Frances Creek Revegetation Management Plan

Project No: 233/10M/901

Queensland Government

PROJECT DETAILS			
TMR District	Northern District		
Project Name / Description	Frances Creek Revegetation Management Plan		
Project Number	233/10M/901		
Project Location	Bruce Highway 233 / 84.55-86.55 / -20.9989 146.4266 / 1/CY25, 1/CY16 / Frances Creek		
Local Government Area	Hinchinbrook	**QTRIP WBS**	
Road No / Facility No	Bruce Highway 233	**DMS Reference**	450/00027

REPORT PREPARATION			
I have prepared this report based on the best information available at the time. I have taken into account, to the fullest extent possible, all actual and likely environmental impacts of the project.			
Name	Greg Calvert	**Signature**	
Position	Environment Officer	**Date**	03/08/2016

REPORT REVIEW			
Name	Ben Cotton	**Signature**	
Position	Senior Environmental Officer	**Date**	03/08/2016

VERSION HISTORY			
Version No.	**Date**	**Changed by**	**Nature of Amendment**

PROJECT MANAGER ACCEPTANCE			
I agree that this report has been prepared based on the project scope at the time, and accept responsibility for ensuring any future changes to the scope are appropriately assessed. I understand the likely impacts and legislative consequences of not actioning the recommendations.			
Name			
Position	Project Manager, Frances Creek Bridge Upgrade	**Date**	03/08/2016

***Note**: This Environmental Assessment Report shall remain current for 12 months. A review will be required after this time should further subsequent assessment or management actions not be undertaken.*

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1. Introduction

It is proposed to remove approximately 0.7ha of non-remnant habitat on the eastern side of the Bruce Highway at Frances Creek, approximately 11km south of Ingham. Although this area is mapped as non-remnant vegetation and does not constitute 'Essential habitat' under the *Vegetation Management Act 1999*, its strategic location is a priority wildlife corridor make it 'critical habitat' as defined in the draft Mahogany Glider recovery plan. As the existing highway corridor does not represent a barrier to movement, the proposed clearing area may potentially include habitat for one or two gliders, but not a population. Although artificial poles will be erected to facilitate ongoing movement across the new highway corridor, the removal of this 0.7ha area therefore constitutes a residual environmental impact.

1.1 Aims and Objectives

This document outlines the desired outcomes and strategies for the Frances Creek rehabilitation project but does not equate to a Scope of Works to the contractor, and does not override the requirements of relevant Main Roads Specifications and Technical Standards.

To improve the value of remaining mahogany glider habitat within the adjacent road reserve at Frances Creek, the Department of Transport and Main Roads (TMR) will undertake weed management, site rehabilitation and revegetation works.

Some revegetation works along Frances Creek are necessary as a condition of TMR's Riverine protection permit exemption requirements. In accordance with the Draft Mahogany Glider Recovery Plan, the overall restoration and management of Mahogany Glider habitat will promote and conduct best practice management methods.

Unfortunately, no 'Best Management Practice' guidelines have been developed for revegetating mahogany glider habitat. Using relevant revegetation guidelines and scientific literature relating to mahogany glider habitat, diet and threats, we have determined that 'best practice' rehabilitation of the site should aim to achieve the following outcomes:

- maintain and improve existing levels of ease of movement;
- improve existing availability of food resources;
- maintain and improve existing levels of available dens;
- significantly reduce threatening processes (for example weed invasion, thickening by rainforest plants, destructive wildfires);
- use only locally occurring species of local provenance;
- use the Qld Herbarium benchmarks for Regional Ecosystem 7.3.25a (grassy understorey subtype) to monitor progress towards remnant status;
- ensure all revegetation and site rehabilitation works will comply with Main Roads Specifications and Technical Standards, including Environmental Management (MRTS51), Erosion and Sediment Control (MRTS52), Landscape & Revegetation Works (MRTS16) and Earthworks (MRTS04).

1.2 Extent of Works

Following construction work at Frances Creek and removal of the redundant highway pavement, an area of road reserve 35,917m^2 on the eastern side will be dedicated to revegetation and ecological restoration, taking into consideration the necessary clearances from the new highway alignment (14m) and two powerlines (10m). An additional area of 4,710m^2 within road reserve is already mapped as remnant, although some of this area has been determined to be degraded areas dominated by introduced grasses. Although all areas are degraded to some extent, approximately 14,451m^2 (40.11%) is wholly degraded and dominated by weeds.

The site is dissected by two powerlines (66Kv and 11Kv), the easements of which are dominated by tall introduced grasses. These easements will represent a significant fire and weed invasion threat unless they are also managed. Managing the 15,357m^2 of weeds within these corridors should therefore be considered essential to the long term success and sustainability of the site.

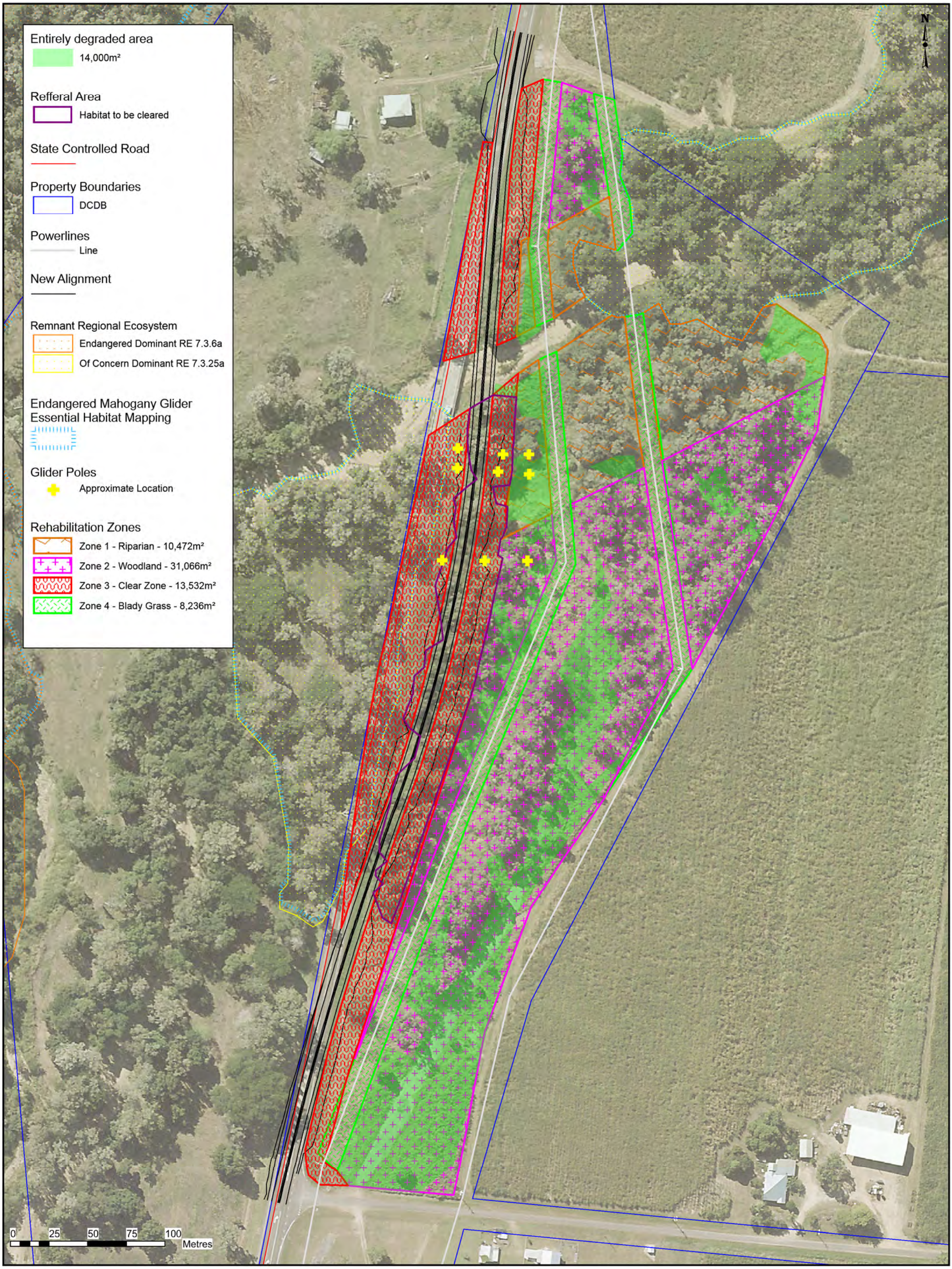
The scope of works will be to remove all woody weeds within the site, and control dominant grassy weeds for as long as is required for revegetated areas to have achieved maturity and suitable levels of fire resistance.

Within wholly degraded areas, revegetation will include tree planting using suitable tree species of local provenance, planted at intervals consistent with remnant vegetation. Benchmarks for the cover and height of canopy trees are available for this regional ecosystem (7.3.25a). Tree selection will consist predominantly of species that are known mahogany glider food plants, fire resistant at maturity and consistent with this vegetation type in the Ingham region.

Within areas where a native tree canopy already exists, weed management will be undertaken to ensure that those trees can continue to develop without the competition and fire risk from the abundant weeds.

Within the weed dominated powerline corridors, a regime of frequent slashing and spot spraying regenerating clumps of Hammil grass should allow low growing grasses to dominate the site. The ultimate aim will be for the understorey to be dominated by blady grass (*Imperata cylindrica*).

Approximate location of available degraded areas and revegetation zones is provided in Figure 1.



Branch/Unit: **Environment and Heritage Services**	**Frances Creek Bridge Replacement Environmental Triggers Map**	Queensland Government	
Projection/ Datum: MGA Zone 55 (GDA 94)		Transport and Main Roads	
File location: G:\TOWD\PROGRAM\DELIVERY\HSC\233-10M-1\02_Dev Phase\Environment		Plan No/ Job No: 11767	Issue: C / Date: 18/8/2016
		Drawn by: R J W	Checked by:

2 Rehabilitation Methodology

Prior to revegetation works, the site will be inspected to ensure the following conditions:

- All redundant pavement, fill, road base material, and temporary culverts associated with the side track and bridge construction works have been removed from site
- Any stockpiled topsoil has been spread over the site
- Compacted areas under the redundant section of highway have been suitably treated (ripping followed by a wheel roller for light compaction/consolidation) to allow for water percolation and root penetration.
- Old sections of pavement within the revegetation area will be removed and ripped (an area of 2349m^2), and stockpiles of gravel and rock and so on removed or relocated out of the revegetation area – Figure 2
- Rock armouring and other erosion protection works in the water courses has been completed

Figure 2: Old asphalt strip within revegetation area

2.1 Weed Control

Habitat degradation through weed invasion, and predation by feral animals are both identified as threatening the Mahogany glider (Parsons & Latch 2007). Weeds suppress grass growth which in turn reduces the ability of fire to progress through the vegetation patch.

A number of invasive species are already present on site. Surveys undertaken identified 15 introduced weed species, including two species declared under the Biosecurity Act 2014 (Table 1). Although control of all declared and priority weeds should be undertaken on the site, the presence of some non-declared environmental weeds is also of concern.

***Table 1:** Introduced weeds present on the Frances Creek site*

Species	Common name	Class	Hinchinbrook Pest Priority*	Form
Centrosema molle	centro			vine
Cucumis anguria	burr gherkin			vine
Cyperus aromaticus	navua sedge		24	grass
Hyptis capitata	knobweed			herb
Leucaena leucocephala	leucaena			shrub/ tree
Macroptilium atropurpureum	siratro			vine
Megathyrsus maximus var. *maximus cv. Hamil*	hamil grass			grass
Opuntia stricta	prickly pear	Restricted 3	17	cactus
Passiflora foetida	stinking passionfruit			vine
Pennisetum purpureum	elephant grass			grass
Sansevieria trifasciata	mother-in-laws tongue			herb
Sida rhombifolia	paddy's lucerne			herb
Spathodea campanulata	African tulip	Restricted 3	14	tree
Stachytarpheta cayennensis	blue snake weed			herb
Urochloa mutica	para grass			grass

*** Pest Management Plan Priority from Hinchinbrook Local Government Area Pest Management Plan 2013 - 2017**

Dominant Grasses: The biggest influence on the site, and the biggest challenge in rehabilitating the site, is the dominance of the large, aggressive perennial grasses Hamil grass (*Megathyrsus maximus* var. *maximus* cv. Hamil) (Figure 3) and elephant grass (*Pennisetum purpureum*). These species both grow to more than 3 metres in height and generate very high fuel loads and can carry hot destructive wildfires. The wildfires in turn can destroy any revegetation works, increase the loss of canopy trees, and consequently sever connectivity. As both species are fire-tolerant, they can dominate a site following fire (Cook 2008).

Hamil grass is also a prolific seed producer. Establishing a crop of this grass only requires 1-3kg seed/ha but infestations can generate 50-100kg seed/ha (Cook 2008). The obvious weakness to exploit in managing Hamil grass is its short-lived seed viability under natural conditions; with little viable seed persisting after 12 months (Stone 2006). Elephant grass has a very low seed set, producing few viable seeds (Loch & Ferguson 1999). As both species are sensitive to regular slashing and applications of glyphosate or selective grass-killers, maintaining an aggressive approach to grass management on site for more than 12 months should effectively eliminate the seed bank of both species, though any flooding is likely to introduce new Hamil grass seed from upstream infestations. While a dense rainforest canopy would be effective in permanently shading out these species, the

woodland structure of the desired remnant vegetation community would be unlikely to exclude the grasses.

Figure 3: Tall Hamil grass* dominates disturbed non-remnant sections of the site

The most desirable understorey grass would be the native blady grass (*Imperata cylindrica*). There are a number of small but pure stands of blady grass on site (Figure 4) and probably represent relics of the former dominant grassy understorey. It is likely to have declined as a consequence of reduced fire frequency, increased shade from colonising rainforest pioneers, and competition from aggressive introduced grasses. Blady grass could be restored onto site by reintroduction of a fire regimes, active control of competing grasses, removal of shady canopy and direct seeding in adequately prepared areas.

This grass will still generate a relatively high fuel load so its use should be largely encouraged in areas away from tree planting, such as underneath the power lines. The use of lower growing grasses may not be able to resist recolonization by the more aggressive hamil and elephant grasses.

Generally, fuel loads need to be carefully managed on the site for a period of at least 5-6 years until revegetated areas develop fire resistance. Weed exclusion mats and/or thick mulch could be used in association with new plantings to reduce weed establishment and trees have their lower branches pruned off to limit leaf scorch and reduce the ability of the fire to ascend.

Figure 4: Stand of blady grass (Imperata cylindrica) at Frances Creek

Woody weeds: Woody weeds such as Leucaena (*Leucaena leucocephala)* and the declared African tulip (*Spathodea campanulata*) can cause vegetation thickening, reducing the ability of Mahogany gliders to be able to traverse the site. Large woody weeds can be poisoned by stem injection or application to the trunk (basal bark application), leaving the dead tree standing. This opens the canopy and provides roosts for birds and open launching sites for mahogany gliders. This approach should not be undertaken where the dead tree may fall within the road reserve or impact on the power lines.

Vines: Several vine species occur on site which are well known to create problems in revegetation sites. Centro (*Centrosema molle*), siratro (*Macroptilium atropurpureum*) and stinking passionfruit (*Passiflora foetida*) can smother and suppress the growth of native plants, particularly at the young sapling stage, however, even large trees can be smothered under blankets of vines.

Where existing lines of native trees persist, a management priority will be restoration of canopy health and improved community resilience using the 'Wingham Brush Method' (Harden *et al*. 2004). In contrast to the low-disturbance principles of the Bradley Method, the principles of the 'Wingham Brush Method' are:

(i) assist the formation of the canopy by eradicating canopy weeds (vines);

(ii) promote succession in large gaps or clearings and on margins by transplanting or planting early successional trees;

(iii) remove ground weeds after the canopy had established; and

(iv) be flexible, adapt the principles to the site and prevailing conditions (Harden *et al*. 2004).

Regrowth of these vines should be specifically targeted during weed management activities, however, the resilience of the site to impacts by vines has been shown to be greatly improved by pruning low tree branches to 1.5-2m.

Fire Management

The use of fire would be desirable as a first measure for managing the site for the following reasons

- Immediate reduction in fuel loads across the site;
- Easy access to site with improved visibility of machinery hazards such as dumped blocks of concrete;
- Reduction in abundance of undesirable rainforest plants in favour of desirable sclerophyll species;
- Significantly reduced costs in slashing grass across the site;
- Stimulation of dormant seed banks of undesirable weeds such as Leucaena, thereby depleting the seed banks and making control more achievable;
- Increased dominance of desirable blady grass; and
- Stimulate out-of-season growth of hamil grass, making herbicide control more effective

The use of fire may be undesirable as:

- There is the potential for electrical arcing from powerlines in excess of 11Kv in the presence of smoke;
- Slashing is required beforehand to protect assets such as powerpoles and trees with hollows;
- Requirement for traffic management due to smoke hazard; and
- Potential loss of regenerating saplings of desirable species

Ultimately, the potential use of fire would need to be assessed for its cost and practicality on site, compared to mechanical methods of weed management.

2.2 Revegetation

The aim of the revegetation project will be to restore the site to a condition consistent with a remnant example of Regional Ecosystem 7.3.25a – 'Riverine wetland or fringing riverine wetland. *Melaleuca leucadendra* open forest and woodland'. Two forms of this community are known – with a rainforest understorey, or with a grassy understorey (Pers comm. Annie Kelly Senior Ecologist, Queensland Herbarium). While inclusion of rainforest plants in the understorey would benefit the site by suppressing weeds, woodland thickening and transition to rainforest encroachment is considered a significant threatening process for the mahogany glider, and creates difficulties for ongoing management (Jackson *et al* 2015). Therefore, revegetation at the Frances Creek site will aim to meet the benchmarks for the cover and height of canopy trees available for the grassy understorey form of this regional ecosystem.

Although a number of rainforest pioneer species were present on the site, these had not developed to the extent that they either dominated or significantly influenced the structure of the vegetation community. No rainforest plants will be used in this revegetation project, although species typical of gallery forest on Frances Creek will be used in the location and density at which they are occurring naturally, such as the Leichardt tree (*Nauclea orientalis*) and river cherry (*Syzygium tierneyanum*). It should be noted that these two spexcies have been identified as glider food trees (Jackson 2001). Revegetation will be predominantly feature sclerophyllous species, particularly Myrtaceous species recorded in the literature as being known mahogany glider food plants.

A grassy understorey will be promoted, though fuel loads need to be carefully managed in the vicinity of planted trees for at least 5-6 years. Some areas, such as underneath the powerlines will be encouraged to become open areas of blady grass (*Imperata cylindrica*) with the expectation of this species becoming the dominant understorey throughout the site. This will allow competition to resist reinvasion of the larger hamil and elephant grasses, will maintain a lower fuel load than the existing exotic grass understorey but will still allow for the ongoing use of fire to maintain a sclerophyll woodland that meets the habitat requirements for mahogany gliders.

2.3 Species selection

In order to maximise the beneficial outcome for the mahogany glider, it is important to revegetate using species that provide both the desirable structural formation and the food resources. To be able to provide valuable foraging habitat, an area should have a high diversity of plants, as different species species have distinct periods of the year when it provides a food resource (Jackson 2001). It is known that the majority of nectar and pollen eaten by the gliders are from plants in the Myrtle family Myrtaceae, particularly species of *Eucalyptus*, *Corymbia* and *Melaleuca* (Jackson 2001), however many more species have attributes that would be attractive to mahogany gliders. They are also known to eat the sap from *Albizia procera* and *Acacia mangium*, insects, lerps and honeydew, *Acacia* arils and fruit from mistletoes (Jackson 2001). A review of food resources by Jackson (2001) lists 64 species of known and potential food plants, and this list includes several rainforest and gallery forest species such as *Dillenia alata, Elaeocarpus angustifolius, Ficus racemosa, Melicope elleryana, Nauclea orientalis, Syzygium tierneyanum* and *Syzygium forte*.

In determining the optimal species composition for re-establishing wildlife corridors for mahogany gliders, the draft Species Recovery plan recommends that the revegetated areas consist of:

1. At least one species of bloodwood (e.g. *Corymbia clarksoniana* or *C. intermedia*),
2. At least two species of eucalypts including Poplar Gum (*Eucalyptus platyphylla*), Forest Red Gum (*Eucalyptus tereticornis*), Red Mahogany (*Eucalyptus pellita*) and/or Cadaghi (*C. torelliana*).
3. One of two species of *Melaleuca*s including Cloudy tea Tree (*Melaleuca dealbata*), Long-leafed Paperbark (*M. leucadendra*), Broad-leafed Tea-tree (*M. viridiflora*), or Broad-leaved Paperbark (*Melaleuca quinquenervia*).
4. Two or more species of *Acacia* including Brown Salwood (*A. crassicarpa*), *A. flavescens* and Brown Wattle (*A. mangium*),
5. *Albizia procera*, and

6. Johnson's Grass Tree (*Xanthorrhoea johnsoni*).

Although mapped as non-remnant, the proposed revegetation site has more than 50% tree cover, and there is good connectivity with the continuous corridor of riparian / gallery forest along Frances Creek. Along the length of the corridor, there is good tree cover along the banks of the stream, consisting of a mixture of weeping paperbark (*Melaleuca leucadendra*), river cherry (*Syzygium tierneyanum*), Leichardt tree (*Nauclea orientalis*) and other typical gallery forest species. Eucalypts such as Moreton Bay ash (*Corymbia tessellaris*) and Forest blue gum (*Eucalyptus tereticornis*) were commonly encountered. Forest siris (*Albizia procera*) is present but uncommon.

Species selection on site will, as a minimum, include the range of glider food species present on the site and incorporate most of the recommendations for optimal revegetation composition listed above. The strategic planting of known food plants may be used to entice gliders to utilise installed glider poles and rope crossings.

Of concern in the region is the spread of the Myrtle rust (*Uredo rangelii*); a fungus of plants in family Myrtaceae which contains most of the species critical to the survival of Mahogany gliders. Myrtle rust infection can cause defoliation, twig mortality and abortion of flowers and fruits so could reduce food availability for gliders. Although the water gum (*Tristaniopsis exiliflora*) is listed as a glider food plant (Jackson 2001), it should not be planted on this site as it is highly susceptible to myrtle rust and is likely to act as a 'gateway species' for a broader infestation of the site.

Planning revegetation at Frances Creek requires the division of the site into several different zones, each with their own limitations, outcomes and preferred species selection. These zones may include the following:

- The use of low growing species (e.g.blady grass) is essential within the 10m clearance zones around powerlines,
- Plantings close to Frances Creek (ie inside the artificial bund walls) are likely to be more likely to be subjected to high water velocities and longer periods of inundation after extreme weather events, so plants in this zone need to be species typical of this habitat
- Plantings further away from the creek are likely to eventually be growing through a grassy understorey, so need to be fire resistant species

Although the riparian strip is more likely to be subject to higher water velocities, the entire site can be expected to be subject to flooding and inundation during extreme events, so all species must be those tolerant of periodic inundation.

Flooding during extreme events have the potential to scour the ground and wash away recent plantings. Plant losses from flooding will be reduced by planting the riparian zone into jute mat or other approved biodegradable erosion matting with a water velocity tolerance of at least 2.5m/second. The upstream leading edge of the strips of jute matting will be secured in a trench 200mm deep and the mat secured with 300mm steep pins at a pinning rate of 3 pins per m^2. Growtube bags and stakes are not to be used.

A list of suitable plant species is provided below, indicating which species are listed in the literature as being known mahogany glider food plants.

Table 2: Recommended revegetation species by zone

Species	Common name	Form	Glider food[#]	Zone
Acacia flavescens	yellow wattle	mid storey tree	Yes	2
Acacia mangium	hickory wattle	canopy tree	Yes	2
Albizia procera	forest siris	mid storey tree	Yes	2
Alphitonia excelsa	soap bush	mid storey tree	No	2
Corymbia clarksoniana	grey bloodwood	canopy tree	Yes	2
Corymbia tessellaris	Moreton Bay ash	canopy tree	Yes	1, 2
*Cynodon dactylon**	green couch	grass	no	3
Cyperus spp.	sedge	sedge	No	1
Eucalyptus tereticornis	forest blue gum	canopy tree	Yes	1, 2
Ficus opposita	sandpaper fig	mid storey tree	Yes	1
Imperata cylindrica	blady grass	ground cover	No	2, 4
Lomandra hystrix	green matrush	ground cover	No	1, 3, 4
Lophostemon suaveolens	swamp box	canopy tree	Yes	1, 2
Melaleuca dealbata	cloudy tea tree	canopy tree	Yes	1
Melaleuca leucadendra	weeping paperbark	canopy tree	Yes	1
Melaleuca quinquenervia	broad-leaved paperbark	canopy tree	Yes	1
Millettia pinnata	pongamia	mid storey tree	No	1
Nauclea orientalis	Leichhardt tree	canopy tree	Yes	1
Pandanus cookii	screw pine	mid storey tree	No	1
Paspalum distichum	water couch	grass	No	3
Phragmites australis	common reed	grass	No	1, 4
Syzygium tierneyanum	river cherry	mid storey tree	Yes	1
*Urochloa decumbens**	signal grass	grass	No	3

- From Dettman *et al* (1995), Jackson (2001)

Albizia procera is a common mahogany glider food plant in the Ingham area and is particularly encouraged due to its importance as a food plant in the area when other food plants aren't flowering as gliders feed on the sap from the trunk. Although several native vines occur in the project area, they have been excluded from the planting list as they may be detrimental to establishing the revegetation in its early stages. It is not recommended to grow Grass Tree (*Xanthorrhoea johnsoni*) on site. The

extent of large introduced grasses is so extensive on the site that the long-term persistence of understorey plants like grass trees is highly doubtful. To break the cycle of exotic grass dominance, a regime of frequent slashing, selective herbicide use and replacement with native grasses such as blady grass will be required.

2.3.1 Fire management:

Regional Ecosystem 7.3.25 is usually considered unlikely to burn owing to lack of flammable grasses, and it is noted that even the typically fire-adapted Melaleuca forest will be damaged if a high intensity or frequent fire regime is imposed (Regional Ecosystem Database REDD Version 6). It is unlikely that the large exotic grasses can be permanently excluded from the site, but to reduce the impact of hot wildfires, it will be necessary to exclude fire for the first five years at least to allow trees to develop the height and fire resistance necessary for their long term persistence on site. The use of fire breaks and fuel load management will be critical in achieving project success. Eventually, once the planted trees are sufficiently mature and the understorey is dominated by blady grass, fire can be used as a management tool. Guidelines for the best practice use of fire for the benefit of mahogany gliders has yet to be developed. Although the Regional Ecosystem Database (REDD Version 6) discourages the deliberate burning of this vegetation community, it is also known that the exclusion of fire from these habitats is detrimental, and that in general, the implementation of an active and ongoing fire management program is required to restore the integrity of the sclerophyll woodlands and forests that comprise mahogany glider habitat (Jackson *et al.* 2015).

2.4 Planting Considerations

In accordance with best practice, it is considered a critical element of revegetation success to use local provenance plants, as the use of native species from other areas can compromise the genetic integrity of the local bushland (Burgin *et al* 2005).

In Zone 1 (Riparian), plants are selected for tolerance to high water velocities and prolonged inundation. Restoration works will require stabilisation of the stream banks while also allowing for the necessary clearances from roads and powerlines, so the planting palette will includes shrubs or herbaceous species for those areas. Where existing native trees are absent, woody plants should be spaced 2m apart, in a staggered formation, using mid storey trees or shrubs as a spacer between the larger canopy tree species. Low growing herbaceous species (e.g sedges) should be planted at staggered intervals 40cm apart. *Melaleuca leucadendra* will be given priority as a canopy species to maintain consistency with the existing appearance and Regional Ecosystem.

In Zone 2 (woodland), plantings should comprise only fire-tolerant sclerophyllous species. Where existing trees occur, canopy health should be restored by managing canopy weeds. In degraded areas where canopy trees are absent, tall introduced grasses should be rigorously controlled but stands of native grasses (for example, Blady grass (*Imperata cylindrica*) should be actively encouraged to expand from existing but limited stands.

Tree spacing in revegetation areas are based on the limited benchmarks for tree spacing for Regional Ecosystem 7.3.25a (grassy understorey type) provided by Annie Kelly (Senior Ecologist Queensland Herbarium). The following benchmarks will be used as a guide only for this project:

- Tree canopy cover – 15%
- Canopy height – 21m
- Grass species richness – 4 species

These benchmarks are at the lower end of desirable outcomes, and additional benchmark sites may need to be established to better determine the normal condition for remnant patches of this community. It is expected that a canopy tree spacing of approximately 5m will be desirable, however, a lower storey of Acacia will be desirable as spacers between trees and to provide competition with the exotic grasses.

Plantings close to the powerline should consist of the lower growing species, with increasing size of plants further away from those clearance zones.

In Zone 3 (highway clear zone), revegetation will be entirely with grasses to allow a clear zone for access and maintenance. Importation of topsoil will be required, as this zone includes the area occupied by the existing Bruce Highway. However, topsoil is a potential source of weed contamination, so regular inspections and weed control (if necessary) should be incorporated into the work program.

Planting in this zone will be undertaken using direct seeding in a bonded fibre matrix (BFM) hydromulch slurry to the area. The mixture would include a slurry of organic mulch (e.g. bagasse, cane fibre, paper mulch, and so on) with a slow release native fertiliser (low P), water retention polymer, glue, water and appropriate grass seeds.

Grasses should be a mixture of annual species that will germinate rapidly and provide rapid ground cover and organic matter. A smaller quantity of perennial grasses will give long term cover and stability to the site. The primary recommended perennial grass species are green couch (*Cynodon dactylon*) and signal grass (*Urochloa decumbens*). Although these are not native plants, they are recommended because they:

- meet TMR specifications for maximum allowable height;
- will provide a high degree of soil stabilisation and protection;
- are tolerant of large variations in rainfall including short-term flooding;
- will suppress regrowth of weeds through competition;
- produce relatively low fuel loads for providing protection from future fires;
- are commercially available in large quantities;
- are suitable for hydroseeding; and
- will not smother native seedlings.

Both species are widespread in the Ingham area, so their use would not be introducing a new plant to the area. Green couch seed will be applied equally as hulled and unhulled. Unhulled seed have low dormancy and will be expected to germinate immediately, while hulled seed will remain dormant longer and germinate sporadically over longer periods as a way of reducing risk from a low establishment success rate from the initial germination event. Signal grass is the most common

roadside grass in the Ingham area. As this species has a long above-ground stem (stolon), it is considered particularly suitable for erosion control and roadside rehabilitation (Heritage Seeds 2014).

Water couch (*Paspalum distichum* or *Brachyachne convergens*) are highly desirable native species for this area, and efforts should be made to include one of these species in the direct seeding mix, preferably as a substitute for signal grass, though it is recognised that bulk seed supplies are not yet commercially available.

Recommended planting rates in the four different zones is provided in Table 5 below.

Table 3: Landscaping schedule for Frances Creek

Zone	Plant Species	Application Rate
Zone 1 (Riparian) 10,472 m^2	Plant Tubestock at 2m spacing in staggered formations, select plants from Table 2	
	• *Melaleuca leucadendra* • 3 spp min canopy trees • 3 spp min midstorey trees • *Phragmites australis* on creek bank	• Use mid-storey tree or shrub in 2/3 spaces to providing spacing between canopy trees
Zone 2 (woodland) 31,066 m^2	Encourage blady grass, plant Tubestock at 2m spacing in staggered formations, select plants from Table 2	
	• *Corymbia* spp • *Eucalyptus* spp • *Albizia procera* • *Acacia* spp	• Use *Acacia* spp in ½ spaces to providing spacing between canopy trees
Zone 3 (h'way clear zone) 13,532 m^2	Hydromulch slurry with grasses and ameliorants	
	Cynodon dactylon	Hydroseed 30kg/ha = 300g/ m^2 (50% hulled & unhulled)
	Urochloa decumbens	Hydroseed 15kg/ha = 150g/ m^2
	Water couch #	Hydroseed 15kg/ha = 150g/ m^2
Zone 4 (clear zone / powerlines) 8,236 m^2	Hydromulch slurry with grasses and ameliorants	
	Cynodon dactylon #	Hydroseed 15kg/ha = 150g/ m^2 (50% hulled & unhulled)
	Imperata cylindrica	Hydroseed 45kg/ha = 100g/ m^2

or other approved perennial native grass suitable for site conditions

The location of the different zones at Frances Creek are shown in Figure 1.

Plants should be fertilised with a slow release native fertiliser and treated with a water retention polymer (e.g Terra Cottem Soil Conditioner) to increase establishment rates.

Through its contractor, TMR will commit to regular watering and maintenance of the plantings and hydromulched areas for the first 4 months to ensure they are properly established. However, it is anticipated that the timing of the revegetation with the expected start of the wet season will result in a minimum of supplementary watering being required. No irrigation supply will be installed.

The site will be inspected on a regular basis thereafter, particularly at the end of the wet season, mid-year and prior to commencement of the wet season. These scheduled maintenance visits will include control of emerging weeds, watering plants as required and inspection for erosion or plant mortality. Dead plants will be replaced during maintenance visits if it is within the period of supplementary watering specified in the TMR technical standards "Landscape & Revegetation Works (MRTS16)". Otherwise, replacement of dead plants will be undertaken at the beginning of the wet season, with an expected mortality of 10% /annum for the first two years. Maintenance requirements will diminish over

time as plantings become established. The site will be maintained four times in the first year, three times in the second year, and twice in the third year. The site will be inspected annually thereafter until such time as the vegetation is self-sustaining.

2.5 Seed and Seedling Procurement Strategy

While there is a degree of flexibility for species selection in the lists provided above, it is highly desirable to restrict plants to those of local provenance (local gene pool). This requires that plants be grown from seed collected locally, as opposed to buying quantities of plants from suppliers interstate. Local provenance will not be a requirement for the direct seeded grasses in Zone 3 (highway clear zone). Any deviation away from the suggested species selection will require prior approval from TMR.

Typically, the species utilised in revegetation projects is significantly influenced by the availability of sufficient quantities of species specified, and last minute substitution of less desirable species is often the consequence.

The success of this revegetation project is therefore dependant on early identification of revegetation needs, and early engagement of a service provider to collect propagules and grow plants so that plants are ready for the commencement of revegetation works. There are two nurseries currently producing local provenance plants from the region – Girringun nursery in Cardwell and the Hinchinbrook Shire Council nursery in Ingham (managed by Darren Luxford).

As some species may be difficult to source, it is advised that the service provider undertakers pre-construction salvage and storage of seeds, seedlings and whole plants where appropriate. Additional seed collection will be required in other areas to generate the necessary quantities. Opportunities exist for indigenous employment, through seed collection and/or seedling production and planting.

3 Key Timeframes

The following Gantt chart shows key timeframes for the project. This chart does not show the minimum watering requirements.

Table 4: Key milestone for revegetation tasks at Frances Creek

Task	Dec 16	Apr-17	May-Sept 17	Nov17	Mar-18	Jun-18	Dec-18	Mar-19	Jun-19	Dec-19	Mar-20	Jun-20	Dec-20
Commence seed procurement & plant production													
Vegetation clearing													
Commence construction													
Prepare site, weed control													
Revegetation													
Post wet season site maintenance													
Mid-year site maintenance													
Pre wet season site maintenance #													

- Replacement of dead plants will only be undertaken during the December site maintenance inspections

Watering regimes during establishment are specified in the TMR technical standards “Landscape & Revegetation Works (MRTS16)”

3.1 Performance indicators

Each of the revegetation zones will require monitoring and maintenance works until established. All vegetation maintenance works on the site are required to be completed and to satisfy the completion criteria before the specified end date of the Defects Liability Period. Typically, this would be 3-12 months after planting, however, due to the nature of the works at Frances Creek, the Defects Liability Period for revegetation works would extend to December 2020.

Indicative performance indicators for Zones 1-3 at key milestones are provided below:

Revegetation Commencement (November 2017)

- All zones planted
- 90% survival rate of seedlings
- Erosion matting secure and damaged sections repaired or replaced
- Site is free from erosion. Where subsoil and topsoil is eroded, the Contractor shall repair and re-ameliorate the subsoil, re-apply topsoil to the affected area and reinstall the vegetation treatment.
- All environmental and declared weeds treated

Post wet season site maintenance (March 2018)

- 100% kill rate of environmental and declared weeds
- 90% survival rate of seedlings. All dead plants are replaced (Where vegetation treatments are poisoned due to overspray, the Contractor shall replace the vegetation treatment with the originally specified treatment)
- Erosion and sediment control devices are in place, erosion matting secure and damaged sections repaired or replaced

Pre wet season site maintenance (December 2018)

- 100% kill rate of environmental and declared weeds
- 80% survival rate of seedlings. (Where vegetation treatments are poisoned due to overspray, the Contractor shall replace the vegetation treatment with the originally specified treatment)

For Zone 4 (direct seeded clear zone), the completion criteria are specified in Section 9.1.2.1 of 'Landscape & Revegetation Works (MRTS16)'. Timing is not included in the Gantt chart in Table 4 as it is dependent on completion of construction and removal of redundant pavement. The following criteria will be met after the completion of the 90 day monitoring period:

a) have a uniform cover of perennial and cover crop grasses over a minimum 90 % of the area

b) have a minimum perennial cover of 30 %

c) show no signs of nutrient deficiency

d) show no signs of water deficiency

e) have no rills or sheet erosion.

f) have no bare areas > 1 m², and

g) are mowed / slashed at a height in accordance with Table 9.1.1.6 (grass seeded areas)..

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