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Appendix J

Arrow Energy Land Disturbance Guideline

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Guideline
ORG-ARW-HSM-GUI-00094

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Arrow Energy – Land Disturbance Guideline

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1 Purpose and Application

The purpose of this guideline is to provide additional information in support of the Arrow *Land Management Standard* and the *Land Disturbance Procedure* to avoid, minimise or mitigate environmental harm associated with land disturbance activities.

This guideline covers vegetation clearing, soil management, site preparation and erosion and sediment control for all Arrow controlled activities during exploration, drilling, construction, operations and decommissioning.

This guideline does not cover site rehabilitation including rehabilitation monitoring (refer to the Arrow *Rehabilitation Procedure* and associated documentation).

For land disturbance impacts associated with weed and pest management, refer to the Arrow *Weed Management Procedure* and *Pest Management Procedure*.

2 Design and Planning

For guidance on locating infrastructure refer to Appendix A (Hierarchy for Locating Infrastructure).

Identify the extent of proposed disturbance area. Where possible, Minimal Disturbance is preferred for well pads and tracks (refer to Appendix B – Decision Tree for Minimal Disturbance Site Preparation). Erosion and Sediment Control Plans (ESCP) are not needed on Minimal Disturbance sites.

Standard ESCPs for low-risk sites are available for well pads and pipeline infrastructure, these plans can be accessed through Arrows document management system – ASSAI. Projects that trigger site specific ESCPs must be reviewed and approved by Arrow prior to disturbance.

2.1 Decommissioning

Following the completion of activities, infrastructure will be decommissioned and removed prior to rehabilitation works commencing in accordance with the latest Australian Pipelines and Gas Association (APGA Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry. For further information on decommissioning rehabilitation requirements, refer to Arrow *Rehabilitation Procedure.*

3 Soil Management

Obtain information on the soil types of the proposed disturbance area (Arrow GIS). Determine if there is enough information available to proceed with erosion and sediment control and land disturbance planning, or if further assessment is required. If soils survey is required, refer to Section 3.1.

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If the soil type is known (by map interpretations or existing data including Arrow surveys and any government/ industry publications or Land Resource Assessment (LRA) and can fit into one of the Arrow soil management categories; or the footprint is small (<5ha), refer to Section 3.3 - Determining Risk, soils surveys are not usually needed.

For sites where the soil type is unknown or for projects with a large disturbance footprint (>5ha), soil surveys to identify soil types are recommended. Alternatively, when the soil type is unknown, a 'worst case' credible soil type can be assumed if it more cost effective to do so e.g. small disturbance area.

3.1 Soil Surveys

Steps for soil survey include:

- Identify the soil types located within the proposed disturbance area.
- Determine the number of sample locations and samples depths required to provide a representative characterisation of each soil unit
- Estimate the number of soil samples that may be required for laboratory analysis
- Confirm the preferred laboratory and analysis codes.
- Soil sampling and analysis should be undertaken by a suitably qualified person.
- Conduct soil survey of the proposed disturbance footprint.

The soil survey should include field inspection, recording of soil features and sampling of soils/soil layers that may present special problems when disturbed (e.g. soil dispersion, soil acidity, soil salinity).

Record landscape and soil profile features at each soil sample site (include enough topographic information to be able to determine slope (as a percentage) at each field inspection site). Note: This layer is available on Arrow web mapping.

Where topsoil thickness varies markedly and is critical for erosion control and/or rehabilitation, conduct an additional 'topsoil' survey to accurately determine spatial variation.

3.2 Determining Soil Type

Soils should be classified using The Australian Soil Classification - Revised Edition (Isbell, 2002).

Using the field survey records and the laboratory results, determine the soil type present on the project area.

Retain the laboratory data and copies of field records for future reference.

3.3 Determining Risk

Refer to the Appendix C - Soil Risk Matrix.

Identify which of the activities listed will be undertaken during the planned disturbance. If there is not a direct match for a planned activity, use an activity with the closest description.

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Each of the activities is presented as a separate row in the Soil Risk Matrix (Appendix C) and each soil is placed in a separate column. Use the matrix to match each identified activity with the Arrow soil to be disturbed.

For the matrix cell that matches the planned activity with the soil to be disturbed, select the appropriate colour coding from the slope category.

Then determine the impact rating from the colour coded reference (legend) at the top of the Soil Risk Matrix.

3.4 Determining Management Strategies

Use the legend at the top of the Soil Risk Matrix (Appendix C) to refer to the relevant Implementation Schedule (Appendix D).

The Implementation Schedules contain a list of core management practices that should be implemented for a particular risk and are arranged into seven groups:

- General soil management
- Topsoil management
- Erosion and sediment control
- Subsoil salinity and sodicity management
- Subsoil acidity management
- Management of disturbance to Strategic Cropping Area (SCA)
- Dust control

Where necessary, seek advice from an independent suitably qualified expert for design of specialist practices prior to any disturbance of land with a severe or extreme impact rating.

These mitigation measures can be included in the site or project specific management plans.

4 Site Access

Unsealed roads and tracks do not have a protective hard seal and are at a high risk of erosion and damage. Specific guidance for the management of erosion and sediment controls for site access tracks is outlined in Appendix E. Refer to the Arrow Engineering General Specification for Roadworks (ORG-ARW-CIV-SPR-00022).

Where possible, slash temporary access tracks to enable faster rehabilitation, minimise ground disturbance and limit weed incursion.

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5 Sensitive Area Protection

Appendix F provides an overview of protection measures appropriate to environmentally sensitive areas.

For highly significant vegetation (e.g. scar trees and mature trees marked to be retained), Tree Protection Zones (TPZ's) should be implemented (refer to Appendix G).

6 Vegetation Clearing and Management

Ensure cleared vegetation is placed at the designated location for re-use during site rehabilitation. If woody vegetation is being cleared by mechanical means, stumps and roots should be grubbed and stockpiled.

Any vegetation not specified to be stockpiled or retained should be mulched. A mixture of timber stockpiles and mulch may be used to reduce the size of stockpiles to assist with fire management. Stockpiles or spread timber should not encroach over the pipeline and be placed to one side of the buried services or other infrastructure. A minimum distance of 3 m from the pipeline should be retained for pipeline maintenance and inspections. Mulched material should be reused on site for erosion control or sediment control.

The depth of mulch and method of application may impact its effectiveness for erosion and sediment control and vegetation re-establishment. The flow chart in Appendix I should be referred to for guidance on appropriate mulching methods, application rates and application methods for low risk sites. Generally, depths of mulch between 25 – 50 mm are appropriate for areas where it is being utilised for erosion control or as a mulch berm/bund for sediment control. A depth of 10 – 25 mm is more appropriate where application is for rehabilitation purposes and vegetation re-establishment is desired. Mulch should not be placed at a depth greater than 50mm due to the increased risk of prolonging fire where a bushfire may have occurred and reducing vegetation regrowth due to high ground temperatures as a result of burning.

Lopping and trimming can be undertaken without approval, if it will not cause the plant to die and the vegetation does not contain hollows, epiphytes, staghorns, nests or orchids.

Slashing and mowing can be undertaken on areas previously disturbed.

7 Erosion & Sediment Control

Effective sediment control requires that critical steps are undertaken during the mobilisation phase and during site disturbance. Refer to Appendix H for a guide to the erosion and sediment control process.

Arrow have developed standard ESCPs for Well Pads (ORGH01-ARW-HSM-LAY-00003 & ORG01-ARW-HSM-LAY-00004) and Gathering and Pipeline Networks (ORGP01-ARW-HSM-LAY-00001). These ESCPs are applicable for low erosion risk sites.

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For sites that exceed the limitation of the standard ESCPs and have a disturbance area greater than 2500 m^2 a site specific ESCP must be developed and certified by a suitably qualified and experienced person.

Where possible clean/dirty water diversion bunds/berms should be constructed, rather than drains, to minimise concentrated flow. If required, clean and dirty water diversion drains should be lined with suitable materials (e.g. spray-on ditch lining / geofabric) to ensure the drains are protected from scouring. The lining should be applied immediately after the drain has been constructed.

Drains should not be cut into dispersive soils unless the drain is lined with a minimum of 100 mm deep non-dispersive soil or gypsum-amended soil prior to lining with the nominated material (e.g. spray-on ditch lining/ geofabric etc.).

Where practicable, clean water diversion berms should be protected at the upslope toe from scouring by installing spray-on linings (e.g. a soil stabiliser with a demonstrated Cover Factor of 0.1 or less) or rolled materials such as geofabric or coir.

A marker peg or post should be placed in sediment basins to identify the water and sediment zones. Any water retained within the sediment zone can be retained for use on site for dust suppression or construction if required.

Sediment basins should be treated and dewatered as soon as practical so that they are empty before the next rainfall event.

All water released to land from Arrow sites must comply with the quality limits detailed in the site specific ESCP.

On project sites, where access to the sediment basins cannot be maintained during wet weather, the use of automated dosing systems should be considered to flocculate the water prior to its discharge. Discharge of water must not result in water turbidity increase of more than 10% in high ecological value waters outside contained construction or maintenance areas.

8 Monitoring

During land disturbance activities, monitoring programs for erosion and sediment controls and soils should be prepared based on the environmental risk of the activities, for example. where the works have the potential to impact high ecological waters.

Monitoring must be undertaken at a frequency that is appropriate to demonstrate compliance with legislation and EA conditions.

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Some parameters for consideration include:

- Erosion and sediment control
- Presence of accelerated sheet, rill, tunnel or gully erosion
- Deposition of sediment from infrastructure and/or earthworks
- Integrity of physical run-off control devices and sediment trap devices
- Turbidity and electrical conductivity (EC) of surface run-off water flowing off-site

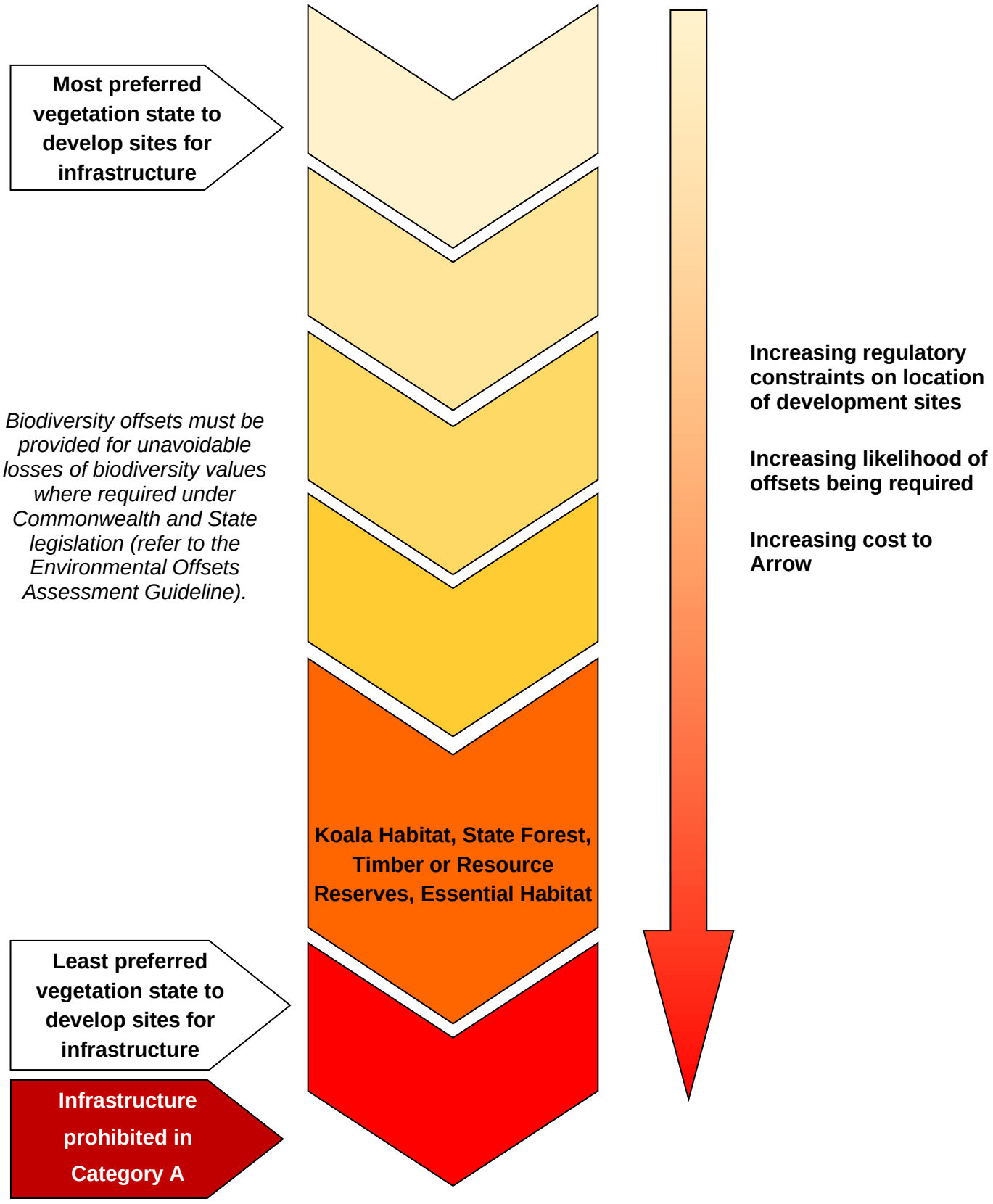
Soils e.g. following completion of earthworks

- pH, electrical conductivity, chloride (Cl), exchangeable sodium percentage (ESP), calcium/magnesium (Ca/Mg) ratio (dispersive indicator)
- Soil correlation area parameters where relevant

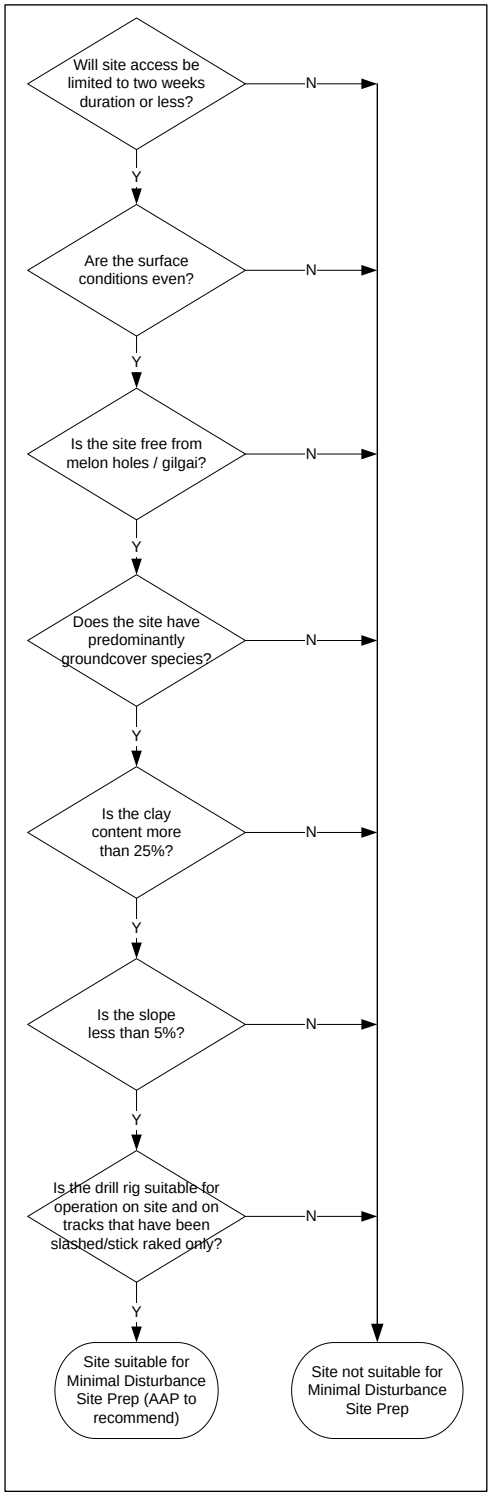
Objectives for monitored parameters should be established to ensure the protection of soils on site. The likelihood of soil movement determines the frequency of monitoring.

Any erosion or sedimentation that exceeds the acceptable range for the target should be remediated.

Appendix A: Hierarchy for Locating Infrastructure



Appendix B: Decision Tree for Minimal Disturbance Site Preparation (Well Pads & Tracks)



Woody vegetation less than or equal to 2m in height

Benefits of Minimal Disturbance Site Preparation
• Reduced site preparation time and faster rehabilitation • Lower construction and rehabilitation costs • Lowers weed risk (unless in a high risk weed area where the weed risk can be raised significantly) • Prevents or lowers erosion risk • Better retained soil structure • Vehicles able to access site following light rainfall.
Implementation
• Avoid soil scraping and disturbance - if soil scraping is required for levelling, establish only the minimum footprint and utilise minimum disturbance for all other areas of site and track access. • Limit access track preparation to stick raking and slashing only. Wherever possible use existing tracks. • Mulch shrubs and saplings to ground level retaining root stock. • Maintain soil cover by slashing grass and ground cover. • Where possible use rubber-tyred machinery only. • Slash well pads to reduce fire hazard instead of using herbicide or grading.

Appendix C: Soil Risk Matrix

Steps:

1. Determine slope of proposed activity/disturbance site
2. Select the Task and Activity (from the Rows)
3. Select the Arrow Soil Type (from the Columns)
4. Identify the cell colour (see Legend below) from site slope and any other constraining factor as included in the matrix
5. Using the impact rating (cell colour) look up the correlating Schedule to determine the appropriate management practices

Note: Arrow's Land Disturbance and Rehabilitation Procedures take precedence where there are conflicts with the management recommendations of these Schedules.

Legend

Slope measurement for erosion hazard (%)	Impact rating	Management practises
Categories • 1-3% • 3-10% • >10% Slope is measured in the direction of maximum change across the overall landscape surface.	Nil	Refer to Schedule A below
	Minor	Refer to Schedule B below
	Moderate	Refer to Schedule C below
	Severe	Refer to Schedule C below
	Extreme	Refer to Schedule D below

Task	Activity	Arrow Soil Type Management Matrix											
		Shallow sands and loams	Shallow clay loams and light clays	Shallow medium-heavy clays	Deep sands and sandy loams	Deep loams and clay loams	Structured earths	Deep cracking clays	Melonhole clays	Massive earths	Non-dispersive TC soils	Thin-surfaced, dispersive TC soils	Thick-surfaced, dispersive TC soils
Clearing and grubbing	Drill wells	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Sandy massive earths: Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
	Build and use access roads	Erosion (3-10% slope)	Erosion (3-10% slope)	Erosion (3-10% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Sandy massive earths: Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
	Build field compression stations	Erosion (>10% slope)	Erosion (>10% slope)	Erosion (>10% slope)						Loamy massive earths: Erosion (1-3% slope)		Erosion (3-8% slope)	Erosion (3-8% slope)
	Build central processing plants									Loamy massive earths: Erosion (>3% slope)		Erosion (>8%)	Erosion (>8%)
	Build water treatment plants	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation
	Build administration facilities												
	Build accommodation facilities												
Strip and stockpile topsoil	All activities except -	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Sandy massive earths: Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
	Install gathering lines with spider plough	Erosion (3-10% slope)	Erosion (3-10% slope)	Erosion (3-10% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Sandy massive earths: Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
		Erosion (>10% slope)	Erosion (>10% slope)	Erosion (>10% slope)						Loamy massive earths: Erosion (1-3% slope)		Erosion (3-8% slope)	Erosion (3-8% slope)
										Loamy massive earths: Erosion (>3% slope)		Erosion (>8%)	Erosion (>8%)
				Subsoil salinity (if very high - extreme)				Subsoil salinity (if very high - extreme)					
				SCA loss (some profiles)			SCA loss (some profiles)	SCA loss (some profiles)			SCA loss (some profiles)		
		Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation
Excavate and stockpile subsoil material	All activities except -	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Sandy massive earths: Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
	Install gathering lines with spider plough	Erosion (3-10% slope)	Erosion (3-10% slope)	Erosion (3-10% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Sandy massive earths: Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
		Erosion (>10% slope)	Erosion (>10% slope)	Erosion (>10% slope)						Loamy massive earths: Erosion (1-3% slope)		Erosion (3-8% slope)	Erosion (3-8% slope)
										Loamy massive earths: Erosion (>3% slope)		Erosion (>8%)	Erosion (>8%)
				Subsoil salinity (if very high - extreme)				Subsoil salinity (if very high - extreme)	Subsoil salinity (if very high - extreme)			Subsoil salinity (if very high - extreme)	Subsoil salinity (if very high - extreme)
				Subsoil acidity (if pH ≤5)				Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)		Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)
				SCA loss (some profiles)			SCA loss (some profiles)	SCA loss (some profiles)			SCA loss (some profiles)		

Task	Activity	Arrow Soil Type Management Matrix											
		Shallow sands and loams	Shallow clay loams and light clays	Shallow medium-heavy clays	Deep sands and sandy loams	Deep loams and clay loams	Structured earths	Deep cracking clays	Melonhole clays	Massive earths	Non-dispersive TC soils	Thin-surfaced, dispersive TC soils	Thick-surfaced, dispersive TC soils
		Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation
Construct hard stand	Drill wells	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Sandy massive earths: Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
	Construct laydown areas	Erosion (3-10% slope)	Erosion (3-10% slope)	Erosion (3-10% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Sandy massive earths: Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
	Build field compression stations	Erosion (>10% slope)	Erosion (>10% slope)	Erosion (>10% slope)						Loamy massive earths: Erosion (1-3% slope)		Erosion (3-8% slope)	Erosion (3-8% slope)
	Build central processing plants									Loamy massive earths: Erosion (>3% slope)		Erosion (>8%)	Erosion (>8%)
	Build administration facilities			SCA loss (some profiles)			SCA loss (some profiles)	SCA loss (some profiles)			SCA loss (some profiles)		
	Build accommodation facilities			GQAL fragmentation (if profile > 60 cm deep)		GQAL fragmentation (if irrigated)	GQAL fragmentation	GQAL fragmentation			GQAL fragmentation (if on alluvium)		
		Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation
Excavate building foundations and shallow pits	Build balancing storage ponds	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Sandy massive earths: Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
	Build brine ponds	Erosion (3-10% slope)	Erosion (3-10% slope)	Erosion (3-10% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Sandy massive earths: Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
		Erosion (>10% slope)	Erosion (>10% slope)	Erosion (>10% slope)						Loamy massive earths: Erosion (1-3% slope)		Erosion (3-8% slope)	Erosion (3-8% slope)
										Loamy massive earths: Erosion (>3% slope)		Erosion (>8%)	Erosion (>8%)
				Subsoil salinity (if medium or higher)				Subsoil salinity (if medium or higher)				Subsoil salinity (if medium or higher)	Subsoil salinity (if medium or higher)
				SCA loss (some profiles)			SCA loss (some profiles)	SCA loss (some profiles)			SCA loss (some profiles)		
				GQAL fragmentation (if profile > 60 cm deep)		GQAL fragmentation (if irrigated)	GQAL fragmentation	GQAL fragmentation			GQAL fragmentation (if on alluvium)		
		Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation
Excavate building foundations and shallow pits	Build field compression stations	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Sandy massive earths: Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
	Build central processing plants	Erosion (>3% slope)	Erosion (>3% slope)	Erosion (>3% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Sandy massive earths: Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
	Build administration facilities									Loamy massive earths: Erosion (1-3% slope)		Erosion (>3% slope)	Erosion (>3% slope)
	Excavate legacy drill pits									Loamy massive earths: Erosion (>3% slope)			
				SCA loss (some profiles)			SCA loss (some profiles)	SCA loss (some profiles)			SCA loss (some profiles)		

Task	Activity	Arrow Soil Type Management Matrix											
		Shallow sands and loams	Shallow clay loams and light clays	Shallow medium-heavy clays	Deep sands and sandy loams	Deep loams and clay loams	Structured earths	Deep cracking clays	Melonhole clays	Massive earths	Non-dispersive TC soils	Thin-surfaced, dispersive TC soils	Thick-surfaced, dispersive TC soils
				GQAL fragmentation (if profile > 60 cm deep)		GQAL fragmentation (if irrigated)	GQAL fragmentation	GQAL fragmentation			GQAL fragmentation (if on alluvium)		
		Dust generation			Dust generation	Dust generation	Dust generation			Dust generation		Dust generation	Dust generation
Excavate pipelines with trenching machine	Install gathering lines	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
	Install trunk lines and export line	Erosion (3-10% slope)	Erosion (3-10% slope)	Erosion (3-10% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
		Erosion (>10% slope)	Erosion (>10% slope)	Erosion (>10% slope)								Erosion (3-8% slope)	Erosion (3-8% slope)
												Erosion (>8%)	Erosion (>8%)
				SCA loss (some profiles)			SCA loss (some profiles)	SCA loss (some profiles)			SCA loss (some profiles)		
		Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation
Prepare road platform	Build access roads/tracks	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)		Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (>1% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)	Erosion (≤1% slope)	Erosion (<1% slope)
		Erosion (3-10% slope)	Erosion (3-10% slope)	Erosion (3-10% slope)			Erosion (>3% slope)	Erosion (>3% slope)		Erosion (>3% slope)	Erosion (>3% slope)	Erosion (1-3% slope)	Erosion (1-3% slope)
		Erosion (>10% slope)	Erosion (>10% slope)	Erosion (>10% slope)								Erosion (3-8% slope)	Erosion (3-8% slope)
												Erosion (>8%)	Erosion (>8%)
		Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation
Form road base				SCA loss (some profiles)			SCA loss (some profiles)	SCA loss (some profiles)			SCA loss (some profiles)		
	Build major access roads			GQAL fragmentation (if profile > 60 cm deep)		GQAL fragmentation (if irrigated)	GQAL fragmentation	GQAL fragmentation			GQAL fragmentation (if on alluvium)		
		Dust generation			Dust generation	Dust generation	Dust generation			Dust generation		Dust generation	Dust generation
Rehabilitate disturbed areas	Reduce hard stand from drilling to operating	Insufficient topsoil	Insufficient topsoil	Insufficient topsoil				Insufficient topsoil	Insufficient topsoil		Insufficient topsoil	Insufficient topsoil	
	Decommission operating wells	Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil			Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil
	Decommission compression stations			Subsoil salinity (if medium or higher)				Subsoil salinity (if medium or higher)	Subsoil salinity (if medium or higher)			Subsoil salinity (if medium or higher)	Subsoil salinity (if medium or higher)
	Decommission central processing plants			Subsoil acidity (if pH ≤5)				Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)		Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)
	Decommission administration facilities	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation

Task	Activity	Arrow Soil Type Management Matrix											
		Shallow sands and loams	Shallow clay loams and light clays	Shallow medium-heavy clays	Deep sands and sandy loams	Deep loams and clay loams	Structured earths	Deep cracking clays	Melonhole clays	Massive earths	Non-dispersive TC soils	Thin-surfaced, dispersive TC soils	Thick-surfaced, dispersive TC soils
Reform and stabilise trenches	Install pipe, gathering and trunk lines	Insufficient topsoil	Insufficient topsoil	Insufficient topsoil				Insufficient topsoil	Insufficient topsoil		Insufficient topsoil	Insufficient topsoil	
		Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil			Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil	Infertile topsoil
				Subsoil salinity (if medium or higher)				Subsoil salinity (if medium or higher)	Subsoil salinity (if medium or higher)			Subsoil salinity (if medium or higher)	Subsoil salinity (if medium or higher)
				Subsoil acidity (if pH ≤5)				Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)		Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)	Subsoil acidity (if pH ≤5)
		Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation	Dust generation

Appendix D: Soil Management Implementation Schedules

Schedule A: Standard management practices for land disturbance

Practice	Description
	General Soil Management
A1	Minimise access and disturbance to only essential areas
A2	Stockpile vegetation in a manner that facilitates respreading or salvaging and does not impede vehicle, stock or wildlife movements. Stockpile sufficient cleared vegetation of large size for restoration of habitat Stockpiled vegetation may be: - re-spread if suitable to do so (where no more access is required); - shredded/mulched and respread, or - shredded/mulched and incorporated with topsoil for re-spreading. Vegetation that is predominantly cypress pine and bulloak (***Allocasuarina***) should not be mulched due to impacts on machinery and soils.
A3	Avoid inverting the soil during clearing and grubbing operations.
A4	On the upslope of larger cleared areas, such as pads and laydown areas, place a soil berm to divert clean water away from the work site.
A5	Stabilise disturbed areas as soon as works are completed.
A6	Note: When backfilling replace and lightly compact[A] the subsoil first then cap with topsoil and manage as required (lightly compact[B] or cultivate).
A7	Do not place infrastructure that will interfere with natural surface flow either within the riparian zone or within overland flow paths.
A8	Place all water quality control structures outside the riparian zone.
	Topsoil Management
A9	Carefully strip to recommended stripping depth[C] and stockpile topsoil before starting bulk earthworks.
A10	Stripping depth[C] is to be determined by: - soil type where soil depth is not variable (refer to Section 12) or - by topsoil survey where topsoil depth is described as variable in Section 12.
A11	Material to be stripped for use as topsoil should not: - have medium or higher salinity (EC>1.2 dS/m not suitable) - be strongly dispersive (ESP ≥15 in shrink-swell soils or ESP ≥6 in all other (rigid) soils). Material to be stripped from SCA crop land for use as topsoil should also not be strongly acid to extremely acid (pH ≤5.0).
A12	Ameliorate topsoil before re-use with gypsum at the amount specified in the AAP. If the AAP does not contain information regarding rehabilitation: - Confirm landholder requirements with LLO - If landholder has no preference ameliorate with gypsum at a rate of 5t/ha If the landholder has requested a fertiliser mix it should be added to the topsoil at the rate recommended by the manufacturer or requested by the landholder. This is best achieved by spreading ameliorant prior to stripping. Fertiliser should be coated if using in riparian zones or in areas where water flow or ant predation is expected.
A13	Stockpile topsoil and other unsuitable material separately; stockpile topsoil to maximum 2 m height.
A14	Stockpile and windrow batter gradient should be no greater than 33% (1V:3H). Controls are to be put in place if area constraints result in steeper batters.

Practice	Description
A15	Long-term and permanent stockpiles to be stabilised and planted with appropriate cover crop and/or sprayed with stabilisers.
A16	Ensure stockpiles are located outside the riparian zone and not on overland flow paths.
	Erosion and Sediment Control
A17	Avoid, where possible, major earthworks programs between November and February. For works within this timeframe ensure appropriate controls are in place.
A18	On cut and fill batters: - treat dispersive clay subsoil that is exposed as soon as possible through amelioration, or - cap (with planting media or impermeable material), or - apply both measures.
A19	When construction is completed stabilise all bare earth areas not covered by hard stand, where required revegetate with topsoil and a seed mix that is appropriate for the site and original soil that has been disturbed.
A20	Cap all long-term (to be retained > 12 months) and permanent stockpiles of unsuitable material with at least 100 mm of topsoil.
A21	After decommissioning, rehabilitated areas are to be revegetated to the requirements outlined in the Environmental Authority or Rehabilitation Procedure/ Plan.
A22	Ameliorants should be mixed with topsoil for re-spreading (particularly with gypsum application for treating dispersion).
A23	Locate stream crossing points to avoid: - sections of high turbulence - active undercutting of either bank - sections where sediments are dumped within the stream bed.
A24	Design channels/drains and inlet and outlet work to convey water at least up to the design peak flow.
A25	Incorporate check dam and/or sediment trap and/or sediment detention basin into storm water run-off control for all large infrastructure (e.g. Central Gas Processing Plant (CGPF), administration facilities etc).
A26	Install energy dissipaters at drainage outlets to all watercourses.
	Dust Control
A27	If dust is likely to be an issue at nearby sensitive receptors, regularly water access routes that are frequently used during construction activities. Consider the use of speed reduction/dust suppression products/polymers to conserve water use. Also consider the sourcing of water for dust suppression (refer to the Arrow D*ust Management Guideline* for greater detail). CSG water can be used on ATPs provided it meets EA criteria and appropriate records maintained.
A28	Locate vehicle access routes at construction sites so as to minimise dust generation.

Notes:

[A] Lightly compacting subsoil refers to soil compaction aimed at attaining 90% maximum dry density. This operation should be done preferably with a padfoot / sheepsfoot roller that leaves an uneven surface on top of the subsoil and thus thicker pockets of topsoil for plant roots to key into after rehabilitation.

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[B] Lightly compacting topsoil refers to simply pressing the material down to enhance soil cohesion whilst maintaining a friable seedbed with good soil-seed contact. This operation would be done preferably with machinery such as agricultural press wheels or equivalent.

[C] Stripping depth is the depth from the ground surface to any unsuitable soil material below and usually includes the surface layer and subsurface layer (if present) but may also include subsoil in some soil management groups. Refer to *Land Disturbance Procedure.*

Schedule B: Management practices for land with a minor impact rating

Practice	Description
	General Soil Management
B1	Apply practices A1 to A8 listed in Schedule A.
	Topsoil Management
B2	Apply practices A9 to A16 listed in Schedule A.
B3	Only undertake topsoil stripping immediately before starting bulk earthworks OR Install appropriate, temporary run-off control structures immediately after stripping (if a time lag to works is involved).
B4	Ensure stockpiles are: - constructed on the contour - protected from run-on water with diversion bank or similar device upslope - protected with a berm/catch drain/sediment control immediately down slope to control run-off.
B5	If on-site stripping to recommended depth (as per *Land Disturbance Procedure*) produces insufficient topsoil for rehabilitation: - source additional topsoil that is suitable for use as planting media from off-site areas if possible.
B6	Test topsoil fertility to determine if fertiliser should be applied when re-spreading and the rate of application.
	Erosion and Sediment Control Note: these controls should be addressed in a site specific ESC Plan
B7	Apply practices A17 to A26 listed in Schedule A.
B8	Level the land surface outside the earthworks footprint immediately after any clearing and grubbing operations are finished; the levelling should create a slight convex shape that spreads run-off water away from the disturbed area rather than allowing it to concentrate.
B9	Ensure any holes in a surface to be levelled are filled with topsoil.
B10	Lightly compact [A] the levelled surface to ensure it is not easily moved by raindrop splash and running water.
B11	Leave the land surface on top of laid pipeline and adjacent service tracks in a slight convex shape that spreads run-off water away from the pipeline or track rather than allowing it to concentrate (to avoid erosion).
B12	At construction sites for large infrastructure (CGPF, WTP, administration facilities) protect the hardstand area with the following options: - diversion bank and/or diversion drain on the up slope side - locate stockpiles away from where run-off water will leave the hardstand area - sediment trap or sediment detention basin at the end of the drain (appropriately designed for the soil type) - revegetation of any bare land around the hardstand.

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Practice	Description
B13	Where required, design sediment trap or sediment detention basin at end of diversion drains to specification for: - dispersive material on all *dispersive texture contrast soils* and on the *Melonhole clays* (Type D basin) - coarse material on all soils described as *sands and sandy loams* or as *sandy earths* (Type C basin) - fine material on all other soils (Type F basin). Basin types according to *International Erosion Control Association 2008.*
Subsoil Salinity Management	
B14	For saline profiles of *Deep cracking clays* and *Melonhole clays, r*egard any soil layer with medium or high salinity ($EC_{1:5}$ ≥0.24 dS/m) as unsuitable soil material and cap with suitable topsoil to a thickness matching the pre-disturbance topsoil depth.
Management of Disturbance to Strategic Cropping Area	
B15	Do not locate FCS, CGPF, WTP, administration facility, aggregation pond, brine pond and borrow pit on SCA.
B16	Minimise disturbance to SCA crop land by locating well sites and access tracks where there is least disturbance to cultivation, in consultation with landholder.
B17	Insert all pipelines so that the pipe and bedding material in which it is laid are at least 900 mm below ground surface.
Dust Control	
B18	Apply practices A27 to A28 listed in Schedule A.
B19	Reduce vehicle speed (eg.10 kph) at construction sites.

Notes:

[A] Lightly compacting subsoil refers to soil compaction aimed at attaining 90% maximum dry density. This operation should be done preferably with a pad foot/sheeps foot roller that leaves an uneven surface on top of the subsoil and thus thicker pockets of topsoil for plant roots to key into after rehabilitation.

Schedule C: Management practices for land with a moderate to severe impact rating

Practice	Description
	General Soil Management
C1	Apply practices A1 to A8 listed in Schedule A.
	Topsoil Management
C2	Apply practices B2 to B6 listed in Schedule B.
C3	Ameliorate topsoil before re-use with gypsum, dolomite or lime to a recommended specification (refer to *Land Disturbance Procedure*). Apply fertiliser mix to topsoil when re-spreading at a suitable rate dependent on soil type, pH and EC. Ameliorants should be mixed with topsoil for re-spreading. This is best achieved by spreading ameliorant prior to stripping. As a guide: - matured manure at 10t/ha, or NPK fertilisers at a nominal rate of 200kg/ha - fertiliser should be coated if using in riparian zones or in areas where water flow is expected.
	Erosion and Sediment Control
C4	Apply practices B7 to B13 listed in Schedule B.
C5	Where backfilling [A] on SCA crop land refer to Practices C21 to C24.
C6	Where backfilling [A] on soils other than SCA the fill of unsuitable soil material should: - be lightly compacted [B] - be capped with suitable topsoil to a thickness matching the pre-disturbance topsoil depth - have topsoil seeded with appropriate plant species.
C7	Incorporation of run-off control devices is recommended to reduce slope length on access tracks and pipelines: - permanent devices such as “whoa boys” and berms to be installed at areas where vegetation cover will not re-establish within 12 months - temporary devices such as sediment fences, coir logs or geotextile socks (of at least 300 mm diameter filled with coarse filter media) can be used in areas where cover will re-establish within 12 months.
C8	Protect borrow pits during construction, operation and following decommission by building a diversion bank and/or diversion drain on the upslope side.
C9	Protect mudpits, where existing, during construction and operation by: - building a diversion bank and/or diversion drain on the upslope side - protecting any entry point for run-off from the hardstand and pit wall below with impermeable membrane.
C10	Leave final cut faces on borrow pits as close to vertical as possible (to minimise erosion due to raindrop splash).
	Subsoil Salinity Management
C11	Apply practice B14 listed in Schedule B.
C12	On cut and fill batters, cap subsoil that has medium or higher salinity soil as soon as possible with at least 100 mm of suitable topsoil or with impermeable material.
C13	Where backfilling with subsoil of medium or higher salinity on land other than SCA: - lightly compact [B] backfill [A]; and - then cap with suitable topsoil to a thickness matching the pre-disturbance topsoil depth. Where backfilling on SCA refer to Practice C21.

Practice	Description
C14	Protect borrow pits during construction, operation and following decommission by: - building a perimeter berm around any pit that exposes subsoil with high, very high or extreme salinity (eg. $EC_{1:5}$ ≥0.56 dS/m, or Cl ≥800 mg/kg where gypsum is present), or with extreme acidity (pH<5).
Subsoil Acidity Management	
C15	Avoid inverting the soil during clearing and grubbing operations.
C16	On cut and fill batters with very strong to extreme acidity (pH ≤5) that is exposed on the surface: - ameliorate top 100 mm of subsoil as soon as possible with 1.5 kg/m^2 (equivalent to 15 kg/m^3) of dolomite or lime, or - cap with minimum 100 mm topsoil, or - cap with impermeable material.
C17	Where backfilling [A] with subsoil of very strong to extreme acidity (pH ≤5) on land other than SCA crop land: - ameliorate top 100 mm of subsoil as soon as possible with 1.5 kg/m^2 (equivalent to 15 kg/m^3) of dolomite or lime to a specification as per *Land Disturbance Procedure*. - lightly compact [B] backfill and - then cap with suitable topsoil to a thickness matching the pre-disturbance topsoil depth. Where backfilling on SCA refer to Practice C21.
Management of Disturbance to SCA	
C18	Apply practices B15 to B17 listed in Schedule B.
C19	Avoid disturbance of overland flow patterns by: - avoiding any above ground infrastructure within overland flow paths and grassed waterways.
C20	Material to be stripped for use as topsoil in SCA should not: - have high, very high or extreme salinity - be strongly acid to extremely acid (pH ≤5.0), or - be strongly dispersive (ESP ≥15 or Ca:Mg ratio ≤0.1).
C21	Where backfilling [1] in SCA: - either bury unsuitable soil material below 300 mm of suitable topsoil (as per A11) - or ameliorate unsuitable soil material (as per C22) that is not saline, and then cap with 50 mm of suitable topsoil - but unsuitable soil material that is saline cannot be ameliorated and is to be buried below 300 mm of suitable topsoil (as per A11).
C22	Soil material with very strong to extreme acidity (pH ≤5) or that is strongly dispersive (ESP ≥15 or Ca:Mg ratio ≤.01) can be ameliorated to achieve 300 mm of suitable topsoil by: - applying 15 kg/m^3 (or 1.5 kg/m^2 per 100 mm thickness) of dolomite or lime to a specification as per *Land Disturbance Procedure*.
C23	For all permanent impacts: - seek advice to avoid, minimise and provide mitigation inside an SCA Management Area.

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Practice	Description
C24	For all temporary impacts: - avoid, minimise and undertake restoration in compliance with the Standard Conditions Code or seek an SCA decision - also implement relevant practices C4 to C23 where not in conflict with the Standard Conditions Code.
Dust control	
C26	Apply practices B18 to B19 listed in Schedule B.
C27	Apply dust suppressant or pave vehicle access routes at construction sites.
C28	Apply dust suppressant or pave major roads to be used frequently during production.

Notes:

[A] Backfilling refers to filling in excavated voids, natural depressions and erosion gullies. Most erosion gullies will be in soils with subsoil that represents unsuitable soil material but a few gullies may be in other soils with no unsuitable soil material. Unsuitable soil material should only be used to backfill erosion gullies where such material is already present.

[B] Lightly compacting unsuitable soil material being used as backfill refers to soil compaction aimed at attaining 90% maximum dry density. This should be done preferably with a pad foot/sheeps foot roller that leaves an uneven surface on top of the subsoil and thus thicker pockets of topsoil for plant roots to key into after rehabilitation.

[C] Unsuitable soil material with medium or higher salinity should not be ameliorated to create topsoil.

Schedule D: Management practices for land with an extreme impact rating

Practice	Description
D1	Avoid disturbance and seek an alternative site or route; or if an alternative site/route is not available: - seek specialist advice from an independent land management expert for design of specialist practices prior to any disturbance - special management and mitigation practices need to be designed for each specific site or route.
D2	If disturbance must be undertaken, apply all relevant practices listed in Schedules A, B and C as well as recommended strategies from the land management expert.

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Appendix E: Access Tracks – Erosion and Sediment Control Considerations

The main techniques to minimise erosion and damage to unsealed roads and tracks are:

- Good shaping (camber, super-elevation etc)
- Good drainage
- Turn-out drains (refer to Table 1)

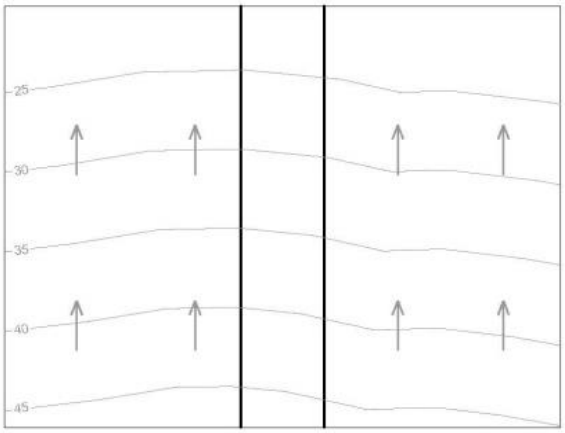
Should the EA place constraints on track widths, these compliance constraints should be managed to ensure that adequate drainage is achieved. Every effort should be made to accommodate track drainage wherever practicable.

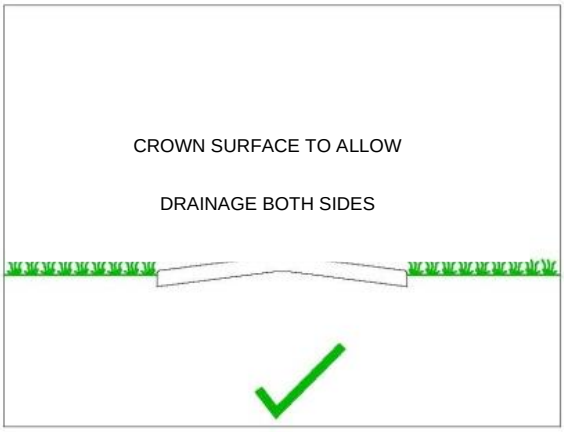
Table 1 – Recommended spacing of turn-out drains for different slope gradients (IECA, 2008)

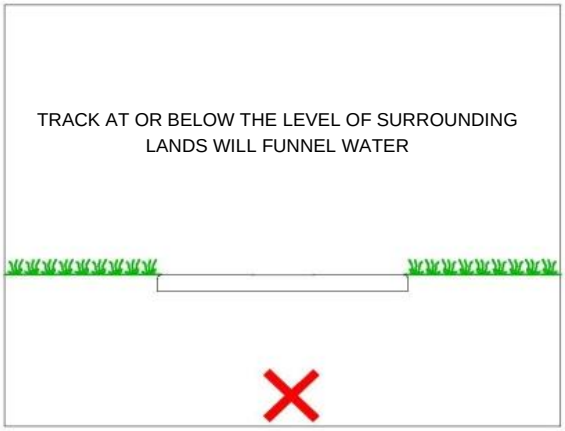
Slope Gradient	Maximum Spacing of Turn-out (Mitre) Drains
0-2%	120m
2-4%	60m
4-8%	30m
>8%	15m

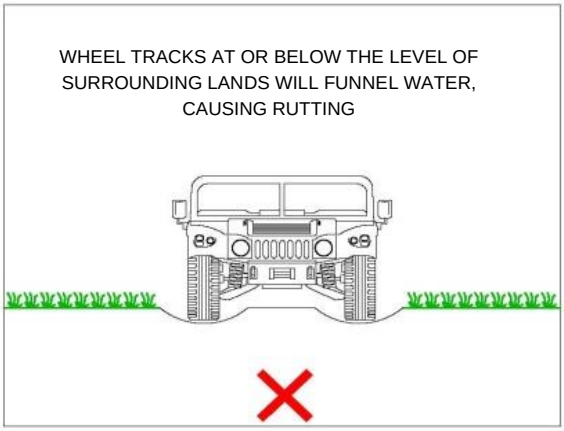
The below diagrams relate to good practice erosion and sediment control for access track construction across a range of scenarios.

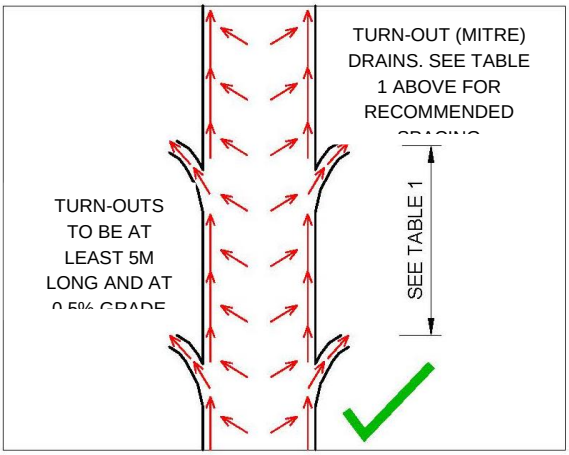
Access tracks running perpendicular to the natural slope

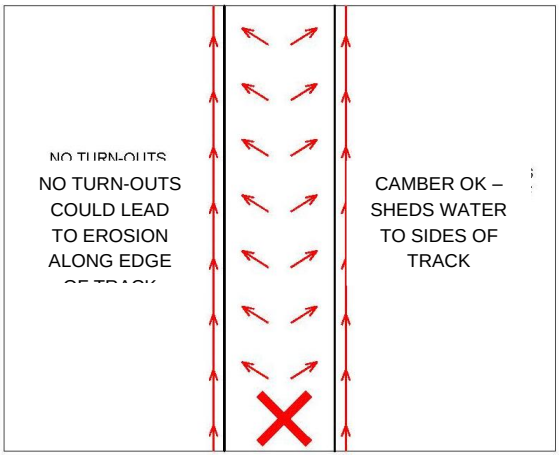


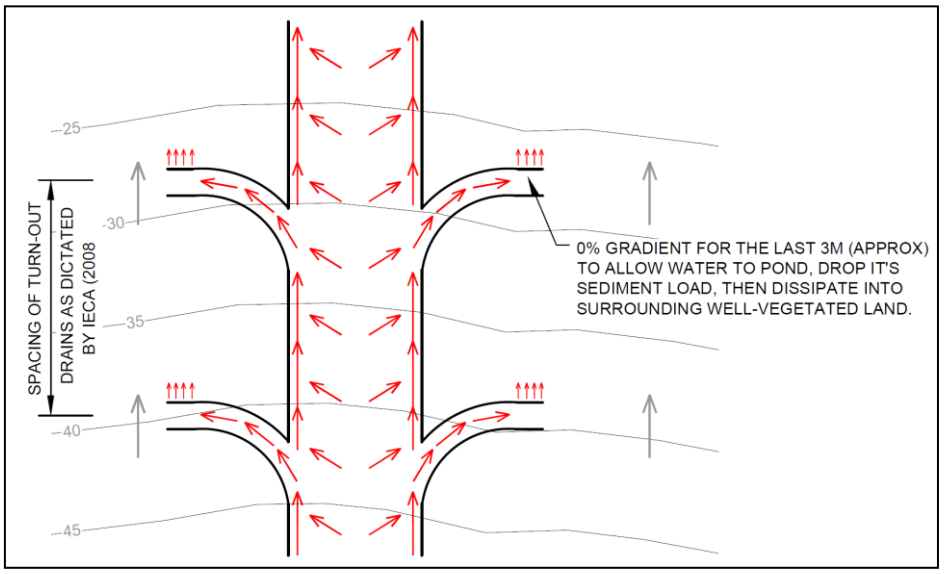




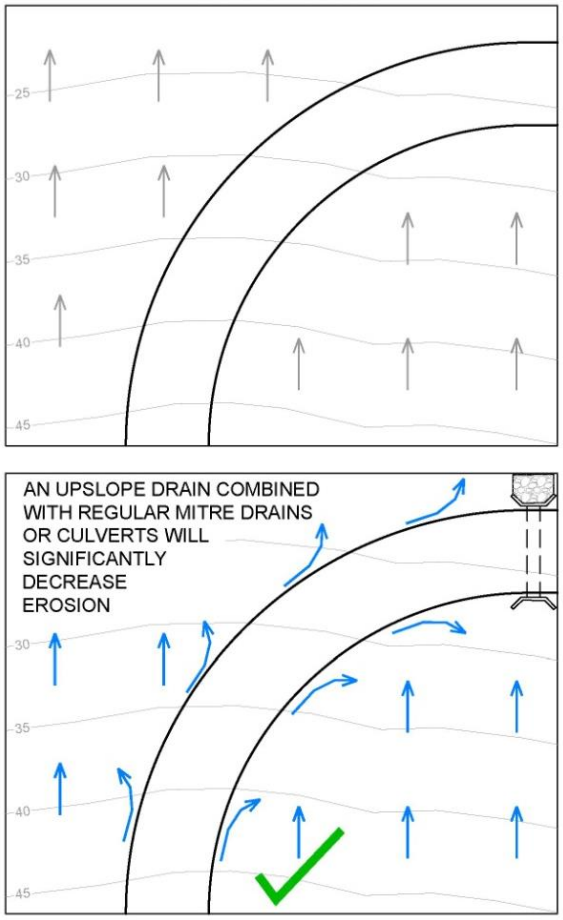




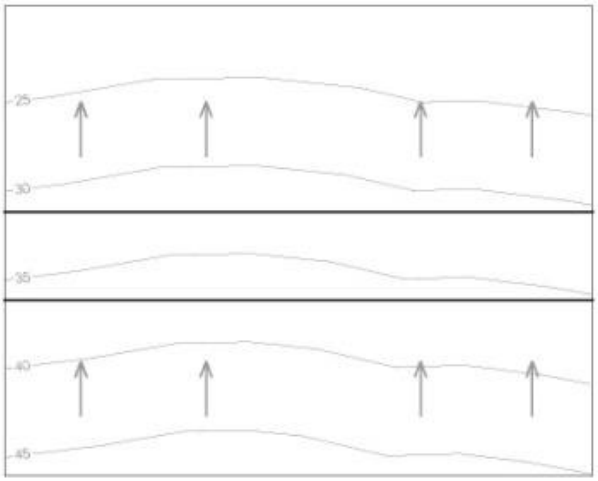


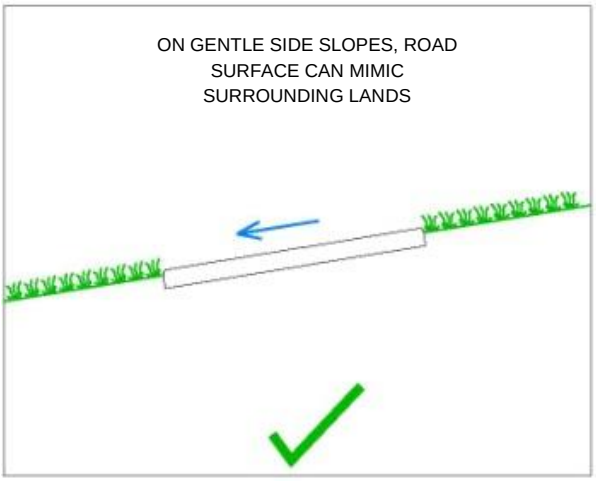


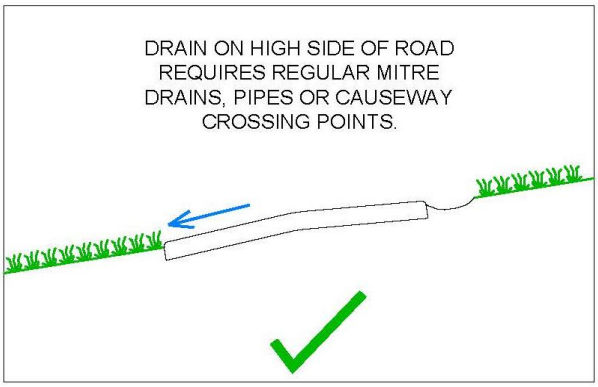
Access tracks wrapping around the natural slope

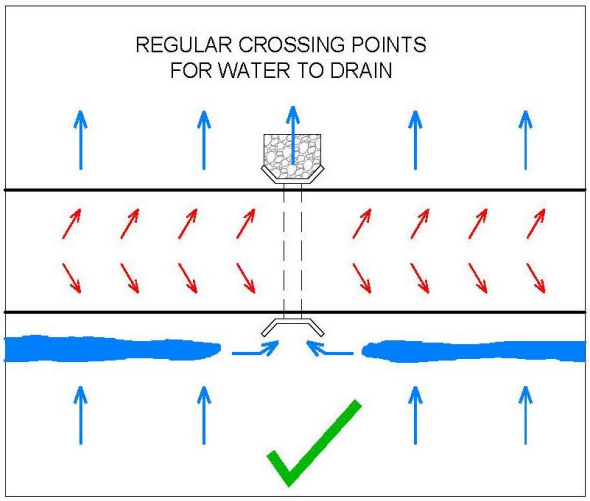


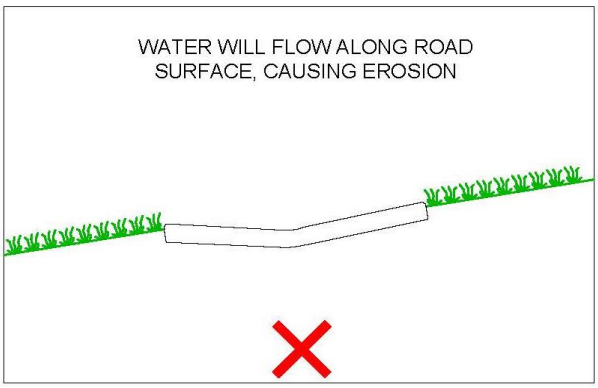
Access tracks running across (i.e. right angles to) the natural slope
(Note: Need to be careful with one-way cross fall as it is dangerous on curves.)

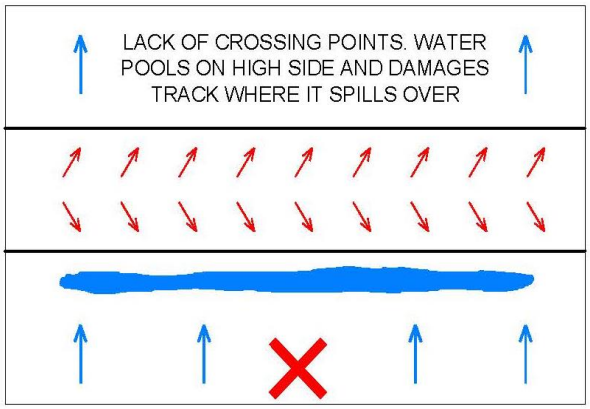




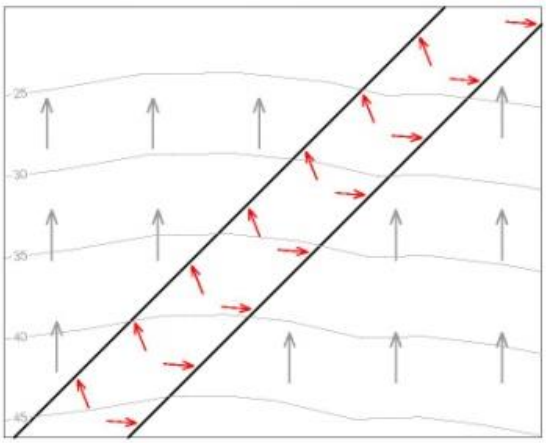


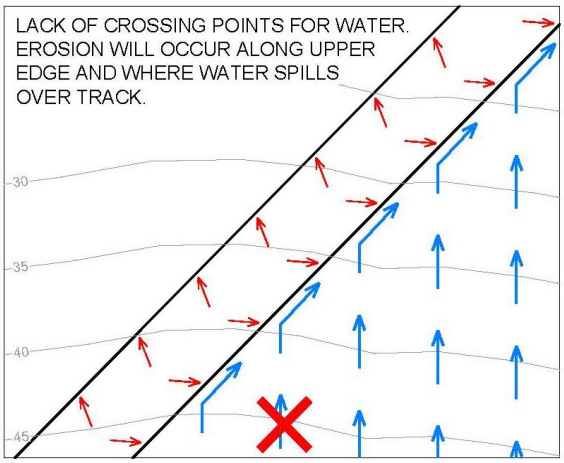


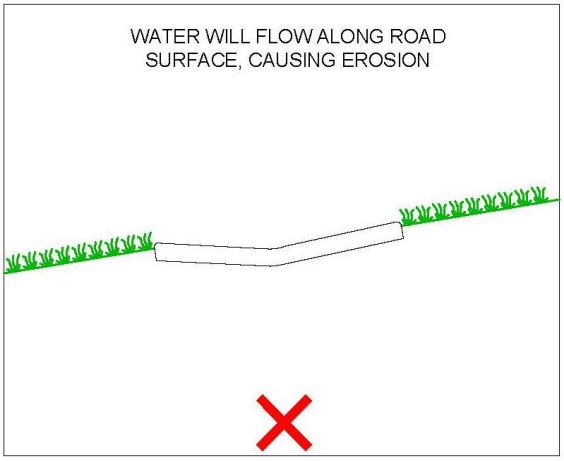


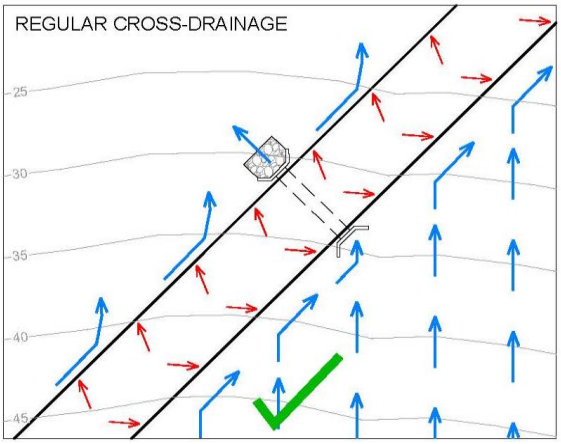


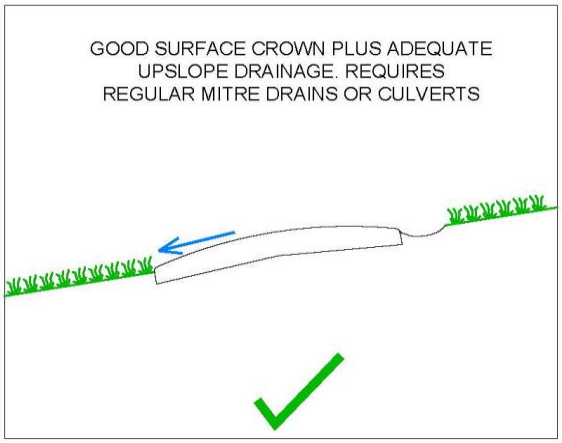
Access tracks running diagonal to the natural slope

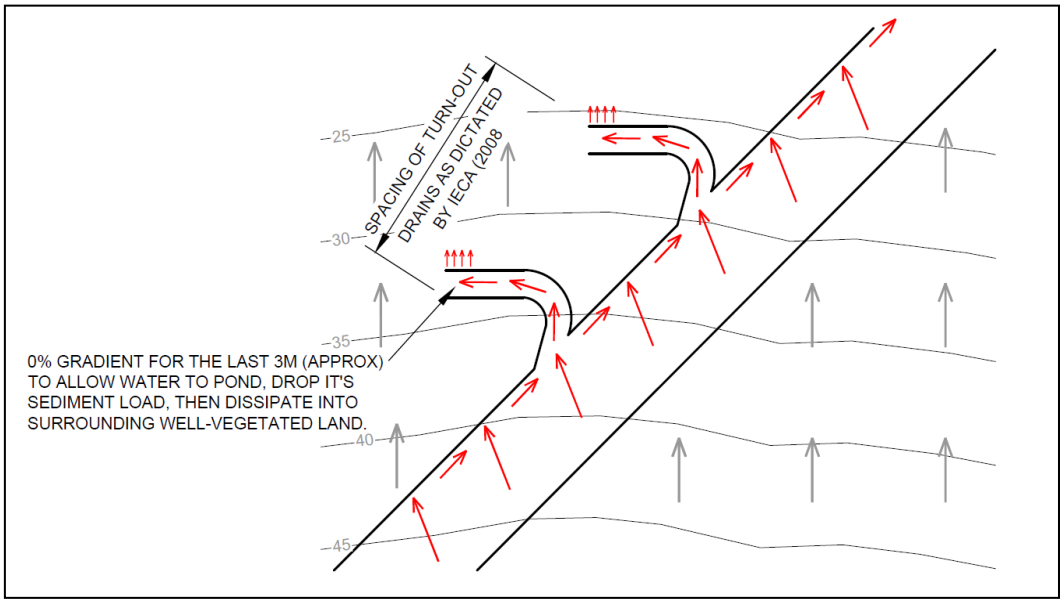




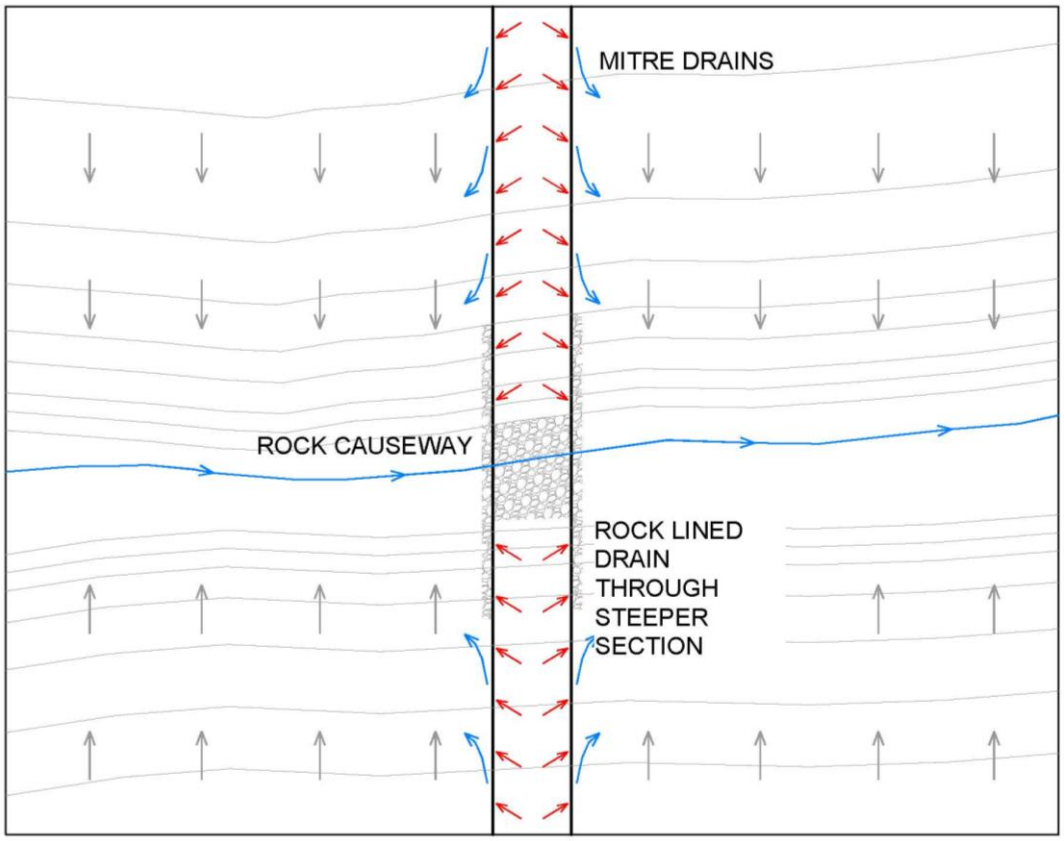








Access tracks cutting across a gully or watercourse crossings (bed level crossings are preferred but other options are available)



Appendix F: Protection Measures for Sensitive Areas

Protection Measures							
Sensitive Areas Requiring Protection	Site induction	Permanent fencing	Temporary fencing*	Signage	Identified plants to be relocated	Site access limited	Tree Protection Zones (TPZ)
Scarred Trees	✓	✓	✓	✓		✓	✓
Culturally Significant Vegetation	✓		✓	✓		✓	✓
Threatened Plant Species			✓	✓	✓		✓
Significant Trees to be Retained				✓			✓
Individual Habitat Trees			✓	✓			✓
Significant Fauna Habitat			✓	✓			
Waterways, Wetlands and sensitive vegetation communities (eg. Brigalow)**			✓				

* Temporary fencing should be highly visible and may utilise products such as safety barrier / bunting secured to star pickets.

** Waterways and wetlands should only be fenced where they adjoin a construction site (i.e. designated ‘no-go’ areas)

Appendix G: Tree Protection Zones

Tree Protection Zones (TPZs) are the principal means of protecting trees on development sites, and should be installed prior to land disturbance works. The TPZ is a combination of the root area and crown area requiring protection. It is an area isolated from construction disturbance by flagging or barricading, so that the tree remains viable.

The Tree Protection Zone incorporates the Structural Root Zone (SRZ). The radius of the TPZ is calculated for each tree by multiplying its DBH (diameter of trunk at 1.4m above the ground) by 12.

- TPZ = DBH x 12
- Where DBH = trunk diameter measured at 1.4m above the ground.
- A TPZ should not be less than 2m or greater than 15m (except where crown protection is required). The TPZs of palms, other monocots, cycads and tree ferns should not be less than 1m outside the crown protection (*AS4373- 2007*).

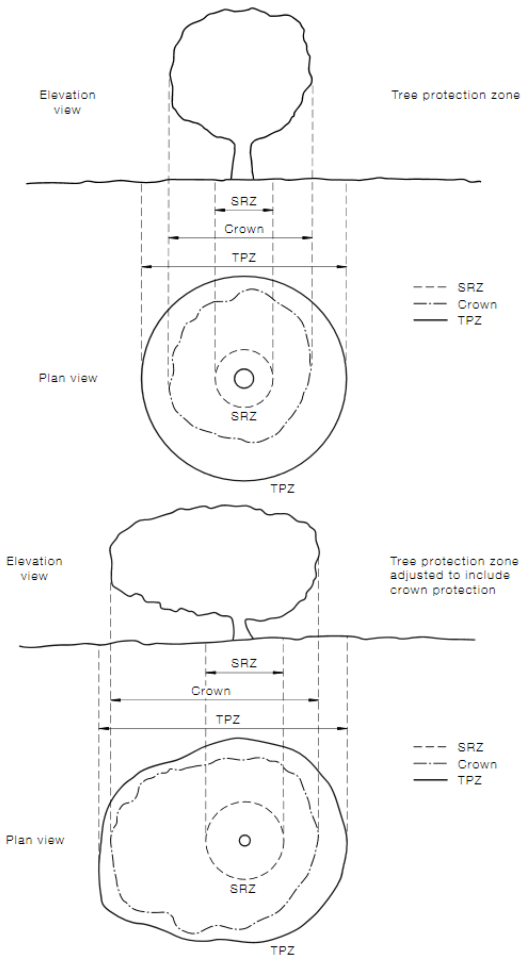
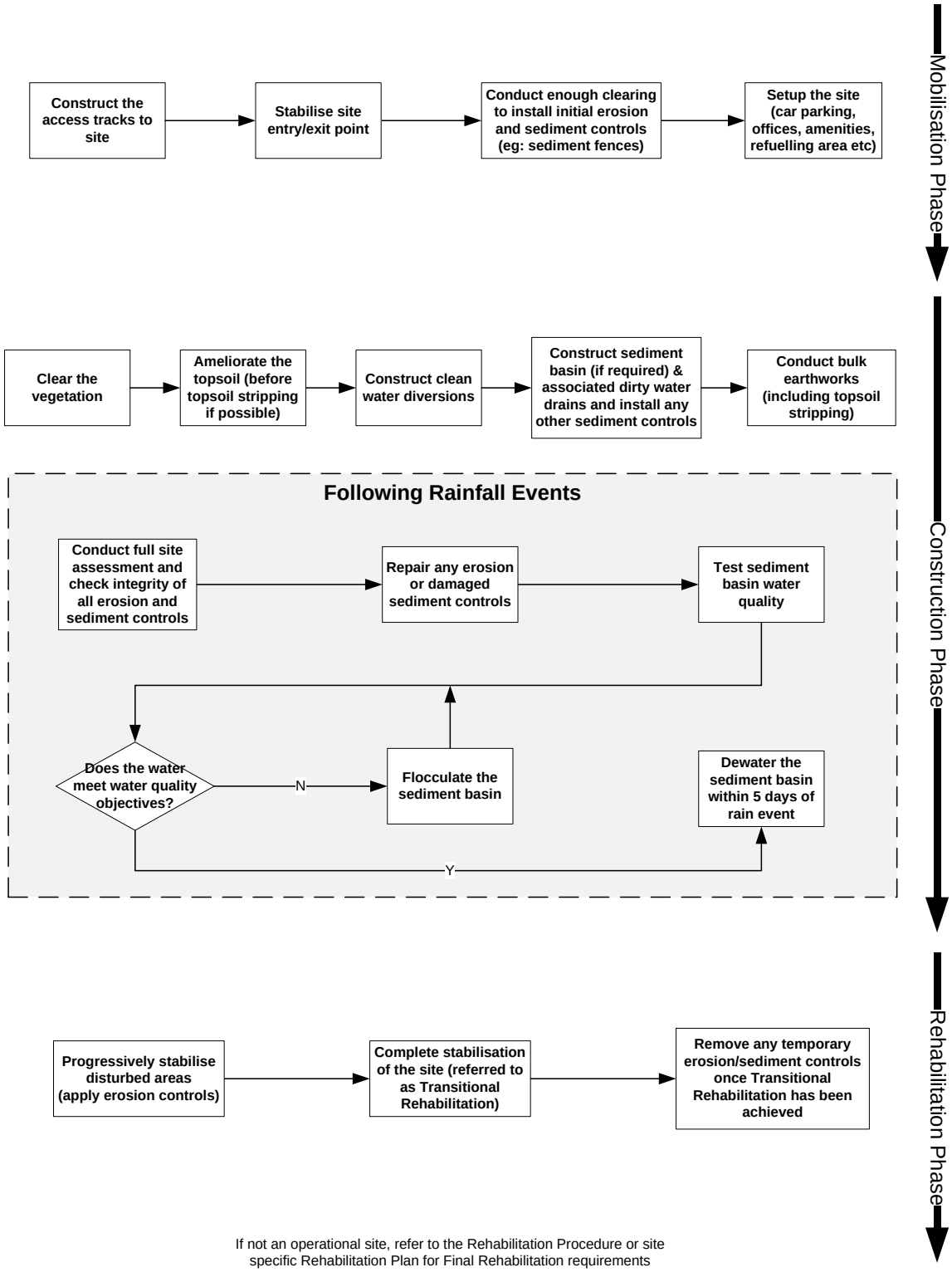


Figure 1: Tree Protection Zones



Figure 2: TPZ Example Signage

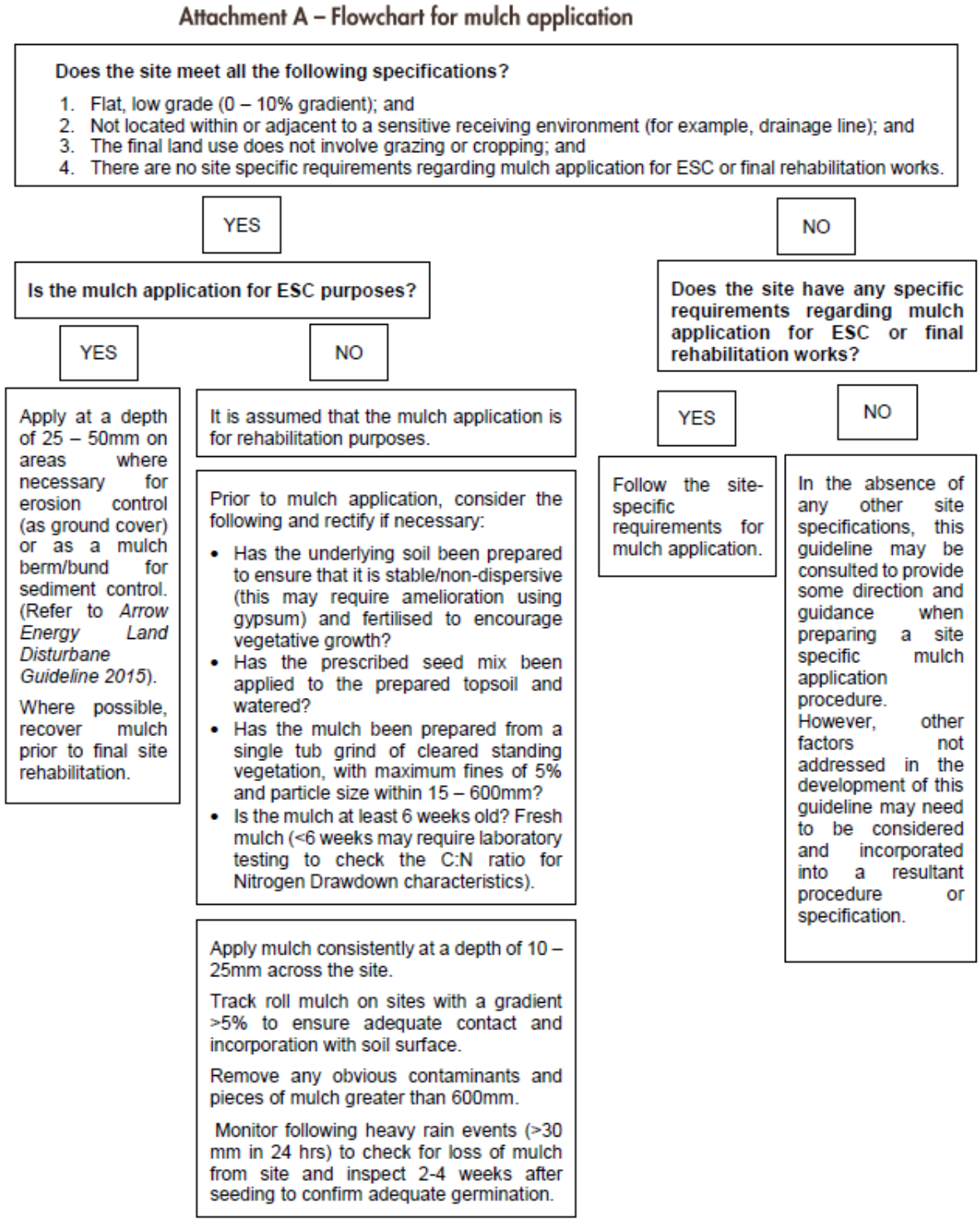
Appendix H: Erosion and Sediment Control Process



If not an operational site, refer to the Rehabilitation Procedure or site specific Rehabilitation Plan for Final Rehabilitation requirements

Appendix I: Mulch Application

(from Report – Development of Guideline: Mulch application on disturbed areas (Landloch, Dec 2016)



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9 Document Administration

Revision history

Revision	Revision Date	Revision Summary	Author
1	30/06/15	Issued for use	K Sanson
2.0	30/06/17	Routine review and updated template	L Fiedler
3.0	01/02/22	Issued for use Section 2.1 'Decommissioning' added	Tim Riseley
4.0	02/11/23	Issued for use: Minor updates	Dan Blunt
5.0	03/02/25	Issued for use: Minor updates	J. Kil

Related documents

Document Number	Revision Summary
ORG-ARW-HSM-PRO-00146	Land Disturbance Procedure
ORG-ARW-HSM-STA-00036	Land Management Standard
ORG-ARW-HSM-PRO-00073	Rehabilitation Procedure
ORG-ARW-CIV-SPR-00022	General Specification for Roadworks
ORG-ARW-CIV-SPR-00007	General Specification for Bulk Earthworks
ORG-ARW-HSM-PRO-00139	Weed Management Procedure
ORG-ARW-HSM-PRO-00138	Vehicle and Machinery Hygiene
ORG-ARW-HSM-PRO-00070	Ecological Impact Assessment Procedure
ORG-ARW-HSM-GUI-00103	Fauna Management Guideline
ORGP01-ARW-HSM-LAY-00001	Erosion and Sediment Control Plan Gathering and Pipeline Networks
ORGH01-ARW-HSM-LAY-00001	Erosion and Sediment Control Plan Well Pad
n/a	Australian Soil and Land Survey Field Handbook – 3rd edition (NCST, 2009)
n/a	The Australian Soil Classification – Revised Edition (Isbell, 2002).
99-V-GDL-0007	Erosion and Sediment Control Guideline
99-V-GDL-0008	Site Preparation and Vegetation Clearing Guideline

Acceptance and release

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Position	Incumbent	Release Date
Environment Advisor	Julie Kil	03 February 2025

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