



mainroads
WESTERN AUSTRALIA

Environmental Guideline Revegetation Topsoil Management

Contents

1	INTRODUCTION	4
1.1	How to achieve successful revegetation	4
2	PLANNING FOR CLEARING AND TOPSOIL MANAGEMENT	5
3	DURING CONSTRUCTION	6
3.1	Clearing and Topsoil Removal	6
3.1.1	Weed Control	6
3.1.2	Clearing of vegetation.....	6
3.1.3	Treatment of Cleared Vegetation.....	7
3.1.4	Stripping and Handling of Topsoil.....	8
3.1.5	Stockpiling and Preparation of Materials.....	9
3.2	Soil Surface Preparation	10
3.2.1	Stepping and Benching of Batters.....	10
3.2.2	Use of Surplus Materials	11
3.2.3	Batter Protection Measures	11
3.3	Preparation of Stockpiled Materials.....	12
3.3.1	Chipping of Stockpiled Vegetation	12
3.3.2	Constructed Topsoil.....	13
3.3.3	Imported Topsoil and Mulch.....	13
3.3.4	Topsoil Preparation	13
3.4	Respreading Topsoil and Mulch.....	14
3.1	Planting and seeding	15
4	AFTER CONSTRUCTION.....	15
4.1.1	Vegetation Establishment Period.....	15
4.1.2	Assessment of Completion of Works	15
5	REFERENCES.....	16
6	APPENDICES	16
	Appendix 1: Revegetation Planning Process	17

Document Control

Owner	Executive Director Planning & Technical Services
Custodian	Manager Environment
Document Number	D13#429846
Issue Date	April 2016
Review Frequency	3 Years

Amendments

Revision Number	Revision Date	Description of Key Changes	Section / Page No.
1	Apr 2016	Update document to new Corporate Branding	All
0	Aug 2013	Initial Issue	

1 INTRODUCTION

This document provides guidance on clearing and topsoil management, during the road construction process, to achieve the revegetation outcomes set for a project.

1.1 How to achieve successful revegetation

Management of topsoil (and cleared vegetation) during construction is the key component of successful revegetation work

Revegetation outcomes can be compromised during the process of clearing, the earthworks, stockpiling and respread of materials.



Clearing



Earthworks



Stockpiling



Respread



Planting and Seeding



Establishment

The timing of revegetation activities is important and the control of invasive weed species during the clearing and earthworks is critical. For example, failure to consider the weed seed bank in topsoil will result in a poor revegetation outcome and lead to expensive and lengthy remedial works.

Site management decisions and treatment methods will vary by the scale of the works, the location and the revegetation objectives. For example there are differences in the methods proven effective in the drier Wheatbelt region compared to the higher rainfall regions in South West and Great Southern. Vegetation and topsoil quality can vary significantly over a project area (particularly for large projects).

The following proven best practice measures for revegetation can be applied to any road construction project.

- Plan for and manage the clearing and earthworks to allow for revegetation.
- Identify suitable and unsuitable topsoil and cleared vegetation before the works.
- Conserve and chip good quality vegetation, during clearing, for reuse as mulch.
- Conserve good quality topsoil, during earthworks, and respread on finished batters.
- Treat or dispose of unsuitable topsoil and cleared vegetation during the works.
- Control the spread of weed seed within the project area.

2 PLANNING FOR CLEARING AND TOPSOIL MANAGEMENT

Effective management of topsoil requires planning before any works are undertaken to ensure that effective treatments are integrated into the clearing and earthworks process.

A general staging of revegetation activities, before, during and after road construction is shown below as Figure 1.

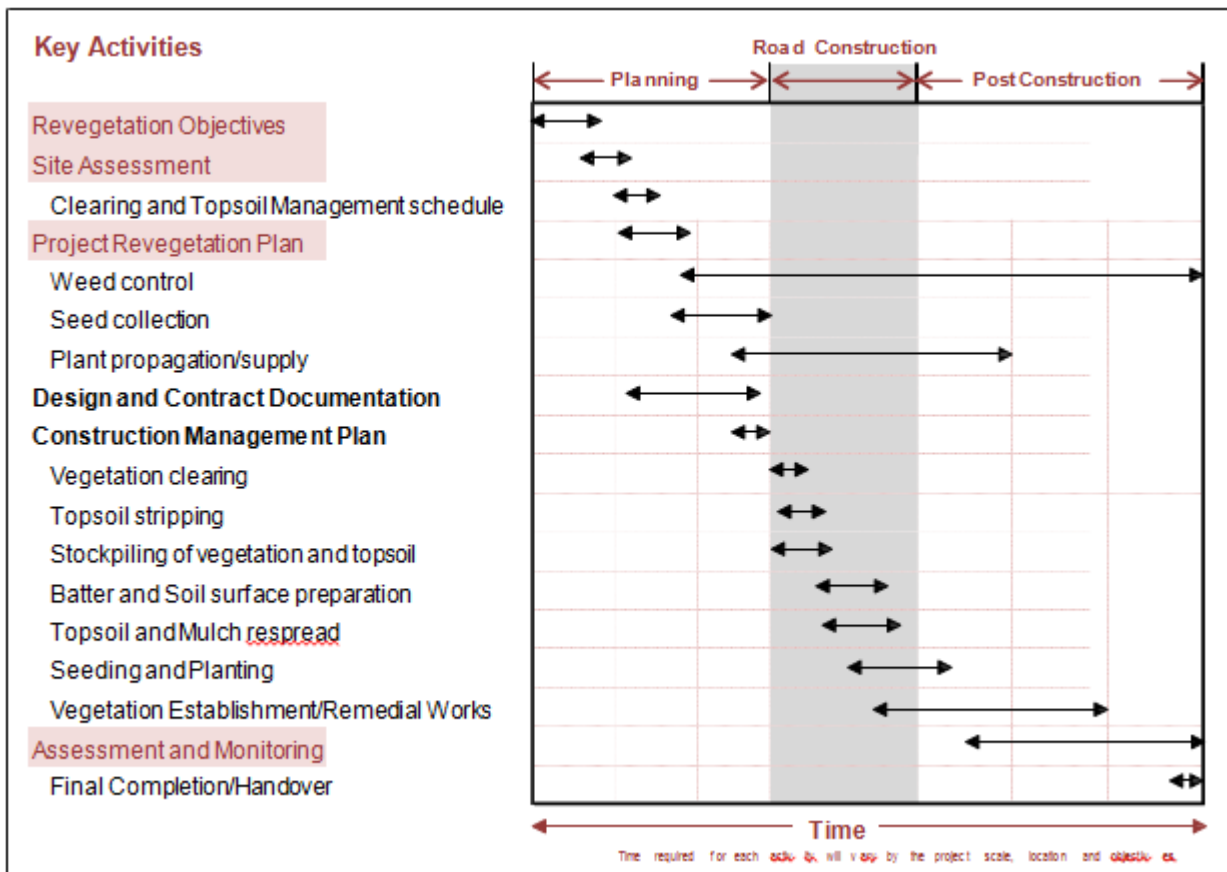


Figure 1: Staging of revegetation activities in the road works process.

Early in the project a site assessment is required to decide how to best manage the remnant vegetation to be removed, the topsoil and other site materials (e.g. rock and spoil).

This allows realistic requirements to be defined, before any construction begins, on the management of the site vegetation, topsoil and other materials. The recommended process is:

1. Assess the site i.e. vegetation and topsoil quality.
2. Plan the project revegetation works based on the site information obtained.
3. Implement the works according to the project revegetation plan.

The clearing and topsoil management requirements can be identified by road SLK, project chainage or work zone. These requirements can be translated into specifications and schedules in the project construction management plan for the movement and handling of cleared vegetation and topsoil materials during the clearing and topsoil handling operations.

Refer to Appendix 1 for more detail on the key steps in planning for the clearing and topsoil management as part of the revegetation process.

3 DURING CONSTRUCTION

Revegetation outcomes can be compromised without due regard to the handling of site materials during the clearing and earthwork operations. Failure to consider the weed seed bank in the existing topsoil will result in a poor revegetation outcome and expensive and lengthy remedial works. A key concern is to avoid the mixing of useful and unsuitable materials e.g. clean weed free topsoil and soils infested with weeds.

3.1 Clearing and Topsoil Removal

Requirements for the management of topsoil, site vegetation and other materials (e.g. spoil) during the clearing and earthworks are enforced via hold points and quality checks during the works and other contract arrangements.

3.1.1 Weed Control

Weed control prior to clearing and topsoil recovery will help reduce the weed seed content within the topsoil, particularly if regard has been made for the timing of weed species germination. Even if pre-recovery weed control is conducted, weed seed will remain within the topsoil and may germinate while the topsoil is stockpiled. Stockpiled topsoil can also accumulate a weed seed bank which will be spread when the stockpile is eventually utilised. Several rounds of weed control may be necessary to adequately control the new growth of weed species (from the weed seeds existing in the soil) and reduce the competition on site for the planting or seeding. Weed control is most effective at particular times of the year.

3.1.2 Clearing of vegetation

Clearing includes but is not limited to the removal of vegetation, rubbish and debris, surface boulders and grubbing out of large tree roots.



Extent of clearing work clearly pegged on site

Refer to specifications 301 Clearing for the sequence of operations, requirements and typical details.

The limits of clearing are nominated in the drawings and pegged out on site prior to a clearing hold point release.

This includes side-tracks and locations for the stockpiling of site materials. The clearing operations are undertaken in accordance with the procedures for dieback management and weed control as specified in the contract documents.



Use of clearing equipment suitable to site vegetation type.



Shrub rolling of low vegetation type

Suitable equipment is dependent on the type of vegetation, e.g. heavy timber, shrubland or heath. In some locations (e.g. in sandy heath vegetation) the most cost effective treatment is by rolling over the existing shrub and understory vegetation in-situ, and in the process to roughly incorporate the vegetation into the existing topsoil, with suitable land clearing equipment.

The management of any vegetation, to be retained and protected, during the clearing operations (includes the retention of existing large trees in cut or fill) should form part of the contract documentation.

This includes the locations of vegetation protection zones and protection details. No activities should occur within the vegetation protection zone.

The salvage and disposal of timber logs for milling (includes any handling, temporary storage and transport) may form part of the clearing operations.

For some projects the lifting and temporary storage of selected species, (e.g. grass trees) for later transplanting to the final location, may also form part the clearing operations.



Remnant native vegetation retained and protected within the clearing area.

3.1.3 Treatment of Cleared Vegetation

Appropriate treatments for cleared vegetation are prescribed in the revegetation plan and design documentation (i.e. in the clearing and topsoil management drawings or as annexures in the specification).

Good quality cleared vegetation (e.g. vegetation with a high proportion of desirable species) is reused in the revegetation process. Poor quality cleared vegetation (e.g. vegetation with significant weed content) is sent to landfill as green waste. One or more of the following treatments for cleared vegetation may be applicable by project.

- **Unsuitable** - Disposal of unwanted vegetation off site (e.g. disease and or weed infected or if excess to the quantity of mulch required for the works).
- **Suitable** - Removal and stockpiling of cleared vegetation (disease and weed-free) for chipping later and respread as mulch over batter slopes and cleared surfaces.

- **Suitable** - Chipping of vegetation and or 'shrub rolling' of vegetation (shrubs and groundcovers) and incorporation of the vegetation (disease and weed-free) into the existing topsoil for stockpiling and later respread.

3.1.4 Stripping and Handling of Topsoil



Site topsoil ready for removal and stockpiling

Topsoil refers to the top soil surface layer, but may include vegetative material incorporated during the clearing operation. Refer to specifications 302 Earthworks for the sequence of operations, requirements and typical details.

Areas of topsoil to be stripped and stockpiled or removed to spoil are pegged out on site, as nominated in the topsoil management schedule/drawings, prior to a hold point release.

The topsoil removal operations are undertaken in accordance with the procedures for dieback management and weed control as specified in the contract documents. Topsoil and vegetation stripped in one operation.

The typical sequence of operations for topsoil removal is:

- Confirm areas of topsoil to be removed with the Superintendent
- Separately scalp topsoil from areas nominated with weeds and or dieback
- Scalp good quality topsoil to stockpile or windrow to each side of the earthworks

Poor handling and stockpiling practices will result in a significant loss of viable seed and topsoil quality. Quality control procedures should be applied for the movement and handling, storage and respread of soil layers for use in revegetation.



Site topsoil graded into windrow

This will help avoid the mixing of good topsoil and weed contaminated soils and other unsuitable materials.

Cleaning down of machinery before and between operations is essential to prevent the introduction and spread of weeds or dieback.

Dieback and weed infected soil must be handled separately to minimise the risk of spreading dieback and weed species across the site.

Only the upper site soil layer is usually biologically active and of value in revegetation and landscaping (the depth varies with the soil type and location). Sufficient topsoil should be scalped/stripped from the Site and/or imported to provide a supply of suitable growing medium (to support vegetation) for use in revegetation and landscaping.

The depth for scalping/stripping will depend on a number of factors including:

- Volume required for revegetation works;
- Type of soil within project area (e.g. rocky soils will provide difficulties in stripping);
- Characteristics of subsoil (e.g. shallow subsoil with adverse characteristics may need to be avoided);
- Equipment available for use; and
- Relative importance of the soil seed bank which will be diluted with increasing depth of topsoil recovery.

It is important that:

- The surface topsoil layer and the subsoil is not mixed in the stripping and stockpiling process;
- The stripping and handling of topsoil should occur when the field soil moisture content is optimum for the particular soil texture class.

Measures to improve the workability of the soil may be required, i.e. allowing the soil to dry out or watering to bind dry soil and control dust. Movement of soil that is too wet or dry may result in the loss of topsoil properties that are important for the effective use in revegetation and landscaping e.g. stripping dry sandy soil will result in mixing of the topsoil and subsoil layers. The properties of topsoil will degrade much more rapidly if recovered when too wet. Reduce the movement of large equipment over topsoil materials to minimize compaction.

3.1.5 Stockpiling and Preparation of Materials

Suitable stockpile locations are identified as early as possible. Stockpile locations will depend on where the topsoil has been recovered from, where the topsoil is proposed to be used and the available space within the road reserve or on adjacent land.

Cleared vegetation and topsoil should be stacked in manageable stockpiles. The height and width at the base should be limited (refer to specifications 301 Clearing) with the length dictated by the available space. Larger stockpiles may result in some loss in microbial content and viable seed.

Stockpile locations should be prepared prior to stockpiling of materials by the removal of the existing soil layer and early weed control of the surrounding area.

Once established stockpile areas should be kept free of weeds to ensure that the properties of the materials are not degraded and made unsuitable for use in the revegetation and landscaping works.

It is important that:

- Stockpiling is limited to the minimum practical period;
- The height of topsoil stockpiles and batter slopes are limited.
- The properties of stockpiled topsoil are not degraded by weed infestation or erosion.

In some circumstances, direct transfer of topsoil from one area to another may be possible. This will optimise the use of the available seed bank and soil flora and fauna.



View of project area with locations designated for the stockpiling of site materials



The length of time that topsoil is stockpiled will affect its quality. Stockpiles of a short duration are likely to give a better revegetation outcome than topsoil that has been stockpiled for lengthy periods e.g. in excess of a year.

The temporary stockpiling of the cleared vegetation should be minimised to reduce the drop of viable seed material (that is useful for revegetation) to the ground. Cartage to the final stockpile location should be undertaken as soon as possible after the clearing operations.

Temporary stockpiling of chipped site vegetation within the cleared alignment

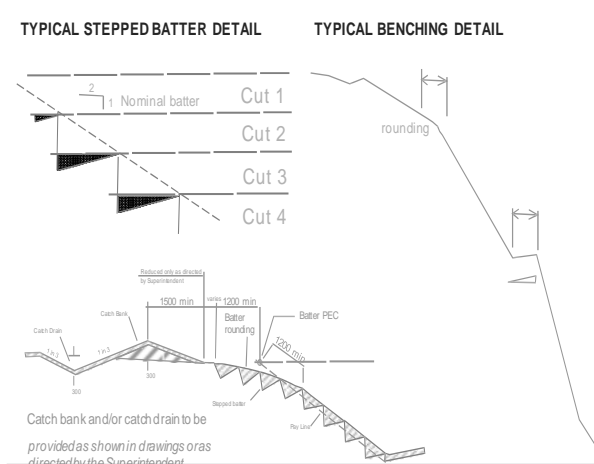
3.2 Soil Surface Preparation

Regeneration from site topsoil, by direct seeding or by planting will not be effective unless the soil surface remains stable during the construction and vegetation establishment period. The requirement for soil surface preparation varies with the site and project conditions. This may involve land forming, benching and stepping of batters, erosion control or soil surface protection measures.

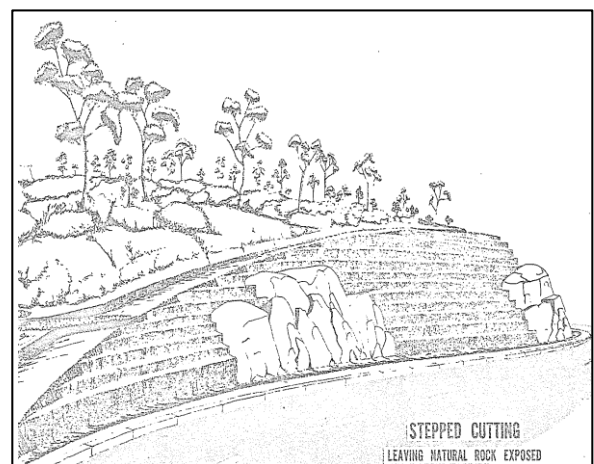
3.2.1 Stepping and Benching of Batters

Treatment of batter slopes may be required prior to any proposed revegetation measures. Steep and long slopes increase surface runoff and down slope transport of soil material. Bare soil areas upslope may provide a catchment to transport surface runoff across revegetation areas. Key locations for attention are steep batter slopes where subsoil, rock and groundwater may cause instability of topsoil and vegetation.

The stability of finished surfaces can be optimised by ‘benching’ and ‘stepping’ the batter slope. This roughening ensures a strong ‘connection’ of the topsoil respread with the surface of the batter slope.



Example detail for benches and stepping of batters



View of stepped cutting with rock exposed

Where random rock outcrops occur, leave these and step the batter up to both sides of the outcrop. Leaving the natural rock face exposed and revegetating the remaining benched batters can make a considerable improvement to the overall appearance of the cuttings.

Roughening the surface is important so the topsoil, when applied, can be ‘keyed into’ the surface and is less likely to be susceptible to wind and water erosion. In some projects, the roughening effect has been achieved by using excavator teeth.



Benching of batter slope.



Stepping of batter slope.

Cut batters should be benched or stepped to provide drainage and erosion control as detailed in the drawings. The floor of the bench should not vary by more than the nominated tolerances and the bench must drain away from the lowest cut face and provide for longitudinal drainage. Benches should be maintained free of loose materials until the finishing of batters and ground surfaces.

On fill batters during the compaction process for the formation layers leave 200mm of rough and un-compacted soil at ends to assist in the revegetation of the fill batter surfaces.

3.2.2 Use of Surplus Materials

Surplus or unsuitable road building material (e.g. redundant pavement, excess fill) may be used to flatten embankment batter slopes, fill depressions or cover unwanted grassed areas to facilitate revegetation.

Contaminated soil and weed-infested soil should not be respread or used in revegetation works. Composting and mitigation measures may be practical in some locations. Only approved waste disposal sites are to be used for the disposal of these materials. In some cases it may be buried in accordance with the standard specifications.

Ripping/pulverising of redundant pavement has proven to be an effective medium for revegetation.

Degraded Topsoil can be used in construction projects to achieve embankment stabilisation or to provide mow zones for safe recovery zones provided weeds are managed.



Ripping of redundant pavement area prior to seeding and planting

3.2.3 Batter Protection Measures

Newly exposed soil surface material (especially on steep batters) is subject to easy movement by wind and rain. Unless the soil surface is kept in place during the initial stage of revegetation no seeding or planting can establish. Mulch provides good batter protection, but in some cases (e.g. steep batters) other batter protection measures are necessary.

Control of the on-site surface drainage is important to minimise potential erosion (eg due to rainstorms). Drainage design should seek to minimise the need for soil erosion measures by reducing the potential for surface runoff across revegetation areas.

Erosion control matting or netting (e.g. geocells, coir or jute matting) can be used to provide surface protection and stability of the finished soil surface prior to planting.



Soil surface erosion following earthworks



Use of geocell material to stabilise steep batter



Use of coir matting used to stabilise batter

Other batter protection measures include hydro-mulch or seeding with a temporary cover crop or by spreading of insitu or imported vegetation mulch). Use of these measures should complement the proposed seeding and planting operations.

3.3 Preparation of Stockpiled Materials

Site materials may require additional preparation prior to respread to optimise the use for revegetation purposes. Specific requirements are documented in the project Construction Management Plan dealing with the clearing and earthworks.

3.3.1 Chipping of Stockpiled Vegetation

Site vegetation may be chipped and stored for later re-spread as mulch or mixed with site topsoil. No weed material (woody or herbaceous) should be included into the chipped material.

All disease-free and weed-free cleared vegetation nominated for chipping should be reduced in size by chipping, splitting, cutting, mowing, slashing, grinding, etc. The average grade size should be between 15mm - 150mm, with no individual pieces greater than 150mm in most locations.



Chipping of site vegetation prior to stockpiling



Stockpiling of chipped vegetation

3.3.2 Constructed Topsoil

Some road projects may have insufficient suitable topsoil within the road project area to undertake the desired revegetation works. This situation may arise where the existing topsoil has high weed infestations which are not logistically controllable within the time and resource constraints of the project. Similarly, native soils may have an unfavourable characteristic that makes their recovery and future utilisation of limited benefit. In these circumstances, there are two options available – the importation of topsoil from elsewhere or the use of ‘constructed’ topsoil.

Constructed topsoil is obtained by mixing soil or clean fill with green waste and compost. It should be ‘constructed’ in an area free of weeds and of sufficient area to allow stockpiling and mixing of the various components.

The recommended characteristics of the topsoil and stockpile configuration are:

- Two parts mulch to 1 part soil plus 7-10% compost (this combination is optimal for achieving the appropriate C:N ratio – usually 30 or 40:1);
- Well mixed to ensure all sections of the stockpile have undergone pasteurisation;
- Windrows of less than 3 m;
- Moisture content of 45 to 65%;
- Oxygen content of 12-14%;
- Stockpile age of 6-10 weeks; and
- At least one turn following the initial incorporation of materials to re-oxygenate and reactivate stockpile.



View of constructed topsoil stockpiles within project area

Other amendments, such as lime or fertiliser, may be necessary to form a complete soil.

3.3.3 Imported Topsoil and Mulch

An alternative to constructed topsoil is the importation of topsoil/compost from outside of the road project area. If it can be sourced and is viable to use, it must be assessed in the same manner as is done for topsoil within the road project area. Weed seed content is likely to be a primary consideration. Similarly, if imported mulch or sand is proposed in order to achieve better soil characteristics, the potential weed content is also a consideration. Refer to Specification 304 – Revegetation and Landscaping for typical requirements.

3.3.4 Topsoil Preparation

Some level of topsoil preparation is required prior to any direct seeding and or planting. Soil properties and conditions vary across the state and may vary within a project area. It is critical that the soil properties (physical, chemical and biological) provide a suitable growing medium to support vegetation. Testing, amendments and soil conditioning measures may be required prior to or after topsoil respread.

To optimise its use, topsoil may require additives, such as fertiliser, lime, gypsum or mulch. The requirement for any additives should be identified at the assessment stage and provision should be made for how the material will be handled. For example, gypsum is ineffective when spread on the surface and it must be incorporated into the soil for maximum benefit. Agricultural equipment may be required to achieve this.



Soil cultivated before seeding and planting

Another amendment that may be required is a soil wetting agent. This can prove useful in soils that are hydrophobic and do not readily allow the infiltration of water. Sandy soils on the Swan Coastal Plain are known to often have this property.

Mounding and soil preparation may be needed in salt-affected areas or zones prone to water logging.



Mounding before planting in low lying areas

3.4 Respreading Topsoil and Mulch

Topsoil and other materials are handled and transported by suitable earthmoving equipment ready for spreading by dozer, loader or spreader. Agricultural spreaders have been used with success for topsoil and mulch. Topsoil should not be handled when wet as it may compact (depending on the soil type).



Site topsoil respread over finished batter

Mulch is applied to the surface of the topsoil or incorporated into the soil as a soil amendment. Mixing of mulch with topsoil prior to spreading has the advantage of reducing the spreading phase to one operation. Excess depth of surface mulch can impede plant germination and infiltration of rainfall.



Side spreader of topsoil or mulch

On batters the topsoil/mulch should be 'rolled' or tracked into the soil to achieve a corrugated effect. The corrugations retain moisture, collect seed and impede the development of scour. Surface roughening of batters by creating furrows up slopes (tracking the soil surface), or terracing, reduces erosion potential of surface runoff by decreasing runoff velocities and trapping sediment. This increases water infiltration along the slope and will facilitate effective mulching, seeding and planting.

Cost effective reuse of site materials and the management of the clearing and topsoil operations will significantly increase the likely success of any revegetation works.



Dozer tracking up batter slope

3.1 Planting and seeding

Specific project requirements for directing seeding and planting are defined in the project revegetation plan and design documents and incorporated into the Construction Management Plan. Refer to Specification 304 – Revegetation and Landscaping for typical requirements.



Emergent vegetation during establishment

4 AFTER CONSTRUCTION

4.1.1 Vegetation Establishment Period

All new vegetation requires time to establish and grow (i.e. several years). Failure to establish the new vegetation cover means a loss of the investment in the project.

The need for remedial works is identified by the periodic assessment of the progress during the establishment period.

Remedial works typically include weed control and infill replanting. Under some circumstances, such as surface erosion or adverse soils property (e.g. compaction), additional topsoil management may be required. It may be advisable to retain a small reserve of topsoil for this purpose.

For most projects a minimum vegetation establishment period is recommended, of at least three seasons (over the dry or low rainfall period typical for the location), following the Practical Completion of the works.

4.1.2 Assessment of Completion of Works

The timing of assessments, the criteria and completion targets for the revegetation works are identified in Project Revegetation Plan.

Standard criteria include vegetation cover, density, diversity, extent of soil erosion and weed cover.

A final assessment occurs prior to the issue of the Final Certificate of Completion for the works. Monitoring of the revegetation continues until the completion criteria have been achieved for the

project site.

A successful vegetation cover over the site should be established prior to the handover to the Asset Manager to form part of the ongoing roadside maintenance program.



Vegetation cover established before handover.

5 REFERENCES

Encycle Consulting Pty Ltd (2011). *The Manufacture of Soil for the New Perth Bunbury Highway*, January 2011.

FHWA, (2007), *A Manager’s Guide to Roadside Revegetation using Native Plants*.

Keighery, B. (1994), *Bushland Plant Survey: A Guide to Plant Community Survey for the Community*, Wildflower Society of WA Inc. Nedlands Western Australia.

MRWA - *Scope of Works and Technical Criteria (SWTC)*. MRWA - *Standard technical specifications*.

MRWA - *Environmental Guideline - Revegetation Planning and Techniques (Doc no. 6707/031)*.

Southern Gateway Alliance – *New Perth Bunbury Highway Topsoil Management Plan - a case study*.

6 APPENDICES

Appendix	Title
Appendix 1	Revegetation Planning Process
A1.1	Revegetation across project types
A1.2	Project revegetation objectives
A1.3	Planning the clearing and topsoil management
A1.4	Clearing and Topsoil Management schedules
A1.5	Project Revegetation Plan
A1.6	Design and Contract Documentation
A1.7	Construction Management Plan

Appendix 1: Revegetation Planning Process

Early planning is a key factor for successful revegetation work. Figure A.1 below shows the key steps in planning for the clearing and topsoil management in a standard roadwork project.

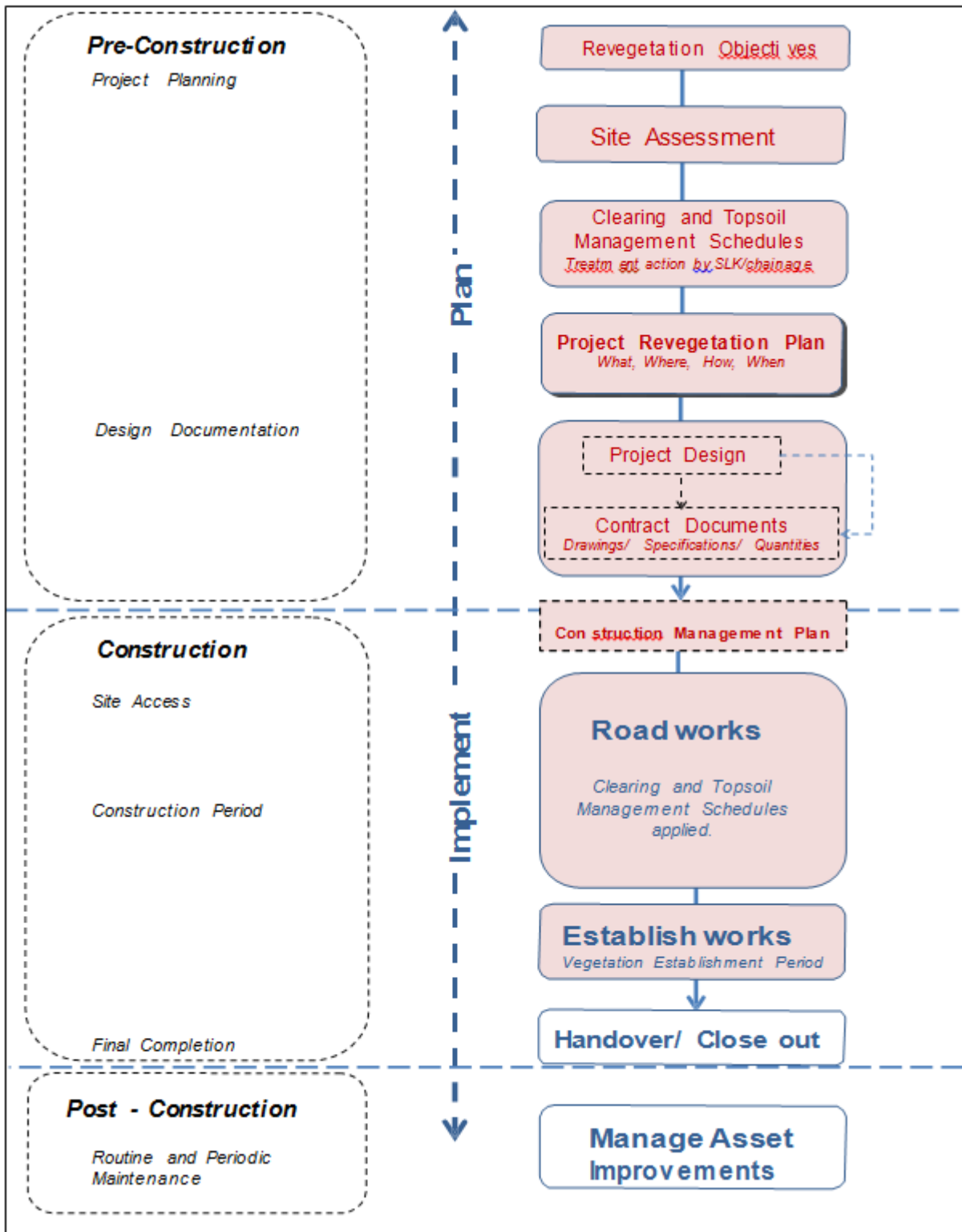


Figure A.1 - Key steps in planning topsoil management for revegetation in roadwork projects

All road projects must have a project revegetation plan based on a clearing and topsoil management strategy for the works. Construction management plans must include clearing and topsoil management schedules.

A1.1 Revegetation across project types

Revegetation may occur as part of a standard roadworks project, a design and construct roadworks project or as stand-alone revegetation works not directly associated with any roadwork project. Table 1 below describes components of revegetation works across different project types.

Aspect	Vegetation improvement works along existing roads (1)	Rehabilitation of new road works (includes borrow pits)		
		Minor infrastructure works (e.g. footpaths)	Standard road works (Cat 2)	Major road works (Cat 1)
Scope of works	Usually limited to planting and weed control. Limited clearing and earthworks.	Some earthworks. May include clearing of vegetation. May include weed control, planting and seeding. Scale varies.	Scale of clearing and earthworks varies. Usually includes weed control, planting and seeding etc.	Usually large scale clearing and earthworks. includes weed control, planting and seeding etc.
Scale of disturbance	Nil - Minor	Minor	Minor - Moderate	Moderate - Significant
Delivery/ Procurement	Usually direct managed, with requirements based on regional template (past contracts). May be standard item in maintenance contract.	Usually design then construct or standard item in maintenance contract. Requirements based on regional template (past contracts).	Design then construct or standard item in maintenance contract. Requirements based on standard contract including standard specifications.	Design and construct or alliance. Requirements based on Scope of Works and Technical Criteria (SWTC)
Project planning (2)	Project revegetation plan (short form).	Project revegetation plan; requirements defined in contract documentation.		Strategy and revegetation plan, contract documentation.
Co-ordination of activities (3)	May not be applicable	Yes	Yes	Yes
Establishment Period and Handover (4)	May be limited to weed control.	Includes remedial works e.g. infill plantings, erosion control and weed control.		

Table 1 –Components of revegetation works by project type

- 1 This includes the small scale improvement works identified within Regional Revegetation Plans.
- 2 Project specific requirements are determined by project and contract staff. Revegetation requirements are set in the project revegetation plan and contract documentation. For major projects this occurs in consultation with a revegetation specialist.
- 3 Co-ordination of clearing, earthworks and other road construction activities with revegetation works is critical to help achieve cost effective and successful outcomes.
- 4 Establishment Period activities are critical to establish the vegetation cover. Should include infill and remedial works, erosion control and weed control. Min of 3years of funding needed for most locations.

Refer to the guideline Revegetation Planning and Techniques (Doc no. 6707/031) for guidance on planning and managing revegetation works associated with the project types.

Appropriate measures vary by project but there are a number of steps that must be applied, before any works begin, for effective results.

- Determine the overall objectives to be achieved by the revegetation.
- Assess the site and decide the best methods to use appropriate to the site.
- Prepare a project revegetation plan (prior to design and start of works).

A1.2 Project revegetation objectives

Revegetation objectives must be determined early in the project planning. Objectives are typically based on conditions set by regulators and by project commitments, e.g. environmental approval conditions, clearing permit commitments or offsets, stakeholder expectations, or are based on the surrounding land use and site conditions.

A1.3 Planning the clearing and topsoil management

The process for planning the clearing and topsoil management can be summarised as follows:

1. Assess the site vegetation and topsoil quality and weed cover. This is a visual observation but require sampling and analysis.
2. Identifying treatment zones within the site that will receive the same management regime. This would usually be on the basis of topsoil quality.
3. Plan the clearing and topsoil management based on information obtained. Determine any requirements for constructed topsoil or specific weed management. Decide how each treatment zone will be managed and incorporate this into the Project Revegetation Plan.
4. Implement the works according to the Project Revegetation Plan.

Site Assessment

In order to properly plan for revegetation work during construction an assessment must be made of the site vegetation quality, extent of dieback and weed cover and topsoil quality.

A site vegetation and topsoil assessment provides the basis for decision making on the management of clearing and topsoil handling during the earthworks. A guidance scale, adopted in recent major road projects, is summarised overleaf in Table 1.

Note that the prescriptions identified in table 1 are a guide only and must be adapted to suit particular situations. Some experience and judgment is necessary to optimise the use of the available resources. For example, in situations where there is little remnant vegetation, the assessment may be based on the presence or absence of invasive weeds.

It may be appropriate to undertake targeted soil sampling and analysis. Typically, such testing would be seeking to identify 'problem' soils – soils with excessive weed seed, saline, sodic or acidic, or soils affected by fertiliser drift or in some way contaminated. Testing can also be used to profile other soil characteristics – nutrient status, organic content etc. This information will help determine the requirements, if any, for soil conditioning or amendments, for constructed or imported topsoil and mulch. Degraded soils may still be useful if there is a requirement for soil on areas to be grassed within the project area. The site assessment may provide the information needed to prepare weed and dieback management plans.

There may be a number of distinct treatment zones across the site. Prescription details by treatment zone, for clearing of vegetation and reuse of mulch, reuse of good quality topsoil, the need for imported or constructed topsoil and weed management etc., may be developed as separate schedules or appended into a single schedule.

A1.4 Clearing and Topsoil Management schedules

Treatment zones and prescriptions are recorded and mapped across the project area by SLK, chainage or work zone. These schedules provide an estimate of quantities for use in planning the clearing and topsoil management operations. For example the volumes of topsoil required, and

topsoil depths available for respread, available quantities of chipped vegetation and requirements for imported topsoil and mulch, the area required for the stockpiling of materials. Attachment A.1 provides an example of an assessment sheet and topsoil management schedule.

Existing Vegetation		Topsoil management	
1* Vegetation Condition Scale (use in site assessment)		2* Topsoil Management (use in project revegetation planning)	
Condition	Description	Treatment	Description
Well Conserved	Native vegetation free of weeds with a broad representation of locally indigenous native plant species. These areas are usually associated with conservation areas. <i>Pristine (6) to Excellent (5) in Keighery scale</i>	Conserve and reuse	Clearing and stockpiling of native vegetation. Removal and stockpiling of topsoil. May be mixed in single operation. Respread over finished surfaces. Weed control and dieback management as needed.
Conserved	Native vegetation with slight weed infestations, usually grasses. Vegetation still contains a broad representation of locally indigenous native plant species. These areas are usually fringing vegetation related to well conserved areas. <i>Very Good (4) in Keighery scale</i>		
Partially Degraded	Native vegetation with moderate infestation of weed. Trees, shrubs and groundcovers are present however the majority of locally occurring indigenous plant species are absent. <i>Good (3) in Keighery scale</i>	Treat and reuse	Selective clearing and stockpiling of chipped (or slashed) vegetation. Selective removal and stockpiling of topsoil. May be mixed in single operation. Respread over finished surfaces. Weed control and dieback management as needed.
Degraded	Areas dominated by weeds associated with pasture land or farmland with a dominance of grasses. <i>Degraded (2) in Keighery scale</i>		
Unsuitable	Areas dominated by weeds associated with pasture land or farmland and the presence of invasive environmental weeds or declared weeds (3*). <i>Completed Degraded (1) in Keighery scale</i>	Dispose	Selective clearing and stockpiling of vegetation and disposal off site. Selective removal and stockpiling of topsoil and disposal off site.

Table 1 Guidance scale for vegetation condition and topsoil management

1* Scale is based on the Keighery, B. (1994) Bushland Plant Survey:

2* Treatment is determined mainly on vegetation condition, weed level and dieback status. Dieback infected soils used in areas of like for like dieback status. Seed collection of native plant species may occur (for direct seeding or plant propagation).

3* Declared species under the Australian Agricultural Related resources protection Act (1976).

A1.5 Project Revegetation Plan

A project revegetation plan is prepared to document the best methods to deliver the works given the site conditions (vegetation, topsoil and weeds levels). Revegetation may include some or all of the following components.

- Seed collection and plant supply;
- Weed control;
- Protection of retained site vegetation;
- Clearing and stockpiling of cleared vegetation;
- Chipping and re-spreading of vegetation;
- Topsoil management (strip, stockpile and re-spread);
- Soil preparation, erosion control and batter protection;
- Seeding and planting.

A project revegetation plan should provide a realistic strategy, which is reasonable and achievable, given the site conditions and within the scope of the overall road project.

Timing and the methods used vary by the geographic region, rainfall pattern and soil type,

higher winter rainfall regions in South West and Great Southern and the drier Wheatbelt region, the Kimberly region with summer rainfall and the irregular rainfall of the arid zones.

Weed control is probably the single most significant aspect of topsoil management and the main factor that determines whether a revegetation project will be successful. Weed control is often required throughout the construction process (see Figure A.1). In some locations, based on the risk (e.g. declared or invasive species in environmental sensitive areas), a separate Weed Control Program is prepared prior to clearing operations.

Seed collection from the site may need to be conducted over an extended period as the seeds of different species mature at different times. In a year with poor rainfall, seed set may be limited and collection may need to be conducted in the following year. Planting and seeding may not be successful due to drought or other factors and follow up works may be necessary.

The project revegetation plan should also identify appropriate measures to stabilise batters and exposed soil surfaces, between activities e.g. clearing and earthworks or before the seeding or planting can occur. Site conditions may require the installation of temporary and or permanent erosion control measures before any clearing and grubbing operations to control site erosion and sedimentation into natural drainage lines.

The project revegetation plan should define the staging and include an initial estimate of costs, as well as completion criteria and targets.

The project revegetation plan should be prepared and approved prior to the commencement of design and documentation. This will help design staff understand the site constraints and opportunities for revegetation and what needs to be achieved for the project.

A1.6 Design and Contract Documentation

Treatment zones and prescriptions need to be translated into specific requirements in the Design Documentation dealing with the clearing and earthworks. Project Prescriptions for Clearing and Topsoil Management are based on the treatment schedules by SLK, chainage or work zone to set out the clearing, stripping and handling, stockpiling and respread requirements. These requirements can be translated into drawings, specifications and prescriptions in order to plan for the clearing, and topsoil management.

Estimating the Volume of Vegetation to be Cleared

An estimate of the expected volume of cleared vegetation will provide an estimate of the required stockpile area. The following estimates are based on prior experience in the local land clearing industry.

Heavy vegetation (Forest, well timbered) ~ 300 -350 m³/ha

Medium vegetation (Banksia woodland) ~ 200 m³/ha

Light vegetation (scrubland, wattles) ~ 50 -100 m³/ha

Area (m²) of stockpile required = ~ estimate of total volume of cleared vegetation/height of stockpiles (~1.5 m). Allow access for placing materials and management of stockpiles of chipped. For mixed vegetation cover (i.e. varied across the project area) the estimate of volume should be based on the above rates and the area of cover. In South West forest areas the vegetation cover may get heavier up to 450 m³/ha.

Estimating Topsoil Quantities

The first step is to estimate the area (m²) by chainage or work zone for each topsoil management strategy and the stripping depth. The volume of available topsoil is calculated as follows:

$V_a = A * D$
 where:
 V_a = the volume of topsoil to be stripped in m³, and
 A = the area of topsoil to be stripped in m², and
 D = the depth to which topsoil will be stripped

This available topsoil volume then needs to be matched against the respread volume required topsoil requirement for the project. The respread volume is determined by the area m² of surfaces requiring topsoil and the desired topsoil depth.

$V_a = V_r$
 where:
 V_a = the volume of topsoil available in m³, and
 V_r = the volume of topsoil required for respread in m³

If the available topsoil resource is inadequate, the following options (in order of preference) may be considered:

- Increase the stripping depth for the useable topsoil;
- Supplement the topsoil resource through the use of constructed topsoil (Section 3.3);
- Review the topsoil classification and the use of less suitable topsoil.
- Import topsoil from outside of the project (Section 3.3).

Clearing and Topsoil Management Drawing(s) should be prepared as part of the design documentation for the works. The drawings should clearly show the extent of clearing

to allow for any topsoil windrow), stockpile locations and include typical details as necessary. Specifications and prescriptions for the movement and handling of cleared vegetation and topsoil materials should be used to direct the clearing and topsoil operations. Relevant Main Roads standard technical specifications include:

- Specification 204 – Environment;
- Specification 301 – Clearing;
- Specification 302 – Earthworks;
- Specification 302 – Borrow Pits;
- Specification 304 – Revegetation and Landscaping.

A1.7 Construction Management Plan

Operational requirements are incorporated into the Construction Management Plan.

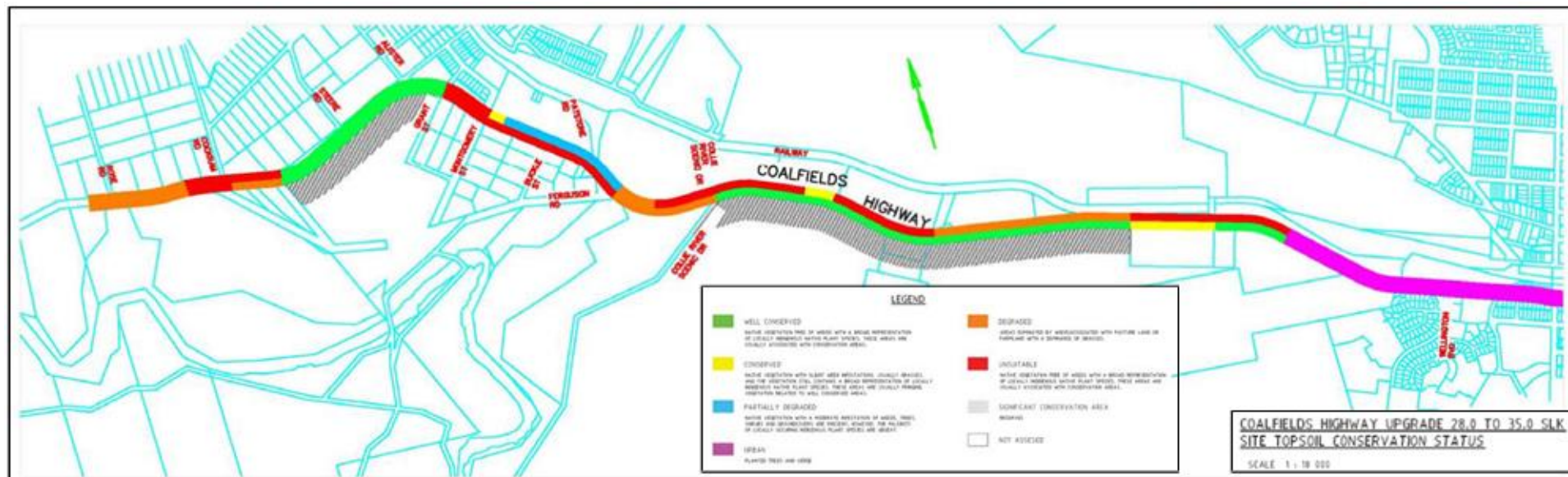
There needs to be clear quality control procedures for the movement and handling, storage and respread of soil layers for use in revegetation. The control of invasive weed species during the clearing and earthworks is critical. Clearing and topsoil management schedules are useful in planning the operations to identify:

- Expected quantities to be stripped;
- What materials will go where, both during storage and when respread;
- Specific management requirements e.g. dust suppression, signage, weed control;
- General timing for all activities.

Detailed schedules are required in environmentally sensitive areas (e.g. declared rare flora and dieback-affected areas), where it is important to minimise the extent of clearing.

Attachments A.2 and A.3 provide an example of topsoil removal/stripping topsoil respread plans.

Attachment A.1 - Example of topsoil condition assessment

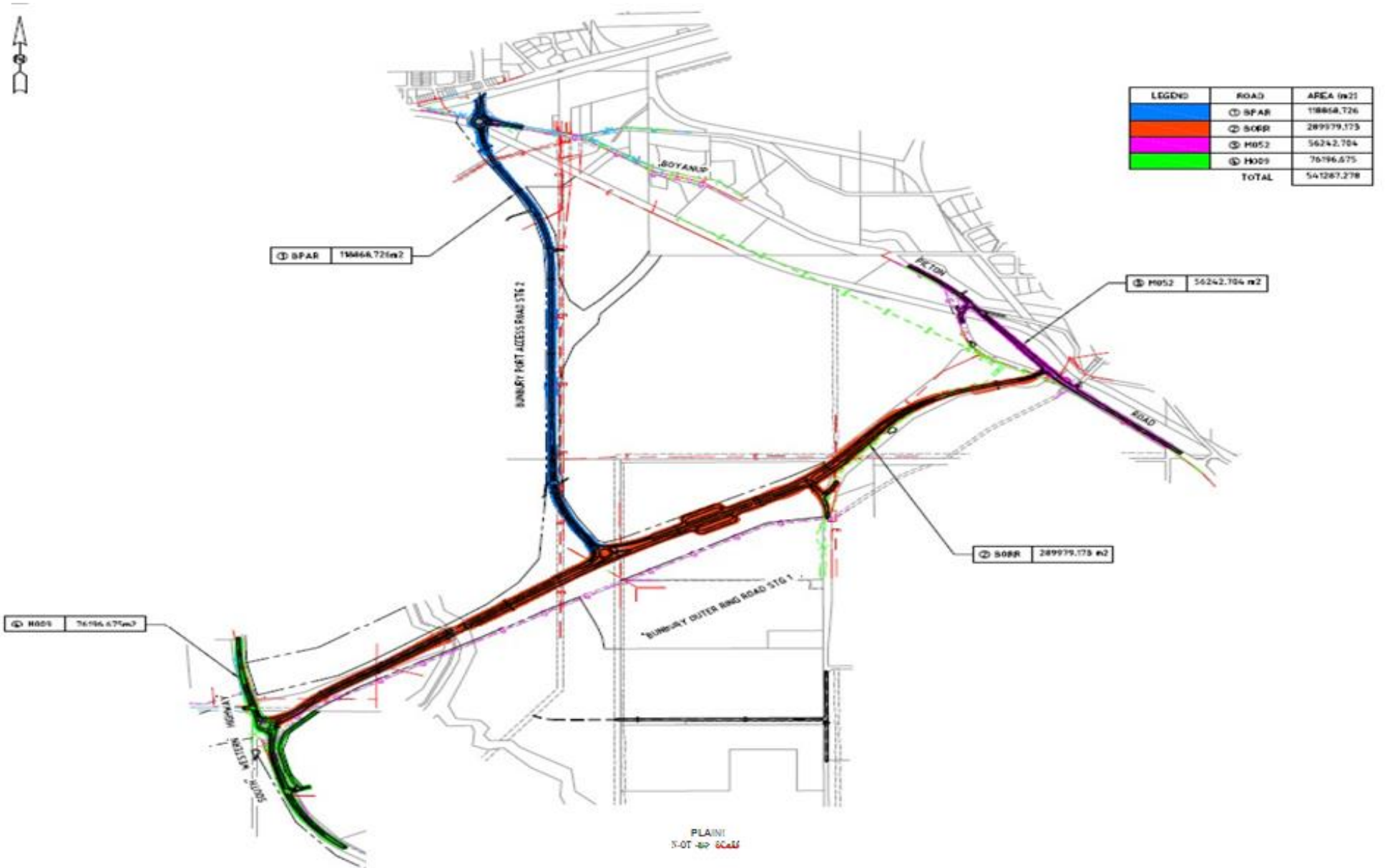


Example of Clearing and Topsoil Management Schedule

Project Name and Location

Classification key			1 = Well Conserved	2 = Conserved	3 = Partially Degraded	4 = Degraded (To spoil off site or buried under 500mm class 1, 2 or 3 topsoil)	5 = Unsuitable (Dispose off site to spoil)	Other - See comment		
Item #	Chainage Start	Chainage Finish	Distance	LHS Classification	LHS Management Actions Proposed	Adjacent Landuse, or Feature	RHS Classification	RHS Management Actions Proposed	Adjacent Landuse, or Feature	General Comments
1	28.860	29.810	0.950	Well Conserved	Conserve and re-use topsoil LHS	Wide road verge LHS Well conserved vegetated reserve within Allanston townsite.	Well Conserved	Conserve and re-use topsoil LHS	RHS Well conserved vegetated reserve within Allanston townsite.	High value topsoil for rehabilitation
2	29.810	30.060	0.250	Unsuitable	Spoil topsoil LHS	Wide road verge LHS Urban roadside in Allanston.	Unsuitable	Spoil topsoil LHS	RHS narrow urban roadside in Allanston townsite.	Lovegrass and other weeds present
3	30.060	30.140	0.080	Conserved	Reuse topsoil LHS	Allanston townsite.	Unsuitable	Spoil topsoil LHS	RHS narrow urban roadside in Allanston townsite.	Conserve LHS minimise disturbance no topsoil respired
4	30.140	30.870	0.530	NA	NA	Allanston townsite east at 30.870	NA	NA	Allanston townsite east at 30.870	
5	30.870	30.800	0.660	Partially Degraded	Spoil topsoil LHS	East of Allanston townsite. No topsoil respired LHS	Unsuitable	Spoil topsoil LHS	RHS east of Allanston townsite no topsoil respired	Manage Lovegrass and Watsonia.
6	30.800	31.000	0.200	Degraded	spoil topsoil LHS	adjacent to private property	Degraded	spoil topsoil LHS	adjacent to private property	Management of declared weed required (a Blackberry and Watsonia present)
7	31.000	31.030	0.300	Unsuitable	Spoil topsoil LHS	adjacent to private property	Degraded	spoil topsoil LHS	adjacent to private property	Management of declared weed required (a Blackberry and Watsonia present)
8	31.030	31.470	0.440	Unsuitable	Spoil topsoil LHS	adjacent to private property	Well Conserved	Conserve and re-use topsoil RHS	RHS adjacent to conservation park (reserve 6738)	LHS cleared RHS Westalla Conservation Park, RHS topsoil of high value
9	31.470	31.880	0.140	Conserved	Respired topsoil LHS	LHS adjacent to private property	Well Conserved	Conserve and re-use topsoil RHS	RHS adjacent to conservation park (reserve 6738)	LHS cleared RHS Westalla Conservation Park, RHS topsoil of high value

Attachment A.2 - Example of a project topsoil stripping plan



Attachment A.3 - Example of a project topsoil stripping plan

