Vegetation Assessment of VicRoads Option 1 By–pass on private land adjoining Langi Ghiran State Park

Review of Section 2B of the Western Highway Duplication Project EES (Beaufort to Ararat)

Client: MairiAnne Mackenzie

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The proposed actions recommended in this report were based on information collected and available at the time of assessment and may be subject to modification over time due to changes in knowledge and management priorities.

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Contents

Summary

- VicRoads' duplication of the Western Highway between Buangor and Ararat includes plans for a new dual carriageway By–pass south of Langi Ghiran State Park;
- Critics of this proposed By–pass have argued that overall environmental impacts would be significantly lower along the existing highway and that the EES conducted was inadequate;
- This report describes a vegetation and botanical assessment across all three farms within the By–pass footprint and identified large areas of overlooked significant remnant vegetation and other important environmental features;
- An additional ~15 ha of loss was identified in the planned road footprint, comprising ~4.9 HaHa of mostly High and Very High Conservation Significance vegetation on the farmland. This represents a nearly one–and–half fold increase on the area reported in the EES and other previous assessments;
- Specimens of the rare Yarra Gum , rare natural springs overlooked in the EES, and potential habitat for many other significant species, were also identified;
- Compared with a carefully sited alignment beside the existing highway (the so called 'Northern Option'), these results show the proposed By–pass is likely to have equal or greater vegetation and ecological impact on the natural features listed above; and
- This assessment provides further evidence against the supposed environmental benefits of the proposed By–pass and should compel an immediate rethink of highway plans.

Background

VicRoads proposes to duplicate the Western Highway between Beaufort and Ararat as part of a larger project to widen the highway between Ballarat and Stawell to freeway dimensions (Western Highway Project Section 2 – Beaufort to Ararat – WHP2). While the project would mainly involve construction of a second carriageway adjacent to the existing highway, new dual By–pass carriageways are proposed south of Langi Ghiran State Park (SP) and at Buangor (respectively VicRoads Options 1 and 2) (Appendix 1).

Following a lengthy statutory process, in 2013 the Minister for Planning, concluded that: "*VicRoads Option 1 provides a more appropriate balance between the likely environmental effects, social and economic outcomes*" (State of Victoria 2013a).

Opponents of this option have long argued environmental impact will be minimised by siting the new lanes close to the existing highway corridor and have pointed both to the significantly lower capital cost and the inadequacy of the 2012 Environmental Effects Statement (EES) (Practical Ecology 2012) (Foreman 2014).

In particular, Foreman 2014 recommended further assessment of VicRoads Option 1 across all freehold land to more accurately describe both direct and off–site impacts.

This report describes a vegetation and botanical assessment on part of VicRoads Option 1 footprint across farmland from Pope Road to where the By–pass re–joins the existing Western Highway near the intersection of Langi Ghiran Picnic Road. This covers the full length of the Langi Ghiran SP By–pass section of VicRoads Option 1, and is mostly pastoral farmland owned by Alan Kilpatrick and Marion Wallace, Iona Mackenzie, MairiAnne Mackenzie, and Tim Webb (Appendix 2). The bushland roadside, railway reserve and private sections along this route (owned by David Bates and MairiAnne Mackenzie) have been previously assessed (Ecology and Heritage Partners 2012). The visual offsite impact of VicRoads Option 1 (over an area of ~146 sq. km.) is shown in Appendix 14.

Methodology

All farmland paddocks intersecting the proposed route, comprising a 385 ha Study Area, were stratified based on vegetation structure and condition.

Field survey was conducted over two days in July 2015, and on a further day in September, and involved assessment of vegetation richness and composition, and for selected patches, Vegetation Quality Assessment (VQA or Habitat Hectare approach – DNRE 2002; Parkes et al. 2003).

The VQA required a review of mapped pre–1750 and Extant Ecological Vegetation Classes (EVCs) across the Study Area (see Appendix 3 for background notes on methods).

The final Habitat Hectare tally across all remnant patches within the footprint , and break down by Conservation Significance, was calculated by multiplying areas within the footprint by the VQA scores (24 sites; Appendix 10 & 12).

Spatial comparison was undertaken in ArcGIS 10.3 using a spatial layer produced by Ecology and Heritage Partners as part of the 2012 EES (Appendix 4).

The vegetation richness and composition assessment consisted of a detailed search of 27, 900–square–metre quadrats (30 x 30 m) for all vascular plants and an estimate of the cover/abundance of each taxa and other relevant data.

Cover/abundance categories were based on standard methods used by the Department of Environment. Land, Water and Planning (DELWP) and its predecessors (see Muir *et al.* 1995), namely:

(+) <1% Projected Foliage Cover (PFC), few individuals;

(1) <1% PFC, many individuals;

(2) 1 to 5% PFC, any number of individuals;

(3) 6 to 25% PFC, any number of individuals;

(4) 26 to 50% PFC, any number of individuals; and

(5) >50% PFC, any number of individuals.

Search time per quadrat ranged from 30 to 90 minutes, and most quadrats established in July 2015 were briefly revisited in September to assess for the presence of spring flowering geophytes and ephemerals, or any other significant species. While the species lists are thorough, additions could be made with further searching.

All plant taxonomy follows Walsh and Entwistle (1994, 1996 and 1999) and Walsh and Stajsic (2007). Site coordinates were recorded using a Garmin Oregon 650 GPS. All spatial information was entered into ArcGIS 10.3 for preparation of maps and exported to MS EXCEL for tabular presentation and simple analyses.

The location of possible GDE remnants was based on interpretation of Google Earth imagery dated November 2009 – following above average spring rainfall at higher elevations in the immediate area (see rainfall for Ben Nevis – BOM website).

See Appendix 6 for Floristic Ordination graph and Cluster Analysis methods.

A limited review of State Government flora databases and Australia's Virtual Herbarium (www.avh.chah.org.au) was also undertaken for records of significant species in surrounding areas.

Results

The Study Area and its vegetation

Introduction

The Study Area farmland occupies the sheltered aspects and slopes of the metaphoric aureole encircling the Langi Ghiran SP granitic batholith (G376 – Biotite granite: highly fractionated; light grey; medium grained; even texture; little or no magnetite; a member of the Mount Cole Suite). Running east to west, the Study Area wraps from low hills and the lee side of the steepest part of the aureole where it intersects with Hillside Road, to the top of a subdued ridge of granite where it re–joins the existing Western Highway.

The soil and moisture holding characteristics of this southerly slope (<400 m ASL) has resulted in a productive ecosystem that is desirable for agriculture – hence the land is freehold and has been cleared. Despite the extent of modification under private land use, pockets of residual native vegetation persist and still reflect elements of the original biota. In fact, nearly two thirds of the area within the footprint and along this slope is mapped as extant vegetation (see Appendix 3).

The footprint was found to comprise a mix of remnant native vegetation (34%) and areas developed for plantations, infrastructure and exotic pastures, that was mostly non–native vegetation (66%). The native vegetation was broadly cast into patches of Grassy Woodland, Grassy Forest and Disclimax or Derived Grassland; segregated into various broad compositional types (EVCs), and in a range of condition (Figure 1; Appendices 3, 5, 6 & 7).

Figure 1: *Summary of vegetation patches mapped across the footprint based on EVC data and floristic analysis*

Pre1750 EVCs	*Native Vegetation*			*Non–native Vegetation*			***Grand Total***	***Total%***
	Disclimax Grassland	Grassy Forest	Grassy Woodland	Cultivated or developed land	Exotic dom. pasture	Plantation		
Grassy Woodland	0.09	0.00	0.01	0.00	2.46	0.00	2.56	*4.3%*
Grassy Woodland/Heathy Dry Forest Complex	4.93	0.19	6.85	1.25	7.46	2.00	22.68	*38.2%*
Heathy Dry Forest	0.00	1.74	0.00	0.00	6.36	0.00	8.10	*13.6%*
Heathy Woodland	0.08	0.00	0.00	0.00	1.76	0.00	1.84	*3.1%*
Hills Herb–rich Woodland	4.22	0.00	2.10	0.00	17.71	0.15	24.19	*40.7%*
Grand Total	**9.33**	**1.93**	**8.96**	**1.25**	**35.76**	**2.14**	59.37	
Total%	*15.7%*	*3.2%*	*15.1%*	*2.1%*	*60.2%*	*3.6%*		

The methods used for assigning an EVC typology based on pre-1750 and extant EVC mapping and their published descriptions (DELWP website) is explained in Appendix 3.

Note that this assessment focuses mostly on vegetation impact: Large Old Tree loss, the impact on Golden Sun Moth and other offsite impacts, such as the additional fragmentation and landscape impacts – all very important considerations – also need to be taken into account in reviewing the route options. For example, the visual impact of VicRoads Option 1 starkly contrasts with the almost negligible visual impact of the Northern Option (Appendix 14).

Past land use and evidence of residual ecological integrity

As supported by landholder testimony (MairiAnne Mackenzie pers. comm.), significant parts of the footprint have been little or never fertilised, and not cultivated or sown down to exotic pasture species such as Toowoomba Canary–grass (**Phalaris aquatica*). Consequently, native species richness is high in many areas, with a diverse representation from a wide range of shrubs, perennial grasses and allies, perennial forbs, and geophytes including a number of orchids and lilies (Appendix 13).

Mairianne Mackenzie's paddocks have not been grazed by stock since spring 2014, and generally have been lightly stocked with sheep in the past. Thus any remnant native ground layer was readily evident during all field inspections in 2015. The same applies for the adjoining property, owned by Tim Webb, where there are also pockets of similar sometimes quite species–rich remnant vegetation that is also lightly grazed.

All disclimax or derived grassland and Grassy Woodland remnants on farmland were dominated by perennial indigenous grasses, but especially, Weeping Grass (*Microlaena stipoides var. stipoides*), Wallaby Grasses (*Rytidosperma* spp.), Spear Grasses (*Austrostipa* spp.) and Common Wheat–grass (*Anthosachne scabra* s.l.). Average Cover of these plants was between ~45% and 55% and total indigenous cover ranged from ~25% to >75%. Although a range of ubiquitous exotic species were present at all such sites, total weed cover ranged from ~10% to ~50% with the cover of any one dominant weed species rarely exceeding 15% (Appendix 13).

Further evidence of the integrity of the remnant paddock vegetation was found in the diversity of indigenous lilies and orchids, with up to six different geophytes – often in great abundance – observed at 12 of the paddock disclimax grassland and grassy woodland quadrats. Species included: Chocolate Lily (*Arthropodium* spp.), Milkmaids (*Burchardia umbellata*), Blue Stars (*Chamaescilla corymbosa var. corymbosa*), Golden Moths (*Diuris chryseopsis*), Yellow Star (*Hypoxis vaginata var. vaginata*), Onion Orchid (*Microtis* spp.), Sun Orchid (*Thelymitra* spp.), Twining Fringe–lily (*Thysanotus patersonii*), Yellow Rush–lily (*Tricoryne elatior*), and Common Early Nancy (*Wurmbea dioica*) (Appendix 13).

Evidence for Grassy Woodland and possible EPBC listed EC

The floristic data provides evidence of a widespread complex of ecotonal grassy woodlands across much of this broad and extensive sheltered fall and associated lower slopes and drainage lines mostly running down towards Gorrin Creek at the edge of the adjoining volcanic plains. This analysis is consistent with the DELWP EVC mapping showing much of this south slope dominated by a Grassy Woodland/Heathy Dry Forest Complex with a Conservation Significance of 'endangered' (Appendix 3). The dominance of the relatively tall Yellow Box (*Eucalyptus melliodora*), species–rich disclimax grassland and the fact that the entire slope has been partly cleared and long exploited for productive agriculture, is further corroborative evidence the original bush was probably dominated by some form of grassy woodland (Appendices 3, 5 & 6).

Although such complexes do not have specific EVC benchmarks, it is entirely consistent with the above analyses to default to Grassy Woodland EVC 175_61 described as: "a variable open eucalypt woodland to 15 m tall over a diverse ground layer of grasses and herbs. The shrub component is usually sparse. It occurs on sites with moderate fertility on plains or undulating hills on a range of geologies." While the farmland remnants support some 'species typical of at least part of the EVC range,' the absence of canopy species such as Yellow Box in the benchmark likely reflects the lack of adequate sampling on private land in the surrounding region (see Appendix 3).

This evidence further suggests at least parts of the remnant grassy woodland and derived native grassland on the farmland could be considered remnants of the EPBC listed ecological community (EC): "White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland." Specifically, this is based on the following points (Department of Environment, Climate Change and Water NSW 2010):

- "The EC can occur either as woodland or derived native grassland (i.e. grassy woodland where the tree overstorey has been removed). It is characterised by a species-rich understorey of native tussock grasses, herbs and scattered shrubs (where shrub cover comprises less than 30% cover), and a dominance or prior dominance of White Box (*Eucalyptus albens*) and/or Yellow Box (*E. melliodora*) and/or Blakely's Red Gum (*E. blakelyi*) trees."
- "In Victoria this ecological community is not listed as threatened under the Flora and Fauna Guarantee Act 1998 (FFG Act), [but] broadly equates to EVCs including (in the Central Victorian Uplands bioregion): 175_62: Granitic Grassy Woodland, and 175_61: Grassy Woodland."
- "The EC "occurs along the western slopes and tablelands of the Great Dividing Range from southern Queensland through NSW and the ACT to central Victoria where rainfall is between 400 and 1200 mm per annum, on moderate to highly fertile soils at altitudes of 170 metres to 1200 metres."
- Characteristic species (over a wide geographic range) include: Common Wheat-grass (*Anthosachne scabra* s.l.), Chocolate Lilies (*Arthropodium* spp.), Spear Grasses (*Austrostipa* spp.), Flax Lilies (*Dianella* spp.), Austral Crane's-

bill (*Geranium solanderi* s.l.), Small St John's Wort (*Hypericum gramineum*), Scaly Buttons (*Leptorhynchos squamatus*), Mat-rushes (*Lomandra* spp.), Weeping Grass (*Microlaena stipoides var. stipoides*), Common Tussock-grass (*Poa labillardierei*), Grey Tussock-grass (*Poa sieberiana*), Wallaby Grasses (*Rytidosperma* spp.), and Kangaroo Grass (*Themeda triandra*) – all of which are present and often abundant and/or dominant within the footprint and greater Study Area.

It is recommended further assessment be undertaken to determine if the any of the remnant farmland vegetation meets minimum conditions for this EC (Department of Environment, Climate Change and Water NSW 2010), namely:

- The remnant "must be, or have previously been, dominated or co-dominated by one or more of the following overstorey species: White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) or Blakely's Red Gum (*E. blakelyi*);"
- The remnant must have a predominately native understorey (i.e. more than 50% of the perennial vegetative groundlayer must comprise native species);"
- "The area covered by the ecological community (i.e. the patch size) must be > 0.1 hectares (ha);"
- "The ecological community must contain 12 or more native understorey species (excluding grasses), including one or more important species (as listed in Appendix 1);" and
- "If the groundlayer does not meet this last criterion (i.e. does not contain 12 or more native forb species and one or more important species) then the patch size must be 2 ha or greater in area and have an average of 20 or more mature trees per ha, or natural regeneration of the identified dominant overstorey eucalypts."

The results of this assessment suggest at least some areas would meet these minimum conditions, including remnants within the footprint.

Other vegetation types

The floristic results clearly show another two broad vegetation groups within the Study Area associated with the more drought–prone, exposed upper slopes, ridge tops and northern slopes on granite or metamorphic or sedimentary rocks. It is assumed these two equate to Hills Herb–rich Woodland on the granite and metamorphic rocks, and Heathy Dry Forest associated with metamorphic and sedimentary rocks. And interestingly, this analysis also provides the first clear evidence of a Groundwater Dependent Ecosystem (GDE) – see below (Appendices 5 & 6).

Rare or threatened species

Despite the long history of pastoralism, given the quality of many remnant patches, Victorian Rare or Threatened plants (VROTs) in addition to the Yarra Gum (*Eucalyptus yarraensis* – rare) could well be present (Appendix 5, 7 & 13). Species most likely include: perennial grasses, geophytes (including orchids), perennial forbs tolerant of some level of grazing, and ephemerals like Single Bladderwort, Foot Triggerplant, and Tiny Bog–sedge possibly associated with the remnant GDE soaks or springs. The list compiled is indicative only and is based on records from similar terrain in the surrounding landscape, but many others are also possible (Figure 2).

Figure 2: *Indicative list of VROTs possible in the Study Area. AROT = Australian Rare or Threatened; VROT – Victorian Rare or Threatened; FFG = Flora and Fauna Guarantee Act 1988 listed (L); k = poorly know, r = rare, and v/V = vulnerable*

NAME	*COMMONNAME*	*AROTS*	*VROTS*	*FFG*
Alternanthera sp. 1 (Plains)	Plains Joyweed		k	
Austrodanthonia monticola	Small–flower Wallaby–grass		r	
Austrostipa exilis	Heath Spear–grass		r	
Austrostipa hemipogon	Half–bearded Spear–grass		r	
Diuris behrii	Golden Cowslips		v	
Eucalyptus yarraensis	Yarra Gum		r	
Glycine latrobeana	Clover Glycine	V	v	L
Schoenus nanus	Tiny Bog–sedge		r	

Stylidium calcaratum var. ecorne	Foot Triggerplant	k
Swainsona behriana	Southern Swainson–pea	r
Utricularia uniflora	Single Bladderwort	k

A total of 119 native species and 43 exotics were identified across the 27 sites during the July and September assessment – mostly graminoids, including sedges, rushes and geophytes (63 species), but also 26 trees and shrubs, and 30 forbs and other lifeforms (Appendices 11 & 13). It was noted earlier a number of additional cryptic geophytes such as Golden Moths (*Diuris chryseopsis*) and Yellow Star (*Hypoxis vaginata var. vaginata*) were observed frequently and often in abundance in the farmland remnants during the September 2015 survey.

Although none of these rare or threatened species were observed during a brief follow up survey in September 2015, it is still possible some will be found with further targeted search effort.

Likely presence of a Groundwater Dependent Ecosystem (GDE)

Highest native richness was found in areas suspected to be remnants of a GDE – mostly across the more sheltered central section of the footprint (Appendices 2, 7 & 13). This region was flagged as a likely zone for GDEs and possible spring activity under the EES, but no field data was gathered; only a desktop assessment including appraisal of groundwater risks. The EES states: "the potential GDEs in the Study Area are largely associated with the granitic geology near the Langi Ghiran State Park" (Chapter 11 of EES – GHD 2012).

The closest aligned EVC in the Central Victorian Uplands would be Spring Soak Woodland (EVC 80), which in its natural state, is a: "woodland to 10 m tall with an understorey dominated by medium and small herbs and occasional shrubs. Generally occurring on granitic–outwash soils and dependent on the continual availability of a reliable water supply." (see EVC benchmarks). The fact that the benchmark floristics does not include wetland species affiliated with similar natural springs elsewhere in the state reflects the lack of adequate sampling and mapping in the bioregion.

The FFG Act listed community: Granite Foothills Spring Wetland (North–East Victoria) Community, is perhaps one the better known affiliated systems. "This community is a seasonal wetland, typically comprising a range of structural vegetation types in zones radiating from the source of moisture: the wetter centre supports tall sedges and rushes usually surrounded by a shrubby woodland [often with Prickly Tea–tree or *Leptospermum continentale*] with an outer edge of low herbland, which at many sites is all that remains. The community is degraded due to a long history of human disturbance" (SAC 2011).

The areas observed in the Study Area likely supporting remnant patches of a GDE were located within the footprint or directly downslope and would likely be affected by changes to surface and groundwater hydrology resulting from freeway development.

Risk Pathway GW4 in the EES (Table 11.3) lists: "cuts below water table along alignment requiring dewatering" could permanently result in changed groundwater flow regime which "adversely affects groundwater flow to GDEs". The associated environmental management measure (Table 11.4) proposes to establish "an alternate water supply….. to maintain environmental water requirements, e.g. treated stormwater / road drainage could be redirected as a replenishing or alternative water supply" (Chapter 11 of EES – GHD 2012).

However, given it hasn't been possible to survey these areas during a wet year, a Vegetation Quality Assessment (based on Spring Soak Woodland benchmark) has not be undertaken here. Given at least some areas both within and immediately downslope of the footprint are likely retain some natural wetland elements and species (such as Sites 289 & 290 – see Appendix 5 & 13), in light of these statements from the EES, steps should be taken as soon as practicable to: (1) fully assess the extent, condition and significance of the GDE's in the Study Area; and (2) incorporate the additional cost of maintaining environmental water requirements into the proposed By–pass design specification (assuming it proceeds).

Vegetation Quality Assessment

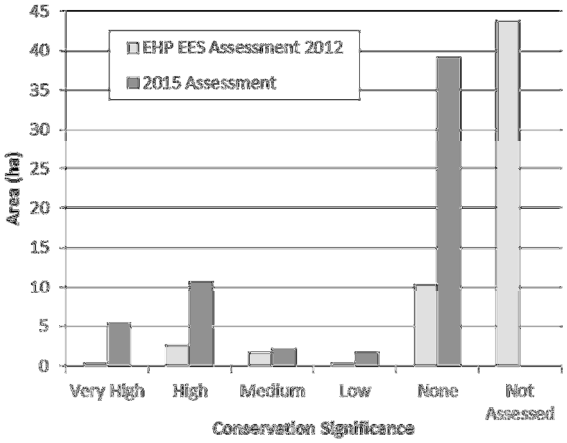
VQA results within the footprint

Habitat Hectare scores were used to assess condition of the various patches as this was the method used in past assessments (Ecology and Heritage Partners 2012; Practical Ecology 2012). In general, as would be expected, the quality of

the vegetation from the 23 patches scored along the footprint was lower than the adjoining – less modified – public land with HaHa scores ranging from 24 to 53. However, Conservation Significance ranged from Low to Very High as there were numerous, relatively diverse and important remnants of a Grassy Woodland complex and Hills Herb–rich Woodland that would be directly and indirectly affected (Appendices 5, 9 & 10).

In comparison with the EES assessment for the equivalent area, there were significant increases in the proportion of High and Very High Conservation Significance remnant patches; respectively up from around 5 to 18%, and from 1 to 9% (Figure 3; Appendix 9).

Figure 3: *Summary comparison of Study Area footprint impact between the 2012 EES and this assessment*



On balance, compared with the 2012 EES, an additional 15.13 ha of loss was identified within the footprint, comprising 4.85 HaHa's in mostly High and Very High Conservation Significance vegetation. Incorporating this 'additional impact' into the options comparison collated by Practical Ecology for this part of the duplication project (PE 2012, Table 2), there is a 143% increase in the area of remnant vegetation lost and more than a doubling in the loss of HaHa's than has been previously accounted for (Figure 4).

Figure 4: *Additional loss of native vegetation identified under this 2015 assessment compared with the 2012 EES.*

Highway Route Options	*Area of loss (ha)*	*HaHa loss*	*Source/Comment*
Northern Option 1	15.31	11.00	PE(2012) Tb. 2
Northern Option 2	13.11	9.44	PE(2012) Tb. 2
VicRoads Option 1 [C]	10.61	4.28	PE(2012) Tb. 2
VicRoads Option 1 (Revised) [C+(A–B)]	25.74	9.13*	Plus 'Additional Impact' on Farmland Sect.
VicRoads Option 1 (Farmland Sect.) [A]	20.21	7.32	This assessment
VicRoads Option 1 (Farmland Sect.) [B]	5.08	2.47	EHP 2012 spatial data
VicRoads Option 1 (Farmland Sect.) [A–B]	15.13	4.85	'Additional Impact'

* This figure is likely an underestimate as does not include the higher impact in the "bush block" due to reclassification of the EVC to HHrW (Appendix 8), nor the likely higher impacts resulting from EVC reclassifications along Hillside Road and the railway line.

VQA results elsewhere

On top of this 'Additional Impact' of previously overlooked remnant vegetation, a further point of difference arises from the differential EVC classification between Ecology and Heritage Partners (2012), and the reviews undertaken here and also by Practical Ecology (2012).

To illustrate, an example from the south west corner of the 'bush block' owned by David Bates and MairiAnne Mackenzie, around site 155, is described in Appendix 8 (also see Appendices 10, 11 & 13). According to the EHP mapping, the vegetation impacted by the proposed By-pass is a mix of Grassy Dry Forest (GDF 4; Condition Score = 0.22; CS = elevated to High due to the presence of unnamed threatened species) and Heathy Dry Forest (HDF 3; Condition Score = 0.59; CS = elevated from Low to High due to the presence of unnamed threatened species). This mapping is problematic not just

because the current assessment identifies the EVC here as Hills Herb-rich Woodland (EVC 70; CS = Vulnerable), but also because EHP's patch mapping is questionable, with some patches apparently fragmented into multiple polygons spread across a range of tenures, sometimes many kilometres apart. Based on the condition score of 0.64 for the current assessment, the HaHa score and Net Gain figure, should be significantly higher than previously reported.

Finer-scale assessment is also warranted in this section of the highway because of the area's greater environmental integrity, the higher potential of adverse impact from any development, and because selection of the optimal route (on environmental grounds) is not straight forward.

In relation to the Northern Option:

> "*Practical Ecology generally applied a finer scale of mapping to distinguish between cleared areas, such as below power-line easements and vehicle tracks/roads. Many such areas are approximately 25 metres wide or greater, so they could potentially accommodate a single two lane carriageway. It appears that the E&HP (2012) report has not used a fine enough scale of mapping to distinguish site scale quality differences between features such as the ~25 metre wide power-line easement, existing roads and surrounding native vegetation. For example, the section of existing highway adjacent to Habitat Zones GDF1 and HHrW3 consist of broad zones, however, quality differences on the ground, such as a lack of tree canopy beneath a ~25 wide power-line easement were clearly enough to warrant the delineation of new Habitat Zones within this area.*
>
> *Mapping resolution that does not allow for delineation of site scale quality differences does not provide decision makers with the necessary detailed information to facilitate the avoidance and minimisation of native vegetation removal in accordance with the Framework (DNRE 2002)*" (Practical Ecology 2012).

Implication of new information

This report has primarily focused on the farmland, and some of the bushland, directly affected by Option 1. It has provided compelling evidence that a substantial area of remnant vegetation has been overlooked and/or misclassified and that past comparisons has significantly under stated the (Net Gain) impact of Option 1. Conversely, the lack of sufficiently fine-scale mapping of patch types and site quality assessment along the Northern Option, as concluded by Practical Ecology (2012), has meant that past comparisons have likely over stated the (Net Gain) impact of the Northern Option.

Figure 5: *Adjusted Net Gain Figures show a convergence of the two alternative routes*

Alternative routes	2012*	2015**
Northern Option 1 (2 x 25 m carriageways)	21.83	19.30
VicRoads Option 1 (Planned route)	6.48	16.06

* Sources: Practical Ecology (2012), Ecology & Heritage Partners (2012) plus data from this assessment
**Corrections made for under-scoring on planned route and over-scoring on Northern Option 1 (incl. Heathy Woodland patches adjusted down to High CS)

On the basis of data from the three key reports, the Net Gain HaHa figures for both routes have been adjusted for the discovered errors in EVC classification and associated Conservation Significance as well as the significant extent of overlooked remnant vegetation on the farmland (Figure 5). Given basic data was not readily available for the impact on crown land along the planned route, reasonable estimates have been used as (a small) part of the adjusted figures in Figure 5. Despite this limitation and other data uncertainties, the adjusted figures show a near convergence of the two Net Gain figures for the two routes. It is possible these figures will further converge with a more thorough review of the data and design refinements along the Northern Option.

On the face of it, this new information suggests this section of VicRoads Option 1 has as great an impact on vegetation as either of the Northern Options carefully sighted along the existing Highway corridor, if not greater when other indirect impacts are also considered. This conclusion casts doubt on the decision to opt for this substantially more expensive option, ostensibly chosen to minimise environmental impact.

Conclusions and recommendations

- It is clear from the EES (Ecology & Heritage Partners 2012) and the appraisal of the Northern Options (Practical Ecology 2012) that past assessment of the VicRoads Option 1 By–pass over farmland to the south of Langi Ghiran SP has been inadequate;
- Mapping from the EES shows the Study Area footprint supports only very small clumps of mostly Grassy Dry Forest in a matrix of 'degraded treeless vegetation' with the majority balance apparently not even assessed. According the EES, almost 92% of the Study Area footprint was either not assessed or thought to have no native vegetation of any conservation value – a stark contrast to both the existing EVC mapping and the results of the more detailed investigation undertaken here;
- The current assessment found the By–pass footprint was in fact a mix of remnant native vegetation (34%) comprising patches of Grassy Woodland, Grassy Forest and Disclimax Grassland of various EVCs (similar to those in the existing EVC mapping) and in a range of condition, plus developed areas that was mostly non–native vegetation (66%);
- Some remnants contained rare species (Yarra Gum or *Eucalyptus yarraensis*; 40+ cm dbh) despite the history of farming, and given the quality of the remnants, a range of other rare species could well be found with further search effort;
- Highest native richness was found in areas suspected as remnants of a Groundwater Dependent Ecosystem (GDE) located within the area flagged as likely for spring activity under the EES. Some of the remnants found during this assessment are within the footprint and others immediately down slope, but all would likely to be affected by changes to surface and groundwater hydrology resulting from By–pass development. Immediate steps should be taken to fully assess the extent and significance of these GDE patches, and to incorporate the cost of maintaining environmental water into duplication planning;
- Although the majority of the footprint was found to support degraded vegetation with no conservation value in 2015, compared to the EES, there were significant increases in the proportion of High and Very High Conservation Significance patches including some areas that could meet minimum conditions for the EPBC Act 1999 listed EC: 'White Box - Yellow Box - Blakely's Red Gum Grassy Woodland and Derived Native Grassland';
- Overall, an additional ~15 ha of loss was identified, comprising ~4.9 HaHa in mostly High and Very High Conservation Significance vegetation. This represents a nearly one-and-a-half fold increase in the area of remnant vegetation that would be lost and more than a doubling in the loss of HaHa along the By–pass than is identified in the EES;
- Further erroneous VQA values were noted elsewhere both along the VicRoads Option 1 footprint, but also along the existing highway, that indicate a need for a broader review of the impact of both VicRoads Option 1 and the Northern Options, at least for this section;
- This revision suggests the VicRoads Option 1 By–pass would have equal (if not greater) vegetation and ecological impact as either of the Northern Options, casting doubt on the feasibility of the supposedly greenest but more expensive By–pass option. (Note that vegetation impact here excludes Large Old Tree loss, impact on Golden Sun Moth and other offsite impacts such as the additional fragmentation resulting from a new major highway. The visual impact of VicRoads Option 1 starkly contrasts with the near negligible impact of the Northern Option – see Appendix 14); and
- This assessment result should compel a rethink of plans for this section of the Western Highway Duplication project, including the option of reverting to a sensitive upgrade along the existing highway where it is likely there would be less overall environmental impact for much less cost.

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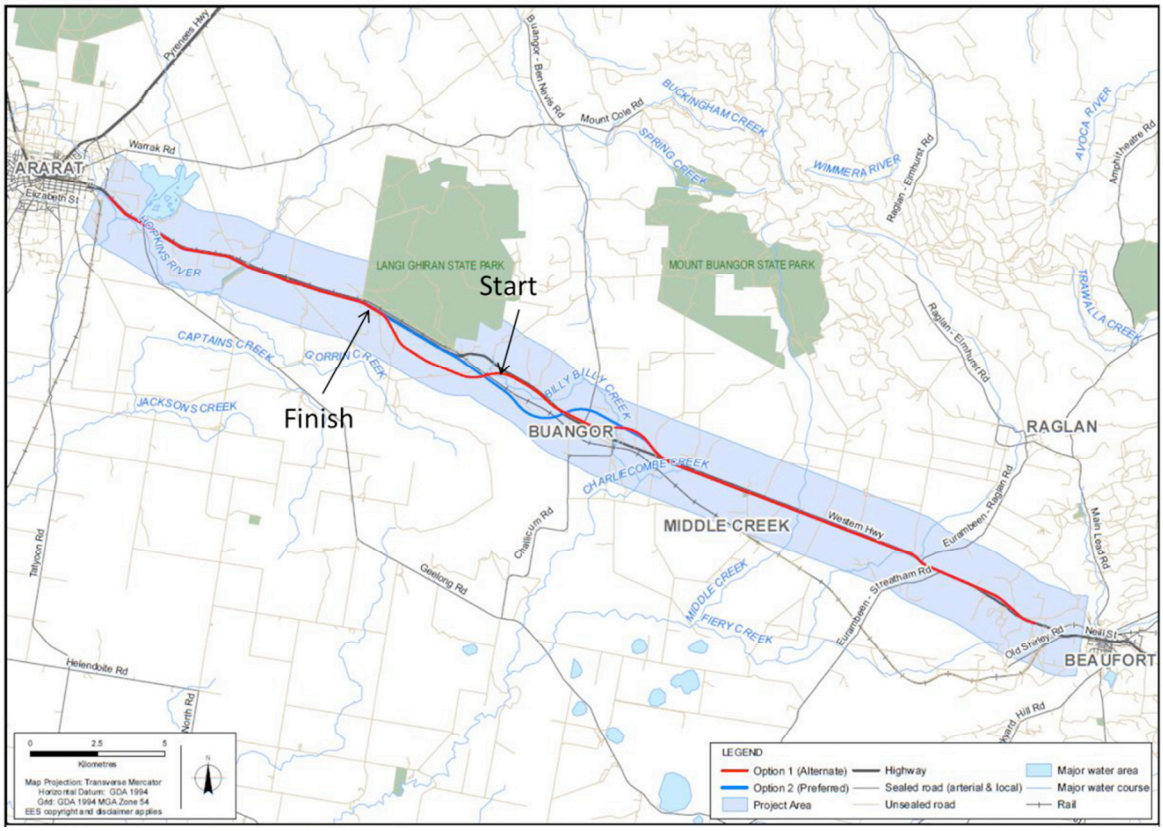
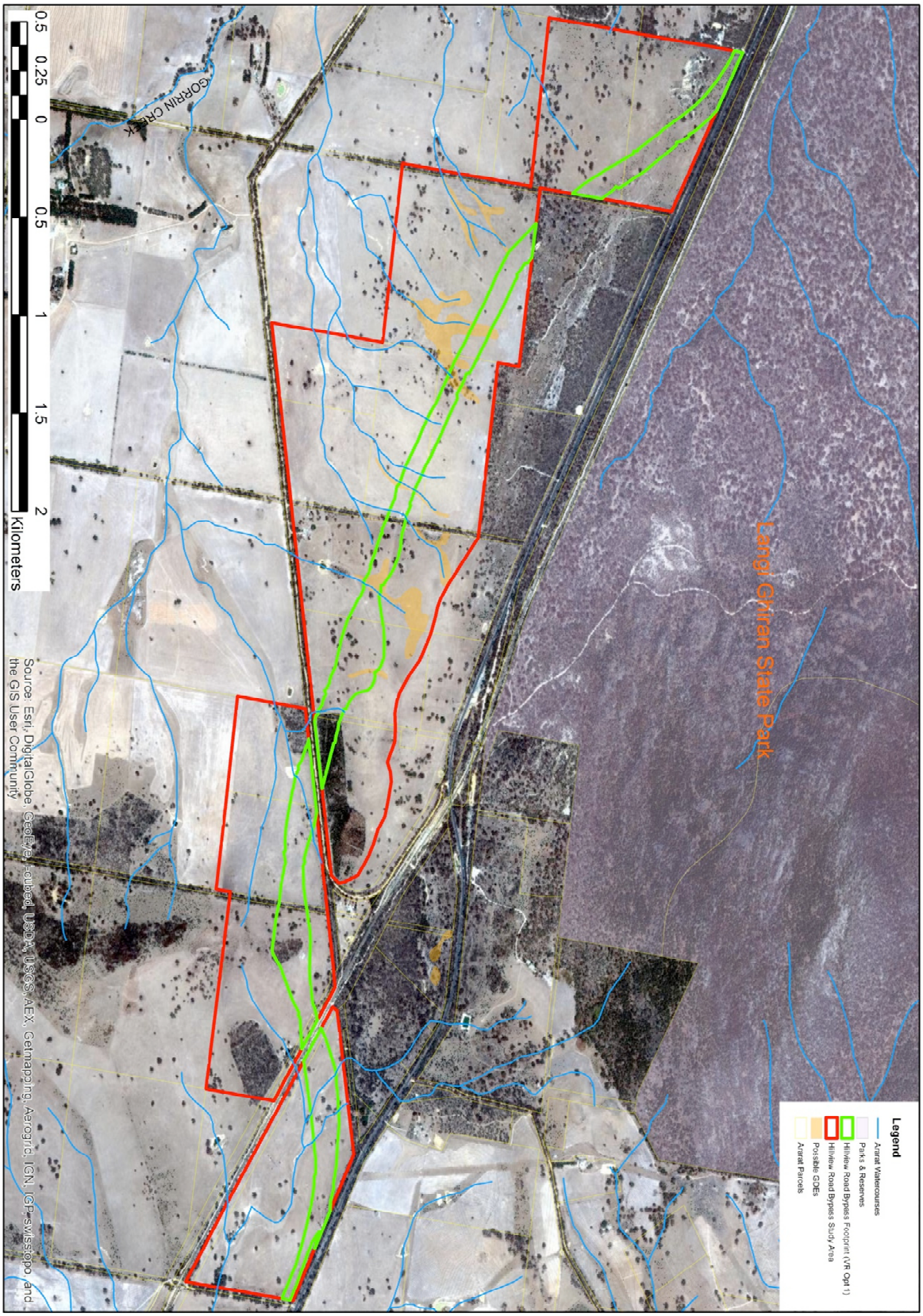
Appendices

Appendix 1: Study Area context

Source: State of Victoria 2013a



Appendix 2: Study Area (red), VicRoads Opt 1 footprint (green) & possible GDEs (orange)

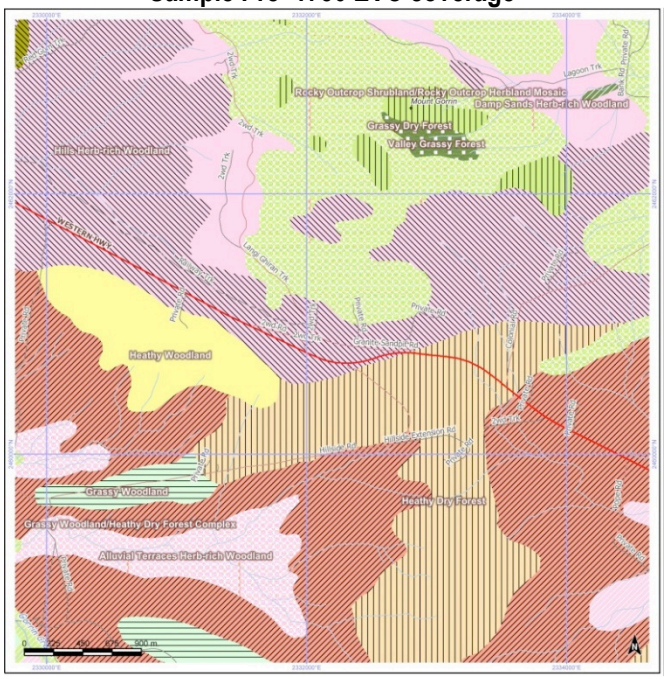


Appendix 3: Background notes on methods used for review of EVC mapping

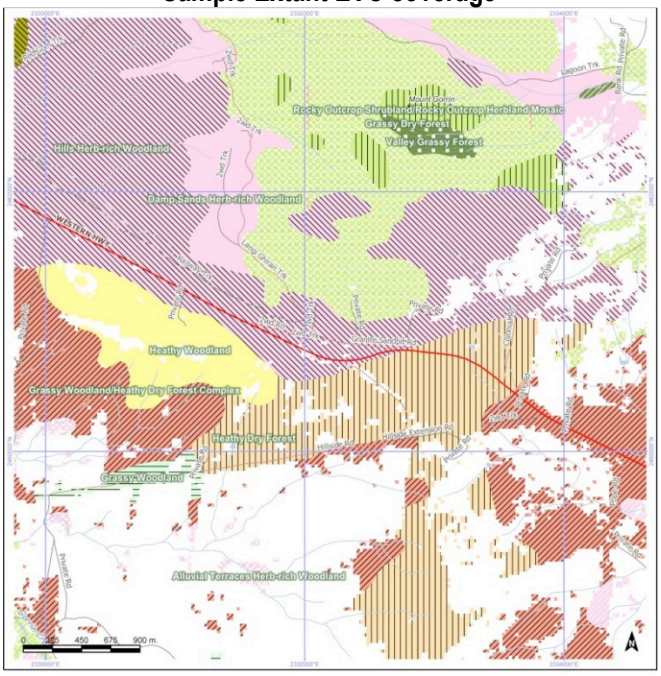
It should be noted that "*EVCs represent aggregations of floristic communities with structural, physiognomic and floristic affinities that exist under a common regime of ecological processes within a particular environment*" (Parkes *et al.* 2003). In practice mapped EVC boundaries are considered stable with change represented by: (1) the extent of clearing; and (2) a diminution in state, as measured by indices such as Habitat Hectares, compared with a hypothetical Pre–1750 type benchmark.

The example below compares the Pre–1750 and extant EVC mapping in the vicinity of Hillside Road as available on the Biodiversity Interactive Map Tool. In this context, site specific disturbance is interpreted as causing a change or deterioration in state through loss of species, weed invasion, timber harvesting etc., but not a shift in the 'common regime of ecological processes' that drive fundamental vegetation type patterns such as rainfall, temperature, soil type, parent material, elevation, aspect etc.

Sample Pre–1750 EVC coverage



Sample Extant EVC coverage



Quite rightly, it is also convention that the state–wide EVC coverage act to 'guide' site specific assessment. The broad resolution of the state–wide coverage inevitably results in inaccuracies and errors at finer scales. However, in translating down to the site level, the same conceptual framework still applies, namely: that the patterns are necessarily tenure blind and driven by finer resolution patterns in bottom–up drivers. And also, as far as possible, the fundamental type interrelationships represented locally by the maps as developed by independent ecologists, should be maintained.

The process of refining the EVC mapping used here comprised two separate considerations: (1) bottom–up factors that drive patterns of broad types and the (sometimes fuzzy) boundaries between them, and (2) factors that alter the condition of broad types. Tenure blind patterns that correlate with bottom–up drivers should be a logical test of vegetation mapping irrespective of scale.

And given the floristics in the EVC benchmarks are necessarily not characteristic or diagnostic, but rather "typical of at least part of EVC range", EVC polygon attribution and line work was only altered if absolutely necessary – and primarily to adjust for scale, while retaining the fundamental interrelationships depicted in the maps of the immediate area.

For example, the Heathy Woodland (EVC 48) located in the centre–west below, and predominantly on the exposed coarse-granite ridgeline and northern aspect, was adjusted upslope on the upper southern fall where it is replaced with the slightly more mesic Hills Herb–rich Woodland (EVC 71). According to the local EVC mapping, it is the Grassy Woodlands that replace these EVCs running down slope into the valleys and plains to the south, especially on the sheltered aspects.

Given most of the clearing has occurred in this now predominantly freehold part of the landscape, any remaining fragments are generally very poorly sampled, if not completely overlooked. Thus EVC benchmarks for these types are often quite seriously skewed, and in floristic terms, poorly representative of the of EVC community heterogeneity across the bioregion. Both this inherent unrepresentativeness for many EVCs, and the lack of any formal process to identify, describe and update the EVC mapping and associated benchmark descriptions in light of new information, is a profound limitation of the current system.

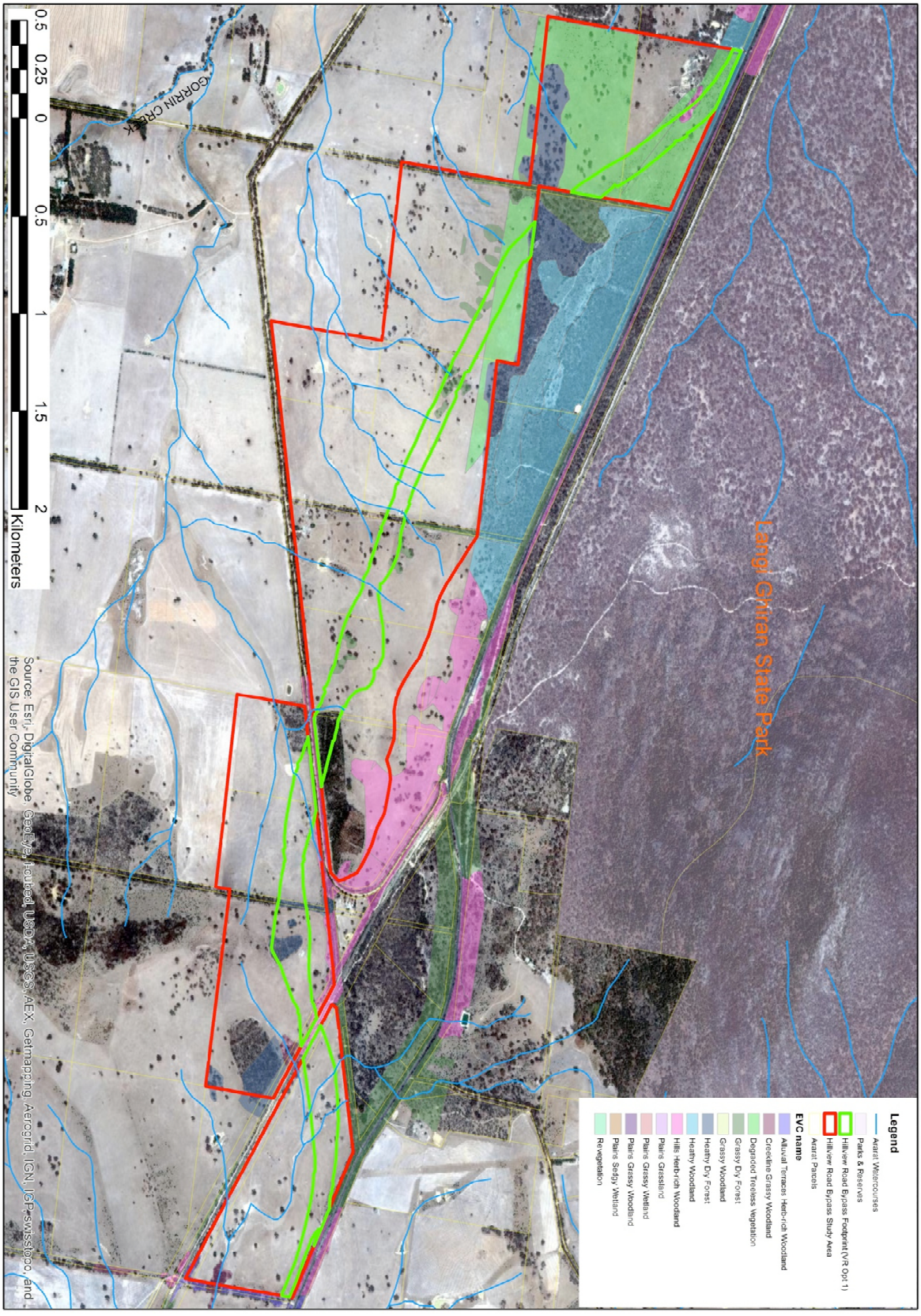
In this context, far more weight should be given to the broad mapped patterns and the higher level descriptive components in the benchmarks such as: the initial short description; canopy cover, height and dominant genera; understorey life-form profile; soils, lithology, terrain and aspect. It is highly problematic to rely heavily on the so called character species (in the canopy) when most of these are widespread and listed as characteristic of multiple EVCs throughout the bioregion. For example Yellow Box is listed as 'characteristic' of no less than six EVCs in the bioregion, namely: EVC 47: Valley Grassy Forest; EVC 70: Hillcrest Herb-rich Woodland; EVC 71: Hills Herb-rich Woodland; EVC 127: Valley Heathy Forest; EVC 177: Valley Slopes Dry Forest; and EVC 803: Plains Woodland. And furthermore, we also know Yellow Box is often dominant throughout Central Victoria in EVC 175 Grassy Woodland (Department of Environment, Climate Change and Water NSW 2010).

The map in Appendix 5 represents the product of the approach described above as implemented in the following stages: first, the broad type patterns are defined/reviewed, and then any overlaying remnant patches identified based on broad patterns of indigenous canopy, shrub and ground layer cover. Then the EVCs are automatically assigned to the remnants, with the patch VQA scores quantifying the degree of 'diminution in state'. This is a straightforward, transparent and ecological defensible approach, preferable to practices often seen in the industry were field based EVC determinations, sometimes resulting in significant changes to the EVC coverage, are made by subjective 'expert' judgement, supported with no data or written evidence.

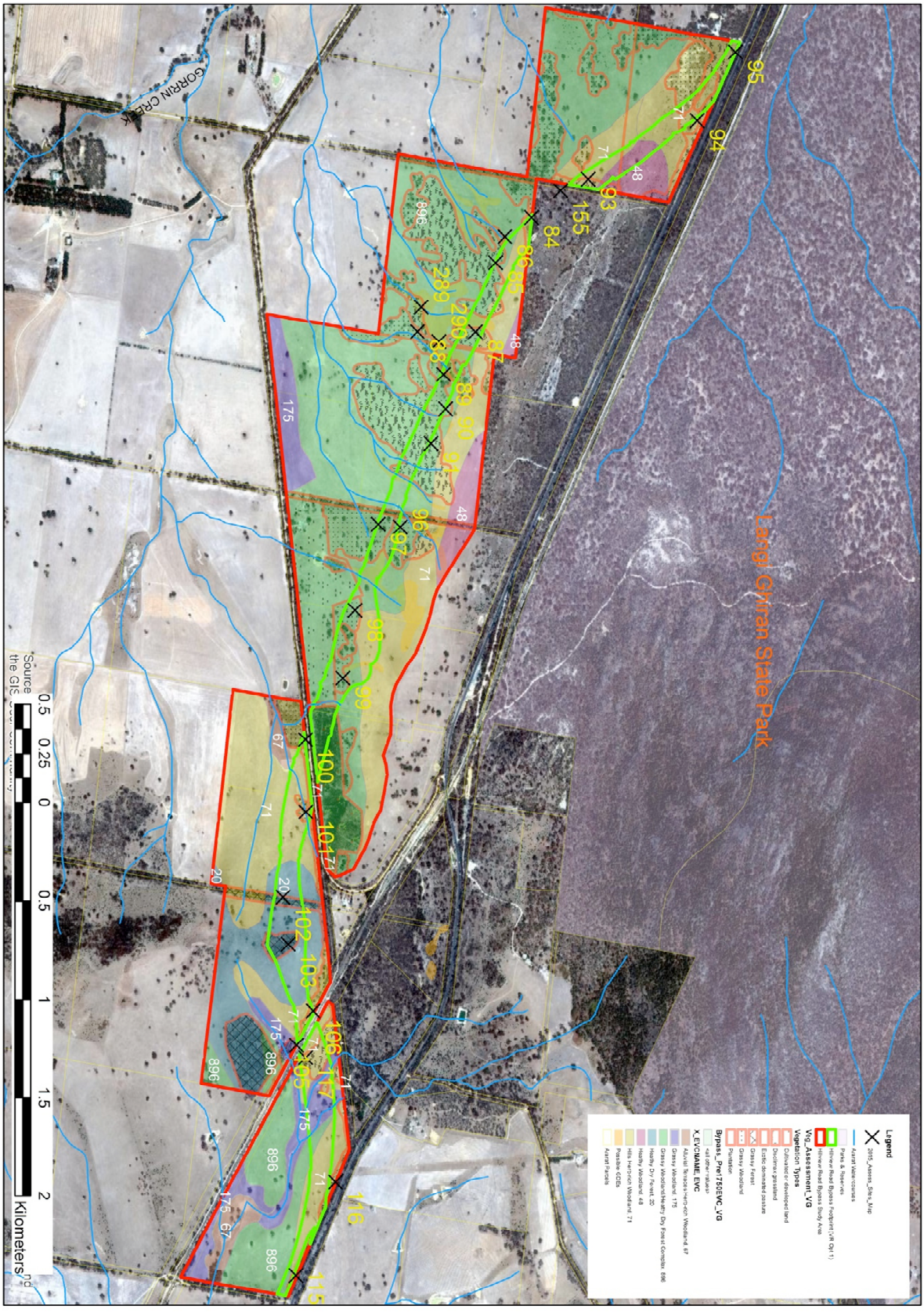
It should be noted in the table below, summarising the breakdown of the extant EVC coverage within the footprint, that: (1) about two thirds of the footprint area is considered uncleared, and (b) the Grassy Woodland/Heathy Dry Forest Complex occupies nearly 20%. Furthermore, there is no Grassy Dry Forest within the footprint, with the closest location being the steep upper granitic slopes of Mount Langi Ghiran, almost entirely well above 400 m in elevation.

Extant EVCs with Footprint	*Area (ha)*	*%*
Grassy Woodland/Heathy Dry Forest Complex	11.54	19.4%
Heathy Dry Forest	14.27	24.0%
Heathy Woodland	6.64	11.2%
Hills Herb-rich Woodland	6.88	11.6%
Cleared	*20.03*	*33.7%*
Grand Total	**59.37**	

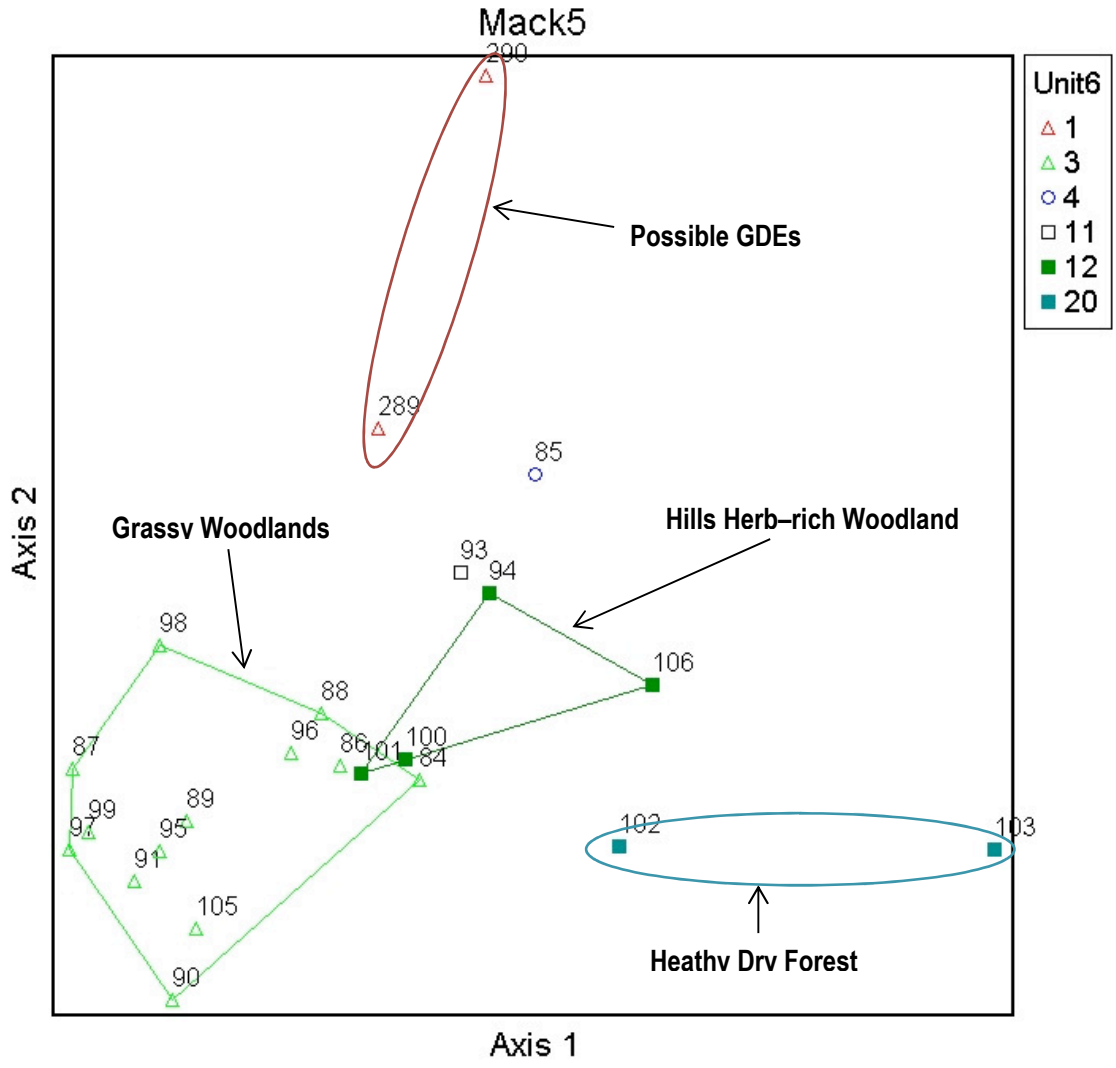
Appendix 4: 2012 EHP Vegetation assessment for EES



Appendix 5: 2015 Vegetation assessment overview



Appendix 6: Ordination Graph and Cluster Analysis



Explanation: Plot of all quadrats across the Study Area showing similarity relationships based on plant composition. Aggregated quadrats (as shown by different coloured lines and symbols) represent broad groups that generally correspond with the EVC labels shown. Note that the majority of the quadrats are in the Grassy Woodland group, which is most closely related to Hills Herb–rich Woodland: a widespread EVC on the foot–slopes of Langi Ghiran SP. The probable GDE quadrats, which are embedded in the broad matrix of Grassy Woodland across the farmland, are very distinct in terms of species composition.

Notes: Hierarchical Cluster Analysis and Ordination graph performed using the Relative Sorensen co–efficient at the six–group level. All analyses were conducted using PC–ORD Version 6.08 (McCune and Mefford 2011). The cluster dendrogram showed the 23 quadrats split into four floristically distinct groupings: Group 1 – Possible GDE; Group 3 – Grassy Woodlands; Group 12 – Hills Herb–rich Woodland; and Group 20 – Heathy Dry Forest. Excludes quadrats 115 to 117.

Appendix 7: Images of remnant grassy woodland and native pasture patches

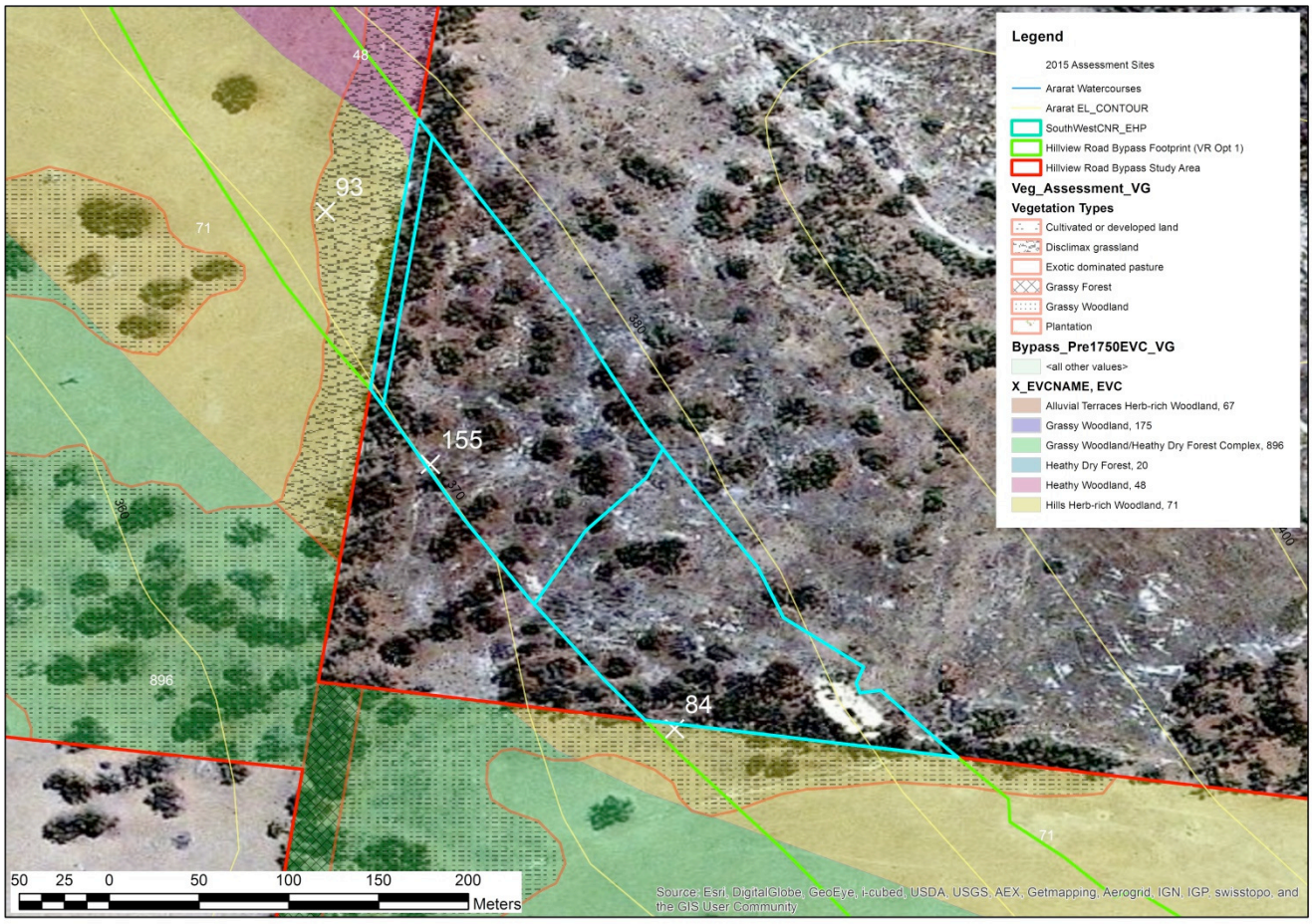
Near Quadrat 289: Part possible GDE site (Sept 2014)

Near Quadrat 86 showing dominance of Weeping Grass, Spear Grasses and Common Wheat Grass with Yellow Box

Near Quadrat 85 showing active spring

Near Quadrat 91 showing more disclimax native pasture with scattered Yellow Box and Drooping She-oak.

Appendix 8: Review of VQA figures for south west corner of 'bush block'



EHP:						
EVC/Patch	**Con. St.**	**Score**	**Ha**	**HaHa**	**Multiplier**	**Net Gain**
HDF3	High	0.59	1.34	0.79	1.50	1.19
GDF4	High	0.22	1.59	0.35	1.50	0.52
DTV	-	-	-	-	-	-
Total			**2.93**	**1.14**		**1.71**
This Assessment:						
HHRW	V. High	0.64	2.93	1.88	2.00	3.75

Notes: Top – location of ~3 ha section of south west bush block owned by David Bates and MairiAnne Mackenzie (Footprint in Blue); Bottom Left Photo: Image of Hills Herb-rich Woodland near quadrat 155 showing dominance of Yellow Box; Table: Comparison of Net Gain accounting showing significantly higher values under this assessment

Appendix 9: Comparison of Study Area footprint impact between the 2012 EES and this assessment

Vegetation Categories (all values in ha unless shown otherwise)	*EHP EES Assessment 2012 (Conservation Significance)*								*2015 Assessment (Conservation Significance)*							
	Very High	High	Medium	Low	None	Not Assessed	**Grand Total**	Tot%	Very High	High	Medium	Low	None	Not Assessed	**Grand Total**	Tot%
Degraded Treeless Vegetation	–	–	–	–	10.42	–	**10.42**	17.6%	–	–	–	–	–	–	–	–
Grassy Dry Forest	–	–	1.72	0.36	–	–	**2.08**	3.5%	–	–	–	–	–	–	–	–
Grassy Woodland	–	–	–	–	–	–	**–**	–	–	0.09	–	–	2.46	–	**2.55**	4.3%
Grassy Woodland/Heathy – Dry Forest Complex	–	–	–	–	–	–	**–**	–	4.61	7.37	–	–	10.71	–	**22.69**	38.2%
Heathy Dry Forest	–	2.00	–	–	–	–	**2.00**	3.4%	–	–	–	1.74	6.36	–	**8.10**	13.6%
Heathy Woodland	–	0.06	–	–	–	–	**0.06**	0.1%	–	–	0.08	–	1.76	–	**1.84**	3.1%
Hills Herb–rich Woodland	0.40	0.60	–	–	–	–	**1.00**	1.7%	0.84	3.32	2.17	–	17.86	–	**24.19**	40.7%
Not Assessed	–	–	–	–	–	43.81	**43.81**	73.8%	–	–	–	–	–	–	–	–
Grand Total	**0.40**	**2.65**	**1.72**	**0.36**	**10.42**	**43.81**	**59.37**		**5.45**	**10.77**	**2.25**	**1.74**	**39.15**	**–**	**59.37**	
Tot%	0.7%	4.5%	2.9%	0.6%	17.6%	73.8%			9.2%	18.1%	3.8%	2.9%	66.0%	–		

Appendix 10: Quadrat-based Habitat Hectare scores

Quadrat	*Max. Score*	***84***	***85***	***86***	***87***	***88***	***89***	***90***	***91***	***93***	***94***	***95***	***96***	***97***	***98***	***99***	***100***	***101***	***102***	***103***	***105***	***106***	***115***	***116***	***117***	***155***	***289***	***290***
Large Old Trees	10	3	3	0	0	–	3	3	3	0	3	0	4	3	3	3	0	3	3	0	3	3	0	0	3	3	–	–
Canopy Cover	5	3	0	3	0	–	3	3	0	0	3	0	3	3	3	3	3	3	5	3	5	3	0	0	0	5	–	–
Understorey	25	15	5	15	5	–	15	10	5	5	15	10	15	5	5	5	15	5	15	15	15	15	5	5	5	11	–	–
Lack of Weeds	15	11	7	11	7	–	11	11	11	11	11	7	11	7	7	7	11	11	11	11	11	7	11	11	7	15	–	–
Recruitment	10	6	1	6	0	–	3	3	1	3	3	6	3	0	0	3	6	5	6	3	6	6	0	0	0	10	–	–
Organic Litter	5	3	3	3	3	–	5	5	5	5	3	3	5	3	3	3	5	5	3	3	3	3	5	5	3	5	–	–
Logs	5	0	0	0	0	–	0	0	0	0	0	0	0	0	0	0	5	3	2	2	0	0	0	0	0	2	–	–
Patch Size	10	1	6	1	1	–	2	2	6	1	2	2	2	2	2	2	2	1	1	1	2	2	1	1	2	4	–	–
Neighbourhood	10	5	4	4	4	–	5	3	5	4	5	5	2	2	2	1	2	2	2	2	3	2	2	3	3	5	–	–
Distance to core	5	4	4	4	4	–	4	4	4	4	4	4	4	4	4	4	4	4	2	2	2	2	4	4	4	4	–	–
	100	**51**	**33**	**47**	**24**	**–**	**51**	**44**	**40**	**33**	**49**	**37**	**49**	**29**	**29**	**31**	**53**	**42**	**50**	**42**	**50**	**43**	**28**	**29**	**27**	**64**	**–**	**–**

Appendix 11: Species Richness results

Site	*289*	*290*	*84*	*86*	*87*	*88*	*89*	*90*	*91*	*95*	*96*	*97*	*98*	*99*	*105*	*85*	*93*	*94*	*100*	*101*	*106*	*102*	*103*	*115*	*116*	*117*	*155*
Veg Group (Ord)	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	4	11	12	12	12	12	20	20	N/A	N/A	N/A	N/A
EVC	80/896	80/896	71	896	896	896	896	896	896	71	896	896	896	896	175	896	71	71	71	71	71	20	20	71	71	71	71
HaHa	N/A	N/A	51	47	24	N/A	51	44	40	37	49	29	29	31	50	33	33	49	53	42	43	50	42	28	29	27	64
Total Richness	75	53	36	42	33	55	43	43	39	34	51	24	27	31	44	21	26	27	48	28	40	34	31	34	33	19	49
Exotic Richness	17	13	14	13	8	13	13	11	13	14	13	7	6	8	16	5	7	8	19	10	12	9	9	17	13	8	15
Native Richness	58	40	22	29	25	42	30	32	26	20	38	17	21	23	28	16	19	19	29	18	28	25	22	17	20	11	34
Forb Richness	12	5	3	5	4	7	6	4	6	2	10	4	5	4	4	2	4	2	5	2	3	3	3	7	7	4	9
Graminoid Richness	20	13	7	5	7	12	7	8	7	6	8	4	2	5	6	3	4	5	7	5	8	2	5	5	7	4	13

Units: Number of species per quadrat (900 square metres); 80/896 represent possible complex between a form of Spring Soak Woodland and Grassy Woodland; 896 can likely be assigned to Grassy Woodland, especially further down slope.

Appendix 12 Patch-based Habitat Hectare scores within Option 1 footprint

FID	*Sect.*	*Owner*	*Structural Patch Type*	*EVC*	*EVC_MUT*	*X_EVCNAME*	*EVC_BCS*	*Quad*	*Score*	*Area (ha)*	*Impact HaHa*	*NetG*	*CS*
1	Mid	Mairianne Mackenzie	Exotic dominated pasture	896	complex	GW/HDF	E	N/A	-	1.15	-	-	N/A
2	Mid	Mairianne Mackenzie	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	1.23	-	-	N/A
3	Mid	Mairianne Mackenzie	Exotic dominated pasture	896	complex	GW/HDF	E	N/A	-	2.05	-	-	N/A
4	Mid	Mairianne Mackenzie	Grassy Woodland	71	EVC	HHrW	V	84	51	0.35	0.18	0.35	Very High
5	Mid	Mairianne Mackenzie	Disclimax grassland	896	complex	GW/HDF	E	85	33	1.48	0.49	0.73	High
6	Mid	Mairianne Mackenzie	Disclimax grassland	71	EVC	HHrW	V	85	33	0.31	0.10	0.10	Medium
7	Mid	Mairianne Mackenzie	Disclimax grassland	896	complex	GW/HDF	E	87	24	0.74	0.18	0.27	High
8	Mid	Mairianne Mackenzie	Disclimax grassland	71	EVC	HHrW	V	87	24	0.04	0.01	0.01	Medium
9	Mid	Mairianne Mackenzie	Grassy Woodland	896	complex	GW/HDF	E	*87, 89	35	0.16	0.06	0.08	High
10	Mid	Mairianne Mackenzie	Grassy Woodland	896	complex	GW/HDF	E	89, 90	48	1.24	0.59	1.19	Very High
11	Mid	Mairianne Mackenzie	Disclimax grassland	896	complex	GW/HDF	E	91	40	2.59	1.04	2.07	Very High
12	Mid	Tim Webb	Plantation	896	complex	GW/HDF	E	N/A	-	2.00	-	-	N/A
13	Mid	Tim Webb	Plantation	71	EVC	HHrW	V	N/A	-	0.15	-	-	N/A
14	Mid	Tim Webb	Disclimax grassland	896	complex	GW/HDF	E	*96	45	0.09	0.04	0.09	Very High
15	Mid	Tim Webb	Cultivated or dev. land	896	complex	GW/HDF	E	N/A	-	1.25	-	-	N/A
16	Mid	Tim Webb	Grassy Woodland	896	complex	GW/HDF	E	98, 99	30	2.31	0.69	1.04	High
17	Mid	Tim Webb	Grassy Woodland	71	EVC	HHrW	V	98	29	0.08	0.02	0.02	Medium
18	Mid	Tim Webb	Grassy Woodland	896	complex	GW/HDF	E	96	49	0.68	0.33	0.66	Very High
19	Mid	Other	Grassy Forest	896	complex	GW/HDF	E	*96, 97	38	0.19	0.07	0.11	High
20	Mid	Tim Webb	Grassy Woodland	896	complex	GW/HDF	E	97	29	1.30	0.38	0.57	High
21	Mid	Tim Webb	Exotic dominated pasture	896	complex	GW/HDF	E	N/A	-	3.29	-	-	N/A
22	Mid	Tim Webb	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	2.55	-	-	N/A
23	Mid	Tim Webb	Grassy Woodland	896	complex	GW/HDF	E	*98, 99	20	0.74	0.15	0.22	High
24	Mid	Tim Webb	Grassy Woodland	71	EVC	HHrW	V	*98, 99	20	0.01	0.00	0.00	Medium
25	Mid	Mairianne Mackenzie	Grassy Woodland	896	complex	GW/HDF	E	*87	25	0.42	0.10	0.16	High
26	West	Mairianne Mackenzie	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	1.60	-	-	N/A
27	West	Mairianne Mackenzie	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	0.22	-	-	N/A
28	West	Mairianne Mackenzie	Exotic dominated pasture	48	EVC	HW	D	N/A	-	1.33	-	-	N/A
29	West	Mairianne Mackenzie	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	1.06	-	-	N/A
30	West	Mairianne Mackenzie	Exotic dominated pasture	48	EVC	HW	D	N/A	-	0.43	-	-	N/A

31	West	Mairianne Mackenzie	Grassy Woodland	71	EVC	HHrW	V	^HHrW7	57	0.39	0.23	0.45	Very High
32	West	Mairianne Mackenzie	Disclimax grassland	71	EVC	HHrW	V	95	37	1.32	0.49	0.73	High
33	West	Mairianne Mackenzie	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	0.73	-	-	N/A
34	West	Mairianne Mackenzie	Disclimax grassland	71	EVC	HHrW	V	93	33	0.44	0.15	0.22	High
35	West	Mairianne Mackenzie	Disclimax grassland	48	EVC	HW	D	93	33	0.08	0.03	0.03	Medium
36	West	Mairianne Mackenzie	Grassy Woodland	71	EVC	HHrW	V	94	49	0.45	0.22	0.33	High
37	East	Iona Mackenzie	Exotic dominated pasture	20	EVC	HDF	LC	N/A	-	1.63	-	-	N/A
38	East	Iona Mackenzie	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	4.21	-	-	N/A
39	East	Iona Mackenzie	Grassy Woodland	71	EVC	HHrW	V	100	53	0.10	0.05	0.11	Very High
40	East	Iona Mackenzie	Disclimax grassland	71	EVC	HHrW	V	*101	35	0.39	0.14	0.20	High
41	East	Iona Mackenzie	Grassy Woodland	896	complex	GW/HDF	E	105	50	0.01	0.01	0.01	Very High
42	East	Iona Mackenzie	Grassy Woodland	71	EVC	HHrW	V	106	43	0.29	0.13	0.19	High
43	East	Iona Mackenzie	Grassy Forest	20	EVC	HDF	LC	103	42	1.20	0.50	0.50	Low
44	East	Iona Mackenzie	Exotic dominated pasture	20	EVC	HDF	LC	N/A	-	4.74	-	-	N/A
45	East	Iona Mackenzie	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	0.61	-	-	N/A
46	East	Iona Mackenzie	Grassy Forest	20	EVC	HDF	LC	102	50	0.54	0.27	0.27	Low
47	East	Iona Mackenzie	Grassy Woodland	71	EVC	HHrW	V	101	42	0.42	0.18	0.27	High
48	Far East	Kilpatrick & Wallace	Disclimax grassland	175	EVC	GW	E	117	27	0.04	0.01	0.02	High
49	Far East	Kilpatrick & Wallace	Disclimax grassland	175	EVC	GW	E	117	27	0.05	0.01	0.02	High
50	Far East	Kilpatrick & Wallace	Disclimax grassland	896	Complex	GW/HDF	E	115	28	0.02	0.01	0.01	High
51	Far East	Kilpatrick & Wallace	Disclimax grassland	71	EVC	HHrW	V	117	27	0.10	0.03	0.03	Medium
52	Far East	Kilpatrick & Wallace	Disclimax grassland	71	EVC	HHrW	V	117	27	0.00	0.00	0.00	Medium
53	Far East	Kilpatrick & Wallace	Disclimax grassland	71	EVC	HHrW	V	117	27	1.36	0.37	0.37	Medium
54	Far East	Kilpatrick & Wallace	Disclimax grassland	71	EVC	HHrW	V	115	28	0.09	0.03	0.03	Medium
55	Far East	Kilpatrick & Wallace	Disclimax grassland	71	EVC	HHrW	V	116	29	0.18	0.05	0.05	Medium
56	Far East	Kilpatrick & Wallace	Exotic dominated pasture	175	EVC	GW	E	N/A	-	2.46	-	-	N/A
57	Far East	Kilpatrick & Wallace	Exotic dominated pasture	896	Complex	GW/HDF	E	N/A	-	0.97	-	-	N/A
58	Far East	Kilpatrick & Wallace	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	0.21	-	-	N/A
59	Far East	Kilpatrick & Wallace	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	0.54	-	-	N/A
60	Far East	Kilpatrick & Wallace	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	0.39	-	-	N/A
61	Far East	Kilpatrick & Wallace	Exotic dominated pasture	71	EVC	HHrW	V	N/A	-	4.36	-	-	N/A
										59.37	**7.32**	11.51	

Notes: ^ - value sourced from EHP assessment; * - values modelled on results from nearby quadrats; CS – Conservation Significance rating based purely on HaHa scores; FID – a ArcGIS layer can be provided linking this number of specific polygons with the footprint as required; NetG = HaHa scores x Net Gain multiplier (1, 1.5 or 2).

Appendix 13 Flora from the vegetation assessment

SCIENTIFIC NAME	COMMON NAME	ORIGIN	VROTS	84	85	86	87	88	89	90	91	93	94	95	96	97	98	99	100	101	102	103	105	106	115	116	117	155	289	290
Acetosella vulgaris	Sheep Sorrel	*		2	2	1	1	1	1	1	1	2	3	2					+					1	1			1	+	1
Agrostis capillaris	Brown-top Bent	*					+		+					1	1	1	1	2	2	1			1	1	1	1	1		+	1
Aira spp.	Hair Grass	*		1		1			1		1							1	1						+			1		1
Amaryllis belladonna	Belladonna Lily	*																		+										
Arctotheca calendula	Cape Weed	*		1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	1	1	2	1	1	+	1	2	1	+	1
Avena spp.	Oat	*											2	1					1											
Briza maxima	Large Quaking-grass	*		1	1	1								1					2	1			1		+	1		3		
Briza minor	Lesser Quaking-grass	*													1													+	2	1
Bromus diandrus	Great Brome	*									1		1	1					1		2				+	1				1
Bromus hordeaceus subsp. hordeaceus	Soft Brome	*				+		1	1	1	1			1	3	2	2	2	1	1	1		1	1						1
Cerastium spp.	Mouse-ear Chickweed	*																										+		
Chondrilla juncea	Skeleton Weed	*			+																									
Cirsium vulgare	Spear Thistle	*				+		+			+			+	+	+	+	1											+	+
Cynosurus echinatus	Rough Dog's-tail	*			+	1	1	+		1	1				+	+	1	1	1							1			1	1
Dactylis glomerata	Cocksfoot	*				+				+				+							2		2	1	+				+	
Ehrharta erecta var. erecta	Panic Veldt-grass	*																	+									1		
Ehrharta longiflora	Annual Veldt-grass	*																							+					
Erodium botrys	Big Heron's-bill	*		1	1	1	1	1	1	+		+		+	1	+	2	1									1		1	
Holcus annuus	Annual Fog	*																											1	
Holcus lanatus	Yorkshire Fog	*			1	+	+	1	+	+	+			2		+													+	1
Hordeum murinum s.l.	Barley-grass	*					+																		1					
Hypochaeris glabra	Smooth Cat's-ear	*		1	2	1	1	1	1	1	1	1	1	1	+	1	+	+	1			1		1	1	1	2	1	2	2
Hypochaeris radicata	Flatweed	*		2	3	2	2	2	2	1	2	2	2	2	2	1	2	1	2	1		+	1	2	1	1	1	+	2	3
Isolepis levynsiana	Tiny Flat-sedge	*																											1	
Leontodon taraxacoides subsp. taraxacoides	Hairy Hawkbit	*						1							+														+	1
Lolium perenne	Perennial Rye-grass	*						+		+	+		+					1												
Lolium rigidum	Wimmera Rye-grass	*						1	1	+	1					+			+		1		1		1	1		1		1
Molineriella minuta	Small Hair-grass	*																										+		
Oxalis pes-caprae	Soursob	*																		1										
Phalaris aquatica	Toowoomba Canary-grass	*			1	+	+	+		+	+						+	2	1	2			1	1						+
Poa bulbosa	Bulbous Meadow-grass	*								+	+		1		+			1		1	1				1	1		+		
Romulea rosea	Onion Grass	*		2	2	1	2	1	2	1	2	3	2	2	1	2	2	2	2	2	2	2	2	2	2	2	2	1	3	2
Rosa rubiginosa	Sweet Briar	*																	+											
Rumex crispus	Curled Dock	*																							+	+			+	
Solanum nigrum s.l.	Black Nightshade	*									+	+																		
Sonchus asper s.l.	Rough Sow-thistle	*						+			+				+															
Sonchus oleraceus	Common Sow-thistle	*									+				1	+	+	+	+			+							+	

Trifolium campestre var. campestre	Hop Clover	*												+														
Trifolium spp.	Clover	*				1																					1	
Trifolium subterraneum	Subterranean Clover	*	1	3	2	3	2	2	1	3	2	2	2	2	3	3	3	1	1	1	1	+	2	+	+	2	+	2	2
Vicia spp.	Vetch	*																+										
Vulpia muralis	Wall Fescue	*																									3	4
Vulpia spp.	Fescue	*	1	2	2	3	2	2	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1		
Acacia aculeatissima	Thin-leaf Wattle						+																						
Acacia gunnii	Ploughshare Wattle				+							+																	
Acacia implexa	Lightwood								+																				
Acacia mearnsii	Black Wattle																	1				+	3						1
Acacia paradoxa	Hedge Wattle		+					+	2	+				1				3	3	1	2	2	2					+	
Acacia pycnantha	Golden Wattle		2								+	+						1		3	4	1	3				3		
Acacia verniciflua s.l.	Varnish Wattle		+		+			+			+	+						1									3	+	
Acaena echinata	Sheep's Burr		+		1	+	1	1	1	+	+		+	2	1	+	1	1	1				+		1	+		1	+
Allocasuarina verticillata	Drooping Sheoak						+			2								+			2							+	
Amphibromus nervosus	Common Swamp Wallaby-grass																											1	
Amyema pendula	Drooping Mistletoe									+												+					1	
Anthosachne scabra s.l.	Common Wheat-grass		2	4	2	2	3	1	2	2	1	1	+	2	2	2	1	2	1	1		2	2	1	2	1		+	1
Arthropodium fimbriatum	Nodding Chocolate-lily																			+									
Arthropodium spp. (s.s.)	Vanilla Lily						+	+	+					1				+				1	+	+	+	+	2	1	1
Arthropodium strictum s.l.	Chocolate Lily																				1								
Astroloma conostephioides	Flame Heath																										+		
Astroloma humifusum	Cranberry Heath		+		+						+	+						+			2	+	+				2	
Austrostipa densiflora	Dense Spear-grass		2	4	2		2		1	+	1		1					2			3	1	1	+	+		1	1	
Austrostipa mollis	Supple Spear-grass																			1	+	+	+		+				
Austrostipa nodosa	Knotty Spear-grass					+	2	2		2				1					1								+	2	
Austrostipa scabra	Rough Spear-grass		1		1			2	1	1				1	+		1											1	+
Austrostipa semibarbata	Fibrous Spear-grass		1		1	+	1	1	2			1		3	2	3	2	1	2			2						+	
Austrostipa setacea	Corkscrew Spear-grass					1																							
Brachyloma daphnoides	Daphne Heath		+									+															2		
Burchardia umbellata	Milkmaids																				1								+
Bursaria spinosa	Sweet Bursaria																			+									
Calocephalus citreus	Lemon Beauty-heads						+							+															
Carex breviculmis	Common Grass-sedge						+							+				+				+							
Cassytha melantha	Coarse Dodder-laurel										+																		
Centrolepis glabra	Smooth Centrolepis																										2		
Centrolepis strigosa subsp. strigosa	Hairy Centrolepis																										2		
Chamaescilla corymbosa var. corymbosa	Blue Stars		+		1																+						1	1	2
Cheilanthes austrotenuifolia	Green Rock-fern																				+								
Chrysocephalum apiculatum s.l.	Common Everlasting																	1									2		
Crassula decumbens var. decumbens	Spreading Crassula																							1	1	1	1		
Crassula sieberiana s.l.	Sieber Crassula																										1		
Dianella admixta	Black-anther Flax-lily										+	+						+		+		+	+				1		

Dichondra repens	Kidney-weed								+																						1
Diuris chryseopsis	Golden Moths																												+		
Drosera glanduligera	Scarlet Sundew																									1	+				+
Drosera peltata subsp. auriculata	Tall Sundew																											1	+		
Drosera whittakeri subsp. aberrans	Scented Sundew					+	1	1	+				+						1	1	1	1	1	+			1				
Eleocharis spp.	Spike Sedge																														+
Eragrostis brownii	Common Love-grass		1		1		+	1					+																+		3
Eucalyptus aromaphloia	Scentbark																					1									3
Eucalyptus camaldulensis	River Red-gum																			2											
Eucalyptus goniocalyx s.l.	Bundy		+							1	+	+							1	2	+	+									
Eucalyptus macrorhyncha	Red Stringybark																		1	1	2	1									
Eucalyptus melliodora	Yellow Box		+		2		+	2	2		+	2	+	1	+	+	2	1	2	3		2						3			
Eucalyptus yarraensis	Yarra Gum	r																													1
Euchiton sphaericus	Annual Cudweed																													1	
Geranium solanderi s.l.	Austral Crane's-bill						1	1	2	2				2				1	1		2		1							+	
Geranium spp.	Crane's-bill																									1	+		+		
Gonocarpus tetragynus	Common Raspwort		2		1	+	+	1	1	2	1	1	1	1				1			+	1	2	+	+		2	1			
Haloragis heterophylla	Varied Raspwort						1																						2	2	
Hibbertia crinita	Hoary Guinea-flower																											2			
Hibbertia spp.	Guinea Flower											+																			
Hypericum gramineum	Small St John's Wort		+										+									+	+							
Hypoxis vaginata var. vaginata	Yellow Star																											1			
Isolepis marginata	Little Club-sedge																												+		
Isotoma fluviatilis subsp. australis	Swamp Isotome																												1	1	
Juncus australis	Austral Rush																														+
Juncus bufonius	Toad Rush																												1		
Juncus holoschoenus	Joint-leaf Rush																												+		
Juncus homalocaulis	Wiry Rush																														+
Juncus pallidus	Pale Rush		+			+												+											+	1	
Juncus pauciflorus	Loose-flower Rush																														+
Juncus remotiflorus	Diffuse Rush		1		+			+									+	1					+						+		
Juncus spp.	Rush		+				+																+						+		
Juncus subsecundus	Finger Rush					+	+	+	+	+	+	+		+			+	+	1		+	+		+	+	+			+	+	+
Lachnagrostis filiformis s.l.	Common Blown-grass																		1										+	1	
Lepidosperma laterale	Variable Sword-sedge						+		+																				+		
Lepidosperma semiteres	Wire Rapier-sedge																						+								
Leptorhynchos squamatus	Scaly Buttons												+																		
Leptospermum continentale	Prickly Tea-tree																														+
Leptospermum myrsinoides	Heath Tea-tree																											1			
Lissanthe strigosa subsp. subulata	Peach Heath						+						+				+		2	3	+	1		+		2	1			
Lomandra filiformis	Wattle Mat-rush		2	1	3	1	2	2	2	2	1	1	2	3	+	1	+	1		4	2	+	1	1	+		1	+	+		
Lomandra nana	Dwarf Mat-rush		1		1	+		+	+		1								+	+		+			+	+	1	+			
Lomandra sororia	Small Mat-rush					1	+	+	+				+	+		+		+		1	2		1								
Luzula meridionalis	Common Woodrush																				+	+									
Microlaena stipoides var. stipoides	Weeping Grass		3	2	3	4	3	4	5	5	2	1	4	3	4	3	4	3	3	3	2	4	2	3	4	4	2	3	2		

Microtis spp.	Onion Orchid																									1		
Millotia tenuifolia var. tenuifolia	Soft Millotia																									+		
Oxalis spp.	Wood Sorrel	+	1	1	+	+	1	+	+	+	+		+		2	1	1	1		+	+	1	1		+	+	+	+
Pelargonium rodneyanum	Magenta Stork's-bill			+			+										+		+									
Pentapogon quadrifidus var. quadrifidus	Five-awned Spear-grass					+																				1		
Pimelea curviflora var. sericea	Curved Rice-flower																+				+							
Pimelea humilis	Common Rice-flower											1				1			+			1		1	+		+	1	
Pimelea linifolia	Slender Rice-flower			+																								
Poa labillardierei var. labillardierei	Common Tussock-grass					+																						+
Poa sieberiana var. hirtella	Grey Tussock-grass											+																
Poa sieberiana var. sieberiana	Grey Tussock-grass					+		1	+			1							+	+		+				+		
Poa spp. (rhizomitous)	Tussock Grass					+																						
Poranthera microphylla s.l.	Small Poranthera																									1		
Ranunculus inundatus	River Buttercup																										+	
Rumex brownii	Slender Dock		+	+	+	1	+			+	+		+		+	+	+	+	+								+	+
Rytidosperma caespitosum	Common Wallaby-grass				+	1	2	+	1		1		1		1												1	+
Rytidosperma duttonianum	Brown-back Wallaby-grass					+																					1	
Rytidosperma erianthum	Hill Wallaby-grass																				+						+	
Rytidosperma fulvum	Copper-awned Wallaby-grass																						+					+
Rytidosperma geniculatum	Kneed Wallaby-grass	3	2	2		1		1	1	3	2	1	1		1	1	2	1	1	2	2	1	3	3	3	3	+	1
Rytidosperma laeve	Smooth Wallaby-grass			+	+	1	+	+																				2
Rytidosperma penicillatum	Weeping Wallaby-grass																										+	
Rytidosperma pilosum	Velvet Wallaby-grass				1	2						+	1															
Rytidosperma racemosum var. racemosum	Slender Wallaby-grass	2	1	2	1		3	2	2	2	4	2	2	2	3	2	3	4	2	2	2	3				1		
Rytidosperma setaceum var. setaceum	Bristly Wallaby-grass								1																		2	
Rytidosperma spp.	Wallaby Grass									1													2	2	2			1
Schoenus apogon	Common Bog-sedge																										2	1
Schoenus spp.	Bog Sedge			+		+	+					+															1	
Solenogyne dominii	Smooth Solenogyne											+		+													1	
Stellaria spp.	Starwort																						1	+				
Thelymitra spp.	Sun Orchid	1		1			+																			+	+	
Themeda triandra	Kangaroo Grass			+		2	1	1				1		1	1	1		1		2	1						+	+
Thysanotus patersonii	Twining Fringe-lily																										+	
Tricoryne elatior	Yellow Rush-lily					+	+	+				+								+						1	3	1
Vittadinia gracilis	Woolly New Holland Daisy					+																						
Wurmbea dioica	Common Early Nancy						+					+																
Xanthorrhoea minor subsp. lutea	Small Grass-tree																		+			+						
	Total	36	21	42	33	55	43	43	39	26	27	34	51	24	27	31	48	28	34	31	44	40	34	33	19	49	75	53
	Exotics	10	13	16	14	17	13	16	20	9	11	16	17	14	13	16	20	12	9	7	11	11	17	13	8	15	20	18
	Natives	26	8	26	19	38	30	27	19	17	16	18	34	10	14	15	28	16	25	24	33	29	17	20	11	34	55	35

Appendix 14 Landscape impact of proposed By-pass