Threatened Species Management

Monitoring of Threatened Flora

Pacific Highway Upgrade: Woolgoolga to Ballina

Sections 1 & 2 – July 2016

NSW GOVERNMENT

Threatened Species Management

Monitoring of Threatened Flora

during Construction in Sections 1 and 2

July 2016

Woolgoolga to Ballina Pacific Highway Upgrade

Landmark Ecological Services Pty Ltd
PO Box 100, Suffolk Park 2481
Phone 02 6685 4430
Email landmark@landmarkonline.com.au

For

NSW Roads and Maritime Services

July 2017

EXECUTIVE SUMMARY

New South Wales Roads and Maritime Services (Roads and Maritime) is required to monitor threatened flora species in the vicinity of the route of the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project, during and post-construction. A monitoring program has been designed, and baseline data collected in 20 x 20m quadrats (Jacobs 2014). For Sections 1 and 2 of the project, the first monitoring survey and assessment was undertaken in June to July 2016.

Six threatened flora species had been identified for monitoring during and post construction. These are:

Maundia	*Maundia triglochinoides*
Moonee Creek Quassia	*Quassia* sp Moonee Creek
Noah's false chickweed	*Lindernia alsinoides*
Slender screw-fern	*Lindsaea incisa*
Square-fruited ironbark	*Eucalyptus tetrapleura*
Square-stemmed spike-rush	*Eleocharis tetraquetra*

Baseline data were available for 28 quadrats, which included 37 monitoring sites since some quadrats contained more than one threatened species. Monitoring inspections were restricted in some locations by lack of access to private property and, in four instances, by partial / complete clearing of quadrats. Visual inspections made from within the project boundary occurred at a number of sites due to limited access to monitoring quadrats on adjoining private landholdings.

Of the 28 quadrats, 26 were available for direct quadrat-based data collection (depending upon access availability). Two, however, were not surveyed where plants had been recorded as dead at baseline and an additional quadrat had been newly erected during the current inspection. Where access was not possible, and in the case of one cleared and one partly cleared quadrat, boundary observations were undertaken to detect and document project impacts in the vicinity of the monitoring sites.

Overall, some loss of threatened flora species and habitat was identified, as a result of clearing associated with construction. The clearing arose when the project design was modified after the monitoring had been designed and quadrats established. The monitoring layout was not altered to accommodate the changes to the project footprint, so that two quadrats originally set up on lands adjacent to the corridor were impacted from clearing activities.

Where comparison of baseline and monitoring data was possible, it was difficult to quantify changes in abundance since different observers had undertaken surveys in 2014 and 2016, seasonal factors confounded comparisons (including high water levels in aquatic species habitat) and the boundaries of some quadrats could not confidently be re-located. Over the monitoring period, it was observed that some minor changes had occurred to localized hydrology and sediment mobilization.

Observations of threatened species and habitat on adjoining lands from within the project boundary are considered useful for the detection of impacts of construction, despite the lack of relevant control plots.

Contents

Tables

1. Introduction

1.1 Project background

New South Wales Roads and Maritime Services (Roads and Maritime) has approval for the Woolgoolga to Ballina (W2B) Pacific Highway upgrade project under Part 5.1 of the NSW Environmental Planning and Assessment Act 1979 (EP and A Act) and the Commonwealth Environment Protection and Biodiversity Act 1999 (EPBC Act). In accordance with the NSW Minister's Conditions of Approval (MCoA) D8, and Commonwealth EPBC Act Condition of Approval (CoA) 12, a Threatened Flora Management Plan (TFMP) has been developed and has been subject to periodic update.

In 2014, Jacobs undertook baseline monitoring to satisfy the preconstruction survey requirements for the threatened flora, as specified in the draft Threatened Flora Management Plan (TFMP) (Roads and Maritime *et al.* 2015). Jacobs (2014) and Roads and Maritime *et al.* (2015) refer to the whole project (11 sections), while Sections 1 and 2 are the subjects of the current monitoring inspection and evaluation.

Jacobs (2014) identified six threatened flora species for monitoring during and post-construction in the project area of Sections 1 and 2 (Table 1).

Table 1 Threatened flora species monitored in Sections 1 and 2

Common name	Scientific name	TSC Act	EPBC Act	Section 1	Section 2
Maundia	*Maundia triglochinoides*	V		x	x
Moonee Creek Quassia	*Quassia* sp Moonee Creek	E	E	x	
Noah's false chickweed	*Lindernia alsinoides*	E		x	
Slender screw-fern	*Lindsaea incisa*	E		x	x
Square-fruited ironbark	*Eucalyptus tetrapleura*	V	V	x*	x
Square-stemmed spike-rush	*Eleocharis tetraquetra*	E		x	

*identified during pre-clearing surveys

A new TFMP was prepared in 2015 (RMS *et al.* 2015). The Plan identifies management and monitoring objectives for threatened plant species which were considered to be directly impacted or at greatest risk from the project. The plan identifies the proposed mitigation measures to be implemented for threatened plants and a program for monitoring the effectiveness of these measures. The plan provides:

- A summary of the locations where threatened plants have been identified and would be impacted by the project and the extent of that impact.
- A description of the management and mitigation measures that would be implemented pre-construction, during construction and during operation, to ensure the protection of in-situ threatened flora.
- A description of corrective actions to be used, should mitigation measures not be implemented successfully.

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

- Review of weed control measures and potentially an increase in weed control or change in control measures to minimise competition
- Replacement of retained individuals that have not survived due to edge effects associated with the project; and
- Reporting losses and underlying reasons in the monitoring reports.

Performance targets and triggers for corrective actions are set out in Table 6.1 (for construction phase) and Table 7.1 (for operational phase) of the TFMP.

1.2 Baseline data collection

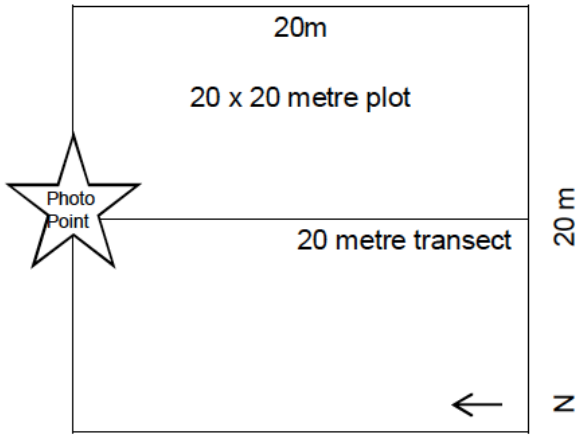
Jacobs (2014) designed a threatened flora monitoring program, and collected baseline data, in order to assess plant and habitat condition during construction and operation of the project. A particular focus was to identify any changes in condition which require management actions for remediation. Mitigation measures were to be proposed where impacts were detected and monitoring was to be continued during and post-construction until the mitigation measures were proven successful for three consecutive monitoring periods.

Monitoring locations for *in situ* threatened flora populations were established directly adjacent to the clearing boundary. Control sites were located at occurrences of threatened flora species and their habitat that were remote from the impacts associated with the project. Control sites were located in relatively natural habitats with limited disturbance and threatening processes. Where practical, the controls were located greater than 50 metres from the project boundary. The purpose of the control site was to monitor natural variation within populations and habitats which are not attributable to the impacts associated with the project (e.g. prevailing climatic conditions, bushfires, widespread insect attack and other natural phenomena). Control sites provide a basis for determining if the source of potential impacts to a threatened species and their habitat are from the project or due to natural events unrelated to the project (Jacobs 2014).

The total 37 monitoring sites were contained within 28 quadrats, since a number of the quadrats included more than one threatened flora species (refer Table2).

The site numbering system incorporates a (usually) two-lettered species code, a C prefix for control sites, number 1 or 2 to designate sections and decimal divisions for multiple sites.

A 20 x 20m quadrat was established at each site with layout as follows:



Layout of quadrat for each monitoring site (Jacobs 2014)

Sections 1 and 2 included 36 monitoring sites of which 23 were *in situ* sites and 13 were control sites (Table 2, maps Appendix 1). One site, Elt-1.5 was not re-surveyed as it had been discarded by Jacobs, as the plant Square-stemmed spike-rush *Eleocharis tetraquetra* was recorded as dead.

Importantly, an additional site, Et-1.1, was added during the current monitoring inspection, following the detection of a specimen of Square-fruited ironbark *Eucalyptus tetrapleura* in Section 1 during pre-clearing surveys, for a total of 37 monitoring sites.

2 Methods

2.1 Methods - general

Monitoring was undertaken in June-July 2016.

Desktop review and preliminary field inspection following construction identified a number of monitoring quadrats for which monitoring inspections would not be possible, or for which inspections would be limited to observations from the project boundary. The limitations were due to lack of access to private property and clearing of two quadrats (as a result of changes to the project design since baseline data had been collected).

Complete (quadrat-based) data collection

Quadrat-based data collection occurred at 20 monitoring sites, repeating the baseline surveys conducted by Jacobs (2014). The 20 sites included 2 quadrats with minor clearing impacts and one which could could be viewed across a project boundary.

Data collected, where relevant to site and species, included:

- Genus, species and subspecies.
- Identifier – unique plant number.
- Location – location; easting, northing & description.
- General condition – score on a scale of 0 to 5, where 0 is dead and 5 is excellent.
- Leaf condition – healthy/unhealthy, colour, vigour.
- Flower/fruit – flower/fruit presence.
- Length of new shoots – average length of new shoots (estimate) and abundance of new shoots (counts or basic scale).
- Disease symptoms – evidence of disease (including presence / absence of Myrtle Rust or Cinnamon Fungus)
- Recruitment.
- Evidence of any other damage or disturbance.
- Plant community type.
- Canopy cover.
- Mid-storey cover.
- Ground-layer cover and composition.
- Weed abundance and composition.
- Recruitment of canopy and mid-storey species.
- Climatic events (e.g. drought, flood, unusually cold winter temperatures etc.).
- Maintenance carried out – when and what kind of maintenance carried out at the site since the last monitoring
- Any other ecological impacts.

Habitat monitoring transect lines had been set up by Jacobs (2014). Transects were 20m long, usually oriented N-S, marked with double pink flags on tree trunks and labeled “Landmark 2016”.

Habitat data collected included:

- Dominant flora species in each structural layer,
- Prevailing site conditions and (ie soil moisture, climate, and water levels and flow), and
- Landscape parameters (ie landform, drainage, slope and aspect)

Cover of vegetation layers was recorded using the 20 metre transect with the canopy and midstorey (greater than one metre high) cover recorded as percentage foliage cover every five metres (four points) along the transect.

Groundcover attributes were recorded at every metre (20 points) as either forb, grass, shrub (less than one metre high), bare/water, litter or exotic.

The targeted threatened species were counted where practical. For species with growth forms not suited to counts and measurements of individual stems, eg Noah's false chickweed and Slender screw fern, area- and density-based measurements were deemed to be more suitable.

Photographs were taken at each location including:

- Habitat view from north point of transect
- Individual plants and/or clusters of plants, insect attack, dieback and habitat conditions.

Boundary data collection

Where access was not possible (12 sites), a limited set of observations was conducted from the project boundary, as follows:

- photo with way point and direction recorded
- erosion
- sedimentation
- change to hydrology
- dieback, physical damage to vegetation
- any observations of threatened flora where visible, including binocular scan
- other notes (site specific threats or damage, with reference to Jacobs (2014) data for the locations where observation is possible)
- recommendations

Boundary observations were also documented where a quadrat had been cleared but threatened flora populations and habitat were continuous across the project boundary and into adjacent lands (2 sites).

No data was collected on 2 sites within one cleared quadrat.

2.2 Methods – species specific

Moonee Creek Quassia

Abundance, measurement and condition data for Moonee Creek Quassia *Quassia* sp. Moonee Creek had previously been collected for individual stems, each of which appeared to have been identified by numbering flags tied around each stem. After two years, many flags had deteriorated and numbers were rarely discernible. The remaining flags were removed, as they may affect the stems to which they are attached.

A simplified method for data collection was employed, grouping stems into clumps, each of which was assigned a number displayed on a spike label.

For each clump, data collection comprised:

easting
northing
number of stems
clump diameter (cm)
height range (cm)
general condition (0-5)
leaf condition (0-5)
notes (flowering/fruiting, recruitment, disease/insect attack, dieback, threats)

Stem height was measured without straightening the stems, many of which were leaning and often tangled in leaf litter.

Each clump was photographed.

Note that the clumps may represent clones, but stem connections below ground cannot be established without extensive excavation.

The approach used to count stems is consistent with the TFMP response to comment DoE10 as follows:

> "If multiple stems could been seen as arising from one base then they were counted as being one individual. If there was not an obvious surface or shallow sub-surface connection between one stem and another, then the separate stems were counted as individuals."

The use of this method is still subject to observer differences, depending on resources expended searching for ground level connections.

Maundia, Noah's false chickweed, Slender screw-fern and Square-stemmed spike-rush

Species with the capacity for lateral spread from layered stems or sprouting from rhizomes are difficult to count as individuals. This group of low-growing species share a capacity for lateral vegetative spread, as follows:

- Maundia *Maundia triglochinoides* is a perennial with rhizomes c. 5 mm thick and emergent tufts of leaves arising along their length.
- Noah's false chickweed *Lindernia alsinoides* has erect or creeping stems which layer to expand vegetatively.
- Slender screw-fern *Lindsaea incisa* has a creeping rhizome along which fronds arise
- Square-stemmed spike-rush *Eleocharis tetraquetra* has a rhizome with tufts of culms arising, together with a new rhizome, at intervals of up to 1m

Counts of stems, leaves, culms or fern fronds are not indicative of individual plants, and excavation, often underwater, to detect the extent of connection between above-ground/water parts would be required to estimate the number of individual plants. Number of individuals is of limited usefulness as a measure of quantitative change for monitoring species in this group.

Plants of these species were mapped, or locations described. Areas and cover estimates were employed as measures of abundance. Percentage foliage cover was estimated visually. Although between-observer differences are likely, samples which use precise methods such as foliar line intercepts are unlikely to span the range of variation in percentage cover within a patch of the target species (Hnatiuk, R.J., Thackway, R. and Walker, J. 2009).

Square-fruited ironbark

All but one specimen were mature trees. Data collected for each tree were:

Grid reference
Height
Crown diameter (width)
Dbh
Condition (1-5)
Capsules present

3 Results

Full baseline data sets (2014) were available for 36 monitoring sites. Baseline data had been collected by Jacobs (2014) for all 36 sites, including one in which the plants were recorded as dead and not surveyed in the current monitoring event. Landmark (this survey) collected baseline data for one new site Et-1.1 (Table 2, Appendix 2).

Details of monitoring data collection type are set out in Table 2.

In this monitoring event, full quadrat-based data sets were collected for 18 monitoring sites. This included one sites on a partly cleared quadrat. Boundary observations were conducted for 15 sites

(viewed from the closest point on the project boundary, or adjacent to a cleared quadrat and a partly cleared quadrat). No data were collected for 2 sites (within one of the cleared quadrats) and a further site at which plants had been scored as dead at baseline.

The full results including site attributes, location, habitat conditions and a selection of photographs are provided for each location in Appendix 2.

Two of the monitored species, *Lindsaea incisa* Slender screw-fern and *Quassia* sp. Moonee Creek were apparently unaffected by construction, although a project boundary fence traversed the edge of one Quassia quadrat (fence installed prior to construction of project). The minor disturbance to the habitat may have stimulated root suckering. Quassia populations are likely to be further favoured by appropriate fire management (unrelated to the project).

Two Slender screw-fern sites are recovering well from a fire which preceded construction. A control site at Halfway Creek is in very good condition.

Square-fruited ironbarks have suffered bushfire damage during the construction period (both *in situ* and controls affected) but are generally recovering. Some indirect impacts on this species were observed as a result of edge effects along cleared edges of the forests.

As is to be expected for a species which depends on local hydrological conditions and rainfall, Maundia has expanded in some quadrats and contracted in others. A site in an “island” between highway lanes is doing well at Halfway Creek.

Limited information is available for Square-stemmed Spike-rush and Noah’s false chickweed. Both species have incurred clearing damage to *in situ* sites and access restrictions for controls.

As the observations were made after a rain event during the early stages of construction, some runoff from the construction sites was noted.

An evaluation of the impacts of construction on threatened flora is provided, species by species, in Table 3, together with recommended management actions.

Table 2 Details of monitoring

Stage: B = Baseline (Jacobs 2014 plus Landmark 2016 data for Et-1.1); M_1= Monitoring 1 (Landmark data, this study)

Data collection type:

Complete = quadrat based data set following Jacobs 2014,

Boundary = general observations undertaken from or adjacent to project boundary for sites for which access is not possible or where quadrat is cleared

Species codes:

Elt	*Eleocharis tetraquetra*	Square-stemmed spike-rush
Et	*Eucalyptus tetrapleura*	Square-fruited ironbark
La	*Lindernia alsinoides*	Noah's false chickweed
Li	*Lindsaea incisa*	Slender screw-fern
QM	*Quassia* sp Moonee Creek	Moonee Creek Quassia
Mt	*Maundia triglochinoides*	Maundia

Site code	Stage	Date	Quadrat status	Access status	Data collection type	Easting	Northing	Quadrat no	Location
Mt-1.1	B	28-Apr-14	Intact	y	Complete	516806	6679580	1	Cassons Creek, west of Post Office Lane
Mt-1.1	M-1	3-Jul-16	Intact	n	Boundary	516806	6679580	1	Cassons Creek, west of Post Office Lane
Li-1.1	B	28-Apr-14	Intact	y	Complete	516799	6679670	2	Cassons Creek, west of Post Office Lane
Li-1.1	M-1	3-Jul-16	Intact	n	Boundary	516799	6679670	2	Cassons Creek, west of Post Office Lane
Mt-C1.1	B	6-May-14	Intact	y	Complete	517126	6679730	3	Cassons Creek, west of Post Office Lane
Mt-C1.1	M-1	3-Jul-16	Intact	n	Boundary	517126	6679730	3	Cassons Creek, west of Post Office Lane
Elt-1.1	B	29-Apr-14	Intact	y	Complete	516531	6680300	4	Redbank Creek downstream of project
Elt-1.1	M-1	3-Jul-16	Cleared	y	Boundary	516531	6680300	4	Redbank Creek downstream of project
Mt-1.2	B	29-Apr-14	Intact	y	Complete	516531	6680300	4	Redbank Creek downstream of project
Mt-1.2	M-1	3-Jul-16	Cleared	y	Boundary	516531	6680300	4	Redbank Creek downstream of project
La-C1.1	B	29-Apr-14	Intact	y	Complete	516605	6680330	5	Redbank Creek downstream of project
La-C1.1	M-1	3-Jul-16	Intact	n	Boundary	516605	6680330	5	Redbank Creek

Site code	Stage	Date	Quadrat status	Access status	Data collection type	Easting	Northing	Quadrat no	Location
									downstream of project
Mt-C1.2	B	29-Apr-14	Intact	y	Complete	516605	6680330	5	Redbank Creek downstream of project
Mt-C1.2	M-1	14-Jul-16	Intact	n	Boundary	516605	6680330	5	Redbank Creek downstream of project
Elt-1.2	B	6-May-14	Intact	y	Complete	516256	6680690	6	Tributary of Redbank Creek
Elt-1.2	M-1	n/a	Cleared	n/a	None	516256	6680690	6	Tributary of Redbank Creek
La-1.1	B	6-May-14	Intact	y	Complete	516256	6680690	6	Tributary of Redbank Creek
La-1.1	M-1	n/a	Cleared	n/a	None	516256	6680690	6	Tributary of Redbank Creek
Elt-C1.1	B	29-Apr-14	Intact	y	Complete	516141	6680940	7	Northern tributary of Redbank Creek
Elt-C1.1	M-1	14-Jul-16	Intact	n	Boundary	516141	6680940	7	Northern tributary of Redbank Creek
La-C1.2	B	29-Apr-14	Intact	y	Complete	516141	6680940	7	Northern tributary of Redbank Creek
La-C1.2	M-1	14-Jul-16	Intact	n	Boundary	516141	6680940	7	Northern tributary of Redbank Creek
Elt-C1.2	B	1-May-14	Intact	y	Complete	515750	6680990	8	Northern tributary of Redbank Creek
Elt-C1.2	M-1	14-Jul-16	Intact	y	Boundary	515750	6680990	8	Northern tributary of Redbank Creek
La-C1.3	B	1-May-14	Intact	y	Complete	515750	6680990	8	Northern tributary of Redbank Creek
La-C1.3	M-1	14-Jul-16	Intact	n	Boundary	515750	6680990	8	Northern tributary of Redbank Creek
Elt-1.3	B	29-Apr-14	Intact	y	Complete	515998	6681010	9	Northern tributary of Redbank Creek
Elt-1.3	M-1	14-Jul-16	Partly cleared	y	Boundary	515998	6681010	9	Northern tributary of Redbank Creek
La-1.2	B	29-Apr-14	Intact	y	Complete	515998	6681010	9	Northern tributary of Redbank Creek
La-1.2	M-1	14-Jul-16	Partly cleared	y	Boundary	515998	6681010	9	Northern tributary of Redbank Creek
Elt-1.4	B	1-May-14	Intact	y	Complete	515801	6681020	10	Northern tributary of Redbank Creek
Elt-1.4	M-1	14-Jul-16	Intact	n	Boundary	515801	6681020	10	Northern tributary of Redbank Creek
La-1.3	B	1-May-14	Intact	y	Complete	515801	6681020	10	Northern tributary of

Site code	Stage	Date	Quadrat status	Access status	Data collection type	Easting	Northing	Quadrat no	Location
									Redbank Creek
La-1.3	M-1	14-Jul-16	Intact	n	Boundary	515801	6681020	10	Northern tributary of Redbank Creek
QM-C1.1	B	30-Apr-14	Intact	y	Complete	514990	6681980	11	Dirty Creek Range, southern population
QM-C1.1	M-1	21-Jun-16	Intact	y	Complete	514990	6681980	11	Dirty Creek Range, southern population
QM-1.1	B	30-Apr-14	Intact	y	Complete	515007	6681990	12	Dirty Creek Range, southern population
QM-1.1	M-1	14-Jun-16	Intact	y	Complete	515007	6681990	12	Dirty Creek Range, southern population
QM-C1.2	B	30-Apr-14	Intact	y	Complete	514698	6682120	13	Dirty Creek Range, northern population
QM-C1.2	M-1	21-Jun-16	Intact	y	Complete	514698	6682120	13	Dirty Creek Range, northern population
QM-1.2	B	30-Apr-14	Intact	y	Complete	514667	6682150	14	Dirty Creek Range, northern population
QM-1.2	M-1	21-Jun-16	Intact	y	Complete	514667	6682150	14	Dirty Creek Range, northern population
Et-1.1	B	29-Jun-16	New quadrat	y	Complete	513860	6682475	15	Range Road
Elt-1.5	B	5-Sep-14	Intact	y	Complete	511237	6686780	16	Halfway Creek
Li-C2.1	B	1-May-14	Intact	y	Complete	508904	6688360	17	Halfway Creek rest area
Li-C2.1	M-1	22-Jun-16	Intact	y	Complete	508904	6688360	17	Halfway Creek rest area
Li-2.1	B	1-May-14	Intact	y	Complete	508856	6688430	18	Halfway Creek rest area
Li-2.1	M-1	22-Jun-16	Intact	y	Complete	508856	6688430	18	Halfway Creek rest area
Mt-C2.1	B	2-May-14	Intact	y	Complete	506768	6690440	19	Halfway Creek, up stream of project, northern side of drainage line
Mt-C2.1	M-1	3-Jul-16	Intact	y	Complete	506768	6690440	19	Halfway Creek, up stream of project, northern side of drainage line
Mt-2.1	B	2-May-14	Intact	y	Complete	506677	6690450	20	Halfway Creek crossing
Mt-2.1	M-1	3-Jul-16	Intact	y	Complete	506677	6690450	20	Halfway Creek crossing
Mt-2.2	B	2-May-14	Intact	y	Complete	506288	6692080	21	Wells Crossing, downstream of the project,

Site code	Stage	Date	Quadrat status	Access status	Data collection type	Easting	Northing	Quadrat no	Location
									private property
Mt-2.2	M-1	3-Jul-16	Intact	n	Complete	506288	6692080	21	Wells Crossing, downstream of the project, private property
Mt-2.3	B	2-May-14	Intact	y	Complete	506320	6692140	22	Wells Crossing, in 'island' between bridges
Mt-2.3	M-1	27-Jun-16	Intact	y	Complete	506320	6692140	22	Wells Crossing, in 'island' between bridges
La-2.1	B	2-May-14	Intact	y	Complete	506418	6692190	23	Wells Crossing upstream of project
La-2.1	M-1	27-Jun-16	Intact	y	Complete	506418	6692190	23	Wells Crossing upstream of project
Li-2.2	B	2-May-14	Intact	y	Complete	506418	6692190	23	Wells Crossing upstream of project
Li-2.2	M-1	27-Jun-16	Intact	y	Complete	506418	6692190	23	Wells Crossing upstream of project
Mt-2.4	B	2-May-14	Intact	y	Complete	506418	6692190	23	Wells Crossing upstream of project
Mt-2.4	M-1	27-Jun-16	Intact	y	Complete	506418	6692190	23	Wells Crossing upstream of project
Mt-C2.2	B	2-May-14	Intact	y	Complete	506448	6692210	24	Wells Crossing upstream of project
Mt-C2.2	M-1	27-Jun-16	Intact	y	Complete	506448	6692210	24	Wells Crossing upstream of project
Et-2.1	B	3-May-14	Intact	y	Complete	506152	6692700	25	Wells Crossing Flora Reserve
Et-2.1	M-1	26-Jun-16	partly cleared	y	Complete	506152	6692700	25	Wells Crossing Flora Reserve
Et-2.2	B	3-May-14	Intact	y	Complete	505836	6693690	26	Sandy Hill, north of Wells Crossing
Et-2.2	M-1	26-Jun-16	Intact	y	Complete	505841	6693690	26	Sandy Hill, north of Wells Crossing
Et-C2.1	B	3-May-14	Intact	y	Complete	504886	6697790	27	Glenugie, north of Franklins Road
Et-C2.1	M-1	26-Jun-16	Intact	y	Complete	504886	6697790	27	Glenugie, north of Franklins Road
Et-2.3	B	3-May-14	Intact	y	Complete	504777	6697810	28	Glenugie, north of Franklins Road
Et-2.3	M-1	26-Jun-16	Intact	y	Complete	504777	6697810	28	Glenugie, north of Franklins Road

Table 3 Summary of impacts of construction and mitigation on threatened flora species

Species	Impacts	Recommended mitigation
Eleocharis tetraquetra Square-stemmed Spike-rush	Observations were from project boundary. Clearing had impacted a small amount of previously occupied habitat within the quadrat. Some remaining habitat was subject to runoff from construction.	Continue to review and maintain boundary protections and minimize runoff from construction in vicinity of habitat. Maintain erosion and sediment controls.
Eucalyptus tetrapleura Square-fruited ironbark	Six trees appear to have been lost through clearing. Trees in burnt areas (extensive bushfire in August 2014, not a project impact) are generally recovering well, with mortality restricted to trees separately approved to be cleared within the project boundary. There were some observations of sediment runoff from construction works and tree-felling on the cleared edge.	Continue to review and maintain clearing limit flagging and sediment controls, and maintain project boundary delineation.
Lindernia alsinoides Noah's false chickweed	Observations were from project boundaries. Clearing had impacted a small amount of previously occupied habitat within the quadrat.	Continue to review and maintain clearing limit flagging and sediment controls, and maintain project boundary delineation.
Lindsaea incisa Slender screw-fern	Plants at Halfway Creek rest area appear to be developing well following a fire (preceding baseline), no project impacts apparent.	No management actions observed to be required.
Maundia triglochinoides	Observations were difficult as plants were covered in deep water at some locations. Quantitative comparison of plant abundance difficult.	Maintaining suitable hydrological conditions will be critical to survival and development. Ensure maintenance of the localized hydrology and maintain sediment control.
Quassia Moonee Creek	Quantitative comparison of plant abundance is not meaningful due to differing count methods and observers. Some parts of the population are covered in leaf litter and debris. The control site includes a previously established fence line, otherwise no apparent construction impacts.	Fire management desirable to reduce leaf litter and stimulate flowering/fruiting. Fence maintenance activities to take place with care to avoid Quassia stems using low-impact methods (hand tools preferred to machinery and suitable protective barriers).

4 Discussion

Interpretation of differences between baseline and monitoring data was constrained by:

- the use of methods for which observer variability was likely to affect the results
- seasonal factors also confounded results (autumn observations in 2014, winter in 2016). Winter was not an ideal time to survey for species such as Square-stemmed spikerush *Eleocharis tetraquetra*.
- Difficulty in re-locating quadrats - there was one instance where field markers had been destroyed by fire.

The basis of the monitoring design is that construction impacts will be identified through a comparison of current and baseline data from control and *in situ* quadrats. Interpretation must be cautious since:

- Sample numbers are inevitably small
- Access to controls for monitoring has been limited.

Future monitoring will provide data sets for which comparisons between baseline and monitoring events can be more useful – matched for season of data collection (autumn and spring) and attention to reducing variation between observers.

As a result of changes to project design some impact to quadrats occurred. Available GIS point data reviewed as part of the project refinement approval process, suggests that 13 Noah's false chickweed *Lindernia alsinoides* & 7 Square-stemmed spikerush *Eleocharis tetraquetra* were removed. Where additional impacts have occurred, all impacted threatened flora will be offset in accordance with the Biodiversity offset strategy.

The remaining impacts will be best ameliorated with site specific actions including:

- maintaining localised hydrological regimes
- maintaining sedimentation mitigations such as sediment fence and mulch bunds etc; and
- Ensuring protective barriers maintained on edges and other vulnerable sites.

Weeds are generally not problematic to date.

It is considered that the observations from the project boundary were useful for identifying erosion, sedimentation and changes to hydrology and, where access continues to be restricted, it is recommended that this approach should continue throughout the monitoring program. While many control sites, being located at a distance from the project boundary, could not be observed directly, their theoretical value as a means of distinguishing project impacts from more general changes to threatened flora species is not always relevant. Sedimentation and changes to hydrology can usually be detected and attributed to an impact from the project without reference to a control.

Bushfires that have affected *in situ* but not control sites for Square-fruited ironbark *Eucalyptus tetrapleura* are an example of an impact that is unrelated to the project.

It is considered unlikely that any options to add more monitoring plots are available, given the sparse and localised distribution of most species and limitations to access. Square-fruited ironbark *Eucalyptus tetrapleura* may be an exception as fairly extensive forests on accessible public land are present in the vicinity of the project. The original *in situ* versus control design is useful in some instances but is limited by the inevitably small sample numbers. Sample numbers are now reduced further. With or without controls, site- and species-specific ecological

interpretation can, however, be expected to usefully evaluate impacts of the project, provide a basis for recommendations and an evaluation of mitigation measures.

The data collection and evaluation, through baseline and monitoring comparisons, has demonstrated that most of the threatened species populations and habitat immediately adjacent to the clearing boundary have suffered minimal or no direct impact from construction (with some clearing recognised as a consequence of changes to project design). Some indirect impacts have been identified – runoff and sedimentation in waterways observed following a rain event. These impacts are short term and the normal mitigation measures are expected to be effective in protecting vegetation adjacent to construction.

The boundary observations are also considered to have been valuable for documenting construction impacts where access to formal monitoring sites has been restricted.

Changes to local hydrology are apparent and may have short and longterm consequences for species such as Maundia. However, changes observed to date may be the result of normal variability.

5 Recommendations

Implement species-specific recommendations as set out in Table 3.

Investigate options for access to control and *in situ* sites that occur on adjoining private property where access during this monitoring period was denied by the landholder. If agreement cannot be reached, it is recommended that the method of observation from Project Boundary be continued in future monitoring events.

Continue data collection as set out in the TFMP, with some species-specific modifications as set out in Section 2.2.

Frequency should comply with the requirements of the TFMP noting inspections during the growing season are likely to be more favourable for detection of some species.

References

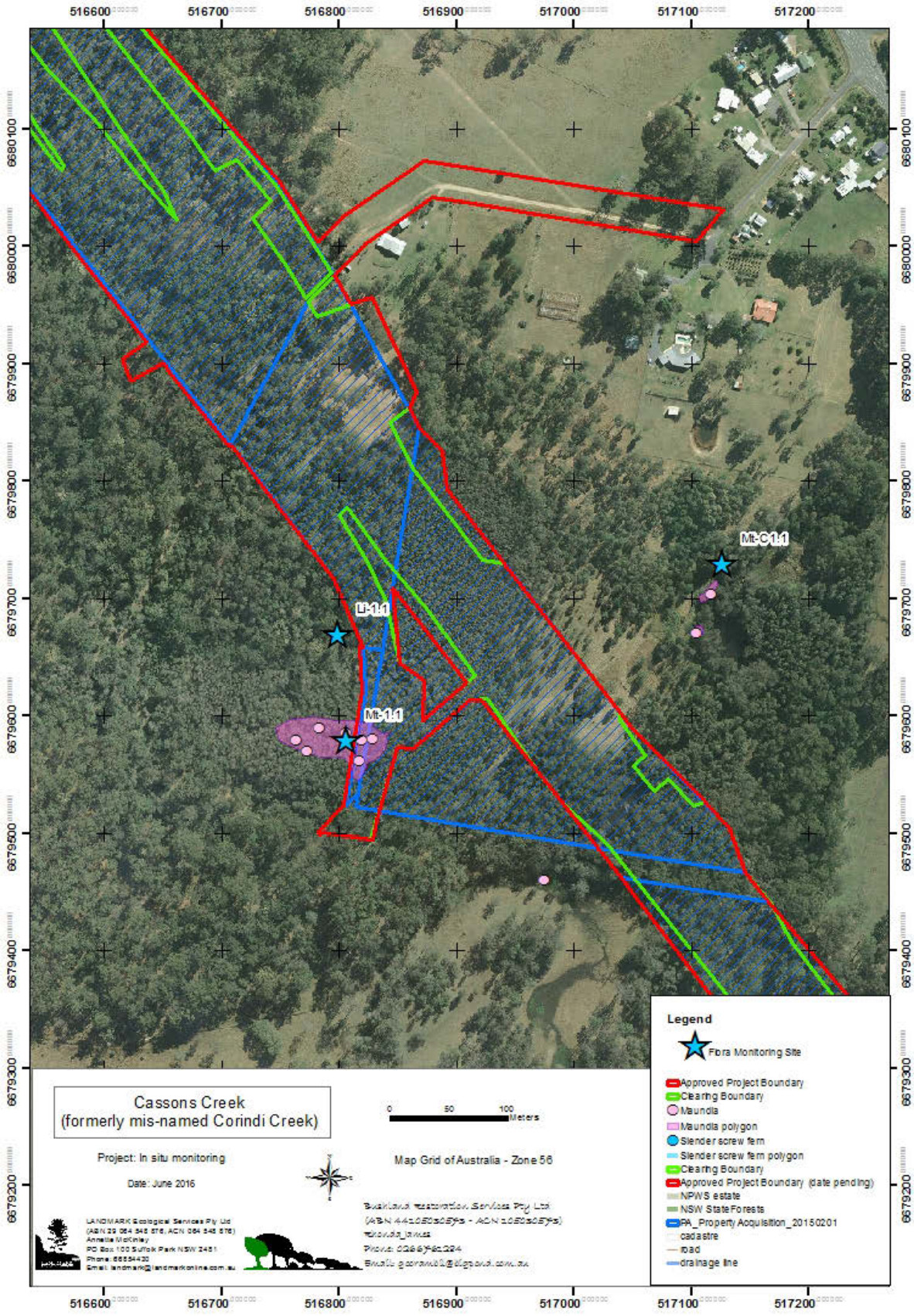
Hnatiuk, R.J., Thackway, R. and Walker, J., 2009. Vegetation. In *Australian soil and land survey field handbook* (3rd edition). CSIRO Publishing, Melbourne.

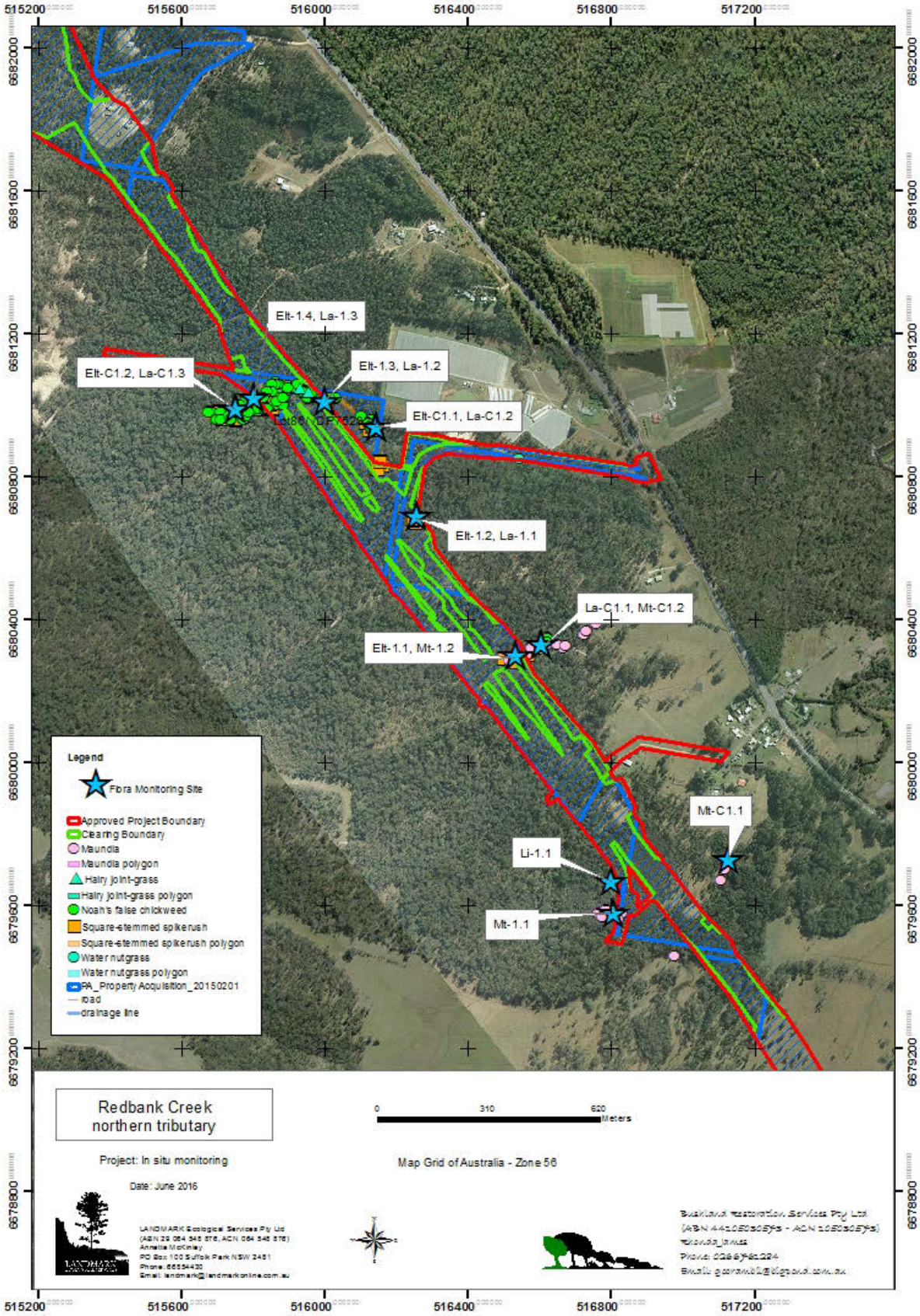
Jacobs, 2014. Woolgoolga to Ballina Pacific Highway Upgrades, NSW Roads and Maritime Services, Threatened Flora Pre-construction Surveys, Rev02

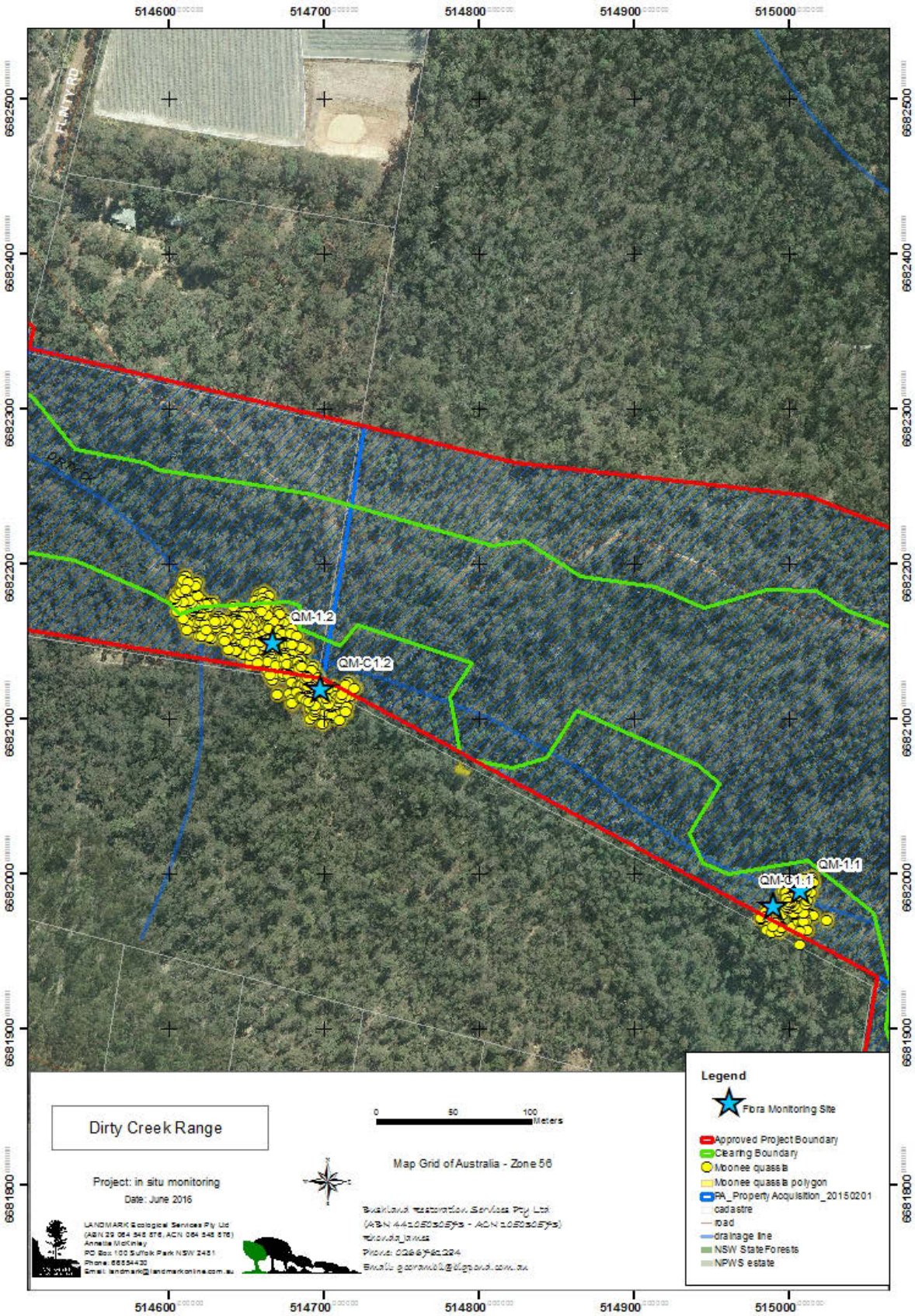
NSW Roads and Maritime Services, Aurecon, Sinclair Knight Merz and Amec Foster Wheeler, 2015. Woolgoolga to Ballina Pacific Highway Upgrade: Threatened Flora Management Plan. Sections 1 to 11 (including Soft Soil Work Areas) Version 3 August 2015 Roads and Maritime Services, NSW.

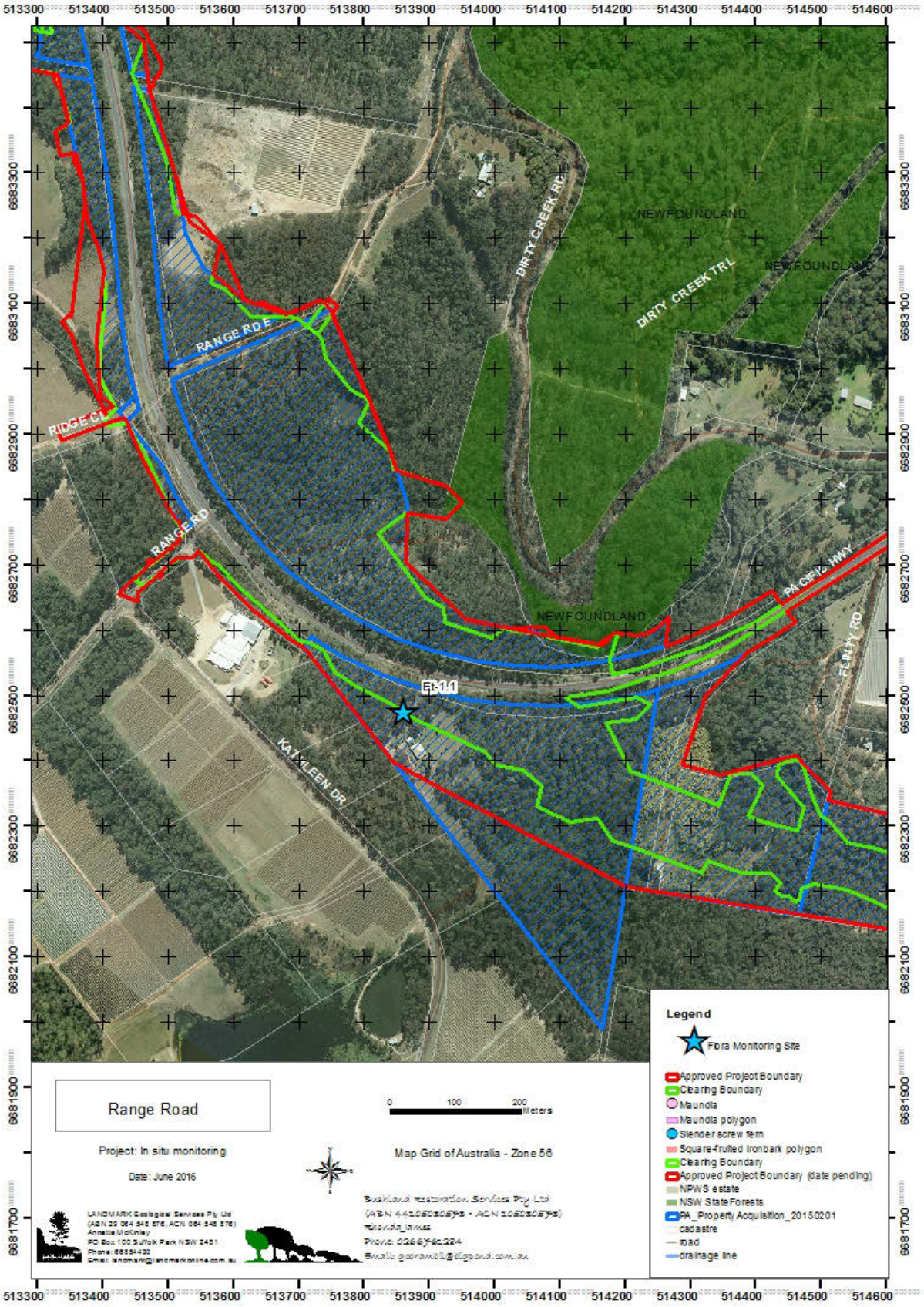
Appendix 1 Maps

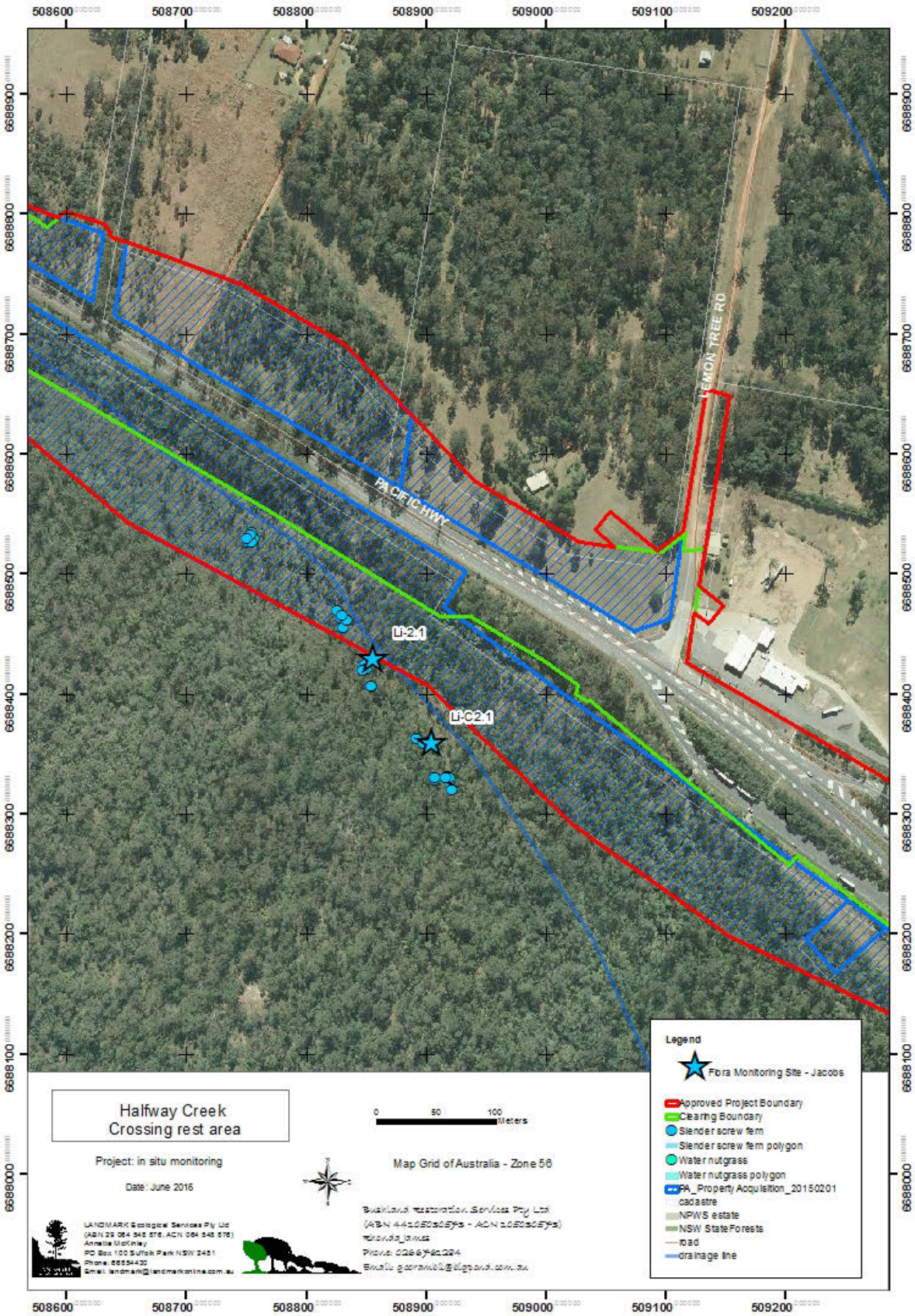
Cassons Creek
Redbank Creek Area
Dirty Creek
Range Road
Halfway Creek rest area
Halfway Creek crossing north
Wells Crossing
Bald Knob Tickgate Road
Franklins Road

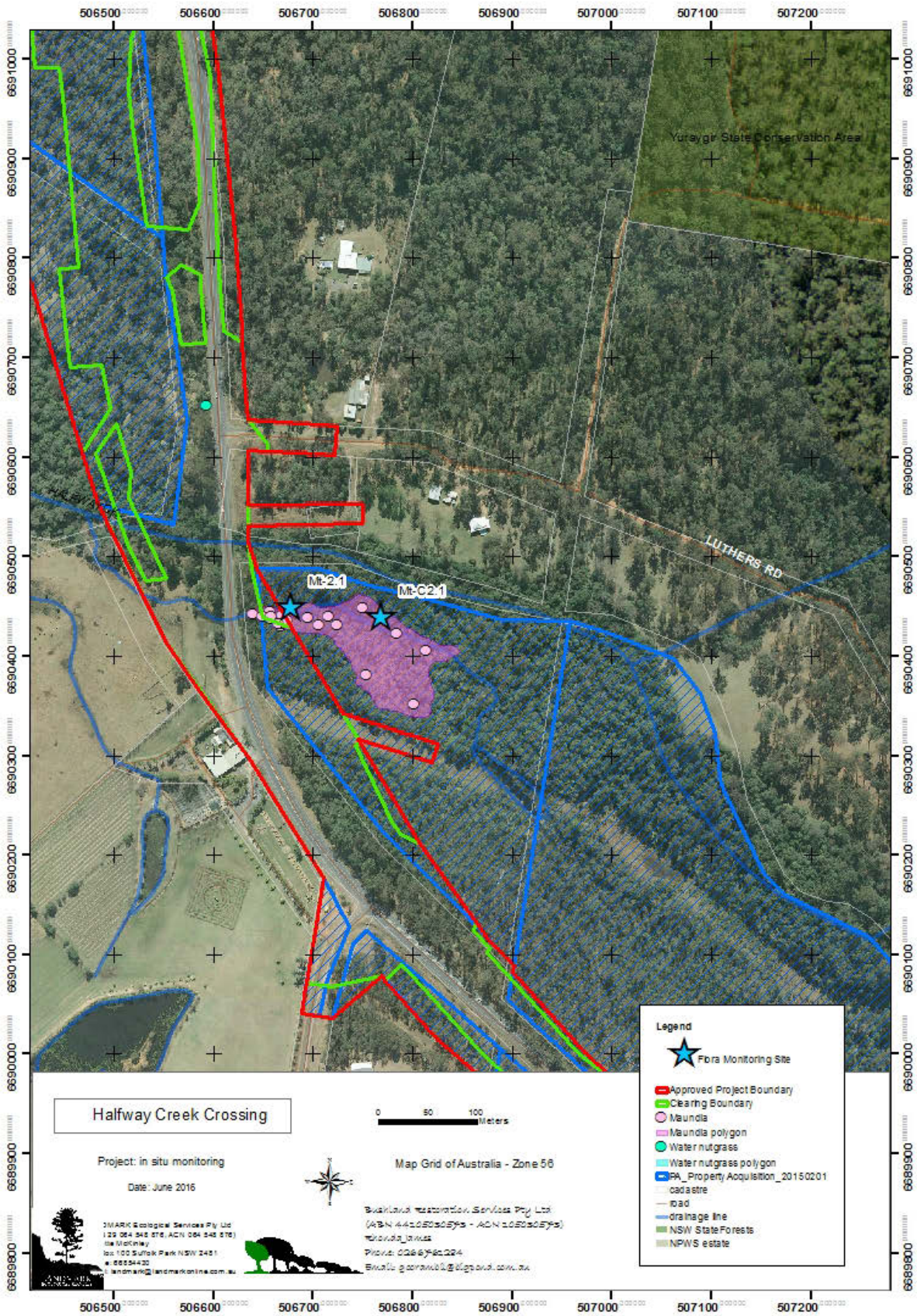

516600
516700
516800
516900
517000
517100
517200
6680100
6680000
6679900
6679800
6679700
6679600
6679500
6679400
6679300
6679200
Mt-C1.1
Li-1.1
Mt-1.1
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Maundia
Maundia polygon
Slender screw fern
Slender screw fern polygon
Clearing Boundary
Approved Project Boundary (date pending)
NPWS estate
NSW State Forests
PA_Property Acquisition_20150201
cadastre
road
drainage line
Cassons Creek
(formerly mis-named Corindi Creek)
Project: In situ monitoring
Date: June 2016
0
50
100
Meters
Map Grid of Australia - Zone 56
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 345 876, ACN 064 345 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66554430
Email: landmark@landmarkonline.com.au

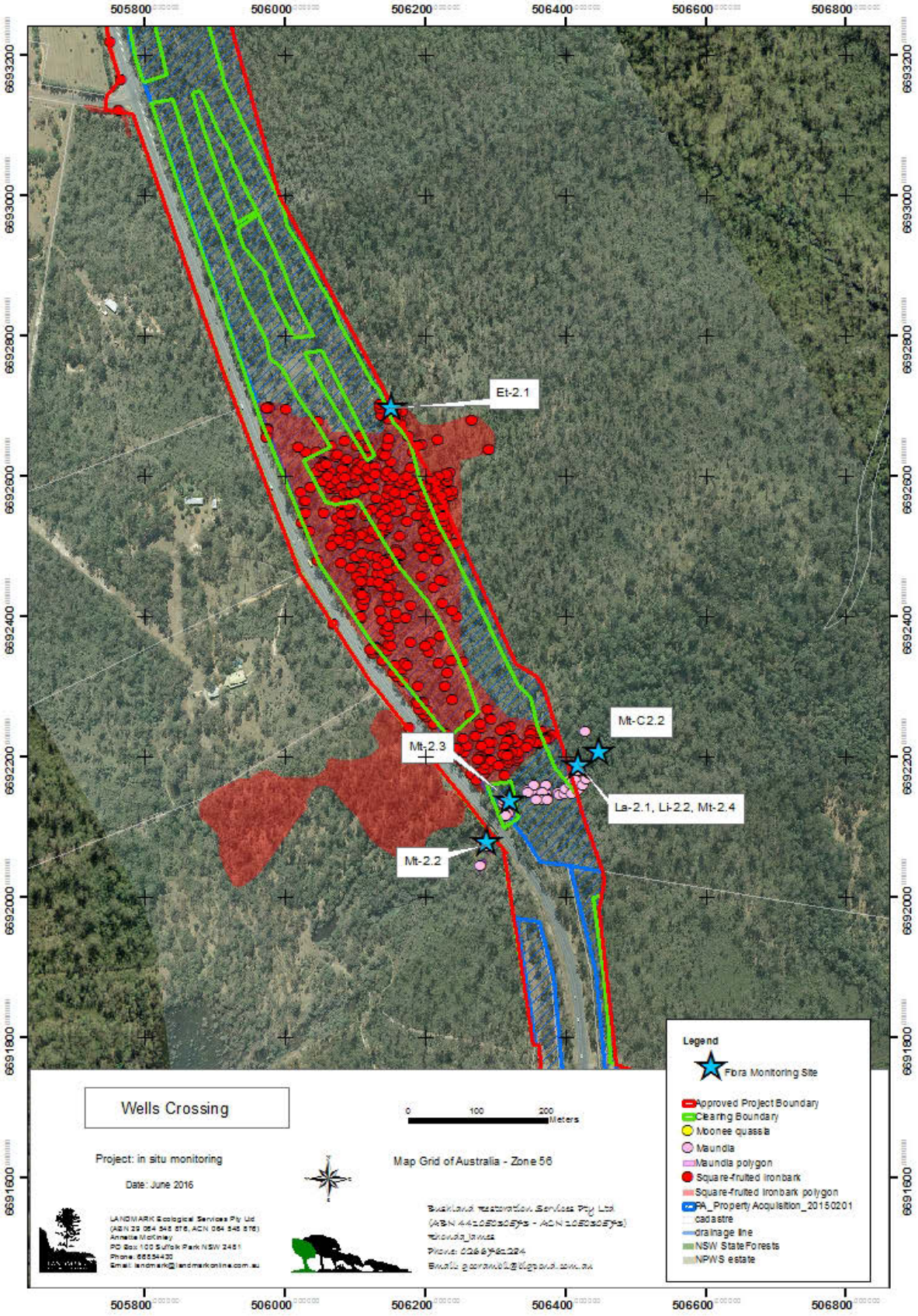

515200
515600
516000
516400
516800
517200
6682000
6681600
6681200
6680800
6680400
6680000
6679600
6679200
6678800
Elt-1.4, La-1.3
Elt-C1.2, La-C1.3
Elt-1.3, La-1.2
Elt-C1.1, La-C1.2
Elt-1.2, La-1.1
La-C1.1, Mt-C1.2
Elt-1.1, Mt-1.2
Mt-C1.1
Li-1.1
Mt-1.1
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Maundia
Maundia polygon
Hairy joint-grass
Hairy joint-grass polygon
Noah's false chickweed
Square-stemmed spikerush
Square-stemmed spikerush polygon
Water nutgrass
Water nutgrass polygon
PA_Property Acquisition_20150201
road
drainage line
Redbank Creek
northern tributary
0
310
620
Meters
Project: In situ monitoring
Map Grid of Australia - Zone 56
Date: June 2016

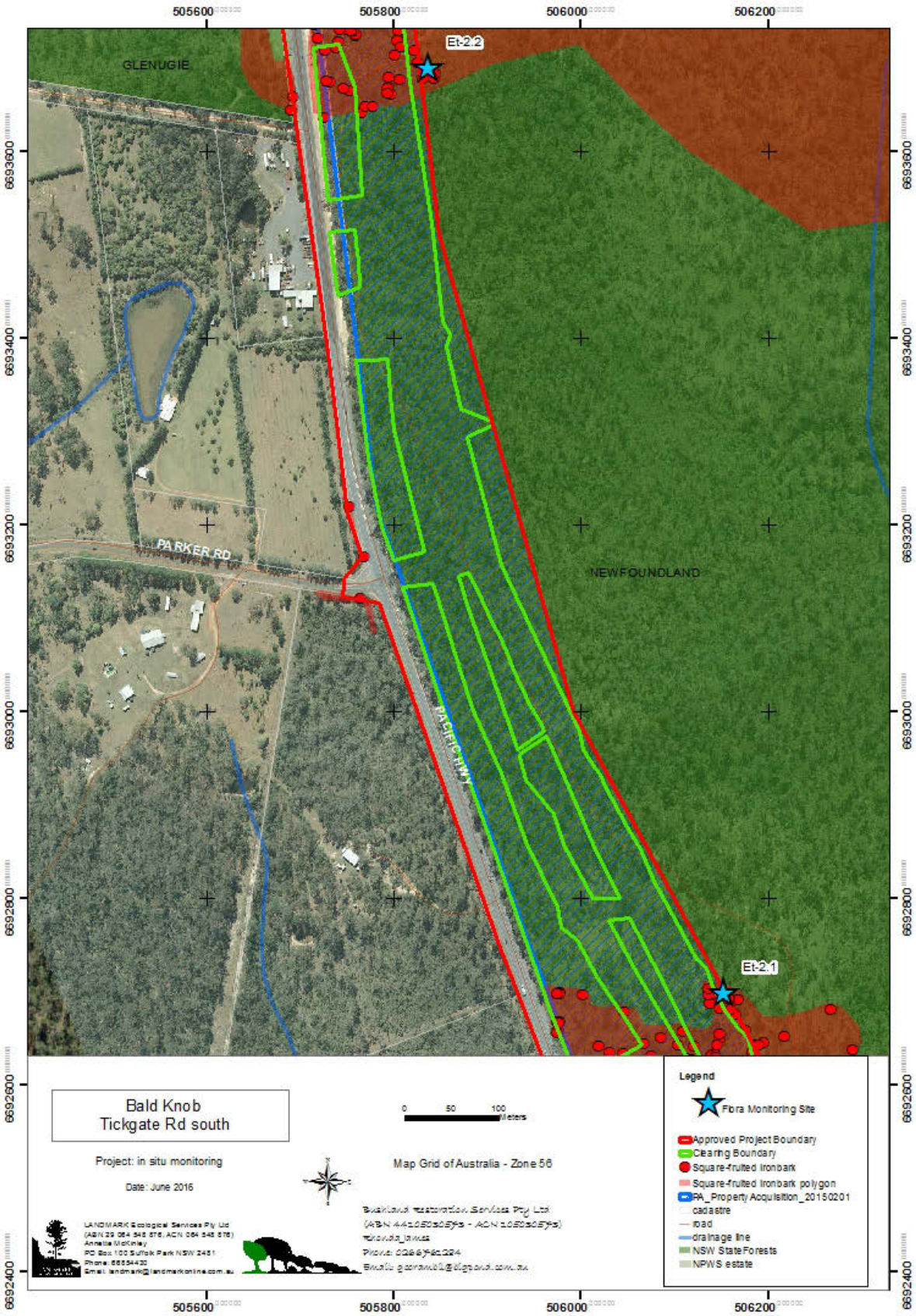

514600
514700
514800
514900
515000
6682500
6682400
6682300
6682200
6682100
6682000
6681900
6681800
QM-1.2
QM-C1.2
QM-1.1
QM-C1.1
Dirty Creek Range
0
50
100
Meters
Map Grid of Australia - Zone 56
Project: in situ monitoring
Date: June 2016
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Moonee quassia
Moonee quassia polygon
PA_Property Acquisition_20150201
cadastre
road
drainage line
NSW State Forests
NPWS estate

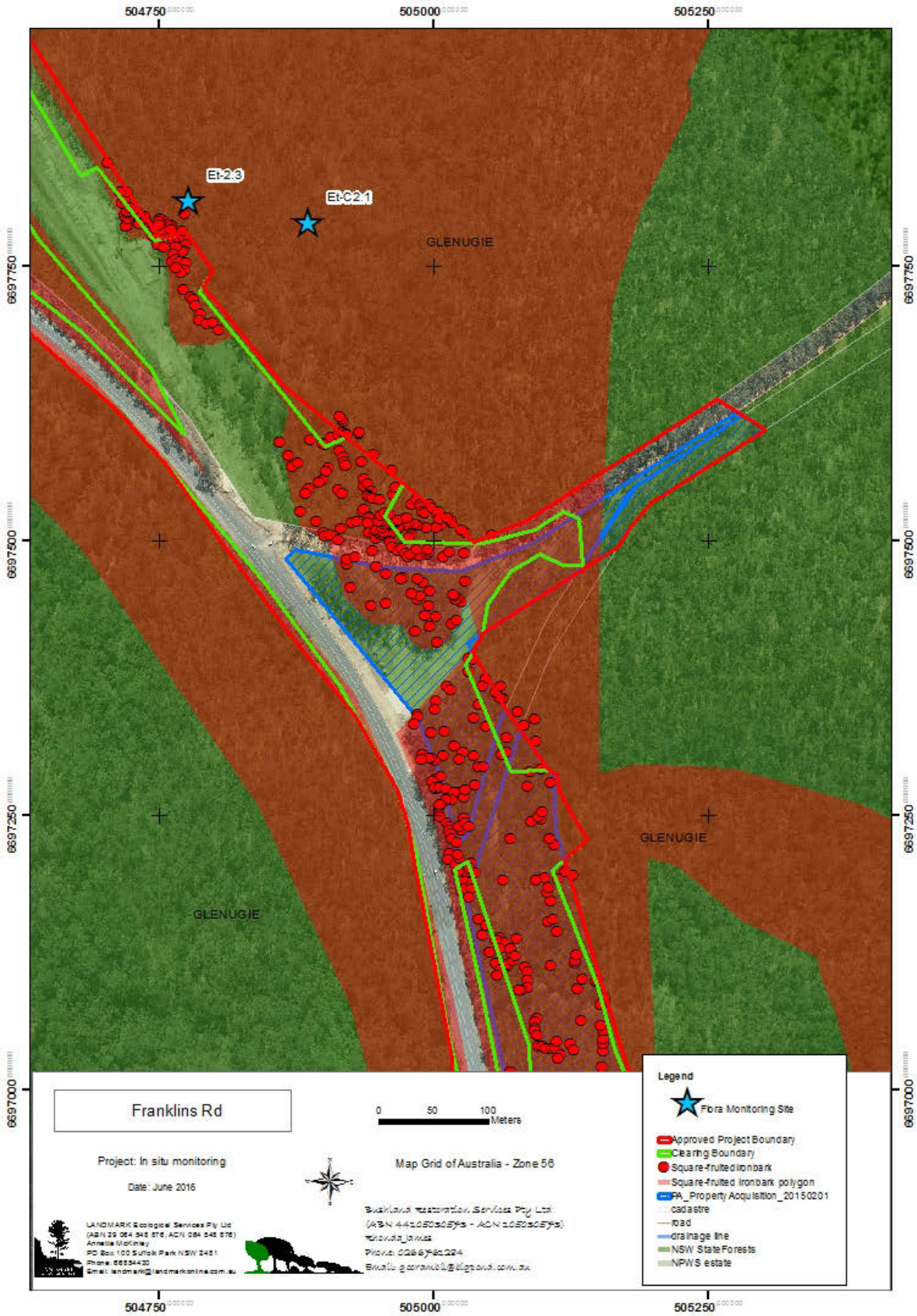

513300
513400
513500
513600
513700
513800
513900
514000
514100
514200
514300
514400
514500
514600
6683300
6683100
6682900
6682700
6682500
6682300
6682100
6681900
6681700
DIRTY CREEK RD
NEWFOUNDLAND
DIRTY CREEK TRL
RANGE RD E
RIDGE CT
RANGE RD
PACIFIC HWY
FERRY RD
EL1.1
KATHLEEN DR
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Maundia
Maundia polygon
Slender screw fern
Square-fruited Ironbark polygon
Clearing Boundary
Approved Project Boundary (date pending)
NPWS estate
NSW State Forests
PA_Property Acquisition_20150201
cadastre
road
drainage line
Range Road
Project: In situ monitoring
Date: June 2016
0
100
200
Meters
Map Grid of Australia - Zone 56
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 845 876, ACN 064 845 876)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66554430
Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
(ABN 44105305975 - ACN 105305975)
Phone: 02667 61224


508600
508700
508800
508900
509000
509100
509200
6688900
6688800
6688700
6688600
6688500
6688400
6688300
6688200
6688100
6688000
LEMON TREE RD
PACIFIC HWY
Li-2.1
Li-C2.1
Legend
Flora Monitoring Site - Jacobs
Approved Project Boundary
Clearing Boundary
Slender screw fern
Slender screw fern polygon
Water nutgrass
Water nutgrass polygon
PA_Property Acquisition_20150201
cadastre
NPWS estate
NSW StateForests
road
drainage line
Halfway Creek
Crossing rest area
Project: in situ monitoring
Date: June 2016
0
50
100
Meters
Map Grid of Australia - Zone 56
LANDMARK Ecological Services Pty Ltd
(ABN 29 064 545 576, ACN 064 545 576)
Annette McKinley
PO Box 100 Suffolk Park NSW 2481
Phone: 66554420
Email: landmark@landmarkonline.com.au
Bushland Restoration Services Pty Ltd
(ABN 44 050 305 795 - ACN 050 305 795)
Travis Jones
Phone: 0266761224
Email: greenmail@bigpond.com.au


506500
506600
506700
506800
506900
507000
507100
507200
6891000
6890900
6890800
6890700
6890600
6890500
6890400
6890300
6890200
6890100
6890000
6889900
6889800
Yuraygir State Conservation Area
LUTHERS RD
Mt-2.1
Mt-C2.1
Halfway Creek Crossing
Project: in situ monitoring
Date: June 2016
0 50 100 Meters
Map Grid of Australia - Zone 56
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Maundia
Maundia polygon
Water nutgrass
Water nutgrass polygon
PA_Property Acquisition_20150201
cadastre
road
drainage line
NSW State Forests
NPWS estate


505800
506000
506200
506400
506600
506800
6693200
6693000
6692800
6692600
6692400
6692200
6692000
6691800
6691600
Et-2.1
Mt-C2.2
Mt-2.3
La-2.1, Li-2.2, Mt-2.4
Mt-2.2
Wells Crossing
0
100
200
Meters
Project: in situ monitoring
Date: June 2016
Map Grid of Australia - Zone 56
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Moonee quassia
Maundia
Maundia polygon
Square-fruited ironbark
Square-fruited ironbark polygon
PA_Property Acquisition_20150201
cadastre
drainage line
NSW State Forests
NPWS estate


505600
505800
506000
506200
6693600
6693400
6693200
6693000
6692800
6692600
6692400
GLENUGIE
Et-2.2
PARKER RD
NEWFOUNDLAND
PACIFIC HWY
Et-2.1
Bald Knob
Tickgate Rd south
Project: in situ monitoring
Date: June 2016
0 50 100 Meters
Map Grid of Australia - Zone 56
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Square-fruited Ironbark
Square-fruited Ironbark polygon
PA_Property Acquisition_20150201
cadastre
road
drainage line
NSW StateForests
NPWS estate


504750
505000
505250
6697750
6697500
6697250
6697000
Et-2.3
Et-C2.1
GLENUGIE
GLENUGIE
GLENUGIE
Franklins Rd
0 50 100 Meters
Project: In situ monitoring
Date: June 2016
Map Grid of Australia - Zone 56
Legend
Flora Monitoring Site
Approved Project Boundary
Clearing Boundary
Square-fruited Ironbark
Square-fruited Ironbark polygon
PA_Property Acquisition_20150201
cadastre
road
drainage line
NSW State Forests
NPWS estate

Appendix 2 Monitoring site details (quadrat data)

Species are arranged alphabetically. Controls are followed by related *in situ* sites, listed south to north.

2014 photos from Jacobs (2014)

Contents

Eucalyptus tetrapleura

Habitat transect data Et-C2.1, Et-1.1, Et-2.1, Et-2.2, Et-2.3

Site Code	Et-C2.1	- Et-C2.1	Et-1.1	Et-2.1	Et-2.1	Et-2.2	Et-2.2	Et-2.3	Et-2.3
Date	**3/05/2014**	**26/06/2016**	**29/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**
Marker	Green Tape	Pink tape	Pink tape	Green Tape	Pink tape	Green Tape	Pink tape	Green Tape	Green Tape
Location	Glenugie, north of Franklins Road	Glenugie, north of Franklins Road	;	Wells Crossing Flora Reserve	Wells Crossing Flora Reserve	Sandy Hill, north of Wells Crossing	Sandy Hill, north of Wells Crossing	Glenugie, north of Franklins Road	Glenugie, north of Franklins Road
Location 2	Glenugie State Forest	Glenugie State Forest		Wells Crossing Flora Reserve	Wells Crossing Flora Reserve	Wells Crossing Flora Reserve	Wells Crossing Flora Reserve	Glenugie State Forest	Glenugie State Forest
Easting	504886	504886	513860	506152	506152	505836	505841	504777	504777
Northing	6697790	6697790	6682475	6692700	6692700	6693690	6693690	6697810	6697810
Transect orientation	South	South	South	South	South	South	South	South	South
Climate previous	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period
Climate current	Raining yesterday and earlier in week	Clear, dry	Clear, dry	Raining yesterday and earlier in week	Clear, dry	Raining yesterday and earlier in week	Clear, dry	Raining yesterday and earlier in week	Clear, dry
Landform		Flat	hill slope	Mid slope	Mid slope	Upper slope	hillcrest/flat	Mid to upper slope	Mid to upper slope
Drainage		Moderate	good	Poor	Poor to moderate	Poor-moderate, clay/sand mixed soil	poor to moderate	Poor, clay soils, in drainage area	Poor, clay soils, in drainage area
Slope	Moderate	Very slight	Slight	Low	Slight	Slight	flat	Low	Slight
Aspect	Southwest	Southwest	Northeast	Southwest	Southwest	Southeast	n/a	North	North
Soil moisture	Moderate	Moderate	damp	High	High	High	High	High	High
Water levels	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Water flow	n/a	n/a	none	n/a	n/a	n/a	n/a	Little/None	Little/None
Plant condition (0-5)	4	3 to 5	5	4	2 to 4	3 to 4	2 to 4	4	2 to 5
Height		13 to 22m	23m	Up to 20 m	Up to 24 m	15 to 18 m	10 to 19m		8 to 25
Width		2.5 to 9m	10m	5 to 7 m	1 to 5.5m				3 to 9
DBH			49 cm						21-67

Site Code	Et-C2.1	- Et-C2.1	Et-1.1	Et-2.1	Et-2.1	Et-2.2	Et-2.2	Et-2.3	Et-2.3
Date	**3/05/2014**	**26/06/2016**	**29/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**
Leaf cond	Appear healthy, limited access		5	Appear healthy, limited access	5	Appear healthy, limited access		Appear healthy, limited access	
Length new shoots	No access to canopy	Not observed	not observed	No access to canopy		No access to canopy	Not observed	No access to canopy	Not observed
Flowers	No	No	buds, flowers	Yes	No	Yes	No	No, unlike flowering individuals at Wells Crossing, few flower buds not many	Buds on one tree
Fruit	Old fruit on ground	Capsules present on most trees		Yes, some trees	No	Yes, some trees	Yes, a few on some trees	Old fruit on ground	One tree only
Recruitment	One juvenile suspected (base of Tree 8)	One juvenile suspected (2m NW of Tree 8)	No	Saplings present, no seedlings observed	Yes	Yes, 1 x juvenile present (tree 8)	None	No	None
Disease/insect	Insect galls	Herbivory and galls (minor)	none observed	Some chewed leaves	None observed	Insect galls	Insect galls	Insect galls	Herbivory (minor)
Dieback	Yes	Small branch dieback on some trees	none observed	Yes, dead small branches	Recovering from fire, some branch dieback	Yes	Small branches on some trees	Yes	One trunk dying back, some branches
Threats	Feral horses	Signs of horses	Located on edge of clearing for highway, adjacent to parking lot. Rubbish and garden dumping adjacent, sediment runoff from road upslope	Limited	Partly cleared for highway	Limited	Signs of cattle, fire recent but recovery adequate	Runoff from road, feral horses	Piped water from sediment basin, evidence of recent heavy water flow, geotextile and sediment fence washed into quadrat. Horse tracks
VegComm	Spotted Gum-Ironbark Forest	Spotted Gum-Ironbark Forest	Stringybark-Grey Ironbark Forest	Spotted Gum-Ironbark Forest	Spotted Gum-Ironbark Forest	Sandy swamp woodland/ Sandy Dry Forest	Sandy swamp woodland/ Sandy Dry Forest	Spotted Gum-Ironbark Forest	Spotted Gum-Ironbark Forest

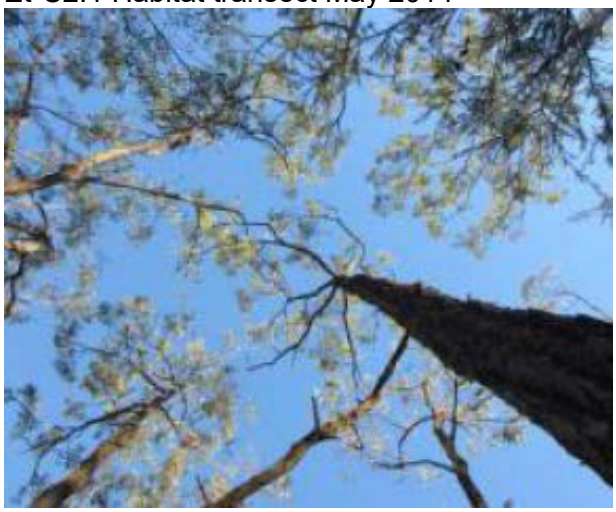
Site Code	Et-C2.1	- Et-C2.1	Et-1.1	Et-2.1	Et-2.1	Et-2.2	Et-2.2	Et-2.3	Et-2.3
Date	**3/05/2014**	**26/06/2016**	**29/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**
Canopy species	*Corymbia henryi, Eucalyptus tetrapleura, Eucalyptus seeana*	*Corymbia henryi, Eucalyptus tetrapleura, Eucalyptus seeana*	*Eucalyptus acmenoides(?), E. siderophloia, E. tetrapleura*	*Corymbia henryi, Eucalyptus tetrapleura, Eucalyptus fibrosa*	*Corymbia henryi, Eucalyptus tetrapleura*	*Angophora woodsiana, Eucalyptus resinifera, Eucalyptus tetrapleura, Corymbia gummifera, Eucalyptus bancroftii*	*Eucalyptus resinifera, Eucalyptus tetrapleura, Corymbia gummifera, Eucalyptus bancroftii*	*Corymbia henryi, Eucalyptus tetrapleura, Corymbia intermedia suaveolens, Eucalyptus seeana, Lophostemon*	*Corymbia henryi, Eucalyptus tetrapleura, Corymbia intermedia, Eucalyptus seeana*
Midstorey species	*Acacia disparrima, Melaleuca nodosa*	*Acacia disparrima, Melaleuca nodosa*	*Acacia disparrima, Angophora woodsiana*	*Acacia disparrima, Pultenaea villosa*	*Acacia disparrima, Pultenaea villosa*	*Melaleuca sieberi, Pultenaea tuberculata, acacia complanata*	*Melaleuca sieberi, Pultenaea tuberculata, acacia complanata*	*Acacia disparrima, Melaleuca nodosa, Hakea silaifolia, Breynia oblongifolia*	*Acacia disparrima, Melaleuca nodosa, Breynia oblongifolia, Lophostemon suaveolens*
Understorey species	*Gahnia aspera, Entolasia stricta, Entolasia marginata, Themeda australis*	*Gahnia aspera, Entolasia stricta, Entolasia marginata, Themeda australis*	*Themeda australis, Imperata cylindrica, Lomandra sp., Lepidosperma laterale*	*Ptilothrix deusta, Entolasia stricta, Lepidosperma laterale*	*Ptilothrix deusta, Entolasia stricta, Lepidosperma laterale*	*Ptilothrix deusta, Lomandra sp., Lepidosperma laterale, Entolasia stricta, Aristida vagans*	*Ptilothrix deusta, Lomandra sp., Lepidosperma laterale, Entolasia stricta*	*Goodenia paniculata, Centella asiatica, Hydrocotyle tripartita, Eragrostis brownii, Imperata cylindrica*	*Centella asiatica, Eragrostis brownii, Imperata cylindrica, Gahnia aspera, Pratia purpurascens*
Canopy	16	8	35	20	15	15	25	21	18
Midstorey	5	5	5	11	0	6	1	24	15
Forb	10	15	10	30	10	55	10	20	10
Grass	40	10	60	50	50	20	20	35	30
Shrub (<1m)	0	5	0	0	20	0	5	0	0
litter	50	95	25	20	30	25	70	45	50
bare/water	0	5	15	0	45	0	20	0	15
exotic	0	0	10	0	0	0	0	0	0
Weed Species	None	None	*Andropogon virginicus, Sporobolus fertilis*	None	None	None	None	None, some in road easement	None, some in road easement
Weed abundance	None	None	occasional, patchy	None	None	None	None	None	None

Site Code	Et-C2.1	- Et-C2.1	Et-1.1	Et-2.1	Et-2.1	Et-2.2	Et-2.2	Et-2.3	Et-2.3
Date	**3/05/2014**	**26/06/2016**	**29/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**	**3/05/2014**	**26/06/2016**
Recruitment (canopy/mid)	Minor	Occasional saplings	Occasional saplings	Yes	Occasional saplings, smaller trees	Yes	Yes	Yes	Small trees and saplings
Disturbance	Feral horses	Feral horses	Edges close to clearing, roads, parking lot. Sediment run-off	Limited	Cleared edge, recent fire	Limited	Limited	Runoff from road, feral horses	Treefalls within plot, some along highway edge. Water flow.
Comments					Quadrat partly cleared, about 3/4 remains		Quadrat markers burnt, new quadrat marked to enclose marked trees		
Comments 2					Markers burnt in fire, re-marked				
Abundance summary	8 trees	8 trees, 1 sapling (?)	1 tree	7 trees	5 trees	9 trees	5 trees	8 trees	8 trees

Photos Et-C2.1

Et-C2.1 Habitat transect May 2014

Et-C2.1 Habitat transect June 2016



Tree 3 May 2014

Tree 3 June 2016

Juvenile 2m NW of base of Tree 8 June 2016

Details of trees Et-C2.1

Tree no	1	2	3	4	5	6	7	8
Easting	504888	504885	504882	504883	504887	504891	504893	504882
Northing	6697797	6697792	6697783	6697783	6697780	6697780	6697786	6697795
Height (m)	13	20	22	18	22	18	18	20
Width (m)	2.5	5	9	5	8	8	5	5
dbh (cm)	21	40	38	25	67	38	33	38
Condition	3	4	4	4	5	4	4	5
Capsules	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Notes	leaves sparse, some crown dieback	leaves sparse, some branch dieback	some branch dieback and herbivory	some branch dieback	galls (tree forked at 1.5m)	small branch dieback, herbivory	herbivory	juvenile located 2m nw of tree

Photos Et-1.1

Et-1.1 Habitat transect June 2016

Tree 1 June 2016

Rubbish dumping June 2016

Run-off from upslope side road June 2016

Details of tree Et-1.1

Tree no	1	dbh (cm)	49
Easting	513861	Condition	5
Northing	6682472	Capsules	sparse + flowers and buds
Height (m)	23	Notes	very close to cleared edge
Width (m)	10		

Photos Et-2.1

Et-2.1 Habitat transect May 2014

Habitat transect, quadrat partly cleared, June 2016

Tree 1, good recovery from fire June 2016

Tree 2 on exposed edge June 2016

Details of trees Et-2.1

Tree no	1	2	3	4	5
Easting	506154	506136	506158	506157	506154
Northing	6692700	6692706	6692697	6692694	6692687
Height (m)	19	6	14	24	21
Width (m)	4	1	3	5.5	4
dbh (cm)	23	10	19	48	29
Condition	2	2	4	4	3
Capsules	No	No	No	No	No
Notes	Burnt, shoots from trunk, good recovery	Burnt, shoots from trunk, good recovery on exposed edge	small branch dieback	small branch dieback	small branch dieback

Photos Et-2.2

Et-C2.2 Habitat transect May 2014

Et-C2.2 Habitat transect (newly marked, photos poorly matched) June 2016

Tree 5 Dieback evident May 2014

Tree 5 June 2016

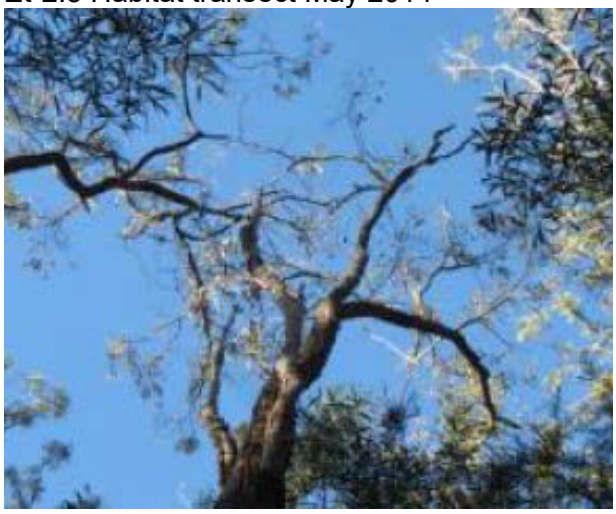
Details of trees Et-2.2

Tree no	1	2	3	5	6
wp	476	477	478	480	481
Easting	505834	505833	505841	505832	505840
Northing	6693685	6693684	6693680	6693683	6693675
Height (m)	11	16	11	19	10
Width (m)	2	8	2	5	2
dbh (cm)	17	45	19	33	17
Condition	2	4	2	3	2
Capsules	No	Yes (few)	No	Yes (few)	No
Notes	burnt with shoots from trunk	small branch dieback	dieback	recovery from dieback noted in 2014	burnt but recovering

Photos Et-2.3

Et-2.3 Habitat transect May 2014

Et-2.3 Habitat transect June 2016



Tree 5 May 2014 - dieback evident

Tree 5 June 2016 – deterioration since 2014

Pipe from sediment basin diverts water into quadrat June 2016

Details of trees Et-2.3

Tree no	1	2	3	4	5	6	7	8
wp	467	468	469	470	471	472	473	474
Easting	504772	504761	504769	504776	504777	504770	504763	504750
Northing	6697816	6697814	6697805	6697810	6697810	6697801	6697795	6697802
Height (m)	25	18	20	15	8	22	21	18
Width (m)	8	6	6	5	3	8	9	3.5
dbh (cm)	33	30	33	32	25	41	46	26
Condition	5	5	4	3	2	4	4	4
Capsules	Few	No	No	Yes	No	Few + flower buds	Few	No
Notes			Herbivory, small branch dieback	Dieback on trunk and branches	Small branch dieback. On edge of quadrat	Small branch dieback, herbivory	Herbivory, small branch dieback	Herbivory, small branch dieback

Lindernia alsinoides

Habitat transect details La-2.1

Site Code	La-2.1	La-2.1
Date	2/05/2014	27/06/2016
	Lindernia alsinoides	*Lindernia alsinoides*
Marker	Pink Tape	Pink Tape
Location	Wells Crossing upstream of project	Wells Crossing upstream of project
Location 2	On Halfway Creek	On Halfway Creek
Easting	506418	506418
Northing	6692190	6692190
Transect orientation	South	South
Plant ID codes	n/a	n/a
Climate previous	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period
Climate current	Raining today and earlier in week	Clear, dry
Landform	Creek	Creek
Drainage	Poor	Poor
Slope	Flat	Flat
Aspect	Flat	Flat
Soil moisture	High	High
Water levels	Moderate	High
Water flow	Little/None	Little/None
Plant condition (0-5)	4 to 5	4
Height	Mostly to 10 cm	Up to 10cm high
Width	Up to 50 cm, sprawling	
DBH	n/a	n/a
Leaf cond	Healthy, bright green	Slight browning on some plants
Length new shoots	Mostly to 10 cm	Up to 10cm
Flowers	Yes	No
Fruit	Yes	No
Recruitment	Possible	Possible
Disease/insect	None obvious	None obvious
Dieback	None obvious	Slight browning on some plants
Threats	Grazing and trampling by wild horses and pigs	Grazing and trampling by wild horses and pigs

Site Code	La-2.1	La-2.1
Date	**2/05/2014**	**27/06/2016**
	evident	evident
VegComm	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)
Canopy species	*Eucalyptus robusta*	*Eucalyptus robusta*
Midstorey species	*Melaleuca alternifolia, Acacia floribunda, Leptospermum juniperinum*	*Melaleuca alternifolia, Acacia floribunda* (dead stems, kllled by fire)
Understorey species	*Eleocharis sphacelata, Maundia triglochinoides, Isachne globosa*	*Eleocharis sphacelata, Maundia triglochinoides, Lindsaea incisa, Isachne globosa* (? No fertile material)
Canopy	18	18
Midstorey	23	15
Forb	80	75
Grass	5	10
Shrub (<1m)	0	5
litter	15	15
bare/water	0	6
exotic	0	0
Weed Species	None	None
Weed abundance	None	None
Recruitment (canopy/mid)	Minor	occasional small trees
Disturbance	Grazing and trampling by wild horses and pigs evident	Fire, horse tracks
Comments		
Abundance summary	Low	Low

Photos La-2.1

La-2.1 Habitat transect April 2014

La-2.1 Habitat transect June 2016

La-2.1 Leaves of *Lindernia alsinoides* submerged, June 2016

Habitat of *Lindernia alsinoides*, June 2016

Lindsaea incisa

Habitat transect data Li-C2.1, Li-2.1 and Li-2.2

Site Code	Li-C2.1	Li-C2.1	Li-2.1	Li-2.1	Li-2.2	Li-2.2
Date	**1/05/2014**	**22/06/2016**	**1/05/2014**	**22/06/2016**	**2/05/2014**	**2/05/2014**
Marker	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape
Location	Halfway Creek rest area	Halfway Creek rest area	Halfway Creek rest area	Halfway Creek rest area	Wells Crossing upstream of project	Wells Crossing upstream of project
Location 2	Halfway Creek rest area	Halfway Creek rest area	Halfway Creek rest area	Halfway Creek rest area	On Halfway Creek	On Halfway Creek
Easting	508904	508904	508856	508856	506418	506418
Northing	6688360	6688360	6688430	6688430	6692190	6692190
Transect orientation	South	South	South	South	South	South
Plant ID codes	Li501-Li504	Li501-Li504	Li501-Li512	Li501-Li512	n/a	n/a
Climate previous	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period
Climate current	Clear, raining yesterday	sunny, dry	Clear, raining yesterday	sunny, dry	Raining today and earlier in week	Clear, dry
Landform	Swampy creek line	Swampy creek line	Swampy creek line	Swampy creek line	Creek	Creek
Drainage	Poor-moderate on sandy soils edges of wetland	Poor-moderate on sandy soils edges of wetland	Poor-moderate on sandy soils edges of wetland	Poor-moderate on sandy soils edges of wetland	Poor	Poor
Slope	Slight	Slight	Slight	Slight	Flat	Flat
Aspect	Northeast	Northeast	Northeast	Northeast	Flat	Flat
Soil moisture	High	High	High	High	High	High
Water levels	Moderate	Moderate	Moderate	Moderate, small area of standing water on north edge of plot	Moderate	High
Water flow	Low	Low	Low	Low	Little/None	Little/None
Plant condition (0-5)	5	5	5	5	4 to 5	5
Height	Up to 20 cm	Up to 50cm but some very small	Up to 20 cm	Up to 40 cm	Up to 70 cm	Up to 50cm
Width	n/a	n/a	n/a	n/a	n/a	
DBH	n/a	n/a	n/a	n/a	n/a	n/a
Leaf cond	All healthy green, resprouting plants following fire and dry summer	5	All healthy green, resprouting plants following fire and dry summer	5	Healthy, bright green	Healthy, bright green
Length new shoots	1 to 20 cm, mean 10 cm		2 to 20 cm, mean 10 cm		Mostly 15 cm	Up to 50cm
Flowers	No	No	No	No	Sori on larger plants	No
Fruit	No	No	No	No	Sori on larger plants	Immature sori
Recruitment	Possible, most likely	Possible, most likely	Possible, most likely	Possible, most likely	Possible	Regeneration from

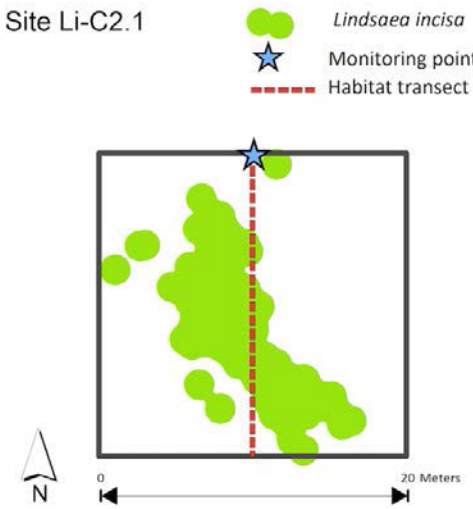
Site Code	Li-C2.1	Li-C2.1	Li-2.1	Li-2.1	Li-2.2	Li-2.2
Date	**1/05/2014**	**22/06/2016**	**1/05/2014**	**22/06/2016**	**2/05/2014**	**2/05/2014**
	resprouting from rhizome	resprouting from rhizome	resprouting from rhizome	resprouting from rhizome		rhizomes
Disease/insect	No	No	No	No	None obvious	None obvious
Dieback	No	No	No	No	Minor, on larger plants	None observed
Threats	Fire regime, fire in last 1-2 years,	Fire regime, fire in last 3-4 years,	Fire regime, fire in last 1-2 years,	Fire regime, fire in last 3-4 years,	Grazing and trampling by wild horses and pigs evident	Grazing and trampling by wild horses and pigs evident
VegComm	Swamp Sclerophyll Forest (EEC)/ Scribbly Gum Forest	Swamp Sclerophyll Forest (EEC)/ Scribbly Gum Forest	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)
Canopy species	*Eucalyptus robusta, Melaleuca quinquenervia*	*Eucalyptus robusta, Melaleuca alternifolia*	*Eucalyptus robusta, Eucalyptus resinifera*	*Eucalyptus robusta, Eucalyptus resinifera*	*Eucalyptus robusta*	*Eucalyptus robusta*
Midstorey species	*Leptospermum juniperinum, Banksia oblongifolia*	*Eucalyptus robusta and Melaleuca alternifolia saplings, Acacia sp.*	*Melaleuca alternifolia, Leptospermum juniperinum, Banksia oblongifolia*	*Melaleuca alternifolia, Leptospermum juniperinum, Banksia oblongifolia*	*Melaleuca alternifolia, Acacia floribunda, leptospermum juniperinum*	*Melaleuca alternifolia, Acacia floribunda (dead stems, klled by fire)*
Understorey species	*Baumea sp., Dampiera stricta, Gahnia clarkei, Baloskion tetraphyllus, Pteridium esculentum*	*Baumea sp., Gahnia clarkei, Baloskion tetraphyllus, Pteridium esculentum*	*Baumea sp..,Empodisma minus, Isachne globosa, Imperata cylindrica*	*Baumea sp..,Empodisma minus, Gahnia clarkei, Isachne globosa, Imperata cylindrica*	*Eleocharis sphacelata, Maundia triglochinoides, Isachne globosa*	*Eleocharis sphacelata, Maundia triglochinoides, Lindsaea incisa, Isachne globosa (? No fertile material)*
Canopy	15	8	16	6	18	18
Midstorey	1	1	0	0	23	15
Forb	85	75	55	85	80	75
Grass	0	20	15	10	5	10
Shrub (<1m)	5	5	15	6	0	5
litter	10	45	15	5	15	15
bare/water	0	0	0	0	0	6
exotic	0	0	0	0	0	0
Weed Species	None	None	None	None	None	None
Weed abundance	None	None	None	None	None	None
Recruitment (canopy/mid)	Mid-storey species only (Pultenaea retusa), resprouting Banksia oblongifolia	Canopy species saplings	Mid-storey species only (Pultenaea retusa), resprouting Banksia oblongifolia	Mid-storey species only (Pultenaea retusa), resprouting Banksia oblongifolia	Minor	occasional small trees
Disturbance	Fire in last 1 to 2 years, entire area burnt, resprouting Banksia oblongifolia. Open swamp habitat	Fire in last 3 to 4 years.	Fire in last 1 to 2 years, entire area burnt, resprouting Banksia oblongifolia. Open swamp habitat	Fire in last 3 to 4 years.	Grazing and trampling by wild horses and pigs evident	Fire, horse tracks

Site Code	Li-C2.1	Li-C2.1	Li-2.1	Li-2.1	Li-2.2	Li-2.2
Date	**1/05/2014**	**22/06/2016**	**1/05/2014**	**22/06/2016**	**2/05/2014**	**2/05/2014**
	with sparse canopy, possibly previously cleared		with sparse canopy, possibly previously cleared			
Comments	High to moderate abundance, smaller area than in situ plot by estimated 25%	Cover estimated at average 5% in mapped area (110m^2)	High to moderate abundance, larger area than control plot	Cover estimated at average 5% in mapped area (130m^2)		
Comments 2				Plot is distant from direct impacts of construction and no hydrological impacts were apparent.		
Abundance summary	High-Moderate	High-Moderate	High-Moderate	High-Moderate	High-Moderate	Cover 20% average, patch 12 x 3 m

Photos Li-C2.1

Li-C2.1 Habitat transect April 2014

Li-C2.1 Habitat transect June 2016 showing development of lower storey

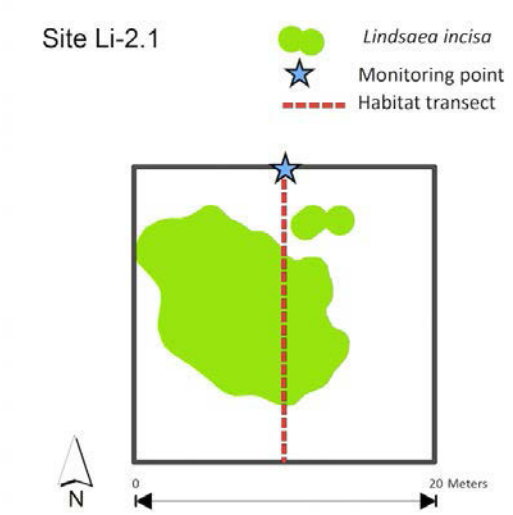


Li-C2.1 Fronds June 2016

Photos Li-2.1

Li-2.1 Habitat transect April 2014

Li-2.1 Habitat transect June 2016 Habitat transect June 2016 showing development of lower storey




Li-2.1 Fronds June 2016

Photos Li-2.2


Li-2.2 Habitat transect April 2014


Li-2.2 Habitat transect June 2016


L1-2.2 Dense fronds of *Lindsaea incisa*, June 2016

Maundia triglochinoides

Habitat transect data Mt-C2.1, Mt-2.1, Mt-C2.2, Mt-2.2, Mt-2.3, Mt-2.4

Site Code	Mt-C2.1	Mt-C2.1	Mt-2.1	Mt-2.1	Mt-C2.2	Mt-C2.2	Mt-2.2	Mt-2.2	Mt-2.3	Mt-2.3	Mt-2.4	Mt-2.4
Date	**2/05/2014**	**3/07/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**27/06/2016**
Marker	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape	Pink Tape
Location	Halfway Creek, up stream of project, northern side of drainage line	Halfway Creek, up stream of project, northern side of drainage line	Halfway Creek crossing	Halfway Creek crossing	Wells Crossing upstream of project	Wells Crossing upstream of project	Wells Crossing, downstream of the project, private property	Wells Crossing, downstream of the project, private property	Wells Crossing, in 'island' between bridges	Wells Crossing, in 'island' between bridges	Wells Crossing upstream of project	Wells Crossing upstream of project
Location 2	On Halfway Creek	On Halfway Creek	On Halfway Creek	On Halfway Creek	Wells Crossing	Wells Crossing	Wells Crossing	Wells Crossing	Wells Crossing	Wells Crossing	Wells Crossing	Wells Crossing
Easting	506768	506768	506677	506677	506448	506448	506288	506288	506320	506320	506418	506418
Northing	6690440	6690440	6690450	6690450	6692210	6692210	6692080	6692080	6692140	6692140	6692190	6692190
Aspect orientation	South	South	South	South	South	South	South	South	South	South	South	South
Climate previous	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period	Rain end of March and during April, dry preceding	Heavy rain in early June after a long dry period
Climate current	Recent rainfall, however soils not very moist and water levels relatively low considering recent rainfall	sunny, dry	Recent rainfall, however soils not very moist and water levels relatively low considering recent rainfall	sunny, dry	Raining today and earlier in week	Clear, dry	Raining today and earlier in week	sunny, dry	Raining today and earlier in week	Clear, dry	Raining today and earlier in week	Clear, dry
Landform	Swampy creek line	Swampy creek line	Swampy creek line	Swampy creek line	Creek	Creek	Creek	Creek	Creek	Creek	Creek	Creek
Drainage	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Slope	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat
Aspect	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat	Flat

Site Code	Mt-C2.1	Mt-C2.1	Mt-2.1	Mt-2.1	Mt-C2.2	Mt-C2.2	Mt-2.2	Mt-2.2	Mt-2.3	Mt-2.3	Mt-2.4	Mt-2.4
Date	**2/05/2014**	**3/07/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**27/06/2016**
Soil moisture	Moderate	High	Moderate	High	High	High	High	High	High	High	High	High
Water levels	Low-Moderate	High	Low-Moderate	High	Moderate	High	Moderate	Moderate	Moderate	High	Moderate	High
Water flow	Little/None	Little/None	Little/None	Little/None	Little/None	Little/None	Little/None	Little/None	Little/None	Little/None	Little/None	Little/None
Plant condition (0-5)	2 to 3		0 to 3		0 to 4	4	3 to 4	4 to 5	3 to 4	4	1 to 4	3 to 4
Height	Up to 50 cm		Up to 50 cm		Up to 1 m	to 50cm	Up to 50 cm, mean 30 cm	Up to 30 cm	Up to 20cm, mean 15 cm	Up to 40 cm but mostly small	Up to 1 m	Up to 40cm
Width	n/a		n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
DBH	n/a		n/a		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Leaf cond			Plants stunted, limited large healthy plants present, dead plants not obvious here		Healthy, bright green, lots of dieback, yellowing evident	Some browning	Healthy, bright green, smaller upright plants, no larger upright plants present	Healthy, bright green, smaller upright plants, no larger upright plants present	Healthy, bright green, smaller plants, no larger upright plants present	Healthy, bright green, smaller plants, no larger upright plants present	Healthy, bright green, moderate dieback, yellowing evident	Some plants browning off
Length new shoots	Up to 50cm, mean 40cm		Up to 50cm, mean 20cm		Up to 1 m	Leaves up to 30cm tall	Up to 50 cm, mean 30 cm	Up to 30 cm	Up to 20cm, mean 15 cm	Up to 40 cm but mostly small	Up to 1 m	Up to 40cm
Flowers	No		No		No	No	No	No	No	No	No	No
Fruit	No		No		No	No	No	No	No	No	No	No
Recruitment	Possible	No plants detected	Possible, small plants present (see photos)	No plants detected	Possible, small plants on muddy edges	Possible	Possible	Possible	Possible	Possible	Possible, small plants	Possible, small plants
Disease/ insect	Limited		Yes some chewed leaves	Yes some chewed leaves	Some chewed leaves	Not observed	Some chewed leaves	None observed	Some chewed leaves	None evident	Some chewed leaves	Some chewed leaves

Site Code	Mt-C2.1	Mt-C2.1	Mt-2.1	Mt-2.1	Mt-C2.2	Mt-C2.2	Mt-2.2	Mt-2.2	Mt-2.3	Mt-2.3	Mt-2.4	Mt-2.4
Date	**2/05/2014**	**3/07/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**27/06/2016**
Dieback	None obvious, but likely		Yes, some plants have completely died back		Yes, dead/dying plants evident	Not observed	None obvious	None obvious	None obvious	None evident	Yes, dead/dying plants evident on edges	Confined to mild browning
Threats	Drought	Drought, change to hydrology	Further drought conditions	Drought, change to hydrology	Grazing and trampling by wild horses and pigs evident	Horses trampling	Cattle grazing, trampling evident	Cattle grazing, trampling evident	Macropod trails, grazing	Possible changes to hydrology	Grazing and trampling by wild horses and pigs evident	Recent fire, horse tracks
VegComm	Swamp Sclerophyll Forest (EEC) / Freshwater Wetland (EEC)	Swamp Sclerophyll Forest (EEC) / Freshwater Wetland (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)	Swamp Sclerophyll Forest (EEC)
Canopy species	*Melaleuca alternifolia, Angophora floribunda*	*Melaleuca alternifolia*	*Melaleuca alternifolia, Eucalyptus resinifera*	*Melaleuca alternifolia*	*Eucalyptus robusta, Lophostemon suaveolens*	*Eucalyptus robusta, Lophostemon suaveolens*	*Eucalyptus robusta, Lophostemon suaveolens*	*Eucalyptus robusta, Lophostemon suaveolens*	*Eucalyptus robusta, Lophostemon suaveolens*	*Eucalyptus robusta, Lophostemon suaveolens*	*Eucalyptus robusta*	*Eucalyptus robusta*
Midstorey species					*Melaleuca alternifolia*	*Melaleuca alternifolia*	Melaleuca alternifolia	*Melaleuca alternifolia*	*Melaleuca alternifolia*	*Melaleuca alternifolia, Acacia suaveolens*	*Melaleuca alternifolia, Acacia floribunda, leptospermum juniperinum*	*Melaleuca alternifolia, Acacia floribunda (dead stems, klIled by fire)*
Under-storey species	*Carex inversa, Persicaria pratermissa, Sparganium subglobosum, Eleocharis sphacelata, Triglochin microtuberosum*	*Carex inversa, Persicaria pratermissa, Sparganium subglobosum, Eleocharis sphacelata*	*Blechnum indicum, Baumea sp., Sparganium subglobosum*	*Baumea sp., Sparganium subglobosum, Gahnia sp.*	*Eleocharis sphacelata, Philydrum lanuginosum, Isachne globosa*	*Eleocharis sphacelata* (? No fertile material), *Philydrum lanuginosum, Isachne globosa (? No fertile material)*	Myriophyllum sp., Eleocharis spp., Isachne globosa	*Myriophyllum sp., Eleocharis spp., Isachne globosa, Andropogon virginicus, Sporobolus fertilis*	*Baumea sp., Eleocharis sp., Lobelia alata, Isachne globosa, Imperata cylindrica*	*Baumea sp., Eleocharis sp., Imperata cylindrica*	*Eleocharis sphacelata, Maundia triglochinoides, Isachne globosa*	*Eleocharis sphacelata, Maundia triglochinoides, Lindsaea incisa, Isachne globosa* (? No fertile material)
Canopy	14		33	10	5	5	15		60	10	18	18
Midstorey	0		0	0	14	10	8		40	15	23	15
Forb	100		85	20	60	80	20		0	80	80	75
Grass	0		0	0	5	0	15		0	70	5	10

Site Code	Mt-C2.1	Mt-C2.1	Mt-2.1	Mt-2.1	Mt-C2.2	Mt-C2.2	Mt-2.2	Mt-2.2	Mt-2.3	Mt-2.3	Mt-2.4	Mt-2.4
Date	**2/05/2014**	**3/07/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**27/06/2016**
Shrub (<1m)	0		0	0	0	0	0		0	0	0	5
litter	0		15	0	20	0	15		0	5	15	15
bare/water	0		0	80	15	20	25		0	10	0	6
exotic	0	0	0	0	0	0	25		0	0	0	0
Weed Species	None	None	*Pinus elliottii*	*Pinus elliottii*	None	None	*Axonopus fissifolius*	*Axonopus fissifolius, Andro-pogon virginicus, Myrio-phyllum sp.*	None	None	None	None
Weed abundance	None	None	Low	Low	None	None	Moderate	Moderate	None	None	None	None
Recruit-ment (canopy/ mid)	None	None	No	No	None	Occasional saplings	Yes	Yes	Yes	Yes, small trees present	Minor	occasional small trees
Disturb-ance	Drought	Flood	Drought	Flood	Grazing and trampling by wild horses and pigs evident	Grazing and trampling possible but not observed	Cattle grazing, trampling evident	Cattle grazing, trampling evident	Limited	May be changes to hydrology, tree fall across patch of Maundia but not likely to affect	Grazing and trampling by wild horses and pigs evident	Fire, horse tracks
Comments	On northern side of drainage area	No plants detected but may be present under water - too deep for observation	Population will expand following sufficient rainfall, no large healthy plants currently present	No plants detected but may be present under water - too deep for observation	*Maundia triglochinoides* estimated 10% cover across entire plot			Evidence of high water flow in recent flood. Probably no effect on hydrology from highway.				
Comments 2			Look at previous photos of this population ?		*Maundia triglo-chinoides* 20% cover along transect		Heavy rain came through during survey	Heavy rain came through during survey		Additional small patches located in 2014 not found	*Maundia triglochinoides* 40% cover along transect	*Maundia triglochinoides* 40% cover along transect

Site Code	Mt-C2.1	Mt-C2.1	Mt-2.1	Mt-2.1	Mt-C2.2	Mt-C2.2	Mt-2.2	Mt-2.2	Mt-2.3	Mt-2.3	Mt-2.4	Mt-2.4
Date	**2/05/2014**	**3/07/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**3/07/2016**	**2/05/2014**	**27/6/2016**	**2/05/2014**	**27/06/2016**
Abundance summary	Low-Moderate	Not detected	Low-Moderate	Not detected	Moderate-High	Patch 10 x 10m with 30% cover, patch 5 x 5m 10% cover mixed with Eleocharis, northern small channel 5 x 2m with 1% cover.	Low-Moderate	Probably reduced from 2014, based on photos (but close inspection not possible)	Low-Moderate	Patch about 3 x 2m, cover 5% within patch. Location 506315E, 6692136N	Moderate-High	Moderate-High

Photos Mt-C2.1

Mt-C2.1 Habitat transect April 2014

Mt-C2.1 Habitat transect June 2016

Mt-C2.1 Habitat on eastern boundary of plot June 2016

Photos Mt-2.1

Mt-2.1 Habitat transect April 2014

Mt-2.1 Habitat transect June 2016

Note photos are poorly matched. Construction had removed markers, transect re-marked.

Mt-2.1 Looking SW at damming effect of highway, bank and sediment fence June 2016

Water flow was previously east-west from standing water on east side of bridge. Water is now dammed and water is very deep, at least 70cm, in the quadrat area. Erosion and sediment appear well controlled.

The change to the hydrology resulting from construction probably also has a bearing on site Mt-C2.1.

Photos Mt-2.2

Mt-2.2 Habitat transect April 2014

Mt-2.2 Habitat transect June 2016 (taken from boundary, photos not matched)

Mt-2.2 Maundia growing in shallow pool, June 2016

Mt-2.2 Maundia growing with Myriophyllum June 2016

Photos Mt-2.3

Mt-2.3 Habitat transect April 2014

Mt-2.3 Habitat transect June 2016. Treefall since 2014 but unlikely to affect Maundia.

Mt-2.3 Maundia leaves, June 2016

Photos Mt-2.4

Mt-2.4 Habitat transect April 2014

Mt-2.4 Habitat transect June 2016

Mt-2.4 Maundia along the transect line June 2016

Mt-2.4 Maundia, slight browning off, June 2016

Species *Quassia sp. Moonee Creek*

Habitat transect data QM-C1.1 and QM-1.1

Site code	QM-C1.1	QM-C1.1	QM-1.1	QM-1.1
Date	**30-Apr-14**	**21-Jun-16**	**30-Apr-14**	**14-Jun-16**
Marker	Yellow Tape	Pink Tape	Yellow Tape	Pink Tape
Location	Dirty Creek Range, southern population	Dirty Creek Range, southern population	Dirty Creek Range, southern population	Dirty Creek Range, southern population
Location 2	Dirty Creek	Dirty Creek	Dirty Creek	Dirty Creek
Easting	514990	514990	515007	515007
Northing	6681980	6681980	6681990	6681990
Transect orientation	Southeast, parallel to property boundary	Southeast, parallel to property boundary	South	South
Climate previous	Rain end of March and start of April, dry preceding	Heavy rain in previous 3 weeks following long dry period	Rain end of March and start of April, dry preceding	Heavy rain in previous 3 weeks following long dry period
Climate current	Rain developing	Clear, light cloud	Rain developing	Showers
Landform	Lower to mid slope	Lower to mid slope	Lower slope / gully	Lower slope / gully
Drainage	Good	Good	Good	Good
Slope	Steep	Moderate	Steep	Steep
Aspect	Northeast	Northeast	Northeast	Northeast
Soil moisture	Moderate-High	Moderate-High	Moderate-High	Moderate
Water levels	No water in drainage line	No water in drainage line (distant from plot)	No water in drainage line	Moderate
Water flow	None	None	None	Moderate
Plant condition (0-5)	4 to 5	2 to 5	4 to 5	1 to 4
Height	0.1 to 0.6 m	0.1 to 0.6 m	0.1 to 1.5 metres, mostly to 0.5 m	0.1 to 1 m
Width	0.1 to 0.3 m	Clumps to 0.8m diameter	Mostly to 0.5 m	Clumps to 1.5m diameter
DBH	n/a	n/a	n/a	n/a
Leaf cond	Healthy, dark green	4-May	Healthy, dark green	2 to 4
Length new shoots	None		None	
Flowers	No	No	No	No
Fruit	No	No	No	No
Recruitment	Possible	Possible	Possible	Possible
Disease/insect	None	Yes, some herbivory	None	None
Dieback	Some minor yellowing on some plants, one dead plant present	Some minor yellowing on some plants, some stem dieback	Some minor yellowing on some plants	Moderate amount of dieback
Threats	Graded trail and clearing for fence construction, plants have regenerated on trail	Graded trail and clearing for fence construction, plants have regenerated on trail	Lack of fire, competition, smothering with leaf litter	Lack of fire, competition, smothering with leaf litter
VegComm	Large-fruited Blackbutt	Large-fruited Blackbutt	Large-fruited Blackbutt Forest	Large-fruited Blackbutt Forest

Site code	QM-C1.1	QM-C1.1	QM-1.1	QM-1.1
Date	**30-Apr-14**	**21-Jun-16**	**30-Apr-14**	**14-Jun-16**
	Forest	Forest		
Canopy species	*Eucalyptus pyrocarpa, Angophora woodsiana, Corymbia gummifera*	*Eucalyptus pyrocarpa, Angophora woodsiana, Corymbia gummifera*	*Eucalyptus pyrocarpa, Syncarpia glomulifera, Angophora woodsiana, Corymbia gummifera*	*Eucalyptus pyrocarpa, Syncarpia glomulifera, Angophora woodsiana, Corymbia gummifera*
Midstorey species	*Acacia terminalis, Hakea sericea,*	*Acacia terminalis, Hakea sericea,*	*Acacia complanata, Hakea sericea, Pultenaea tuberculata*	*Acacia complanata, Hakea sericea, Pultenaea tuberculata*
Understorey species	*Entolasia stricta*	*Entolasia stricta*	*Lepidosperma laterale, Patersonia sericea, Microlaena stipoides*	*Lepidosperma laterale, Patersonia sericea, Microlaena stipoides*
Canopy	9	10	14	25
Midstorey	4	0	15	10
Forb	5	0	20	0
Grass	25	10	5	5
Shrub (<1m)	0	10	0	0
litter	70	100	75	95
bare/water	0	0	0	5
exotic	0	0	0	0
Weed Species	None	None	None	None
Weed abundance	None	None	None	None
Recruitment (canopy/mid)	Yes	Yes	Yes	Yes
Disturbance	Graded trail and clearing for fence construction, plants have regenerated on trail	Graded trail and clearing for fence construction, plants have regenerated on trail	Trail construction upslope	Not obvious
Comments	Dieback natural habit of species	Dieback exacerbated by dry season preceding?	Some plants resprouting after being smothered with leaf litter	Dieback exacerbated by dry season preceding?
Comments 2		Boundary location, review options for future tenure of adjacent parcel.		
Abundance summary	19 stems	35 stems in 15 clumps	54 stems	174 stems in 21 clumps

Photos QM-C1.1 and QM-1.1

QM-C1.1 Habitat transect April 2014

QM-C1.1 Habitat transect June 2016

QM-1.1 Habitat transect April 2014

QM-1.1 Habitat transect June 2016

QM-C1.1 Clump 1 June 2016

QM-C1.1 Clump 13 June 2016

QM-1.1 Herbivory June 2016

QM-1.1 Clump 9 June 2016

Site data detail QM-C1.1 and QM-1.1

QM C1.1									
Clump/plant no	easting	northing	No stems	Clump diameter (cm)	Height (lower) (cm)	Height(upper) (cm)	General condition (0-5)	Leaf condition (0-5)	Notes
1	514989	6681968	1	0	50	50	5	5	
2	514989	6681969	2	20	50	65	4	5	
3	514989	6681971	1	0	35	35	4	5	
4	515012	6681971	3	20	50	60	3	4	dead branches, leaves yellowing
5	514992	6681964	4	40	10	15	2	4	shoots from exposed roots and prostrate stems on bank
6	514997	6681972	2	20	15	25	4	5	
7	514998	6681973	2	20	25	45	4	4	
8	514997	6681972	5	80	30	50	4	4	
9	514995	6681972	4	50	15	50	4	4	one dead stem
10	514996	6681973	1	0	50	50	3	4	
11	514983	6681969	1	20	25	40	4	5	some dead branches
12	514987	6681971	4	40	40	55	4	4	
13	514978	6681970	1	0	50	50	5	5	
14	514978	6681978	3	10	15	30	4	4	
15	514979	6681980	1	0	25	25	4	4	
		TOTAL	35						

QM-1.1									
Clump/plant no	**easting**	**northing**	**No stems**	**Clump diameter**	**Height (lower)**	**Height(upper)**	**General condition**	**Leaf condition**	**Notes**
				(cm)	(cm)	(cm)	(0-5)	(0-5)	
1	515006	6681976	16	70	10	40	3	3	some leaf herbivory
2	515010	6681975	17	60	5	20	4	4	
3	515012	6681976	8	30	10	30	3	3	some leaf herbivory
4	515008	6681981	19	150	10	60	3	4	
5	515007	6681984	16	90	10	40	3	4	
6	515010	6681983	6	50	10	40	3	4	
7	515008	6681984	6	80	20	100	4	4	
8	515007	6681985	8	70	10	50	3	4	some branches dying back
9	515010	6681993	2	40	10	30	4	4	some leaf herbivory
10	515011	6681987	7	50	10	40	3	4	some leaf herbivory
11	515013	6681984	4	50	20	40	4	4	
12	515003	6681982	3	40	10	40	1	3	main stems dead or dying, two new shoots from ground
13	515002	6681988	1	0	80	80	2	3	one dead stem, some herbivory
14	515003	6681984	7	30	10	80	4	4	
15	515003	6681988	7	60	10	30	4	4	some leaf herbivory
16	515002	6681990	9	120	10	70	3	4	
17	515005	6681988	5	50	10	30	2	2	stems and branches dying back, herbivory, yellowing
18	515005	6681983	23	70	10	40	2	4	leaves sparse, apparently dying back
19	514999	6681984	3	10	10	30	2	3	leaves sparse, apparently dying back
20	515005	6681980	5	40	20	40	3	3	some leaf herbivory
21	515001	6681980	2	10	15	20	3	3	some leaf herbivory
		TOTAL	174						

Habitat transect data QM-C1.2 and QM-1.2

Site Code	QM-C1.2	QM-C1.2	QM-1.2	QM-1.2
In situ/control	Control	Control	In situ	In situ
Date	30-Apr-14	21-Jun-16	30-Apr-14	21-Jun-16
Section	1	1	1	1
Marker	Yellow Tape	Pink Tape	Yellow Tape	Pink Tape
Location	Dirty Creek Range, northern population	Dirty Creek Range, northern population	Dirty Creek Range, northern population	Dirty Creek Range, northern population
Location 2	Dirty Creek	Dirty Creek	Dirty Creek	Dirty Creek
Easting	514698	514698	514667	514667
Northing	6682120	6682120	6682150	6682150
Transect orientation	South	South	South	South
Climate previous	Rain end of March and start of April, dry preceding	Heavy rain in previous 3 weeks following long dry period	Rain end of March and start of April, dry preceding	Heavy rain in previous 3 weeks following long dry period
Climate current	Rain developing	Clear, light cloud	Rain developing	Rain
Landform	Lower slope / gully	Lower slope / gully	Lower slope / gully	Lower slope / gully
Drainage	Good	Good	Good	Good
Slope	Steep	Steep	Steep	Steep
Aspect	North	North	South	South
Soil moisture	Moderate-High	High	Moderate-High	High
Water levels	Moderate	Moderate (watercourse outside plot)	Moderate	High
Water flow	Moderate	Moderate (watercourse outside plot)	Moderate	Moderate
Plant condition (0-5)	4 to 5	3 to 4	4 to 5	4 to 5
Height	0.1 to 1.5 m	0.1 to 1.0 m	0.5 to 1.5 metres, mostly to 0.5 m	0.1 to 0.9 m
Width	Mostly to 0.5 m	Clumps to 1.2m diameter	Mostly to 0.5 m	Clumps to 1.2m diameter
DBH	n/a	n/a	n/a	n/a
Leaf cond	Healthy, dark green, new red shoots	3 to 4	Healthy, dark green, new red shoots	4 to 5
Length new shoots	5 to 10 cm red leaves (see photos)		10 cm red leaves (see photos)	
Flowers	Yes	No	No	No
Fruit	No	No	No	No
Recruitment	Possible	Possible	Possible	Possible
Disease/insect	Yes, caterpillars (see photos)	Yes, some herbivory	None	Minimal herbivory
Dieback	Minor	Minor	Very minor	Some dieback
Threats	Fire regime, lots of litter smothering plants	Fire regime, lots of litter smothering plants	Fire regime	Fire regime
VegComm	Large-fruited Blackbutt Forest	Large-fruited Blackbutt Forest	Large-fruited Blackbutt Forest	Large-fruited Blackbutt Forest
Canopy species	*Eucalyptus pyrocarpa, Angophora woodsiana*	*Eucalyptus pyrocarpa, Angophora woodsiana*	*Eucalyptus pyrocarpa, Angophora woodsiana*	*Eucalyptus pyrocarpa, Angophora woodsiana*
Midstorey species	*Leptospermum trinervium, Ceratopetalum gummifera, Acacia oshanesii*	*Leptospermum trinervium, Ceratopetalum gummifera, Acacia oshanesii*	*Acacia oshanesii, Leptospermum polygalifolium, Bursaria spinosa, Epacris pulchella, Pultenaea tuberculata*	*Acacia oshanesii, Leptospermum polygalifolium, Bursaria spinosa, Epacris pulchella, Pultenaea tuberculata*

Site Code	QM-C1.2	QM-C1.2	QM-1.2	QM-1.2
Understorey species	*Caustis flexuosa, Entolasia stricta, Themeda australis*	*Caustis flexuosa, Entolasia stricta, Themeda australis*	*Gahnia clarkei, Entolasia stricta, Aotus ericoides*	*Gahnia clarkei, Entolasia stricta, Aotus ericoides*
Canopy	14	8	14	25
Midstorey	14	15	3	7
Forb	5	5	15	0
Grass	20	15	10	10
Shrub (<1m)	15	5	10	0
litter	55	90	45	75
bare/water	0	5	25	10
exotic	0	0	0	0
Weed Species	None	None	None	None
Weed abundance	None	None	None	None
Recruitment (canopy/mid)	Yes	Occasional saplings	Yes	Occasional saplings
Disturbance		Litter and debris build up possibly due to storms		
Comments				Plants are in much better condition than 1.1
Comments 2				
Abundance summary	26 stems	152 stems in 28 clumps	78 stems	149 stems in 24 clumps

Photos QM-C1.2 and QM-1.2

QM-C1.2 Habitat transect April 2014

QM-C1.2 Habitat transect June 2016

QM-1.2 Habitat transect April 2014

QM-1.2 Habitat transect June 2016

QM-C1.2 Clump 7 June 2016

QM-C1.2 Flowers June 2016

QM 1.2 Clump 11 June 2016

QM 1.2 Clump 18, typical sprouts from leaning stems June 2016

^Site data detail QM-C1.2 and QM-1.2

QM-C1.2									
Clump/plant no	easting	northing	No stems	Clump diameter (cm)	Height (lower) (cm)	Height(upper) (cm)	General condition (0-5)	Leaf condition (0-5)	Notes
1	514702	6682104	18	100	20	80	4	4	
2	514707	6682110	12	120	20	80	3	4	
3	514706	6682110	6	100	30	100	3	4	
4	514706	6682109	9	100	30	80	3	4	stems bent over, partly covered in debris
5	514708	6682108	2	80	30	50	3	4	stems bent over, partly covered in debris
6	514709	6682107	3	50	30	50	3	4	
7	514709	6682107	1	0	50	50	3	4	stems bent over, partly covered in debris
8	514710	6682106	3	50	25	30	4	4	
9	514710	6682102	4	20	30	40	3	4	stems bent over, partly covered in debris
10	514710	6682103	2	20	15	20	3	4	stems bent over, partly covered in debris
11	514702	6682111	6	50	20	40	3	4	
12	514706	6682105	2	20	30	30	3	4	
13	514705	6682108	2	10	40	40	3	4	some herbivory
14	514704	6682110	5	10	40	50	4	4	some herbivory
15	514706	6682110	8	80	30	60	4	4	most stems bent over, partly covered, some herbovory
16	514704	6682111	8	100	30	100	4	4	most stems bent over, partly covered, some herbovory
17	514705	6682114	11	60	10	30	4	4	
18	514707	6682112	2	40	10	20	3	3	some herbivory
19	514690	6682100	2	20	10	50	4	4	
20	514704	6682113	3	40	20	50	3	3	partly covered, some herbivory
21	514695	6682106	7	60	30	100	4	4	
23	514699	6682114	6	50	20	100	4	4	
22	514699	6682115	9	30	40	100	4	4	some stems and branches dying back
24	514700	6682116	2	10	40	50	4	4	
25	514696	6682109	4	100	40	80	4	4	some stems and branches dying back
26	514695	6682108	4	80	30	50	4	4	stems bent over
27	514693	6682110	8	50	20	50	4	4	
28	514693	6682110	3	50	20	40	4	4	stems bent over
		TOTAL	152						

QM-1.2 Clump/plant no	easting	northing	No stems	Clump diameter	Height (lower)	Height(upper)	General condition	Leaf condition	Notes
				(cm)	(cm)	(cm)	(0-5)	(0-5)	
1	514668	6682162	1	0	60	60	4	4	
2	514669	6682158	10	100	10	60	4	4	some stems dying back
3	514673	6682156	6	40	10	30	4	4	
4	514673	6682160	9	50	10	30	4	4	
5	514670	6682159	1	0	20	20	5	5	
6	514675	6682154	5	50	5	50	4	4	
7	514674	6682152	8	100	20	25	4	4	
8	514667	6682152	4	50	20	40	4	5	
9	514664	6682156	3	30	15	20	4	5	
10	514667	6682156	1	0	40	40	4	5	
11	514666	6682146	7	50	14	20	4	4	some leaf herbivory
12	514654	6682138	12	100	15	60	4	5	
13	514661	6682142	10	60	10	90	4	4	
14	514666	6682142	9	60	20	80	4	4	
15	514740	6682181	21	100	10	50	4	4	
16	514653	6682161	10	100	20	30	4	4	
17	514668	6682148	3	50	30	40	4	4	
18	514657	6682151	2	30	20	50	4	4	over hanging creek
19	514659	6682150	1	0	30	30	4	5	
20	514661	6682152	3	20	30	60	4	5	
21	514661	6682153	15	120	20	50	5	5	
22	514658	6682156	5	30	10	20	5	4	
23	514661	6682158	1	0	20	20	5	5	
24	514702	6682104	2	20	20	30	5	5	
		TOTAL	149						

Appendix 3 Monitoring site details (boundary observations)

Contents

Site codes:

Li-1.1
Mt-1.1
Mt-C1.1
LaC1.1, Mt-C1.2, Mt-1.2, Elt-1.1
Elt-1.3
Elt-C1.1, La-C1.2
Elt-1.4, La-1.3
Elt-C1.2, La-C1.3

Site code	Li-1.1	
Date	03-Jul-16	
Location	Cassons Creek, west of Post Office Lane	
Data collection location	Boundary, edge and within clearing boundary	
Erosion	None apparent	
Sedimentation	Channel contains sediment and has netting on banks	Photo from 516812, 6679681 looking SW
Other notes (site specific threats or damage etc)	No impact on Lindsaea	
		Channel on side of road

Site code	Mt-1.1	
Date	03-Jul-16	
Location	Cassons Creek, west of Post Office Lane	
Data collection location	From boundary, about 20m from plot	
Change to hydrology	Banked up water on roadside	
Dieback, physical damage to vegetation	None observed	
		Photo from 516828, 6679570, looking W
Any observations of threatened flora where visible, including binocular scan	No Maundia observed	
Recommendations	Discarded fencing to be removed	
		Sediment load in water, no sediment fence, flowing into wetland

Site code	Mt-C1.1	
Date	03-Jul-16	
Location	Cassons Creek, west of Post Office Lane	Photo from 516941, 6679729, looking east.
Data collection location	From boundary	
Change to hydrology	Diversion of ater with sediment load into wetland. The control site is distant from the project edge.	Photo from 516941, 6679729, looking south.
		
		Edge of artificial channel showing overflow into wetland

Site code	**LaC1.1, Mt-C1.2, Mt-1.2, Elt-1.1**
Date	03-Jul-16
Location	Redbank Creek downstream of project
Data collection location	From boundary
Change to hydrology	Sediment flowing down channel and into private property
Recommendations	Review hydrological management and erosion control. Protective fencing for threatened species required

Photo from 516548, 6680293 La C1.1 is 60m ENE. Elt-1.1 is at photopoint, no plants observed.

Evidence of recent high water flows, damage to protective matting

Site code	Elt-1.3, La-1.2	
Date	14-Jul-16	
Location	Northern tributary of Redbank Creek	
Data collection location	Boundary, edge	
Change to hydrology and sediment-ation	Short term sedimentation into private property and threatened species habitat	
Recommend ations	Review hydrology and sediment management. Need repairs to sediment fence and protection for threatened species habitat	Photo from 517838, 6677708 looking NNE towards N point of quadrat (which is about 5m inside boundary).
		
		Photo from 517838, 6677708 looking SE, showing clearing for fence line taking in much of quadrat.
		
		Remaining threatened species habitat requires re-instatement of protective fencing

Site code	Elt-C1.1, La-C1.2	
Date	14-Jul-16	
Location	Northern tributary of Redbank Creek	
Data collection location	Boundary, distance	
Threats	Habitat (outside quadrat) is bisected by minor channel	
		Photo from 516041, 6680952, looking NE towards site. Distant from boundary, no impact likely
Recommendations	Consider options for encouraging recovery of natural habitat and also for using a bund to prevent scouring during high flood.	
		Downstream observations: side drain (local road drain) adjacent to quadrat, traverses habitat.

Site code	Elt-1.4, La-1.3	
Date	14-Jul-16	
Location	Northern tributary of Redbank Creek	
Data collection location	Boundary, edge	
Threats	Quadrat is intact but on private property, upstream from impacts but there will be more light exposure since clearing	
		Photo from 516828, 6679570, looking W
Recommendations	Existing monitoring should pick up any weed problems due to exposed edge	

Site code	Elt-C1.2, La-C1.3	
Date	14-Jul-16	
Location	Northern tributary of Redbank Creek	
Data collection location	Boundary, distance	
	Same photopoint as Elt-1.4, La-1.3, quadrat is distant	
Threats	None apparent	
		Photo from 516828, 6679570, looking W