SMOKY CREEK SOLAR POWER STATION - CONCEPTUAL EROSION AND SEDIMENT CONTROL PLAN

Terra Solutions Pty Ltd

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Smoky Creek Solar Power Station - Conceptual Erosion and Sediment Control Plan

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Document status

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Approval for issue

Approver	Signature	Approval date
A. Fitzgerald		25/11/2022

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1 INTRODUCTION

Edify Energy Pty Ltd are proposing to construct the Smoky Creek Solar Power Station. The Project is required to contribute to Australia's emissions reduction targets by providing an additional source of renewable electricity to the national electricity grid.

The Smoky Creek Solar Power Station is similar in structure and design to other utility scale solar facilities constructed in Australia. It consists of various linked components required to generate electricity from solar radiation including solar modules, module mounts, electrical transformers and inverters, electrical wiring, telecommunication equipment, electrical substation, a battery energy storage system (BESS) and electrical controllers.

This Conceptual Erosion and Sediment Control Plan (CESCP) should be used by the Contractor to develop a site-specific Erosion and Sediment Control Plan (ESCP) once detailed design, construction and site establishment information becomes available.

1.1 Purpose

This CESCP has been developed in accordance with Best Practice Erosion and Sediment Control (BPESC) guidelines for Australia (International Erosion Control Association (IECA)). The intent of CESCP is to ensure the rate of soil loss and sediment movement is the same, or less than, prior to the development.

Contractors are required to submit a certified (written evidence from a Certified Professional in Erosion and Sediment Control (CPESC) site specific ESCP for their relevant parcel of works prior to the commencement of works and within 20 business days after completion of works.

The purpose of the CESCP is to provide a conceptual set of overarching erosion and sediment control principals, concept layout plans and preliminary calculations as a guide to contractors. The control principles and management techniques outlined in this document are to be used by each Contractor during the project to minimise / eliminate the potential for sediment laden runoff to be discharged into the receiving environment for each site. In this regard, the purpose of this document is consistent with section 5.2 of the IECA Best Practice Sediment and Erosion Manual (IECA Manual). The contractor is responsible for implementing all erosion and sediment control measures and these must be implemented in accordance with best practice principles.

The IECA Manual states the following:

Conceptual Erosion and Sediment Control Plans

High-risk sites may require preparation of a conceptual ESCP to assist in the appropriate planning of developments. These conceptual ESCPs are generally not as detailed as the final ESCPs because their very purpose requires them to be developed before key site layout and design information are finalised.

The purpose of preparing conceptual ESCPs is to:

- *Ensure appropriate soil data is collected and site constraints are identified*
- *Ensure consideration of erosion and sediment control requirements, site constraints and key environmental issues are introduced to the planning phase of the development*
- *Allow regulatory authorities to voice their key concerns before a development proposal progresses too far through the planning and site*
- *Demonstrate to the regulatory authority that there is a feasible means of constructing the project while still protecting key environmental values*

The content of required conceptual ESCPs can be highly variable depending on the available site and project data; however, all conceptual ESCPs need to satisfy at least the following outcomes:

- *Identify the need for the construction of sediment basins on the site*

- *Identify that adequate space has been made available for the construction and operation of major sediment traps and essential flow diversion systems*
- *Demonstrate to the regulatory authority that there is a feasible means of constructing the project while still protecting key environmental values*
- *Identify problem soil areas including, dispersive soils, acid sulphate soils, areas of potential mass movement*
- *Identify protected environmental features on the site such as protected vegetation*

This document does not prescribe or locate any permanent or temporary sediment and erosion control measures in detail but provides guidance with regards to the sediment control methodology which may be required to satisfy the Contractor's responsibilities for the proposed works. Therefore, the Contractor is responsible for developing site and stage specific ESCPs, taking into consideration site knowledge and the staging or works. All ESCPs are to be developed in accordance with the best practice principles of the IECA Manual.

1.2 Scope

The scope of works included the following tasks:

- Preparation of a CESCP in accordance with the IECA 2008 guidelines
- Identification of erosion hazards and erosion risk assessment in accordance with the IECA 2008 guidelines
- Identification of soil and surface water control measures required to mitigate erosion within the areas of disturbance

1.3 Legislative framework

The relevant legislation or guidance material that have been considered in the development of this CESCP is outlined in Table 1.

Table 1 Legislative framework

Environmental Protection Act 1994 (EP Act) and Environmental Protection Regulation 2019 (EP Reg)	The EP Act is the primary legislation for environmental management and protection in Queensland. It plays an important role in the protection and management of Queensland's environment, particularly in relation to the regulating activities which have potential to release contaminants into the environment (defined as Environmentally Relevant Activities (ERAs)) and defines Environmental Values. The EP Reg includes environmental objectives and performance outcomes for key environmental aspects such as air, water, wetlands and land.
Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP (Water and Wetland Biodiversity))	The purpose of the EPP (Water and Wetland Biodiversity) is to identify EVs as defined in Section 9 of the EP Act (and associated Water Quality Objectives (WQO)) for Queensland waters.

Planning Act 2016 (Planning Act) and Planning Regulation 2017 (Planning Regulation)	The Planning Act and Planning Regulation are mechanisms for assessing all development within Queensland. The Planning Act establishes the process for sustainable planning and development assessment in an ecologically sustainable way. Under the Planning Act, it is a serious offence to breach development conditions, including those relating to erosion and sediment control or stormwater quality.

1.4 Relevant guidelines

This CESCP has been prepared in accordance with the International Erosion and Sediment Control Association (IECA) BPESC guidelines (IECA Manual) with reference to Catchments and Creeks Erosion and Sediment Control – A Field Guide for Construction Site Managers Ver 6 (2017).

1.5 Contractor responsibilities

The Contractor will be responsible for developing site-specific ESCPs, taking into consideration the staging of works.

In accordance with Chapter 7 of the IECA Manual, the Contractor shall generally be responsible for all items prescribed in this Report. The Contractor shall identify appropriate persons to ensure compliance with erosion and sediment control requirements and objectives for the project duration.

In addition to the erosion and sediment control elements detailed in this report, the Contractor shall also ensure the following general management practices are incorporated:

- Establish an erosion and sediment control training program for site staff
- Appropriately control subcontractors and material suppliers
- Suitably control site traffic to minimise dust generation and undesirable soil compaction outside designated access roads
- Maintain adequate supplies of emergency erosion and sediment control materials and ensure that these items are always available, particularly prior to imminent rainfall
- Establish an appropriate site inspection routine as well as the staff responsible for these inspections.

For further information regarding general construction practice and the management of construction sites, refer to Chapter 7 of the IECA Manual and the IECA 'Site Management' fact sheet.

2 OVERVIEW OF PROJECT

This section presents and overview of the project and provides a summary of the development footprint, impact, avoidance and mitigation measures.

The project will involve the construction of utility scale solar facility over an area of approximately 1,823 ha and will incorporate solar modules and associated infrastructure, electrical transformers and inverters, electrical substation, battery energy storage system (BESS), new transmission infrastructure, electrical controllers and internal property access tracks. The approximate areas of each of these elements are presented in Table 2 and shown spatially on Figure 1.

The solar photovoltaic panels to be utilised at the Smoky Creek Solar Power Station are supported on steel frames and operate under a solar tracking system. The solar tracking system will adjust the panel angles to remain perpendicular to the sun over the course of the day maximising the collection of solar radiation. The top edge of the panels will typically range from 3.0 m to 4.5 m above the ground with the bottom edge ranging from approximately 0.5 – 3.0 m above the ground depending on the sun's position.

Electrical inverters will convert energy generated from the PV panels from direct current (DC) to alternating current (AC) and subsequently transformers will increase the voltage to 33 (kV).

An underground electrical network will collect and transfer generated power to an internal electrical substation for export to the national grid via a new overhead powerline connecting to the 275kV Calvale to Stanwell transmission line.

The solar panel arrays will be surrounded by grassed areas and gravel access tracks will encircle the entire facility perimeter (which will also provide part of the Asset Protection Zone buffer away from the property boundaries) with additional tracks providing access to the inverter/transformer pads located within the arrays. The perimeter access track will function as a fire break and will be accessed through the site entrance.

A 2.4m high Chain Wire Security fence will be constructed outside the fire break for public health and safety protection. Additional safety measures will provide restricted access to high-risk areas and during construction.

The facility will be operated from a control building / switch room located in the Operations and Maintenance Building area. The area will contain parking facilities for staff and visitors which will be accessible from Dodsons Road. The driveway to the control building will consist of a gravel access track.

Other onsite infrastructure may include temporary site buildings, site office and amenities for construction, and temporary laydown areas and construction compound/s.

Table 2 Disturbance areas

Project components and areas	Area (ha)
Operations and maintenance building area	2.0
Transmission easement	48.9
Substation and centralised battery	3.1
Adjoining access tracks	<1 ha
Panel area A	44.5
Panel area B	135.2
Panel area C	235.3
Panel area D	52.3
Panel area E	283.3
Panel area F	151.2
Panel area G	16.6

Project components and areas	Area (ha)
Panel area H	24.3
Panel area I	384.4
Panel area J	67.4
Panel area K	73.5
Panel area L	138.1
Panel area M	143.4
Panel area N	4
Panel area O	16.4
Total	**1,823.9**

2.1 Construction activities

The Smoky Creek Solar Power Station has been designed to minimise the need for extensive civil works. The facility would be constructed from a range of materials including glass, steel, aluminium, copper, and plastics.

Internal access roads are not required between each panel row and will instead be constructed between zones for the placement of power units and around the boundary of each solar zone.

The construction process will generally be undertaken in the following order of works although some activities will be undertaken in parallel:

- Site office and amenities set up
- Vegetation removal and grubbing
- Construction of laydown areas
- Fencing construction
- Road construction
- Pile installation
- Trenching and underground cable installation
- Mechanical installations
- Solar module installation
- Inverter installation
- Battery system installation
- Construction of control building, HV switch room and spare parts building
- Testing and commissioning

LEGEND

Project area boundary

Subject Lots

TOMLINS ROAD

DODSONS ROAD

18RN271

28RN211

29RN210

32RN194

33RN210

39RN395

37RN1147

37RN1147

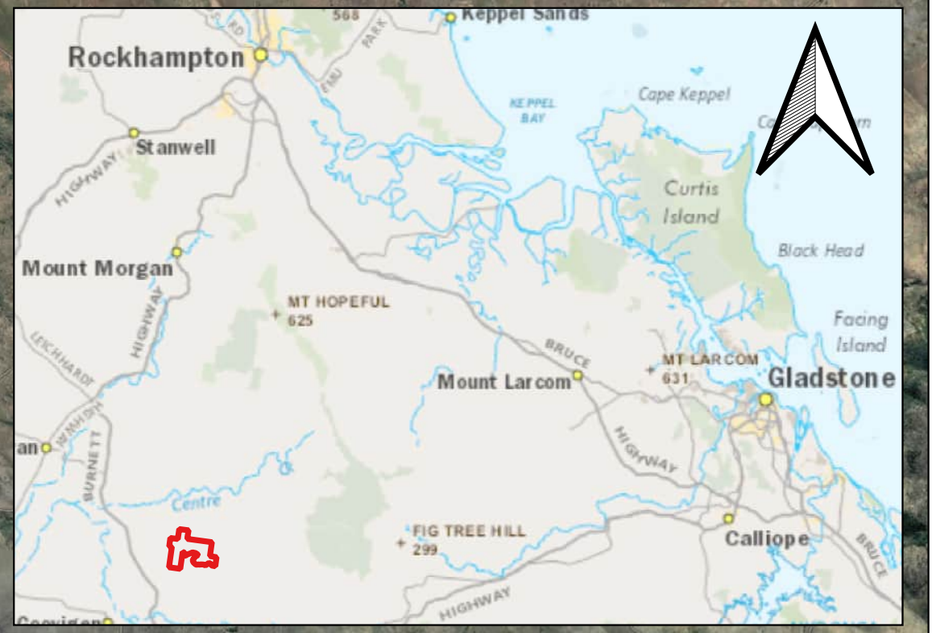

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FIGURE 1: PROJECT LOCATION

0 1.5 3 4.5 6 km

1:35,000

Credits:

Google Satellite Hybrid

DOCUMENT: 202104 - Figure 1 - Location Map with Inset

DATE: 28/11/2022

AUTHOR: Anton Fitzgerald

Coordinate system: GDA2020 / MGA zone 56 EPSG:7856

3 SITE ASSESSMENT

The assessment of erosion and sediment risks inherent in the proposed solar power station has considered the following factors.

3.1 Rainfall

The climate of the Banana local government area is typically classified as semi-arid with a summer dominant rainfall. Annual rainfall from the nearby Bureau of Meteorology Station at Woodbine (1973 – 2020) is between 630.1 mm and on average 75 % of annual rain falls between October and March (Table 3). Winter rainfall is generally reliable in the area despite being somewhat reduced. Summers are hot with at least one heat wave each summer and frosts occur on the low-lying country between May and September (Muller 2008).

Table 3 Rainfall statistics for Woodbine (BOM Station 039257) for 1973 - 2020

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	95.1	84.3	64.2	36.5	35.8	29.8	20.3	24.7	26.2	58.8	68.3	102.0	630.1
Lowest	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.4	318.7
10th %ile	24.8	12.0	5.1	3.5	2.2	3.8	0.0	0.0	0.0	5.2	13.2	21.7	425.0
Median	91.7	66.4	48.6	26.5	24.5	16.2	11.6	19.6	12.6	48.4	61.2	61.0	655.8
90th %ile	166.3	163.1	129.9	79.3	84.2	79.7	47.3	55.0	70.9	121.2	127.9	205.8	827.7
Highest	411.9	390.4	345.2	165.0	209.2	167.3	103.2	94.4	129.0	203.8	165.4	581.8	928.9

3.2 Topography

Site elevation ranges from approximately 250 m AHD from hilly country in the extreme east of Lot 37 to 155 m AHD on Lot 18 and 28 in the north-west. Undulating plains are dominant in Lot 28, Lot 32, Lot 33 and Lot 37 and the eastern parts of Lot 28 where they decline in elevation from the west and north-west (around 220 m AHD to 170 m AHD). The project area flattens to level and gently undulating plains in the western parts of the site including most of Lot 39 and the Lot 28. Gilgai microrelief is present in the west of Lot 28 and the north-west of Lot 39. The steepest sections of the site are associated with the lower slopes of a lateritic tableland occurring south of Lot 37 with the steepest sections outside of the project area.

3.3 Soils

In total, 15 separate soil profiles are mapped within the project area. Sodosols and Vertisols are the dominant soil orders and occupy 971.53 ha (43%) and 861.81 ha (38%) of the project area respectively. The cracking clays are diverse with six different profiles categorised on the site whilst only three sodic duplex soils are mapped.

Vertisols within the project area are categorised as either moderately well drained soils that are high in exchangeable calcium or strongly sodic with a highly saline subsoil (Muller 2008) and both types are common on the site. Within the project area the Vertosols that formed from unconsolidated Cainozoic alluvial-colluvial sediments possess a saline subsoil. These soils often form gilgai mounds and depressions and are mapped in the western extent of the project area.

- Earlsfield is found throughout the Callide Valley and commonly on the clay sheets to the north and west of Banana. Earlsfield soils are very deep cracking clays with occasionally widely spaced melonhole that range in size from 10 – 15 m horizontally and 0.3 – 0.5 m deep.
- Greycliffe soils are deep cracking clays with widely spaced melonhole gilgai. Gilgai sizes range in size from 10 – 30 m horizontally and 0.1 – 0.2 m deep. These gilgai are poorly drained with very slow runoff but are shallow and therefore support water for shorter periods. Soils on the mounds are strongly sodic with very high salt content.
- Greycliffe - melonhole phase soils are very deep cracking clays with strongly developed melonhole gilgai. Gilgai range in size from 20 – 60 m horizontally and 0.5 – 1.6 m deep. These gilgai are poorly drained with a very slow runoff and due to their size and depth contain water for long periods. Soils on the mounds are strongly sodic with very high salt content.

Typically for gilgai clay soils, the phosphorous content of the mound is significantly lower than for the depression due to the movement of topsoil by erosion from the mounds into the depression. This exposes the saline subsurface soils which in turn favours salt-tolerant species. This was observed in all gilgai areas throughout the site and has been exacerbated through the clearing of brigalow and disturbance of surface soils by cattle.

All mapped sodic duplex soils on the site are formed from unconsolidated Cainozoic alluvial- colluvial sediments. This soil type consists of sands and loams overlying a sodic clay subsoil of which three profiles are mapped on the site.

- Kokotungo is one of the most extensive soils in the Banana Land Resource Survey and is also the most extensive soil profile in this project area (940.11 ha). Kokotungo has a clay loamy topsoil with a strongly sodic subsoil that is highly dispersive.
- The Desdemona soil occurs in only a few small areas on the extensive colluvial plains to the north-east of Goovigen. Desdemona has a sandy topsoil with a sodic subsoil which is less prone to dispersal than Kokotungo.
- Ulogie often occurs near Tertiary sandstone plateaus. It has a sandy loam to clay loam topsoil with a dense and strongly sodic subsoil that is highly dispersive and erodible.

Detailed soil information for each the profiles mapped in the study are presented in Table 4 and the mapping is presented in Figure 2.

Table 4 Key land and soil features

Soil profile	Dominant soil order	Landform	Parent material	Description	Area
Sandy or loam over friable earthy clay					
Thalberg (Tb)	Chromosol - Brown	Undulating rises to level plains	Unconsolidated Cainozoic alluvial colluvial sediments	Thalberg is a hard setting, very deep (>1.5 m), brown or red, duplex soil, with a 0.2 to 0.5 m thick, fine sandy clay loam or clay loam fine sandy topsoil, that occasionally has a pale or sporadically bleached A2 horizon. The topsoil overlies a prismatic or blocky structured, fine sandy light medium or medium clay subsoil that has a neutral or alkaline soil reaction trend. Thalberg is formed on Cainozoic, alluvial-colluvial sediments.	0.03
Bluff (Bf)	Kurosol - Red	Steep escarpments	Deeply weathered Tertiary sedimentary rocks	Bluff is a moderately deep to deep (0.5-1.2 m), red, brown or grey, strongly acid duplex soil, with a stony, sandy loam to clay loam topsoil, 0.1 to 0.35 m thick, overlying a strongly acid, sometimes mottled, medium clay subsoil. Bluff has an acid soil reaction trend and is formed on deeply weathered, Tertiary, sedimentary rocks.	91.33
Total					**91.36**
Friable non-cracking clay or clay loam soils – Dermosols, Ferrosols					
Santo, fertile phase (SnFp)	Dermosol - Red	Undulating low hills to gently undulating rises	Permian and Devonian intermediate volcanic rocks	Santo fertile phase is shallow or moderately deep (0.3 to 0.9 m), structured, red or brown, non-cracking clay with a moderately thick (0.1 to 0.2 m), light clay or light medium clay topsoil that overlies a blocky structured, light clay to medium clay subsoil. Santo fertile phase has a neutral or alkaline soil reaction trend and is formed on Permian, intermediate, volcanic rocks.	58.64
Santo, stony phase (SnSp)	Dermosol - Red	Dissected rolling low hills to rolling rises	Permian and Devonian intermediate volcanic rocks	Santo stony phase is a shallow to moderately deep (0.2-0.8 m), stony, red or brown, uniform or gradational soil with a 0.05 to 0.25 m thick, clay loam fine sandy to light medium clay topsoil that overlies a blocky structured light clay to medium clay subsoil. Santo stony phase has a neutral to alkaline soil reaction trend and is formed on Permian, intermediate, volcanic rocks.	65.17
Total					**123.81**
Red, yellow or grey loam or earth soils - Kandosols					

Soil profile	Dominant soil order	Landform	Parent material	Description	Area
Spier (Sp)	Kandosol - Red	Level to undulating plateau surfaces	Deeply weathered Tertiary sedimentary rocks	Spier is a deep to very deep (1.1->1.5 m), massive, red gradational soil with a fine sandy loam to clay loam topsoil that grades into a clay loam fine sandy to fine sandy light medium clay subsoil. Spier is formed on Tertiary sandstone and has a neutral or acid soil reaction trend.	73.03
Total					73.03
Sand or loam over sodic clay – Sodosols, Kurosols					
Desdemona (Dd)	Sodosol - Brown	Undulating rises to level plains	Unconsolidated Cainozoic alluvial- colluvial sediments	Desdemona is a very deep (>1.5 m), brown, sodic duplex soil with a thick or very thick (0.4-0.9 m), sandy topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a brown, sometimes mottled, fine sandy light or light medium clay subsoil with a coarse prismatic structure. Desdemona has a neutral soil reaction trend and is formed on unconsolidated Cainozoic alluvial-colluvial sediments.	19.01
Kokotungo (Kt)	Sodosol - Brown	Undulating rises to level plains	Unconsolidated Cainozoic alluvial-colluvial sediments	Kokotungo is a very deep (>1.5 m), brown or grey, sodic duplex soil with a moderately thick to thick (0.1-0.5 m), clay loamy topsoil that has a sporadically bleached A2 horizon, that overlies a light medium of medium clay, prismatic structured subsoil. Kokotungo has mainly an alkaline soil reaction trend.	940.11
Ulogie (Ug)	Sodosol - Brown	Undulating rises to level plains	Unconsolidated Cainozoic alluvial-colluvial sediments	Ulogie is a very deep (>1.5 m), brown or grey, strongly sodic, duplex soil with a moderately thick to thick (0.15-0.5 m), fine sandy loam to clay loam sandy topsoil that has a sporadically bleached A2 horizon. The topsoil overlies a coarse columnar structured, fine sandy light medium or medium clay subsoil that is sometimes mottled. Ulogie has variable subsoil pH so that the soil reaction trend is equally acid, neutral or alkaline, and is formed on Cainozoic, alluvial-colluvial sediments.	12.41
Total					**971.53**
Annandale (An)	Vertisol - Black	Gently undulating plains and rises	Tertiary basalt	Annandale is a moderately deep (0.4-0.85 m), black, fine to coarse self-mulching, strongly cracking clay soil that is formed on basalt. Weakly developed normal gilgai can be present on the deeper profiles.	164.78
Belldeen (Bd)	Vertisol - Black	Undulating low hills to gently undulating rises	Permian and Devonian intermediate volcanic rocks	Belldeen is a moderately deep to very deep (0.7->1.5 m), black, cracking clay soil formed on Permian volcanic rocks. It usually has well developed	7.76

Soil profile	Dominant soil order	Landform	Parent material	Description	Area
				linear gilgai that have fine self-mulching mounds, with pedal or coarse self-mulching topsoils in the depressions.	
Clancy (Cc)	Vertisol - Black	Gently undulating plains and rises	Tertiary basalt	Clancy is a shallow to moderately deep (0.3-0.9 m), black, very coarse self-mulching, strongly cracking clay soil with an alkaline soil reaction trend that is formed on basalt.	114.35
Earlsfield (Ef)	Vertisol - Black	Undulating rises to level plains	Unconsolidated Cainozoic alluvial-colluvial sediments	Earlsfield is a very deep (>1.5m), black, dark brown or grey, cracking clay soil with a very fine self-mulching topsoil. The subsoil is strongly sodic (ESP>15), with high levels of soluble salts (EC >0.8 dS/m) below 0.8m. It has a predominantly acid soil reaction trend and is formed on uncosolidated, alluvial-colluvial sediments.	153.01
Greycliffe, melonhole phase (GcMp)	Vertisol - Grey	Undulating rises to level plains	Unconsolidated Cainozoic alluvial-colluvial sediments	Greycliffe melonhole phase is a very deep (>1.5 m), grey cracking clay with well-developed melonhole gilgai. It is strongly sodic (ESP >15) with high levels of soluble salts (EC1:5 >0.8dS/m) in the upper 0.3 to 0.5 m of the subsoil, and has mainly an acid soil reaction trend.	353.01
Greycliffe (Gc)	Vertisol - Grey	Undulating rises to level plains	Unconsolidated Cainozoic alluvial-colluvial sediments	Greycliffe is a very deep (>1.5 m), grey or brown cracking clay soil with a pedal to coarse self-mulching topsoil and an acid soil reaction trend. The upper subsoil is strongly sodic (ESP >15), and has high to very high levels of soluble salts (0.8 to 2.5 dS/m). Greycliffe has widely spaced, melonhole gilgai separated by inter-gilgai flats up to 50 m in width.	68.9
Total					**861.81**
Complex of sand or load over sodic clay with cracking clay soils					
Kokotungo-Greycliffe complex (Kt-Gc)	Sodosol - Brown and Vertisol - Grey complex	Undulating rises to level plains	Unconsolidated Cainozoic alluvial-colluvial sediments	Refer to Kokotungo and Greycliffe above.	118.37
Total					**118.37**

LEGEND

Project area

Soils of the Banana area

- Cracking clay soils - Vertosols
- Friable non-cracking clay or clay loam soils - Dermosols, Ferrosols
- Red, yellow or grey loam or earth soils - Kandosols
- Sand or loam over friable or earthy clay - Chromosols, Kurosols
- Sand or loam over sodic clay - Sodosols, Kurosols

Ug Rt Ug Gn Sp Kt Kt SnFp Sn Sn Bd Tb Dd Ug Cc GcMp Tr Cc Ef Db Kt-Gc Kt SnFp An SnSp SnFp GcMp GcMp Cc An Ef An An Gc Gc SnFp Lf Kt Cc Lf Sp Bf Kr Gc GcMp Kt Sp Bd Ug SnSp Sp Ef Ug Kt

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FIGURE 2: SOILS OF THE BANANA AREA

0 1 2 3 4 5 km

1:30,000

Credits:

Soils - soils of the Banana area central Queensland - BAN © State of Queensland (Department of Environment and Science) 2020,Includes material © State of Queensland (Department of Resources); © Planet Labs Netherlands B.V. reproduced under licence from Planet and Geoplex, all rights reserved, 2022.

DOCUMENT: E:\OneDrive - Terra Solutions\Resources\QGIS\Project

DATE: 07/04/2022

AUTHOR: Anton

Coordinate system: GDA94 / MGA zone 56 EPSG:28356

Land soil features observed at the site by Range (2019) and determined from Muller (2008) are presented in Table 5.

Table 5 Key land and soil features

Constraint	Description	Soils
Gilgai microrelief (melonholes)	- Gilgai are depressions that form in the surface of cracking clay soils (vertosols) and can hold water during the wet season. - Continuous cultivation can level out some shallow gilgai. But they will reform if the ground is left undisturbed. - Gilgai soil profiles includes soils that are dispersive, very strongly acid and moderately saline - Melonhole gilgai were observed in the field commonly greater than 0.5 m deep and at least several metres wide. - Soils that form gilgai occur across 20% of the lease areas.	Belideen, Greycliffe and Greycliffe Melonhole Phrase
Shrink swell soils	- Shrink-swell soils (or cracking clay soils) move or react to soil moisture. - Infrastructure engineering designs need to account for soil movement by shrink-swell soils. - Shrink swell soils occur across 39% of the lease areas	Annandale, Belldeen, Clancy, Earlsfield, Greycliffe and Greycliffe Melonhole Phase.
Surface rock	- Dense surface rock was observed in parts of the lease areas. Rocks ranged in size from medium pebbles (6-20mm) to stones (60-200 mm) - Surface rock can impede cultivation practices	Kokotungo, Spier, Ulogie and Annandale
Dispersive soils	- Dispersive soils include soils with Exchangeable Sodium Percentage (ESP) of 15 or more or a Ca:Mg ratio <0.1. Dispersive soils present a high erosion risk if exposed. They also impede drainage and root growth. - Topsoil (A horizon) is not normally dispersive soil. Dispersive soils commonly occur in the subsoil (B horizon) - Dispersive soils at the site are mainly associated with gilgai soils (from 0.2 m) and texture contrast soils (from 0.2 m). Dispersive soils occur at 0.8 m for Earlsfield soils (Vertosols). - Soils with dispersive soils in their profile occur across 75% of the lease areas	Bluff, Desdemona, Earlsfield, Grecliffe, Greycliffe Melonhole Phase, Kototungo and Ulogie.
Very strongly acid soils	- Very strongly acid soils have a pH<5. Very strongly acid soils can limit plant growth for agriculture or rehabilitation due to decreased nutrient availability and increased elemental toxicity. - Very strongly acid soils at the site are mainly associated with gilgai soils (from 0.4 m) and acid texture contrast soils (Kurosols) (throughout the profile). Very strongly acid soils occur at depth (1.4 m) for the Spier soils. - Soils with very strongly acid soils in their profile occur across 27% of the lease areas.	Greycliffe and Greycliffe Melonhole Phase, Bluff and Spier.
Contaminated soil	- Cattle dips were located at Lease Areas A and E. - Common soil contaminants at cattle dips include arsenic and DDT - Contamination at cattle dips is usually localised to the dip area (i.e. nominally within 30 m of the dip and associated infrastructure)	Greycliffe and Kokotungo
Steep slopes	- Steeply sloping land exceeds 3%. Steeply sloping land occurs in lease areas A, B1, B2, D2 and G2 - Steeply sloping land, particularly where dispersive soils occur, can increase the risk of erosion for land disturbing activities for agriculture or construction	Annaandale, Belldeen, Bluff, Clancy, Earlsfield, Greycliffe Melonhole Phase, Greycliffe, Kototungo, Santo, Fertile Phase, Santo Stony Phase, Spier, Ulogie

3.4 Watercourse and wetland mapping

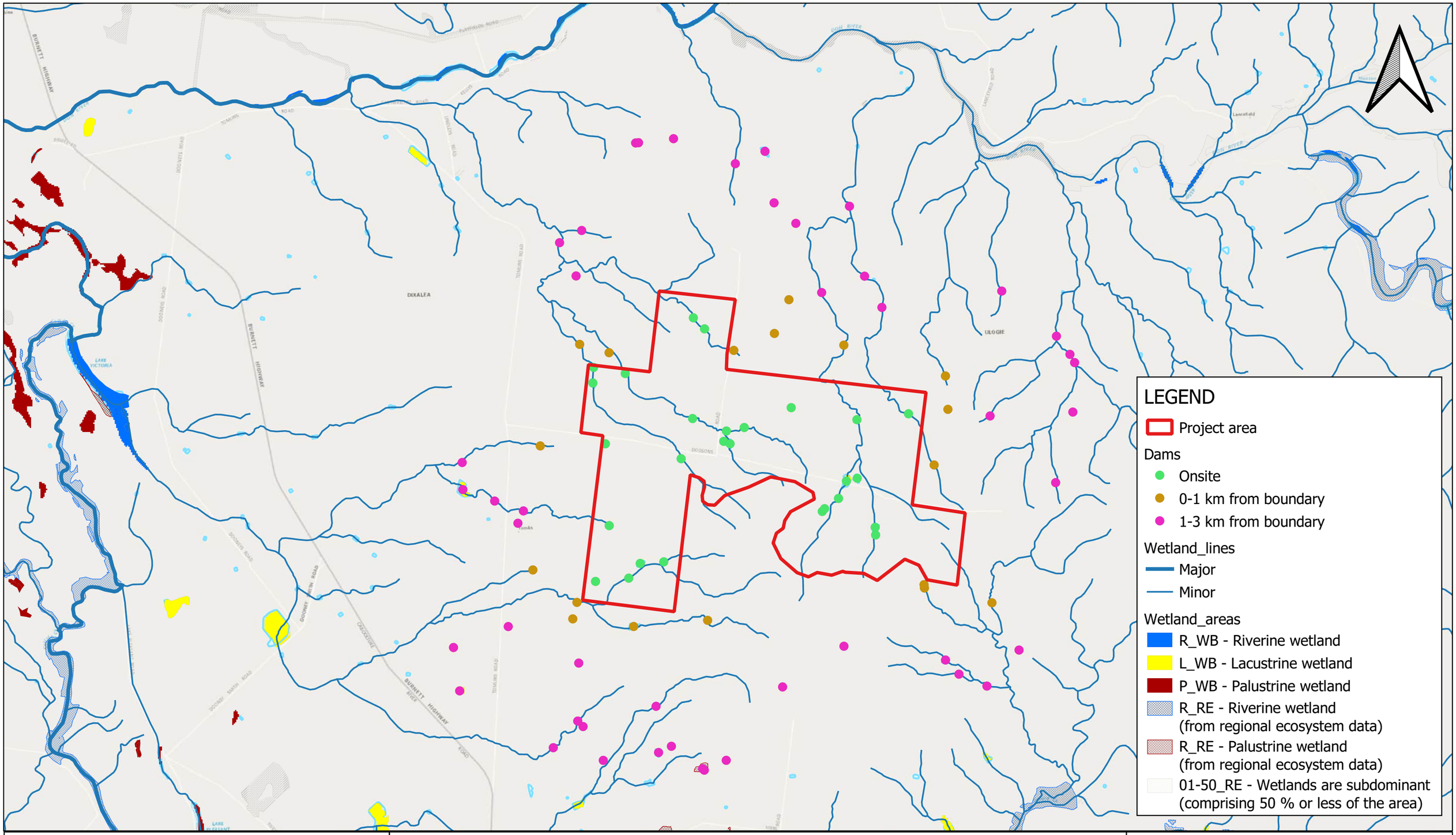
The site is located within the Dawson River sub-basin which is in the Fitzroy basin of the Northeast Coast drainage division of Queensland. Watercourses within the project areas is shown in Figure 3.

Drainage from the site is variable but in general terms includes the following:

- The southern extent of Lot 39 is drained by one of the large watercourses in the project area and its smaller tributaries following a westerly path toward a large dam north of Dooney Smooth Road. The central part of Lot 39 also drains west but slightly downstream of the dam and flows into a long linear billabong associated with Callide Creek (Lake Victoria).
- Water from Lot 18, Lot 28, most of Lot 29 and the western half of Lot 37 drain in a northwest direction and eventually combine with the Don River approximately 6.5 km from the site. Water from Lot 32, Lot 33, and most of the eastern half of Lot 37 drain north combining with the Don River further upstream approximately 6.5 north of the site.
- The eastern half of Lot 37 is the only area which drains in a southerly direction. Watercourses and drainage lines in this area ultimately join Gerard Creek, approximately 4.5 km south-southeast of the site.

All watercourses on the site are small (one or two stream orders) and classified as ephemeral systems with intermittent flashy flow regimes. The direction and quantity of flow off the site are affected by numerous in-stream dams which have been constructed to support agricultural enterprises. The dams would provide for a prolonged water supply which may extend year-round, except in drought years. The dams are in various states of repair with substantial rill erosion on the earthen dams constructed from sodic soils, nevertheless all contained water at the time of this survey.

Non-fluvial flows in the western half of the project area processes pool in gilgai habitats to the west of the project area. These small wetlands range in size and water holding capacity and ephemerality with some of the smaller water bodies evaporating relatively quickly whilst some others probably lasting well into the spring months.



Terra SOLUTIONS

CLIENT: EDIFY ENERGY

FIGURE 3: WATER RESOURCES

0 2 4 6 8 10 km

1:65,000

DOCUMENT: E:\OneDrive - Terra Solutions\Projects\202104_ Edify

DATE: 07/04/2022

AUTHOR: Anton

Credits:

Derived from Watercourse lines - Queensland © State of Queensland (Department of Resources) 2021,Wetland data - version 5 - wetland lines - Queensland © State of Queensland (Department of Environment and Science) 2020,Wetland data - version 5 - wetland areas - Queensland © State of Queensland (Department of Environment and Science) 2020,Queensland basemap colour web service © State of Queensland (Department of Resources) 2021

Coordinate system: GDA94 / MGA zone 56 EPSG:28356

4 EROSION HAZARD ASSESSMENT

4.1 Overview

In accordance with section 5.2 of the BPESC Guidelines, a preliminary erosion hazard assessment has been undertaken to provide an indication of the erosion risk for the site and identify areas where erosion and sediment control measures may need to be implemented.

4.2 Land disturbance activities

As detailed in section 2.1, the construction process will generally be undertaken in the following order of works although some activities will be undertaken in parallel:

- Site office and amenities set up
- Vegetation removal and grubbing
- Construction of laydown areas
- Fencing construction
- Road construction
- Pile installation
- Trenching and underground cable installation
- Mechanical installations
- Solar module installation
- Inverter installation
- Battery system installation
- Construction of control building, HV switch room and spare parts building
- Testing and commissioning

4.3 Rainfall and erosion risk

Where construction activities are anticipated to result in exposure of bare earth (i.e. site office, road construction, trenching), increased erosion and sediment control measures shall be implemented to reduce / eliminate runoff to sensitive areas.

The erosion risk rating for the site based on the IECA (2008) erosion risk rating is shown in Table 6. The IECA (2008) erosion risk rating based on average monthly rainfall is shown in Table 7.

Table 6 Mean rainfall for Woodbine (BOM Station 039257) for 1973 - 2020

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean (mm)	95.1	84.3	64.2	36.5	35.8	29.8	20.3	24.7	26.2	58.8	68.3	102.0
Erosion risk rating	M	M	M	L	L	VL	VL	VL	VL	M	M	H

Note: E=extreme, H=High, M=Moderate, L=Low, VL=Very Low

Table 7 Erosion risk rating based on average monthly rainfall (IECA 2008)

Erosion risk rating	Expected 24-hour rainfall	Average monthly rainfall
Very Low	0 to 2 mm	0 to 30 mm
Low	2+ to 10 mm	30+ to 45 mm
Moderate	10+ to 25 mm	45+ to 100 mm
High	25+ to 100 mm	100+ to 225 mm
Extreme	>100 mm	> 225 mm

Note: E=extreme, H=High, M=Moderate, L=Low, VL=Very Low

Ideally, most of the bulk earthworks should be in the dry season (i.e. April to September). Where works are undertaken during the wet season, they should be minimised during heavy rainfall events to avoid the potential risk of soil erosion.

The construction contractor should ensure rain forecasts are viewed on a weekly basis. Rainfall exceeding 10 mm significantly increases the risk of erosion. During these periods the construction contractor is required to ensure there are no unprotected exposed surfaces, and that all sediment controls are functioning and have the required capacity prior to predicted (greater than 50% chance) rainfall events of greater than or equal to 10 mm.

4.4 Preliminary erosion hazard assessment

An erosion hazard assessment derived from the BPESC Guidelines was completed for the project and attached in Appendix A.

This CESCP requires submission to Council for approval during the planning phase due to the following erosion hazard assessment determinants.

- Construction duration of more than 6 months
- Total hazard assessment score exceeding 17

5 EROSION AND SEDIMENT CONTROL MANAGEMENT STRATEGIES

5.1 Induction and training

Staff training is essential for the effective operation of erosion and sediment control measures. Formal environmental site induction procedures should be established for all site personnel including subcontractors. These documented procedures should include a register of training and induction activities.

It is the responsibility of the site manager to take appropriate steps to ensure that site staff, including subcontractors are appropriately trained. These documented procedures should include a register of training and induction activities.

5.2 Construction staging and timing

Where practicable, the soil erosion hazard on the site should be kept as low as possible. The staging of works, and therefore the amount and duration of the soil's disturbance should be minimised to limit the exposure of the site to erosion hazards.

The works schedule shall take into consideration the expected and predicted rainfall forecast for the region. Clearing and rehabilitation activities shall aim to avoid periods of predicted significant rainfall. These factors are the greatest importance when works are programmed to occur within or adjacent to sensitive areas, i.e. works near waterways or access tracks traversing waterways. Clearing and rehabilitation activities shall be halted during periods of significant rainfall, and appropriate temporary control measures may be required to be implemented and closely monitored during these events.

The Contractor shall ensure implementation of erosion and sediment controls and shall also keep a record of rainfall forecast for the following week. Rainfall events more than 10 mm significantly increases erosion risk. The Contractor will have to ensure that there are no unprotected exposed surfaces, and that all sediment controls are functioning and have the required capacity where construction surfaces are exposed.

5.3 Site access and establishment

The following site establishment procedures shall be implemented:

- Obtain necessary permits and plan approvals prior to establishment
- Ensure detailed ESCPs have been prepared and are available on site prior to construction
- Where appropriate, establish perimeter fencing to manage public safety and unauthorised dumping
- Establish the site compound erosion and sediment controls, installing all necessary drainage. When establishing the site compound the following must be considered:
  - Establish only the minimum number of entry/exit points
  - Ensure site office and carpark are established in locations that minimise safety risks to site visitors (locating close to site entry points to reduce visitor movement through active work areas).
  - Use gravelling techniques to minimise soil compaction and the generation of excessive mud around the site compound.
- Construct and stabilise site entry/exit points, including appropriate control measures.
- Establish stockpile areas, including all necessary drainage and sediment controls.

- Stockpile materials necessary for the installation and ongoing maintenance of erosion and sediment control measures including those materials necessary for emergency erosion and sediment control activities in the event of imminent rainfall
- Establish any non-disturbance or exclusion areas identified within the ESCP.
- Implement remaining erosion and sediment control measures in accordance with the specified installation sequence.

5.4 Erosion, sediment and drainage control

The key principles below were considered in achieving the objectives of an ESCP:

- Reduce the risk of soil erosion
- Control stormwater and run-off
- Reduce sediment transport off the site
- Maintain or improve the ecological, landscape and recreational values of the site.

The selection and implementation of appropriate ESC measures is dependent on several factors including the anticipated disturbance, duration, slope, soil characteristics and availability of materials, etc.

The following are the suggested erosion and sediment control measures for the project, where standard drawings have been sourced from BPESC guidelines and referred to in Appendix B. All erosion and sediment controls should be endorsed by a suitably qualified person possessing a Certified Professional in Erosion and Sediment Control or equivalent and installed within the project boundary. All erosion, sediment and drainage control measures must remain in place until all construction works are completed and surface is stabilised and rehabilitated.

Erosion, sediment and drainage control measures that are required only for the construction phase of the Project will remain in place until the applicable construction works are completed and surfaces are stabilised and rehabilitated. The timeframe for such controls will vary and will align with the staging of construction, which is expected to take around 18 months, with a staged approach across the entire alignment.

Some erosion, sediment and drainage control measures are an integral part of the solar farm infrastructure and will remain in place permanently, namely those associated with permanent infrastructure.

5.5 Drainage control

The primary functions of drainage control measures are to minimise the risk of erosion, minimise the risk to the adopted erosion and sediment control measures, control the velocity and location of water flowing through the site, and to appropriately manage ‘clean’ and ‘dirty’ water flows through the site.

The proposed measures for the Project are as follows:

- During all phases of construction, the management of upstream waters must be considered and appropriately managed. Upstream water must be either diverted, bunded or pumped through the Project during periods of low flows. During periods of high flows, the Contractor must ensure upstream flows are diverted via stabilised drainage paths.
- Provide diversion works (clean water diversion bunds/drains) to direct clean water flows from external catchments upslope of the proposed construction towards existing discharge points where possible. Diversion drains are to be constructed as trapezoidal bunds or channels and approximately lined to minimise the risk of scour occurring.

- Provide diversion works (disturbed diversion drains) to direct dirty water flows from external catchments upslope of the proposed construction area towards existing discharge points, where possible. Diversion drains are to be constructed as trapezoidal bunds or channels and appropriately lined to minimise the risk of scour occurring.
- Provide diversion works (disturbed diversion drains) to direct dirty water flows from internal catchment towards sediment treatment devices, for off-site discharge.
- Provide mid slope diversion bunds to minimise rill erosion and divert runoff to more formalised diversion drains, which contain rock check dams at regular intervals to control flow velocity.
- Provide temporary diversion topsoil bunds upslope of stockpiles locations.
- Sediment weirs or rock check dams (gradient <10%) are to be placed within exposed diversion and drainage channels at appropriate intervals, where required, to reduce runoff velocities and minimise soil erosion caused during rainfall runoff events. If soils are erosive, then consider the use of an underlying geotextile skirt place under each check dam.
- If dispersive soils are encountered and slopes steeper than 10%, drainage control can be undertaken using a various channel/chute lining techniques dependant of flow velocities, including rock and geosynthetic lining etc.
- Unsealed access tracks should allow stormwater to shed at regular intervals with runoff released as sheet flow via a level spreader (standard drawing in Appendix B) into adjacent grass/bushland or riparian zone (if adjacent a water course). Stormwater must also be able to freely discharge from unsealed roads preferably via outfall drainage). If outfall drainage is installed, any ‘windows’ that develop along the down-slope side of the track need to be removed.

All drainage control measures must be designed in accordance with Section 4.3.1 of the BPESC Manual.

5.6 Erosion control

5.6.1 Site access

The movement of vehicles around and between construction sites is to be limited to the access and haulage tracks as much as possible.

5.6.2 Minimise disturbance area

Installation of barrier fencing and sediment fencing, as per standard “Sediment Fence SF-01 and SF-02” in Appendix B, should be employed to clearly define the limits of works and any “No-Go” zones to minimise or prevent access by personnel or vehicles. Temporary fencing or barricading such as para webbing or perimeter tape is to be utilised on the cleared perimeter with accompanying signage. Site inductions and toolbox meetings should include the importance of observing “No Go” zones, particularly in areas near to any identified sensitive area.

5.6.3 Vegetation clearance

Any vegetation to be retained shall be clearly marked to mitigate the risk of accidental clearing occurring. Where vegetation clearing is necessary, any cleared native vegetation shall be mulched and/or retained for use on site such as to provide a temporary blanket as erosion control on cleared areas. Progressive stabilisation where appropriate and rehabilitation of disturbed riparian areas shall occur as soon as possible after the completion of earthworks and trenching activities.

If vegetation clearing is required to be carried out well in advance of earthworks, the Contractor shall aim to remove only woody vegetation leaving the understorey growth. Grubbing and removal of ground cover and understorey is to be delayed until immediately prior to earthworks occurring within that stage of works.

Any mulch that is generated from the clearing activities may be used as temporary ground cover however must be placed in a manner that is unlikely to result in mulch entering adjacent waterways.

5.6.4 Groundcover and surface treatments

Rehabilitation and the establishment of low-growing ground cover vegetation can be one of the most effective forms of permanent erosion controls (IECA 2008). Vegetation and groundcover increase surface roughness slowing stormwater runoff, protects the soil against raindrop impact, and reduces the evaporation losses from the underlying soil.

Refer to Table 4.4.7 of the BPESC Manual for best practice measures associated with site rehabilitation depending on the erosion risk based on monthly erosivity (very low – extreme).

Key stabilisation requirements for the project are as follows:

- Stripped topsoil must be reinstated as soon as possible after the completion of earthworks and trenching activities.
- All temporary earth banks, flow diversion systems, and embankments where runoff should flow uncontrolled off site are to be stabilised with rock/gravel over geo-textile, or vegetation, as per standard “Gravelling Gravel-01”, “Erosion Control Blankets ECB-01” and “Revegetation – General R-01” in Appendix C.
- Exposed soils, particularly around drainage channels and batters, are to be stabilised and covered with a suitable temporary cover material, such as soil binder as soon as practicable following earthworks in the immediate area.
- A success criterion for ground cover is a minimum of 75% cover.

5.6.5 Construction entry/exists

Stabilised entry and exit points shall be established to minimise the risk of construction and site personnel vehicles transporting sediment onto public access roads. Stormwater runoff from access roads and stabilised entry/exit points shall drain to an appropriate sediment control device. The site entry/exit points shall be constructed in accordance with the best practice sediment control measures for construction site entry/exit points presented in Section 4.5.10 of the IECA Manual. Dumped rock or vibration grids may be used at key access points to the site, i.e., stockpile sites and laydown areas.

If sediment is transported onto a public road adjoining the project area, supplementary street sweeping may be required and will remain the responsibility of the Contractor.

5.7 Sediment control

Sediment control techniques shall be applied across the disturbed areas to limit mobilisation of and settle mobilised soil particles across the site. Sediment control techniques slow the movement of water and allow the influence of gravity to settle out particles before discharging into the receiving environment.

The minimum sediment control standard is determined based on the erosion risk of the site (IECA 2008), which the Contractor is required to complete as part of the detailed ESCP.

Based on the erosion risk, the assumed catchment areas, the preliminary erosion hazard assessment, the uncertainty in the timing of works and estimated project duration, as well as the receiving environments, 'Type 1' treatments may be required as the sediment control standard for the project. The timing and duration of works, as well as the Contractor's construction methodology and staging may result in a lesser sediment control standard. The Contractor shall therefore determine the appropriate sediment control standard for each disturbed area when developing the construction erosion and sediment control plans for each distinct stage of the project.

5.7.1 Sediment control devices

Sediment control measures should comprise the following, with all controls remaining in place until all exposed soil has been stabilised or permanent controls have been constructed:

- Clean water diversion bunds/drains upslope of construction works, where appropriate, to divert undisturbed runoff around the project area
- Disturbed diversion drains along the downslope of all earthwork activities to direct runoff to appropriate sediment controls, prior to off-site discharge
- Rock check dams within all stabilised diversion channels, with sediment weirs within the main drainage channel, to reduce flow velocity and encourage sediment fall-out. If soils are erosive, then consider the use of an underlying geotextile skirt place under each check dam.
- Rock filter dams at the base of small and isolated catchment areas to treat runoff
- Type 1 sediment controls, such as sediment basin, at the concentrated off-site discharge locations to treat disturbed runoff prior to off-site discharge.

5.7.2 Stockpiles

All stockpiles (uncontaminated material) are to:

- Be separated into soil and use types (topsoil to be kept separate to subsoil)
- Be located further than 40 metres from any waterway
- Be located at least one metre from site boundary fencing
- Not be located at the base of significant trees
- Be watered and or protected through effective erosion control emulsions (Vital Bon-Matt Stonewall or equivalent approved by CPESC), as required, to minimise dust emissions
- Have sediment fences (Appendix B) or other appropriate control measure (e.g. earth bund) (where practicable) located down slope to minimise the risk of sediment laden runoff
- Be located down slope of the access track
- Be covered if significant rainfall is expected.
- Not be located within any on or off-site drainage lines

Note that cleared vegetation can be stockpiled on top of topsoil stockpiles so as to act as an additional erosion and sedimentation control (as-is or mulched).

5.7.3 Dust suppression

The most effective control measure against wind erosion is through rehabilitation and revegetation of disturbed areas, however in some cases this is not reasonably practicable until the end of the construction period. In the interim, water tankers shall be employed to suppress dust on site during construction periods and other times as necessary. Exposed drainage channel surfaces must be rehabilitated as soon as possible to minimise the potential environmental risk.

5.8 Trench management

To minimise the effects of erosion and sedimentation within cable trenches, layout of the construction corridor should be as follows:

- Spoil stockpile adjacent to trench for ease of trench reinstatement
- Topsoil/vegetation stockpile adjacent spoil stockpile for ease of trench topsoil reinstatement (note: vegetation can be placed on top of topsoil to assist with controlling erosion/sedimentation, as-is or mulched)
- Diversion of clean water away from the trench/stockpiles through the use of sandbag (or other material e.g. spoil) flow diversion banks, as per standard “Flow Diversion Banks DB-01” in Appendix B (bank location dependent on grade of land)

In addition, the trench shall be managed as follows:

- The use of mulch berms should be implemented to prevent dirty water leaving the site, as per standard “Mulch Filter Berms MB-01” in Appendix B.
- If rainfall greater than 10mm is imminent, use sandbags to provide trench stops at 70m for flat trenches and 35m for trenches with a steep grade to limit flow length and velocities at the base of the trench; and
- In case dewatering of the trench is required, it will be achieved by employing a dewatering pump with discharge sediment control measures
- Following construction:
    - Flow control berms are to be installed to reduce flow velocities of water near the trench centre line and help avoid scour problems and trench subsidence, as per standard “Flow Control Berms CM-01” in Appendix B. Flow control berms can be formed by using sandbags and are to be constructed across the entire alignment at the following intervals:
        - Slopes 1% and less – 90m interval
        - Slopes between 1% and 2% - 70m interval
        - Slopes between 2% and 3% - 50m interval
        - Slopes between 3% and 4% - 40m interval
        - Slopes greater than 4% - 25m interval

5.9 Permanent infrastructure management

Permanent infrastructure is not anticipated to require extensive erosion, sediment or drainage control measures. These structures will undergo a detailed design process in which these factors are accounted for at an engineering design level. However, the following must be considered for the temporary control of erosion and sedimentation (during the construction phase).

5.9.1 Sediment Control

Downslope sediment control treatments are to be installed to prevent sediment laden water affecting the receiving environment. Sediment fences and isolation barrier are to be installed on the banks of watercourses to prevent entry of sediment from land-based construction activities.

5.9.2 Drainage control

The following drainage controls must be considered:

- Provide diversion channels to direct undisturbed water flows from external catchments upslope of work areas towards existing discharge points.
- Provide diversion works (disturbed water channels) to direct disturbed water flows from ground disturbance catchments towards sediment treatment devices, where necessary.
- Rock check dams are to be placed within the cleared areas on slopes to reduce runoff velocities and minimise soil erosion caused during rainfall runoff events.

The following drainage control techniques are suitable for low-gradient slopes:

- Catch Drain
- Compost Berm
- Diversion Channel
- Flow Diversion Bank

Regarding velocity control structures for channels and drains, the following techniques may be utilised:

- Fibre Roll
- Rock Check Dam
- Sandbag Check Dam

The following channel and chute lining options should be considered:

- Cellular Confinement System
- Erosion Control Mat
- Rock Mattress
- Rock Lining

5.10 Waterways

All works in and around waterways are to be designed and undertaken following Appendix I of the IECA Guidelines which details Instream works.

Prior to commencement of any temporary waterway barrier works, invert levels of both waterway banks and grade of waterway bed must be surveyed to allow for proper reinstatement following trenching and placement of cover material. Waterways must be reinstated to pre-disturbance grades and levels to ensure unimpeded water flow as soon as possible (preferably within 5 business days) after the completion of earthworks and trenching activities.

In addition to the above, the following management procedures should also be adopted:

- If possible, works within waterways should be undertaken during dryer months when heavy rainfall is not expected. Weather should be monitored by the Contractor during the construction works to identify any specific weather-related changes to ESC measures as necessary.

- Temporary waterway barrier works within waterways mapped as Queensland waterways for waterway barrier works are to be undertaken in accordance with the 'Accepted development requirements for operational work that is constructing or raising waterway barrier works' (DAF 2018), including the requirement for pre and post work notifications.
- Permanent waterway barrier works that are accepted development within waterways mapped as Queensland waterways for waterway barrier works must be undertaken in accordance with the 'Accepted development requirements for operational work that is constructing or raising waterway barrier works' (DAF 2018). If the proposed work does not comply with the accepted development requirements, or the work is not accepted development, a Development Approval must first be obtained under the *Planning Act 2016* and *Fisheries Act 1994*. The work must then be undertaken in accordance with the conditions of the Development Permit.
- Works within waterways should try and maintain as much natural flow through the waterway as is possible for the duration of works. If the waterway is classed as a fish passage, IECA details that a maximum of 30% flow area can be blocked at any one time. If this is not possible, a maximum of 50%. Temporary waterway barrier works must also comply with the duration requirements under the 'Accepted development requirements for operational work that is constructing or raising waterway barrier works' (DAF 2018).
- If fish become trapped by any waterway barrier works, fish salvage activities are to be undertaken immediately in accordance with the Fisheries Queensland Guidelines for Fish Salvage (available at www.daf.qld.gov.au). Any fish kills must also be reported to the DES on 1300 130 372.
- Temporary access tracks, if required across waterways, are to be constructed of clean hard rock of adequate size (200mm minimum) to withstand likely flows, placed over non-woven geofabric and with minimal placement of fine aggregate on the top surface. Any temporary culverts are to be sized according to DAF guidelines to maintain fish passage. Causeways are to be profiled to ensure stream flows minimise bank erosion. Refer to "Temporary Culvert Crossing TCC-01 and TCC-02" in Appendix B.
- Floating Silt Curtains should be used within waterways where sedimentation and high turbidity may occur as a result of construction works. See "Floating Silt Curtain FSC-01, FSC-02 and FSC- 03" in Appendix B.
- If works are not in accordance with the Riverine protection permit exemption requirements under the Water Act 2000, a permit will be required to excavate, place fill or destroy vegetation in a watercourse.

Additionally, topsoil and vegetation stripped prior to commencement of the works must be reinstated as soon as possible in accordance with the Rehabilitation Management Plan for the Project and as part of the erosion and sediment control process.

5.10.1 Waterway with no flow

Where works are to be undertaken within a dry waterway, normal Trench Management erosion and sediment control is to be implemented, as per Section 5.5.

Contractors are to have some erosion and sediment control materials on site and monitor weather data to track the likelihood of rainfall and thus waterway flow. Should the likelihood of rain arise, the site specific ESCP should follow control measures as per above so as to anticipate stream flow.

6 MANAGEMENT

6.1 Maintenance requirements

In accordance with Section 6.8 of the IECA Manual, all ESC measures must be maintained in working order at all times during their required operational life. Proper working order includes maintaining the required hydraulic capacity and operational effectiveness. All temporary ESC measures need to be removed and the affected land stabilised as soon as possible after the satisfactory completion of the defined “maintenance period”.

Best practice site management includes:

- Ensuring all material removed from ESC devices is disposed in a manner that does not cause ongoing erosion or environmental harm
- Ensure all sediment is removed from roads, or from sediment control measures at stormwater inlets
- Ensuring maintenance mowing of grassed road shoulders, table drains, batters and other surfaces likely to erode, aims to leave the grass leaf length no shorter than 50mm wherever possible
- Ensuring appropriate written records are kept on all ESC monitoring and maintenance activities conducted during construction and maintenance periods.

6.2 Monitoring and maintenance program

In accordance with Section 7.2 of the IECA Manual the Contractor shall make allowance for the preparation of a formal monitoring and maintenance program prior to site establishment. The monitoring and maintenance program shall make allowance for required site inspections, monitoring of erosion and sediment control devices (which may include water quality monitoring) and reporting of results, inspections and non-compliance.

Site inspections and monitoring are to be undertaken in accordance with Sections 6.17, 7.4, 7.5, 7.6 and Appendix I of the IECA Manual and as detailed below. ESCPs are living documents that can and should be modified as site conditions change, or if the adopted measures fail to achieve the required treatment standard. When a site inspection detects a notable failure in the adopted ESC measures, the source of the failure must be investigated, and appropriate amendments made to the site and the plans.

Site inspection and monitoring should consider the following:

- Appropriate procedures and personnel should be engaged to plan and conduct site inspections and water quality monitoring throughout the construction
- All ESC measures should be inspected in accordance with the IECA (2008) guidelines
- All site monitoring data including rainfall records, dates of water quality testing, testing results and records of controlled water releases for the site, should be documented onsite. The documentation should be maintained up to date for the duration of the approved works and be available on-site for inspection by the assessing authority on request.
- All environmental incidents should be documented and should remain accessible to the relevant regulatory authorities on request. When an Environmental Incident (i.e. breach of limits or exceedance of trigger value) occurs, it is the responsibility of the environmental manager to investigate and initiate remedial actions commensurate with the severity of the incident
- A system should be implemented and maintained that monitors and records site compliance and non-compliance with the report requirements.

6.2.1 Inspection requirements

In accordance 7.4 of the IECA Manual, the Contractor shall undertake inspections of all drainage, erosion and sediment control measures as outlined in Table 8.

Table 8 Inspection requirements

Inspection	Inspection requirements
Daily site inspections during periods of runoff resulting from rainfall	- All drainage, erosion and sediment control measures - Occurrences of excessive sediment deposition (whether on-site or off-site) - All site discharge points
Weekly site inspection	- All drainage, erosion and sediment control measures - Occurrences of excessive sediment deposition (whether on-site or off-site) - Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements - Litter and waste receptors - Oil, fuel and chemical storage facilities
Site inspection immediately prior to anticipated runoff-producing rainfall	- All drainage, erosion and sediment control measures - All temporary (e.g. over-night) flow diversion and drainage works
Site inspection immediately following anticipated runoff-producing rainfall	- Treatment and de-watering requirements of sediment basin - Sediment deposition within sediment basins and the need for its removal - All drainage, erosion and sediment control measures - Occurrences of excessive sediment deposition (whether on-site or off-site) - Occurrences of construction materials, litter or sediment placed, deposited, washed or blown from the site, including deposition by vehicular movements - Occurrences of excessive erosion, sedimentation, or mud generation around the site office, car park and /or material storage areas
Monthly site inspections	- Surface coverage of finished surfaces (both area and percentage cover) - Health of recently established vegetation - Proposed staging of future land clearing, earthworks, and site/soil stability

7 REFERENCES

Catchments & Creeks Erosion and Sediment Control – A Field Guide for Construction Site Managers Ver 6 (2017)

Catchments & Creeks Erosion and Sediment Control – Standard Drawings, https://www.catchmentsandcreeks.com.au/STDdrawings.html, accessed 16 November 2021

DAF 2018, Accepted Development requirements for fisheries development: Waterway barrier works, Department of Agriculture and Fisheries, https://www.daf.qld.gov.au/business-priorities/fisheries/habitats/fisheries-development/accepted-development, accessed 16 November 2021

IECA 2008, Best Practice Erosion & Sediment Control – for building and construction sites, International Erosion Control Association (Australasia), 2008

Appendix A

Erosion Hazard Assessment Form

Erosion Hazard Assessment Form			
Condition	**Points**	**Score**	**Trigger value**
AVERAGE SLOPE OF DISTURBANCE AREA [1] • not more than 3% [3% . 33H:1V] • more than 3% but not more than 5% [5% = 20H:1V] • more than 5% but not more than 10% [10% = 10H:1V] • more than 10% but not more than 15% [15% . 6.7H:1V] • more than 15%	0 1 2 4 6	2	**4**
SOIL CLASSIFICATION GROUP (AS1726) [2] • GW, GP, GM, GC • SW, SP, OL, OH • SM, SC, MH, CH • ML, CL, or if *imported fill* is used, or if soils are untested	0 1 2 3	3	
EMERSON (DISPERSION) CLASS NUMBER [3] • Class 4, 6, 7, or 8 • Class 5 • Class 3, (default value if soils are untested) • Class 1 or 2	0 2 4 6	4	**6**
DURATION OF SOIL DISTURBANCE [4] • not more than 1 month • more than 1 month but not more than 4 months • more than 4 months but not more than 6 months • more than 6 months	0 2 4 6	6	**6**
AREA OF DISTURBANCE [5] • not more than 1000 m^2 • more than 1000 m^2 but not more than 5000 m^2 • more than 5000 m^2 but not more than 1 ha • more than 1 ha but not more than 4 ha • more than 4 ha	0 1 2 4 6	6	**4**
WATERWAY DISTURBANCE [6] • No disturbance to a watercourse, open drain or channel • Involves disturbance to a constructed open drain or channel • Involves disturbance to a natural watercourse	0 1 2	0	**2**
REHABILITATION METHOD [7] Percentage of area (relative to total disturbance) revegetated by seeding without light mulching (i.e. worst-case revegetation method). • not more than 1% • more than 1% but not more than 5% • more than 5% but not more than 10% • more than 10%	0 1 2 4	4	
RECEIVING WATERS [8] • Saline waters only • Freshwater body (e.g. creek or freshwater lake or river)	0 2	2	

SUBSOIL EXPOSURE [9] • No subsoil exposure except of service trenches • Subsoils are likely to be exposed	0 2	0	
EXTERNAL CATCHMENTS [10] • No external catchment • External catchment diverted around the soil disturbance • External catchment not diverted around the soil disturbance	0 1 2	2	
ROAD CONSTRUCTION [11] • No road construction • Involves road construction works	0 2	2	
pH OF SOILS TO BE REVEGETATED [12] • more than pH 5.5 but less than pH 8 • other pH values, or if soils are untested	0 1	1	
Total Score [13]		**32**	

Explanatory notes

Requirements: Specific issues or actions required by the proponent.

Warnings: Issues that should be considered by the proponent.

Comments: General information relating to the topic.

[1] **REQUIREMENTS:**

For sites with an average slope of proposed land disturbance greater than 10%, a preliminary ESCP must be submitted to the regulatory authority for approval during planning negotiations.

Proponents must demonstrate that adequate erosion and sediment control measures can be implemented on-site to effectively protect downstream environmental values.

If site or financial constraints suggest that it is not reasonable or practicable for the prescribed water quality objectives to be achieved for the proposal, then the proponent must demonstrate that alternative designs or construction techniques (e.g. pole homes, suspended slab) cannot reasonably be implemented on the site.

WARNINGS:

Steep sites usually require more stringent drainage and erosion controls than flatter grade sites.

COMMENTS:

The steeper the land, the greater the need for adequate drainage controls to prevent soil and mulch from being washed from the site.

[2] **REQUIREMENTS:**

If the actual soil K-factor is known from soil testing, then the Score shall be determined from Table 1.

If a preliminary ESCP is required during planning negotiations, then it must be demonstrated that adequate space is available for the construction and operation of any major sediment traps, including

the provision for any sediment basins and their associated embankments and spillways. It must also be demonstrated that all reasonable and practicable measures can be taken to divert the maximum quantity of sediment-laden runoff (up to the specified design storm) to these sediment traps throughout the construction phase and until the contributing catchment is adequately stabilised against erosion.

WARNINGS:

The higher the point score, the greater the need to protect the soil from raindrop impact and thus the greater the need for effective erosion control measures. A point score of 2 or greater will require a greater emphasis to be placed on revegetation techniques that do not expose the soil to direct rainfall contact during vegetation establishment, e.g. turfing and *Hydromulching*.

COMMENTS:

Table 2 provides an *indication* of soil conditions likely to be associated with a particular Soil group based on a statistical analysis of soil testing across NSW. This table provides only an initial estimate of the likely soil conditions.

The left-hand-side of the table provides an indication of the type of sediment basin that will be required (Type C, F or D). The right-hand-side of the table provides an indication of the likely erodibility of the soil based on the Revised Universal Soil Loss Equation (RUSLE) K-factor.

Table 3 provides some general comments on the erosion potential of the various soil groups.

Table 1 – Score if soil K-factor is known

	RUSLE soil erodibility K-factor			
	K < 0.02	**0.02<K<0.04**	**0.04<K<0.06**	**K > 0.06**
Score	0	1	2	3

Table 2 – Statistical analysis of NSW soil data [1]

Unified Soil Class System	Likely sediment basin classification (%)			Probable soil erodibility K-factor (%) [2]			
	Dry	Wet		Low	Moderate	High	Very High
	Type C	Type F	Type D	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
GM	30	**58**	12	12	**51**	26	12
GC	**42**	33	25	13	**71**	17	0
SW	40	**48**	12	**49**	39	12	0
SP	**53**	32	15	**76**	18	5	1
SM	21	**67**	12	26	**48**	25	1
SC	26	**50**	24	16	**64**	18	2
ML	5	**63**	32	4	35	**45**	16
CL	9	**51**	39	12	**56**	19	13

Unified Soil Class System	Likely sediment basin classification (%)			Probable soil erodibility K-factor (%) [2]			
	Dry	Wet		Low	Moderate	High	Very High
	Type C	Type F	Type D	K < 0.02	0.02<K<0.04	0.04<K<0.06	K > 0.06
OL	2	**80**	18	34	**61**	5	1
MH	12	41	**48**	15	19	**41**	25
CH	5	44	**51**	39	**43**	11	7

Notes: [1] Analysis of soil data presented in Landcom (2004).

[2] Soil erodibility based on Revised Universal Soil Loss Equation (RUSLE) K-factor.

Unified Soil Classification System (USCS)

GW Well graded gravels, gravel-sand mixtures, little or no fines

GP Poorly graded gravels, gravel-sand mixture, little or no fines

GM Silty gravels, poorly graded gravel-sand-silt mixtures

GC Clayey gravels, poorly graded gravel-sand-clay mixtures

SW Well graded sands, gravelly sands, little or no fines

SP Poorly graded sands, gravelly sands, little or no fines

SM Silty sands, poorly graded sand-silt mixtures

SC Clayey sands, poorly graded sand-clay mixtures

ML Inorganic silts & very fine sands, rock flour, silty or clayey fine sands with slight plasticity

CL Inorganic clays, low–medium plasticity, gravelly clays, sandy clays, silty clays, lean clays

OL Organic silts and organic silt-clays of low plasticity

MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts

CH Inorganic clays of high plasticity, fat clays

OH Organic clays of medium to high plasticity

Table 3 – Typical properties of various soil groups [1]

Soil Groups	Typical properties [2]
GW, GP	• Low erodibility potential.
GM, GC	• Low to medium erodibility potential. • May create turbid runoff if disturbed as a result of the release of silt and clay particles.
SW, SP	• Low to medium erodibility potential.
SM, SC	• Medium erodibility potential. • May create turbid runoff if disturbed as a result of the release of silt and clay particles.
MH, CH	• Highly variable (low to high) erodibility potential. • Will generally create turbid runoff if disturbed.
ML, CL	• High erodibility potential. • Tendency to be dispersive. • May create some turbidity in runoff if disturbed.

Note: [1] After Soil Services & NSW DLWC (1998).

[2] Any soil can represent a high erosion risk if the binding clays or silts are unstable.

Table 4 provides **general** guidelines on the suitability of various soil groups to various engineering applications.

Table 4 – Engineering suitability based on Unified Soil Classification [1]

Unified Soil Class	USC Group	Embankments		Fill	Slope stability	Untreated roads
		Water retaining	Non water retaining			
Well graded gravels	GW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded gravel	GP	Unsuitable	Average	Excellent	Average	Unsuitable
Silty gravels	GM	Unsuitable	Average	Good	Average	Average
Clayey gravels	GC	Suitable	Average	Good	Average	Excellent
Well graded sands	SW	Unsuitable	Excellent	Excellent	Excellent	Average
Poorly graded sands	SP	Unsuitable	Average	Good	Average	Unsuitable
Silty sands	SM	Suitable [2]	Average	Average	Average	Poor
Clayey sands	SC	Suitable	Average	Average	Average	Good
Inorganic silts	ML	Unsuitable	Poor	Average	Poor	Unsuitable
Inorganic clays	CL	Suitable [2]	Good	Average	Good	Poor
Organic silts	OL	Unsuitable	Unsuitable	Poor	Unsuitable	Unsuitable

Unified Soil Class	USC Group	Embankments		Fill	Slope stability	Untreated roads
		Water retaining	Non water retaining			
Inorganic silts	MH	Unsuitable	Poor	Poor	Poor	Unsuitable
Inorganic clays	CH	Suitable [2]	Average	Unsuitable	Average	Unsuitable
Organic clays	OH	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable
Highly organic soils	Pt	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable

Notes: [1] Modified from Hazelton & Murphy (1992)

[2] Suitable only after modifications to soil such as compaction and/or erosion protection

[3] If the soils have not been tested for Emerson Class, then adopt a score of 4.

[2] **REQUIREMENTS:**

Works proposed on sites containing Emerson Class 1 or 2 soils have a very high pollution potential and must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

WARNINGS:

Class 3 and 5 soils disturbed by cut and fill operations or construction traffic are highly likely to discolour stormwater (i.e. cause turbid runoff). Chemical stabilisation will likely be required if these soils are placed immediately adjacent to a retaining wall. Any disturbed Class 1, 2, 3 and 5 soils that are to be revegetated must be covered with a non-dispersive topsoil as soon as possible (unless otherwise agreed by the regulatory authority).

Class 1 and 2 soils are highly likely to discolour (pollute) stormwater if exposed to rainfall or flowing water. Treatment of these soils with gypsum (or other suitable substance) will most likely be required. These soils should not be placed directly behind a retaining wall unless it has been adequately treated (stabilised) or covered with a non-dispersible soil.

The duration of disturbance refers to the total duration of soil exposure to rainfall up until a time when there is at least 70% coverage of all areas of soil.

[3] **REQUIREMENTS:**

All land developments with an expected soil disturbance period greater than 6 months must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the authority) during planning negotiations.

COMMENTS:

Construction periods greater than 3 months will generally experience at least some significant storm events, independent of the time of year that the construction (soil disturbance) occurs.

[4] **REQUIREMENTS:**

Development proposals with an expected soil disturbance in excess of 1ha must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

The area of disturbance refers to the total area of soil exposed to rainfall or dust-producing winds either as a result of:

(a) the removal of ground cover vegetation, mulch or sealed surfaces;
(b) past land management practices;
(c) natural conditions.

WARNINGS:

A *Sediment Basin* will usually be required if the disturbed area exceeds 0.25ha (2500m^2) within any sub-catchment (i.e. land flowing to one outlet point).

COMMENTS:

For soil disturbances greater than 0.25ha, the revegetation phase should be staged to minimise the duration for which soils are exposed to wind, rain and concentrated runoff.

[5] **REQUIREMENTS:**

All developments that involve earthworks or construction within a natural watercourse (whether that watercourse is in a natural or modified condition) must submit a conceptual ESCP to the regulatory authority for review and/or approval (as required by the regulatory authority) during planning negotiations.

Permits and/or licences may be required from the State Government, including possible submission of the ESCP to the relevant Government department.

[6] **REQUIREMENTS:**

No areas of soil disturbance shall be left exposed to rainfall or dust-producing winds at the end of a development without an adequate degree of protection and/or an appropriate action plan for the establishment of at least 70% cover.

COMMENTS:

Grass seeding without the application of a light mulch cover is considered the least favourable revegetation technique. A light mulch cover is required to protect the soil from raindrop impact, excessive temperature fluctuations, and the loss of essential soil moisture.

COMMENTS:

All receiving waters can be adversely affected by unnatural quantities of sediment-laden runoff. Freshwater ecosystems are generally more susceptible to ecological harm resulting from the inflow of fine or dispersible clays than saline water bodies. The further inland a land disturbance is, the greater the potential for the released sediment to cause environmental harm as this sediment travels towards the coast.

For the purpose of this clause it is assumed that all sediment-laden runoff will eventually flow into saline waters. Thus, sediment-laden discharges that flow first into freshwater are likely to adversely affect both fresh and saline water bodies and are therefore considered potentially more damaging to the environment.

This clause does **not** imply that sediment-laden runoff will not cause harm to saline waters.

COMMENTS:

This clause refers to subsoils exposed during the construction phase either as a result of past land practices or proposed construction activities. The exposure of subsoils resulting from the excavation of minor service trenches should not be considered.

WARNINGS:

The greater the extent of external catchment, the greater the need to divert up-slope stormwater runoff around any soil disturbance.

COMMENTS:

The ability to separate “clean” (i.e. external catchment) stormwater runoff from “dirty” site runoff can have a significant effect on the size, efficiency and cost of the temporary drainage, erosion, and sediment control measures.

[7] **REQUIREMENTS:**

Permission must be obtained from the owner of a road reserve before placing any erosion and sediment control measures within the road reserve.

WARNINGS:

Few sediment control techniques work efficiently when placed on a road and/or around roadside stormwater inlets. Great care must be taken if sediment control measures are located on a public roadway, specifically:

- safety issues relating to road users;
- the risk of causing flooding on the road or within private property.

The construction of roads (whether temporary or permanent) will usually modify the flow path of stormwater runoff. This can affect how “dirty” site runoff is directed to the sediment control measures.

COMMENTS:

“On-road” sediment control devices are at best viewed as secondary or supplementary sediment control measures. Only in special cases and/or on very small projects (e.g. kerb and channel replacement) might these controls be considered as the “primary” sediment control measure.

WARNINGS:

Soils with a pH less than 5.5 or greater than 8 will usually require treatment in order to achieve satisfactory revegetation. Soils with a pH of less than 5 (whether naturally acidic or in acid sulfate soil areas) may also limit the choice of chemical flocculants (e.g. Alum) for use in the flocculation of *Sediment Basins*.

[8] **REQUIREMENTS:**

A preliminary ESCP must be submitted to the local government for approval during the planning phase for any development that obtains a total point score of 17 or greater or when any trigger value is scored or exceeded.

Appendix B

Erosion and Sediment Control Standard Drawings

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, DIMENSIONS AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEREVER PRACTICAL, LOCATE THE LEVEL SPREADER ON UNDISTURBED, STABLE SOIL.

3. ENSURE FLOW DISCHARGING FROM THE LEVEL SPREADER WILL DISPERSE ACROSS A PROPERLY STABILISED SLOPE NOT EXCEEDING 10:1 (H:V) AND SUFFICIENTLY EVEN IN GRADE ACROSS THE SLOPE TO AVOID CONCENTRATING THE OUTFLOW.

4. THE OUTLET SILL OF THE SPREADER SHOULD BE PROTECTED WITH EROSION CONTROL MATTING TO PREVENT EROSION DURING THE ESTABLISHMENT OF VEGETATION. THE MATTING SHOULD BE A MINIMUM OF 1200mm WIDE EXTENDING AT LEAST 300mm UPSTREAM OF THE EDGE OF THE OUTLET CREST AND BURIED AT LEAST 150mm IN A VERTICAL TRENCH. THE DOWNSTREAM EDGE SHOULD BE SECURELY HELD IN PLACE WITH CLOSELY SPACED HEAVY-DUTY WIRE STAPLES AT LEAST 150mm LONG.

5. ENSURE THAT THE OUTLET SILL (CREST) IS LEVEL FOR THE SPECIFIED LENGTH.

6. IMMEDIATELY AFTER CONSTRUCTION, TURF, OR SEED AND MULCH WHERE APPROPRIATE, THE LEVEL SPREADER.

MAINTENANCE

1. INSPECT THE LEVEL SPREADER AFTER EVERY RAINFALL EVENT UNTIL VEGETATION IS ESTABLISHED.

2. AFTER ESTABLISHMENT OF VEGETATION OVER THE LEVEL SPREADER, INSPECTIONS SHOULD BE MADE ON A REGULAR BASIS AND AFTER RUNOFF-PRODUCING RAINFALL.

3. ENSURE THAT THERE IS NO SOIL EROSION AND THAT SEDIMENT DEPOSITION IS NOT CAUSING THE CONCENTRATION OF FLOW.

4. ENSURE THAT THERE IS NO SOIL EROSION OR CHANNEL DAMAGE UPSTREAM OF THE LEVEL SPREADER, OR SOIL EROSION OR VEGETATION DAMAGE DOWNSTREAM OF THE LEVEL SPREADER.

5. INVESTIGATE THE SOURCE OF ANY EXCESSIVE SEDIMENTATION.

6. MAINTAIN GRASS IN A HEALTH CONDITION WITH NO LESS THAN 90% COVER UNLESS CURRENT WEATHER CONDITIONS REQUIRE OTHERWISE.

7. GRASS HEIGHT SHOULD BE MAINTAINED AT A MINIMUM 50mm BLADE LENGTH WITHIN THE LEVEL SPREADER AND DOWNSTREAM DISCHARGE AREA, AND A MAXIMUM BLADE LENGTH NO GREATER THAN ADJACENT GRASSES.

REMOVAL

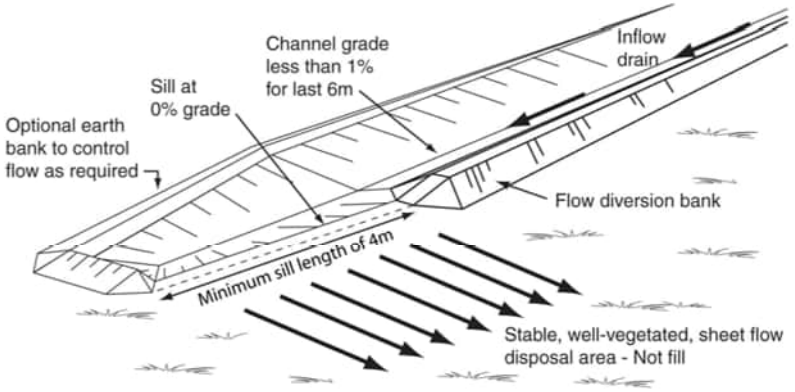
1. TEMPORARY LEVEL SPREADERS SHOULD BE DECOMMISSIONED ONLY AFTER AN ALTERNATIVE STABLE OUTLET IS OPERATIONAL, OR WHEN THE INFLOW CHANNEL IS DECOMMISSIONED.

2. REMOVE COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

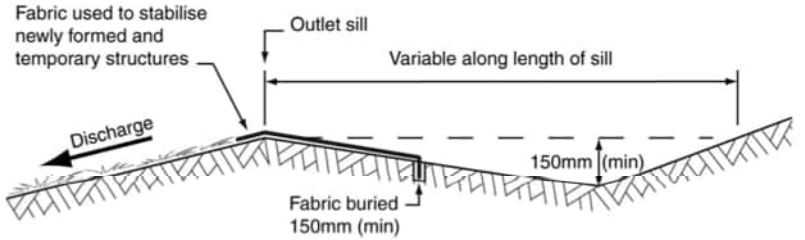
3. REMOVE AND APPROPRIATELY DISPOSE OF ANY EXPOSED GEOTEXTILE.

4. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

5. STABILISE THE AREA AS SPECIFIED ON THE APPROVED PLAN.

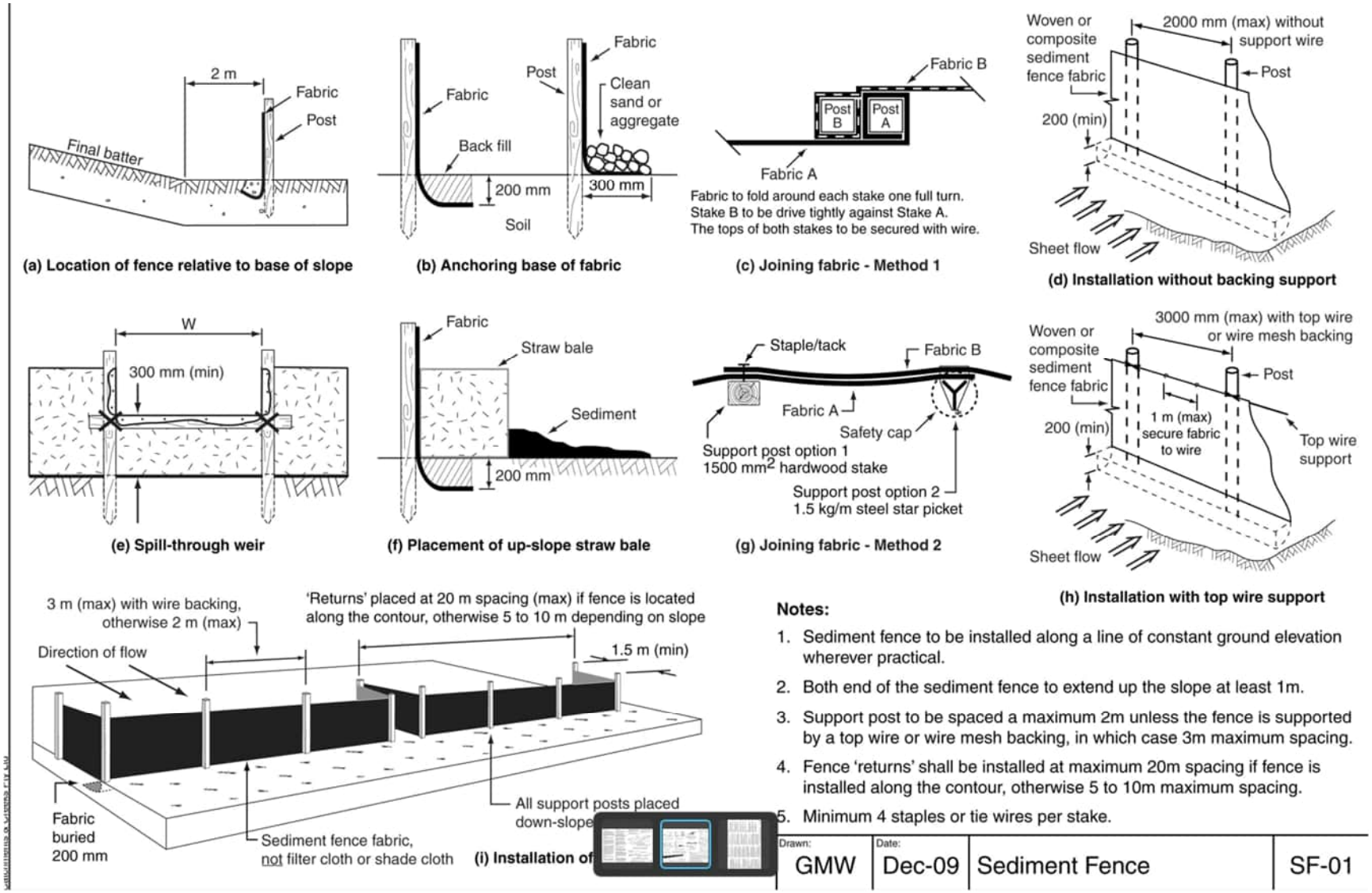


(a) Typical layout of level spreader



(b) Typical profile of the the outlet weir

Drawn:	Date:		
GMW	Dec-09	Level Spreaders	LS-01



Notes:

1. Sediment fence to be installed along a line of constant ground elevation wherever practical.
2. Both end of the sediment fence to extend up the slope at least 1m.
3. Support post to be spaced a maximum 2m unless the fence is supported by a top wire or wire mesh backing, in which case 3m maximum spacing.
4. Fence 'returns' shall be installed at maximum 20m spacing if fence is installed along the contour, otherwise 5 to 10m maximum spacing.
5. Minimum 4 staples or tie wires per stake.

Drawn:	Date:		
GMW	Dec-09	Sediment Fence	SF-01

MATERIALS

FABRIC: POLYPROPYLENE, POLYAMIDE, NYLON, POLYESTER, OR POLYETHYLENE WOVEN OR NON-WOVEN FABRIC, AT LEAST 700mm IN WIDTH AND A MINIMUM UNIT WEIGHT OF 140GSM. ALL FABRICS TO CONTAIN ULTRAVIOLET INHIBITORS AND STABILISERS TO PROVIDE A MINIMUM OF 6 MONTHS OF USEABLE CONSTRUCTION LIFE (ULTRAVIOLET STABILITY EXCEEDING 70%).

FABRIC REINFORCEMENT: WIRE OR STEEL MESH MINIMUM 14-GAUGE WITH A MAXIMUM MESH SPACING OF 200mm.

SUPPORT POSTS/STAKES: 1500mm^2 (MIN) HARDWOOD, 2500mm^2 (MIN) SOFTWOOD, OR 1.5kg/m (MIN) STEEL STAR PICKETS SUITABLE FOR ATTACHING FABRIC.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND REQUIRED TYPE OF FABRIC (IF SPECIFIED). IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, FABRIC TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. TO THE MAXIMUM DEGREE PRACTICAL, AND WHERE THE PLANS ALLOW, ENSURE THE FENCE IS LOCATED:
(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;
(ii) ALONG A LINE OF CONSTANT ELEVATION WHEREVER PRACTICAL;
(iii) AT LEAST 2m FROM THE TOE OF ANY FILLING OPERATIONS THAT MAY RESULT IN SHIFTING SOIL/FILL DAMAGING THE FENCE.

3. INSTALL RETURNS WITHIN THE FENCE AT MAXIMUM 20m INTERVALS IF THE FENCE IS INSTALLED ALONG THE CONTOUR, OR 5 TO 10m MAXIMUM SPACING (DEPENDING ON SLOPE) IF THE FENCE IS INSTALLED AT AN ANGLE TO THE CONTOUR. THE 'RETURNS' SHALL CONSIST OF EITHER:
(i) V-SHAPED SECTION EXTENDING AT LEAST 1.5m UP THE SLOPE; OR
(ii) SANDBAG OR ROCK/AGGREGATE CHECK DAM A MINIMUM 1/3 AND MAXIMUM 1/2 FENCE HEIGHT, AND EXTENDING AT LEAST 1.5m UP THE SLOPE.

4. ENSURE THE EXTREME ENDS OF THE FENCE ARE TURNED UP THE SLOPE AT LEAST 1.5m, OR AS NECESSARY, TO MINIMISE WATER BYPASSING AROUND THE FENCE.

5. ENSURE THE SEDIMENT FENCE IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE FENCE, AND THE UNDESIRABLE DISCHARGE OF WATER AROUND THE ENDS OF THE FENCE.

6. IF THE SEDIMENT FENCE IS TO BE INSTALLED ALONG THE EDGE OF EXISTING TREES, ENSURE CARE IS TAKEN TO PROTECT THE TREES AND THEIR ROOT SYSTEMS DURING INSTALLATION OF THE FENCE. DO NOT ATTACH THE FABRIC TO THE TREES.

7. UNLESS DIRECTED BY THE SITE SUPERVISOR OR THE APPROVED PLANS, EXCAVATE A 200mm WIDE BY 200mm DEEP TRENCH ALONG THE PROPOSED FENCE LINE, PLACING THE EXCAVATED MATERIAL ON THE UP-SLOPE SIDE OF THE TRENCH.

8. ALONG THE LOWER SIDE OF THE TRENCH, APPROPRIATELY SECURE THE STAKES INTO THE GROUND SPACED NO GREATER THAN 3m IF SUPPORTED BY A TOP SUPPORT WIRE OR WEIR MESH BACKING, OTHERWISE NO GREATER THAN 2m.

9. IF SPECIFIED, SECURELY ATTACH THE SUPPORT WIRE OR MESH TO THE UP-SLOPE SIDE OF THE STAKES WITH THE MESH EXTENDING AT LEAST 200mm INTO THE EXCAVATED TRENCH. ENSURE THE MESH AND FABRIC IS ATTACHED TO THE UP-SLOPE SIDE OF THE STAKES EVEN WHEN DIRECTING A FENCE AROUND A CORNER OR SHARP CHANGE OF DIRECTION.

10. WHEREVER POSSIBLE, CONSTRUCT THE SEDIMENT FENCE FROM A CONTINUOUS ROLL OF FABRIC. TO JOIN FABRIC EITHER:
(i) ATTACH EACH END TO TWO OVERLAPPING STAKES WITH THE FABRIC FOLDING AROUND THE ASSOCIATED STAKE ONE TURN, AND WITH THE TWO STAKES TIED TOGETHER WITH WIRE; OR
(ii) OVERLAP THE FABRIC TO THE NEXT ADJACENT SUPPORT POST.

11. SECURELY ATTACH THE FABRIC TO THE SUPPORT POSTS USING 25 X 12.5mm STAPLES, OR TIE WIRE AT MAXIMUM 150mm SPACING.

12. SECURELY ATTACH THE FABRIC TO THE SUPPORT WIRE/MESH (IF ANY) AT A MAXIMUM SPACING OF 1m.

13. ENSURE THE COMPLETED SEDIMENT FENCE IS AT LEAST 450mm, BUT NOT MORE THAN 700mm HIGH. IF A SPILL-THOUGH WEIR IS INSTALLED, ENSURE THE CREST OF THE WEIR IS AT LEAST 300mm ABOVE GROUND LEVEL.

14. BACKFILL THE TRENCH AND TAMP THE FILL TO FIRMLY ANCHOR THE BOTTOM OF THE FABRIC AND MESH TO PREVENT WATER FROM FLOWING UNDER THE FENCE.

ADDITIONAL REQUIREMENTS FOR THE INSTALLATION OF A SPILL-THROUGH WEIR

1. LOCATE THE SPILL-THROUGH WEIR SUCH THAT THE WEIR CREST WILL BE LOWER THAN THE GROUND LEVEL AT EACH END OF THE FENCE.

2. ENSURE THE CREST OF THE SPILL-THROUGH WEIR IS AT LEAST 300mm THE GROUND ELEVATION.

3. SECURELY TIE A HORIZONTAL CROSS MEMBER (WEIR) TO THE SUPPORT POSTS/ STAKES EACH SIDE OF THE WEIR. CUT THE FABRIC DOWN THE SIDE OF EACH POST AND FOLD THE FABRIC OVER THE CROSS MEMBER AND APPROPRIATELY SECURE THE FABRIC.

4. INSTALL A SUITABLE SPLASH PAD AND/OR CHUTE IMMEDIATELY DOWN-SLOPE OF THE SPILL-THROUGH WEIR TO CONTROL SOIL EROSION AND APPROPRIATELY DISCHARGE THE CONCENTRATED FLOW PASSING OVER THE WEIR.

MAINTENANCE

1. INSPECT THE SEDIMENT FENCE AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR ANY TORN SECTIONS WITH A CONTINUOUS PIECE OF FABRIC FROM POST TO POST.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. IF THE FENCE IS SAGGING BETWEEN STAKES, INSTALL ADDITIONAL SUPPORT POSTS.

5. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 1/3 THE HEIGHT OF THE FENCE.

6. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. REPLACE THE FABRIC IF THE SERVICE LIFE OF THE EXISTING FABRIC EXCEEDS 6-MONTHS.

REMOVAL

1. WHEN DISTURBED AREAS UP-SLOPE OF THE SEDIMENT FENCE ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE FENCE MUST BE REMOVED.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

Drawn:	Date:		
GMW	Apr-10	Sediment Fence	SF-02

Catchments & Creeks Pty Ltd

MATERIAL

GRAVEL: 20–50mm HARD, ANGULAR, DURABLE, WEATHER RESISTANT AND EVENLY GRADED WITH 50% BY WEIGHT LARGER THAN THE SPECIFIED NOMINAL ROCK SIZE AND SUFFICIENT SMALL ROCK TO FILL THE VOIDS BETWEEN THE LARGER ROCK. THE DIAMETER OF THE LARGEST ROCK SIZE SHOULD BE NO LARGER THAN 1.5 TIMES THE NOMINAL ROCK SIZE.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. SPREAD ENOUGH GRAVEL TO COMPLETELY COVER THE SURFACE OF THE SOIL AT THE DENSITY OR THICKNESS SPECIFIED IN THE APPROVED PLANS. IF THE APPLICATION DENSITY IS NOT SUPPLIED, THEN APPLY AT A THICKNESS OF AT LEAST TWICE THE MEAN ROCK SIZE.

3. MAKE ALL NECESSARY ADJUSTMENTS TO ENSURE ANY RUN-ON STORMWATER FLOW IS ALLOWED TO PASS FREELY ACROSS THE TREATED AREA FOLLOWING ITS NATURAL DRAINAGE PATH.

MAINTENANCE

1. INSPECT ALL TREATED SURFACES FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. CHECK FOR RILL EROSION, OR DISLODGMENT OF THE GRAVEL.

3. REPLACE ANY DISPLACED GRAVEL TO MAINTAIN THE REQUIRED COVERAGE.

4. IF WASH-OUTS OCCUR, REPAIR THE SLOPE AND REINSTALL SURFACE COVER.

5. IF THE GRAVELLING IS NOT EFFECTIVE IN CONTAINING THE SOIL EROSION IT SHOULD BE REPLACED, OR AN ALTERNATIVE EROSION CONTROL PROCEDURE ADOPTED.

Drawn:	Date:		
GMW	Dec-09	Gravelling	Gravel-01

Catchments & Creeks Pty Ltd

MATERIALS

UNLESS OTHERWISE SPECIFIED, THE FOLLOWING MATERIAL SPECIFICATIONS SHOULD APPLY.

GEOTEXTILE BLANKETS:
(i) WOVEN POLYPROPYLENE FABRIC.
(ii) MINIMUM THICKNESS OF 1.5mm.
(iii) MINIMUM WIDTH OF 3.6m.

STAPLES:
(i) MINIMUM 11 GAUGE STEEL WIRE.
(ii) U-SHAPED WITH 200mm LEG LENGTH AND 50mm CROWN.

EXCELSIOR BLANKETS:
(i) CURLED WOOD FIBRE BLANKET WITH 80% OF FIBRES LONGER THAN 150mm.
(ii) MINIMUM ROLL WIDTH OF 1200mm.
(iii) AVERAGE WEIGHT OF 0.43kg/m^2 +/-10%.

STRAW BLANKETS:
(i) MINIMUM ROLL WIDTH OF 2m.
(ii) MINIMUM WEIGHT OF 0.27kg/m^2.

COCONUT FIBRE BLANKETS:
(i) MINIMUM ROLL WIDTH OF 2m.
(ii) MINIMUM WEIGHT OF 0.27kg/m^2.

INSTALLATION

THE METHOD OF INSTALLATION VARIES WITH THE TYPE OF MATERIAL USED AND THE TASK BEING PERFORMED BY THE BLANKET. INSTALLATION PROCEDURES SHOULD BE SUPPLIED BY THE MANUFACTURER OR DISTRIBUTOR OF THE PRODUCT. A TYPICAL INSTALLATION PROCEDURE FOR ROLLED EROSION CONTROL PRODUCTS IS DESCRIBED BELOW.

APPLICATION OF ROLLED BLANKETS ON SLOPES NOT SUBJECTED TO CONCENTRATED FLOW:

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND INSTALLATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR AWAY TRASH AND LARGE STONES, AND GRADE SMOOTHLY TO ELIMINATE FOOTPRINTS, TRACKS AND RUTS.

3. PREPARE A SMOOTH SEEDBED OF APPROXIMATELY 75mm OF TOPSOIL.

4. APPLY SEED, SOIL AMELIORANTS AND WATER AS SPECIFIED, THEN RAKE TO REMOVE ANY REMAINING SURFACE IRREGULARITIES.

5. COMMENCE PLACEMENT OF THE BLANKETS AT THE TOP OF THE SLOPE. BURY THE UPPER EDGE OF THE BLANKET WITHIN A 300mm DEEP TRENCH AND STAPLE AT 200 TO 250mm CENTRES.

6. THE BLANKETS CAN BE PLACED LENGTHWISE EITHER ALONG THE SLOPE (PARALLEL TO THE CONTOURS) OR DOWN THE SLOPE (TRANSVERSE TO THE CONTOURS), BUT NOT DIAGONALLY ACROSS THE SLOPE.

7. OVERLAP THE SIDES OF EACH BLANKET BY AT LEAST 100mm.

8. BURY THE EDGE OF THE BLANKET LOCATED ALONG THE OUTER MOST EDGE OF THE TREATED AREA WITHIN A 300mm DEEP TRENCH AND STAPLE THE BLANKET WITHIN THE TRENCH AT 200 TO 250mm CENTRES.

9. WHERE MORE THAN ONE BLANKET IS USED DOWN THE SLOPE, OVERLAP EACH BLANKET BY AT LEAST 300mm WITH THE UPPER BLANKET PLACED OVER THE LOWER BLANKET (SHINGLE STYLE).

10. WHEN SPREADING THE BLANKETS, AVOID STRETCHING THE FABRIC. THE BLANKETS SHOULD REMAIN IN GOOD CONTACT WITH THE SOIL.

11. STAPLE THE EXPOSED FABRIC SURFACE AT 1m CENTRES.

12. BLANKETS, ONCE FIXED, MAY BE ROLLED WITH A ROLLER WEIGHING 60 TO 90kg/m LENGTH, THEN WATERED.

13. THE INSTALLATION PROCEDURE MUST ENSURE THAT THE BLANKET ACHIEVES AND RETAINS INTIMATE CONTACT WITH THE SOIL.

14. DAMAGED FABRIC SHALL BE REPAIRED OR REPLACED.

15. WHERE DIRECTED, AN ADDITIONAL MESH (JUTE OR COIR) ANCHOR MAY NEED TO BE PLACED OVER THE BLANKETS TO MINIMISE DISPLACEMENT BY STRONG WINDS.

ADDITIONAL REQUIREMENTS ASSOCIATED WITH USE NEAR AIRPORT PAVEMENTS:

1. ONLY BLANKETS THAT ARE DOUBLE NETTED SHALL BE ALLOWED WITHIN 3m OF ANY AIRPORT PAVEMENT USED BY AIRCRAFT WITH THE EXCEPTION OF AIRPORTS CLASSIFIED AS AIR CARRIER OR CORPORATE/TRANSPORT. IF THE AIRPORT IS CLASSIFIED AS AN AIR CARRIER OR CORPORATE/TRANSPORT, THERE WILL BE NO BLANKETS ALLOWED WITHIN 9m OF PAVEMENT USED BY AIRCRAFT.

2. ONLY BIODEGRADABLE ANCHORING DEVICES SHALL BE ALLOWED IN THE INSTALLATION OF ANY BLANKET FOR AIRPORT APPLICATIONS. NO METAL STAPLES WILL BE ALLOWED.

MAINTENANCE

1. DURING THE ACTIVE CONSTRUCTION PERIOD, INSPECT THE TREATED AREA FORTNIGHTLY AND AFTER RUNOFF-PRODUCING STORM EVENTS AND MAKE REPAIRS AS NEEDED.

2. THE TREATED AREA SHOULD BE INSPECTED AT LEAST FORTNIGHTLY FOR THE FIRST 3 MONTHS.

3. INSPECT THE TREATED AREA TO SEE IF:
(i) CONSTRUCTION ACTIVITY OR FALLING DEBRIS HAVE DAMAGED THE BLANKETS;
(ii) RUNOFF IS UNDERMINING THE FABRIC;
(iii) THE BLANKETS ARE IN GOOD CONTACT WITH THE SOIL; AND
(iv) THE BLANKETS MAINTAIN ADEQUATE OVERLAP.

4. IF DAMAGED, REPAIR OR REPLACE THE DAMAGED SECTION. IF WATER IS UNDERMINING THE FABRIC, REPAIR ANY HOLES OR JOINTS OR RE-BURY THE UPPER ENDS OF THE DAMAGED SECTIONS.

Drawn:	Date:		
GMW	May-10	Erosion Control Blankets	ECB-01

Catchments & Creeks Pty Ltd

CAUTION; SPECIFICATIONS FOR SITE REVEGETATION VARY CONSIDERABLY FROM SITE TO SITE. SITE SUPERVISORS SHOULD OBTAIN SITE SPECIFIC PLANTING SPECIFICATIONS.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND APPLICATION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF APPLICATION CONTACT THE ENGINEER, LANDSCAPE ARCHITECT OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. ENSURE ALL NECESSARY SOIL TESTING (e.g. SOIL pH, NUTRIENT LEVELS) AND ANALYSIS HAS BEEN COMPLETED, AND REQUIRED SOIL ADJUSTMENTS PERFORMED PRIOR TO PLANTING.

3. APPLY SOIL CONDITIONERS AND FERTILISER AS SPECIFIED ON THE APPROVED PLANS. RIP THE SOIL 100 TO 150mm TO MIX THE COMPONENTS INTO THE SOIL AND TO LOOSEN AND ROUGHEN THE SOIL SURFACE BEFORE SEEDING.

4. WHERE POSSIBLE, THERE SHOULD BE SUFFICIENT SOIL DEPTH TO PROVIDE AN ADEQUATE ROOT ZONE. THE DEPTH TO ROCK OR IMPERMEABLE LAYERS SUCH AS HARDPANS SHOULD BE 300mm OR MORE, EXCEPT ON SLOPES STEEPER THAN 2:1(H:V) WHERE SUCH SOIL DEPTH MAY NOT BE FEASIBLE.

5. ENSURE THE SOIL pH IS WITHIN THE SPECIFIED RANGE.

6. APPLY SEED UNIFORMLY BY HAND OR WITH A CYCLONE SEEDER, DROP-TYPE SPREADER, DRILL, HYDROSEEDER, HYDROMULCHER, OR OTHER SUITABLE EQUIPMENT AS SPECIFIED.

7. WHEN USING BROADCAST-SEEDING METHODS, SUBDIVIDE THE AREA INTO WORKABLE SECTIONS AND APPLY ONE-HALF THE SPECIFIED QUANTITY OF SEED WHILE MOVING BACK AND FORTH ACROSS THE AREA, MAKING A UNIFORM PATTERN. THEN APPLY THE SECOND HALF IN THE SAME WAY, BUT MOVING AT RIGHT ANGLES TO THE FIRST PASS. COVER BROADCAST SEED BY RAKING OR CHAIN DRAGGING; THEN FIRM THE SURFACE WITH A ROLLER TO PROVIDE GOOD SEED CONTACT.

8. APPLY SEED AT THE RECOMMENDED RATE, AND DISC OR OTHERWISE MECHANICALLY TREAT THE SURFACE TO BRING THE SEED INTO CONTACT WITH THE SOIL.

9. THE SEEDED AREA SHOULD BE MULCHED AS SPECIFIED IN THE APPROVED PLAN.

MAINTENANCE

1. DURING THE CONSTRUCTION PHASE, INSPECT THE TREATED AREA FORTNIGHTLY AND AFTER RUNOFF-PRODUCING RAINFALL. MAKE REPAIRS AS NEEDED.

2. WATERING THE VEGETATION PERIODICALLY IS ESSENTIAL, ESPECIALLY IN THE FIRST 7 DAYS AFTER ESTABLISHMENT. USE LOW-PRESSURE SPRAYS BECAUSE HIGH-PRESSURE JETS CAN WASH AWAY THE SEED AND MULCH COVER.

3. WATERING SHOULD START IMMEDIATELY AFTER PLANTING. WATERING SHOULD COMPLY WITH SPECIFICATIONS PROVIDED WITH THE APPROVED PLANS. GENERALLY WATERING SHOULD VARY ACCORDING TO WEATHER AND SOIL CONDITIONS. A TYPICAL WATERING SCHEDULE MAY CONSIST OF THE FOLLOWING:
(i) 25mm EVERY SECOND DAY FOR THE FIRST THREE WATERINGS;
(ii) 25mm TWICE A WEEK FOR THE NEXT THREE WEEKS; AND
(iii) 25mm ONCE WEEKLY FOR A FURTHER TWO WEEKS.

4. MONITOR SITE REVEGETATION, PARTICULARLY AFTER RAINFALL, AND APPROPRIATE MAINTENANCE AND/OR AMENDMENT TO ENSURE THAT THE REVEGETATION IS CONTROLLING EROSION AND STABILISING SOIL SLOPES AS REQUIRED.

5. WHERE PRACTICABLE, FILL IN, OR LEVEL OUT, ANY RILL EROSION BETWEEN PLANTS. IF EXCESSIVE EROSION OCCURS, THEN CONSIDER INCREASING THE PLANTING DENSITY, APPLYING APPROPRIATE EROSION CONTROL MEASURES, OR INTRODUCING ALTERNATIVE, NON-CLUMPING PLANT SPECIES.

6. AREAS MUST BE RE-SEEDED AND MULCHED IF THE VEGETATION FAILS TO ESTABLISH OR IS DAMAGED BY RUNOFF OR CONSTRUCTION ACTIVITIES.

7. IF THE TEMPORARY VEGETATION COVER OR EROSION CONTROL MEASURE (e.g. MULCH COVER) SHOULD FAIL FOR ANY REASON BEFORE ESTABLISHMENT OF THE PERMANENT VEGETATION COVER, THEN IT MUST BE REPLACED WITH AN APPROPRIATE TYPE OF COVER SUFFICIENT TO CONTROL SOIL EROSION.

8. IF THE PERMANENT VEGETATION SHOULD FAIL TO ESTABLISH OR TO ADEQUATELY RESTRAIN EROSION FOR ANY REASON DURING THE CONSTRUCTION OR MAINTENANCE PERIOD, THE AREA SHOULD BE REVEGETATED OR PROTECTED WITH OTHER EROSION CONTROL MEASURES AS APPROPRIATE.

9. IN AREAS WHERE THE OBTAINED VEGETATION COVER IS CONSIDERED INADEQUATE FOR EROSION CONTROL, THE AFFECTED AREA SHOULD BE OVER-SEEDED AND FERTILISED USING HALF THE ORIGINALLY SPECIFIED RATES, OR AS DIRECTED.

10. MAINTAIN GRASS BLADE LENGTH AT A MINIMUM 50mm HEIGHT WITHIN MEDIUM TO HIGH VELOCITY DRAINAGE AREAS, AND 20 TO 50mm WITHIN LOW VELOCITY FLOW PATHS.

11. WHERE NECESSARY, OR AS DIRECTED BY THE SITE SUPERVISOR, SLASH THE TEMPORARY CROP/GRASS COVER TO ALLOW THE SUCCESSFUL GROWTH OF THE UNDERLYING PERMANENT VEGETATION COVER.

12. CONTROL WEED GROWTH WITHIN 1m OF I-MMATURE TREES FOR 6 TO 12 MONTHS FOR FAST GROWING SPECIES, AND 18 TO 20 MONTHS FOR SLOWER GROWING SPECIES, OR UNTIL THE END OF THE SPECIFIED MAINTENANCE PERIOD.

13. WHERE MULCH IS USED TO CONTROL WEED GROWTH, INSPECT AND WHERE NECESSARY, RENEW AT MAINTENANCE PERIODS NOT EXCEEDING 4 TO 6 MONTHS.

14. APPLY ADDITIONAL SEED, MULCH AND/OR SOIL CONDITIONING AS REQUIRED. MULCHES USUALLY NEED TO BE MAINTAINED OR RENEWED (AS NECESSARY) 2 TO 3 TIMES A YEAR.

15. INSPECT AND WHERE NECESSARY REPAIR PROTECTIVE FENCING AT MAINTENANCE PERIODS NOT EXCEEDING 1 MONTH.

16. RE-FIRM PLANTS LOOSENED BY WIND-ROCK, LIVESTOCK OR WILDLIFE.

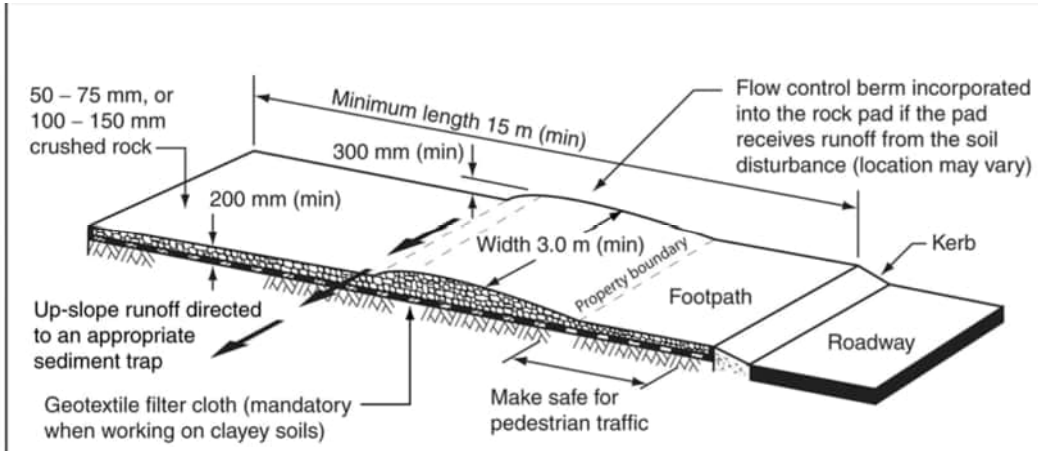
17. REPLACE DEAD OR SEVERELY RETARDED PLANTS.

18. PRUNE ANY PLANTS OF DEAD OR DISEASED PARTS. CUT OFF ALL DAMAGED TREE LIMBS ABOVE THE TREE COLLAR AT THE TRUNK OR MAIN BRANCH. USE SEVERAL CUTS INCLUDING UNDERCUTTING TO AVOID PEELING BARK FROM THE HEALTHY AREAS OF THE TREE.

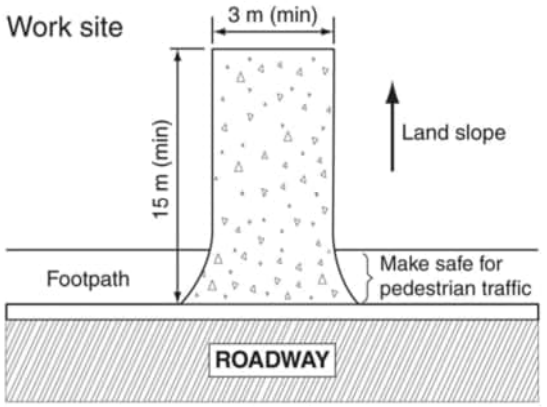
19. DISPOSE OF CLEARED VEGETATION IN AN APPROPRIATE MANNER SUCH AS CHIPPING OR MULCHING, ON-SITE BURIAL, OR OFF-SITE DISPOSAL. CLEARED VEGETATION SHOULD NOT BE DUMPED NEAR A WATERCOURSE OR ON A FLOODPLAIN WHERE IS COULD BE REMOVED BY FLOODWATERS. VEGETATION SHOULD NOT BE BURNT ON-SITE WITHOUT SPECIFIC APPROVAL FROM THE LOCAL AUTHORITY.

20. REPAIR DAMAGED TREE ROOTS BY CUTTING OFF THE DAMAGED AREAS AND SEALING THEM WITH AN APPROVED PRODUCT. SPREAD MOIST TOPSOIL OVER EXPOSED ROOTS.

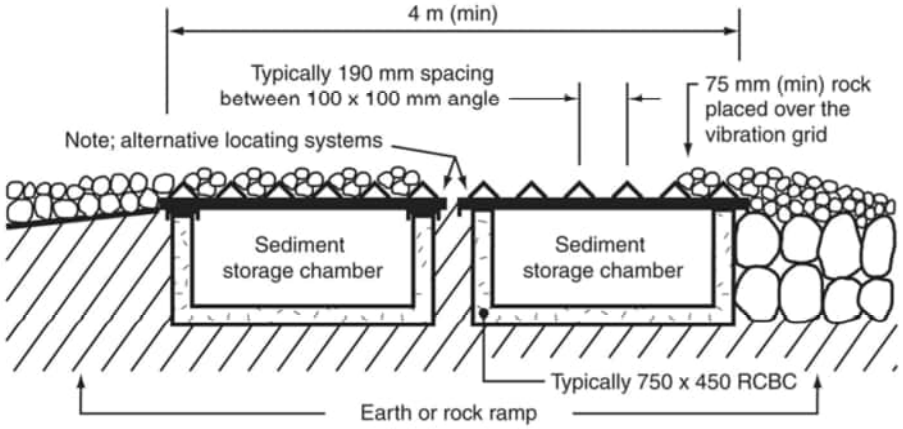
Drawn:	Date:		
GMW	Dec-09	Revegetation - General	R-01



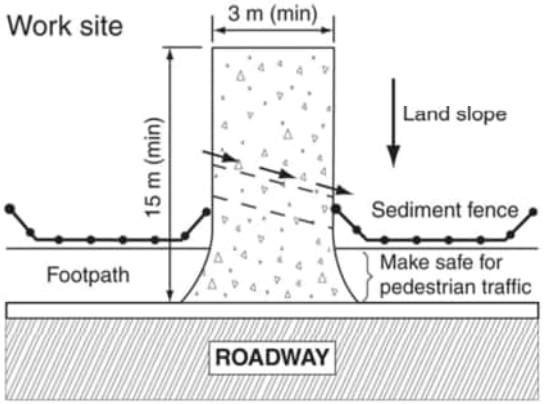
(a) Rock entry/exit pad for construction sites (refer to Standard Drawing Exit-03 for building sites)



(b) Rock pad sloping away from road



(c) Alternative low maintenance arrangement (still under development)



(d) Rock pad sloping towards the road

Drawn:	Date:		
GMW	Apr-10	Construction Exit - Rock Pad (construction sites only)	Exit-01

MATERIALS

ROCK: WELL GRADED, HARD, ANGULAR, EROSION RESISTANT ROCK, NOMINAL DIAMETER OF 50 TO 75mm (SMALL DISTURBANCES) OR 100 TO 150mm (LARGE DISTURBANCES). ALL REASONABLE MEASURES MUST BE TAKEN TO OBTAIN ROCK OF NEAR UNIFORM SIZE.

FOOTPATH STABILISING AGGREGATE: 25 TO 50mm GRAVEL OR AGGREGATE.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH ('BIDIM' A24 OR EQUIVALENT).

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION OF THE ROCK PAD, REMOVING STUMPS, ROOTS AND OTHER VEGETATION TO PROVIDE A FIRM FOUNDATION SO THAT THE ROCK IS NOT PRESSED INTO SOFT GROUND. CLEAR SUFFICIENT WIDTH TO ALLOW PASSAGE OF LARGE VEHICLES, BUT CLEAR ONLY THAT NECESSARY FOR THE EXIT. DO NOT CLEAR ADJACENT AREAS UNTIL THE REQUIRED EROSION AND SEDIMENT CONTROL DEVICES ARE IN PLACE.

3. IF THE EXPOSED SOIL IS SOFT, PLASTIC OR CLAYEY, PLACE A SUB-BASE OF CRUSHED ROCK OR A LAYER OF HEAVY-DUTY FILTER CLOTH TO PROVIDE A FIRM FOUNDATION.

4. PLACE THE ROCK PAD FORMING A MINIMUM 200mm THICK LAYER OF CLEAN, OPEN-VOID ROCK.

5. IF THE ASSOCIATED CONSTRUCTION SITE IS UP-SLOPE OF THE ROCK PAD, THUS CAUSING STORMWATER RUNOFF TO FLOW TOWARDS THE ROCK PAD, THEN FORM A MINIMUM 300mm HIGH FLOW CONTROL BERM ACROSS THE ROCK PAD TO DIVERT SUCH RUNOFF TO A SUITABLE SEDIMENT TRAP.

6. THE LENGTH OF THE ROCK PAD SHOULD BE AT LEAST 15m WHERE PRACTICABLE, AND AS WIDE AS THE FULL WIDTH OF THE ENTRY OR EXIT AND AT LEAST 3m. THE ROCK PAD SHOULD COMMENCE AT THE EDGE OF THE OFF-SITE SEALED ROAD OR PAVEMENT.

7. FLARE THE END OF THE ROCK PAD WHERE IT MEETS THE PAVEMENT SO THAT THE WHEELS OF TURNING VEHICLES DO NOT TRAVEL OVER UNPROTECTED SOIL.

8. IF THE FOOTPATH IS OPEN TO PEDESTRIAN MOVEMENT, THEN COVER THE COARSE ROCK WITH FINE AGGREGATE OR GRAVEL, OR OTHERWISE TAKE WHATEVER MEASURES ARE NEEDED TO MAKE THE AREA SAFE.

MAINTENANCE

1. INSPECT ALL SITE ENTRY AND EXIT POINTS PRIOR TO FORECAST RAIN, DAILY DURING EXTENDED PERIODS OF RAINFALL, AFTER RUNOFF-PRODUCING RAINFALL, OR OTHERWISE AT FORTNIGHTLY INTERVALS.

2. IF SAND, SOIL, SEDIMENT OR MUD IS TRACKED OR WASHED ONTO THE ADJACENT SEALED ROADWAY, THEN SUCH MATERIAL MUST BE PHYSICALLY REMOVED, FIRST USING A SQUARE-EDGED SHOVEL, AND THEN A STIFF-BRISTLED BROOM, AND THEN BY A MECHANICAL VACUUM UNIT, IF AVAILABLE.

3. IF NECESSARY FOR SAFETY REASONS, THE ROADWAY SHALL ONLY BE WASHED CLEAN AFTER ALL REASONABLE EFFORTS HAVE BEEN TAKEN TO SHOVEL AND SWEEP THE MATERIAL FROM THE ROADWAY.

4. WHEN THE VOIDS BETWEEN THE ROCK BECOMES FILLED WITH MATERIAL AND THE EFFECTIVENESS OF THE ROCK PAD IS REDUCED TO A POINT WHERE SEDIMENT IS BEING TRACKED OFF THE SITE, A NEW 100mm LAYER OF ROCK MUST BE ADDED AND/OR THE ROCK PAD MUST BE EXTENDED.

5. ENSURE ANY ASSOCIATED DRAINAGE CONTROL MEASURES (e.g. FLOW CONTROL BERM) ARE MAINTAINED IN ACCORDANCE WITH THEIR DESIRED OPERATIONAL CONDITIONS.

6. DISPOSE OF SEDIMENT AND DEBRIS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

REMOVAL

1. THE ROCK PAD SHOULD BE REMOVED ONLY AFTER IT IS NO LONGER NEEDED AS A SEDIMENT TRAP.

2. REMOVE MATERIALS AND COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.
3. RE-GRADE AND STABILISE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

struction Exit - Rock Pad (construction sites only)	Exit-02

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE BANK, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY. DO NOT USE DEBRIS TO BUILD THE BANK.

4. FORM THE BANK FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.

5. IF EARTH IS USED, THEN ENSURE THE SIDES OF THE BANK ARE NO STEEPER THAN A 2:1 (H:V) SLOPE, AND THE COMPLETED BANK MUST BE AT LEAST 500mm HIGH.

6. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.

7. CHECK THE BANK ALIGNMENT TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.

8. THE BANK SHOULD BE VEGETATED (TURFED, SEEDED AND MULCHED), OR OTHERWISE STABILISED IMMEDIATELY, UNLESS IT WILL OPERATE FOR LESS THAN 30 DAYS OR IF SIGNIFICANT RAINFALL IS NOT EXPECTED DURING THE LIFE OF THE BANK.

9. ENSURE THE EMBANKMENT DRAINS TO A STABLE OUTLET, AND DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW DIVERSION BANKS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. INSPECT THE BANK FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.

3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

5. REPAIR ANY PLACES IN THE BANK THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW DIVERSION BANK SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

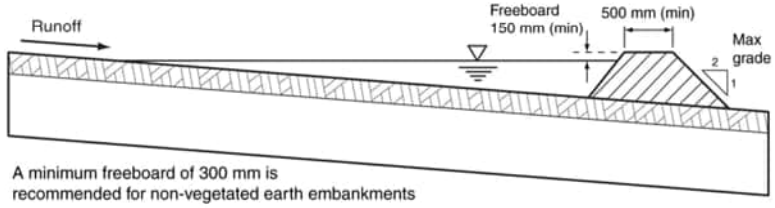


Figure 1 - Typical profile of flow diversion bank formed from earth

Table 1 - Recommended dimensions of flow diversion banks

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

Drawn:	Date:		
GMW	Dec-09	Flow Diversion Banks	DB-01

MATERIALS

(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.

(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.

(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:

(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;

(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);

(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;

(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.

3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.

4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.

5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.

6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.

7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.

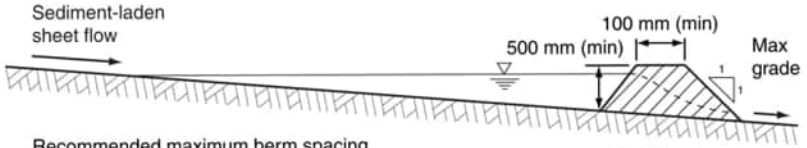
5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL (IF REQUIRED)

1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.

2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.



Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure 1 - Typical placement of mulch filter berm

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION, EXTENT, AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. CLEAR THE LOCATION FOR THE BERM, CLEARING ONLY THE AREA THAT IS NEEDED TO PROVIDE ACCESS FOR PERSONNEL AND EQUIPMENT.

3. REMOVE ROOTS, STUMPS, AND OTHER DEBRIS AND DISPOSE OF THEM PROPERLY.

4. FORM THE BERM FROM THE MATERIAL, AND TO THE DIMENSION SPECIFIED IN THE APPROVED PLANS.

5. IF FORMED FROM SANDBAGS, THEN ENSURE THE BAGS ARE TIGHTLY PACKED SUCH THAT WATER LEAKAGE THROUGH THE BAGS IS MINIMISED.

6. CHECK THE ALIGNMENT OF THE BERM TO ENSURE POSITIVE DRAINAGE IN THE DESIRED DIRECTION.

7. ENSURE THE BERM DISCHARGES TO A STABLE OUTLET.

8. ENSURE THE BERM DOES NOT DISCHARGE TO AN UNSTABLE FILL SLOPE.

MAINTENANCE

1. INSPECT FLOW CONTROL BERMS AT LEAST WEEKLY AND AFTER RUNOFF-PRODUCING RAINFALL.

2. INSPECT THE BERM FOR ANY SLUMPS, WHEEL TRACK DAMAGE OR LOSS OF FREEBOARD. MAKE REPAIRS AS NECESSARY.

3. CHECK THAT FILL MATERIAL OR SEDIMENT HAS NOT PARTIALLY BLOCKED THE DRAINAGE PATH UP-SLOPE OF THE EMBANKMENT. WHERE NECESSARY, REMOVE ANY DEPOSITED MATERIAL TO ALLOW FREE DRAINAGE.

4. DISPOSE OF ANY COLLECTED SEDIMENT OR FILL IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

5. REPAIR ANY PLACES IN THE BERM THAT ARE WEAKENED OR IN RISK OF FAILURE.

REMOVAL

1. WHEN THE SOIL DISTURBANCE ABOVE THE BANK IS FINISHED AND THE AREA IS STABILISED, THE FLOW CONTROL BERM SHOULD BE REMOVED, UNLESS IT IS TO REMAIN AS A PERMANENT DRAINAGE FEATURE.

2. DISPOSE OF ANY SEDIMENT OR EARTH IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.
3. GRADE THE AREA AND SMOOTH IT OUT IN PREPARATION FOR STABILISATION.

4. STABILISE THE AREA BY GRASSING OR AS SPECIFIED IN THE APPROVED PLAN.

Table 1 - Recommended dimensions of flow control berms

Parameter	Earth banks	Vegetated banks	Compost berms	Sandbag berms
Height (min)	500 mm	500 mm	300 mm	N/A
Top width (min)	500 mm	500 mm	100 mm	N/A
Base width (min)	2500 mm	2500 mm	600 mm	N/A
Side slope (max)	2:1 (H:V)	2:1 (H:V)	1:1 (H:V)	N/A
Freeboard	300 mm	150 mm	100 mm	50 mm

Drawn:	Date:		
GMW	Dec-09	Flow Control Berms	CB-01

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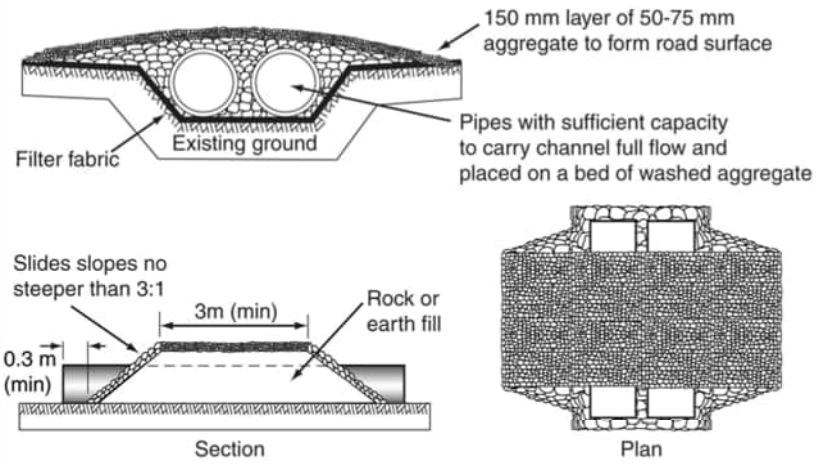
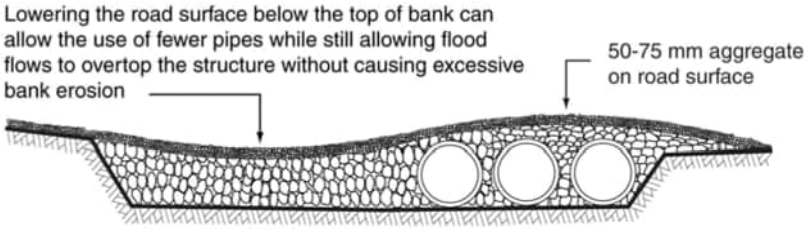
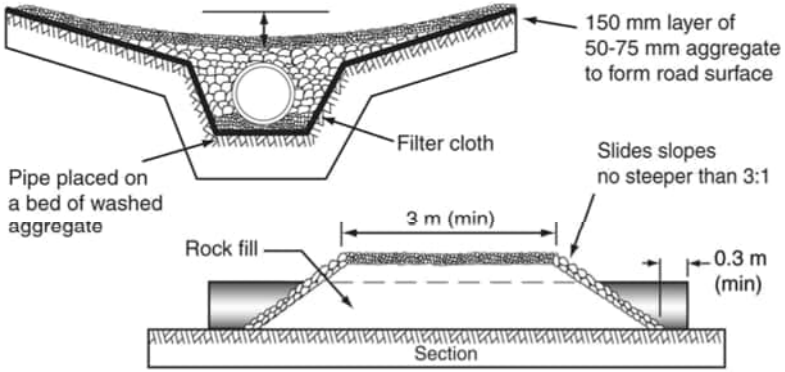


(a) Preferred arrangement for temporary culvert crossings

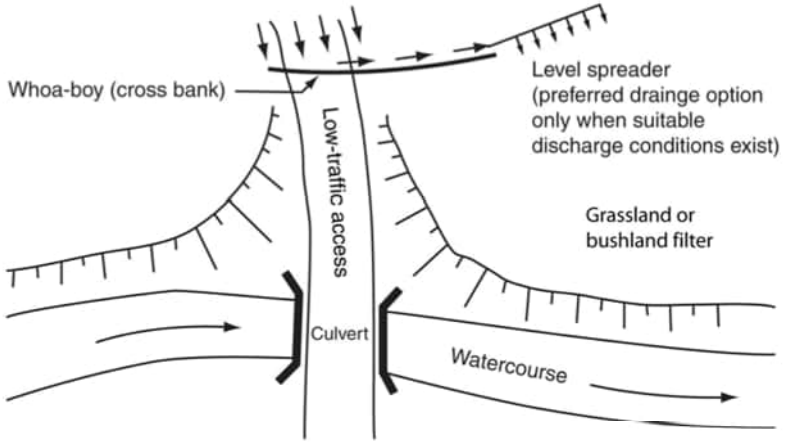


(b) Typical profile of temporary culvert crossings of wide channels

In situations where it is not practicable to allow overflows to initially passing around the culvert on a stable (well vegetated) stream bank, then the center must be set low to allow flow to pass over the culvert along the centreline of the channel



(c) Alternative layout for the crossing of confined channels



(d) Typical arrangement of surface runoff controls associated with approach ramps

Drawn:	Date:		
GMW	Dec-09	Temporary Culvert Crossing	TCC-01

MATERIALS

CULVERTS: ANY COMMERCIAL CONDUIT THAT IS SUITABLE FOR THE REQUIRED TRAFFIC LOADING.

ROCK: MINIMUM 150mm NOMINAL ROCK SIZE.

AGGREGATE: 50–75mm CLEAN AGGREGATE.

GEOTEXTILE FABRIC: HEAVY-DUTY, NEEDLE-PUNCHED, NON-WOVEN FILTER CLOTH (MINIMUM BIDIM A34 OR EQUIVALENT).

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONSTRUCT THE TEMPORARY WATERCOURSE CROSSING, INCLUDING PERMITS FOR THE DISTURBANCE OF BANK VEGETATION, AQUATIC VEGETATION (e.g. MANGROVES) AND ANY TEMPORARY INSTREAM FLOW DIVERSION BARRIERS OR SEDIMENT CONTROL MEASURES.

2. REFER TO APPROVED PLANS FOR LOCATION AND CONSTRUCTION DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION OR METHOD OF INSTALLATION, CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

3. ENSURE THAT THE LOCATION OF THE CROSSING WILL NOT INTERFERE WITH FUTURE CONSTRUCTION WORKS.

4. PRIOR TO SIGNIFICANT LAND CLEARING OR CONSTRUCTION OF THE APPROACH RAMPS, ESTABLISH ALL NECESSARY SEDIMENT CONTROL MEASURES AND FLOW DIVERSION WORKS (INSTREAM AND OFF-STREAM AS REQUIRED). CLEARING ONLY THOSE AREAS NECESSARY FOR INSTALLATION OF THESE MEASURES.

5. TO THE MAXIMUM DEGREE PRACTICABLE, CONSTRUCTION ACTIVITIES AND EQUIPMENT MUST NOT OPERATE WITHIN OPEN FLOWING WATERS.

6. MAINTAIN CLEARING AND EXCAVATION OF THE WATERCOURSE BED AND BANKS TO A MINIMUM. INITIALLY CLEAR ONLY THE AREA NECESSARY TO ALLOW ACCESS FOR CONSTRUCTION. CLEAR THE REMAINDER OF THE APPROACH RAMPS ONLY WHEN ADEQUATE DRAINAGE AND SEDIMENT CONTROLS ARE IN PLACE.

7. IF FLOW DIVERSION SYSTEMS CANNOT BE INSTALLED, THEN CONDUCT BANK EXCAVATIONS BY PULLING THE SOIL AWAY FROM THE CHANNEL.

8. WHERE PRACTICABLE, CONSTRUCT THE WATERCOURSE CROSSING PERPENDICULAR TO THE CHANNEL.

9. WHERE PRACTICABLE, THE APPROACH RAMPS SHOULD BE STRAIGHT FOR AT LEAST 10m AND SHOULD BE ALIGNED WITH THE CROSSING.

10. WHERE PRACTICABLE, DIRECT STORMWATER RUNOFF FROM THE APPROACH RAMPS INTO STABLE DRAINS, ADJACENT VEGETATION, OR APPROPRIATE SEDIMENT TRAPS TO MINIMISE THE RELEASE OF SEDIMENT INTO THE WATERCOURSE.

11. SHAPE THE CHANNEL, IF NECESSARY, TO RECEIVE THE PIPE/S.

12. IF HIGHLY EROSIVE SOILS ARE DETECTED, THEN APPROPRIATELY STABILISE SUCH SOILS AS SOON AS PRACTICABLE.

13. COVER THE CROSSING FOOTING WITH HEAVY-DUTY FILTER CLOTH.

14. COVER THE FILTER CLOTH WITH A MINIMUM 150mm OF CLEAN, 50 TO 75mm AGGREGATE.

15. PLACE THE SPECIFIED SIZE AND NUMBER OF CULVERT CELLS AND ALIGN THEM WITH THE DIRECTION OF THE DOWNSTREAM CHANNEL.

16. ENSURE THE PIPES EXTEND AT LEAST 300mm BEYOND THE PROPOSED EXTEND OF ROCK FILL.

17. FILL BETWEEN THE PIPE/S WITH 75 TO 100mm AGGREGATE.

18. COVER PIPE/S WITH SUFFICIENT ROCK (MINIMUM 300mm LAYER) TO SATISFY MANUFACTURER'S LOADING REQUIREMENTS TO AVOID DAMAGE TO THE PIPE/S RESULTING FROM THE EXPECTED TRAFFIC LOAD. SLOPE OF ROCK FACE UPSTREAM AND DOWNSTREAM OF THE CULVERT NO STEEPER THAN 3:1 (H:V).

19. FORM THE SHAPE OF THE ROAD SURFACE IN ACCORDANCE WITH THE PLANS AND/OR STANDARD DRAWINGS.

20. APPLY A SUITABLE COVER OF AGGREGATE OVER THE ROCK FILL TO FORM THE TRAFFICABLE ROAD SURFACE.

21. FINISH CONSTRUCTION AND STABILISATION OF THE APPROACH ROADS INCLUDING THE APPROACH RAMPS EACH SIDE OF THE BRIDGE CROSSING.

22. TAKE ALL REASONABLE MEASURES TO PREVENT EXCESS ROCK, DEBRIS AND CONSTRUCTION MATERIAL FROM ENTERING THE WATERCOURSE, ESPECIALLY ANY STILL OR FLOWING WATER.

23. IF IT IS NOT PRACTICABLE TO STABILISE THE ACCESS RAMPS AGAINST EROSION, THEN INSTALL FLOW DIVERSION BANKS ACROSS THE WIDTH OF EACH ACCESS RAMP ADJACENT THE TOP OF THE CHANNEL BANK, AND AT REGULAR INTERVALS DOWN THE RAMPS (AS REQUIRED) TO PREVENT OR MINIMISE SEDIMENT-LADEN RUNOFF FLOWING DIRECTLY INTO THE WATERCOURSE.

24. APPROPRIATELY STABILISE ANY DISTURBED WATERCOURSE BANKS.

25. STABILISE ALL DISTURBED AREAS THAT ARE LIKELY TO BE SUBJECTED TO FLOWING WATER, INCLUDING BYPASS AND OVERFLOW AREAS, WITH ROCK OR OTHER SUITABLE MATERIALS.

MAINTENANCE

1. TEMPORARY WATERCOURSE CROSSINGS SHOULD BE INSPECTED WEEKLY AND AFTER ANY SIGNIFICANT CHANGE IN STREAM FLOW.

2. DEBRIS TRAPPED ON OR UPSTREAM OF THE CROSSING SHOULD BE REMOVED.

3. REPAIR ANY DAMAGE CAUSED BY CONSTRUCTION TRAFFIC. IF TRAFFIC HAS EXPOSED BARE SOIL, STABILISED AS APPROPRIATE. MAINTAIN A MINIMUM 200mm COVER OVER THE CULVERTS.

4. CHECK FOR EROSION OF THE FORMED EMBANKMENT, CHANNEL SCOUR, OR ROCK DISPLACEMENT. MAKE ALL NECESSARY REPAIRS IMMEDIATELY.

5. CHECK THE BYPASS FLOODWAY MAKING SURE THE BANKS ARE STABLE.

6. CHECK FOR EXCESSIVE EROSION ON THE APPROACH ROADS.

7. CHECK THE CONDITIONS OF ANY FLOW DIVERSION CHANNELS/BANKS AND THE OPERATING CONDITIONS OF ASSOCIATED SEDIMENT TRAPS.

REMOVAL

1. TEMPORARY WATERCOURSE CROSSINGS SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER ALTERNATIVE ACCESS IS ACHIEVED OR THE CULVERT IS NO LONGER NEEDED.

2. REMOVE ALL SPECIFIED MATERIALS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Dec-09	Temporary Culvert Crossing	TCC-02

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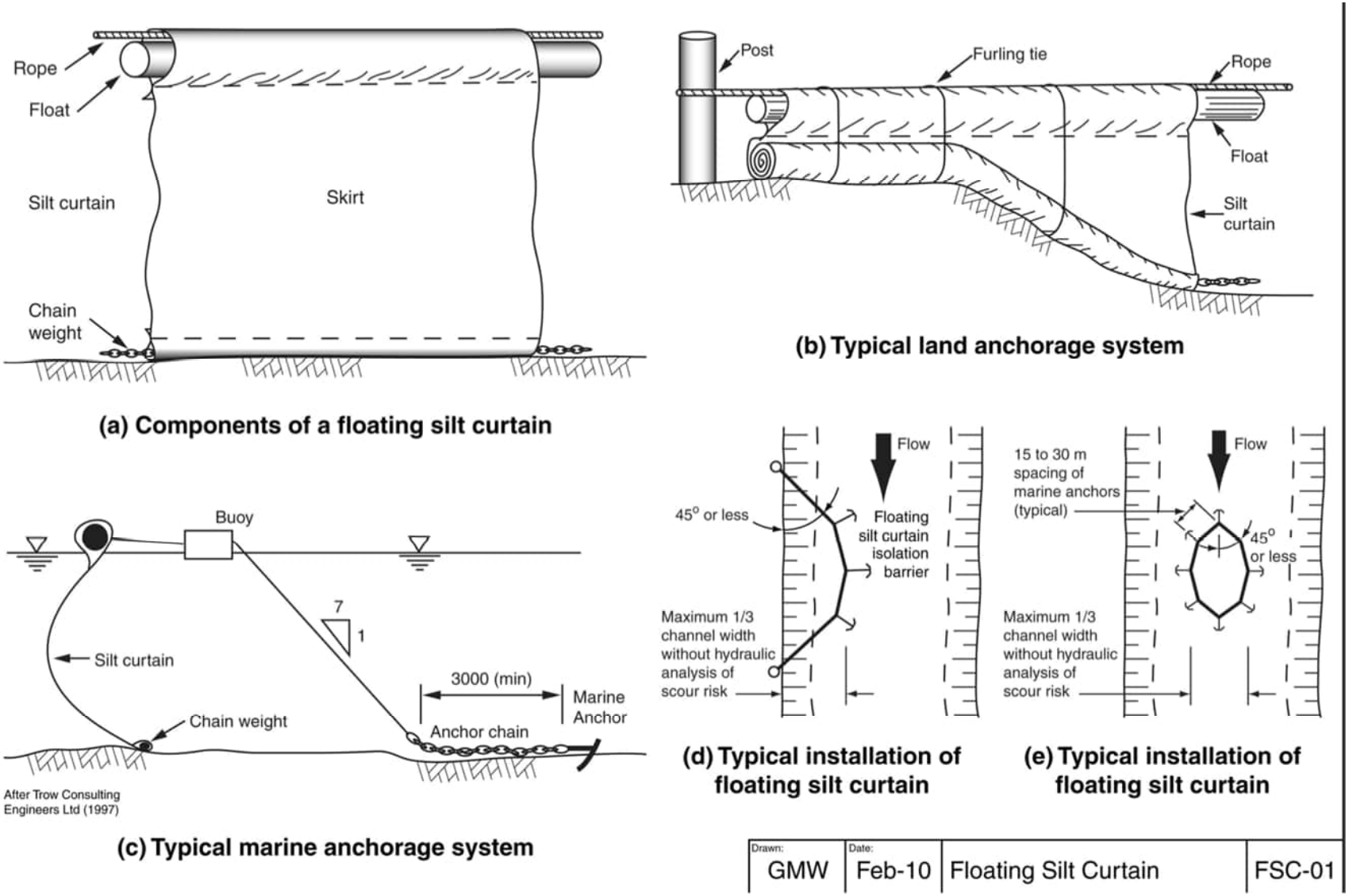
Rope
Float
Silt curtain
Skirt
Chain weight
(a) Components of a floating silt curtain
Post
Furling tie
Rope
Float
Silt curtain
(b) Typical land anchorage system
Buoy
7
1
Silt curtain
3000 (min)
Marine Anchor
Chain weight
Anchor chain
After Trow Consulting Engineers Ltd (1997)
(c) Typical marine anchorage system
Flow
45° or less
Floating silt curtain isolation barrier
Maximum 1/3 channel width without hydraulic analysis of scour risk
(d) Typical installation of floating silt curtain
15 to 30 m spacing of marine anchors (typical)
Flow
45° or less
Maximum 1/3 channel width without hydraulic analysis of scour risk
(e) Typical installation of floating silt curtain
Drawn: GMW
Date: Feb-10
Floating Silt Curtain
FSC-01

MATERIALS

SILT CURTAIN FABRIC: MANUFACTURED FROM A WOVEN GEOTEXTILE, CANVAS/TARP MATERIAL, OR A COMMERCIALLY AVAILABLE SILT CURTAIN SUCH AS NYLON REINFORCED POLYVINYL CHLORIDE (PVC) OR EQUIVALENT.

BALLAST CHAIN: 10 TO 13mm GALVANISED CHAIN WITH MINIMUM 1.9 TO 3.3kg/m WEIGHT.

LAND ANCHOR: MINIMUM 100mm DIAMETER TIMBER POST (OR EQUIVALENT).

MARINE ANCHOR: MINIMUM 5kg LIGHTWEIGHT (DANFORTH) TYPE ANCHOR WITH 10 TO 13mm NYLON TIE ROPE AND MINIMUM 3m LENGTH OF 8mm GALVANISED CONNECTING CHAIN.

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONDUCT THE NECESSARY WORKS INCLUDING PERMITS FOR THE DISTURBANCE OF RIPARIAN AND AQUATIC VEGETATION, AND THE CONSTRUCTION OF ALL PERMANENT OR TEMPORARY INSTREAM BARRIERS AND INSTREAM SEDIMENT CONTROL MEASURES.

2. PRIOR TO THE INSTALLATION, CHECK WEATHER REPORTS FOR A SUITABLE WINDLESS, CALM DAY. DO NOT PROCEED WITH THE INSTALLATION UNLESS SAFE TO DO SO.

3. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

4. CLEAR THE IMMEDIATE LAUNCHING AREA OF ROCK AND DEBRIS. AVOID DISTURBING GROUNDCOVER VEGETATION.

5. LAYOUT A PLASTIC LAUNCHING PAD (SPILLWAY) AT RIGHT ANGLES TO THE WATERCOURSE BANK AND PEG OR ANCHOR IT DOWN. THIS IS TO PROTECT THE CURTAIN AND REDUCE FRICTION WHEN LAUNCHING.

6. UNFOLD THE CURTAIN IN AN OPEN AREA PRIOR TO ITS INSTALLATION. ENSURE THE BARRIER IS FABRICATED WITH SUFFICIENT DIMENSIONS TO BE IN GOOD CONTACT WITH THE BOTTOM OF THE CHANNEL. THE DEPTH OF THE BARRIER SHOULD BE APPROXIMATELY 10% GREATER THAN THE WATER DEPTH TO ENSURE IT RESTS ON THE BED.

7. IDEALLY, THE LENGTH OF THE BARRIER IS 10 TO 20% LONGER THAN THE MEASURED LENGTH OF THE PROPOSED ENCLOSURE.

8. UNFOLD THE FIRST CURTAIN PANEL ON THE SLIPWAY.

9. INSERT THE FLOATS BOTH ENDS FOR EASE OF INSTALLATION.

10. PULL THROUGH THE STEEL CHAIN IN THE BOTTOM SLEEVE USING THE DRAW CORD.

11. PULL THROUGH THE ROPE USING THE DRAW CORD.

12. PRIOR TO DEPLOYING THE BARRIER, GATHER UP THE CURTAIN AND TIE THE CURTAIN WITH LIGHTWEIGHT STRAPS OR ROPE EVERY 1 TO 1.5m. THE AIM OF THIS IS TO ENABLE THE CURTAIN TO BE SET IN PLACE IN THE WATER EASILY WITHOUT THE CURTAIN BEING DRAGGED ALONG THE CHANNEL BED.

13. SET THE UPSTREAM BANK ANCHOR POINT AND TIE OFF ONE END OF THE BARRIER, ENSURING NO WATER WILL BE ABLE TO FLOW INTO THE UPSTREAM END.

14. DEPLOY THE BARRIER FROM THE END OF A BOAT. FASTEN THE FREE END OF THE BARRIER TO THE DOWNSTREAM ANCHOR POINT, THEN ANCHOR THE BARRIER AT INTERMEDIATE POINTS.

15. TAPER THE ENDS OF THE BARRIER TO THE SHAPE OF THE SHORELINE, OTHERWISE TIE THE ENDS OF THE BARRIER WITH FURLING STRAPS SO THE DEPTH OF THE BARRIER CAN BE ADJUSTED TO THE SHAPE OF THE BANK.

16. AFTER THE BARRIER HAS BEEN ANCHORED, CHECK TO SEE THAT THE SKIRT IS NOT TWISTED AROUND THE FLOTATION UNITS. WHEN THE BARRIER IS PROPERLY DEPLOYED, CUT THE TIE ROPES AND LET THE BALLAST WEIGHTS SINK TO THE BED.

17. ENSURE THE SKIRT (AT MAXIMUM WATER LEVEL) IS FREE OF LARGE PLEATS THAT MAY COLLECT SEDIMENT CAUSING THE BARRIER TO BE PULLED UNDER THE WATER SURFACE.

MAINTENANCE

1. INSPECT THE SILT CURTAIN DAILY FOR DAMAGE.

2. ENSURE THE TOP OF THE BARRIER REMAINS ABOVE THE WATER SURFACE, AND THE CURTAIN IS FREE OF TEARS OR GAPS.

3. ENSURE THE BARRIER REMAINS IN THE SPECIFIED LOCATION.

4. CHECK FOR TURBIDITY LEAKS.

5. CHECK ALL ANCHOR POINTS.

6. REPAIR OR REPLACE ANY TORN SEGMENTS.

7. CHECK FOR SEDIMENT BUILD-UP ON THE BOTTOM OF THE SKIRT THAT MAY BEGIN TO PULL THE CURTAIN UNDER THE WATER.

8. DISPOSE OF ANY EXCESSIVE SEDIMENT OR DEBRIS DEPOSITS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

9. REPAIR ANY PLACES IN THE ISOLATION BARRIER THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM INFLOWS OR OVERTOPPING WATER.

REMOVAL

1. THE SILT CURTAIN SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE THE CHANNEL WATER CONTAINED WITHIN THE ENCLOSURE HAS ACHIEVED A SUITABLE WATER QUALITY BEFORE REMOVING THE SILT CURTAIN.

4. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE SILT CURTAIN.

5. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

6. REMOVE ALL CONSTRUCTION MATERIALS, EXCESSIVE SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain	FSC-02

MATERIALS

SILT CURTAIN FABRIC: MANUFACTURED FROM A WOVEN GEOTEXTILE, CANVAS/TARP MATERIAL, OR A COMMERCIALLY AVAILABLE SILT CURTAIN SUCH AS NYLON REINFORCED POLYVINYL CHLORIDE (PVC) OR EQUIVALENT.

BALLAST CHAIN: 10 TO 13mm GALVANISED CHAIN WITH MINIMUM 1.9 TO 3.3kg/m WEIGHT.

LAND ANCHOR: MINIMUM 100mm DIAMETER TIMBER POST (OR EQUIVALENT).

MARINE ANCHOR: MINIMUM 5kg LIGHTWEIGHT (DANFORTH) TYPE ANCHOR WITH 10 TO 13mm NYLON TIE ROPE AND MINIMUM 3m LENGTH OF 8mm GALVANISED CONNECTING CHAIN.

ALTERNATIVE LAND-BASED INSTALLATION PROCEDURE

1. UNFOLD THE FIRST CURTAIN PANEL ON THE SLIPWAY.

2. INSERT THE FLOATS BOTH ENDS FOR EASE OF INSTALLATION.

3. PULL THROUGH THE STEEL CHAIN IN THE BOTTOM SLEEVE USING THE DRAW CORD.

4. PULL THROUGH THE ROPE USING THE DRAW CORD.

5. PRIOR TO DEPLOYING THE BARRIER, GATHER UP THE CURTAIN AND TIE THE CURTAIN WITH LIGHTWEIGHT STRAPS OR ROPE EVERY 1 TO 1.5m. THE AIM OF THIS IS TO ENABLE THE CURTAIN TO BE SET IN PLACE IN THE WATER EASILY WITHOUT THE WEIGHTS BEING DRAGGED ALONG THE BOTTOM.

6. SET THE UPSTREAM BANK ANCHOR POINT AND TIE OFF ONE END OF THE BARRIER, ENSURING NO WATER WILL BE ABLE TO FLOW INTO THE UPSTREAM END.

7. INSTALL AN EXTRA LENGTH OF ROPE OR CABLE IN THE FINAL CURTAIN POSITION IN THE WATER.

8. TIE THE END OF THE CURTAIN ROPE TO THE EXTRA LENGTH ALREADY IN POSITION AND PULL THE CURTAIN INTO THE WATER STOPPING WHEN THE END OF THE FIRST SECTION OF CURTAIN IS STILL ON THE BANK.

9. UNFOLD THE SECOND SECTION OF CURTAIN ON THE SLIPWAY MAKING SURE THE CURTAIN IS CORRECTLY ORIENTATED WITH THE FIRST SECTION OF CURTAIN

10. INSERT THE FLOATS, CHAIN AND ROPE AS BEFORE.

11. USING THE DRAW CORD FROM THE FIRST SECTION, TIE UP THE ENDS USING THE EYELETS ALREADY IN THE CURTAIN.

12. GATHER UP THE CURTAIN AND TIE TOGETHER WITH TWINE OR THIN ROPE.

13. LAUNCH AS BEFORE.

14. CONTINUE UNTIL THE ENTIRE CURTAIN IS INSTALLED.

15. ANCHOR WELL TO SHORE ANCHORS.

16. USING A SUITABLE BOAT, MOVE ALONG THE CURTAIN AND CUT THE TIES HOLDING THE CHAIN AND CURTAIN AND ALLOW THE WEIGHTED END TO SINK.

17. ENSURE THE SKIRT (AT MAXIMUM WATER LEVEL) IS FREE OF LARGE PLEATS THAT MAY COLLECT SEDIMENT CAUSING THE BARRIER TO BE PULLED UNDER THE WATER SURFACE.

MAINTENANCE

1. INSPECT THE SILT CURTAIN DAILY FOR DAMAGE.

2. ENSURE THE TOP OF THE BARRIER REMAINS ABOVE THE WATER SURFACE, AND THE CURTAIN IS FREE OF TEARS OR GAPS.

3. ENSURE THE BARRIER REMAINS IN THE SPECIFIED LOCATION.

4. CHECK FOR TURBIDITY LEAKS.

5. CHECK ALL ANCHOR POINTS.

6. REPAIR OR REPLACE ANY TORN SEGMENTS.

7. CHECK FOR SEDIMENT BUILD-UP ON THE BOTTOM OF THE SKIRT THAT MAY BEGIN TO PULL THE CURTAIN UNDER THE WATER.

8. DISPOSE OF ANY EXCESSIVE SEDIMENT OR DEBRIS DEPOSITS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

9. REPAIR ANY PLACES IN THE ISOLATION BARRIER THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM INFLOWS OR OVERTOPPING WATER.

REMOVAL

1. THE SILT CURTAIN SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE THE CHANNEL WATER CONTAINED WITHIN THE ENCLOSURE HAS ACHIEVED A SUITABLE WATER QUALITY BEFORE REMOVING THE SILT CURTAIN.

4. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE SILT CURTAIN.

5. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

6. REMOVE ALL CONSTRUCTION MATERIALS, EXCESSIVE SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain (alt)	FSC-03