Australia (2012) noted that their observations of *Tylophora linearis* from the Pilliga Forests occurred across a broad range of vegetation types which often had evidence of disturbance from forestry or recent fire. Specifically, Eco Logical Australia (2012) noted that the species was most often found in areas of vegetation which had been heavily burnt by a 2007 wildfire, along track edges and in recently cut road drains. Records of *Tylophora linearis* within the MCCM Project Boundary and surrounds have occurred in association with forested and woodland areas and commonly in areas identified as having a midstorey of *Callitris glaucophylla* (Cumberland Ecology 2011).

1.3.3 Life-cycle

Tylophora linearis is a perennial species, although the life-cycle of the species commonly includes a reduction, or the complete absence, of above ground biomass during extended dry periods (Ecoplanning 2020a). Forster et al. (2004) describe an underground rhizome from which the plant can re-sprout following fire, a feature that would also accommodate the reduction and re-sprouting of above-ground biomass in response to rainfall. Occurrences of *Tylophora linearis* are commonly quantified as a number of stems rather than individual plants because multiple stems of *Tylophora linearis* can originate from a rhizome (common underground root) with all stems arising from the same rhizome being genetically identical and part of a single plant (Forster et al. 2004; Niche 2014). A population of *Tylophora linearis* will typically consist of a number of genetically different parent plants each capable of producing multiple clones (stems). The term 'ramets', which refers to the group of clones belonging to a parent plant, can be used to quantify the population of clonal plants. However, this quantification cannot be readily applied in the field and is dependent upon genetic analysis.

The inflorescence of *Tylophora linearis* consists of up to eight flowers produced on umbels with flowering time reported as spring (Harden 1992; PlantNET 2023). However, previous monitoring surveys have also recorded flowering within autumn months (Niche 2014;

Ecoplanning 2020a). Fruiting is thought to occur 2 to 3 months after flowering (DPIE 2020). Pollinators for *Tylophora linearis* are unknown, although it is thought that insect-mediated transfer of pollen between flowers is necessary for pollination of the species, as this is the case with most Asclepiad species (Ollerton & Liede 1997; Foster et al. 2004). Members of the Family Asclepiadaceae form sac-like structures called pollinia (singular pollinium) that contain a number of pollen grains. These pollinia are the product of only one anther and are transferred during pollination as a single unit (Sinha & Mondal 2011; Niche 2014). This species is also at least partially clonal (Foster et al. 2004), whereby plants can produce new plants vegetatively.

1.3.4 Threats

Documented threats to *Tylophora linearis* (DEWHA 2008; DPIE 2020) and are primarily associated with forestry activities including track maintenance, which is likely due to the widespread occurrence of the species across State Forests. Other identified threats to the species include grazing, fire and introduced weeds.

2 Approvals and requirements

Relevant management plans, approval conditions and requirements which relate to *Tylophora linearis* are summarised in **Table 2.1**.

Table 2.1: MCCM statutory requirements and management plans relevant to *Tylophora linearis*

Approval / Management plan	Requirement	Response
Approval under the EPBC Act (EPBC Approval 2010/5566), Condition 32	*"In the event that any additional matters of national environmental significance are recorded within the project area and a significant impact on the matter/s is likely, the department must be notified in writing within 14 days of the matter/s being recorded. In accordance with condition 37, the Minister may request that the person taking the action revise any relevant plans to ensure better protection of the relevant matter/s."* In a letter to Whitehaven (dated 18 July 2014), the Department states: "*the Department will accept, on a precautionary basis, a 3:1 ratio of known Tylophora linearis habitat. Alternatively, Whitehaven may apply the EPBC Act Environmental Offset Policy and Guide. Should you apply the offset policy, the Department recognises that this is a little known and cryptic species and that as such, compensatory measures may be appropriate."*	On the 16 April 2014, the former Department of the Environment (DotE) was notified of the presence of the additional MNES. The *Tylophora linearis* Offsets Package was delivered (as documented in Hunter Eco 2021) and approved by the former Commonwealth Department of Agriculture, Water and Environment on 28 September 2021.
Project Approval (PA 10_0138) Schedule 3, Condition 52	"*The Proponent shall prepare and implement a Biodiversity Management Plan for the project to the satisfaction of the Director-General."*	A BMP has been prepared (WHC 2017) and is currently being revised (WHC In prep.).
Biodiversity Management Plan - Section 3.1.2	*"Prior to clearing, a pre-clearing flora survey will be conducted to search for threatened plant species that have potential to occur, based on habitat available. If a threatened plant species is identified, the numbers of plants will be counted and/or the population estimated/mapped. A review of translocation methods, collection of propagules, and*	A propagation and translocation program for *Tylophora linearis* was previously prepared (Appendix C of the

Approval / Management plan	Requirement	Response
	propagation from seeds or cuttings from plants within the MCCM disturbance area and/or surrounds will be undertaken. Following this review, a translocation/propagation program will be developed and implemented where appropriate in consultation with BCS, DPHI and Cth DCCEEW (for Matters of National Environmental Significance [MNES]).”	MCCM BMP [WHC 2017]). This propagation and translocation program reviews, updates, and supersedes the previous Propagation and Translocation Plan (WHC 2017).

3 Current and past management actions and trials

Completed management actions undertaken by WHC to date for *Tylophora linearis* have been documented within the MCCM Annual Reviews. The previous *Tylophora linearis* propagation and translocation program (WHC 2017) included the following stages:

- Stage 1 – Root architecture and growth study (complete).
- Stage 2 – Seed production monitoring (complete).
- Stage 3 – Seed collection and storage (complete).
- Stage 4 – Seed propagation (complete); and
- Stage 5 – Translocation trials (complete).

Stages 1 – 4 of the previous *Tylophora linearis* propagation and translocation program (MCCM BMP 2017 Appendix C) were completed and documented in annual reports (Hunter Eco 2016; Hunter Eco 2017; WHC 2018; Ecoplanning 2020). Actions outlined within the updated TFPP (Ecoplanning 2021a) and Restoration and Translocation Strategy (Ecoplanning 2020a) for *Tylophora linearis* are as follows:

- Monitoring of the translocated individuals for life cycle/ecological analysis.
- Surveillance of natural populations of *Tylophora linearis* to continue to monitor seed production and germination, identify any threats to threatened flora and to increase knowledge of each species' ecology and reproductive habits.
- Where propagules are available, further translocations of *Tylophora linearis* via multiple methods including salvage translocations of whole plants (from within approved MCCM disturbance areas) and seed collection to enable further germination trials.

The following sections summarise the works completed to date, and general results as presented within Annual Reviews (Hunter Eco 2015a - 2017; WHC 2019; Ecoplanning 2020b-2024).

3.1 Root architecture and growth study

During mine clearing activities in 2014, a selection of *Tylophora linearis* within the area to be cleared were excavated to document their root architecture and growth. Niche (2014) conducted a study of the root architecture of *Tylophora linearis* to better understand possible constraints to translocation of whole plants. It was shown that the species has a rhizomatous root structure (**Figure 3.1**). Of the 27 emergent stems excavated, nine were connected to a rhizome. *Tylophora linearis* is therefore at least partially clonal. In many instances a thickened, vertical rhizome was observed connecting the aerial stem to a thinner horizontal rhizome. Stems recorded in the immediate vicinity of other stems may therefore be clones of a single plant.

Forster et al. (2004) describes that *Tylophora linearis* has an underground rhizome from which more than one aerial stem can emerge, but the extent of the underground rhizome was unknown before this study.

Figure 3.1: *Tylophora linearis* root architecture showing rhizomatous root structure (Source: Niche 2014)

3.2 Seed production monitoring, collections and propagation

Seed production monitoring initially involved monitoring of 20 flowering *Tylophora linearis* plants for the development of fruit over four months commencing in May 2014 (Niche 2014). Only one mature fruit was recorded and collected during the seed production monitoring, although six pods were opportunistically collected from a single plant within the mine footprint on 20 August 2014 (Niche 2014). A total of 157 seeds from the seven collected pods were utilised for the initial germination trial. These seeds were subject to propagation trials which found Gibberellic Acid treatment resulted in 60% higher germination than untreated seed, suggesting the presence of a dormancy mechanism.

Between 2015 and early 2020, there were no further opportunities to collect seed (Ecoplanning 2020a). Since 2020, ongoing monitoring of both translocated populations of *Tylophora linearis* and naturally occurring populations across the WHC managed lands has been conducted in accordance with the Restoration and Translocation Strategy (Ecoplanning 2020a). The purpose of this monitoring and surveillance includes monitoring seed production. However, this monitoring has not resulted in detection of any opportunities for seed collection form naturally occurring populations. In Autumn 2020, a total of 13 seeds from *Tylophora linearis* were collected from pods produced by translocated plants within the MCCM Wollandilly Offset Property (see **section 3.2**). Unfortunately, much of the collected seed was not viable and only a single seed was successfully germinated with the single germinant short-lived and dying shortly after germination.

In association with the regular inspections of naturally occurring populations of T*ylophora linearis* inspections in accordance with the TFPP (Ecoplanning 2021a), a hand-pollination trial commenced during spring 2023. This trial involved hand pollination of a subset of observed flowering *Tylophora linearis* with subsequent inspections undertaken to determine whether any pods have been produced as a result of hand-pollination attempts. To date, no pods have been produced from hand pollinated flowers.

3.3 Translocation trials

From the initial seed collections in in August 2014, a propagation trial commenced) producing 77 seedlings which were translocated into seven enclosures within the Wollandilly Offset Property on 3 December 2015 (**Figure 3.2; Figure 3.3**; **Figure 3.4**). Post-translocation monitoring of these plants from 2015-2024 has identified a survival rate of approximately 6.5 %. The low survival rate of these plants is at least partially the result of a very high attrition rate in the period immediately after planting, with 83% estimated to have died within the first 12 months (Hunter Eco 2016). This high number of plants which died in the first 12 months after planting may be attributed to low soil moisture before the plants could establish. A supplementary watering regime is to be established as per relevant guidelines (Commander et al. 2018) for all future translocations as documented in **section 5.3.7**.

The surviving translocated *Tylophora linearis* have flowered and produced fruit (**Figure 3.3**), which has also created opportunities for further seed collection and germination (as discussed in **section 3.2**). The flowering and seed production of translocated plants demonstrates continued progress towards the previously stated goal of establishing self-sustaining populations of *Tylophora linearis* from the translocated individuals.

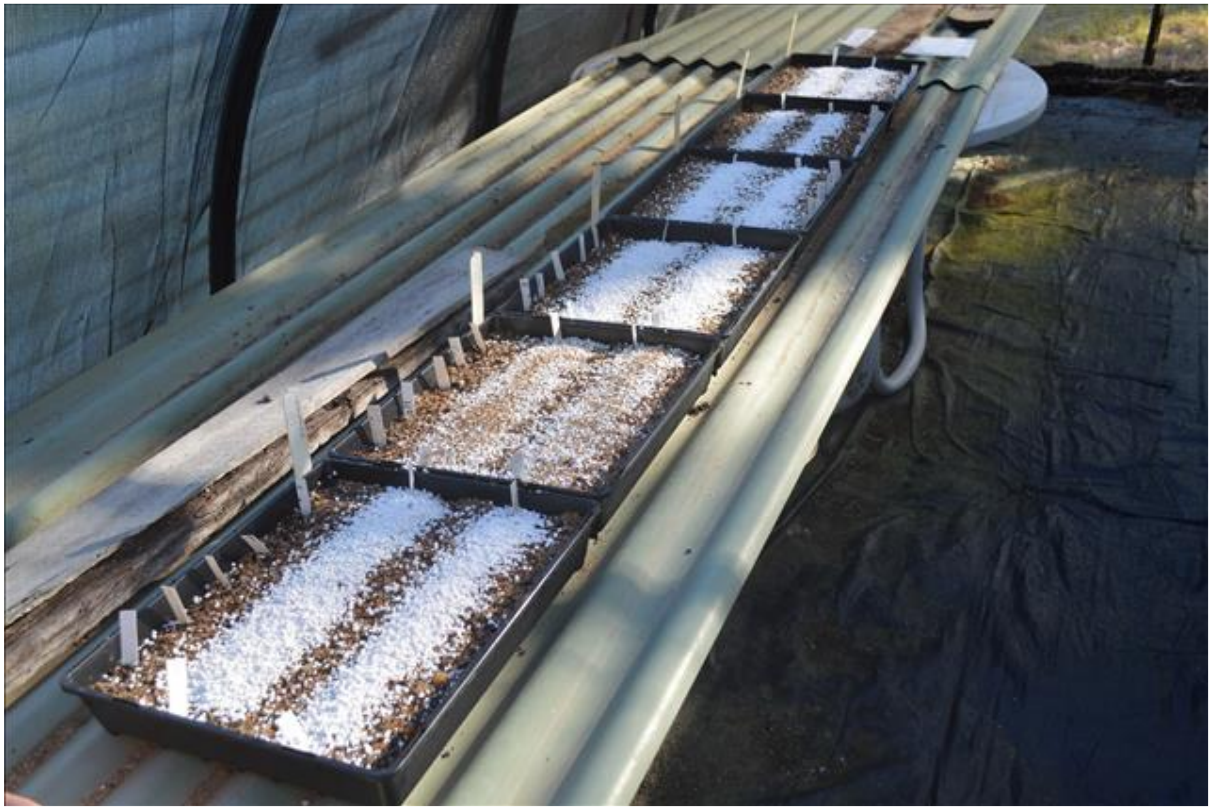

Figure 3.2: Seed propagation trials (Source: Hunter Eco 2015a)

Figure 3.3: *Tylophora linearis* tubestock prior to prior to translocation (left; Source Hunter Eco 2016) and translocated individual with developing follicle (right).

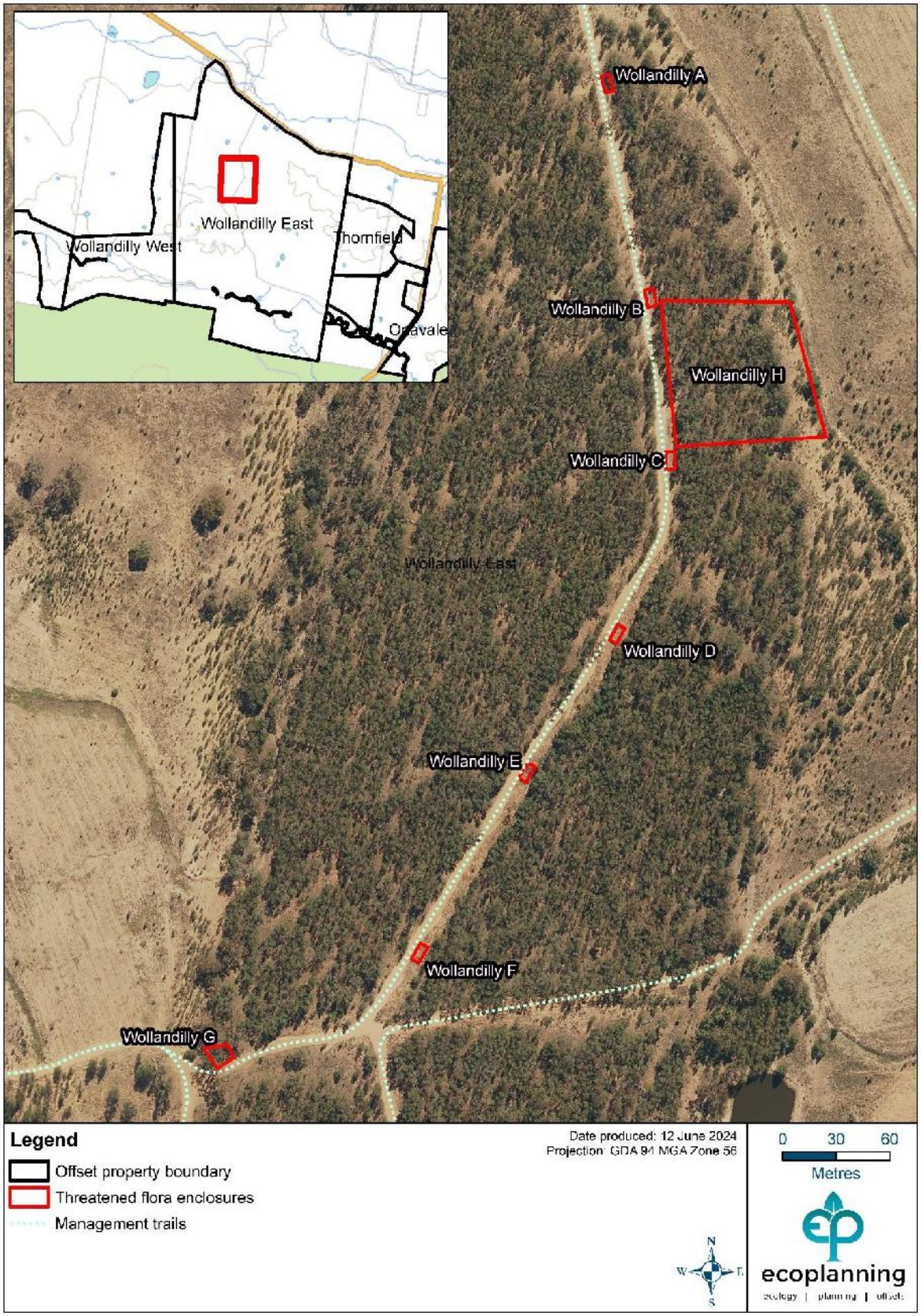

Figure 3.4: Existing recipient sites within the Wollandilly Offset Property

3.3.1 Topsoil translocation

Translocation of topsoil from *Tylophora linearis* habitat within the approved MCCM disturbance areas was undertaken in 2019. Approximately 20 cm of topsoil (including shrubs and ground cover) from supporting *Tylophora linearis* (identified during pre-clearance surveys) was translocated and spread within five enclosures, designated E1 – E5, located within the Teston South Offset Property (**Figure 3.5**; **Figure 3.6**). The Teston South site was chosen as a recipient site based upon the following:

- The presence of modelled suitable habitat,
- Previous *Tylophora linearis* records within the Offset Property,
- The proximity to the donor sites,
- The presence of natural woodlands
- The proximity to existing tracks for delivery, management and monitoring access.

Topsoil was spread at a similar depth to the excavation depth (20 cm). The enclosures were watered approximately weekly from June to October, with the watering regime reduced to monthly from October to better approximate natural conditions of wetting and drying. Topsoil had initially been placed in a stockpile prior to transfer to each enclosure site. Following transfer to the five enclosures a small patch of topsoil remained. This patch serves as a control site with no fencing or watering. Monitoring of the five enclosures involves recording soil moisture levels, recording the number of *T. linearis* stems present (quarterly inspections with all stems flagged, numbered, their length measured and dated) and weed monitoring. As of the end of 2023, there were no *Tylophora linearis* stems recorded in the transplantation enclosures at Teston South.

Figure 3.5: Topsoil translocation site within Teston South Offset Property

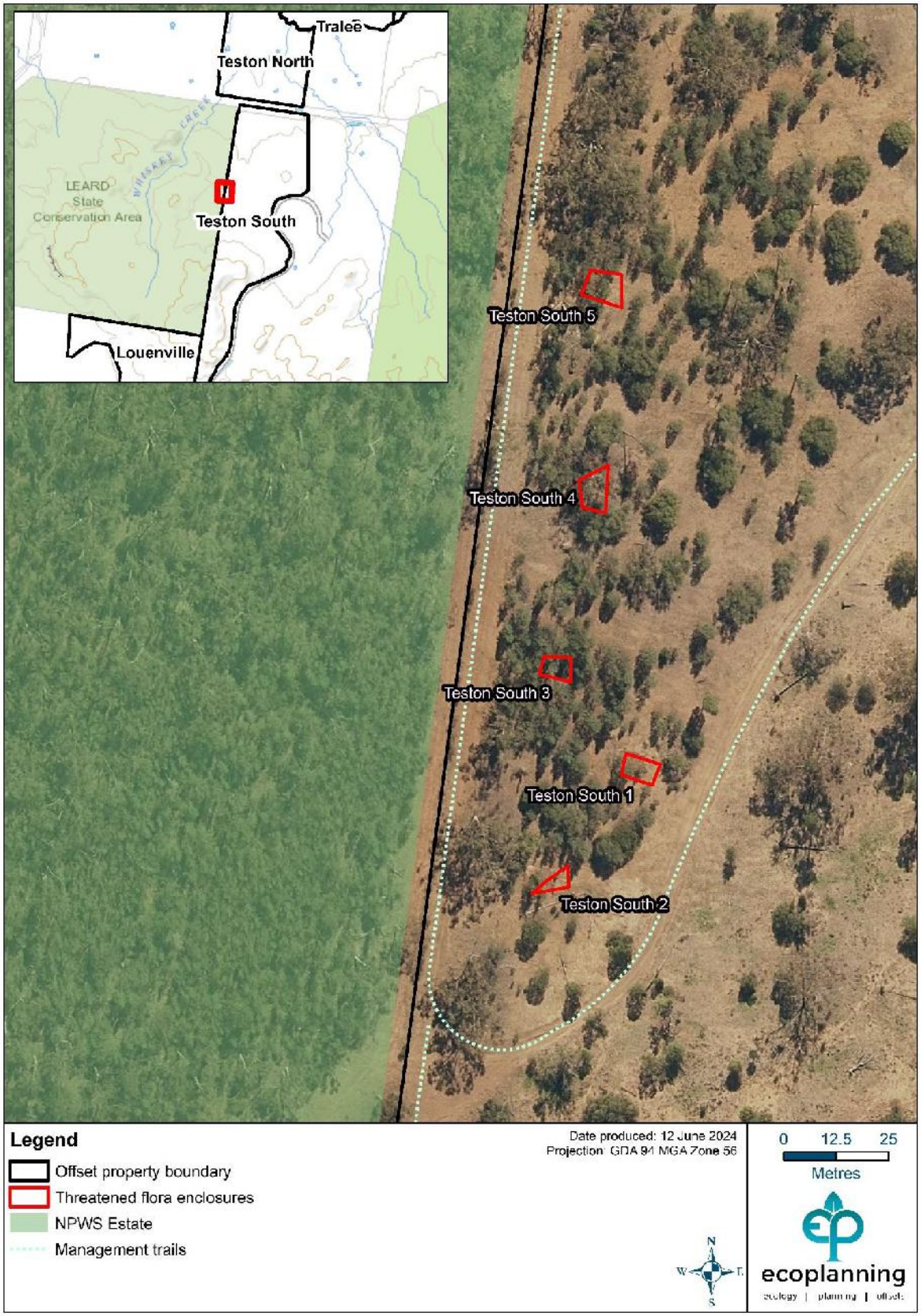

Figure 3.6: Existing recipient sites within the Teston South Offset Property

4 Protection and restoration management actions

Details of management actions across WHC managed lands to maintain, protect and enhance habitat for naturally occurring populations of *Tylophora linearis*, including any additional populations detected in the future, and translocated populations of the species, are detailed within the TFPP (Ecoplanning 2021a). These actions include, but are not limited to, the following:

- Exclusion of livestock grazing to promote natural regeneration.
- Weed and feral animal control.
- Access control.
- Bushfire management.
- Active revegetation (planting or direct seeding) depending on the success of natural regeneration.

These management actions aim to address all the identified threats to *Tylophora linearis* (DPIE 2020) which are associated with habitat disturbance and loss, invasion by introduced weeds, and inappropriate fire regimes. Several actual and potential additional threats to *Tylophora linearis* have also been observed in the WHC managed lands, including herbivory by macropods and rabbits as well as insect attack. As a result, fences have been constructed around existing recipient sites to prevent grazing by macropods and stock.

4.1 Monitoring

Monitoring of translocated *Tylophora linearis* individuals and habitat is to continue under this program, including future translocations, to:

- Increase undertaking of the biology of the species.
- Provide early warning of problems with the actions undertaken as part of the translocation.
- Generate quantitative evidence of translocation success or failure against stated objectives.
- Document information on population dynamics within areas of habitat.
- Highlight ways to make future translocations more effective.

Additionally, monitoring of naturally occurring populations of *Tylophora linearis* is required to document the health of these populations including the operation of any recognised threats.

Consistent within monitoring of translocations to date, all translocated seedlings are permanently tagged, and data collected prior to planting to enable comparisons over time, between individuals and between recipient sites. All translocated seedlings should undergo monitoring, not a subset. Monitoring of translocated seedlings is to take place monthly for the first year after a seedling is planted, quarterly for the two proceeding years and biannually after that. Monitoring should be ongoing, dependent on the success of the program.

Consistent with monitoring to date, reference sites must also be monitored to provide benchmark data and assist in determining attrition or impacts that may be attributed to a natural event that has impacted the general population and not just translocated individuals.

Variables to be monitored at translocation and reference sites are detailed within **Table 4.1**. Collection of this data should provide quantitative data which will guide future management actions including:

- Time to maturity (e.g. first flowering)
- Flowering / fruiting (comparisons between sites and populations).
- What proportion of plants are producing viable seed?
- Are plants in certain locations / situations surviving better than others? Can anything be inferred from this?
- Evidence of second generation and abundance.
- Any experimental micro-siting and treatment variables implemented as part of the program (e.g. fenced / unfenced, shaded / unshaded).

All aspects such a watering frequency, unusual climatic conditions and rainfall should also be considered and documented.

Table 4.1: Data to be monitored for translocated *Tylophora linearis*

Variable	Data to be recorded
Vegetative growth	Height of individual plant
Plant health / vigour	Repeatable scale of measurement as per the following: 1 Plant dead 2 Widespread dieback/damage 3 Dieback/damage observed on multiple branches 4 Minor dieback/damage evident on isolated leaves or branches 5 Healthy plant with no signs of dieback/damage
Reproductive status	Repeatable scale of measurement as per the following: 1 No. flowers (incl. buds) or fruits observed 2 Isolated flowers or fruits 3 Flowering/fruiting on 5 - 25% of branches 4 Flowering/fruiting on 25 - 75% of branches 5 Flowering/fruiting on 75 - 100% of branches

5 Restoration and translocation program

This propagation and translocation program has been prepared based upon a review of species ecology, scientific reviews, results of previous management actions, best practice guidelines and the project approvals to maximise the chance of successfully achieving the aim of the translocation as outlined within **Section 1**.

5.1 Justification for ongoing translocations

The requirements of the project approval (PA 10_0138) and the MCCM BMP provide justification for ongoing translocation of *Tylophora linearis* including translocation of any additional individuals occurring within the MCCM surface development area. Considering the applicable approvals for the MCCM surface development areas and therefore the fate of any additional plants located within the surface development area, any attempts at salvage translocations represent worthwhile actions to minimise impacts to the species. It is noted that based upon the relatively small extent of remaining habitat within the MCCM surface development areas, opportunities for additional salvage translocations in the future may be limited. The translocation actions included within this program are to be undertaken in conjunction with management actions outlined in Section 4 which aim to protect habitat and build resilience.

In addition to salvage translocations occurring within the MCCM surface development area, translocations utilising seeds collected from WHC managed lands, is justified to increase understanding of the species biology and to reinforce existing translocated populations. Increased understanding of the species biology may lead to improve management techniques for the population of the species occurring across WHC managed lands.

5.2 Recipient site selection

The existing recipient sites within the Wollandilly (**Figure 3.4**) and Teston South (**Figure 3.5**) Offset Properties will form the recipient sites for this plan. That is, any future translocations will aim to reinforce the existing translocated populations. The nominated recipient sites include existing fenced enclosures to exclude threats and these fenced areas should be the initial planting locations for any additional *Tylophora linearis* seedlings produced as part of this plan. If additional seedlings become available in subsequent seasons planting may occur across the larger recipient sites outside the existing enclosures (where individual plant guards may be used to protect seedlings from grazing or trampling).

5.3 Translocation methodology

This propagation and translocation program has been prepared based upon a review of species ecology, scientific reviews, results of previous management actions, best practice guidelines (the Australian Network for Plant Conservation Guidelines for the Translocation of Threatened Plants in Australia; Commander et al. 2018) and the project approvals to maximise the chance of successfully achieving the aim of the translocation as outlined within **Section 1**.

Experience has shown that this species is inconsistent and irregular in terms of the availability of both reproductive and/or salvage materials. Therefore, a number of translocation methods have been outlined in this program to allow for the translocation (only if the opportunity

presents) to adapt to available resources and where the initial results of one method prove unsuccessful. It is possible that more than one option may be implemented concurrently, where the availability of seeds and seedlings permit. WHC propose methods of translocation of *Tylophora linearis* in the following order of preference:

1. Seed collection.
2. Seed germination/propagation.
3. Salvage transplanting; and
4. Stem cutting / tissue culture (pending further investigations on viability).

Translocation via seed collection, seed propagation and planting is considered one of the most effective sources of regenerative material due to capacity to encompass a large proportion of the species diversity within a population (Commander et al. 2018). This method also represents one of the most common methods for translocation (Silcock et al. 2019) and has been utilised with some degree of success for the species (see **section 3**). The collection of available *Tylophora linearis* seed from the MCCM impact area and a proportion of seed from WHC managed lands and wild populations in other areas (e.g. Leard State Forest under Threatened Species Licence and with permission from Forestry Corporation NSW), and planting of seedlings germinated in a nursery, represents the most effective way to achieve the aims of the translocation.

A key limiting factor for the propagation and translocation program is likely to be the availability of seed. Niche (2014) suggested that given the low rate of flowering and fruit set observed in *Tylophora linearis,* propagation from stem cuttings was considered likely to be more viable than relying on the propagation of seed alone. Therefore, this program includes production of seedlings from cuttings or tissue culture as a secondary option if ongoing seed collection is unsuccessful. Propagation using cuttings or tissue culture may not capture sufficient diversity as plants propagated using these methods are genetic clones of their source plant and so care must be taken in tracking source material to ensure one clone is not over represented in the *ex situ* collection (Commander et al. 2018) if even feasible at all for this species.

Poor results from rhizome trials were seen during both the WHC studies and studies of other *Tylophora* species (Ecos Environmental 2017). This approach would require significant disturbance to plants and would only to be possible for ‘salvage’ plants. Based upon the low success rate in the past using topsoil or rhizome translocation, a modified technique involving whole turve translocation is recommended for any ‘salvage’ translocations.

5.3.1 Seed collection

A combination of favourable rainfall and temperature is necessary for stem growth and flowering (Niche 2014), which is likely to affect seed production. The previously observed low rate of seed production have limited seed-based propagation in the past and may limit the proposed program. Seed should be collected from all ‘salvage’ *Tylophora linearis* in impact areas prior to their transplantation. Identification of *Tylophora linearis* with follicles should be undertaken as part of pre-clearance surveys.

Seed has previously been collected over a variety of months (March, April, May, August [Niche 2014, Ecoplanning 2020b]) and fruiting appears to be opportunistic in response to favourable conditions. To maximise the probability of collecting seed, plants from known populations

should be inspected regularly to detect inflorescence and their subsequent development into fruit. As per the TFPP (Ecoplanning 2021a), inspections should be quarterly, however this frequency may be decreased during unfavourable conditions (prolonged dry periods) and increased where flowering or early stages of fruit development are observed. Where fruiting is recorded, inspection frequency should be increased to ensure any seed collection opportunities are not missed. Where possible, seed should be collected from geographically separated areas by undertaking searches for reproductive material across all known populations. To maximise the amount of seed of *Tylophora linearis* collected from the source population, seed collection should also occur across multiple years.

Seed collection, management and storage should be undertaken in consideration of Florabank guidelines (http://www.florabank.org.au/) and the relevant Threatened Species Licences (C0005930). Specifically, seed collection is to:

- Be limited to a maximum of 20 % of the follicles/fruits from each plant annually.
- Include no more than 100 individuals from within Leard State Forest, Jacks Creek and Pilliga East State Forests per year.
- Collect seed from spatially separated individuals to reduce chance of collecting seeds from related plants.
- Be fully documented so that data on the plants and locations where seed collection occurred can be tracked over time.

To date only a small quantity of seed has been collected from *Tylophora linearis*, due to limited seed production, and seed retention has not been practical. In the event that any large quantities of seed are collected, retention of some seed collected seed (20%) is recommended to enable planting over multiple years and allows for future plantings and cuttings if the initial plantings/translocations fail. Generally, staggered translocations give better protection against the potential consequences of adverse stochastic events (Commander et al. 2018).

5.3.2 Seed germination

Tylophora linearis seeds collected will be used for germination and plant propagation. Studies undertaken by Hunter Eco (2015a) found Gibberellic Acid treatment resulted in 60% higher germination than untreated seed, suggesting the presence of a dormancy mechanism. The fact that there was 50% germination of untreated seed suggests either that dormancy is weak or had been partially broken, possibly by cold storage of seeds for 3 months prior to the germination trial (Hunter Eco 2015a). Ultimately, the seed germination techniques employed including any further trials utilising different techniques will be determined by the quantity of seed available. Where limited seed is available, the results of the previous seed germination trials (including Hunter Eco 2015a) should inform germination techniques with previously successful methods applied preferentially. Where larger quantities of seed are available, an experimental approach may be employed to test other germination techniques, however all seed pre-treatments (e.g. scarification, stratification, after-ripening) used should be fully documented.

Where successful seed germination occurs, seedlings should have a structure to encourage the twining habit of the species and avoid seedlings becoming intertwined in the nursery.

5.3.3 Stem cuttings

For species where timing of fruit set and seed release are not available, and for species with clonal reproduction, cuttings, division, grafting or using micropropagation techniques are alternative sources of propagules. As outlined above, cuttings should be collected as a second option should seed availability and / or successful seed propagation be limited. Where inspections of wild populations detect limited or no flowering or follicle development of *Tylophora linearis* over the spring period, stem cuttings should be collected from healthy and robust individuals of the species. Cuttings should either be taken by qualified horticulturalists, or under their direction, ensuring that resources and materials are ready and available to receive the cuttings.

Vegetative cuttings and cutting media should be treated with a systemic fungicide. An experimental approach including the use of hormone solution or powder to encourage root development should be employed before being planted into cutting mix in trays or pots. The techniques and for cuttings, including any experimental treatments, should be fully documented and any subsequent cutting propagation should review the results of previous trials.

Stem cuttings should be preferentially collected from plants within approved mine disturbance footprints (i.e. salvage plants) and only from existing populations within the WHC managed lands where large, robust, multi-stemmed individuals are identified. No more than 5% of plant material from any one plant within WHC managed lands should be removed (not applicable to salvage translocations) and greater than 10 m should be left between sampled plants to avoid sampling from potential clones.

Once plant material has been collected, the time necessary for propagation needs to be considered. All cuttings should be taken to the nursery to allow for a period of 'hardening off.' Plants require sufficient time in the nursery to obtain a size and condition that is robust enough for handling during the planting phase, usually including a 'hardening off' period to adjust them to conditions more like the recipient site. Commander et al. (2018) suggests that the process of hardening off and root strike can take between 6 and 12 months.

Some level of short-term success and early research suggests that microhabitat placement, seasonal rainfall and access to supplementary water (irrigation) are essential for translocation success in stem cutting translocations (Commander et al. 2018). Cuttings from WHC managed lands should not be taken or planted during adverse weather conditions and during long dry periods additional water may be required. All stem cuttings should be translocated to sites currently supporting existing populations and to a location that best mimics the microhabitat features where existing plants occur.

Tissue culture

This method is noted in this program but is not considered as primary restoration and transplantation method in this program due to technical and cost challenges with method. Tissue culture is likely to be an expensive option and can take up to 24 months before planted growth using this method would be ready for translocation if even feasible at all for this species. Micropropagation techniques, such as tissue culture, involve inducing small pieces of plant tissue to form a new plant. These techniques require specialised equipment, facilities and expertise (Commander et al 2018).

5.3.4 Salvage transplanting

A combination of translocation techniques are to be employed as part of salvage translocation of any *Tylophora linearis* within approved MCCM disturbance areas. It is noted that based upon the limited extent of remaining habitat within the MCCM surface development areas, opportunities for additional salvage translocations in the future may be limited. However, where opportunities for salvage translocations are identified, the following methods should be utilised:

1. Seed collection.
2. Stem cuttings.
3. Whole plant translocations.

All seed detected during pre-clearance surveys should be collected from *Tylophora linearis* in impact areas prior to disturbance. Additionally, stem cuttings should be taken from a sample of stems (preferentially selecting larger healthier individuals and ensuring spatial separation between recipient cuttings to maximise genetic diversity within cuttings), to test the viability of this propagation method. Treatment of collected seed and cuttings should be as detailed within sections 5.1.2 and 5.1.3.

Transplanting entire plants from naturally occurring populations has a low success rate as many plants die without successfully reproducing at their new location. Despite the low success rate of this technique, transplantation is considered a worthwhile mitigation measure considering the fate of plants within the mine footprint. Preliminary trials and studies have demonstrated that transplanting of whole turves, rather than just topsoil, result in higher success rates and significantly lower ongoing management of weeds (Commander et. al 2018). Further, results obtained from rhizome (topsoil) transplantation studies of *Tylophora linearis* undertaken by Hunter Eco (2020) are still unknown. Given the uncertainty around the success of this approach, and the success of projects transplanting other *Tylophora* sp. (Ecos Environmental 2017), the use of whole plant translocation, including whole turve relocation, is proposed for the *Tylophora linearis* 'salvage' translocations that form part of this program. As many individuals, or stems, as possible should undergo 'salvage' transplanting via whole turve relocation. However, due to the time & equipment required for the process and uncertainty of success, it is anticipated that a maximum of 20 turves per season could be collected for translocation to enable adequate management to occur.

Turves is a plant that is removed in a block of soil without breaking the soil and roots, if possible, which requires careful excavation. Excavation, transport and replanting should be carried out as quickly as possible. Once planted, the soil plug associated with a whole plant transplant can often have gaps between it and the natural ground. Such gaps can result in a rapid loss of soil moisture and should be in-filled by ensuring soil is used to fill all gaps (Commander et al. 2018). Transplanted plants should be watered during transplanting to minimise water stress and planted at pre-marked points. Salvaged whole plants can often die from the shock to the plant associated with transplanting without regular, ongoing care.

A proportion of the *Tylophora linearis* turves from the impact area should be salvaged for direct transplanting (75%) and the remaining 25% removed and maintained in a nursery for continued growth under nursery conditions. Maintaining salvaged *Tylophora linearis* within a nursery

aims to increase survival rates and if established, could be used for tissue cultures / stem cuttings.

It is important to note that seed collection, recipient site selection (see **section 5.2**) and preparation must be undertaken prior to the removal of any 'salvage' plants. All salvaged plants should be labelled at the recipient site in a manner that allows them to be found should the individual die back.

5.3.5 Translocation of propagated seedlings

Following successful seed germination, or propagation via cuttings, seedlings should be planted into the WHC managed lands consistent with techniques utilised to date. Specifically, plantings should occur in autumn/winter, with high soil moisture and low levels of heat stress. Planting should be conducted in the following manner:

1. Prepare a hole for each plant with an auger (or similar) to a depth of approximately 750 mm, and width 50% wider than the largest pot size. Rough the sides of the hole to ensure that it is not round or glazed.
2. Return the soil to the hole and pour 10-15 litres of water onto the soil.
3. Prepare an additional hole in the same manner that will be used to monitor soil moisture.
4. Return 2-3 days later after steps 1-3 for planting.
5. Make sure potted plants have been watered the day prior to planting.
6. Remove plant from pot and trim roots, as required.
7. When planted, the soil level of the potted plant should sit 40 mm below ground level creating a dish. Cover root ball by 40 mm.
8. Place tree guard around the plant, if required.
9. Apply approximately 5 litres of water onto each plant.
10. Monitoring plant and soil moisture weekly. Test for moisture using a fork or dig the soil in the additional hole and observe soil moisture, then replace soil.
11. Only water if required. Overwatering may prevent healthy root growth.
12. Do not apply fertiliser.

5.3.6 Fencing and protection

Several potential threats have been observed in the WHC managed lands, including trampling and herbivory by vertebrates and invertebrates or other inadvertent sources of disturbances. Planted individuals require protection from vertebrate grazing and will either have a tall hingejoint (grid mesh) fence around each recipient site, or guards around individual plants. Demarcating style fence (plain top wire) will be installed around the extent of known populations with signage to minimise inadvertent disturbance. As proposed planting locations are within existing *Tylophora linearis* habitat (see **section 5.2**), existing fencing is already present.

5.3.7 Watering schedule

All translocated plants should be marked clearly so they can be found easily for watering and monitoring. Watering during hot and/or dry periods may be beneficial during the plant establishment phase. If a site is exposed to seasonally dry conditions, Commander et al. (2018) recommend providing weekly or fortnightly water to translocated individuals during the first two dry seasons to mitigate losses during this time.

All translocated individuals should be watered during planting. Initial watering should replicate frequent, small rainfall events (10 mm max and approximately four litres per plant), and later watering should replicate infrequent, large rainfall events (>10 mm and approximately seven to eight litres per plant, or until soils are saturated). Follow-up watering should also occur during any extended dry periods (absence of weekly rainfall in excess of 5 mm in a single rainfall event) or if any signs of dieback are observed which may be linked to dry conditions. Decisions regarding the watering schedule after planting will need to be made based upon the rainfall at the time and the response of planted seedlings during monitoring. Lack of post-translocation care and ongoing monitoring are factors that commonly lead to failure of translocation projects (Commander et al. 2018). Post-translocation actions including timing, frequency and amount of watering should be documented to inform decision-making for any future planting events.

5.3.8 Translocation schedule

Past research on translocations has shown that past translocations have been unsuccessful for several reasons including hot and dry conditions over summer and frost damage in colder regions (Commander et al. 2018). Planting within WHC managed lands will aim to occur in autumn/winter, with high soil moisture and low levels of heat stress. Planting timing and frequency will be determined based on availability of *Tylophora linearis* seedlings.

Seed propagation will occur following the collection of sufficient seed or mature plant material (if insufficient seed is collected). Commander et al. (2018) suggest that seed propagation usually takes about 12 to 18 months and the study on *Tylophora linearis* conducted by Hunter Eco (WHC 2019) showed that it took 13 months to germinate and grow to a suitable sized seedling for planting. Therefore, timeframes for germination need to be considered and accounted for when planning for the translocation.

6 Review and reporting

The outcomes of implementation of this propagation and translocation program will reported in the MCCM Annual Reviews summarising the results of quarterly inspections on the various stages of the propagation and translocation program as well as any recommendations.

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APPENDIX G

POMADERRIS QUEENSLANDICA PROPAGATION AND TRANSLOCATION PROGRAM

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Propagation and Translocation Program

Pomaderris queenslandica

Maules Creek Coal Mine

Prepared for: Whitehaven Coal

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PROJECT NAME	Propagation and Translocation Program			
PROJECT ADDRESS	Maules Creek Coal Mine			
PREPARED FOR	Whitehaven Coal			
AUTHOR/S	Brian Towle, Bruce Mullins. Jai Brien-Cooper			
REVIEW	**Technical**	**QA**	**Version**	**Date to client**
	Brian Towle		1.0	29 May 2024
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LICENCES	**Scientific Licence**		SL101557 & C0005930	
	BioNet Sensitive Species Data Licence		1115	
	Animal Research Authority Ethics Licence		Fauna Surveys and Monitoring (16/346)	
	Scientific Collection - Aquatic		P19/0009-1.0 & OUT19/2602	

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Glossary and abbreviations

Acronym	Description
ANBG	Australian National Botanic Gardens
BC Act	*Biodiversity Conservation Act 2016*
BCS	Biodiversity, Conservation and Science Directorate within the NSW DCCEEW
BMP	Biodiversity Management Plan
Cth. DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DPHI	NSW Department of Planning, Housing and Infrastructure
DAWE	Former Department of Agriculture, Water and Environment, now Cth. DCCEEW
DotE	Former Department of the Environment, now Cth. DCCEEW
DPE	Former NSW Department of Planning and Environment, now either DPHI or NSW DCCEEW
DPIE	Former Department of Planning, Industry and the Environment, now either DPHI or NSW DCCEEW
DSEWPAC	Former Department of Sustainability, Environment, Water, Population and Communities, now Cth. DCCEEW
EP&A Act	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
MCCM	Maule Creek Coal Mine
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	Former NSW Office of Environment and Heritage, now NSW DCCEEW

Acronym	Description
PCT	Plant Community Type
TFPP	Threatened Flora Project Plan
WHC	Whitehaven Coal

1 Introduction

In accordance with Project Approval (PA 10_0138) Schedule 3, Condition 52, a Biodiversity Management Plan (BMP) has been prepared by Whitehaven Coal Pty Ltd (WHC) for the Maules Creek Coal Mine (MCCM; WHC 2017). A revision to this BMP is currently underway (WHC In prep.) and Section 3.1.2 of the revised BMP, states that:

> "*Prior to clearing, a pre-clearing flora survey will be conducted to search for threatened plant species that have potential to occur, based on habitat available. If a threatened plant species is identified, the numbers of plants will be counted and/or the population estimated/mapped. A review of translocation methods, collection of propagules, and propagation from seeds or cuttings from plants within the MCCM disturbance area and/or surrounds will be undertaken. Following this review, a translocation/propagation program will be developed and implemented where appropriate in consultation with BCS, DPHI and Cth DCCEEW (for Matters of National Environmental Significance [MNES])."*

Pomaderris queenslandica (Scant Pomaderris), an endangered species listed under the NSW *Biodiversity Conservation Act 2016* (BC Act), was identified within the MCCM during pre-clearing flora surveys in 2015. A propagation and translocation program for *P. queenslandica* was previously prepared in consultation with Dr Colin Driscoll (Hunter Eco), Office of Environment and Heritage (OEH) and the Department of Planning and Environment (DPE) and was included in Appendix D of the BMP (WHC 2017). In 2021, an updated Threatened Flora Project Plan (Ecoplanning 2021a) and *P. queenslandica* Restoration and Translocation Strategy (Ecoplanning 2021b) were prepared to support the propagation and translocation program (WHC – 2017 Appendix D), pending the revision of the BMP.

Management actions undertaken by WHC to date for *P. queenslandica* have been documented annually in the MCCM Annual Reviews (Hunter Eco 2016; Hunter Eco 2017; WHC 2018; Ecoplanning 2020-2024).

This propagation and translocation program has been prepared for inclusion in the revised BMP (WHC In prep.) and reviews, updates, and supersedes the previous *P. queenslandica* Propagation and Translocation Plan (WHC 2017) and the *P. queenslandica* Restoration and Translocation Strategy (Ecoplanning 2021b). This program has been prepared to fulfil the ongoing requirements of the revised BMP (WHC In prep.). Further, this propagation and translocation program is integrated as part of WHCs Threatened Flora Project Plan (TFPP; Ecoplanning 2021) which provides overarching guidance on the management habitat for threatened flora species within and adjacent to WHC mining operations and Biodiversity Offset Areas (hereafter referred to as WHC managed areas).

This program adopts the definition of 'translocation' as included in the third version of the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018), which is:

> *"… the deliberate transfer of plants or regenerative plant material from an ex situ collection or natural population to a new location, usually in the wild. It includes reintroduction, introduction, reinforcement, assisted migration and assisted colonization.*

Translocations involve a diverse range of methods including: seed collection and propagation; propagation via cuttings or tissue culture; planting of containerised plants; direct seeding; transplantation of whole plants from one site to another; and the transfer of soil, leaf litter, brush or pollen."

1.1 Aims and objectives

The overall aim of this propagation and translocation program is to directly support the conservation of *P. queenslandica,* and to maintain a self-sustaining, genetically diverse population of the species within the WHC managed areas, which is capable of surviving in the long term. To ensure long-term survival, research suggests that populations of around 200 to 250 plants are required to minimise reduced genetic and demographic outcomes associated with small populations (Young and Brown 1999). Therefore, success of the propagation and translocation program would be achieved by translocations establishing one or more sub-populations with between 200 and 250 individuals and with population size either stable (recruitment equal to any losses) or trending up (recruitment greater than losses). While resources are available, WHC aims to continue undertaking translocations until five stable and resilient (between 200-250 individuals) sub-populations of *P. queenslandica* have been established across WHC managed lands.

The specific objectives of this strategy include:

- To guide the successful translocation of *P. queenslandica* individuals grown from seed, stem cuttings, or soil seedbank transfer, to suitable habitat within the protected areas that form part of the WHC managed lands
- To provide clear management and monitoring measures to ensure the long-term success of the propagation and translocation program

This strategy primarily represents a 'Reinforcement' and 'Introduction' translocation according to the definitions of Commander et al. (2018). That is, the translocation aims to transfer seedlings grown under *ex situ* conditions and/or seed to locations where there is an existing population of *P. queenslandica* (including previously translocated individuals). This strategy also identifies locations for future 'introductions', involving translocations to an area where the species has not previously occurred (but is within the known range of the species and provides similar habitat to known occurrences).

1.2 Ecology of *Pomaderris queenslandica*

1.2.1 Distribution and population size

Pomaderris queenslandica is a medium sized woody shrub 2–3 m high. The species was first described by White (1951) from Queensland, although the geographical range extends south into NSW including the North Coast, New England Tablelands, North West Slopes and Central Western Slopes (including Hunter Valley) regions of NSW (Bell 2001). Across its wide range, records of the species are uncommon, and populations are typically small (well less than 1000 plants; Bell 2001). Within NSW, larger populations exceeding 1,000 individuals are limited to the Pilliga Forests region, with the population occurring within Jacks Creek and Pilliga East State Forest having been estimated to include at least 4,000 individuals in 2010 (DPIE 2020a).

The presence of *P. queenslandica* was initially identified within the MCCM Project Boundary by Cumberland Ecology (2015), and subsequently validated by Niche Environment and Heritage, during flora pre-clearance surveys undertaken between February and April 2015 (**Figure 1.1**). The entire population consisted of 463 plants all of which were within the approved MCCM disturbance footprint (WHC 2017) and have since been impacted by the approved MCCM.

Natural occurrences of *P. queenslandica* have also been recorded within additional WHC managed lands, specifically the 'Narrabri Onsite' offset site (Rosevale, West Haven and Greylands properties; **Figure 1.1**). The exact population of *P. queenslandica* within the 'Narrabri Onsite' offset site is unknown, with counts in spring 2021 (Ecoplanning 2021d) recording between 15-20 mature individuals in flower and numerous seedlings within the Rosevale Property. However, individuals within the Narrabri Onsite offset site are located within habitat contiguous with Jacks Creek State Forest where a population of *P. queenslandica* in excess of 4,000 individuals has been recorded (DPIE 2020a; **Figure 1.1**).

Based upon the regional distribution of the species, it is possible other natural occurrences of the species are present within other WHC managed lands but have been undetected to date. It is noted that *P. queenslandica*, has previously been reported as occurring within the Greenwood Biodiversity Stewardship Agreement property (formerly known as the proposed Offset Site 7 for the Vickery Coal Mine), however these plants have subsequently been confirmed by the National Herbarium of NSW as *Alphitonia excelsa* (Red Ash).

Details of translocated populations of *P. queenslandica* within WHC managed lands are detailed in **Section 3**.

1.2.2 Habitat associations

Known habitat preferences for *P. queenslandica* are limited, with the species having been generally identified as occurring in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and often along creeks (DPIE 2020b; Bell 2019). However, individuals of the species from the Pilliga Forests have also been recorded from "…*rocky ridge crests and slopes*" (DPIE 2020b). Similarly, Bell (2019) reports a population near Glen Gallic as occurring on a ridgeline, noting that the ridgeline habitat is unusual for the species, and that nearby sheltered slopes and gullies may support many more individuals. Plants recorded by Cumberland Ecology (2015) within MCCM as part of pre-clearance surveys were along sheltered ephemeral drainage lines within vegetation equivalent to the Plant Community Type (PCT) '*Narrow-leaved Ironbark – White Cypress Pine Woodland on slopes and flats in the Coonabarabran – Pilliga Scrub regions* (PCT 394)'.

1.2.3 Life-cycle

Flowering of *P. queenslandica* has been identified as occurring from August to October in Queensland (Elliot & Jones 2010) and during spring-summer in NSW (PlantNET 2020). Observations of naturally occurring and translocated individuals within WHC managed lands has recorded flowering in spring months with mature seed produced in summer. No specific studies into the pollination mechanism of *P. queenslandica* have been identified, although insects have been considered the most likely pollinators for species of *Pomaderris*. Results of monitoring of the species across WHC managed lands indicate that the species is not pollinator

limited with flowering and seed production consistently observed in each year where monitoring has occurred.

Ants are identified as the main mechanism of dispersal of Australian *Pomaderris* species due to the presence of a small elaiosome within the seeds (Patykowski et al. 2016). *Pomaderris queenslandica* seeds demonstrate physical dormancy (an impermeable seed coat; BioBankSeed 2019), an ecological strategy of other *Pomaderris* species for growing in fire-prone ecosystems (Natale 2016). This physical dormancy suggests that *Pomaderris* seeds may remain viable in the soil for up to 20 years in the absence of fire (Patykowski et al. 2014). Mechanical scarification, consisting of chipping the surface of each seed with a scalpel, has been successfully used to break the physical dormancy (BioBankSeed 2019). Additionally, heat treatments have been shown to break the physical dormancy with temperatures between 130-150 ºC optimal for breaking seed dormancy (BioBankSeed 2024).

The natural lifespan of *P. queenslandica* is unknown, however, other *Pomaderris* species are reported to have a natural lifespan of 10 to 30 years (Patykowski et al. 2014), with some individuals documented as living much longer.

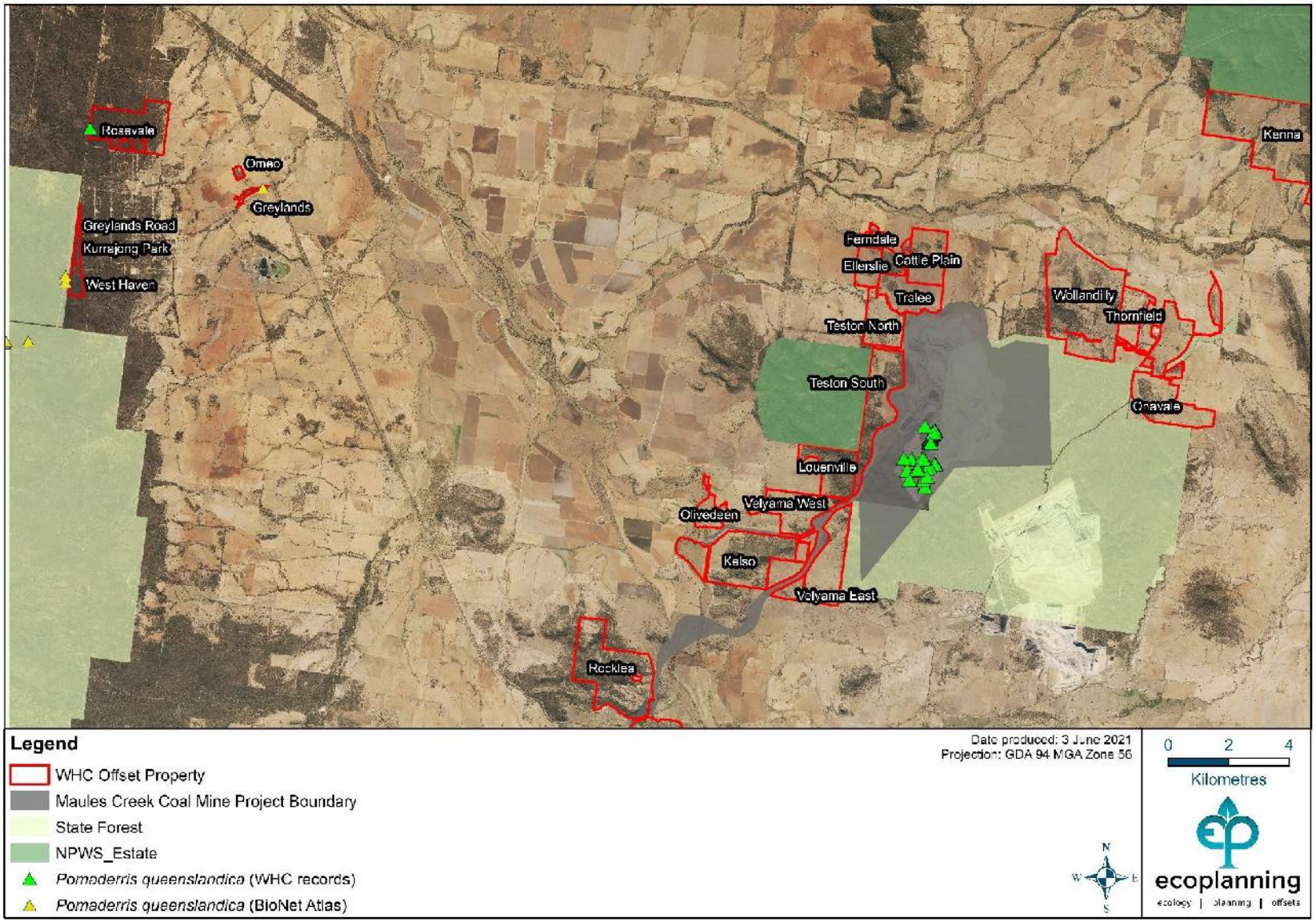

Figure 1.1: Natural *Pomaderris queenslandica* populations within the MCCM Project Area and WHC managed lands.

2 Approvals and requirements

Relevant management plans, approval conditions and requirements which relate to *P. queenslandica* are summarised in **Table 2.1**.

Table 2.1: MCCM statutory requirements and management plans relevant to *P. queenslandica*

Approval / Management plan	Requirement	Response
Project Approval (PA 10_0138) Schedule 3, Condition 52	"*The Proponent shall prepare and implement a Biodiversity Management Plan for the project to the satisfaction of the Director-General."*	A BMP has been prepared (WHC 2017) and is currently being revised (WHC In prep.).
Biodiversity Management Plan - Section 3.1.2	*"Prior to clearing, a pre-clearing flora survey will be conducted to search for threatened plant species that have potential to occur, based on habitat available. If a threatened plant species is identified, the numbers of plants will be counted and/or the population estimated/mapped. A review of translocation methods, collection of propagules, and propagation from seeds or cuttings from plants within the MCCM disturbance area and/or surrounds will be undertaken. Following this review, a translocation/propagation program will be developed and implemented where appropriate in consultation with BCS, DPHI and Cth DCCEEW (for Matters of National Environmental Significance [MNES])."*	A propagation and translocation program for *P. queenslandica* was previously prepared (Appendix D of the MCCM BMP [WHC 2017]). This propagation and translocation program reviews, updates, and supersedes the previous *P. queenslandica* Propagation and Translocation Plan (WHC 2017).

3 Current and past management actions and trials

Completed management actions undertaken by WHC to date for *P. queenslandica* have been documented within the MCCM Annual Reviews. The previous *P. queenslandica* propagation and translocation program (WHC 2017) included the following stages:

- Stage 1 – Root architecture study (complete).
- Stage 2 – Seed collection (complete).
- Stage 3 – Cuttings propagation (complete).
- Stage 4 – Seed germination (complete); and
- Stage 5 – Translocation trials (ongoing).

Stages 1 – 4 of the previous *P. queenslandica* propagation and translocation program have been completed and documented in annual reports (Hunter Eco 2016; Hunter Eco 2017; WHC 2018; Ecoplanning 2020). The stages completed to date, and general results have included:

- a root architecture study (which identified a shallow root system)
- seed collection (with approximately 2,000 seeds collected in 2016 from within the MCCM boundary)
- propagation of cuttings (with one successful strike from over 400 cuttings in 2016)
- seed germination trials (demonstrating that a physical seed dormancy exists, but which can be broken with treatments including scarification)

Stage 5 (Translocation) commenced in 2017, with a single propagated cutting being planted at the Wollandilly Offset. Translocation trials from Stage 5 of the program are ongoing (WHC 2019; Ecoplanning 2020; Ecoplanning 2021b) and are documented in more detail below.

3.1 Translocation trials

The outcomes of ongoing translocation trials, representing Stage 5 of the *P. queenslandica* propagation and translocation program (WHC 2017 Appendix D) and ongoing trials in accordance with the *P. Queenslandica* Restoration and Translocation strategy (Ecoplanning 2021b) are summarised in **Table 3.1**. Results of each trial to the end of December 2023 are presented in the following sections.

Table 3.1: Summary of *P. queenslandica* translocations to December 2023

Source (provenance)	Date	№ of plants translocated	Translocation Method	Surviving translocations	Cumulative count of surviving plants
MCCM project boundary	November 2017	1	Cuttings	0/1	0
	July 2020	34	Seed collection & propagation	29/34	29
	September 2020	134*	Topsoil (translocation)	131/134*	160
	September 2020	12*	Topsoil (stockpile)	12/12*	172
	August 2021	83	Seed collection & propagation	74/83	246
Rosevale / Jacks Creek SF	May 2022	70		62/70	308
	September 2023	143		133/143	441

*An estimated 134 individuals of *Pomaderris queenslandica* were observed in the topsoil translocation area in 2021. During 2023 98 % of monitored subset of this population was surviving in 2023 and this has been extrapolated for the estimated total population.

3.1.1 Cuttings

The propagation of cuttings found only one successful strike from over 400 cuttings (**Plate 3.1**). The single *P. queenslandica* plant, propagated from a stem cutting taken onsite at MCCM during 2015, was planted at the Wollandilly Offset site in 2017 (**Figure 3.1**; **Plate 3.1**). The single *P. queenslandica* was planted along a drainage line within the upper slopes of the Wollandilly Offset site, which supported regenerating *Eucalyptus albens* (White Box). The *P. queenslandica* was planted within the vicinity of large *E. albens* trees, in a position that would provide shade for the *P. queenslandica*, whilst avoiding competition for soil moisture with the large root systems of the mature trees. A protective enclosure around the *P. queenslandica* was added following damage caused by macropods. In March 2020, the single *P. queenslandica* plant was recorded as dead having died at some time since the last inspection in December 2019, with no foliage observed during March 2020.

Plate 3.1: ***Pomaderris queenslandica*** **cuttings in propagation (left; Source: Hunter Eco 2016) and during planting (right; source: WHC 2017).**

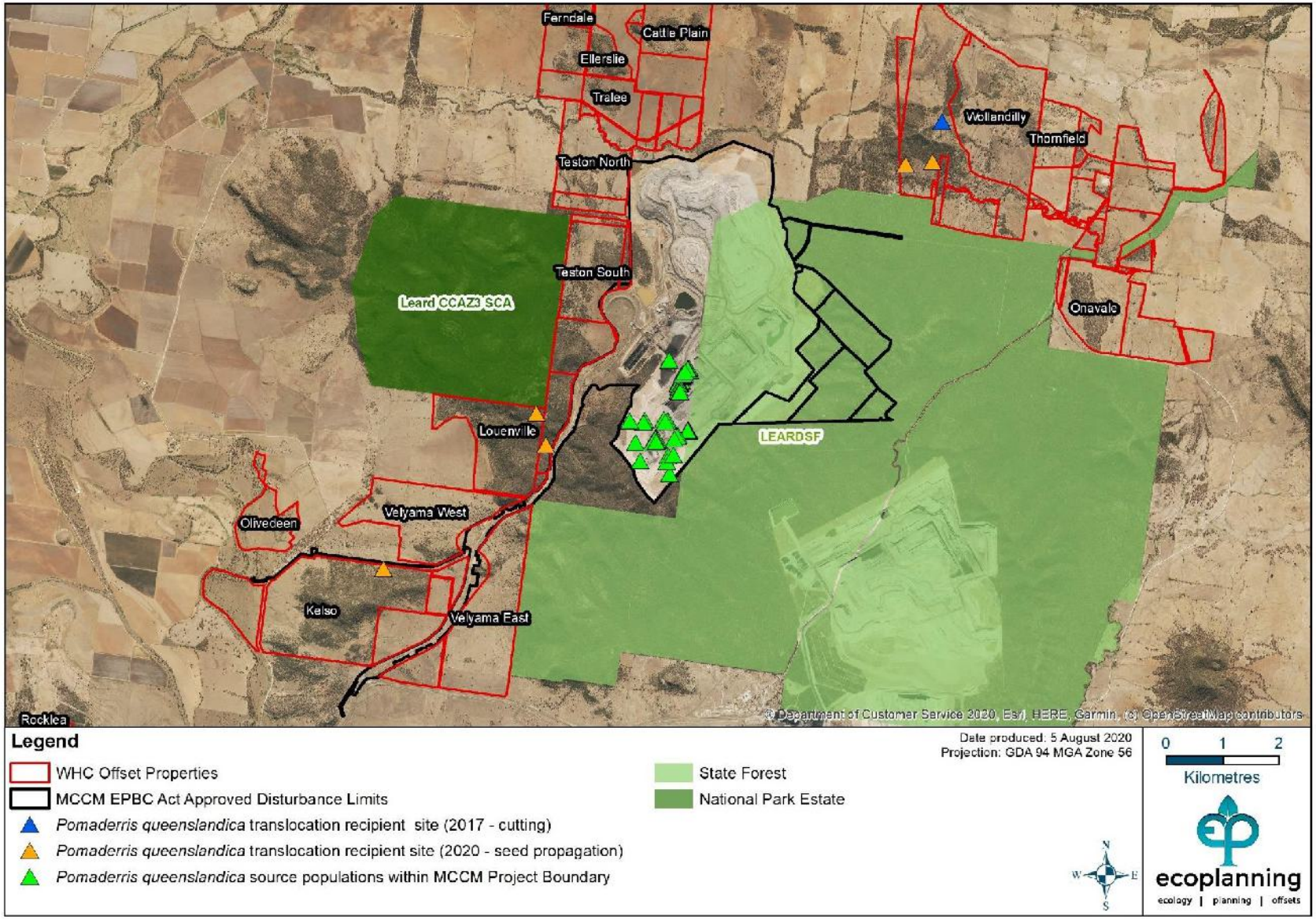

Figure 3.1: *Pomaderris queenslandica* translocation recipient sites

3.1.2 Seed propagation

A seed germination trial by BioBankSeed commenced during 2019 from seed collected in 2016 (BioBankSeed 2019). The seed germination trials found seeds of *P. queenslandica* recorded no or little increase in seed mass following placement on moist filter paper at room temperature for 24 hrs. Consequently, it has been concluded that *P. queenslandica* seeds have a physical dormancy associated with an impermeable seed coat. This dormancy has been identified in other *Pomaderris* species as an ecological strategy for growing in fire-prone ecosystems, with the seed coat broken over time or following fire (Natale 2016).

Seed viability tests conducted by BiobankSeed (2019) involved dissection and visual assessment of 15 full seeds. A total of 188 seeds were randomly selected and cut before 15 full seeds where obtained. Seed viability of the 15 full seeds were tested with a 1% solution of 2,3,5-triphenyl tetrazolium chloride (TTZ test). One of the 15 tested seeds was shown to be unviable by the TTZ test with an additional two seeds only weakly viable (embryos of these absorbed stain only partially). Therefore, seed viability was low with only 14 of 188 tested seed viable.

From seed collected in 2016 a total of 34 individuals of *P. queenslandica* were grown by BioBankSeed and Fields Environmental Solutions for translocation in Winter 2020 (**Plate 3.2**). Recipient sites for the 34 plants planted in July 2020 were selected according to physical, biotic, and management criteria and in locations where environmental variables (vegetation communities, slope, elevation, vegetation structure etc.) matched previously known populations or habitat. See **Appendix A** for details of environmental variables at the source and selected recipient sites. These selected recipient sites were sufficiently spread to ensure that any stochastic environmental conditions, such as fire, are unlikely to impact the entire translocated population. Four properties were selected as optimal recipient sites for the 34 *P. queenslandica* plants: Kelso (1 site), Louenville (1 site), Teston South (1 site) and Wollandilly (2 sites; **Figure 3.1**; **Table 3.2**).

In July 2020, 34 *P. queenslandica* seedlings were planted across the five recipient sites, with seven (7) *P. queenslandica* individuals planted within each recipient site except Kelso (six plants; **Table 3.2**). Fences were erected around each recipient site to protect translocated plants from macropods, with a minimum dimension of 10x10 m (**Plate 3.2**). Sites were selected within 150 m of an access point (i.e. road or clearing) to enable watering, if required. A watering regime was established which aimed to replicate natural periods of wetting and drying.

Additional seedlings from the seed collected within the MCCM boundary in 2016 were grown across 2020 and 2021 with 83 *P. queenslandica* seedlings planted on the 27 August and 20 September 2021 within and adjacent to the enclosures established for the 2020 plantings (**Table 3.2**).

Searches for reproductive material of *P. queenslandica* in September 2020 at known locations enabled seed collection from the Rosevale Offset Property and Pilliga East / Jacks Creek State Forest populations by Fields Environmental in October and November 2020. These collections yielded a total of 58 grams equivalent to 60,650 seeds. Approximately 10,000 seeds from this collection were sent in June 2021 to the National Seedbank and have been banked with a fraction sent to the World Seed Bank.

From seed collected from the Rosevale Offset Property and Pilliga East / Jacks Creek State Forest populations in October and November 2020, an additional 70 seedlings were translocated into the Louenville recipient site in May 2022 and 143 *P. queenslandica* seedlings were translocated to the Wollandilly East and West translocation sites in September 2023 (**Table 3.2**).

Each translocated *P. queenslandica* seedling has a sequential reference number to facilitate ongoing monitoring, with details of the plantings in each recipient site detailed in **Appendix B**. In accordance with Section 4.1 of the *P. queenslandica* restoration and translocation strategy (Ecoplanning 2021b) monitoring of translocated plants occurred monthly for the first year after a seedling is planted, quarterly for the next two years and biannually after that. Results of monitoring of translocated populations are compared to results from a reference population, a monitored natural population of *P. queenslandica* within the Rosevale property (**Figure 1.1**). A total of 20 plants within the Rosevale property population are monitored in accordance with Section 4.1 of the *P. queenslandica* restoration and translocation strategy (Ecoplanning 2021b).

As of December 2023, monitoring of all *P. queenslandica* translocated from germination trials between 2020 and 2023 recorded a survival rate of approximately 84 % (278 individuals surviving from 330 individuals planted). Additionally, flowering and seed production has been observed across all translocated sub-populations. This is a significant step towards the stated aims for the propagation and translocation program to *"…support the conservation of P. queenslandica, and to maintain a self-sustaining, genetically diverse population of the species within the WHC Offset Properties*". Results of monitoring up to December 2023 indicate that the translocated populations become more resilient (higher rates of survivorship and flowering) with time as plants become established, with the health, growth, and flowering of younger translocated plants more susceptible to water stress during hot dry conditions. Encouragingly, the older more established translocations appear more resilient to water stress and drought conditions with fewer plant deaths and more flowering observed in older cohorts of translocated plants.

Plate 3.2: *Pomaderris queenslandica* germinants and seedlings (top; Source: BioBankSeed 2019) and translocated plants and fencing within the Kelso Offset Property (bottom; Source WHC)

Table 3.2: Summary of translocated *P. queenslandica* seedlings across recipient sites

Recipient site (property)	Planting Cohort				Total
	2020	2021	2022	2023	
Kelso	6	16	-	-	22
Louenville	7	17	70	-	94
Teston South	7	17	-	-	24
Wollandilly (East)	7	17	-	61	85
Wollandilly (West)	7	16	-	82	105
Total	**34**	**83**	**70**	**143**	**330**

3.1.3 Soil seedbank transfer

Prior to clearing vegetation within the 2015 MCCM disturbance area, topsoil was collected from around the identified *P. queenslandica* populations and stockpiled (**Plate 3.3**). Loose topsoil was scraped off the surface from an area bounded by approximately 1 metre outside of the drip line of the outer plants of a population. This topsoil was sieved and searched for seeds. A total of forty (40) seeds were retrieved and these were used in an initial germination trial. Upon final clearing, all the topsoil from around the plants was collected and stored for later transfer to a site suitable for in situ germination. Topsoil was stored in piles no greater than 1 metre deep.

On 1 September 2020, spread of topsoil commenced at the Teston South Offset Property (**Plate 3.4**). The topsoil recipient site selected was located at the interface between previously disturbed and regenerating grasslands and woodland areas whilst also being in proximity to a minor drainage line. This location has been selected so that disturbance to existing woodland areas was avoided during topsoil transfer while ensuring any *P. queenslandica* which germinate are in suitable habitat and afforded some shading from adjacent woodland areas. The location of the soil transfer is shown in **Figure 3.2**.

In preparation for topsoil transfer, topsoil was stockpiled at an interim location within the Teston South Offset Property, the recipient area was fenced, broad-leaved weeds were sprayed with herbicide, vegetation was slashed, and the recipient area was lightly ripped along the contours as an erosion control measure and to aid water infiltration and aeration. Existing topsoil was retained (not removed) as the stockpiled soils were consider likely to have undergone nutrient leaching and loss of soil microbe diversity. Topsoil was spread directly from a truck with a limited tray opening, to approximately 10 – 20 cm in depth. This avoided any need to spread any soil with machinery and potentially compact the topsoil.

In the second quarter of 2022, surveys of the topsoil recipient site identified recently germinated *P. queenslandica* within the soil translocation exclosure, although an accurate count of all individuals was not possible (minimum population size counted as 111 individuals). In addition to the topsoil recipient site, *P. queenslandica* was also identified within the interim topsoil storage location within the Teston South property (**Figure 3.2**). Confirmation of the identification of the seedlings as *P. queenslandica* was confirmed from specimens lodged with

the NSW Herbarium (**Appendix C**). Subsequent surveys of the topsoil recipient exclosure and interim stockpile location in August 2022 estimated the population size of *P. queenslandica* within the topsoil recipient site as 134 individuals, with 12 individuals counted within the interim stockpile location.

As of December 2023, monitoring of a subset of the *P. queenslandica* which germinated from topsoil within the Teston South offset property recorded a survival rate of approximately 98 % (51 individuals surviving from 52 individuals monitored). Additionally, flowering and seed production has been observed across this translocated population representing an important step towards the stated aims for the propagation and translocation program to "*…support the conservation of P. queenslandica, and to maintain a self-sustaining, genetically diverse population of the species within the WHC Offset Properties*".

Plate 3.3: ***Pomaderris queenslandica*** **topsoil stockpile (Source WHC)**

Plate 3.4: Spread *P. queenslandica* topsoil within Teston South Offset Property (Source WHC)

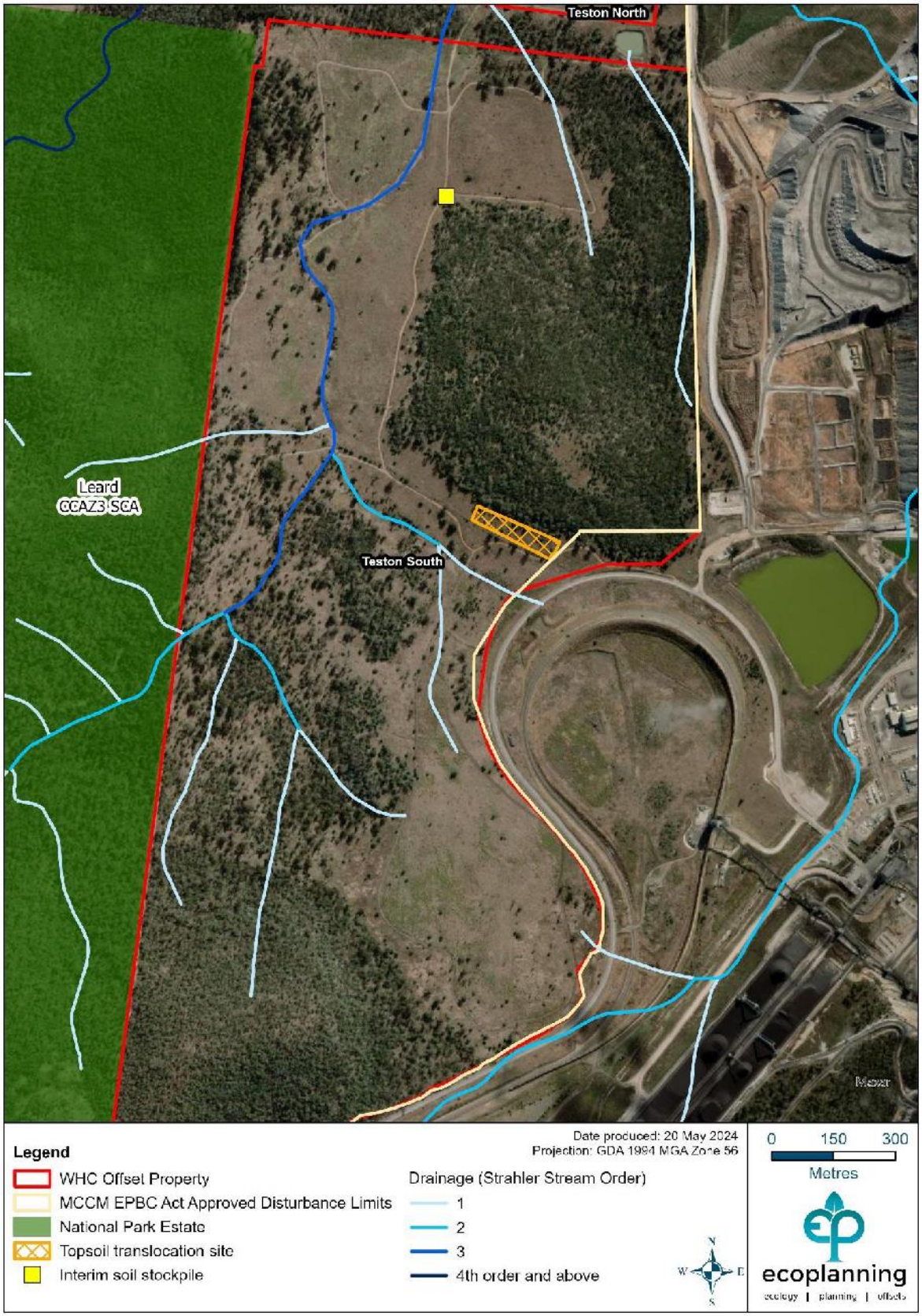

Figure 3.2: Location of *P. queenslandica* topsoil spreading

4 Protection and restoration management actions

Details of management actions across WHC managed lands to maintain, protect and enhance habitat for naturally occurring populations of *P. queenslandica*, including any additional populations detected in the future, and translocated populations of the species, are detailed within the TFPP (Ecoplanning 2021a). These actions include, but are not limited to, the following:

- Exclusion of livestock grazing to promote natural regeneration
- Weed and feral animal control
- Access control
- Bushfire management
- Active revegetation (planting or direct seeding) depending on the success of natural regeneration

These management actions aim to address all the identified threats to *P. queenslandica* (DPIE 2020b) which are associated with habitat disturbance and loss, invasion by introduced weeds, and inappropriate fire regimes.

Several actual and potential additional threats to *P. queenslandica* have also been observed in the offset areas, including herbivory by macropods and goats. As a result, fences have been constructed around existing recipient sites to prevent grazing by macropods and stock.

4.1 Monitoring

Monitoring of translocated *P. queenslandica* individuals and habitat is to continue under this program including future translocations to:

- Provide early warning of problems with the actions undertaken as part of the translocation
- Generate quantitative evidence of translocation success or failure against stated objectives
- Document information on population dynamics within areas of habitat
- Highlight ways to make future translocations more effective

Additionally, monitoring of naturally occurring populations of *P. queenslandica* are required to document the health of these populations including the operation of any recognised threats.

Consistent within monitoring of translocations to date, all translocated seedlings must be permanently tagged, and data collected prior to planting to enable comparisons over time, between individuals and between recipient sites. All translocated seedlings should undergo monitoring, not a subset. Monitoring of translocated seedlings is to take place monthly for the first year after a seedling is planted, quarterly for the two proceeding years and biannually after that. Monitoring should be ongoing, dependent on the success of the program.

Consistent with monitoring to date, reference sites must also be monitored to provide benchmark data and assist in determining attrition or impacts that may be attributed to a natural event that has impacted the general population and not just translocated individuals. Approximately 20 individuals from the natural population of *P. queenslandica* within the

Narrabri Offset (**Figure 1.1**), including a variety of age classes are currently used as reference site and monitored quarterly to assess rates of attrition, flowering, fruiting and natural recruitment. Permanent photos points have been established, and photos are taken from the same place for each monitoring event.

Variables to be monitored at translocation and reference sites are detailed within **Table 4.1**. Collection of this data should provide quantitative data which will guide future management actions including:

- Time to maturity (e.g. first flowering)
- Flowering / fruiting (comparisons between sites and populations).
- What proportion of plants are producing viable seed?
- Are plants in certain locations / situations surviving better than others? Can anything be inferred from this?
- Evidence of second generation and abundance.
- Any experimental micro-siting and treatment variables implemented as part of the program (e.g. fenced / unfenced, shaded / unshaded).

All aspects such a watering frequency, unusual climatic conditions and rainfall should also be considered and documented.

Table 4.1: Data to be monitored for translocated *P. queenslandica* and reference plots

Variable	Data to be recorded
Vegetative growth	Height of individual plant
Plant health / vigour	Repeatable scale of measurement as per the following: 1 Plant dead 2 Widespread dieback/damage 3 Dieback/damage observed on multiple branches 4 Minor dieback/damage evident on isolated leaves or branches 5 Healthy plant with no signs of dieback/damage
Reproductive status	Repeatable scale of measurement as per the following: 1 No. flowers (incl. buds) or fruits observed 2 Isolated flowers or fruits 3 Flowering/fruiting on 5 - 25% of branches 4 Flowering/fruiting on 25 - 75% of branches 5 Flowering/fruiting on 75 - 100% of branches

5 Restoration and translocation program

This propagation and translocation program has been prepared based upon a review of species ecology, scientific reviews, results of previous management actions, best practice guidelines and the project approvals to maximise the chance of successfully achieving the aim of the translocation as outlined within **Section 1**.

For a translocated population to persist in the short term there needs to be enough propagules to establish a viable population and protect against genetic, demographic, and environmental stochasticity; good survival and establishment of the translocated individuals; management and control of threats; and flowering, fruiting and natural recruitment at rates similar to natural populations. For a population to persist in the long term it also needs to possess sufficient genetic diversity to retain its evolutionary potential to adapt to long-term environmental change or infrequent extreme events (Commander et al. 2018). These requirements form the basis of this program. Specifically, this program includes actions to source a large number of propagules, to maximise diversity and to control threats with the aim of maximising survival and establishment of translocated individuals. The proposed *P. queenslandica* translocation incorporates multiple translocation methods to increase the likelihood of success should one method prove unsuccessful. These include:

- Planting of existing nursery-grown plants
- Translocation using seed to reinforce current translocation populations
- Translocation using cuttings to reinforce current translocation populations
- Soil transfer

This propagation and translocation program has been developed considering the Australian Network for Plant Conservation *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018).

5.1 Justification for ongoing translocations

The requirements of the project approval (PA 10_0138) and the MCCM BMP provide justification for ongoing translocation of *P. queenslandica* including translocation of any additional individuals occurring within the MCCM surface development area. Additionally, ongoing reinforcement of translocated populations aims to maximise the chance of achieving the aims of this program, that is establishing a self-sustaining, genetically diverse population of the species within the WHC Offset Properties, which is capable of surviving in the long term.

Considering the applicable approvals for the MCCM surface development areas and therefore the fate of any additional plants located within the surface development area, any attempts at salvage translocations represent worthwhile actions to minimise impacts to the species. The translocation actions included within this program are to be undertaken in conjunction with management actions outlined in Section 4 which aim to protect habitat and build resilience.

5.2 Recipient site selection

Future translocation sites should aim to reinforce all existing populations to establish viable sub-populations to protect against genetic, demographic, and environmental stochasticity. However, future site selection may respond to the relative success of earlier translocation

events and bias planting in those sub-populations/sites with the highest levels of success or avoid planting in sub-populations/sites where success has been limited due to ongoing threats (i.e. herbivory, insect damage or other unknown threats to survival).

Future translocations should include reinforcement plantings (plantings within the five current translocation/recipient sites) until these populations have viable populations and are of a size to protect against genetic, demographic, and environmental stochasticity with flowering, fruiting, and natural recruitment at rates similar to natural populations. Research across Australia confirms that small populations show reduced genetic and demographic outcomes in perennial species (Broadhurst et al. 2008b; Llorens et al. 2012; Llorens et al. 2013; Yates et al. 2007a; Yates et al. 2007b; Young and Brown 1999) and suggests that populations of around 200 to 250 plants are required to minimise these effects. Once sub-populations reach this size (200-250 individuals), additional translocations sites may be established. Planting in partially disturbed sites (e.g. denser canopy, denser shrub layer) as part of an experimental approach to compare success in intact and partially disturbed sites may be considered where sufficient seedlings are available to enable this to be undertaken and a robust assessment of the results. Planting in heavily disturbed sites is not recommended as this is considered unlikely to be successful.

Where additional topsoil translocations are to occur, additional recipient sites will need to be selected. Topsoil recipient site selection should select one or more areas located at the interface between previously disturbed and regenerating grasslands and woodland areas whilst also being in proximity to minor drainage lines. These locations are to be selected so that disturbance to existing woodland areas can be avoided during the topsoil transfer, whilst ensuring any *P. queenslandica* which germinate are in suitable habitat and afforded some shading from adjacent woodland areas.

5.3 Translocation methodology

The translocation methods outlined in this program allow for the translocation to adapt to available resources, particularly where the initial results of one method prove unsuccessful. It is possible that more than one option may be implemented concurrently, where the availability of seeds and seedlings permit, and as new techniques are developed. However, the proposed methods appear broadly in order of preference below, based on the success to date of previous efforts to propagate and translocate the species.

The collection of *P. queenslandica* seed from WHC lands and State Forests (including Leard, Jacks Creek and Pilliga East [subject to licences]) and planting of seedlings germinated in a nursery, represents the most effective way to achieve the aims of the translocation. Although there has been a low success rate from cuttings in the past, this method should be retained to ensure there is a second option should seed availability and / or successful seed propagation be limited.

5.3.1 Seed collection

Translocation via seed collection, seed propagation and planting, represent one of the most effective ways of collecting regenerative material due to the capacity to encompass a large proportion of the species diversity within a population (Commander et al. 2018). As a result, this is one of the most common methods for translocation in general (Silcock et al. 2019). This

method has also proved successful to date with 330 translocated individuals planted into Offset Properties since winter 2020 (**Table 3.2**), with additional seedlings being raised in the nursery (Fields Environmental Solutions).

It is likely that sufficient seed for the purposes of this program is currently held by BioBankSeed. Where additional seed is required in the future, seed should be sourced from a variety of sub-populations across WHC managed lands and adjacent State Forests to increase diversity within the supply of seed for this program. Where possible, seed should be collected from geographically separated areas, although still within the Gunnedah and Narrabri region, as this is likely to maximise the capture of genetic diversity. To ensure the necessary supply of seed of *P. queenslandica*, seed collection may be required across multiple seasons.

Seed collection, management and storage should be undertaken in consideration of Florabank guidelines (http://www.florabank.org.au/). Seed collection permits for threatened species will usually include conditions limiting collections to 20% of the seeds from any individual and from a proportion of individuals in each population depending on the abundance and distribution of the species. This is to ensure that the seed collection does not impact on the fecundity of the source population (Commander et al. 2018).

5.3.2 Seed germination

Pomaderris queenslandica seeds, including existing collections and any future collections, will be used for germination and plant propagation. Seeds will be propagated in a nursery and plants will be translocated to existing translocation sites to reinforce the size and diversity of these populations. Generally, staggered translocations give better protection against the potential consequences of adverse stochastic events (Commander et al. 2018) and an ongoing program of germinations and translocation should be implemented across multiple seasons.

Potential limiting factors to this propagation and translocation program would include, seed availability, seed dormancy and seed viability. However, based upon the success of seed collection and germination trials to date (conducted by BioBankSeed [2019]), these limitations are unlikely to impact the success of this program. Specifically, BioBankSeed (2019) found that dormancy in *P. queenslandica* is robust, and a combination of different dormancy-breaking treatments are required to increase seed viability, and the success of translocations. Seed pre-treatments (e.g. scarification, stratification, after-ripening) should follow methods used to date (BioBankSeed 2019) and should be fully documented, including the time required for these treatments.

The results of previous trials should be reviewed prior to future seed collection and germination. Treatments which have proved successful in previous seasons should be applied preferentially in subsequent seasons.

5.3.3 Stem cuttings

Species of *Pomaderris* have been successfully propagated from stem cuttings in the past (e.g. Australian National Botanic Gardens (ANBG) [2012] and Gardiner [2002]). Gardiner (2002) reported a small number of successful cuttings of *P. aspera*, while the ANBG (2012) reported that cuttings from *P. intermedia* strike readily, when the plant is dipped into a hormone solution. Propagation of the threatened *P. delicata* has also been undertaken successfully via cuttings (McDougall et al. 2018) as seed production is low in this species. Propagation of stem cuttings

of *P. queenslandica* by WHC (2019) in 2015 resulted in a low strike rate, with only one successful strike from over 400 cuttings, although it is unclear if the procedures followed similar techniques as have been successfully applied to other *Pomaderris* species (e.g. ANBG 2012 and Gardiner 2002).

Although there has been varying success in propagation of *Pomaderris* from stem cuttings in the past, this method may be utilised where seed collection and germination is limited or impractical. Therefore, this program details a strategy to produce seedlings from cuttings using either germinated seedlings or mature plant material.

Cuttings should be undertaken in consultation with industry experts to identify the best treatments for cuttings and the likely times for collection and propagation of the species. Initial trials should follow methods identified for other *Pomaderris* species including firm young growth dipped into a hormone solution (ANBG 2012 and Gardiner 2002).

Some level of short-term success and early research suggests that microhabitat placement, seasonal rainfall, and access to supplementary water (irrigation) are essential for translocation success in stem cutting translocations (Commander et al. 2018). Cuttings should not be taken and planted during adverse weather conditions and during long dry periods additional water may be required.

5.3.4 Translocation of propagated seedlings

Following successful seed germination, or propagation via cuttings, seedlings should be planted into the WHC offset areas consistent with techniques utilised to date. Specifically, plantings should occur in autumn/winter, with high soil moisture and low levels of heat stress. Planting should be conducted in the following manner:

1. Prepare a hole for each plant with an auger (or similar) to a depth of approximately 750 mm, and width 50% wider than the largest pot size. Rough the sides of the hole to ensure that it is not round or glazed.
2. Return the soil to the hole and pour 10-15 litres of water onto the soil.
3. Prepare an additional hole in the same manner that will be used to monitor soil moisture.
4. Return 2-3 days later after steps 1-3 for planting.
5. Make sure potted plants have been watered the day prior to planting.
6. Remove plant from pot and trim roots, as required.
7. When planted, the soil level of the potted plant should sit 40 mm below ground level creating a dish. Cover root ball by 40 mm.
8. Place tree guard around the plant, if required.
9. Apply approximately 5 litres of water onto each plant.
10. Monitoring plant and soil moisture weekly. Test for moisture using a fork or dig the soil in the additional hole and observe soil moisture, then replace soil.
11. Only water if required. Overwatering may prevent healthy root growth
12. Do not apply fertiliser.

5.3.5 Fencing and protection

Several potential threats to *P. queenslandica* have been observed in the WHC managed lands including herbivory. A fence must be erected around each recipient site, or as populations spread because of future translocations, individual tree guards may be used. Fences or individual guards should be of a type which excludes macropods and additional measures to exclude rabbits and hares may be required depending on the different sites. Where individual tree guards are utilised, these guards should remain in place until plants are of a suitable size and are considered able to tolerate and survive the level of grazing pressure present within the relevant Offset Property. Stakes may also be used to support the plants initially, if required.

5.3.6 Watering schedule

All translocated plants should be marked clearly so they can be found easily for watering and monitoring. Watering during hot and/or dry periods may be beneficial during the plant establishment phase. If a site is exposed to seasonally dry conditions, Commander et al. (2018) recommend providing weekly or fortnightly water to translocated individuals during the first two dry seasons to mitigate losses during this time.

All translocated individuals should be watered during planting. Initial watering should replicate frequent, small rainfall events (10 mm max and approximately four litres per plant), and later watering should replicate infrequent, large rainfall events (>10 mm and approximately seven to eight litres per plant, or until soils are saturated). Follow-up watering should also occur during any extended dry periods (absence of weekly rainfall in excess of 5 mm in a single rainfall event) or if any signs of dieback are observed which may be linked to dry conditions. Ultimately, decisions regarding the watering schedule after planting will need to be made based upon the rainfall at the time and the response of planted seedlings during monitoring. Lack of post-translocation care and ongoing monitoring are factors that commonly lead to failure of translocation projects (Commander et al. 2018). Post-translocation actions including timing, frequency and amount of watering should be documented to inform decision-making for any future planting events.

5.3.7 Soil seedbank transfer

As detailed in **section 3.1.3**, topsoil transfer has been successfully trialled in the past and resulted in translocation of moderately large number of *P. queenslandica* individuals (at least 134 individuals) into WHC managed lands. Consequently, this method is proposed as part of this program where additional *P. queenslandica* are identified within any approved disturbance areas. It is noted that this technique is typically only recommended (e.g. Commander et al. 2018) where the recipient site is adjacent to the source population due to the potential to transport diseases such as dieback (e.g. *Phytophthora cinnamomi*). However, there is very low risk of *Phytophthora cinnamomi* away from the NSW Coast and Tablelands due to low annual rainfall (McDougall & Liew 2020). Nonetheless, soil translocation recipient site selection should avoid transporting soil across large distances due to the risk of disease spread.

The methods for any future soil translocations should follow the techniques successfully applied in the past. Specifically, topsoil is to be collected from around the *P. queenslandica* inside the approved disturbance area and stockpiled until transported to the recipient site.

Topsoil to a depth of approximately 50 mm should be collected from all areas supporting *P. queenslandica* up to a maximum of approximately 45 m^3 or 75 tonnes. Where *P. queenslandica* occurs at varying density across large areas (therefore generating large volumes of topsoil in excess of 45 m3 or 75 tonnes) topsoil should be preferentially collected from areas supporting the highest density of *P. queenslandica*. All other topsoils are to be managed in accordance with the MCCM Soil Management Protocol as documented within the WHC Mine Site Rehabilitation Plan (WHC 2016). This includes stripping, stockpiling where not utilised immediately, and spreading within rehabilitation areas.

Topsoil recipient sites should be fenced as per existing management of threatened flora enclosures. These enclosures should then be inspected quarterly to identify any *P. queenslandica* seedlings. Where *P. queenslandica* individuals are identified, individuals are to be demarcated and monitored in accordance with **Section 4.1**.

5.4 Translocation schedule

Planting should be conducted over 3-5 seasons (or more) to allow for lessons learned to be incorporated into the future translocations and as it gives better protection against the potential consequences of adverse stochastic events (Commander et al. 2018). While resources are available, translocations involving plantings should continue until ten stable and robust (between 200-250 individuals) sub-populations of *P. queenslandica* have been established across the WHC Offset Properties.

Commander et al. (2018) suggest that seed propagation usually takes about 12 to 18 months to germinate and grow to a suitable sized seedling for planting, which is broadly similar to the experience from the previous seed propagation trials (**Section 3.1.2**). Therefore, timeframes for germination need to be considered and accounted for when planning for the translocation.

6 Review and reporting

The outcomes of implementation of this propagation and translocation program will reported in the MCCM Annual Reviews summarising the results of quarterly inspections on the various stages of the propagation and translocation program as well as any recommendations.

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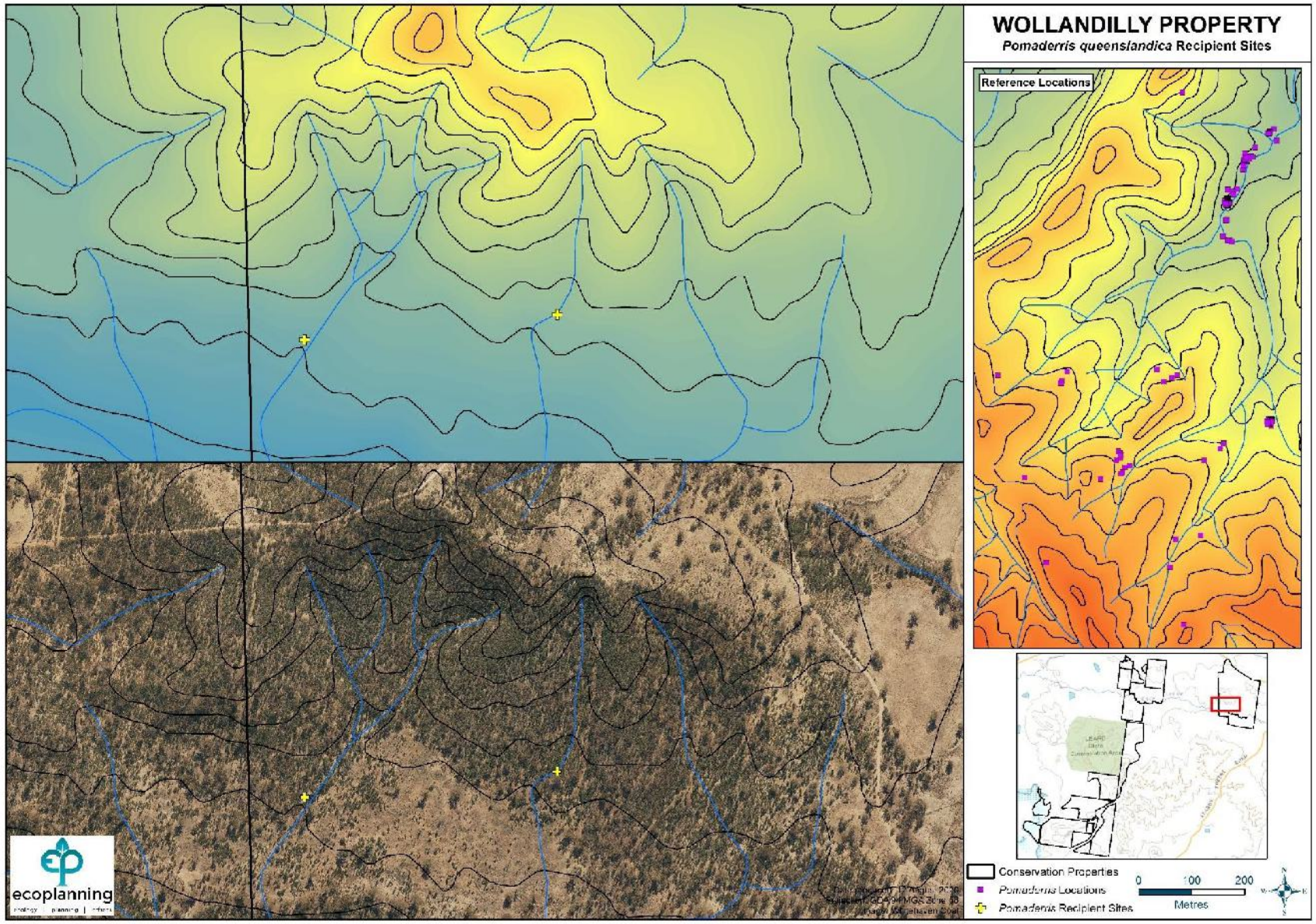
Appendix A Recipient site selection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Conservation Properties
Pomaderris Locations
Pomaderris Recipient Sites
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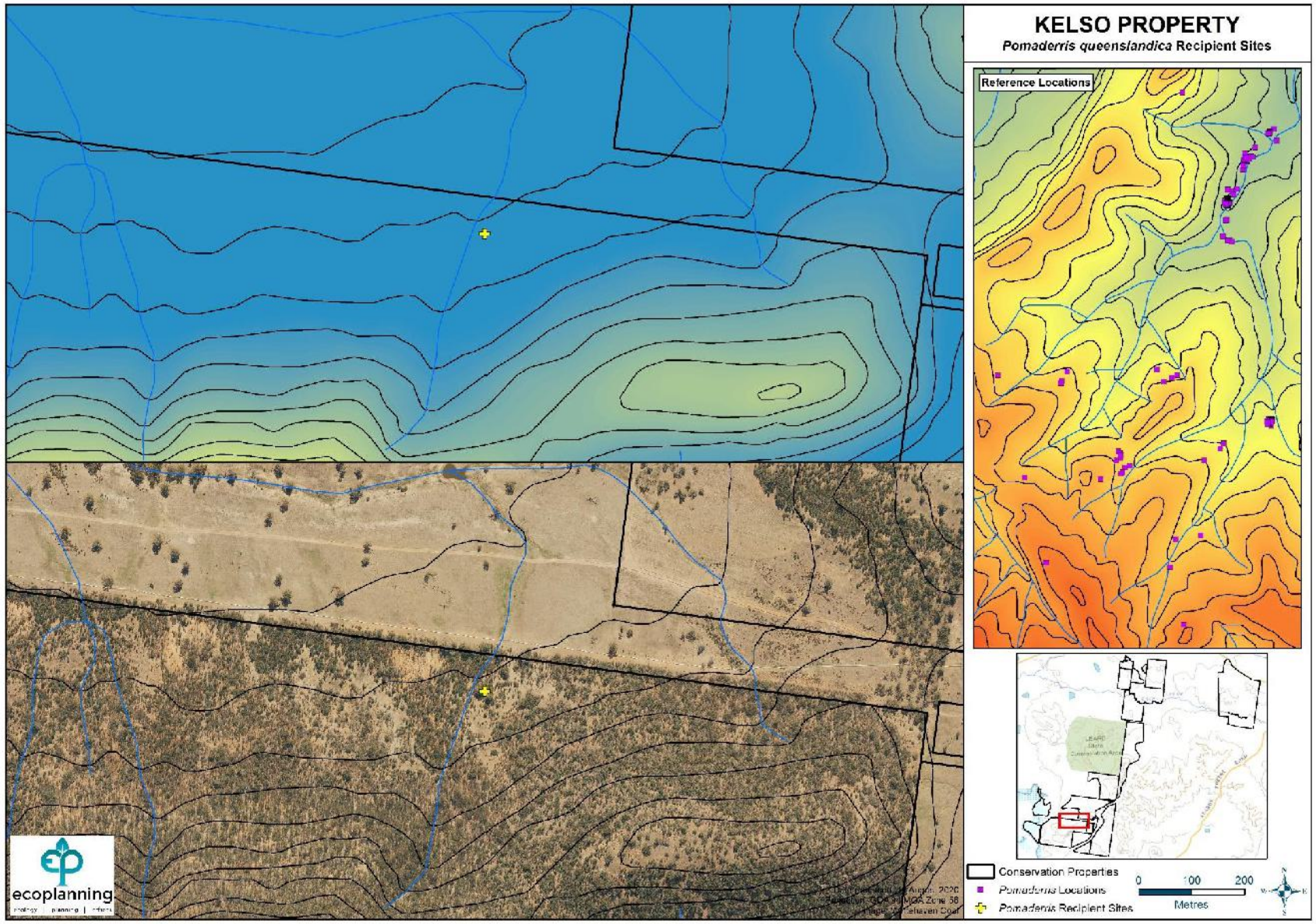
200
Metres
ecoplanning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ecoplanning
Conservation Properties
Pomaderris Locations
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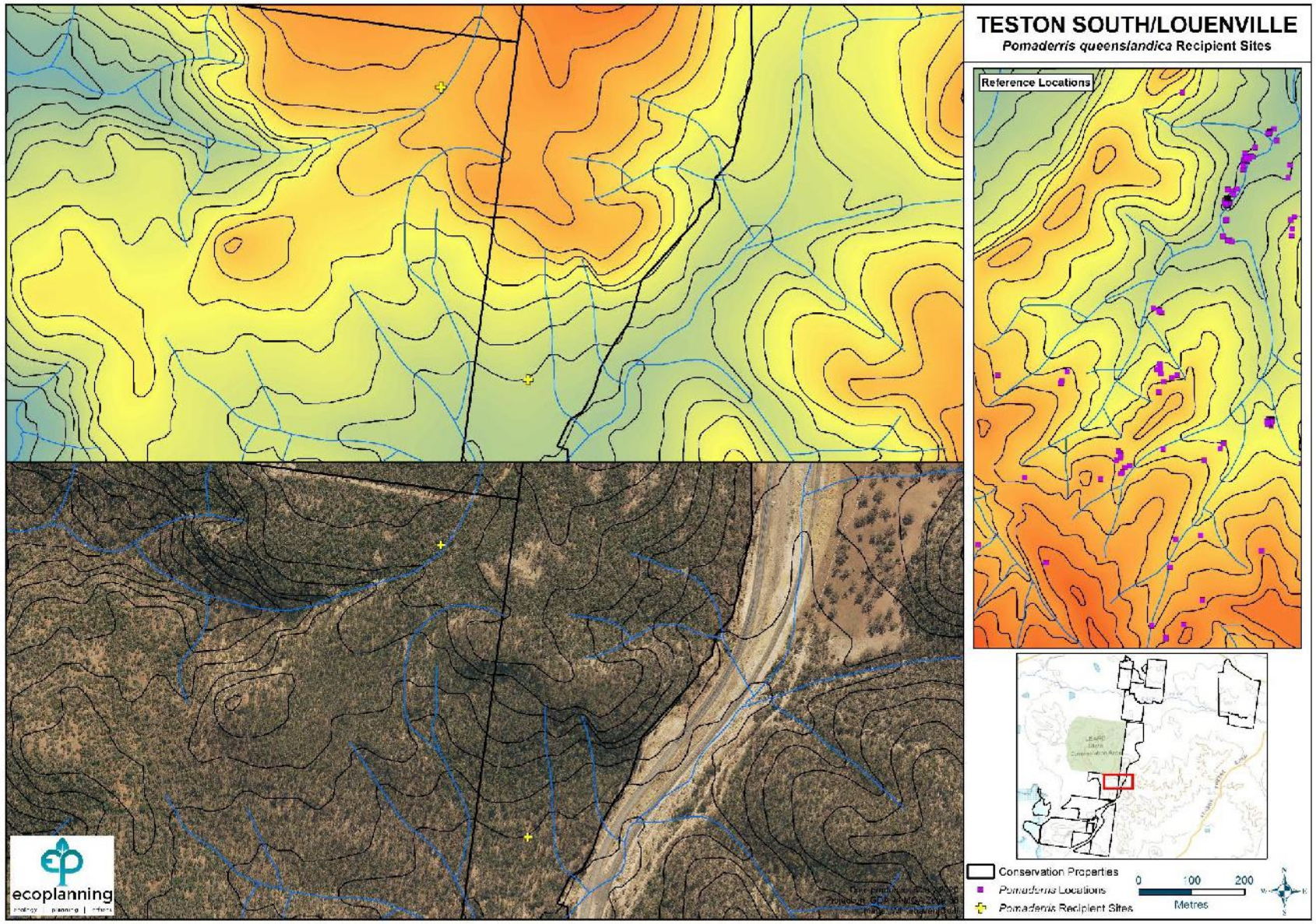
Metres


TESTON SOUTH/LOUENVILLE
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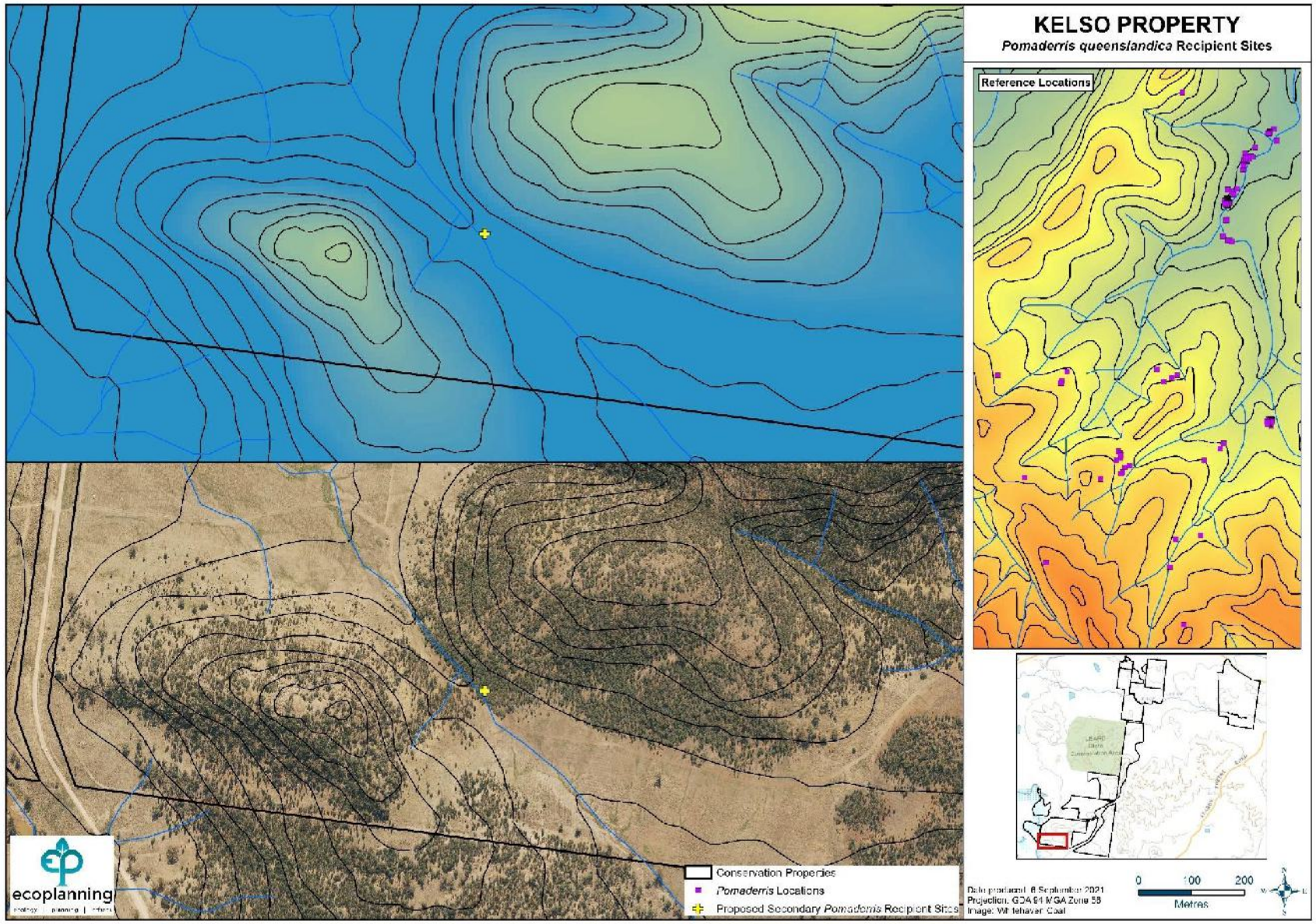
Reference Locations
ecoplanning
Conservation Properties
Pomaderris Locations
Pomaderris Recipient Sites
0
100
200
Metres


KELSO PROPERTY
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ecoplanning
Conservation Properties
Pomaderris Locations
Proposed Secondary *Pomaderris* Recipient Sites
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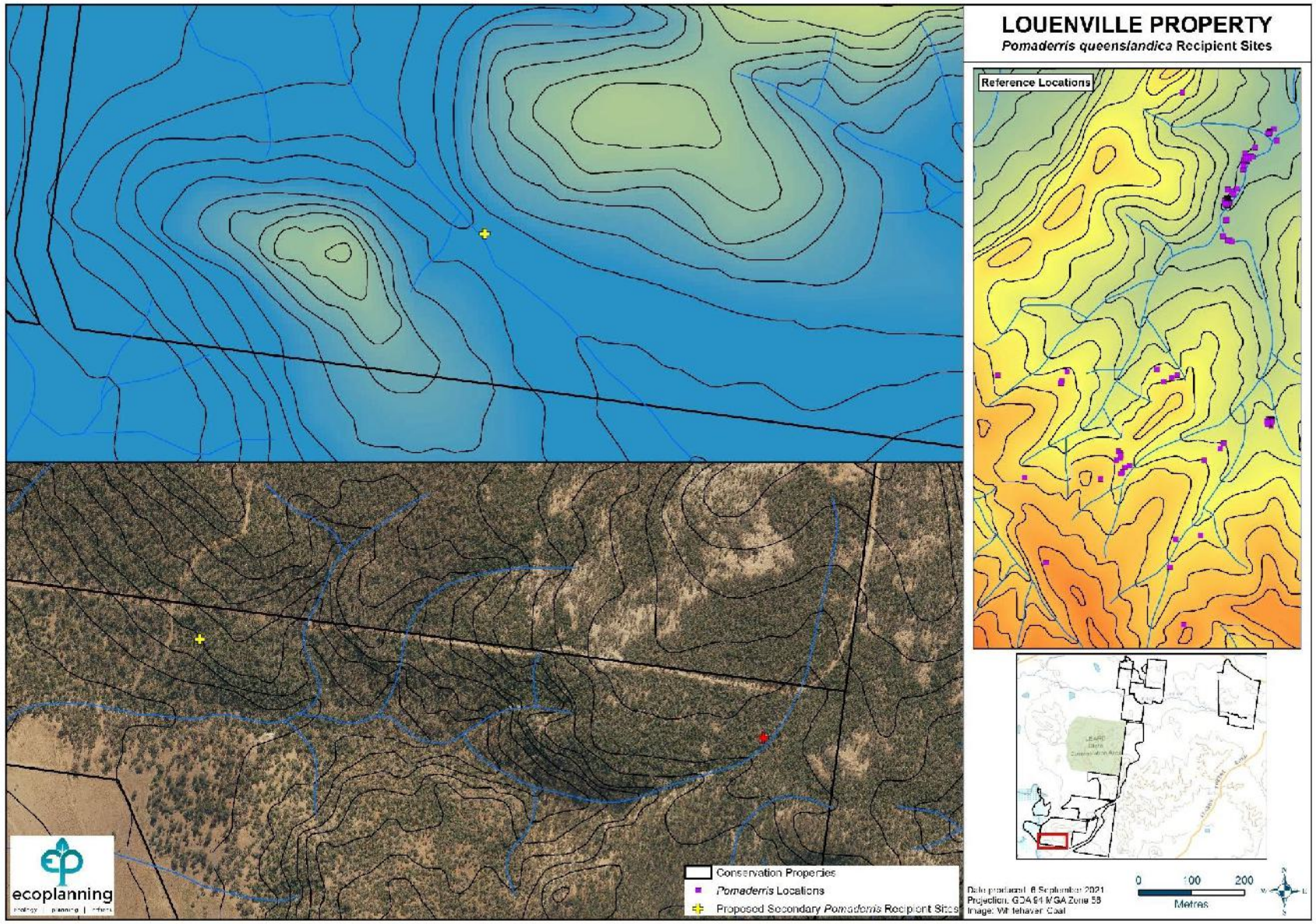
100
200
Metres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Conservation Properties
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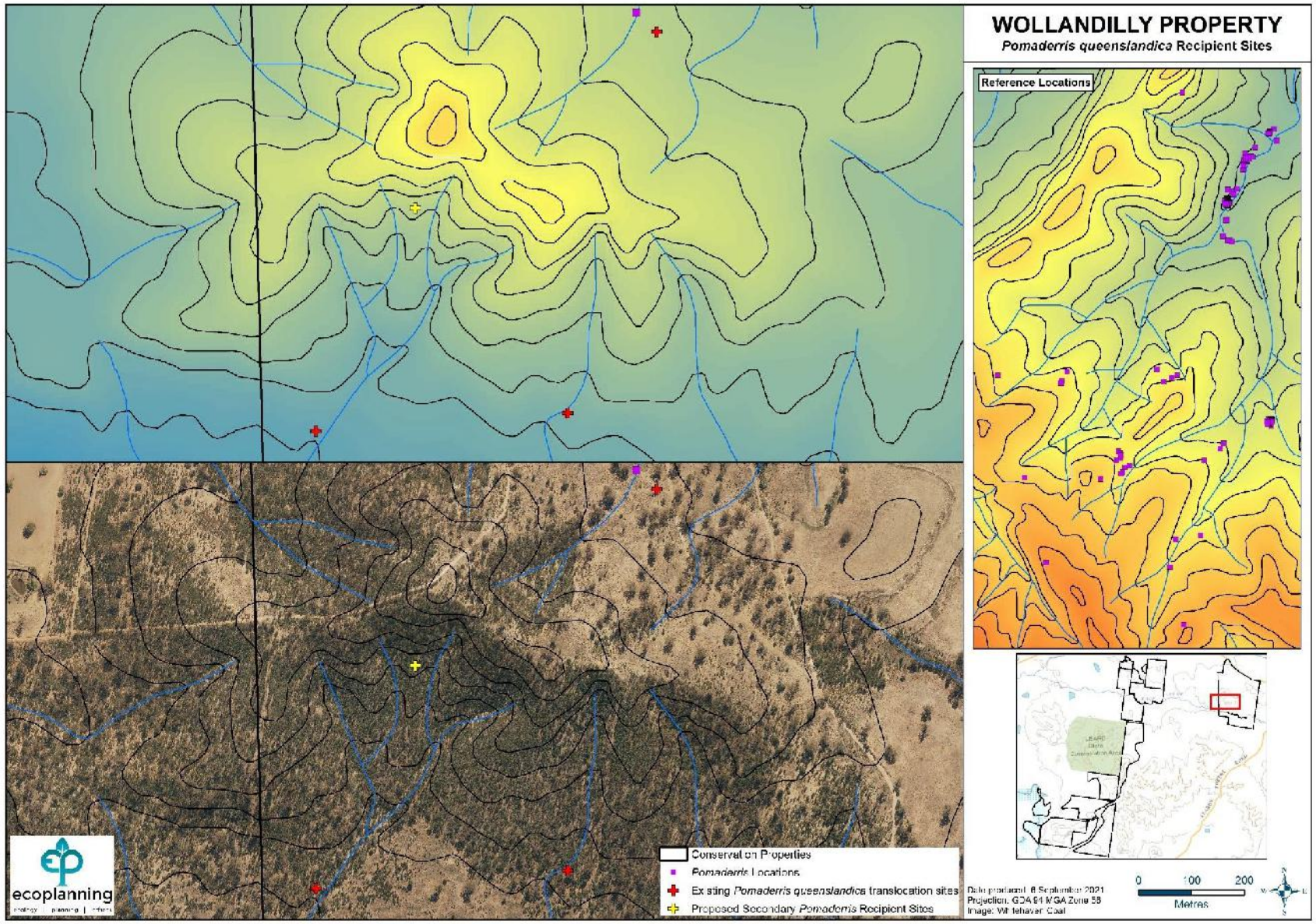
100
200
Metres


WOLLANDILLY PROPERTY
Pomaderris queenslandica Recipient Sites
Reference Locations
ecoplanning
Conservation Properties
Pomaderris Locations
Existing *Pomaderris queenslandica* translocation sites
Proposed Secondary *Pomaderris* Recipient Sites
Projection: GDA94 MGA Zone 56
0
100
200
Metres

Appendix B *Pomaderris queenslandica* plantings

Recipient site (property)	Plant ID
2020 Plantings	
Kelso	32, 33, 34, 14, 15, 16
Louenville	1, 2, 3, 25, 26, 27, 28
Teston South	10, 11, 12, 13, 29, 30, 31
Wollandilly (East)	4, 8, 9, 21, 22, 23, 24
Wollandilly (West)	5, 6, 7, 17, 18, 19, 20
2021 Plantings	
Kelso	45, 69, 70, 80, 81, 82, 83, 84, 85, 86, 87, 98, 99, 100, 101 (outside enclosure) 88 (inside enclosure)
Louenville	38, 39, 43, 89, 90, 93, 94, 95, 106, 107, 108, 109 (outside enclosure) 40, 49, 91, 92, 96 (inside enclosure)
Teston South	44, 47, 50, 53, 55, 56, 57, 59, 102, 103, 104, 105 (outside enclosure) 51, 52, 54, 58, 97 (inside enclosure)
Wollandilly (East)	46, 48, 67, 68, 71, 76, 77, 78, 79, 114, 115, 116, 120 (outside enclosure) 72, 73, 74, 75 (inside enclosure)
Wollandilly (West)	35, 36, 37, 41, 42, 61, 62, 64, 110, 111, 112, 113 (outside enclosure) 60, 63, 65, 66 (inside enclosure)
2022 Plantings	
Louenville	121-190 (outside enclosure)
2023 Plantings	
Wollandilly (East)	273-333
Wollandilly (West)	191-272

Appendix C NSW Herbarium correspondence

The Royal
BOTANIC GARDENS
& Domain Trust

National Herbarium of New South Wales

Jai BRIEN-COOPER
Ecoplanning
1/345 Lawrence Hargrave Dr
Thirroul, NSW 2515

BIS Enquiry No: 22037
Botanical.Is@botanicgardens.nsw.gov.au
Ph. No: (02) 4631 5135
Date: 20th October 2022

Dear Jai,

Re: specimen identification – from Boggabri area

Your specimens have been determined as the following:

- [redacted]
- *Pomaderris queenslandica* – det. A.E. Orme, 19th Oct 2022 – specimen retained
  Simple hairs on undersurface of leaves not quite as dense as other material of this species, but otherwise consistent.

[redacted]

Thank you for your enquiry.

Yours sincerely,

Andrew Orme
Identification Snr Technical Officer
Botanical Identification Service

AUSTRALIAN INSTITUTE OF BOTANICAL SCIENCE

visit NSW Flora Online at plantnet.rbgsyd.nsw.gov.au
to help you identify the plants of New South Wales

NSW GOVERNMENT | Planning, Industry & Environment

The Botanical Identification Service email address is BotanicalIs@botanicgardens.nsw.gov.au
Mrs Macquaries Road Sydney NSW 2000 • Telephone (02) 4631 5135 or (02) 4631 5136

Royal Botanic Gardens and Domain Trust, a statutory body within the Department of Planning, Industry and Environment

APPENDIX H

PULTENAEA IMMINUTA PROPAGATION AND TRANSLOCATION PROGRAM

ecoplanning
ecology | planning | offsets

Pultenaea imminuta Propagation and Translocation Program

Maules Creek Coal Mine

Prepared for: Whitehaven Coal Ltd.

28 February 2025 Version: 1.3 – Draft

PROJECT NUMBER	2023-180-02			
PROJECT NAME	*Pultenaea imminuta* Propagation and Translocation Program			
PROJECT ADDRESS	Maules Creek Coal Mine			
PREPARED FOR	Whitehaven Coal Ltd.			
AUTHOR/S	Brian Towle & Jai Brien-Cooper			
REVIEW	**Technical**	**QA**	**Version**	**Date to client**
	Lucas McKinnon		1.0 - Draft	29 February 2024
			1.1 – Draft	18 April 2024
	Brian Towle & Jo Daly		1.2 – Draft	29 January 2025
	Brian Towle		1.3 – Draft	28 February 2025
COVER PANNEL	Left – *P. imminuta* in flower (M. Robinson) Right – *P. imminuta* in fruit (B. Brown)			
LICENCES	**Scientific Licence**		SL101557	
	Bionet Sensitive Species Data Licence		1115	
	Animal Research Authority Ethics Licence		Fauna Surveys and Monitoring (16/346)	
	Scientific Collection - Aquatic		P19/0009-1.0 & OUT19/2602	

DRAFT

This report should be cited as: 'Ecoplanning (2025). *Pultenaea imminuta* Propagation and Translocation Program – *Maules Creek Coal Mine*. Prepared for Whitehaven Coal Ltd..'

Disclaimer: This report has been prepared by Ecoplanning Pty Ltd for Whitehaven Coal Ltd. and may only be used for the purpose agreed between these parties, as described in this report. The opinions, conclusions and recommendations set out in this report are limited to those set out in the scope of works and agreed between these parties. Ecoplanning P/L accepts no responsibility or obligation for any third party that may use this information or for conclusions drawn from this report not provided in the scope of works or following changes occurring subsequent to the date that the report was prepared.

ECOPLANNING PTY LTD | 428 PRINCES HIGHWAY WOONONA NSW 2517 | P: (02) 4244 2736

Contents

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Glossary and abbreviations

Acronym	Description
BC Act	NSW *Biodiversity Conservation Act 2016*
BMP	Biodiversity Management Plan
DotE	Former Commonwealth Department of the Environment (now Commonwealth DCCEEW)
Commonwealth DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DP&E	Former NSW Department of Planning and Environment (now DPHI and NSW DCCEEW)
DPHI	NSW Department of Planning, Housing and Infrastructure
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
MCCM	Maules Creek Coal Mine
OEH	Former NSW Office of Environment and Heritage (now NSW DCCEEW)
PA	Project Approval
PCT	Plant Community Type
SF	State Forest
TFPP	Threatened Flora Project Plan
WHC	Whitehaven Coal Limited

DRAFT

1 Introduction

In accordance with Project Approval (PA 10_0138) Schedule 3, Condition 52, a Biodiversity Management Plan (BMP) has been prepared by Whitehaven Coal Pty Ltd (WHC, 2017) for the Maules Creek Coal Mine (MCCM). Section 4.1.2 of the BMP, states that if during flora pre-clearance surveys a threatened species is identified:

> "*…the numbers of plants will be counted and/or the population estimated/mapped. A review of translocation methods, collection of propagules, and propagation from seeds or cuttings from plants within the MCCM disturbance area and/or surrounds will be undertaken. Following this review, a translocation/propagation program will be developed and implemented where appropriate in consultation with OEH, DP&E and DotE (for Matters of National Environmental Significance [MNES]).*"

Boggabri Bush-pea (*Pultenaea imminuta*) was identified during the flora pre-clearing surveys undertaken by Ecoplanning in February 2024. *Pultenaea imminuta* is a very recently described species, having been previously included with the *P. setulosa* species complex (Barrett et. al. 2024). At the time of preparation of this plan, *P. imminuta* was not listed under the NSW *Biodiversity Conservation Act 2016* (BC Act), or the EPBC Act[1]. However, a nomination for listing of the species under the BC Act as 'Critically Endangered' is currently in preparation (R. Barrett pers. comm. 2024). In anticipation of the species becoming listed as a threatened species, WHC has requested that Ecoplanning prepare a propagation and translocation program to address the above quoted section of the MCCM BMP (WHC 2017) for *P. imminuta* to be incorporated into a draft MCCM BMP 2025 in preparation.

This propagation and translocation program has been prepared to fulfil the requirements of section 4.1.2 of the MCCM BMP. Further, this propagation and translocation program will be integrated into WHCs Threatened Flora Project Plan (TFPP; Ecoplanning 2021) which provides overarching guidance on the management habitat for threatened flora species within and adjacent to WHC mining operations and Biodiversity Offset Areas (hereafter referred to as WHC managed areas).

This propagation and translocation program adopts the definition of 'translocation' as included in the third version of the Guidelines for the Translocation of Threatened Plants in Australia (Commander et al. 2018), which is:

> *"… the deliberate transfer of plants or regenerative plant material from an ex situ collection or natural population to a new location, usually in the wild. It includes reintroduction, introduction, reinforcement, assisted migration and assisted colonization. Translocations involve a diverse range of methods including: seed collection and propagation; propagation via cuttings or tissue culture; planting of containerised plants; direct seeding; transplantation of whole plants from one site to another; and the transfer of soil, leaf litter, brush or pollen."*

This strategy primarily represents a 'salvage' translocation according to the definitions of Commander *et al.* (2018). That is, the translocation aims to transfer regenerative material,

[1] The entity from which *P. imminuta* was recently split, *P. setulosa*, is listed as vulnerable under the EPBC Act. However, for the purposes of the listing under the EPBC Act, *P. setulosa* is treated in the narrow taxonomic sense and the listing applies only to individuals within the Broad Sound to the Marlborough area in Queensland (Commonwealth DCCEEW 2024).

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including from individuals within approved disturbance areas to locations where there is either an existing population of *P. imminuta* or habitat which is broadly equivalent to that in which the species has been previously recorded.

1.1 Aims and objectives

In anticipation of the species becoming listed as a threatened species, Whitehaven has requested that Ecoplanning prepare a propagation and translocation program to address the above quoted section of the MCCM BMP (WHC 2017) for *P. imminuta*. The overall aim of this propagation and translocation program is to support the conservation of *Pultenaea imminuta*, and to maintain a self-sustaining population, genetically diverse population of the species within WHC managed areas, which is capable of surviving in the long-term. This program provides:

- An estimate of the population size and extent of *P. imminuta*;
- A review of translocation methods, including the collection of propagules, and propagation from seeds or cuttings from plants within the MCCM disturbance area and/or surrounds; and
- Methodology for propagating and translocating *P. imminuta*.

Further this propagation and translocation program will:

- Outline actions for the protection, restoration and management of habitat for *P. imminuta*.
- Provide guidance on the methodologies for the translocation of *P. imminuta* individuals grown from seed, stem cuttings, or soil seedbank back within WHC managed areas.
- Provide clear management and monitoring measures to ensure the long-term success of the translocation program.

1.2 Ecology of *Pultenaea imminuta*

1.2.1 Distribution and population size

Pultenaea imminuta is a shrub reported to grow to approximately 0.6 m (Barrett et. al. 2024), although has been observed to grow to approximately 1.2 m (pers. obs.; **Figure 1.1**). Until very recently, the species was only known from two vouchered collections (D. Landenberger – 2009; M. Robinson 2021) and a third unvouchered record (sighting by Tanya Bangel on 3 Oct. 2018, BioNet Atlas Record No. LJJSI0149462; DCCEEW 2024) all within an approximately 4 km area (**Figure 1.2**). Additional observations of the species were made by Ecoplanning during pre-clearance surveys of the approved MCCM surface development area in February 2024. The population was estimated and mapped as per Section 4.1.2 of the MCCM BMP (WHC 2017), with results presented in **Table 1.1**.

All recorded locations of *Pultenaea imminuta* are located within Leard State Forest (SF) and are shown in **Figure 1.2**. Based upon field surveys conducted by Ecoplanning in February 2024, the total population size was estimated to be approximately 3,000 individuals, with a summary of the sub-populations provided in **Table 1.1**.

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Table 1.1: Known sub-populations of *Pultenaea imminuta*

Sub-population (Source)	Location / Tenure	Date of most recent survey	Number of individuals
Landenberger (2009)	Leard SF - Boggabri Coal (CL 368)	September 2009	Not recorded
BioNet Atlas (2018)	Leard SF - Boggabri Coal (CL 368)	Unknown	Not recorded
M. Robinson (2021) and inspected by Ecoplanning in 2024	Leard SF - Biodiversity Corridor	February 2024	~1600
Ecoplanning (2024)	WHC MCCM surface development area	March 2024	1,200*
Ecoplanning (2024)	Leard SF – South-west of MCCM surface development area	February 2024	34

* Estimate based upon a combination of actual counts and extrapolation from transect data through the sub-population.

Figure 1.1: *P. imminuta* within the MCCM surface development area (B. Brown)

Figure 1.2: Recorded locations of *Pultenaea imminuta*

1.2.2 Habitat associations

Habitat for *Pultenaea imminuta* has been described as (Barret et. al. 2024):

> *"… eucalypt and cypress pine woodland on skeletal soils derived from basalt over conglomerate on mid to upper slopes of hills. Recorded in association with Acacia cheelii, A. leiocalyx, Aristida ramosa, Austrostipa scabra, Callitris glaucophylla, Calotis sp., Cheilanthes distans, Dodonaea stenophylla, D. truncatiales, D. viscosa subsp. angustifolia, D. viscosa subsp. mucronata, D. viscosa subsp. viscosa, Eucalyptus crebra, E. dwyeri, Geijera parviflora, Gonocarpus elatus, Melichrus urceolatus, Notelaea microcarpa var. microcarpa, Oxytes brachypoda, Pimelea neo*anglica, *Pomax umbellata, Psydrax odorata, Rytidosperma fulvum, Rytidosperma racemosum* and *Senna aciphylla*."

Based upon Ecoplanning field observations in February 2024, and previous collection notes, habitat for *Pultenaea imminuta* most closely resembles Plant Community Types (PCT) 592 'Narrow-leaves Ironbark – Cypress Pine – White Box shrubby open forest' and PCT 427 'Cypress pine – Tumbledown Red Gum low open woodland to grassland on rocky benches'. This is supported by the State Vegetation Type Map (SVTM; NSW DCCEEW 2024), which maps these two PCTs (PCT 592 and PCT 497) as occurring across all areas within 100 m of recorded locations of *P. imminuta* (**Figure 1.4**).

Within this habitat type, the species is typically associated with mid to upper slopes, a very open vegetation structure, and skeletal soils with a high density of small (5-10 cm diameter) surface rock. A review of regional surface geology maps (Pratt 1998) indicates that the areas of high surface rock where *P. imminuta* has been found are associated with the upper layers of the Maules Creek Formation. As described by Pratt (1998), the Maules Creek Formation has "*basal carboniferous claystone, pelletoridal clay sandstone, passing into fining-up cycles of sandstone, siltstone, and coal. Conglomerate dominant towards top*".

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Figure 1.3: Typical habitat for *P. imminuta* (J. Brien-Cooper – February 2024)

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Figure 1.4: Vegetation mapping indicating the Plant Community Type at the location of all known *P. imminuta* records.

1.2.3 Life-cycle

Informed by the single observations of flowers of *P. imminuta* in September 2021 (M. Robinson; see cover photo) and recent seed collections in February 2024 (Ecoplanning 2024; **Figure 1.5**), the phenology of the species appears to be broadly consistent with majority of *Pultenaea* species. That is, flowering occurs in Spring with seed produced in Summer (Auld 1996, Benson & McDougall 1996). Due to the recent recognition of the species, and the very restricted distribution, there is very little additional information available on the life-cycle of *P. imminuta.* However, a review of available information for the genus (which is largely informed by the studies compiled by Benson & McDougall (1996) for the Central Coast and Central Tablelands Botanical Divisions) and the broader Fabaceae family (Auld 1996), a number of generalisations can be made:

- *P. imminuta* is likely to be pollinated by native bees attracted by pollen, nectar or both, resulting in a high incidence of outcrossing. The very few reported observations of pollinators of *Pultenaea* species are of native bees (Benson & McDougall 1996), although numerous insects are associated with flowers of the broader Fabaceae with native and introduced bees, wasps, beetles and flies all identified as potential pollinators (Auld 1996).
- Seed are likely to have a high level of physical dormancy and high level of viability. Where documented, seed viability in *Pultenaea* ranged from 90 to 100% with the non-dormant faction of seeds ranging from 10 to 59 % (Benson & McDougall 1996).
- Initial seed dispersal in *Pultenaea* and the Fabaceae varies from passive to explosive, while secondary seed dispersal is primarily by ants, although distances seeds are dispersed are generally less than 10 metres (m) (Auld 1996).
- It is highly likely that *P. imminuta* plants are killed by fire and post fire-recruitment occurs from the soil seed bank (e.g. an obligate seeder). This is the dominant fire response of the genus *Pultenaea*, although there are some examples of species with mature plants resprouting post fire (Benson & McDougall 1996; Auld 1996). No resprouting plants were observed during surveys by Ecoplanning in February 2024.

Figure 1.5: Seed of *P. imminuta* (B. Brown – February 2024)

1.2.4 Genetic analyses

Following identification of the species at MCCM; a genetic analysis was undertaken of the two populations of *P. imminuta* by the NSW Research Centre for Ecosystem Resilience (Bloom-Quinn & Van Der Merwe 2024). The study used samples collected from 74 individuals from two populations of *P. imminuta*; one population from the MCCM 2024 surface development area (accounting for 50 individuals) and the other from the Biodiversity Corridor (24 individuals) (**Figure 1.2**). Bloom-Quinn & Van Der Merwe (2024) made multiple findings and recommendations from on their analyses, which are summarised below.

Although the two populations assessed were relatively close (separated by approximately 2.5 km), each population was genetically distinct but not highly differentiated. They attribute the differentiation of the two populations to genetic drift facilitated by pollinating insects maintaining fidelity to each population (i.e. pollinators not travelling between the two populations). Bloom-Quinn & Van Der Merwe (2024) found that there is a moderate level of inbreeding at both the sites, but that observed heterozygosity remains moderately high. The relatively high levels of heterozygosity, lack of next of kin and absence of clusters of highly related individuals suggests that the species is a preferentially outcrossing plant and that individuals needs to be genetically distant to reproduce successfully. Additionally, pollinators are likely move freely within a site not necessarily staying within a small patch.

The genetic analysis found that each of the two sampled sites hold 90% of the species total alleles, which is encouraging. However, 10% of the common alleles identified with the sequencing of the sampled material from each site are unique to a single site. Analysis of cuttings from each of the individual plants made by Fields Environmental Solutions from the MCCM 2024 surface development area (see section 4.5) indicate that over 10% of the unique diversity of the species has been salvaged. This operation was thus important for maintaining evolutionary valuable material that can contribute towards the survival of the species. Analyses for genetically optimised collections favoured sampling more individuals from the Biodiversity Corridor.

Bloom-Quinn & Van Der Merwe (2024) made the following four recommendations:

1. When establishing a new population material from the two sites should be mixed to maximise genetic diversity and genetic health.
2. Any newly created population needs to maintain high levels of genetic diversity and in all circumstances cuttings that come from the same individual or seed from the same parent should not be planted together. The genetic data indicates that the individuals included in this study were not related and all are thus suitable for translocations.
3. The ex-situ material held by Fields Environmental is of genetic value and the collection should be maintained. Nursery staff should take care to maintain information on maternal lines so that these individuals can be kept separate during the establishment of new populations.
4. To optimise genetically diverse plantings use approximately 30% of plants from Leard SF and 70% from Biodiversity Corridor. Make sure that these individuals represent unique individuals and are not clones (cuttings) from the same maternal line. Multiple new sites can be established to ensure survival. Multiple stochastic processes can lead to failure to survive, and we recommend at least four genetically diverse translocation sites.

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2 Approvals and requirements

Relevant management plans, approval conditions and requirements which relate to *P. imminuta* are summarised in **Table 2.1**.

Table 2.1: Statutory requirements and management plans relevant to *P. imminuta*

Approval / Management plan	Requirement	Response
Maules Creek Coal Mine		
Project Approval (PA 10_0138) Schedule 3, Condition 52	"*The Proponent shall prepare and implement a Biodiversity Management Plan for the project to the satisfaction of the Director-General..*"	A Biodiversity Management Plan (BMP) has been prepared.
Biodiversity Management Plan - Section 4.1.2	"*If a threatened plant species is identified, the numbers of plants will be counted and/or the population estimated/mapped. A review of translocation methods, collection of propagules, and propagation from seeds or cuttings from plants within the MCCM disturbance area and/or surrounds will be undertaken. Following this review, a translocation/propagation program will be developed and implemented where appropriate in consultation with OEH, DP&E and DotE.*"	This propagation and translocation program.

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3 Protection and restoration management actions

P. imminuta is known to occur within the Biodiversity Corridor between the Boggabri and Maules Creek mining projects. The retention of a vegetated buffer corridor of 500 m between the Boggabri and Maules Creek mining projects was recommended by the NSW Planning Assessment Commission, the former NSW Office of Environment and Heritage (OEH; now NSW DCCEEW), the NSW Department of Planning and Environment (DP&E; now Department of Planning, Housing and Infrastructure (DPHI)), and subsequently included in the Boggabri (09_0182) and Maules Creek (10_0138) project approvals.

Consistent with the existing management of known populations of threatened flora recorded within WHC managed areas, standard management actions will be applied to *P. imminuta* habitat for any future identified naturally occurring populations. These actions include, but are not limited to, the following:

- Exclusion of livestock grazing to promote natural regeneration.
- Weed and pest animal control.
- Access control (enclosure and demarcation fencing).
- Bushfire management.
- Active revegetation (planting or direct seeding) depending on the success of natural regeneration.

The existing monitoring of known populations of threatened flora recorded within WHC managed areas will also be applied to *P. imminuta*, such as visual inspections of threatened flora enclosures undertaken quarterly, or in response to incidents (e.g. bushfire), to detect disturbance factors, presence of pest animal species, grazing pressure from over-abundant native herbivores and the presence of exotic weed species. These inspections aim to monitor seed production, germination and to increase knowledge of each species' ecology and reproductive habits.

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4 Translocation strategy

This translocation strategy has been prepared based on a review of the known ecology of the species (including inferences from related species where knowledge gaps occur), scientific reviews, results from previous management actions for threatened flora, best practice guidelines, and the project approvals to maximise the chance of successfully achieving the aim of the translocation as outlined within **Section 1**.

For a translocated population to persist in the short-term, there needs to be:

- A sufficient number of propagules to establish a viable population and protect against genetic, demographic and environmental stochasticity,
- Good survival and establishment of the translocated individuals,
- Management and control of threats; and
- Flowering, fruiting, and natural recruitment at rates similar to natural populations.

For a population to persist in the long term it also needs to possess sufficient genetic diversity to retain its evolutionary potential to adapt to long-term environmental change or infrequent extreme events (Commander et al. 2018). These requirements form the basis of this strategy. Specifically, this strategy includes actions to source propagules that maximise diversity; mitigate threats with the aim of enhancing the chances of survival and establishment of translocated individuals. The proposed *P. imminuta* translocation incorporates multiple translocation methods to increase the likelihood of success should one method prove unsuccessful. These translocation methods include:

- Salvage translocations, including the following techniques.
  - seed collection
  - cuttings
  - soil translocation
- Seed collection (from non-salvage plants) and propagation

Transplanting entire plants, including their root ball, is not proposed due to the limited success associated with this technique. Transplanting whole plants from naturally-occurring populations has a low success rate as many plants die without successfully reproducing at their new location (Commander et al. 2018). Additionally, the rocky habitat in which *P. imminuta* typically occurs is likely to make this process even more difficult as root balls are unlikely to remain cohesive. Resources are considered better applied to increasing the number of propagules collected via alternative techniques.

4.1 Justification for translocations

The requirements of the project approval (PA 10_0138) and the MCCM BMP provide justification for a translocation of *P. imminuta* occurring within the MCCM surface development area. Considering the applicable approvals for the MCCM surface development areas and therefore the fate of plants located within the surface development area, any attempts at salvage translocations represent worthwhile actions to try minimise impacts to the species. The translocation actions included within this strategy are to be undertaken in conjunction with management actions outlined in Section 3 which aim to protect habitat and build resilience

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through habitat restoration and mitigating threatening processes (including pest and weed control).

Translocation via seed collection, seed propagation and planting, represent one of the most effective ways of collecting regenerative material due to the capacity to encompass a large proportion of the species diversity within a population (Commander et al. 2018). As a result, this is one of the most common methods for translocation in general (Silcock et al. 2019). This strategy has been successfully utilised for other threatened flora species found on WHC managed areas (e.g. *Pomaderris queenslandica* and *Bertya opponens*).

4.2 Recipient site selection

As detailed within **Section 1.2**, the current understanding of the range and habitat associations of *P. imminuta* suggest that the species occupies a particular micro-habitat within the broader habitats for PCT 592 and 427. This micro-habitat is characterised by mid to upper slopes with a very open vegetation structure, and skeletal soils with a high density of small (5-10 cm diameter) surface rock. Consequently, identification of similar habitats within WHC managed areas has been key to selecting recipient sites where translocations are likely to be successfully undertaken. An assessment of WHC managed areas (prioritising locations adjacent to the Leard SF and Leard State Conservation Area) has been undertaken to identify areas which represent suitable recipient sites. In accordance with the recommendations of Bloom-Quinn & Van Der Merwe (2024), four recipient sites have been identified as part of this plan. These translocation sites are located in the Onavale, Wollandilly, Teston East, and Teston South offset properties (**Figure 4.1**).

As part of the process for selecting the four recipient sites, the following site characteristics were reviewed using available resources:

- Local surface geology using mapping completed by Pratt (1998).
- Validated vegetation mapping (targeting areas mapped as PCT 427 and 592).
- Topographic position (mid slope and a southerly aspect).

In addition to the above, recipient sites have been selected which have sufficient spatial separation to minimise the risk of stochastic events (e.g. wildfire) having a detrimental effect on multiple sites at the same time. As such, selected recipient sites are separated by at least 1 km.

The habitat features of each nominated recipient site is summarised in **Table 4.1** and examples of each recipient site is shown in **Figure 4.2**. Vegetation mapping and topography of each recipient site are shown in **Figure 4.3** (Onavale), **Figure 4.4** (Teston East), **Figure 4.5** (Teston South), and **Figure 4.6** (Wollondilly). It is noted that the Teston South recipient site includes the Soil Seedbank translocation site (as described in **Section 4.7**).

For the Onavale, Teston South and Wollondilly recipient sites (**Figure 4.3**, **Figure 4.5**, and **Figure 4.6)** the proposed translocations would represent 'introductions' defined as attempts to establish a population in a site where it has not previously occurred but is within proximity to the known range of the species and provides similar habitat to known occurrences. For the Teston East recipient site (**Figure 4.4**) the proposed translocations would represent a 'reinforcement' which is defined as adding individuals of a species into an existing population with the aim of enhancing population viability by increasing population size, genetic diversity

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and/or representation of specific demographic groups or stages. The proposed Teston East recipient site includes an estimated 20 individuals of *P. imminuta*.

Within the nominated recipient sites (**Figure 4.1**), the exact placement of translocated individuals and associated protection fencing will be subject to future due diligence assessments to select the most suitable location(s) in each nominated recipient site. Translocation sites would be approximately 2.4 – 3.0 ha to have capacity to support the recommended population sizes (200-250; **Section 4.2**) and planting densities (<1 plant / 12 m^2, **Section 4.6**).

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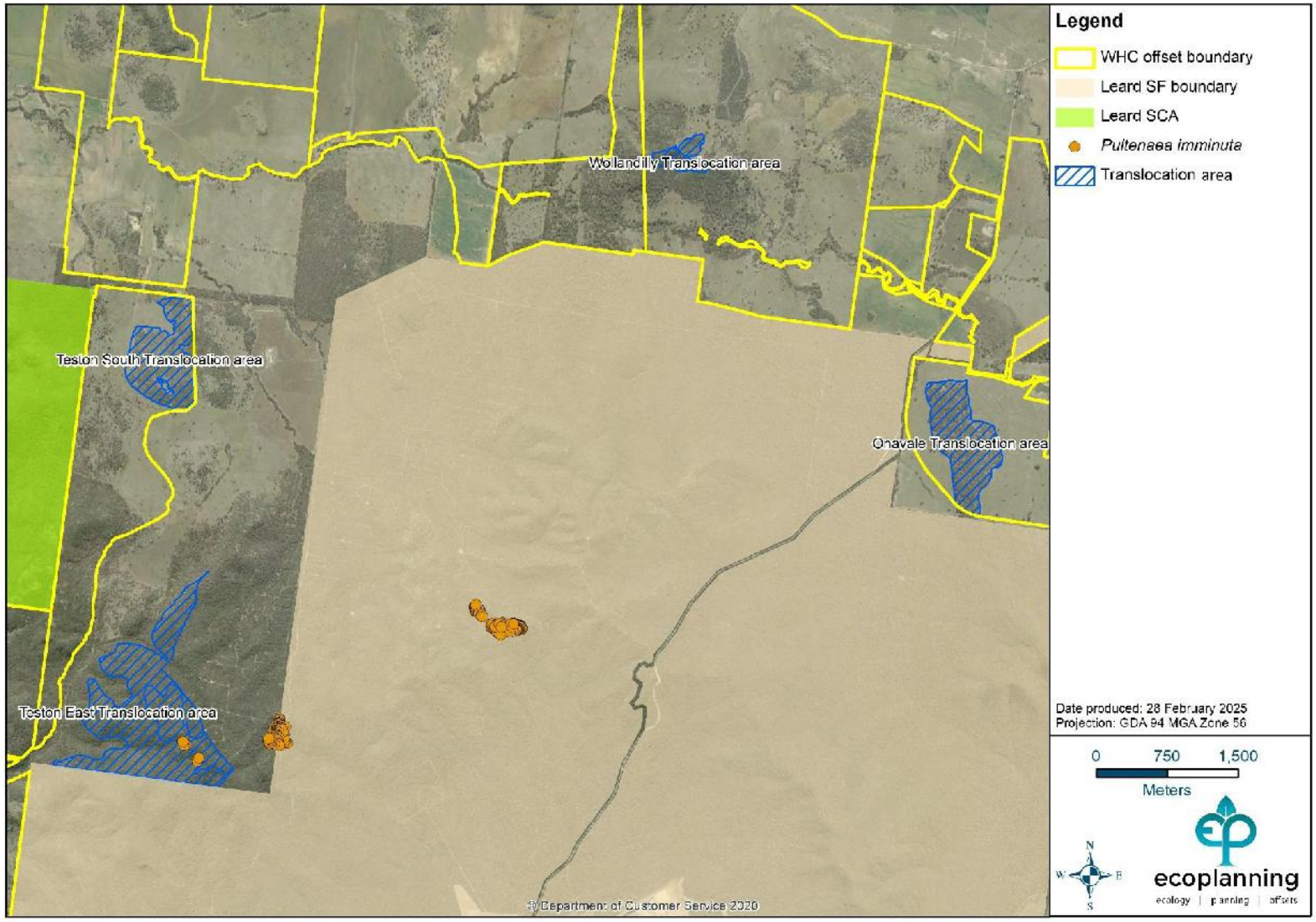

Figure 4.1: Location of the *P. imminuta* recipient sites in relation to all known records of *P. imminuta*, Leard State Forest, and the Maules Creek Coal Mine.

Table 4.1: Comparison of translocation site characteristics to descriptions of known habitat for *P. imminuta*.

Proposed recipient site	Site characteristic			
	Soil and geology	PCT	Topographic position	Figures
Known habitat	Skeletal soils with high proportion of surface stones, derived from Conglomerate in the Maules Creek Formation (Pratt 1998)	427 & 592	Mid slope with southern aspect	**Figure 1.3** and **Figure 1.2**
Onavale	Soils with high proportion of surface stones (depth uncertain), derived from Conglomerate in the Maules Creek Formation (Pratt 1998)	592	Mid slope with eastern aspect	**Figure 4.2.A** and **Figure 4.3**
Teston East	Skeletal soils with high proportion of surface stones, derived from Conglomerate in the Maules Creek Formation (Pratt 1998)	427 & 592	Mid slope with southwest aspect	**Figure 4.2.B** and **Figure 4.4**
Teston South	Skeletal soils with high proportion of surface stones, derived from Boggabri Volcanic Group and Maules Creek Formation (Pratt 1998)	592	Mid slope with southern aspect	**Figure 4.2.C** and **Figure 4.5**
Wollondilly	Soils with high proportion of surface stones (depth uncertain), derived from Conglomerate in the Maules Creek Formation (Pratt 1998)	592	Mid slope with southern aspect	**Figure 4.2.D** and **Figure 4.6**

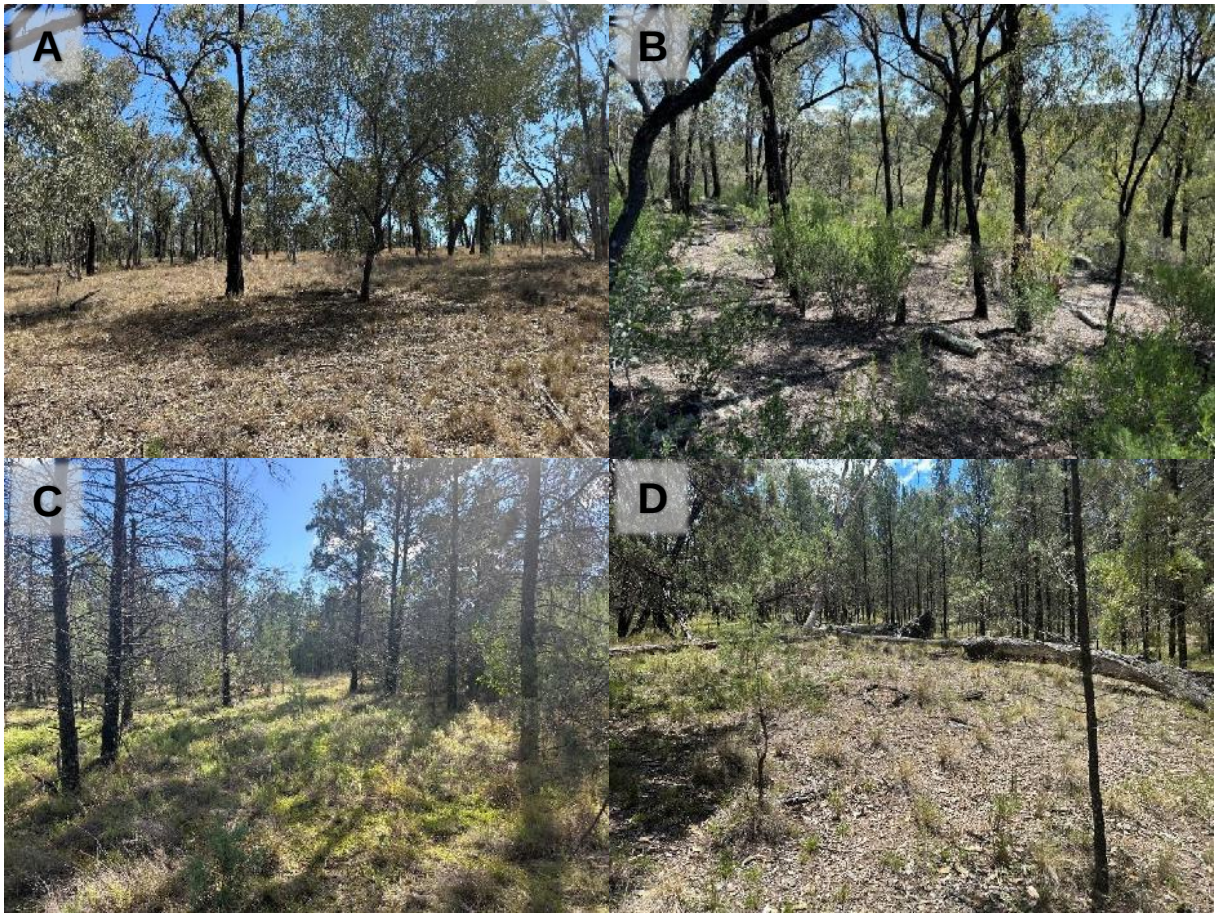

Figure 4.2: Examples of habitat from within each proposed recipient site: A) Onavale (J. Brien-Cooper; February 2025), B) Teston East (J. Brien-Cooper; October 2024), C) Teston South (J. Brien-Cooper; July 2024), and D) Wollondilly (J. Brien-Cooper; January 2025).

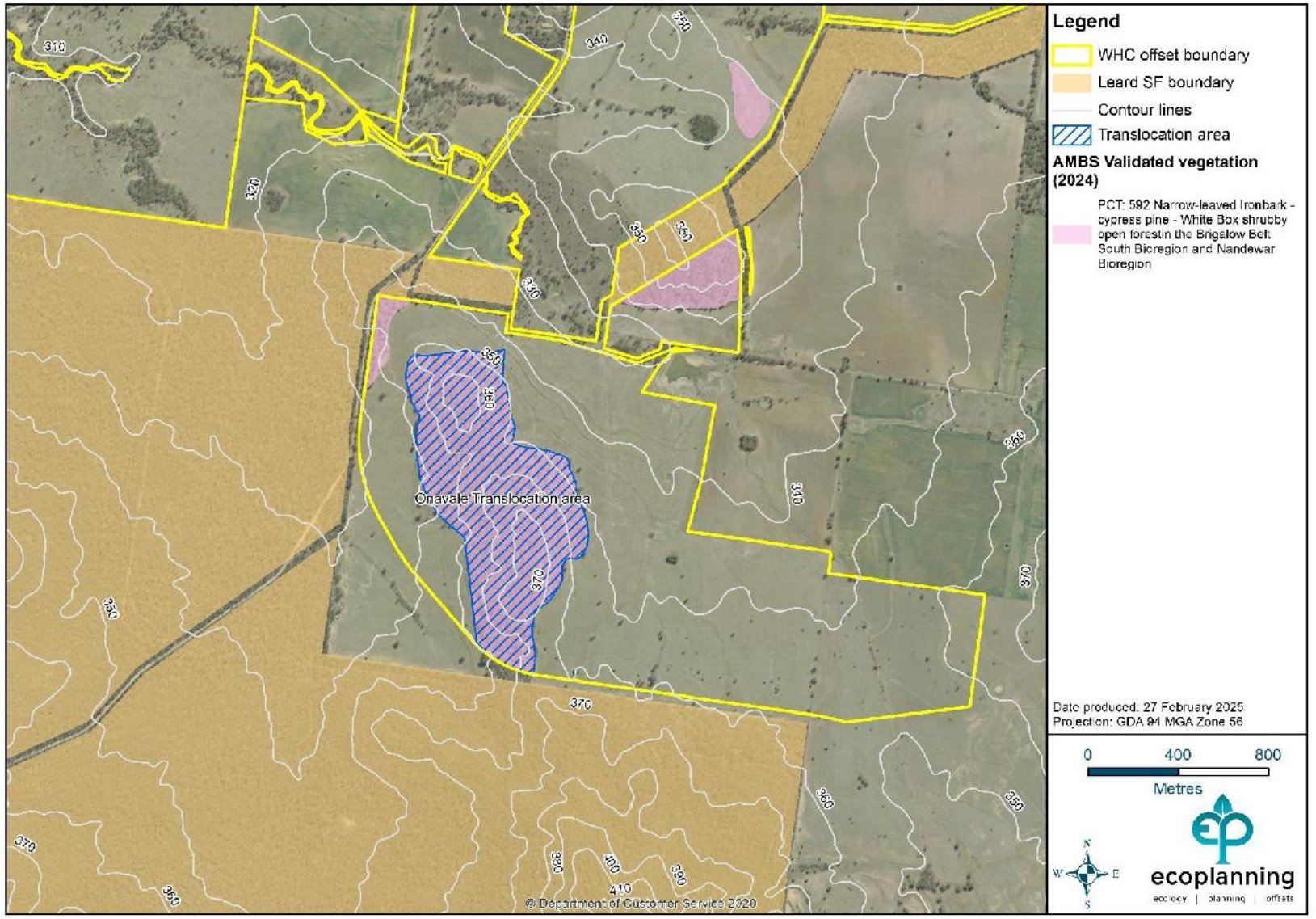

Figure 4.3: Vegetation mapping and topography of the Onavale *P. imminuta* recipient site.

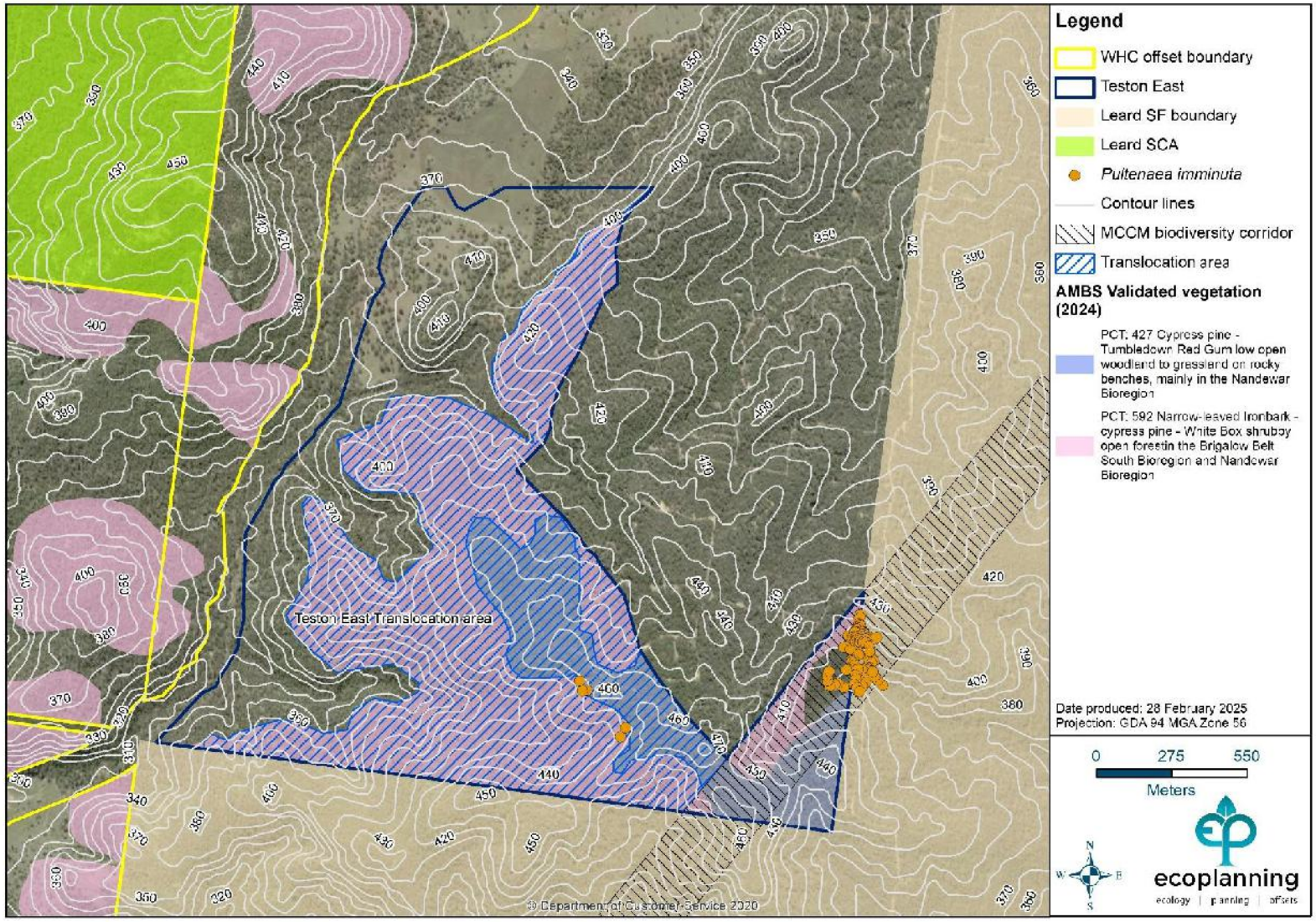

Figure 4.4: Preliminary vegetation mapping and topography of the Teston East *P. imminuta* recipient site.

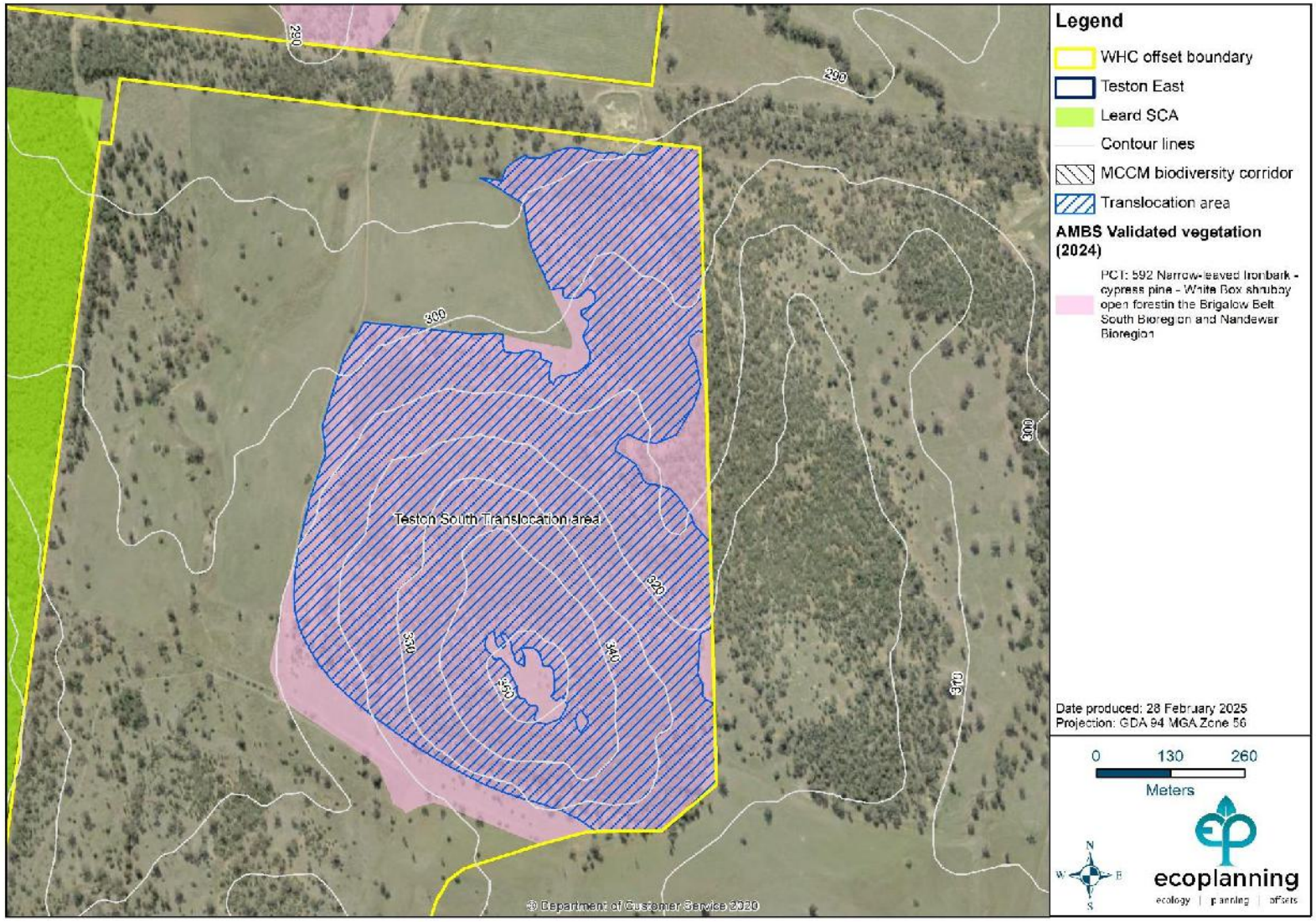

Figure 4.5: Vegetation mapping and topography at the Teston South recipient site.

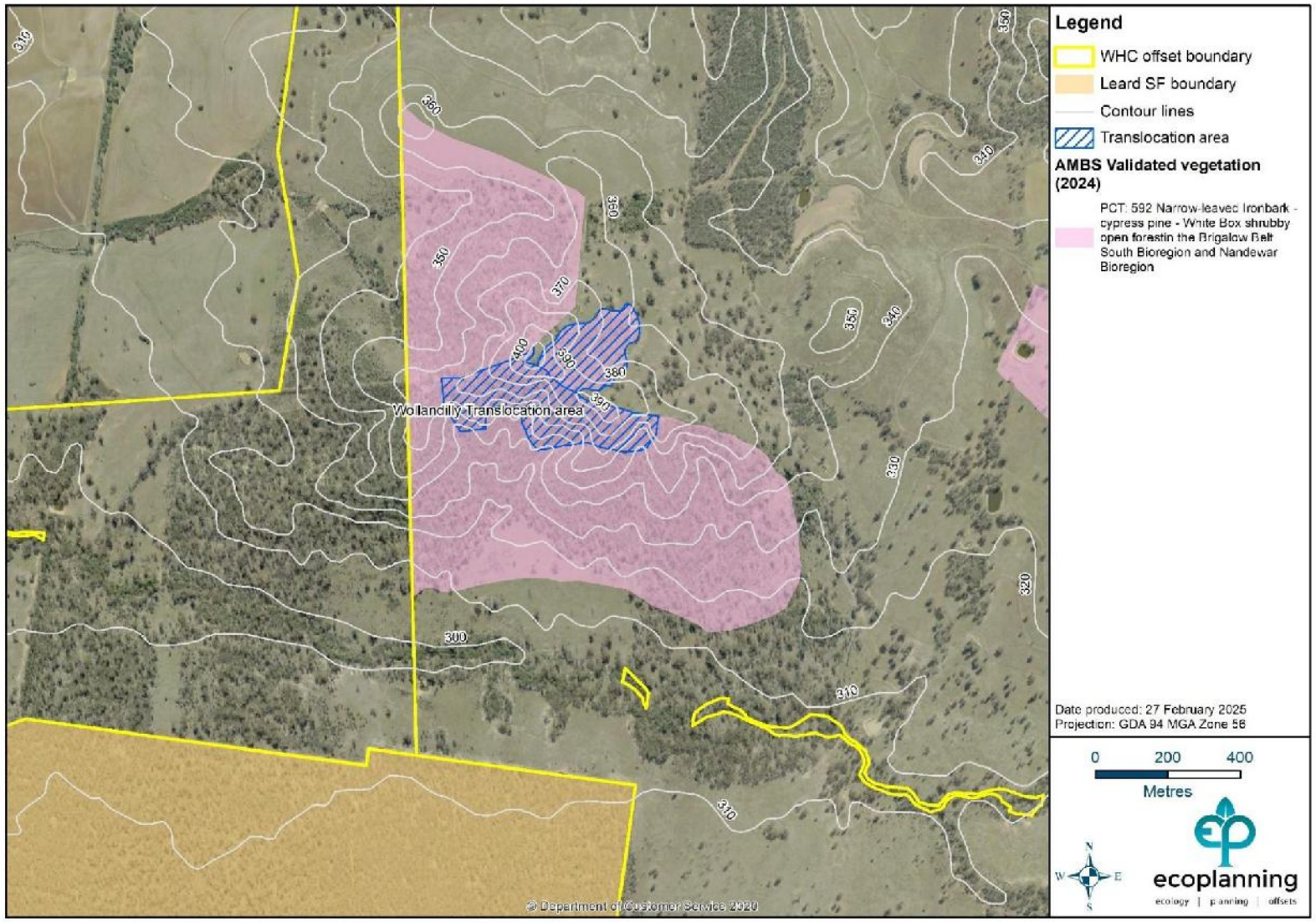

Figure 4.6: Vegetation mapping and topography at the Wollandilly recipient site.

4.3 Seed collection

The success of this translocation method would be dependent upon sufficient seed collection from *P. imminuta* populations within the MCCM surface development area and within the biodiversity corridor. Seed detected during pre-clearance surveys (as required under Sections 4.12 and 4.3 of the BMP [WHC 2017]) should be collected from *P. imminuta* in impact areas prior to disturbance. Seed storage and handling should be as detailed below.

Visual inspections of *P. imminuta* populations are to be undertaken quarterly, or in response to incidents (e.g. bushfire) with one of the aims of these inspections is to monitor seed production. Where seed production is identified during quarterly inspections, seed collection, management and storage should be undertaken in consideration of Florabank guidelines (http://www.florabank.org.au/) including bagging of selected branches prior to seed release to adequately sample between early and late seed release across each seeding production season. Specifically, seed collection from non-salvage plants is to:

- Be limited to a maximum of 20% of the capsules from each plant annually.
- Include no more than 100 individuals per year.
- Collect seed from spatially separated individuals to reduce chance of collecting seeds from related plants.
- Be fully documented so that data on the plants and locations where seed collection occurred can be tracked over time.

Opportunistic seed collection of *P. imminuta* within the 2024 surface development area occurred during pre-clearance surveys in February 2024. Seed was collected from between 50 to 100 individuals yielding a total of 0.54 grams and approximately 328 seeds. Seed germination has commenced with details to be included in future reporting. Targeted seed collection of *P. imminuta* also occurred in late October 2024 with 134g collected from the Biodiversity Corridor site. Future seed collections will consider the recommendations of Bloom-Quinn & Van Der Merwe (2024) to prioritise collections from the population within the Biodiversity Corridor.

4.4 Seed germination

Pultenaea imminuta seeds collected will be used for germination and plant propagation. Subject to actual successful seedlings propagation, propagated seedlings are proposed to be translocated to selected recipient sites to reinforce the size and diversity of existing populations, or to establish additional sub-populations (recipient site selection discussed in Section 4.2).

Key limiting factors for the translocation strategy is likely to be seed availability, seed dormancy and seed viability. A review of available literature suggests that *Pultenaea* seeds typically have high seed viability and high seed dormancy; noting that extrapolating aspects of the ecology of commonly occurring species does not necessarily mean that it will apply to threatened species that face unique challenges absent in other common species of the genus. Seed pre-treatments (e.g. scarification, stratification, after-ripening) should follow methods used to date including the time required for these treatments with details to be included in future reporting.

While the initial seeds collected will be prioritised for germination and propagation trials within nursery conditions; future seed collections will aim to enable translocation work over multiple

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years and allows for future plantings if the initial plantings/translocations fail. Generally, staggered translocations give better protection against the potential consequences of adverse stochastic events (Commander et al. 2018). When sufficient seed is collected for the purposes of staggered translocations, additional seed should be donated to the seedbank at the Australian PlantBank at Mount Annan Botanic Gardens.

The results of previous trials should be reviewed prior to future seed collection and germination. Treatments which have proved successful in previous seasons should be applied preferentially in subsequent seasons.

4.5 Stem cuttings

Species of *Pultenaea* have been successfully propagated from stem cuttings in the past for horticultural purposes (e.g. Australian Plant Society of NSW 2022); noting that extrapolating aspects of commonly occurring species does not necessarily mean that it will apply to threatened species that face unique challenges absent in other common species of the genus. Stem cuttings may be sourced from the same locations and populations as seed collection (MCCM surface development area and within the biodiversity corridor) within the Project Approval area, although stem cuttings from within the annual clearing areas will be prioritised, where identified.

Cuttings will be undertaken by suitable experienced professionals to identify the best treatments for cuttings and the likely times for collection and propagation of the species.

Some level of short-term success and early research suggests that microhabitat placement, seasonal rainfall, and access to supplementary water (irrigation) are essential for translocation success in stem cutting translocations (Commander et al. 2018). Cuttings should not be taken and planted during adverse weather conditions and during long dry periods additional water may be required.

Targeted stem cuttings of *P. imminuta* within the 2024 surface development area occurred in March 2024. Approximately 300 seedlings have struck and survived from these initial cuttings collected from greater than 100 individuals. Propagation work on the stem cuttings has commenced with details to be included in future reporting.

4.6 Translocation of propagated seedlings

Following successful seed germination, or propagation via cuttings, seedlings should be planted into the WHC managed areas (recipient site selection discussed in **Section 4.2**) in autumn/winter, with high soil moisture and low levels of heat stress. Planting should be conducted in the following manner:

1. Prepare a hole for each plant with an auger (or similar) to a depth of approximately 750 mm (or as close to that depth given subsurface conditions and constraints), and width 50% wider than the largest pot size. Rough the sides of the hole to ensure that it is not round or glazed.
2. Return the soil to the hole and pour 10-15 litres of water onto the soil (or until soil is saturated).
3. Prepare an additional hole in the same manner that will be used to monitor soil moisture.
4. Return 2-3 days later after steps 1-3 for planting.

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5. Make sure potted plants have been watered the day prior to planting.
6. Remove plant from pot and trim roots, as required.
7. When planted, the soil level of the potted plant should sit 40 mm below ground level creating a dish. Cover root ball by 40 mm.
8. Place tree guard around the plant, if required.
9. Apply approximately 5 litres of water onto each plant (or until soil is saturated).

Despite the ability of the species to naturally occur at moderate densities, it is recommended that all plants are located at least 2-3 m (no more than 1 plant/12 m^2) from other translocated plants to avoid competition during establishment. Additionally, material from the same parent plant should be planted at least 20 m from each other (Bloom-Quinn & Van Der Merwe 2024). For convenience during monitoring and maintenance of translocated plants, large gaps (>5-10 m) between translocated plants should also be avoided where possible.

4.6.1 Fencing and protection

Potential threats to populations of *P. imminuta* include herbivory by goats and ground disturbance by pigs. A fence will be erected around each recipient site as a preference over using individual tree guards. Fences should be of a type which excludes macropods and additional measures to exclude rabbits and hares may be required depending on the different sites. Where individual tree guards are utilised in addition to fencing, these guards should remain in place until plants are of a suitable size and are considered able to tolerate and survive the level of grazing pressure present within the relevant offset property or other selected recipient sites. Stakes may also be used to support the plants initially, if required.

4.6.2 Watering Schedule

All translocated plants should be marked clearly so they can be found easily for watering and monitoring. Watering during hot and/or dry periods may be beneficial during the plant establishment phase. If a site is exposed to seasonally dry conditions, Commander et al. (2018) recommend providing weekly or fortnightly water to translocated individuals during the first two dry seasons to mitigate losses during this time.

All translocated individuals should be watered during planting. Initial watering should replicate frequent, small rainfall events (10 mm max and approximately four litres per plant), and later watering should replicate infrequent, large rainfall events (>10 mm and approximately seven to eight litres per plant, or until soils are saturated). After planting follow-up watering should also occur during any extended dry periods (absence of weekly rainfall in excess of 5 mm in a single rainfall event) or if any signs of dieback are observed which may be linked to dry conditions. Ultimately, decisions regarding the watering schedule after planting will need to be made based upon the rainfall at the time and the response of planted seedlings during monitoring. Lack of post-translocation care and ongoing monitoring are factors that commonly lead to failure of translocation projects (Commander et al. 2018). Post-translocation actions including timing, frequency and amount of watering should be documented to inform decision-making for any future planting events. The watering schedule and response of translocated plants should be documented and reviewed in each annual review, including recommendations for any changes to watering schedules based upon the monitoring data (see **Section 6**).

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4.6.3 Maintaining genetic diversity of translocated populations

Future translocated populations of *P. imminuta* should aim to contain a high level of genetic diversity. To do this, *P. imminuta* translocation attempts should aim incorporate the following recommendations made by Bloom-Quinn & Van Der Merwe (2024):

- Seedlings from multiple source sites should be mixed (e.g. MCCM surface development area and the Biodiversity Corridor).
- Translocated material from the same parent plant (i.e. cuttings and propagated seed) should planted at least 20 m from each other when planted at the same site or should not be planted at the same translocated site.
- In the long-term, the pedigree of translocated plants (both propagated seed and cuttings) at the same translocation site should represent their source populations at different rates. Specifically, 30% of translocated plants should represent the population from the surface development area and 70% from the Biodiversity Corridor population. However, this ratio will be dependent on the quantity of seedlings germinated and propagated from the seed collected from the Biodiversity Corridor site.

4.7 Soil seedbank translocation

Soil seedbank translocation has been previously successfully utilised for *Pomaderris queenslandica* within the Teston South offset property. Consequently, this method is proposed as part of this strategy and generally follows the techniques applied for that species. It is noted that this technique is typically only recommended (e.g. Commander et al. 2018) where the recipient site is adjacent to the source population due to the potential to transport diseases such as dieback (e.g. *Phytophthora cinnamomi*). However, there is very low risk of *Phytophthora cinnamomi* away from the NSW Coast and Tablelands due to low annual rainfall (McDougall & Liew 2020). Nonetheless, soil translocation recipient site selection should avoid transporting soil across large distance due to the risk of disease spread.

Topsoil was collected separately around the *P. imminuta* population from the Surface Development Area and stockpiled until transported to an area adjacent to the existing *Pomaderris queenslandica* topsoil recipient site, located within the Teston South offset property (**Figure 4.7**). This topsoil recipient site was selected as it is located at the interface between previously disturbed and regenerating PCT592 grasslands and woodland areas. This location has been selected so that disturbance to existing woodland areas can be avoided during topsoil transfer while ensuring any *P. imminuta* which germinate are afforded some shading from adjacent woodland areas.

Topsoil recipient sites have been fenced as per existing management of threatened flora enclosures. These enclosures are to be inspected quarterly to identify any *P. imminuta* seedlings. Where *P. imminuta* individuals are identified, individuals are be demarcated and monitored in accordance with **Section 5**.

P. imminuta topsoil translocations following the above methods were undertaken in December 2024. Existing topsoil was retained (not removed) and topsoil was spread directly from a truck with a limited tray opening, to approximately 10 – 20 cm in depth. This avoided any need to spread any soil with machinery and potentially compact the topsoil. Ongoing monitoring of this site will occur consistent with **Section 5**.

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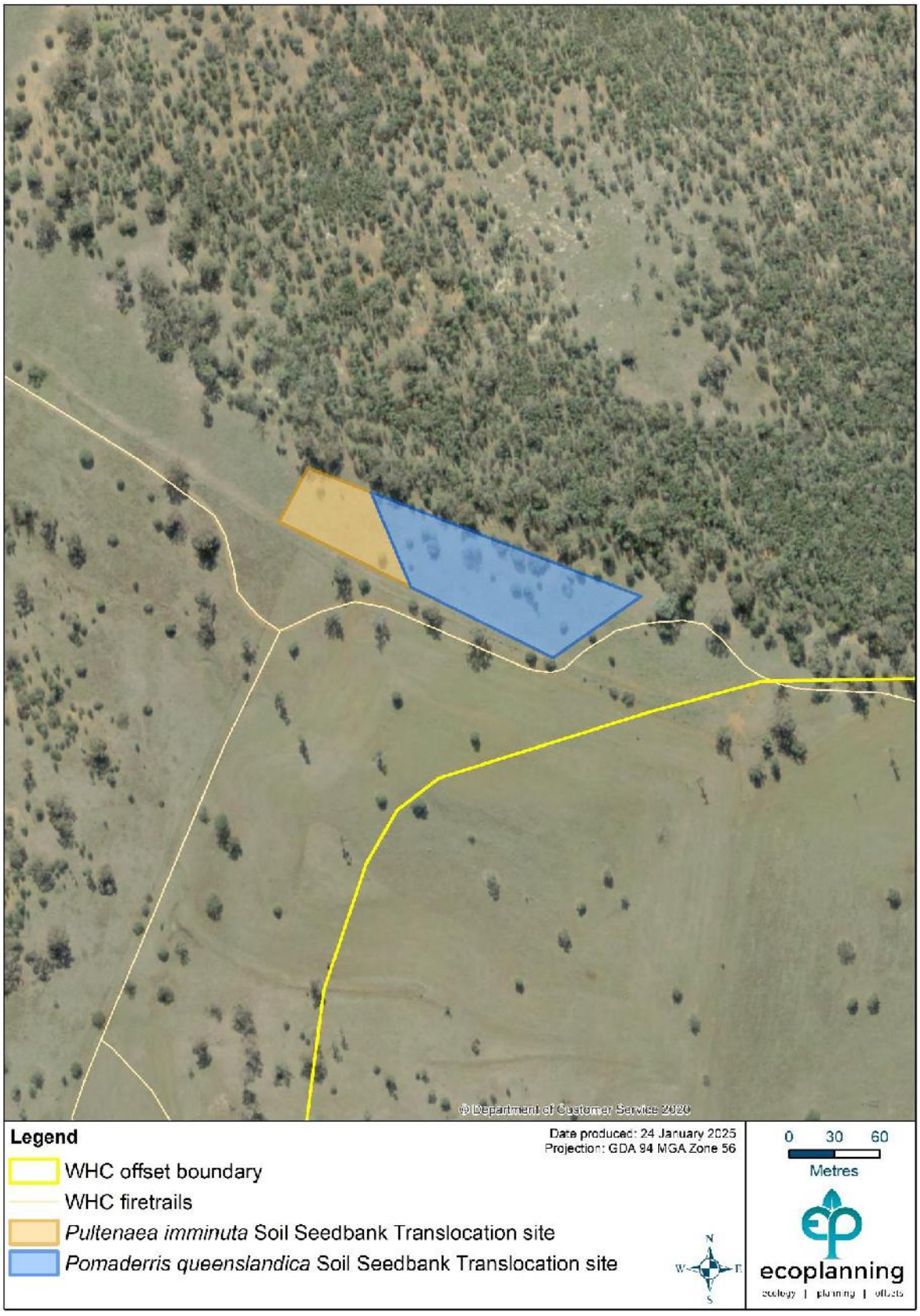

Figure 4.7: Location of the *P. imminuta* Soil Seedbank Translocation site

5 Monitoring and Maintenance

The existing monitoring of known populations of threatened flora recorded within WHC managed areas will also be applied to *P. imminuta* such as the monitoring of seed production, germination and to increase knowledge of each species' ecology and reproductive habits. In addition to these quarterly inspections, more detailed monitoring is to occur for any translocated *P. imminuta*. All translocated plants and areas of topsoil translocation must be permanently tagged, and data collected prior to planting to enable comparisons over time, between individuals and between recipient sites. All translocated plants should undergo monitoring, not only a subset. Monitoring of translocated plants is to take place monthly for the first year after a seedling is planted, quarterly for the two proceeding years and biannually after that. Monitoring should continue for a minimum of 5 years after planting, dependent on the success of the translocation program and availability of seed for collection during the preceding five years.

Reference sites/plants must also be monitored to provide benchmark data and assist in determining attrition or impacts that may be attributed to a natural event that has impacted the general population and not just translocated individuals. Natural populations of *P. imminuta* within the shared biodiversity corridor will be used as reference sites and monitored quarterly to assess rates of attrition, flowering, fruiting and natural recruitment. To monitor the natural populations of *P. imminuta*, it is recommended that permanent monitoring plots (e.g. 10 x 10 m) be established to monitor the natural populations of *P. imminuta* as a reference for the translocated populations and to increase the knowledge on the ecology of the species.

Variables to be monitored for translocated individuals and within reference plots are detailed within **Table 5.1**. Collection of this data should provide quantitative data which will guide future management actions including:

- Time to maturity (e.g. first flowering)
- Flowering / fruiting (comparisons between sites and populations).
- What proportion of plants are producing viable seed?
- Evidence of second generation and abundance.
- Any experimental micro-siting and treatment variables implemented as part of the program (e.g. fenced / unfenced, shaded / unshaded).

All aspects such a watering frequency, unusual climatic conditions and rainfall should also be considered and documented to highlight ways in which future translocations may be more effective.

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Table 5.1: Biometric data to be monitored for translocated *Pultenaea imminuta* and reference plants

Variable	Data to be recorded
Survivorship / recruitment	Number of individuals (if monitoring within plots)
Vegetative growth	Height of individual plant
Plant health / vigour	Repeatable scale of measurement as per the following: 1 Plant dead 2 Widespread dieback/damage 3 Dieback/damage observed on multiple branches 4 Minor dieback/damage evident on isolated leaves or branches 5 Healthy plant with no signs of dieback/damage
Reproductive status	Repeatable scale of measurement as per the following: 1 No. flowers (incl. buds) or fruits observed 2 Isolated flowers or fruits 3 Flowering/fruiting on 5 - 25% of branches 4 Flowering/fruiting on 25 - 75% of branches 5 Flowering/fruiting on 75 - 100% of branches

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6 Review and reporting

The outcomes of implementation of this propagation and translocation program will be reported in the MCCM Annual Review summarising the results of quarterly inspections on the various stages of the propagation and translocation program as well as any recommendations.

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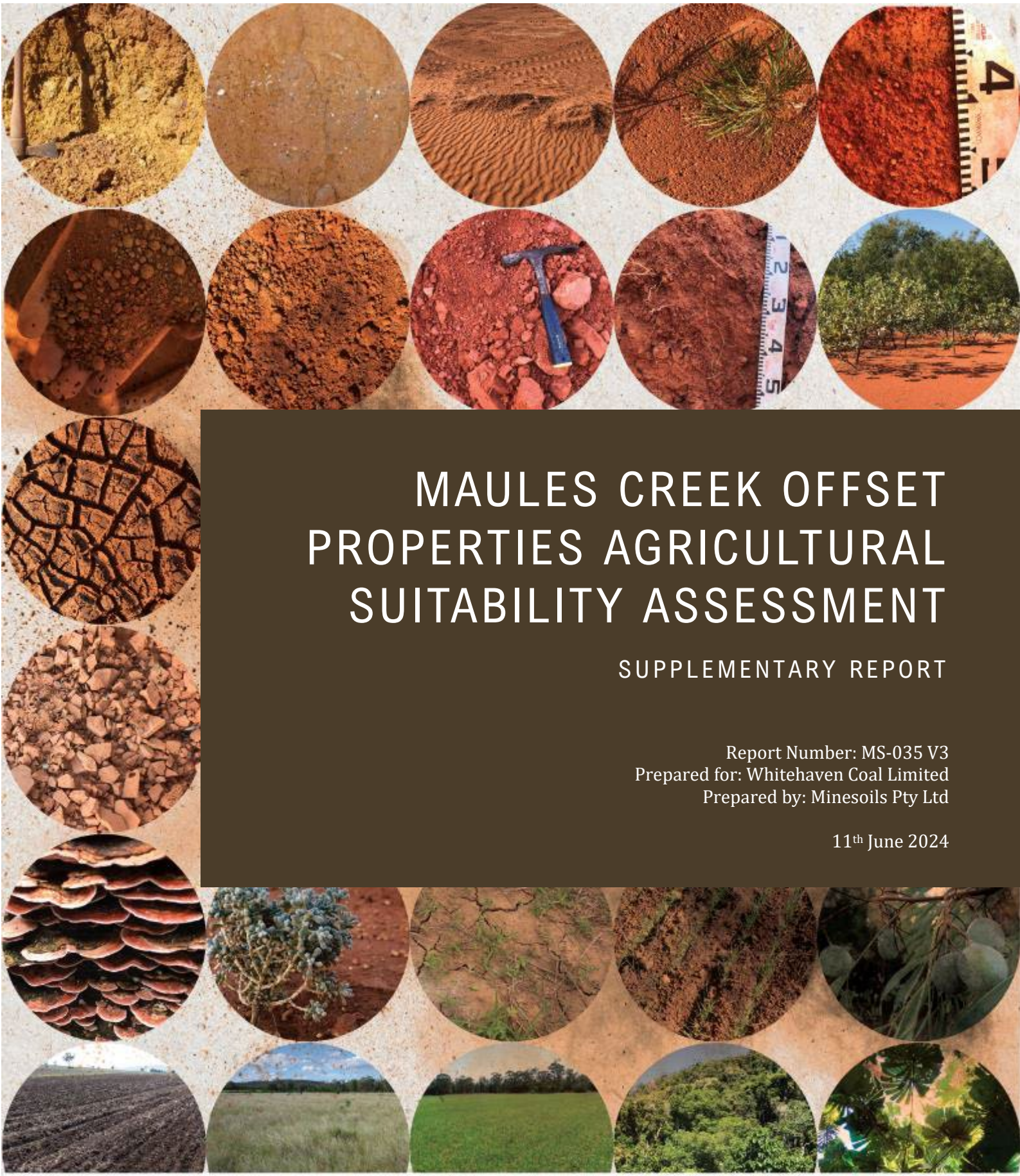
APPENDIX L

AGRICULTURAL SUITABILITY ASSESSMENT SUPPLEMENTARY REPORT



MAULES CREEK OFFSET PROPERTIES AGRICULTURAL SUITABILITY ASSESSMENT

SUPPLEMENTARY REPORT

Report Number: MS-035 V3
Prepared for: Whitehaven Coal Limited
Prepared by: Minesoils Pty Ltd

11th June 2024

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DOCUMENT CONTROL

Reference	Date	Prepared by	Reviewed by
MS-035 Draft V1	22/06/2020	Maddie Whitten	Clayton Richards
MS-035 Draft V2	26/06/2020	Maddie Whitten	Clayton Richards
MS-035 FINAL	30/06/2020	Maddie Whitten	Clayton Richards
MS-035 V3	11/06/2024	Maddie Whitten	Clayton Richards

EXECUTIVE SUMMARY

This Supplementary Report for the Maules Creek Offset Properties - Agricultural Suitability Assessment has been completed by Minesoils Pty Ltd.

Whitehaven Coal Limited (Whitehaven) is required to undertake an Agricultural Suitability Assessment in accordance with the Maules Creek Coal Mine (MCCM) New South Wales Project Approval (PA 10_0138). In 2015 an Agricultural Suitability Assessment was completed by McKenzie Soil Management Pty Ltd for properties associated with the MCCM biodiversity offsets. The assessment was based on observations at 32 representative sites on Whitehaven's offset properties near the MCCM in January 2015, as well as a review of relevant literature and pre-existing soil information. The purpose of this Supplementary Report is to firstly confirm compliance with PA 10_0138 Conditions 46 and 75, and secondly to review and update recommendations for land management and offset property areas that may be suitable for agricultural land use.

This Supplementary Report recognizes the changes in management of the MCCM offset/conservation areas (including both the 2024 approved offset areas registered as conservation areas and other registered conservation areas), including the cessation of agricultural production and subsequent transition to biodiversity management undertaken across the offset properties that has occurred since 2015.

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1. INTRODUCTION

1.1 PROJECT BACKGROUND

Minesoils Pty Ltd was commissioned by Whitehaven Coal Limited (Whitehaven) to undertake a review of the *Maules Creek Coal Mine: Agricultural Suitability Assessment of Land on the Offset Properties* (McKenzie 2015). The review relates to Project Approval conditions for the Agricultural Suitability Assessment including Conditions 46 and 75 of the MCCM New South Wales (NSW) Project Approval (PA 10_0138), as replicated below.

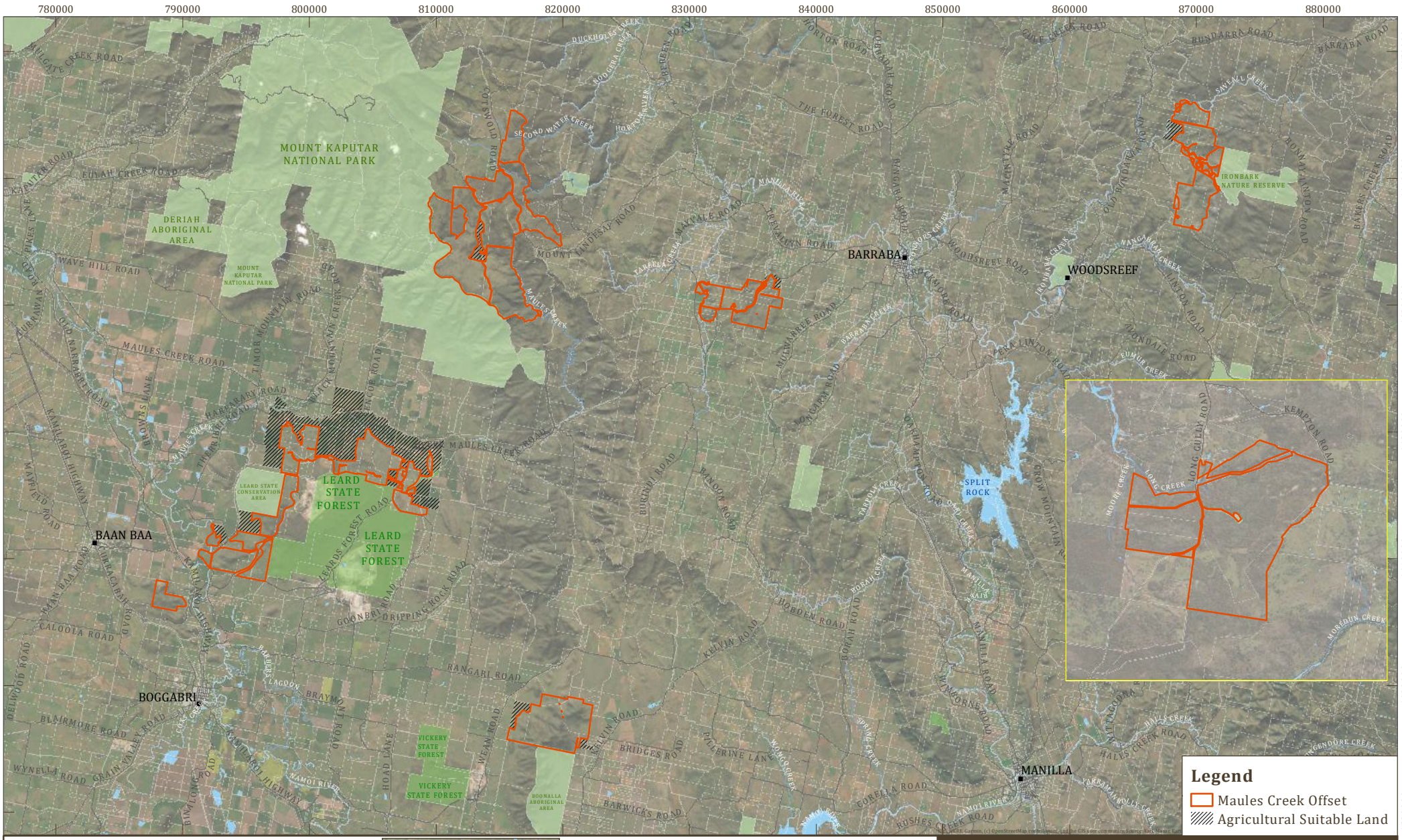
Condition 46:

> *Offset areas are to be managed primarily for the purposes of compensating for biodiversity impacts of the project, and improving regional biodiversity outcomes. However, to the extent that limited agricultural production on the lots purchased for offsets is compatible with these objectives, the Biodiversity Management Plan and other conditions of this approval, the Applicant must:*
>
> a) *include in the Biodiversity Management Plan (see condition 52 below) an agricultural suitability assessment of surplus land on the offset properties, in particular for proposed corridor enhancement zones.*
>
> b) *maintain the agricultural productivity of the surplus areas.*

Condition 75:

> *The Applicant must use its best endeavours to ensure that the agricultural productivity of the land that is project related and owned by the Applicant (including remaining agricultural land on properties forming the biodiversity offset strategy) is maintained or enhanced.*
>
> *Note: this does not include land where disturbance is permitted under the conditions of this approval, or land that is conserved under a conservation agreement, a biodiversity stewardship site, or land dedicated to other biodiversity conservation measures.*

This assessment applies to the biodiversity offset areas, and to the surplus land outside of the offset boundaries which is suitable for agriculture, on properties purchased by Maules Creek Coal (MCC) (Figure 1). In the succeeding nine years since the McKenzie (2015) report was completed, the MCC offset/conservation areas (includes both the 2024 approved offset areas registered as conservation areas and other registered conservation areas) have modified their boundaries/extent in preparation of the conservation agreements, as well as transitioning away from agricultural production to biodiversity management. Grazing has been excluded from offset/conservation areas (not Surplus areas) and on a reflection of these updated grazing exclusions, along with the advanced stages of restoration and revegetation on the offset properties, this report provides updated recommendations for management of the offset/conservation areas as well as the surplus land suitable for agriculture on these properties outside of the offset areas.



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2 COMPLIANCE WITH PROJECT APPROVAL CONDITIONS

To determine compliance with Condition 46(a) and 75 of the MCCM Project Approval, Whitehaven commissioned the agricultural suitability assessment of surplus land on the properties by McKenzie in 2015 that were originally approved as offset areas and included the findings of the assessment in the initial Biodiversity Management Plan for MCC. Subsequently the MCC offset/conservation areas were revised in 2024 with approved offset areas registered as conservation areas and other registered conservation areas. Further, to address the *'proposed corridor enhancement zones'* Whitehaven commissioned AMBS Ecology & Heritage to complete the Maules Creek Coal Mine East/West Corridor Desktop Assessment (2019). This assessment confirms that the East/West corridor, while previously used for agricultural practices, is now being actively regenerated, and managed to control weeds and feral animals. These enhancement actions are incompatible with agricultural productivity, and as such grazing has been excluded from the corridor.

To determine compliance with Condition 46(b) of the MCCM Project Approval, regarding *'maintaining of agricultural productivity of the surplus land'*; Minesoils conducted a series of phone interviews with land managers and licensees of the surplus offset land under agricultural land use management. The purpose of these interviews was to determine if the agricultural productivity of the surplus land has been maintained for the previous three years, in line with the recommendations provided in the McKenzie (2015) report.

The questions, which are included below, were developed in consideration of the prevailing drought conditions at the time across the region between 2017 and 2019 and focus on the six key areas of pasture and grazing management described in *Sustainable Land Management Practices for Graziers NSW DPI Fact Sheet* (Stein *et al.* 2009).

1. How do you manage grazing on the leased land? Do you implement rotational grazing or other techniques to target a specific ground cover percentage?
2. What pasture species are you targeting for both winter and summer production, and are any legumes included?
3. How do you determine overall pasture health? Has any topsoil or subsoil testing been completed to determine any soil constraints to pasture and crop production?
4. Are there any watercourses located on the leased land, and if so, how are they being managed? Similarly, how are stormwater drainage or run off areas managed?
5. During the drought conditions did you do any partial or full de-stocking?
6. Have you undertaken any feral species control measures?
7. Do you use any planning tools for your agribusiness like a Farm Management Plan (or similar)? If yes, how is the plan utilised in your operations on the leased land?
8. Are there any other initiatives or management practices you undertake/implement to maintain agricultural production that we haven't discussed?

These interviews determined that land management has been affected in varying degrees at each of the properties in question due to the drought conditions, but that agricultural productivity had been maintained to some extent, either through grazing or pasture management. A selection of landholder responses is included below in Table 1, and a full collation of all responses is included in Appendix 1.

Table 1 Landholder Responses on Agricultural Management

Interview Question	Selection of landholder responses
How do you manage grazing on the leased land? Do you implement rotational grazing or other techniques to target a specific ground cover percentage?	e.g. 1*: 'Yes that land is grazed. Different techniques were difficult during drought, but we aimed to keep it ground cover at around 35% for stock.'* e.g. 2 *'We rotate stock on that land, to target 100% groundcover.'*
What pasture species are you targeting for both winter and summer production, and are any legumes included?	e.g. 1: *'Nothing targeted during drought, has only been planted again since rain in early 2020.'* e.g. 2: '*Farming crops, rotating legumes and cereals.'*
How do you determine overall pasture health? Has any topsoil or sub soil testing been completed to determine any soil constraints to pasture and crop production?	e.g. 1: '*No soil testing, we just look at plant health.'* e.g. 2: *'Soil testing was done in the past, but now we just look at groundcover.'*
Are there any watercourses located on the leased land, and if so, how are they being managed? Similarly, how are stormwater drainage or run off areas managed?	e.g. 1: *'Two creeks through that area, but neither are fenced.'* e.g. 2: *'We try to exclude stock on watercourse where possible. Try to slow water flow on hilled areas, and de-silt dams etc.'*
During the drought conditions did you do any partial or full de-stocking?	e.g. 1: *'Yes, we fully destocked.'* e.g. 2: *'Yes in that we moved completely off the pasture, but we did keep some stock on the feed lot.'*
Have you undertaken any feral species control measures, for either weeds or animals?	e.g. 1: '*We do control of feral animals, in conjunction with Whitehaven Coal.'* e.g. 2: '*We do weed spraying, in particular green cestrum.'*
Do you use any planning tools for your agribusiness like a Farm Management Plan (or similar)? If yes, how is the plan utilised in your operations on the leased land?	e.g. 1: '*No we don't have a management plan'* e.g. 2: *'We have an operational-type plan, which I developed myself'.*
Are there any other initiatives or management practices you undertake/implement to maintain agricultural production (fertiliser application, irrigation practices, animal care, zero till etc) that we haven't discussed?	e.g. 1: *'Zero til, and other practices, depending on soil type and ground cover.* e.g. 2: *'Fair bit of earth works, repair works after heavy rain. Banks and water way repair.'*

3 UPDATED MANAGEMENT RECOMMENDATIONS

In accordance with the requirements of the MCCM Project Approval, Whitehaven are required to maintain the surplus land outside of the offset/conservation areas which is suitable for agriculture, to retain agricultural productivity. The section below provides an updated revision of *Section 4 Recommendations regarding soil, pasture, livestock and crop management (McKenzie 2015)*.

3.1 RECOMMENDED MANAGEMENT MEASURES FOR SURPLUS LAND OUTSIDE OF THE OFFSET AREAS

Given that much of this surplus land is currently leased for agricultural purposes it is recommended that the following management measures are included within future licence agreements:

- Avoid over-grazing. In drought conditions, partial or full de-stocking may be required to maintain a minimum of ground cover, although small sacrifice paddocks may be established where stock are supplementary fed.
- Aim to maintain a year-round ground cover (eg. establish perennial plants for both winter and summer production).
- Match paddock management and stocking rates to land use capabilities.
- Inspect for biological constraints such as insect infestation.
- Land adjacent to watercourses (rivers/creeks) should be managed to minimise erosion from concentrated flows by maintaining ground cover and by creating buffer zones between the watercourses and the designated pasture areas.
- Stormwater drainage areas in the paddock should be well grassed.
- Control of priority (formerly noxious) and General Biosecurity Duty (GBD) weeds through competition (eg. improved pasture) and herbicide treatments.

It is acknowledged that success of agricultural land management measures is impacted heavily by climate constraints.

3.2 RECOMMENDED MANAGEMENT MEASURES FOR LAND WITHIN THE OFFSET AREAS

Management of the land within the offset/conservation areas should be undertaken to meet the requirements of the approved MCCM Biodiversity Management Plan (Whitehaven, 2024), with the aim to compensate for biodiversity impacts of the project, and to improve regional biodiversity outcomes. Objectives and management actions are listed in the Management Plan for each ecosystem state occurring in the offset/conservation areas. For those areas which are cleared and/or previously cultivated the MCCM Biodiversity Management Plan (BMP) provides the following main management actions: active revegetation (planting or direct seeding); weed and feral animal control; access control; and bushfire management.

Minesoils understands that Whitehaven have undertaken a program of grazing exclusion across the offset/conservation areas over the previous 9 years, as detailed in Table 2. This program reflects a transition through the management phases listed in the BMP, from short term management, through medium term, and finally to long term management in which all agriculture/grazing is to be excluded from the offset/conservation areas

Table 2 Grazing Exclusion on Biodiversity Offset Properties

Offset Area /Property	Ceased Agriculture and Commenced Biodiversity Management	BMP Grazing Strategy Short/Medium/Long Term Management Phase
Bimbooria	October 2016	Long term
Roseglass	November 2017	Long term
Rocklea	Pre 2015	Not applicable
Kelso	Pre 2015	Long term
Velyama	June 2016	Long term
Louenville	June 2016	Long term
Olivedeen	December 2017	Long term
Teston South	Pre 2015	Long term
Blue Range	Ongoing	Not applicable
Teston North	Pre 2015	Long term
Tralee	Pre 2015	Long term
Ferndale	March 2019	Long term
Ellerslie	March 2019	Long term
Cattle Plain	December 2018	Long term
Warriahdool	Ongoing	Not applicable
Wollandilly	Pre 2015	Long term
Thornfield	October 2019	Long term
Onavale	August 2018	Long term
Wirradale	May 2016	Long term
Wongala South	March 2017	Long term
Mt Lindesay	May 2016	Long term
Thornfield	August 2019	Long term
Coonoor	August 2021	Long term
Triangle	December 2020	Long term
Neranghi North	January 2021	Long term
Long Gully	February 2021	Long term

In reflection of these improvements, and in keeping with the requirements of the MCCM Biodiversity Management Plan, the following management measures are recommended for land within the offset/conservation areas:

- Continued exclusion of grazing. Any proposed grazing for high threat weed infestations must have approval under the Biodiversity Conservation Trust Grazing Guideline.
- Continuation of restoration/revegetation efforts as described in the MCCM Biodiversity Management Plan.
- Feral animal monitoring and control, and management of weed infestations. Spot spraying of weeds may be necessary in some areas.
- Ongoing bushfire management.

4 REFERENCES

AMBS Ecology & Heritage 2019, *Maules Creek Coal Mine East/West Corridor Desktop Assessment.*

Biodiversity Conservation Trust (2018), *Livestock Grazing Guidelines for Private Land Conservation*

McKenzie DC (2015) *Maules Creek Coal Mine - Agricultural Suitability Assessment of Land on the Offset Properties*.

Stein B, Keys M, Landford C, Orgill S, Upjohn B (2009) *Sustainable Land Management Practices for Graziers. NSW DPI Fact Sheet*

Whitehaven Coal (2024) *Maules Creek Biodiversity Management Plan.*

APPENDIX 1 LANDHOLDER RESPONSES

Questions	Landholder Responses						
	Property 1	**Property 2**	**Property 3**	**Property 4**	**Property 5**	**Property 6**	**Property 7**
How do you manage grazing on the leased land? Do you implement rotational grazing or other techniques to target a specific ground cover percentage?	Yes that land is grazed. Different techniques were difficult during drought, but we aimed to keep it ground cover at around 35% for stock.	Not during drought	Following drought barely any cattle on the property, they've basically had free reign	Not during drought	Mostly farmed- were leasing more but stock sometime when conditions suitable	We rotate stock on that land, to target 100% groundcover.	Not during drought
What pasture species are you targeting for both winter and summer production, and are any legumes included?	Lucerne	Nothing planted during drought	Nothing targeted during drought, has only been planted again since rain in early 2020.	Nothing planted during drought	Farming crops, rotating legumes and cereals.	Not sowing during the drought	Nothing planted during drought
How do you determine overall pasture health? Has any topsoil or sub soil testing been completed to determine any soil constraints to pasture and crop production?	No soil testing, we just look at plant health. About one third of the leased area is cropped.	Soil testing over the years	No testing	Soil testing over the years	No testing	Soil testing was done in the past, but now we just look at groundcover.	Soil testing over the years
Are there any watercourses located on the leased land, and if so, how are they being managed? Similarly, how are stormwater drainage or run off areas managed?	We try to exclude stock on watercourse where possible. Try to slow water flow on hilled areas, and de-silt dams etc.	Most are fenced to exclude stock	One river, at the moment cattle excluded.	Most are fenced to exclude stock	No watercourses	Two creeks through that area, but neither are fenced.	Most are fenced to exclude stock
During the drought conditions did you do any partial or full de-stocking?	No, due to fact that understocked anyway.	Yes	De-stocked down to 35 head over 200 acres	Yes but we did keep some stock on the feed lot.	Yes	Yes, we fully destocked.	Yes, in that we moved completely off the pasture, but we did keep some stock on the feed lot.
Have you undertaken any feral species control measures, for either weeds or animals?	We do weed spraying, in particular green cestrum.	Weed spraying, and animal control	We do control of feral animals, in conjunction with Whitehaven Coal.	Weed spraying, and animal control	Only weed spraying	Weed spraying, Whitehaven does feral animals	Weed spraying, and animal control

Questions	Landholder Responses						
	Property 1	**Property 2**	**Property 3**	**Property 4**	**Property 5**	**Property 6**	**Property 7**
Do you use any planning tools for your agribusiness like a Farm Management Plan (or similar)? If yes, how is the plan utilised in your operations on the leased land?	No. We have long term goals, but they are dependent on weather.	We have an operational-type plan, which I developed myself.	No	Yes	No we don't have a management plan	No	Yes
Are there any other initiatives or management practices you undertake/implement to maintain agricultural production (fertiliser application, irrigation practices, animal care, zero till etc) that we haven't discussed?	Zero til, and other practices, depending on soil type and ground cover.	Fair bit of earth works; repair works after heavy rain. Banks and water way repair.	Mostly working owned land, but potentially yes with longer term lease.	Earth works	Zero till where possible.	Zero till and fertilizer but less so recently with the drought.	Earth repair works