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Woody Meadow Plantings in Level Crossing Removal Project Sites

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1. Description of Project

Urban greening is expanding in an effort to make our cities more liveable. However, the high costs of maintaining vegetation in public urban landscapes often means that these plantings are often simplistic, with low diversity and little visual appeal (Dunnnett and Hitchmough 2004). This is exacerbated in roadsides, streetscapes, and railway sidings, where site conditions limit plant choice and access for maintenance is restricted and costly.

One way to overcome this is using *naturalistic meadow plantings* that have lower maintenance inputs, but high aesthetic values (Dunnnett and Hitchmough 2004). The success and resilience of meadow landscapes depends on how well species are matched with site conditions and the available resource inputs for maintenance (e.g. soil type, water availability and climate) (Dunnnett and Hitchmough 2004). In public landscapes in temperate parts of Europe and USA, meadows are generally mixtures of flowering herbaceous plants, which are dormant in winter (Dunnnett and Hitchmough 2004). However, in Australia, given severe water limitations during summer, differences in soil fertility and a desire for year-round visual interest, it may be more appropriate to use natural shrubland ecosystems as templates for developing Australian meadow plantings.

Therefore, we have developed the concept of “*Woody Meadows*” which are naturalistic plantings of Australian shrubs, designed to improve the appearance and function of lower maintenance public landscapes (**Figure 1**). Plants chosen are selected for high flowering and aesthetic values, plus their ability to reshoot to maximise floral display and longevity. Maintenance inputs are reduced by increasing plant density and coppicing treatments (hard pruning of all stems close to the ground) every two to four years. This maintains dense canopies that reduces weeds and promote flowering.



Figure 1: Typical lower maintenance urban plantings of single shrub species or strappy leaf monocots (left) and a *Woody Meadow* pilot planting (right) in the City of Melbourne.

For the last four years, we have researched *Woody Meadows* as a collaborative project with the City of Melbourne, the Trawalla Foundation, the Royal Botanical Gardens of Victoria and the University of Sheffield. This research established two (180 m²) pilot *Woody Meadow* plantings in the City of Melbourne, which have thrived over three years with manual coppicing treatments and low maintenance (Backhouse 2018; Martin 2017) (**Figure 1**).

2. Benefits of Woody Meadows

Woody Meadows are a novel approach to designing high-quality landscapes with lower resources and life costs. Lower maintenance landscapes are widely used in locations where vegetation is incorporated into the urban form, but where site, constraints, context, or budget prohibit higher maintenance interventions. High maintenance landscapes are typically associated with higher quality outcomes, including visual, diversity and function; however that does not have to be the case.

Woody Meadows are being designed as a similar and low cost alternative to the more typical monoculture plantings of strappy leaved plants or drought tolerant shrubs. This diverse community of flowering shrubs providing increased aesthetics and a greater variety of plants, in addition to potential benefits such as more human connections to nature and well-being and greater biodiversity. This increased diversity also facilitates more resilience to a changing climate.

3. Opportunities for use of Woody Meadows in infrastructure

The Level Crossing Rail Project (LXRP) is interested in increasing the amount of 'greening' across their sites, including using more low maintenance plantings.

While Woody Meadow plantings have been successfully developed in the City of Melbourne over the last four years, the LXRP requires slightly different design outcomes (for example, reduced height and lower maintenance inputs for railway corridors).

An experimental Woody Meadow (LXRP planting) was installed as part of the Abbots Road, Dandenong Level Crossing Removal Project. Installation of this Woody Meadow was a first of its kind as we had not yet trialled these low maintenance plantings in rail landscapes. A case study has been developed on the Abbots Road site design, specifications and learnings and is attached in **Appendix 1**. A summary of the main learnings from this installation include:

- Subcontractors are involved in installation of the innovative design, which requires more project management due to the 'new' nature of the design elements.
- Plants can be difficult to source and may require long lead times to propagate, therefore, earlier planning may be required than that of standard landscape treatments. Contract ordering may be required.
- Plant substitutions should occur from these guidelines, avoiding the use of strappy plants.
- Clear documentation of site preparation needed to facilitate monitoring and integration of key learnings into new installations.

Further, the Woody Meadows installation at Abbots Road was awarded an 'innovation point' under the Infrastructure Sustainability Rating Tool. A benefit of this status is that any project implementing (or incorporating in their design) the Woody Meadows landscape until September 2020 also receives the 'innovation point'. Suggested evidence to achieve this 'innovation point' through the Infrastructure Sustainability Council of Australia rating tool – is for University of Melbourne to provide a letter of support that the project design meets the intent of the Woody Meadows design. This document also outlines the design development, site preparation and installation specifications, and maintenance guidelines at this site.

The objective of this report is to provide guidance for integrating attractive, robust and low maintenance Woody Meadow plantings across the LXRP network. This includes building from the learnings above with further information to expand Woody Meadow landscape treatments to new railway corridor sites. This guidance here includes design development, specifications for site preparation and installation, and maintenance guidelines.

4. Recommendations for Woody Meadow plantings across further LXP sites

A workshop was held to communicate how Woody Meadows are designed and installed and to discuss future opportunities for Woody Meadows across future LXP sites. Participants discussed design constraints and opportunities of potential sites to inform the recommendations. These recommendations are presented here as guidelines available for use across the wider MTM or V/Line network.

Five design scenarios for LXP sites were presented in the workshop for Woody Meadow plantings:

1. **Community interface areas maintained by council**

These plantings have no height restriction, are in full-sun conditions and have higher visual amenity needs because of their location. These are the optimal sites for Woody Meadows.

2. **Areas adjacent to MTM maintenance tracks and railway sidings or any area with a public interface where plant heights are required to be restricted for passive surveillance**

These plantings are restricted to <0.5 m in height.

3. **Road/ Rail over**

The opportunity for Woody Meadows here are long narrow strips, potentially with significant shade from overhead bridge structures. There may be an opportunity to design for Water Sensitive Urban Design (WSUD); however if not these sites should be irrigated.

4. **Road/Rail under**

The level crossing types provide areas that may have 'battered slopes'.

5. **Projects adjacent to sensitive biodiversity areas**

These sites need to consider indigenous species from relevant EVCs as some projects have adjacent significant biodiversity areas; non-indigenous plant 'spread' into these areas is a concern. Further, indigenous species can be easily deemed an ecological/biodiversity enhancement under the IS rating tool.

4.1. Plant selection

The following criteria were used to develop lists of appropriate species for LXP sites:

• **Plant type**

All plants are native Australian woody plant species, growing naturally from 0.5 to 3 m in height (at 5 years without coppicing).

• **Pruning responses**

Plants selected need to be able to regenerate from periodic coppicing and/or hard-pruning. This information was based on published information and expert recommendations on shrub regeneration in horticulture or in natural ecosystems following fire disturbance (Clarke and others 2015). This criterion also uses data gained from experiments in the Woody Meadow project (Farrell and others 2018).

• **Robustness and resilience**

Because of the minimal site preparation and low maintenance and resource inputs, selected plants must be robust and resilient in cultivation in terms of their growth and performance. These criteria have used available information on shrub performance in public landscapes, including the Woody Meadow experimental plots, road-side revegetation projects and published information.

For selecting species adjacent to sensitive biodiversity areas, 52 shrub species occurring in Melbourne EVCs (Bull 2014) which are known to resprout after fire (Clarke and others 2015) and may be suitable coppicing in Woody Meadow plantings were also identified (**Table 1**). These species may be less robust than the other species presented and should be used where the EVC is the main reason for inclusion of these species.

From these criteria, an initial list of 79 plant taxa were chosen as being potentially suitable for use in Woody Meadow plantings across LXP sites (**Table 2**). These lists do not replace the need for careful site analysis of planting constraints for plant selection during the design process.

This initial plant list was further reduced by evaluation against specific plant growth and environmental factors across the LXP sites by use of a plant selection matrix. These criteria were used to develop tailored lists for the site typologies developed in the workshop. These criteria included:

- **Growth rate**

Due to the limited maintenance, there is a need for rapid plant growth to achieve canopy closure of the shrub planting during the establishment period. This is important to reduce weeds. Fast growth is also recommended on batters for stabilisation in road/rail under sites. The growth rate was scored as: slow = 1, slow-medium = 2, medium = 3, medium-fast = 4, fast = 5.

- **Waterlogging tolerance**

Waterlogging tolerance was used to select species suitable for WSUD applications such as swales. Plants were scored based on their waterlogging tolerance as: poor tolerance = 0, average = 1, moderately good = 2 and very good = 3. Tolerance to waterlogging here can also be used as a proxy for tolerance to compaction.

- **Shade tolerance**

Due overhanging structures in Road/Rail Over sites, a degree of shade tolerance will be required in many locations. Shade tolerance was scored as: full sun = 0, semi-shade to full sun = 1, semi-shade = 2, semi-shade to shade = 3, full shade = 4. For Road/Rail over sites, plants were selected separately for deep shade directly under overhead bridge structures and for moderate shade areas in the immediate area around the bridge structure.

Scoring of these criteria was based on information sourced from the Burnley Plant Guide (accessed October 22, 2019: <https://bpg.unimelb.edu.au/index.jsp>). This evaluation enabled each of the 79 species to be scored and ranked for inclusion in Woody Meadows across LXP sites (**Table 2**).



Table 1: Species occurring in Melbourne EVCs (Bull 2014) which are known to resprout after fire (Clarke and others 2015) and may be suitable for Woody Meadow plantings. Species in bold have been evaluated in Woody Meadow plantings and numbers refer to EVCs (refer to notes table).

Species	2	3	6	8	16	18	22	23
Acacia acinacea						X	X	
Acacia brownii							X	
Acacia gunnii							X	
Acacia imple Xa						X	X	X
Acacia mearnsii		X		X	X	X	X	X
Acacia melano Xylon		X		X	X	X	X	X
Acacia stricta					X	X	X	X
Acacia verniciflua							X	X
Allocasuarina littoralis		X						
Allocasuarina paludosa				X	X			
Allocasuarina verticillata	X							
Aly Xia bu Xifolia	X							
Aotus ericoides		X	X					
Astroloma humifusum		X	X				X	X
Atriple X semibaccata	X							
Billardiera scandens							X	
Bossiaea cinerea	X	X	X					
Bursaria spinosa		X			X	X	X	X
Callistemon sieberi						X		
Calytri X tetragona								
Correa refle Xa var refe Xa		X	X		X	X	X	X
Daviesia latifolia							X	X
Daviesia ulcifolia subsp. ulcifolia								X
Dillwynia glaberimma		X	X				X	
Dillwynia hispida								
Dillwynia phyllicoides								
Dillwynia sericea			X				X	
Dodonaea viscosa subsp spatulata							X	
Enchylaena tomentosa var. tomentosa								
Einadia nutans ssp. nutans								
Eremophila desertia								

29	45	47	48	53	55	56	61	64	68	71	83
		X			X		X	X			
		X	X								
							X				
		X	X		X	X	X	X	X	X	
X	X	X		X	X	X	X		X	X	X
X	X	X		X	X	X			X		X
X	X	X									X
X		X						X			
		X			X	X					
X											
					X			X		X	
		X	X								
		X	X				X				
					X	X	X	X	X	X	
		X					X				
			X								
X	X	X			X	X	X	X	X		X
						X					
X	X	X	X								
X		X									
X	X		X								
		X	X								
					X						
							X				
			X				X				
		X			X	X	X	X			
					X		X	X	X		
							X	X	X		
					X			X	X		

Species	2	3	6	8	16	18	22	23
Goodenia ovata				X	X	X		X
Goodia lotifolia						X		X
Hardenbergia violacea		X			X	X	X	X
Hibbertia riparia		X	X				X	
Hovea heterophylla					X		X	X
Indigofera australis						X	X	X
Kunzea leptospermoides		X		X	X	X	X	
Leptospermum continentale		X	X	X	X	X	X	X
Leptospermum grandifolium						X		
Leptospermum lanigerum				X		X		
Leptospermum obovatum								
Leptospermum scoparium				X	X	X		X
Leucopogon parviflorus	X	X						
Melaleuca ericifolia		X		X		X		
Melaleuca lanceolata	X							
Melaleuca squarrosa		X		X				
Myoporum insulare	X							
Persoonia chamaepeuce					X			
Platylobium obtusangulum		X	X	X	X		X	X
Ricinocarpus pinifolius		X	X					
Senna artemisioides ssp. filifolia								

29	45	47	48	53	55	56	61	64	68	71	83
X	X	X	X	X	X	X	X		X		X
X		X	X								
X		X			X		X		X	X	
X			X								
X		X					X				
X	X	X									X
X	X	X	X	X	X	X	X				X
X	X	X	X	X	X	X					X
X						X					
				X		X			X		X
						X					
X	X	X	X	X							X
			X								
X				X		X			X		X
								X			
			X	X							
							X				
X	X	X	X				X				
			X								
								X			

Species	127	128	132	160	161	164	175	191
Acacia acinacea	X						X	
Acacia brownii	X						X	
Acacia gunnii								
Acacia imple Xa	X	X	X		X			
Acacia mearnsii	X	X	X	X		X	X	X
Acacia melano Xylon	X	X	X			X		X
Acacia stricta	X	X				X		
Acacia verniciflua							X	
Allocasuarina littoralis	X	X				X	X	
Allocasuarina paludosa		X						
Allocasuarina verticillata			X	X	X		X	
Aly Xia bu Xifolia				X	X			
Aotus ericoides								
Astroloma humifusum	X					X	X	
Atriple X semibaccata			X				X	
Billardiera scandens							X	
Bossiaea cinerea								
Bursaria spinosa	X	X	X	X		X	X	X
Callistemon sieberi						X		X
Calytri X tetragona								X
Correa refle Xa var refe Xa	X	X					X	
Daviesia latifolia	X	X	X				X	
Daviesia ulcifolia subsp. ulcifolia							X	
Dillwynia glaberimma								
Dillwynia hispida								
Dillwynia phyllicoides								
Dillwynia sericea		X						
Dodonaea viscosa subsp. spatulata							X	
Enchylaena tomentosa var. tomentosa			X	X	X			
Einadia nutans ssp. nutans			X	X	X			
Eremophila desertia								

641	649	707	710	793	803	851	894	895	902	937	938
					X			X			
X	X					X		X			
X	X					X	X	X	X	X	
X	X	X		X		X	X	X	X	X	X
						X		X			
X				X				X			
			X	X							
	X				X		X	X			
					X			X	X		
					X	X		X			
								X			
X	X				X	X	X	X	X	X	
X						X		X			
								X			
			X					X	X		
										X	
			X					X			
								X			
				X							
								X			
X	X				X			X			
X	X				X			X			
								X			

Species	127	128	132	160	161	164	175	191
Goodenia ovata	X	X		X	X	X	X	X
Goodia lotifolia								X
Hardenbergia violacea	X	X	X			X	X	
Hibbertia riparia	X	X					X	
Hovea heterophylla	X	X				X	X	
Indigofera australis	X	X					X	
Kunzea leptospermoides	X	X				X	X	X
Leptospermum continentale	X	X	X			X	X	X
Leptospermum grandifolium								X
Leptospermum lanigerum								X
Leptospermum obovatum								X
Leptospermum scoparium	X	X				X		
Leucopogon parviflorus				X	X			
Melaleuca ericifolia	X					X		X
Melaleuca lanceolata					X			
Melaleuca squarrosa								X
Myoporum insulare				X	X		X	
Persoonia chamaepeuce								
Platylobium obtusangulum	X	X				X	X	
Ricinocarpus pinifolius								
Senna artemisioides ssp. filifolia								

Notes: EVCs (listed alphabetically): Box Ironbark Forest (61); Clay Heathland (7); Coast Banksia Woodland (2); Coastal Headland Scrub (161); Coastal Dune Scrub (160); Creekline Grassy Woodland (68); Creekline Herb-rich Woodland (164); Damp Forest (29); Damp Heathland (710); Damp Heathy Woodland (793); Damp Sands Herb-rich Woodland (3); Escarpment Shrubland (895); Floodplain Riparian Woodland (56); Grassy Dry Forest (22); Grassy Forest (128); Grassy Woodland (175); Gully Woodland (902); Heathy Woodland (48); Herb-rich Foothill Forest (23); Hills Herb-rich Woodland (71); Lowland Forest (16); Plains Grassland (132); Plains Grassy Woodland (55); Plains Swampy Woodland (651); Plains Woodland (803); Riparian Forest (18); Riparian Scrub (191); Riparian Woodland (641); Rocky Chenopod Woodland (64); Sand Heathland (6); Scoria Cone Woodland (894); Shrubby Foothill Forest (45); Shrubby Gully Forest (938); Sedgy Swamp Woodland (707); Stony Knoll Shrubland (649); Stream Bank Shrubland (851); Swampy Riparian Woodland (83); Swamp Scrub (53); Swampy Woodland (937); Valley Heathy Forest (127); Valley Grassy Forest (47); Wet Heathland (8).

641	649	707	710	793	803	851	894	895	902	937	938
X		X				X		X	X	X	X
								X			
X								X		X	
				X							
				X				X			
								X			
		X		X				X	X	X	
		X	X	X					X	X	X
X						X		X		X	X
X						X		X			
				X					X	X	X
X		X		X					X	X	X
								X			
		X		X							X
								X			
X		X	X	X				X		X	
				X							
					X			X			

Table 2: Tolerance and growth rate scores for Woody Meadow species. Species in bold have been used in Woody Meadow experiments and trials. Other species were included due to their use in low maintenance plantings and tolerance of coppicing or hard-pruning. '*' denotes species from EVC lists (Table 1) with known use in low maintenance plantings. Waterlogging tolerance can be used as a proxy for compaction tolerance.

Plant taxa	Height at 5 years (m)	Shade tolerance (0-4)	Water-logging tolerance (0-3)	Growth rate (1-5)
Acacia acinacea*	1-1.5	1	1	4
Acacia boormanii	2.5	0	1	3
Acacia cutriformis	2	0	1	3
Acacia redolens (Prostrate form)	0.6-1	1	2	4
Acacia stricta*	1.25-2.5	1	1	5
Agonis flexuosa	1.2-1.5	1	0	2
Allocasuarina paludosa*	0.3-1.5	1	3	3
Allocasuarina verticillata*	1.5	0	2	2
Alyogyne huegelii	1-2	1	1	5
Astartea fascicularis	0.5	1	1	3
Atriplex nummularia	1	0	1	3
Atriplex semibaccata*	0.1-0.5	1	1	4
Banksia robur	0.75	1	2	2
Banksia serrata	1-1.5	1	1	1
Banksia spinulosa subsp. spinulosa	1-1.2	1	1	3
Bursaria spinosa*	2	1	1	3
Callistemon citrinus 'Splendens'	1.5	1	3	4
Callistemon salignus	1.5-3	1	3	3
Callistemon sieberi*	2	1	3	3
Callistemon subulatus	1.2	0	3	3
Callistemon viminalis 'Little John'	1.5-2.5	1	3	3
Calothamnus quadrifidus	0.75	0	0	2
Calytrix tetragona*	0.75-1	1	1	2
Correa decumbens	0.2-0.5	1	2	3
Correa 'Dusky Bells'	0.3-0.45	1	2	3
Correa reflexa*	0.3-1	1	1	3
Dampiera alata	0.3-0.6	1	2	3
Dampiera rosmarinifolia	0.2-0.5	1	1	3
Daviesia latifolia*	1	1	1	4
Dodonaea viscosa*	1-1.5	1	2	4

Plant taxa	Height at 5 years (m)	Shade tolerance (0-4)	Water-logging tolerance (0-3)	Growth rate (1-5)
<i>Einadia nutans</i> ssp. <i>nutans</i> *	0.3-1	1	2	4
Enchylaena tomentosa*	0.5	1	1	3
<i>Eremophila glabra</i>	0.3-1	0	1	3
Eucalyptus caesia	3	0	0	3
Eucalyptus latens 'Moon Lagoon'	1.2-2	0	1	3
Eucalyptus preissiana	1.1-1.2	0	1	2
Gastrolobium celsianum	0.3-0.45	1	2	4
Goodenia ovata*	1-1.5	1	2	5
<i>Goodia lotifolia</i> *	1-3	2	1	5
Grevillea baueri	0.45	0	1	2
Grevillea 'Coconut Ice'	0.7	0	0	2
Grevillea lanigera 'Mini Prostrate'	0.3-0.6	0	1	2
Grevillea preissii 'Sea Spray'	0.3-0.5	1	0	2
Grevillea rosmarinifolia	0.3-1	1	1	3
<i>Hardenbergia violacea</i> *	2	1	1	4
Hibbertia scandens	1.5-2	1	1	4
<i>Hovea montana</i>	0.2-0.5	1	1	2
<i>Indigofera australis</i>	1	1	1	5
Kunzea ericoides*	2	4	3	3
Lasiopetalum behrii	1	1	1	4
Leionema lamprophyllum	0.75	2	0	2
<i>Leptospermum continentale</i> *	1-2	1	2	3
<i>Leptospermum lanigerum</i> *	1	1	3	3
Leptospermum myrsinoides	0.75-1	1	2	3
Leptospermum polygalifolium	0.75-1	1	3	3
Leptospermum rotundifolium	0.5-1.2	1	0	3
<i>Leptospermum scoparium</i> *	1-1.5	1	2	2
Melaleuca decussate	1.5-2	1	3	3
Melaleuca incana	1.2	0	3	3
Melaleuca nesophila 'Little Nessie'	1-2	0	1	4
Melaleuca thymifolia	0.7-1	1	3	3
Melaleuca squarrosa*	1.2-1.5	1	3	3
Melaleuca wilsonii	1	0	3	3
Myoporum montanum	2-3	1	1	3
Myoporum viscosum	1-2	1	2	5

Plant taxa	Height at 5 years (m)	Shade tolerance (0-4)	Water-logging tolerance (0-3)	Growth rate (1-5)
<i>Olearia phlogapappa</i>	1.5	1	1	4
<i>Philotheca myoporoides</i> subsp. <i>myoporoides</i> 'Profusion'	1.2	1	1	3
<i>Pomaderris lanigera</i>	1.5	1	1	3
<i>Platylobium obtusangulum</i> *	0.6	1	0	2
<i>Ricinocarpus pinifolius</i> *	1	1	1	2
<i>Rhagodia spinescens</i>	0.3	0	1	3
<i>Senna artemisioides</i> *	1.5-2	1	0	3
<i>Thomasia solanacea</i>	1-2.5	1	1	4
<i>Thomasia quercifolia</i>	0.3-1	1	1	3
<i>Thryptomene saxicola</i> 'F.C. Payne'	0.6	1	0	3
<i>Veronica arenaria</i>	0.6-1	1	1	5
<i>Veronica perfoliata</i>	1.4	1	2	3
<i>Westringia fruticosa</i>	0.75-1	0	1	3
<i>Ziera prostrata</i>	0.2-0.3	1	0	2

Based on this plant evaluation matrix recommended plant lists were developed for different planting applications across LXRP sites (**Table 3**):

1. Community interface areas maintained by council
2. Areas adjacent to MTM maintenance tracks and Railway sidings or areas with height restrictions for passive surveillance
3. WSUD sites
4. Road/ Rail Over (deep shading by overhanging bridge structures)
5. Road/ Rail Over (moderate shading by overhanging bridge structures)
6. Road/Rail Under (level crossing types with 'battered slopes')

Please note:

- For projects adjacent to sensitive biodiversity areas, species in Melbourne EVCs which are suitable for Woody Meadow plantings have also been identified (**Table 4** – asterisked species).
- There are many species that are speculative in these lists as they have largely been untested for use in Woody Meadow plantings.
- Species in bold are more robust and drought adapted and are recommended, where possible, to make up at least 70% of the final planting list for each Woody Meadow planting (**Table 3** – species in bold).

Table 3: Summary of Woody Meadow species for LXP network sites. Species selected for Community interface can be used in large scale Woody Meadows with no particular site restrictions (canopy height, slopes or shading). Species selected for Railway corridors and sidings are plants with <0.5 m height when coppiced every 3 years. Species selected in Road/Rail Over (deep shade) sites are tolerant of more shading than species in Road/Rail Over (moderate shade) sites which may experience some shading by overhead bridge structures. Species selected in WSUD are suitable for Water Sensitive Urban Design (WSUD) applications. Species selected in Road/Rail Under sites are suitable for use on batters (1:4 slopes). Plants from EVC lists are denoted with "*" and should be used when selecting species adjacent to sensitive biodiversity areas (refer to **Table 2** for specific EVC plant lists). Bolded species are more robust and should be 70% of the total plants in Woody Meadows.

Species	Community interface	Railway corridors and sidings	WSUD	Road/Rail Over (deep shade)	Road/Rail Over (moderate shade)	Road/Rail Under
Acacia acinacea*	X				X	
Acacia boormanii	X					
Acacia cutriformis	X					X
Acacia redolens (prostrate form)	X	X			X	X
Acacia stricta*	X				X	
Agonis fle Xuosa	X				X	
Allocasuarina paludosa*	X		X		X	
Allocasuarina verticillata*	X					
Alogyne huegelii	X				X	
Astartea fascicularis	X	X			X	X
Atriple X nummularia	X					
Atriple X semibaccata*	X	X			X	X
Bursaria spinosa*	X				X	
Callistemon citrinus 'Splendens'	X		X		X	
Callistemon salignus	X		X		X	
Callistemon sieberi*	X		X		X	
Callistemon subulatus	X		X			
Callistemon viminalis 'Little John'	X	X	X		X	X
Calothamnus quadrifidus	X					X
Calytri X tetragona*	X	X				X
Correa decumbens	X	X			X	X
Correa 'Dusky Bells'	X	X			X	X
Correa refle Xa*	X	X			X	X
Dampiera alata	X	X			X	X
Dampiera rosmarinifolia	X	X			X	
Einadia nutans ssp. nutans*	X				X	X
Enchylaena tomentosa var. tomentosa*	X	X			X	X

Species	Community interface	Railway corridors and sidings	WSUD	Road/Rail Over (deep shade)	Road/Rail Over (moderate shade)	Road/Rail Under
<i>Eremophila glabra</i>	X	X				X
<i>Eucalyptus albida</i>	X					
<i>Eucalyptus caesia</i>	X					
<i>Eucalyptus latens</i> 'Moon Lagoon'	X					
<i>Eucalyptus preissiana</i>	X					
<i>Gastrolobium celsianum</i>	X	X			X	
<i>Goodia lotifolia</i> *	X			X	X	X
<i>Goodenia ovata</i>*	X	X			X	X
<i>Grevillea baueri</i>	X	X				
<i>Grevillea</i> 'Coconut Ice'	X					X
<i>Grevillea lanigera</i> 'Mini Prostrate'	X	X				X
<i>Grevillea preisii</i> 'Sea Spray'	X				X	X
<i>Grevillea rosmarinifolia</i>	X				X	
<i>Hovea montana</i>		X			X	
<i>Hardenbergia violacea</i> *	X				X	X
<i>Hibbertia scandens</i>	X				X	X
<i>Indigofera australis</i>					X	
<i>Kunzea ericoides</i>*	X		X	X	X	X
<i>Leionema lamprophyllum</i>				X	X	
<i>Leptospermum continentale</i>*	X				X	X
<i>Leptospermum lanigerum</i>*	X		X		X	X
<i>Leptospermum myrsinoides</i>	X				X	X
<i>Leptospermum polygalifolium</i>	X				X	X
<i>Leptospermum rotundifolium</i>	X		X		X	X
<i>Leptospermum scoparium</i>*	X				X	X
<i>Melaleuca decussata</i>	X		X		X	
<i>Melaleuca nesophila</i> 'Little Nessie'	X					

Species	Community interface	Railway corridors and sidings	WSUD	Road/Rail Over (deep shade)	Road/Rail Over (moderate shade)	Road/Rail Under
Melaleuca squarrosa*	X		X		X	
Melaleuca wilsonii	X		X			
Myoporum viscosum	X				X	X
Olearia phlogapappa	X				X	
Philotheca myoporoides subsp. myoporoides 'Profusion'	X	X			X	X
Pomaderris lanigera	X				X	X
Platylobium obtusangulum*	X	X			X	X
Rhagodia spinescens	X	X				X
Senna artemisioides*	X					X
Thryptomene sa Xicola	X	X			X	X
Veronica perfoliata	X	X			X	X
Veronica arenaria	X	X			X	X
Westringia fruticosa	X					X
Ziera prostrata		X			X	

4.2. Guidelines for planting, establishment and maintenance

4.2.1. Plant selection and planting design

For Woody Meadow plant selection we make the following recommendations:

- Complete a thorough site analysis to identify any planting constraints before plant selection. The most ideal conditions for Woody Meadow plantings are full-sun sites with no height restrictions, irrigation over the first summer and ready access for maintenance (esp. coppicing). Site analysis should include identification of site specific issues that may affect plant performance, such as wind, light exposure, rainfall distribution and soil properties (type, depth, contamination, salinity, compaction). These planting lists do not replace these usual practices.
- Use 11-12 species in each Woody Meadow to achieve good plant diversity and provide some resilience to changing conditions. This also enables the plant community to change over time and maintain good canopy coverage. The coppicing maintains overall biomass in the meadows so that individual species do not become dominant. Where coppicing cannot occur due to maintenance restrictions, these plantings are likely to be shorter lived than coppiced Woody Meadows.
- Use at least 70% of the most robust and drought adapted species (**Table 3** – bolded species) in each Woody Meadow planting. However, experimentation across sites is also recommended, with 1-3 new species planted at each site to broaden planting palettes for future plantings.
- For shaded sites (Road/Rail Over sites) and sites adjacent to railway lines (with maximum canopy heights <0.5 m) use approximately 450 mm spacings between plants. This will help reduce maintenance inputs through more rapid canopy closure in these sites where smaller plants are used (<0.5 m tall) or where growth will be reduced due to shade.
- For full-sun plantings, 500 mm spacings are recommended.
- In deep shade (Road/Rail Over sites), Woody Meadow plantings will need to be supplemented with other plants known to be more tolerant of these low light conditions (e.g. *Dianella revoluta* etc.) to improve diversity. These sites will also need irrigation where WSUD is not integrated into the planting (water availability should be determined during site analysis). No consideration has been made here for sites that are affected by rainfall exclusion from overhead structures.
- For any sites beneath tree canopies, avoid planting within 1 m of existing trees. Any future coppicing in these sites will also need to account for the presence of large trees.
- To create naturalistic meadows, we suggest dividing up the areas into 3 x 3 m plots (9 m²) for design and planting. Within each plot plants should be randomly allocated locations on a square grid for planting (as per the Abbotts Road Crossing trial site – **Appendix 1**).

Table 4: Suggested numbers of each species and individuals recommended for planting in Woody Meadow plots (9 m²).

	Full-Sun	Railway Siding	WSUD	Road/Rail Over	Road/Rail Under
Total number of plants	36	44	36	44	36
Number of species	12	11	12	11	12
Number of individuals per species	3	4	3	4	3

4.2.2. Installation

Our recommendations for site preparation and planting are as follows:

- All sites should be decompacted as part of site preparation to alleviate compaction from building works. This can be done through ripping or scoop and dump techniques with machinery. Refer to **Section 720** (Department of Transport) for guidance on decompaction depth and technique. Some soil/sub-soil is needed for installation of the Woody Meadow – growth cannot be maintained by the scoria inorganic mulch layer alone.
- Installation of an inorganic planting substrate, such as scoria block mix (< 8 mm aggregate including fines) to a depth of 200 mm at all sites. Scoria is a locally mined rock and this inorganic mulch replaces topsoil and other forms of mulching such as composted bark or green waste. The use of this layer (on top of decompacted site soils) reduces weeds and ensures tube-stock plants establish well. Other inorganic or mineral mulches can be substituted but should contain fines to ensure plants can be grown successfully– railway ballast for example is not an appropriate material for this purpose.

- Tube-stock plants should be planted directly into this substrate layer at planting (this does not need to be removed away from plants at planting like bark mulch as plants can grow directly into it and it will not cause rot). Choice of mulch should also take into account whether these sites are adjacent to roads, as mechanical coppicing may cause scoria aggregate to become a danger to vehicles.
- Where Woody Meadows are installed as part of WSUD these should be designed as swales or raingardens as per normal, with Woody Meadow species used instead of typical sedges and rushes.
- Planting of tube-stock materials should be completed during late autumn-winter period to maximise establishment with natural rainfall.

4.2.2.1. Opportunities for substituting alternative materials

Site-won topsoil and bark mulch can be reused where desired, but this may not be as successful in promoting growth and reducing weeds as the scoria substrate layer. In these situations, greater maintenance will be required, especially for weed control. Bulk mulch should be removed away from plant stems to avoid rot and may be installed after establishment to avoid this problem.

Where waste products, such as recycled aggregate, are used as the inorganic substrate layer, these should be washed to remove fines (which may cause resetting of concrete-type materials) and be mixed in with the scoria block mix (up to 50% waste aggregate) or other inorganic rock materials which include fines, to avoid issues with alkalinity.

4.2.3. Establishment maintenance

The following is to be included within the Landscape maintenance contract, for implementation during the Defect Liability Period:

- We recommend that irrigation is provided during the first spring-summer period. Irrigation will also be needed in the long-term for plantings where there is rainfall exclusion (i.e. in Road/Rail Over sites with overhanging structures).
- During establishment hand-weeding should be done until canopy closure.
- At 2-3 months post planting all plants should be tip pruned by one third in height to promote basal shoots and denser canopies.

4.2.4. Recurrent maintenance

The following is to be included within the Landscape maintenance contract, for implementation during the Defect Liability Period:

- At 2 years post planting (before handover to MTM and other parties) we recommend that plants are coppiced to a height of approximately 20 cm, with a bladed brush-cutter. Coppicing should ideally occur in early spring to ensure favourable warm conditions post treatment for resprouting.

4.2.4.1. Ongoing maintenance

Coppicing every 2-4 years is recommended after handover to keep vegetation below 1m. However plants in the 'sidings and passive surveillance areas' have been chosen to have lower heights and/or slower growth rates to reduce this risk where ongoing maintenance does not occur.

4.2.5. Research opportunities to improve Woody Meadows

Documentation of the actual installation, establishment maintenance and coppicing (date, height above the ground, equipment used and removal of biomass) should be made and sent to Dr Claire Farrell (c.farrell@unimelb.edu.au) for inclusion in the Woody Meadow database. This will facilitate monitoring and integration of key learnings into new installations.

5. References

Backhouse, M. A whole new playing field: An experiment in public planting with a difference had exceeded expectations. *The Age*. Melbourne: Saturday 18 August, Fairfax Media; 2018

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Dunnett, N.; Hitchmough, J. *The dynamic landscape: design, ecology and management of naturalistic urban planting*: Taylor & Francis; 2004

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6. Appendix 1 – Case study: Abbots Road, Dandenong Level Crossing Removal Project

In collaboration with the Hassell design team, A/Prof John Rayner and Dr Claire Farrell designed and specified a 36 m² trial Woody Meadow planting for the Abbots Road site. This included:

- Plant selection specifically for the site (<0.5 m plant height, low fire risk, low weed risk to adjacent remnant and low maintenance)
- Planting density and arrangement
- Site preparation and installation specifications including fertiliser, tillage and inorganic mulch (8 mm minus scoria block mix installed on the soil surface at 200 mm depth)
- Maintenance guidelines (weeding and coppicing)

6.1. Plant selection

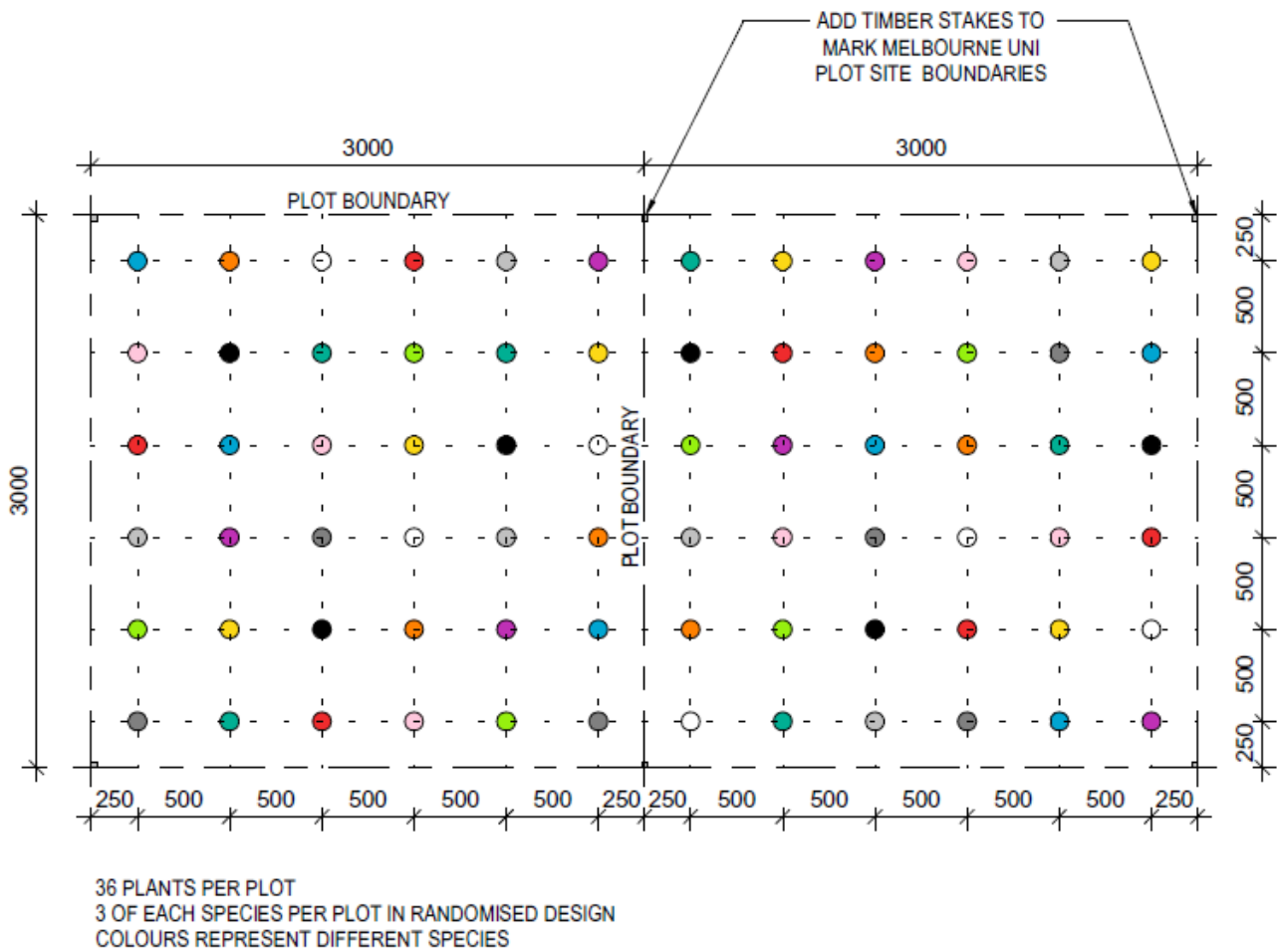
The original plant list for the Woody Meadow at Abbots Road consisted of 12 robust shrub species which performed well in the City of Melbourne research plots. The final plant list for Abbots Road was then reduced to four species due to height restrictions from MTM (Metro Trains Melbourne). Plants selected for the Woody Meadow planting at Abbots Road needed to have a maximum height of 0.5 m when coppiced every 3 years (**Table A1**). During planting, *Dampiera alata* was replaced by *Ficinia nodosa* (knotted club rush) due to plant availability. While substitutions are often necessary, to ensure the Woody Meadow achieves high aesthetic outcomes as a low maintenance landscape, all plants should be woody perennials and strap-like plants such as *F. nodosa* should not be used in Woody Meadow plantings.

Table A1: Recommended Woody Meadow species for the Abbots Road site. Final species used in the planting design are in bold.

Species	Mature height (m)	Mature width (m)
Acacia acinacea	1	0.3
Acacia boormanii	1	0.3
Corea reflexa	1	1
Melaleuca decussata	0.5	0.3
Atriplex nummularia	1.5	0.9
Leptospermum rotundifolium	1	0.9
Veronica perfoliata	1	0.9
Calothamnus quadrifidus	2	1.5
Callistemon citrinus	6	5
Callistemon viminalis 'captain cook'	2	1.5
Kunzea ericoides	5	2
Thryptomene saxicola	1.5	1.5
Dampiera alata	0.3	0.5

6.2. Planting density and arrangement

The original planting design was for 12 species to be planted in 9 m² plots (3 x 3 m) with 3 individuals randomly allocated planting locations across a grid in each plot, with 0.5 m spacing between plants (**Figure 2**).



2 TYPICAL DETAIL - SL-07 WOODY MEADOWS PLANTING PLAN SETOUT
1:50

Figure A1: Diagram from Hassell Studio showing plant spacing and randomised layout of the Woody Meadow planting. This diagram shows the original design for 36 plants in each 3 x 3 m plot, with 3 plants of each of the 12 species (**Table A1**).

In the final design, the trial planting was installed with four species being planted with 0.5 m spacing between plants (**Figure A2**).



Figure A2: Abbotts Road Woody Meadow trial planting after installation. The Woody Meadow plot is the non-mulched area with the scoria substrate. Photos from Hassell Studio.

6.3. Site preparation and installation specifications

The site was prepared by removing existing rock mulch and a bobcat was used to break up any hard pans before installation of the scoria substrate. The scoria substrate (8 mm minus scoria block mix, Aerolite quarries) was installed on the soil surface at 200 mm depth with a bobcat (with no compaction). Final levelling was done with lightweight levellers by hand.

Plants were planted as tube-stock into the scoria substrate. At planting a surface application of slow release fertiliser was applied at 50 gm⁻² [Osmocote Pro Low P, 8-9 months] which has an N-P-K ratio of 16: 1.3: 9.1 and trace elements.

6.4. Maintenance guidelines

Maintenance tasks for the 2-year period include plant replacement, watering, weeding and rubbish removal. At the end of the 2-year maintenance period it was recommended that the Woody Meadow at Abbotts Road be coppiced. In terms of on-going maintenance the Woody Meadow should be coppiced every 3 years to maintain a maximum height of 0.5 m. Coppicing also ensures plants remain dense over time which helps to exclude weeds and promotes flowering. Plant material should be removed from the site after coppicing.

7. Appendix 2 – Section 720: Landscape works

##This section cross-references Sections 176 (or 177), 204 and 750.

If any of the above sections are relevant, they should be included in the specification.

If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:

7.1. 720.01 – General

This section covers the requirements for works associated with the vegetation of the site. This includes, but is not limited to, material supply, site preparation, mulching, planting, grassing, irrigation and landscape maintenance as specified and shown on relevant Drawings, Planting Details and Schedules.

7.2. 720.02 – Definitions

- a. Caliper
The stem or trunk diameter of a tree at a nominated point. Caliper is measured at 300 mm above ground for sizing of nursery plants.
- b. Individual Tree Planting
Any tree planting of single trees each surrounded by a mulch ring and/or grass cover.
- c. Planting Area
Any continuous area where multiple plants are established using stock from containers such as pots, tubes and cells or by direct sowing (other than grassed areas).
- d. Propagule
A propagule is any plant part capable of producing a new plant (e.g. seeds, cuttings, bulbs, corms, rhizomes, etc).
- e. Tube stock or cell stock
Plants grown in small (less than 0.5 litre) containers.
- f. Weed
Any plant which is not desired. Sub-categories include:
 - i. Noxious weed. Any plant listed as a weed for the project area under the Catchment and Land Protection (CALP) Act 1994.
 - ii. Species or individual plants specified to be removed.
 - iii. Weeds of planting beds and around individual trees include any plant not specified in the planting schedule or is not indigenous to the site. This includes all local environmental weeds and noxious weeds.
 - iv. Weeds of mown-grass areas include all species listed in (i) above, broadleaf species (except broadleaf species specified for sowing) and other weeds where specifically listed.

7.3. 720.03 – Submissions and records

The specified inspections, samples, records and certificates shall be made available or submitted to the Superintendent for acceptance prior to the commencement of associated work. Accepted samples shall become the agreed minimum standard and approved source of supply. The Contractor shall be responsible for programming all inspections and review of samples and allow 2 working days notice to the Superintendent. Samples, records and certificates shall be provided to the Superintendent at least 10 working days prior to bulk delivery.

***** The Contractor shall provide the following before commencement of the relevant landscape work:
##[strikethrough inapplicable items below]:**

Inspections

- plant stock for all plant species

Samples

- mulch
- imported topsoil

Records

- evidence of origin of indigenous provenance plant material
- analysis certificates for grass seed
- details of suppliers
- soil tests on topsoil
- copies of fertiliser labels

7.4. 720.04 – Supply of materials

All materials shall be supplied by the Contractor unless otherwise noted. If any materials are supplied by VicRoads, a joint inspection of the materials shall be made by the Contractor and the Superintendent following delivery of the materials to the site. The materials, if satisfactory, shall thereafter become the responsibility of the Contractor.

a. General Supply of Plant Stock

All plants shall be of the type, height, container size and trunk caliper specified in the Plant Schedules, Specification and Planting Plans. These are minimum requirements. No substitution of plants shall be allowed without the written agreement of the Superintendent.

Table 720.041: Plant Stock Supply Properties

Property	Requirement
General Requirements	All plants shall be hardened off for a minimum 4 weeks in conditions matching prevailing conditions on the Works site.
Species Integrity and Labelling	Plants shall be true to type and clearly labelled with at least one label per species per delivery batch.
Container Supply Sizes	Tubes shall be at least 0.2 litres in volume. Cells shall be at least 0.08 litres in volume. Other sizes shall be as specified.
Root Ball Occupancy	Roots shall be adequate to fill the container. Samples shall demonstrate that >85% of soil volume remains intact when the unsupported rootball is shaken.
Root Ball Integrity	Plants shall display a large, well developed and healthy fibrous root system with repeated and sequential division with no evidence of root curl, restriction or damage. The root ball shall not be pot bound and shall generally have roots penetrating to the edge of the pot. Except for monocots with fibrous root systems, plants with girdling, spiralling or j-rooting present in root systems will not be acceptable.
Uniformity of Plant Growth	The size shall be in proportion to the container size and species. Tube stock and cell stock shall not have shoot height greater than 3 times the depth of the container.
Caliper	Trees shall be self supporting.
Health and Vigour	Plants shall show vigorous tip growth and foliage size, texture and colour consistent with that shown in healthy specimens of the species. Plants shall have undamaged limbs and trunk.
Free of Pests and Diseases	Plants shall be free from pests and diseases at time of delivery, with visible attack from previously eliminated pests and disease restricted to <10% of foliage such that long term success of the plant is not affected.
Weed Free	Plants shall be provided in containers free of weeds.

b. Supply of Indigenous Plant Stock

A species listed on the planting schedule shall be classed as an indigenous plant if the plant is likely to have occurred within 10 km of the project site (pre1750).

The Contractor shall source seed or other propagules for indigenous plant stock from within or as close to the project area as practicable and from areas with similar soil type (same parent material) and rainfall (to minus 100 mm ARI). Seed shall be collected in accordance with Florabank Guidelines and Codes of Practice (<http://www.florabank.org.au/>). Further to these guidelines, seed shall not be collected more than 25 km from the project site without prior agreement with the Superintendent. Grasses and wetland species may be sourced up to 50 km from the project site in areas with the same soil type and similar or lower annual rainfall. Where a distinct form of a species occurs naturally in the local area, that form shall be used.

The Contractor shall be responsible for obtaining all necessary native flora collection permits from the Department of Environment, Land, Water and Planning (DELWP).

The Contractor shall submit documentation of origin of indigenous provenance plant material which shall include the following details for each seed lot:

- storage code
- collection locality – Latitude/longitude or AMG
- approximate number of parent plants sampled
- approximate number of plants in that local population

All seed lots of the same species collected at different localities shall be supplied as a separate seed lots. The provenance shall be tracked through propagation to planting for possible future seed collection purposes.

The format of the seed collection records shall be a spreadsheet compatible with Microsoft Excel.

c. Supply of Pesticides

Herbicides applied as a spray shall include sufficient coloured dye to identify application areas for at least 5 days.

d. Supply of Site Topsoil

Site topsoil shall be used wherever possible, in preference to imported topsoil. Topsoil is defined as the weathered surface layer of soils that includes organic matter.

The Contractor shall be responsible for ensuring the growing medium supports normal healthy growth of the specified planting. The Contractor shall determine when soil testing is required and shall undertake soil tests to establish what soil amendments and macro and micro nutrients are required to be added to the topsoil.

The Contractor shall notify the Superintendent of any topsoil characteristic which may reduce the performance of any plant species or grass mix.

e. Supply of Imported Topsoil

In the event that site topsoil is not available or is not adequate to achieve the specified depth of topsoil, the Contractor shall supply imported topsoil to achieve the total specified depth of topsoil.

Imported topsoil shall comply with the following properties:

Table 720.042: Imported Topsoil Blend Supply Properties

Property	Requirement
General Requirements	Imported topsoil shall be suitable for supporting healthy plant growth of the specified and scheduled species.
Texture	The texture shall either match the site topsoil texture or provide a light to medium friable sandy loam with a clay content 10-15%, capable of handling when moist but lacking cohesion so that it will fall apart easily.
Extraneous Material and Contaminants	The topsoil shall be free of sods of subsoil, rubbish, petrol and oil contaminants, lime etc, and meet the requirements for clean fill in EPA publication 448-Classification of Wastes as 'Fill Material' and shall have contaminant levels less than the concentration listed in Table 2 of that document. Stones shall be <5% (by dry weight) with stone size not exceeding 25 mm.
Dry Bulk Density (kg/m ³)	Bulk density shall be >1000.
Soil Nutrients	Adequate levels to support normal plant growth for the scheduled species.
Organic Matter (% by mass)	Decomposed matter shall be 3-15% by mass, and undecomposed matter shall be <5% by mass.
Weed Content and Pathogens	Soil shall meet AS 4419 5.4. No noxious weeds, noxious seed or Phytophthora cinnamomi.
Wettability (mm/min)	Soil shall meet AS 4419 5.5
Soil pH	5 – 8
Phosphorous Content (mg/kg Olsen method)	5 – 10
Electrical Conductivity (dS/m)	Soil shall meet AS 4419 5.6
Dispersibility Category	Soil shall meet AS 4419 5.11
Nitrogen Drawdown (NDI150)	Soil shall meet AS 4419 5.12
Permeability	Soil shall meet AS 4419 5.13
Toxicity	Soil shall meet AS 3743

f. Supply of Fertilisers

Fertilisers for newly grassed areas shall be N:P:K 10:4:6 with trace elements.

Fertilisers for planting areas and advanced trees shall be slow release with a 912 month release period and suitable for the establishment of plant types, sizes and species specified in the plant schedule(s).

g. Supply of Gypsum

Gypsum (Calcium Sulphate) shall comply with the minimum specifications as laid out in the current Victorian Fertiliser Regulations. Only manufactured gypsum shall be used. Gypsum derived from recycled plaster board shall not be used. Sodium shall not exceed 1% by mass.

h. Supply of Wood Mulch (Chipped or Shredded)

All wood mulch shall be supplied, delivered, handled and applied in accordance with AS 4454.

i. Imported Wood Mulch

Wood mulch shall comply with the following properties:

Table 720.044: Shredded or Chipped Wood Mulch General Supply Properties

Property	Requirement
General Requirements	Mulch shall meet AS 4454, Table 3.1 for composted or pasteurised mulch. Mulch type shall have fibrous properties which 'interlock' the particles so that installed mulch is not blown away by wind.
Purity	Mulch shall be free of soil and weeds, plant pathogens, vermin and toxins. Plywood, composite timber product and painted timber shall not exceed a combined maximum of 1% by weight total. Mulch shall be free of treated pine, exposed sharp metal, plastic and other litter.
Sizing	Meet AS 4454-2012, Table 3.1(A) In planting areas adjacent to either roads posted at <80 km/h, pedestrian or cycle paths or recreational open space, 95% of particle size shall be no wider than 40 mm and no longer than 140 mm. No particles longer than 200 mm. In planting areas adjacent to roads posted at ≥80 km/h, 80% of particle size shall be no wider than 50 mm and no longer than 140 mm. No particles longer than 400 mm.

ii. Site Mulch

Site mulch available from the chipping of on-site indigenous or non-weed vegetation shall be used where possible. Any species that could have weed potential by seed or vegetative fragments shall not be recycled in the landscape works. Mulch shall satisfy the purity and sizing requirements shown in **Table 720.044**.

i. Supply of Weed Control Mat and Erosion Control Mat

The Contractor shall supply and install jute or approved equivalent, biodegradable, fire retardant weed and erosion control mat as indicated on the Drawings or as specified. Weed Control Mat shall be minimum 700 grams per square metre and Erosion Control Mat shall be 300 grams per square metre. The surface of the mat shall permit water infiltration.

j. Supply of Tree Guards, Stakes and Marker Stakes

Tree guards shall be either opaque plastic and of sufficient gauge and UV inhibitor to ensure a minimum two year life or minimum 2 litre cartons of sufficient construction to ensure a minimum 18 month life. Tree guard stakes and marker stakes shall be sufficiently robust to be driven into the ground, securely support the tree guards and ensure a minimum two year life.

k. Supply of Grass Seed

Grass seed shall comply with the following properties:

Table 720.045: Grass Seed Properties

Property	Requirement
Species and Proportion	<p>Areas with greater than 700 mm average annual rainfall</p> <ul style="list-style-type: none"> • Calypso II Fine Leaf Perennial Ryegrass 20% by count • Roper Perennial Ryegrass..... 50% by count • Creeping Red or Chewings Fescue 20% by count • Kentucky Bluegrass..... 10% by count <p>Areas with less than 700 mm average annual rainfall</p> <ul style="list-style-type: none"> • Camel Perennial Ryegrass 25% by count • Guard or Safeguard Annual Ryegrass..... 35% by count (or another toxicity resistant variety of <i>L. rigidum</i>) • Currie or Porto Cocksfoot..... 15% by count • Trikkala Subterranean Clover..... 25% by count
Minimum Seed Purity	98% and shall not contain noxious weed seed
Minimum Germination Rate	90% at date of supply

The quality and specified properties of all seed shall be analysed and certified by either:

- i. endorsed in accordance with the AS ISO/IEC 17025 accreditation for the testing laboratory; or
- ii. issued on Seed Lot and Sample Certificates by a laboratory accredited by ISTA (International Seed Testing Authority) to the ISTA International Rules for Seed Testing.

l. Supply of Sterile Grass Seed

Sterile Rye-corn (*Secale cereale*) seed shall be used for the stabilisation of areas to be subsequently sown or planted and for stabilisation of temporary batters and stockpiles.

7.5. 720.05 – Pest and weed control

a. Pest and Weed Management Procedures

The Contractor shall develop and implement site specific pest and weed management procedures to control pest and weed populations. The procedures shall consider pest animals, plants, fungi and other pathogens that may impede plant establishment.

Weed management procedures shall include removal of weeds from their existing locations before, during and after site clearing, topsoil stripping and landscape works. Weed management procedures shall minimise the spread of weeds in topsoil to other locations within and outside the site.

In addition to Sections 204 and ##176 (or 177): of the VicRoads Standard Specifications for Roadworks and Bridgeworks, pest and weed management procedures shall include control of soil borne pathogens including, but not limited to *Phytophthora cinnamomi*, *Armillaria* sp. and soil borne weeds.

b. General Requirements

Pesticides shall be used in accordance with the manufacturer's instructions. Where off-label use of pesticides is considered desirable to achieve pest control requirements, the Contractor shall be responsible for the investigation and procurement of off-label permits. The Contractor shall advise the Superintendent of any proposed off-label pesticide use prior to pesticide application.

Weed and pest control personnel shall be qualified and experienced in the use of pesticides, control of weeds, prevention of pesticide drift and identification of target and non target species found on site and included in the planting schedules.

The Contractor shall prevent runoff into waterways of pesticides not registered for use in waterways.

If 'nontarget' areas or plants are damaged during weed control works, then the Contractor shall be responsible for the reinstatement of those areas to the satisfaction of the Superintendent.

Records of herbicide use shall be made available to the Superintendent upon request.

c. Pre-Planting Weed Control

Pre-planting weed control shall be undertaken to ensure that planting areas and new grassed areas are free of visible weeds prior to the commencement of planting and grassing. Weed control shall be programmed and implemented to deplete the potential weed seed bank within the topsoil to be used in planting beds.

7.6. 720.06 – Setting out of landscape softworks

The Contractor shall set out the location and shape of planting areas in accordance with the Landscape Drawings.

The Contractor shall comply with the plant density requirements and planting offsets as shown in the plant schedule(s).

Individual plants shall be located in accordance with the drawings such that the mature form of the plant will be in accordance with VicRoads Road Design Guidelines, including clear zone and sight distance requirements.

7.7. 720.07 – Site preparation

Further to the requirements of Section 204, the Contractor shall provide the soil preparation described in **Table 720.071**. All elements of soil preparation proceed in order from left to right.

Table 720.071: Soil Preparation Requirements

Situation	Initial Ripping of Subsoil Prior to Topsoil Placement	Minimum Topsoil Depth	Cross Ripping	Cultivation
Planting Areas in disturbed areas flatter than 3h:1v	Min 400 mm deep at max 500 mm spacing. Leave all batters with roughened subsoil to assist with keying of topsoil.	150 mm	-	Min 150 mm deep
Planting Areas in disturbed areas steeper than 3h:1v	Min 300 mm deep at max 500 mm spacing, between parallel to and 45° from contour. Leave all batters with roughened subsoil to assist with keying of topsoil.	100 mm	-	-
Planting Areas in undisturbed areas	Min 400 mm deep at max 500 mm spacing	-	-	Min 150 mm deep
Grassing in disturbed areas	Min 200 mm deep, 500 mm max spacing	75 mm, except 100 mm in swales	Min 100 mm deep, 500 mm max spacing	-
Grassing in undisturbed areas	-	-	-	Min 100 mm deep
Individual Tree Planting (including advanced trees) within grassed areas. The area of treatment is 25 m ² per tree.	Min 400 mm deep at 500 mm max spacing	150 mm in disturbed grassed areas	Min 300 mm deep, max 500 mm spacing	-

Notes:

- Disturbed areas include any area of cut batter, fill batter, site of excavation (including borrow pit), site of dumping (including fill mound), drains, swales or area driven over by machinery resulting in soil compaction. Disturbed areas also include any areas where topsoil is effectively absent or areas of soil with dry bulk density exceeding the maximum shown in **Table 720.072**.
- Undisturbed areas are those areas with the pre construction soil profile retained intact, without compaction or soil loss.
- Initial ripping in granitic soils should be parallel to the contour.
- Topsoil on grassed verge areas shall be left firm.

a. Soil Additives including Gypsum

Soil additives, including any material used to modify the chemical properties of the soil, shall be applied by the Contractor prior to physical ripping and cultivation and in accordance with results and recommendations from site topsoil analysis tests.

The Contractor shall supply and install gypsum to the subsoil where subsoils are dispersive (AS 4419 5.11). The Contractor shall apply sufficient gypsum to ensure soils are not dispersive, incorporating gypsum during ripping to a minimum depth of 300 mm.

The Contractor shall adjust the soil pH if the soil, including subsoil, to a depth of 300 mm is not in the range of 5-8.

Where salinity requirements for existing (unmoved) site subsoil or topsoil do not meet the acceptable range in AS 4419 5.6, the Contractor shall notify the Superintendent.

b. Ripping

The Contractor shall undertake any ripping specified. Ripping shall occur when soil is at or approaching the plastic limit of dryness. Ripping shall be postponed when the soil is at or wetter than field capacity. Narrow tines shall be used in rocky ground and winged tines in other ground types. Rock and rubbish brought to the surface shall be removed and disposed. The Contractor shall inform the Superintendent of sites where the presence of rock prevents the specified minimum ripping depth being achieved and implement alternative techniques (such as a standard tine) to maximise planting bed ground preparation depth.

Ripping shall not occur within the extent of existing vegetation areas marked for protection or within the drip-line of existing woody plants. In the vicinity of woody plants to be retained with greater than 600 mm trunk diameter at breast height, 1.5 times the height of the tree measured horizontally from the tree trunk shall be considered and marked as an area to be protected. For trees less than 600 mm diameter the area to be protected shall be the area within the drip-line. Any planting to be carried out within these protected areas shall be done using hand cultivation techniques to minimise damage to existing tree roots zones.

Where existing planting beds are to be extended, the unplanted areas shall be ripped as described above.

HP The Contractor shall make available each ripped planting area, individual tree planting and grassing area prior to mulching, planting or grassing. The Contractor shall not proceed until the Superintendent acknowledges requirements for ripping have been met. In areas where ripping is not practicable, the Contractor shall submit alternative methods to achieve an equivalent result to the Superintendent for review.

c. Topsoil Application

Following subsoil preparation, topsoil shall be spread on planting areas and grassed areas. Topsoil shall not be compacted.

Weedy site topsoil shall not be spread to other locations on the site. Weedy topsoil shall be handled in accordance with the Contractor's weed management procedures.

d. Cultivation

Cultivation shall be undertaken to break soil down to a tilth with 80% of the volume composed of clods less than 50 mm in diameter. Cultivation equipment that might create a hard pan beneath the depth of cultivation (such as rotary hoes and other powered cultivators) shall not be used. In the event of saturated ground conditions, cultivation shall be delayed until the ground has dried out to a suitable condition. Where ripping and topsoiling is sufficient to allow easy manual excavation of soil to a depth of 300 mm or more, cultivation may be omitted.

Cultivation shall not occur within the extent of existing vegetation areas marked for protection or the drip-line of existing woody plants. Hand cultivation shall be used within root zones of trees to be retained.

e. Topsoil Finished Surface Levels

After cultivation and trimming, the Contractor may lightly compress topsoil for stability on slopes. Vibrating plates shall not be used.

The Contractor shall ensure dry bulk density does not exceed the following:

Table 720.072: Maximum Dry Bulk Density of Soils for Planting and Grassing

Soil Texture(as determined by AS 4419)	Maximum Dry Bulk Density for Topsoils
Clay soils	1.3 g/cm ³ (1.4 g/cm ³ on slopes steeper than 3:1)
Loams	1.5 g/cm ³
Sandy soils	1.7 g/cm ³

The finished level of grassed areas shall be:

- not higher than 125 mm below weep-holes or damp-proof courses in adjacent walls;
- level with the bottom of fence plinths;
- level with adjacent pavements, kerbs, pits and other structures.

The finished level of garden bed mulch and/or topsoil shall be tapered so that the finished mulch and/or topsoil levels meet flush with the adjacent surfaces.

The Contractor shall ensure these conditions are maintained and there is no compaction of prepared soils before planting.

HP The Contractor shall make available each ripped, topsoiled and cultivated planting area, individual tree planting and grassing area prior to mulching, planting or grassing. The Contractor shall not proceed until the Superintendent acknowledges requirements for topsoiling and cultivation have been met. In areas where topsoiling or cultivation is not practicable, the Contractor shall submit alternative methods to achieve an equivalent result to the Superintendent for review.

f. Removal of Unwanted Matter

The Contractor shall remove unwanted matter. Unwanted matter includes the following:

Table 720.073: Unwanted Matter

Mown Grass Areas	Planting Areas
<ul style="list-style-type: none"> any weeds, plastic, metal, glass or material toxic to plants surface stone, rock, building rubble greater than 25 mm in diameter clay lumps, sticks and exposed tree roots greater than 50 mm diameter 	<ul style="list-style-type: none"> any weeds, plastic, metal, glass or material toxic to plants any visible surface stone, rock, building rubble greater than 75 mm in diameter clay lumps, sticks and exposed tree roots greater than 100 mm diameter

g. Existing Planting Areas

Existing planting areas shall exclude areas of naturally occurring remnant vegetation.

Prior to undertaking site preparation or planting within existing plantations, all dead, severely damaged (<40% intact canopy) and fallen trees and shrubs shall be removed from the plantation. Woody weeds with any seed or vegetative material capable of regeneration are to be removed and disposed of off-site.

Any severely pest affected vegetation that cannot be successfully treated using pesticides (or any other treatment) shall be removed and disposed of off-site. All remaining vegetation within the plantation is to be retained and protected from direct and indirect damage from ground preparation, weeding, mulching and infill planting.

Remaining vegetation in the existing plantation shall be assessed for damaged, dead or diseased limbs and branches. All such limbs and branches on existing vegetation with a diameter greater than 50 mm in urban areas and 100 mm in rural areas are to be removed. All pruning works including dead-wooding, canopy uplifting and weight reduction shall comply with the requirements of AS 4373.

The Contractor shall obtain all necessary permits and obtain approval from the Superintendent prior to the pruning or removal of local native vegetation.

7.8. 720.08 – Mulching

a. Wood Mulch (Shredded or Chipped)

The Contractor shall install wood mulch to all Planting Areas unless otherwise specified. Mulch shall extend at least 1 metre beyond plant centres at the outer edges of all Planting Areas. If space does not permit this in median, separator or splitter-island planting, mulching shall extend to the back of kerb.

The Contractor shall install 2 metre diameter mulch rings around all Individual Tree Plantings.

Mulch depths in all situations shall be a minimum 75 mm and maximum 125 mm.

Mulch shall be raked to a even, neat appearance and kept clear of plant stems to avoid collar rot.

b. Weed Control Mat and Erosion Control Mat

The Contractor shall install weed control mat for planting areas steeper than 2:1 and in planting areas prone to flooding or within 2 m of waterways, swales, wetlands and sedimentation ponds or elsewhere as specified.

Weed control mat and erosion control mat shall be laid and anchored in accordance with the manufacturer's instructions.

7.9. 720.09 – Planting

a. Planting

The Contractor shall carry out planting so as to ensure healthy, vigorous growth of plants. In the event the specified plant is unlikely to be suited to the asconstructed growing conditions, the Superintendent shall be notified.

Holes in heavy soils or on batters shall be prepared so as to ensure adequate drainage.

Holes shall not be left smooth sided in basalt or 'plastic' soils. Drill or auger hole diggers shall only be permitted where soils have been cultivated.

Planting holes shall be backfilled with friable topsoil free of debris, rocks and clods greater than 50 mm in diameter.

b. Fertilising

The Contractor shall fertilise advanced trees and, where specified and/or identified by the Contractor's soil analyses, other planting areas with fertiliser in accordance with the manufacturer's recommendations.

c. Initial Watering

The Contractor shall saturate each plant within 8 hours after planting. Cells and tubes shall be irrigated with a minimum 3 litres of water per plant. Other container sizes shall be irrigated with a volume of water greater than the container size.

Under no circumstances shall any plant be planted into a dry planting hole (soil moisture at wilting point or drier). If the soil is dry, the planting hole shall be saturated with water prior to planting.

7.10. 720.10 – Grassing

a. Seeded Grassing

The Contractor shall seed grass to:

- all areas indicated to be grassed on the Drawings, and
- all areas disturbed by the Contractor which will not be a planting area or managed as remnant indigenous vegetation.

Grass seed shall be sown at minimum 100 kg/Ha (if drilled) or 200 kg/Ha (if broadcast), distributed evenly to achieve an even and dense grass cover.

Germination rate shall be minimum 80% cover within 8 weeks and 95% cover within 3 months of sowing. If germination has not been achieved in any grassed area within 8 weeks (except during December to March), then the area(s) shall be reseeded with the specified grass seed mix.

b. Fertilising

The Contractor shall apply fertiliser evenly over the prepared surface in accordance with the manufacturer's recommendations.

c. First Mow

The Contractor shall carry out the first cut when at least 50% of the grassing area to be cut has grown to minimum 75 mm and maximum 150 mm height. Mow to a minimum height of 75 mm. Less than 1/3 the height of the grass shall be removed in the first cut.

7.11. 720.11 – Landscape maintenance

a. Scope of Maintenance

Landscape maintenance tasks shall begin prior to Practical Completion as specified in clause 720.11(d) and shall continue until the completion of the Defects Liability Period for the Whole of the Works or the Defects Liability Period of the landscape works, whichever is the latter.

***** Maintenance of the landscape work shall include the following tasks:**

- i. replanting
- ii. weed control
- iii. watering
- iv. mowing/slashing
- v. reseeded of seeded grass areas
- vi. pest and disease control
- vii. re-mulching
- viii. pruning
- ix. maintaining the site in a neat and tidy condition
- x. repair and removal of tree guards and stakes
- xi. repairs to erosion affected areas
- xii. stockpile areas.

b. Maintenance Program and Joint Inspections

***** The Contractor shall prepare and submit a maintenance program showing sufficient information to enable the landscape maintenance works to be evaluated and shall show as a minimum the following:**

- inspection visits during the period of maintenance;
- maintenance works during the period of maintenance including an outline of replacement planting regime and proposed pest and weed management activities.

Quarterly joint inspections shall be undertaken each year by the Contractor and the Superintendent after commencement of the Defects Liability Period.

Any remedial work shall be performed within three weeks of the date of inspection. Grassing and planting may be delayed until suitable conditions prevail subject to the agreement of the Superintendent.

c. Plant Performance Requirements

Shrub and groundcover planting bed areas shall achieve the following performance requirements:

***** Table 720.111: Performance Requirements for Shrub and Groundcover Planting Areas**

12 months after Practical Completion	24 months after Practical Completion
<ul style="list-style-type: none"> • minimum #:25% ground closure 	<ul style="list-style-type: none"> • minimum #:60% ground closure
<ul style="list-style-type: none"> • all plants showing healthy growth 	<ul style="list-style-type: none"> • all plants showing healthy growth
<ul style="list-style-type: none"> • performance indicating probable #:90% ground closure at 36 months after Practical Completion 	<ul style="list-style-type: none"> • performance indicating probable #:90% ground closure at 36 months after Practical Completion

Planting that does not meet the above performance requirements shall be re-mulched and replanted annually to 100% of the original planting density for the area of planting area gaps.

Tree planting areas shall achieve the following performance requirements:

Table 720.112: Performance Requirements for Tree Planting

Previous 12 months rainfall	Minimum Growth Rate Tubes/Cells	Minimum Growth Rate Advanced Trees
More than 700 mm	750 mm per annum	300 mm per annum
500 – 700 mm	500 mm per annum	200 mm per annum
Less than 500 mm	400 mm per annum	100 mm per annum

Tree planting that does not meet the above performance requirements shall be replaced annually to achieve 100% of the original specified planting numbers.

Planting that does not meet the performance requirements because of soil conditions, the site shall be re-prepared and replanted at the Contractor's expense.

d. Maintenance Tasks

The Contractor shall maintain the works as follows in accordance with the requirements of this specification, the drawings and plant schedules.

i. Noxious Weeds and Weeds to be Removed

Eradication of noxious weeds and weeds to be removed over the whole site shall commence from the date of Possession of Site. The weed eradication targets shall be achieved within six months of Possession of Site and then shall be maintained.

***** The Contractor shall eradicate:**

- all state prohibited weeds
- all regionally prohibited weeds
- all regionally controlled weeds
- the following Weeds of National Significance (WONS):

– ## (specify):

- the following priority weeds identified in the local Catchment Management Authority Weed Action Plan:

– ## (specify):

ii. Mown Grass Weed Control

Weeds within grass areas are to be managed from cultivation of new grass areas.

Mown grass shall be maintained to control broad leaf herbaceous and woody weed populations. Weed control shall be implemented to control broad-leaf weeds that exceed 10% cover in urban areas or 20% over in rural areas. Weed control shall occur prior to the weed plant reaching flowering.

Areas of native broadleaf cover among mown grass shall be brought to the attention of the Superintendent prior to spraying. The Superintendent will direct whether these areas shall be treated.

Bare ground that results from weed control activities shall be cultivated and re-grassed to establish a minimum 95% grass cover.

iii. Weed Control in Planting Areas and Individual Tree Plantings

Weeds within planting areas and around tree plantings are to be managed from when cultivation of the planting site is complete.

All planting areas shall be managed by the Contractor to maintain a minimum of 90% weed free surface with no weeds taller or broader than 200 mm at all times and all weeds are to be removed prior to the production of viable seed. Weeds within Individual Tree Plantings are to be managed for a radius of not less than 1.5 metres at each planting location.

iv. Pest Animals and Diseases

The control of pests and diseases shall begin before the first planting. The Contractor shall maintain all plants free of insect infestation and plant disease so that healthy, vigorous plant growth is sustained. Minor infestations of native pests and diseases on indigenous plants not threatening survival or healthy growth need not be controlled.

The Contractor shall provide protection to plants from vertebrate grazing animals. All planting killed by grazing animals shall be replaced. If more than 5% of planting in a planting area shows signs of damage by grazing animals, the Contractor shall take immediate action to prevent further grazing damage. As a minimum the Contractor shall immediately install tree guards or suitable protective fencing securely around all plants subject to vertebrate grazing.

Where chemical repellents are to be used to prevent grazing, the repellent shall be applied until the growing tip of the plant is beyond the grazing height of the pest animal, subject to the approval of the Superintendent.

v. Replanting

Maintenance for replanting shall begin as soon as planting has begun in a planting area.

Plants which die or do not achieve the specified growth performance shall be replaced and replanted at the Contractor's expense.

The Contractor shall program and allow for the propagation and supply of plants for any replanting during the current or next available planting season. A full pass of replanting shall occur at least once in each year of the Defects Liability Period. Replanting shall be undertaken either in Autumn during the months of April or May or Spring during the months of September or October. Replanting outside of these times can be undertaken with approval from the Superintendent.

vi. Watering

The Contractor shall water all plants as necessary to ensure continued healthy and vigorous growth from time of planting.

vii. Grass Mowing ##(specification writer to strikethrough one of the following and delete this comment):

*** Mowing of all grass areas shall commence from Possession of Site.

*** Mowing of all grass areas shall commence from the earlier of sowing or road opening to traffic.

In addition to areas grassed by the Contractor, the Contractor shall maintain all other grassed areas within the limits of work in accordance with Routine Maintenance Specification RM511 – Grass Mowing, Section 750 of Standard Specification for Roadworks and Bridgeworks.

Areas with less than 95% grass cover (for each grassed area) within three months after sowing shall be resown by the Contractor. The Contractor shall ensure that 95% cover is maintained throughout the duration of the maintenance period.

viii. Re-mulching

Maintenance of areas mulched shall begin from the first planting.

Areas mulched with shredded wood mulch that do not have full foliage cover at ground level shall be maintained at a minimum consolidated depth of 75 mm by the Contractor. Re-mulching is not required where shrub or groundcover canopies have fully connected foliage.

ix. Pruning

Pruning maintenance shall begin from the first planting.

The Contractor shall prune trees and shrubs to remove damaged limbs and branches with a diameter above 10 mm. Tree branches likely to form a dominant 'U' or 'V' shaped crotch shall be pruned to a single leader. All pruning and removal of living or dead stems greater than 10 mm diameter shall be in accordance with AS 4373 Pruning of Amenity Trees.

x. Maintaining the Site in a Neat and Tidy Condition

At any time the site is accessible to the public, the Contractor shall keep the site in a neat and tidy condition free of litter, debris or extraneous materials not associated with the works. Litter that may be carried from the site by wind or water shall be controlled, collected and removed by the Contractor from Possession of Site.

xi. Maintenance of Tree Guards and Stakes

Maintenance of tree guards and stakes shall begin from installation.

Tree guards shall be maintained by the Contractor to ensure healthy vigorous plant growth is not inhibited. Tree guards shall be removed when the plant reaches 7501000 mm in height. Tree guards shall be removed prior to Final Completion of the Contract unless otherwise directed by the Superintendent.

Marker stakes shall be removed when the plant reaches the height of the stake.

xii. Repairs to Erosion Treated and Affected Areas

Maintenance and repairs to erosion treated and affected areas shall begin from the earlier of installation of treatment or erosion occurring.

The Contractor shall maintain all areas of erosion protection treatments from the earlier of installation of treatment or erosion occurring and shall repair all damage or erosion which arises. Such areas shall be re-prepared and reprotected as necessary to minimize erosion occurring and to establish a stable condition.

xiii. Intervention Standards

*** In addition to the above requirements, the Contractor shall maintain the landscaping works in accordance with Routine Maintenance Category Level ##1: of the Intervention and Rectification Standards specified in Section 750 of VicRoads Standard Specification for Roadworks and Bridgeworks for:

- RM411 – Surface Drains and Verges
- RM511 – Grass Mowing
- RM512 – Edge Trimming
- RM513 – Grass and Weed Control
- RM515 – Tree and Shrub Management
- RM517 – Noxious Weed Control
- RM822 – Litter Control

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