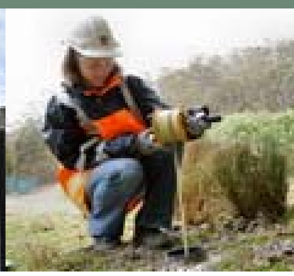
Stormwater Management Strategy: Inverloch Site in Erskine Park, Sydney

Prepared for: Murray Goulburn

Prepared by: Sudath Herath
Date: July 2013

transport infrastructure | community infrastructure | industrial infrastructure | climate change



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Date: 26 July 2013

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Date: 26 July 2013

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Date: 26 July 2013

Report Revision History					
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01		S Herath	J Sherry	D Conley	26/07/13

1. Introduction

Murray Goulburn has appointed **pitt&sherry** to prepare drainage strategy for the proposed development site at Erskine Park. The project site is about 5 ha and located within the Penrith City Council. The drainage strategy and water quality management issues have to be carried out based on the Council's guidelines.

The pipe drainage system has initially been designed for steady state conditions based on a spreadsheet model. Later it was improved by using unsteady dynamic flow modelling using EPA-SWMM developed by US-EPA.

The drainage system comprised of an underground detention system to maintain post development flows close to pre development conditions. In addition to that water quality treatment devices were incorporated to improve stormwater quality prior to discharging to natural water courses.

1.1 Design criteria & methodology

The following conditions taken from Penrith City Council guidelines listed in Section 5 of this report are used to design stormwater drainage systems for the proposed site:

- Pipe drainage system shall be designed for 20 year ARI event without flooding
- On site stormwater detention (OSD) is required to maintain pre development flows from the site for all storms up to and including the 100 year ARI event of all storm durations
- Not more than 15% of the site shall be un-detained

2. Hydraulic Analysis

The hydraulic analysis was based on AR&R 1989 for estimating runoff and EPA-SWMM Version -5 for dynamic hydraulic modelling.

2.1 Pre development case

Runoff from the predevelopment conditions was estimated using Rational Formula and Kinematic Wave Equation using following parameters:

Hydrologic data

Catchment area	= 4.75 ha
Mainstream length	= 345 m
Mainstream slope	= 0.5%
Retardance factor	= 0.023 (for bare eroded soil)
Impervious fraction	= 0

Time of concentration is estimated using Kinematic Wave Equation as proposed by the council as given below;

$$t = 6.94\,(L.n^*)^{0.6} / (I^{0.4}.S^{0.3})$$

Where
t = overland travel time (min)
L = overland sheet flow path length (m)
n* = surface roughness/retardance coefficient
I = rainfall intensity (mm/hr)
S = slope of surface (m/m)

Accordingly time of concentration for predevelopment condition is 16.5 minutes and 100 year ARI rainfall intensity is 136.4 mm/hr.

By using above parameters predevelopment flow rate for 100 year ARI event can be estimated using Rational Formula given below:

$Q = CIA/360$

Where
Q = peak flood (m^3/s)

C= runoff coefficient which represents runoff generation capacity of the catchment surface

I = rainfall intensity (mm/hr)

A = catchment area (ha)

Runoff coefficient C for 10 year ARI can be estimated using following formulae.
Where f is impervious fraction of the area.

$C_{10}= 0.9*f+(1-f)*0.35$ and f=0 thus $C_{10}=0.35$

$C_{100}= 1.2* C_{10}$ thus $C_{100} = 0.42$

$Q_{100} = 0.42*4.75*136.4/360$ m^3/s

$Q_{100} = 0.76$ m^3/s

2.2 Post development case

The proposed development footprint and stormwater drainage layout is shown in the drawing in Appendix A. Generally, two main stormwater drains run on the southern and northern boundary to discharge into proposed underground OSD at southwest corner of the property. For a conservative design whole project area is assumed to be impervious.

The areas where the OSD can be located are limited within this site. One option was to locate the OSD on the southern boundary of the site, but considering the depth needed to outfall the drainage system to an open retention system, the southern boundary was not considered acceptable. The only other option in terms of available area and feasible levels was to locate the OSD as shown in Appendix A.

The proposed OSD would be constructed with modular systems method to prevent any stormwater seepage to the ground which could increase salinity of the area. The OSD can capture nearly 4.30 ha out of 4.75 ha thus leaving un-detained area of 0.45 ha which is less than 10% of the total area and acceptable.

The area allocated for OSD is sloping ground therefore, modular OSD has to be constructed in cascade pattern in order to minimise excavation. The footprint of the OSD is about 900 m^2 with storage capacity of about 1,000 m^3.

Minor storm event analysis:

Underground drainage system is designed for 20 year ARI event with following hydrologic parameters.

Developed condition runoff coefficient C_{20}	= 0.9
Time of concentration	= 6 minutes
Thus design rainfall intensity	= 156 mm/hr

Each node of the drainage system is assigned with a contributing area and time varying inflow is calculated using Modified Rational Formula. Modified Rational Formula assumes, simple hydrograph which peaked at time of concentration and recedes to zero within double time of concentration. Inflows from each node used to evaluate hydraulic behaviour of the stormwater drainage system based on Manning's Equation.

The results of the minor storm analysis indicates that effective storage volume is about 549 m3 and outflow rate from OSD and whole site is 0.75 m^3/s and 0.57 m^3/s. No flooding is predicted at any pits therefore pipe system can handle the minor storm event.

Accordingly, both outflow rates are less than 0.76 m^3/s and acceptable.

Major storm event analysis:
Underground drainage system is designed for 100 year ARI event with following hydrologic parameters for different durations to identify the critical duration which produce highest outflow rate or storage requirement as shown in Table 1.

Table 1 Hydrologic parameters used for major storm events

Duration (min)	Runoff Coefficient (C_{100})	Intensity (mm/hr)
6	1.0	205
10	1.0	167
15	1.0	144
20	1.0	120

During major storm events outflows from the site shall be kept below pre development flows but flooding is allowed as long as it does not create any safety issues. Results of major storm events are tabulated in Table 2.

Table 2 Results of major storm events

Duration (min)	Effective storage (m^3)	Outflow from OSD (m^3/s)	Outflow from project site (m^3/s)	Node flooding (m^3)
6	741	0.88	0.72	11
10	847	0.87	0.76	0
15	907	0.91	0.80	0
20	816	0.84	0.77	0

By observing Table 2, it is clear that node flooding is occurred at 3 locations during six minute duration storm event at north east corner (5 m^3) south east corner (5 m^3) and at car park (1 m^3). Accordingly, flooding is not very significant and lasts only about four minutes. No flooding has been predicted during other storm events.

The critical storm event is 15 minute duration which requires 907 m^3 of effective storage which is less than the available storage of 1,000 m^3 and outflow rate from OSD is slightly higher (5%) than the required rate of 0.76 m^3/s. However, outflow rate from whole project area is higher than the required rate mainly due to runoff from un-detained area.

3. Stormwater Quality Management

Penrith City Council required treating stormwater prior discharging to natural bodies. Stormwater treatment devices should be designed for areas less than 5 ha based on treatable flow rates (TFR) as defined by the council. In Penrith, the TFR for sites equal to or less than 5 ha in area shall be 60 L/s for every hectare of catchment for gross pollutant and 10 L/s for every hectare of catchment for fine particulates. Accordingly, the stormwater treatment devices for this site have been designed for approximately 300 L/s.

In order to address stormwater quality management, it is proposed that litter baskets in the upstream pits and an Ecosol RSF 4600 or similar device before the inlet to the OSD which can handle TFR up to 470 L/s.

Manufacturer reported that above stormwater treatment arrangement would reduce gross pollutant, fine sediments, total nitrogen and total phosphorous by 100%, 64%, 51% and 64% respectively based on MUSIC Model results. This pollutant reduction rates are well above the minimum water quality standards.

4. Emergency Response and Monitoring

This section provides an overview of the stormwater management/trade waste system focusing on the process controls, emergency procedures and monitoring that shall help mitigate stormwater pollution at point source.

4.1 Containment/bunding/roofing of high hazard areas

There are three areas where there is a high risk of spillage. Those areas consist of the following:

- Tank Farm
- Cream Loadout/Chemical Delivery
- Milk Receival

The highest risk areas for potential spillage on the proposed development is predominantly confined to the cream loadout area/chemical delivery area. The other area with a high risk of potential spillage is in the area of milk delivery. The risk is higher for these areas as the frequency of connections/disconnections is greater than in the tank farm. Due to the high risk of spillage in these areas, the decision was taken to roof both areas. In addition to roofing, the pavement shall be designed so as to divert the flow to trade waste drains within these areas. There is no connection to the stormwater from either the chemical delivery area or the milk receival units.

The tank farm shall be designed with a bund surrounding it. Should there be a spill in this area, it will be confined to this relatively small area. The tank farm shall be drained to the stormwater system under normal conditions as it is exposed to the elements. The outfall from the tank farm shall drain to pit with a sensor installed. This sensor shall detect if the effluent from the tank farm is ‘clean’ (i.e. can go through to the stormwater system) or an incident has happened and needs to be diverted to trade waste. If the latter is the case, the sensor shall trigger a valve that shuts the outfall to the stormwater system and diverts it to the trade waste system.

4.2 Pollution prevention and containment

Section 3 of this report addresses the proposed measures to be implemented on this development to prevent pollution of the receiving watercourse.

4.3 Operating procedures

Murray Goulburn shall develop operating procedures to ensure that all of the above measures are put into place.

4.4 Monitoring and maintenance

Stormwater monitoring of both influent and effluent from the stormwater quality improvement device shall be implemented. Constant monitoring upstream and downstream will mean that the quality of the receiving watercourse will not be compromised as a result of this proposed development. The monitoring should comprise of continuous online monitoring as well as regular sampling and lab analysis (say 3-monthly).

5. Conclusion

1. Underground stormwater system can handle the minor storm events without flooding and major stormwater events with negligible flooding.

2. The proposed 1,000 m^3 OSD can maintain pre development flows after the full development of the project site.

3. Ecosol RSF 4600 or similar stormwater treatment device with litter baskets can maintain stormwater quality targets prior to discharging to the creek.

6. References

1. Guidelines for Engineering Works for Subdivisions and Developments- Part 1, 1997: Penrith City Council.

2. Development Control Plan-2010: Penrith City Council

3. Stormwater Drainage for Building Development: Penrith City Council

Appendix 1:
Site Drainage Layout

NOTE:
1. ECOSOL RSF 4600 OR SIMILAR TO BE CONNECTED TO DOWNSTREAM OF PIT NUMBER 6.
2. STORAGE TO BE CONSTRUCTED WITH WATERTIGHT MODULAR SYSTEMS.

DETAIL 1
1:500

P&S FORM DRG-B1 REV 0

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
P3	ADDITIONAL NOTES ADDED	PMD	KD	JS	27.08.13
P2	ADDITION OF DRAINAGE AND NOTES	SP	KD	JS	24.07.13
P1	PRELIMINARY	SP	KD	JS	12.07.13
		SP	KD	DC	JULY 2013

APPROVED: ORIGINAL COPY ON FILE "e" SIGNED BY D CONLEY
SIGNED
DATE 28.06.2013

SCALE (PLOTTED FULL SIZE) 1:500
SHEET SIZE **B1**

REDUCED SCALE PLOT

CAUTION: THIS DRAWING MAY NOT COMPLY WITH AS1100 IF PLOTTED AT A REDUCED SCALE

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CLIENT: MURRAY GOULBURN
CONTRACT TITLE: PROJECT INVERLOCH - NSW
STATUS: **PRELIMINARY**

DRAWING TITLE: BULK EARTHWORKS DRAINAGE STRATEGY
DATUMS: AHD / MGA PLANE
CLIENT No. C201
DRAWING No. ML13007-C201
REVISION P3
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Murray Goulburn Milk Processing Facility at Erskine Park, NSW

Riparian Survey

Murray-Goulburn Co-operative

August 2013

2013.147

Murray Goulburn Milk Processing Facility at Erskine Park, NSW

Riparian Survey

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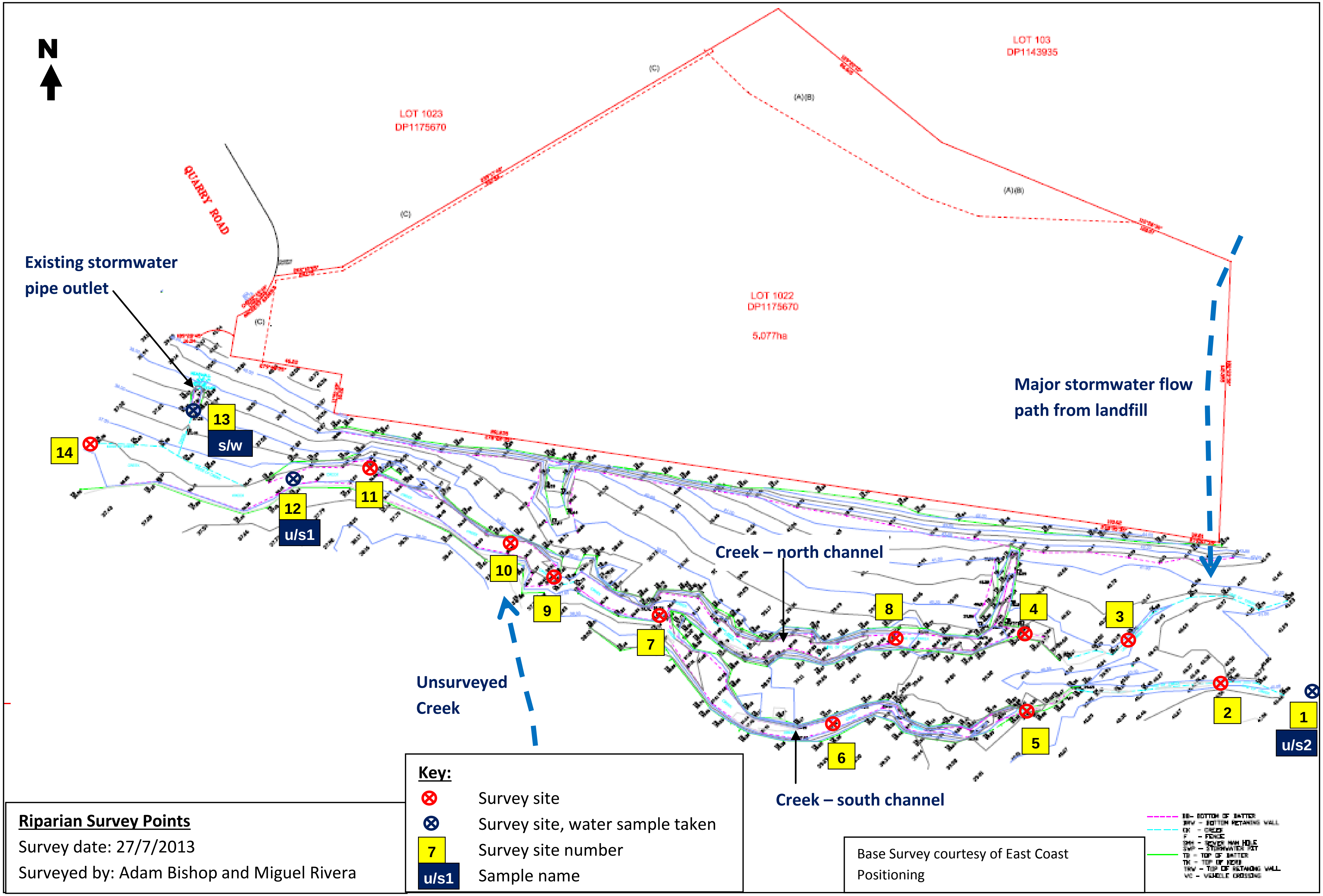
Document Control Log

Revision No.	Amendment	Date	Prepared By	Checked By	Approved By
Rev A	QA review	05.08.13	AB	AB	BC

Survey site	Photos/ samples	Description
1	1u, 1d sample u/s2	Small, well vegetated, stable, meandering creekline characterised by pool/riffle sequences; Some small pools and shallow side channels in surrounding low gradient floodplain; Main channel 1-1.5m wide and typical pool depth to 0.6m, though rarely pools to 1.5m deep; semi-vertical creek banks; water clarity very good; flow estimate < 1L/s; Many and varied aquatic plants (no Typha), some algae on plant roots; Shaded aspect; Occasional log falls and debris dams; Minor sediment bed-load; Surrounding vegetation comprising grassy understorey, paperbarks, eucalypts and wattles
2	2u	Similar to site 1
3	3u, 3d, 3s	Northern channel; Shallow riffle zone with conspicuous sediment slug, likely derived from erosion on landfill/industrial site;
4	4u, 4d	Channel approx. 2m wide and 1m deep; more open exposure than site 1; Typha becoming dominant aquatic vegetation
5	5u, 5d	Southern channel; Stable creekline 3-4m wide and approx. 1.5m deep. Typha and other aquatic veg
6	6u, 6d	Channel approx. 6m wide and 2m deep; well vegetated, some Typha, Juncus and other grasses; Small low-flow channel meandering within bed of major channel
7	7u, 7d, 7n, 7s	Confluence between northern and southern tributaries; South channel is a small riffle zone approx. 2m wide and 0.5m deep; North channel is much larger, 4-5m wide and 2m deep; Some rock/cobble armouring in riffle bed of south channel; North channel overgrown with Typha and containing a conspicuous sediment slug approx. 0.3 - 0.6m deep. Sediment appears recent and likely derived from erosion on adjacent landfill/industrial sites
8	8u, 8d	Upstream from site 7 in northern channel; Channel approx. 5m wide and 2m deep; Small low-flow channel within bed of major channel; Stable bed with Typha and Juncus; Some recent sediment deposition
9	9u, 9d, 9n, 9s	Confluence between the surveyed channel and another unserveyed channel to the south; Typha abundant; Rocky ford/vehicle crossing across main channel; Stable creek bed and banks
10	10u, 10d	Main channel approx. 6m wide and 2m deep; Relatievly open aspect; Typha dominant
11	11u, 11d	Similar to site 10
12	12u, 12d sample u/s1	Main channel approx. 6m wide and 1-1.5m deep; very open aspect; Typha dominant
13	13u, 13d, 13p	Stormwater outlet; sample taken from small pool at outlet; water clear but with thin white film-like crust on surface, not oily; Typha in channel
14	14u, 14d	Very wide and shallow drainage line, main channel obscured by thick vegetation; Very open aspect with full sun; Phragmites dominant/overgrown



Riparian Survey Points

Survey date: 27/7/2013

Surveyed by: Adam Bishop and Miguel Rivera

Photo Log of Creek Survey undertaken on 25/7/13

Numbers in caption are survey site number; u – upstream view, d – downstream view

Refer accompanying Figure for survey site locations

	
1u – small stable channel	1d – riffle zone, some trampling by cattle
	
2u	3u – looking upstream to northeast showing sediment plume
	
3d	3s – sediment slug

	
4u	4d
	
5u	5d
	
6u	6d


7u


7d


7n – view to north towards northern tributary


7s – sediment slug in northern tributary


8u


8d


9u


9d


9n – view to north showing rocky ford / vehicle crossing


9s – view to south looking upstream along unsurveyed southern tributary


10u


10d


11u


11d


12u


12d


13d – view to south along flowline of stormwater outlet, headwall in bottom left corner


13p – pool at pipe outlet

13u – view to north from pipe outlet showing upstream drainage catchment

14u

14d

Conceptual Soil and Water Management Plan

Early Works for

Milk Processing Facility – Quarry Road, Erskine Park

Pitt & Sherry

2 July 2013

Project No. 2013.147

KMH
ENVIRONMENTAL

Conceptual Soil and Water Management Plan

Early Works for Milk Processing Facility – Quarry Road, Erskine Park

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1	Draft for review	1 July 2013	Adam Bishop	Brian Cullinane	Brian Cullinane
2	Final for submission to client	2 July 2013	Adam Bishop	Brian Cullinane	Brian Cullinane

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APPENDICES

1. Introduction

1.1. Purpose and Scope

This Conceptual Soil and Water Quality Management Plan (SWMP) has been prepared to accompany a development application to Penrith Council, for early works associated with the construction of a milk processing facility at Lot 1022 DP 1175670, Quarry Road, Erskine Park (the "Site"). The early works are to be undertaken in advance of major building works, which would be subject to a separate application to the NSW Department of Planning and Infrastructure for State Significant Development.

The purpose of the SWMP is to demonstrate how soil and water resources will be managed during construction of the early works, to minimise offsite pollution caused by erosion and transport of sediment-laden water offsite.

This Conceptual SWMP has been prepared in line with Managing Urban Stormwater: Soils and Construction (Volume 1, 4th edition)(the "Blue Book") to meet the requirements of Penrith Council, including those outlined in Part 4 of the Penrith DCP 2010.

This Conceptual SWMP serves as a framework management document and outlines the fundamental principles to be followed in the planning and implementation of erosion and sediment control measures for the early works for the project. It:

- provides a description of the project;
- outlines the site constraints including identification of sensitive areas and drainage patterns;
- assesses the erosion hazard at the site;
- identifies a suite of erosion and sediment control management practices to minimise associated risks to the environment, and provides an indicative layout for these controls;
- provides directions for installing, monitoring and maintaining erosion and sediment controls;
- describes the procedure for preparing Progressive Erosion and Sediment Control Plans throughout the course of the early works, to address the changing needs of the construction program; and
- outlines the roles and responsibilities of those involved in the implementation of erosion, sediment and water quality management controls.

This SWMP provides a baseline plan showing the indicative layout of key erosion and sediment control measures. However, it does not describe the precise layout of all control measures, nor does it contain detailed engineering design of structures. Progressive ESCPs shall be prepared for this purpose by the construction team in consultation with the Project Engineers and Soil Conservationist, as required, once detailed design plans and details of the construction methodology and staging are available.

1.2. Soil and Water Management Objectives

The primary objective of this SWMP is to minimise erosion, manage sediment and reduce impacts on receiving waters consistent with relevant State and local legislation, policies and guidelines. This will be achieved by:

- minimising ground disturbance during construction activities, and staging works where practicable to reduce the time of disturbance in individual work areas;
- stripping, stockpiling and conserving topsoil (if available) for later use in rehabilitation;
- diverting "clean" run-on stormwater away from construction areas and separating "clean" from "dirty" stormwater, where practicable;
- conveying dirty waters to sediment traps to capture sediment and minimise water pollution;

- installing, monitoring and maintaining erosion and sediment controls in accordance with relevant guidelines and industry best practice;
- rehabilitating the site progressively to reduce the erosion hazard and achieve a stable landscape upon completion; and
- complying with the requirements of applicable legislation and the Conditions of Approval for the Project.

2. Site and Project Description

2.1. Overview of the Early Works Project

The early works will involve earthworks to re-profile site surface levels to form a level platform, with excavation over the more elevated (eastern) portion of the site and raising of site surface levels over the lower (western) portion of the site. Temporary access and construction roads will also be established. Cut and fill depths are expected to be a maximum of about 2m. Compaction of the fill will be as required to meet engineering and geotechnical specifications.

Due to the poor ground conditions all main building elements are to be supported on pile foundations. These piled foundations are to be constructed as part of the early works in readiness for future building.

The foundations will be drilled into the rock using Continuous Flight Auger and the cavity filled with concrete and steel reinforcement. The depths depend on the depth of rock – from the geotechnical information a depth of between 6m and 8m is expected. Approximately 200 piles 750mm diameter will be required.

Once the piles have been installed, they will be 'capped' by small (1m x 1m) concrete foundations enabling cast in bolts for the structural steel building framing to be installed and providing a finished surface level.

Limited drainage works would also be undertaken to secure the site for the early works. This may include construction of temporary diversion drains or earth bunds to divert "clean" stormwater run-on around the development site. Temporary internal drainage works may also be undertaken to direct the flows of clean and dirty water within the site, as part of the Soil and Water management Plan. This is to include construction of a sediment basin. The permanent stormwater drainage system would be constructed at a later stage as part of the major construction works.

A construction compound would be provided for the early works comprising several demountable buildings for offices and amenities. A separate laydown/storage area would also be provided.

It is noted that the early works would generally be confined to areas outside a 40m buffer from the nearby creek to the south, and would avoid activities that could trigger the Controlled Activity provisions of the Water Management Act 2000.

2.2. Landscape

The site is within a recently established industrial estate and occurs in a landscape that has been heavily modified by past earthworks. The site is relatively flat, with the western part of the site grading gently to the west and southwest, and the eastern part of the site grading gently to the southeast.

A large keystone retaining wall (approximately 5.5m to 6.5m high) (refer Figure 1) occurs along the site's northern boundary, with a large fill mound occurring above this to the north. A large fill mound also occurs to the east of site, the toe of which abuts the eastern site boundary (Figure 2). The southern boundary comprises a small keystone block retaining wall (approximately 1.2m to 1.5m high) and supports a fill embankment several metres high within the site (Figure 3). An area of bushland and a small creek system form a designated Biodiversity Corridor to the south of the site. The western boundary adjoins a neighbouring industrial development with metal clad building and concrete paved surrounds, and is relatively level (Figure 4).

Figure 1 View to northeast showing the northern boundary retaining wall and eastern fill embankments

Figure 2 View to the south along the eastern boundary showing sediment deposition from upslope runoff

Figure 3 View east along the site's southern boundary, and showing the existing bushland to the south

Figure 4 View north along the western boundary

Figure 5 View to the east from the site entrance near Quarry Road

2.3. Drainage

Currently the site receives stormwater runoff from the north and east via an informal drainage system. The northern retaining wall subsurface drainage system connects water with a piped easement that runs along the site's northwestern boundary. The site receives uncontrolled runoff from the fill embankments in the east and there is evidence of past erosion and sediment deposition around the toe of this embankment.

Rainfall incident on the site drains via sheet flow away from a central crest, to the west, southwest and southeast. The receiving environment for all runoff from site (and upslope areas) is a small unnamed creek to the south of the site within the Biodiversity Corridor. This unnamed creek drains to the northwest and is within the catchment of South Creek.

It is apparent that improvements to stormwater drainage will be required as part of the major building works on the site. Formalised stormwater drains should be established to capture run-on stormwater from the north and east and convey this safely around the site, and discharge stormwater in a suitable location. As part of early works, temporary drains would be constructed as necessary to divert clean waters around the development site and convey dirty water generated within the site to sediment traps.

2.4. Subsurface Conditions

The report titled Preliminary Geotechnical Investigation (JK Geotechnics, 2013) contains a description of the subsurface conditions using information gathered from nine boreholes drilled on the site. From this report it is noted that the site is immediately underlain by fill ranging in thickness from approximately 2.9m to 7.2 m. Fill typically comprised silty clay with varying gravel content, silty gravelly clay and rarely clayey gravel. The gravels comprised shale, ironstone, sandstone, igneous rock and concrete. The clayey fill was generally assessed to be of medium plasticity and typically moderately compacted but occasionally poorly or well compacted.

Beneath the fill is residual silty clay, which overlies weathered bedrock comprising shale and fine sandstone. It is noted that the 1:100 000 geological map of Penrith indicates the site is underlain by the Bringelly Shale of the Wianamatta Group, consisting of shale, carbonaceous claystone, claystone, laminate, fine to medium grained lithic sandstone, rare coal and tuff.

2.5. Soil Properties

Soil sampling and analysis is being undertaken by Environmental Investigation Services and preliminary data only was available in time for production of the Conceptual SWMP. The preliminary data was reviewed to assess soil properties relevant to erosion hazard and revegetation recommendations. The soil properties and implications for soil and water management are summarised as follows:

- Soils are strongly alkaline with pH values typically in the range 8.5 to 9.5. This high pH is likely to be inhibiting plant growth. A reduction in soil pH to around neutral (pH 7) is recommended to improve revegetation success;
- Soil texture was typically heavy with field textures commonly in the range Clay Loam to Light Medium Clay. This heavy texture is responsible for relatively high stormwater runoff rates and low rainfall infiltration. When exposed to erosion soils are expected to generate turbid runoff containing fine sediment that can be difficult to trap in conventional sediment controls. Extended detention times are required to allow sediment to settle;
- Electrical conductivity of saturated extracts (EC_{SE}) based on 1:5 soil in water suspensions was commonly 2.0 dS/m and rarely up to 4.0 dS/m. Most samples were rated between non-saline and slightly saline. Soil salinity is not expected to pose a significant limitation with respect to erodibility or revegetation;
- Cation exchange capacity of 7 samples tested ranged between 29 and 35 meq/100g, which is rated as high. This does not pose any significant limitations with respect to erodibility or revegetation; and
- Exchangeable sodium percentage (ESP) was calculated and ranged between approximately 1.0 and 2.5 %. These soils are rated as non-sodic (Hazelton & Murphy, 2007).

3. Constraints and Design Factors for Soil and Water Management

3.1. Summary of Key Design factors

This SWMP relies on various site specific design factors and assumptions. A summary of these is provided in Table 1. These factors are explained in more detail in the Blue Book, and further details are provided throughout this chapter.

Table 1 Summary of Key Design Factors

Factor	Value	Comment
Rainfall erosivity (R-factor)	2210	Based on local climate
Soil erodibility (K-factor)	0.045	Estimate, no data available
LS factor	0.65	3% gradient, 80m slope length assumed
P-factor	1.3	Standard for construction sites
C-factor	1	Standard for construction sites
Average annual soil loss	84 t/ha/yr	Using the Revised Universal Soil Loss Equation (RUSLE)
Soil Loss Class	1 (very low)	Refer Blue Book
Soil texture group	Type D (dispersible)	Conservative estimate
Soil Hydrologic Group	Group D	Slow infiltration
Peak flow runoff coeficient (C10)	0.9	Refer Table F3 in Blue Book
Volumetric Runoff Coefficient	0.56	Refer Table F2 in Blue Book
Design rainfall depth for sediment basins	27.4 mm	5-day, 80^{th} percentile rail depth for Penrith
Design ARI for embankment/spillway design	20-yr	Design to ensure stability and erosion control in the nominated ARI storm event
Design ARI for temporary drainage controls	10-yr	Design to ensure stability and erosion control in the nominated ARI storm event
Design ARI for temporary sediment controls	10-yr	Design to ensure stability and erosion control in the nominated ARI storm event

3.2. Soil Constraints

An understanding of soil properties is crucial to understanding soil/water interactions, assessing the erosion hazard and designing sediment controls. An assessment of key soil properties is provided below.

3.2.1. Soil Texture group for Sediment Trap Design

The preliminary soils analysis (refer Section 2.5) indicates soils are heavy textured and although no particle size analysis was available, the heavy field texture suggests soils have high percentages of silt and clay. It follows that eroded sediment that becomes entrained in stormwater will be dominated by fine materials that do not settle rapidly under the action of gravity alone.

For management purposes and development of this Conceptual SWMP it is assumed that soils are Type D (Dispersible), based on the texture classification system described in the Blue Book. This could be revised if appropriate based on future soils analysis.

3.2.2. Soil Hydrologic Group

Soil hydrologic group is a term that associates the soil properties that affect infiltration and runoff. There are four categories, Group A, B, C and D. At one end of the scale, Group A soils have very low runoff potential (eg deep sands) while at the other end, Group D soils have very high runoff potential (eg poorly structured clays, or soils with a very shallow hardpan).

Soils are assumed to be Hydrologic Group D. This property contributes to selection of appropriate runoff coefficients.

3.2.3. Soil Dispersibility

Soil dispersibility is a key property affecting stability and susceptibility to erosion, and consequently effects design of sediment controls. Dispersible soils are structurally unstable in water and readily split into their constituent particles resulting in turbid water that does not clear naturally (Landcom, 2004).

Where dispersible soils are exposed to erosion, assisted flocculation in wet sediment basins is usually required to achieve water quality targets. No data on the dispersion percentage (DP) of soil materials was available. It has been conservatively assumed that soils are significantly dispersible.

3.2.4. Soil Erodibility

The soil erodibility, or K-factor in the Revised Universal Soil Loss Equation (RUSLE), has not been measured to date and therefore a conservative estimate of 0.045 has been adopted. This is relatively high.

3.2.5. Salinity

Soils are mainly non-saline to slightly saline. Salinity should not pose a limitation to earthworks or revegetation.

3.2.6. Potential Acid Sulfate Soils

Potential Acid Sulfate Soils (PASS) are not expected to be a feature of this landscape.

3.3. Hydrology

3.3.1. Design Rainfall Depth

Table 6.3a in the Blue Book contains design 5-day rainfall depths for various decile levels. These depths may be used for the design of sediment controls aimed at complete storm capture, such as “wet” sediment basins for Type F and Type D soils.

In accordance with methods outlined in the Blue Book, it is considered appropriate to select the 80th percentile, 5-day rainfall depth for Penrith as the design storm event for design of sediment basins. This equals 27.4 mm.

This rainfall depth is based on a 5-day basin management period. This is the timeframe between the sediment basin filling, and water being treated and discharged in readiness for the next storm. Alternative management methods can be adopted if desired, to increase or decrease the sediment basin size.

3.3.2. Intensity-Frequency-Duration (IFD) Analysis

A rainfall intensity-frequency-duration (IFD) chart for Penrith is contained in Table 2, which may be used for calculating catchment peak flows for various storm durations and return intervals.

Table 2 IFD Chart

	I (mm/hr) for ARI (yrs)						
Time	1 Year	2 years	5 year	10 year	20 year	50 year	100 year
5 mins	75.7	97.8	127	144	166	196	218
6 mins	70.8	91.5	119	135	156	183	205
10 mins	57.9	74.8	96.9	110	127	149	167
20 mins	42.2	54.5	70.3	79.7	92	108	120
30 mins	34.2	44.2	57	64.6	74.5	87.6	97.6
1 hr	23.2	29.9	38.6	43.7	50.4	59.3	66
2 hrs	15.3	19.7	25.4	28.7	33.1	38.9	43.3
3 hrs	11.9	15.3	19.7	22.3	25.7	30.2	33.6
6 hrs	7.74	10	12.8	14.5	16.6	19.5	21.7
12 hrs	5.01	6.46	8.33	9.43	10.9	12.8	14.2
24 hrs	3.2	4.15	5.43	6.19	7.19	8.51	9.52
48 hrs	1.97	2.58	3.46	4	4.7	5.62	6.34
72 hrs	1.44	1.9	2.58	3.01	3.55	4.28	4.85

3.3.3. Runoff Coefficients

The runoff coefficient relates catchment runoff as a proportion of rainfall depth for nominated storm events. Two different runoff coefficients are used in this plan for design of water management structures. These are:

- Peak flow runoff coefficient (C_{10}) – converts rainfall intensity to peak discharge in a nominated 10-year ARI storm event. The C_{10} is used to calculate peak flows for sizing water conveyance structures. The C_{10} value adopted in this plan equals 0.9; and
- Volumetric runoff coefficient (C_v) – describes the total volume of runoff as a proportion of total rain depth for a nominated storm event. In this plan C_v is used to size sediment basins for Type D and F soils. With reference to Table F2 in the Blue Book, a C_v of 0.56 is used in this SWMP.

Further description of these runoff coefficients and their use is provided in Annex F of the Blue Book.

3.4. Erosion Hazard Assessment

The Blue Book outlines a method for assessing erosion hazard using the revised universal soil loss equation (RUSLE), which is used as a standard across NSW.

The RUSLE is designed to predict the long term, average, annual soil loss from sheet and rill erosion at nominated sites under specified management conditions. It is used to assess erosion hazard at construction sites and estimate sediment flux.

The RUSLE equation is represented by:

A = R K LS P C

where,

A = computed soil loss (tonnes/ha/yr)

R = rainfall erosivity factor

K = soil erodibility factor

LS = slope length/gradient factor

P = erosion control practice factor

C = ground cover and management factor.

The derivation of the RUSLE and the various factors is explained in detail in the Blue Book.

Using the RUSLE, the predicted annual soil loss is 84 tonnes/hectare/year. This is Soil Loss Class 1 (< 150 tonnes/ha/yr) which is rated “very low” (refer Table 4.2 in the Blue Book).

4. Erosion and Sediment Controls

This chapter outlines a suite of erosion and sediment controls that would be used during construction of the Project. The design and operation of all controls would be as outlined in the Blue Book.

Figure A1 (Appendix A) presents a Conceptual Soil and Water Management Plan Drawing for the early works. It is noted however that the Conceptual SWMP Drawing describes just one possible layout of an appropriate suite of erosion and sediment controls. Alternative layouts and controls may exist to achieve an equivalent level of protection, and revisions to the plan may be expected as the detailed construction methodology and staging plans are developed.

Reference is made to a number of Standard Drawings (SDs) from the Blue Book. These Standard Drawings describe key design and construction information for a range of common controls and are reproduced in Appendix B.

4.1. Key Design Issues and Assumptions

On review of the development plans there are several key matters relating to construction site layout and project design that need to be addressed by the project team as part of the soil and water management plan. These are discussed briefly below.

4.1.1. Stormwater Drainage

At the time this Conceptual SWMP was prepared the permanent stormwater drainage design was still to be finalised. Temporary drainage will be constructed as necessary to secure the development site for early works. Key issues that should be addressed for the early works stage of development are:

- Provision of suitable stormwater drains to capture upslope run-on along the northern and eastern boundaries and convey this safely around the construction site. The Conceptual SWMP Drawing indicates one option for management of this water. Drains will need to be sized and stabilised based on their respective catchment areas, design flow rates and flow velocities, which are still to be determined. These drains should be installed upfront and prior to bulk earthworks;
- Identification and design of suitable stormwater discharge/outlet locations. The Conceptual SWMP Drawing indicates two potential discharge locations, in the southeast and southwest. In both locations stormwater may need to be conveyed down relatively steep gradients and appropriate grade control structures would be required. These outlets should be designed to discharge stormwater in suitable locations at non-erosive velocities that will not cause localised flooding or damage to the receiving environment. As far as practicable these works should be kept outside the 40m buffer from the nearby unnamed creek.

4.1.2. Sediment Basin

This Conceptual SWMP recommends installation of a sediment basin for the early works. Indicative design criteria and an approximate location for the basin have been nominated. Detailed design of the sediment basin will need to be undertaken prior to its construction. The detailed design shall address the following as a minimum:

- Preferred location;
- Sizing (length, width, depth, batter gradients);
- Invert levels of inlet and outlet;
- Geotechnical assessment of structural stability and suitability of existing soils for dam formation. This will be crucial if the basin is installed close to the edge of the fill platform; and
- Design of emergency spillway and waterway to convey high flows safely offsite.

4.1.3. Site Entrance and Temporary Access Road

It is assumed that a single site access to the Project Area would be installed from Quarry Road generally as indicated in the Conceptual SWMP. A temporary construction access road providing all weather access for construction vehicles should be provided between Quarry Road and the construction site. This will help restrict disturbance to pre-established corridors and improve trafficability in general.

4.1.4. Site Compound

A location for the site compound has been nominated near the southern boundary. However, alternative locations exist and if the compound location is revised this Conceptual SWMP should be updated to reflect any required modification to soil and water management controls. Establishment of the compound would not require any earthworks, with demountable buildings placed on levelling blocks.

4.1.5. Concrete Batching

This SWMP does not address management of concrete batching plants as it is assumed that a batch plant is not required and that all concrete would be bought to site in concrete trucks. It is further assumed that concrete truck washout would not be undertaken onsite. If concrete batching or concrete truck washout is required onsite, separate management plans would be developed to manage the environmental impacts of these works.

4.2. Progressive Erosion and Sediment Control Plans

This Conceptual SWMP will be supplemented by the production of Progressive Erosion and Sediment Control Plans (PESCPs) as required, detailing any changes to the SWMP in response to finalisation of the detailed design, or to reflect alternative management measures or changes to the plan as the project progresses through different stages. These PESCPs will be prepared once the detailed design documentation is available and once construction methodology and staging details are known, and before works begin in individual areas.

The Progressive ESCPs will:

- be prepared by a suitably qualified professional (preferably a soil conservationist) in association with construction personnel, to formulate practical documents for field reference. This process will allow consideration of specific construction methods and will provide a sense of ownership and buy-in for all parties;
- be prepared for:
  - different stages of construction, as required (e.g. vegetation clearing, grubbing, topsoil stripping and stockpiling with further revision for bulk earthworks, drainage installation and rehabilitation)
  - areas of high erosion hazard, such as on batters and in constructed waterways;
  - key project/construction areas such as temporary access tracks; watercourse crossings; construction compound, laydown yard and concrete batching plant (if any);
- be prepared on base plans that show contours and drainage paths, the constructed drainage network (if any), limits of disturbance and extent of earthworks, location of sensitive areas and location of control measures;
- include documentation to explain the ordering and scheduling of works, particularly the order in which the erosion and sediment controls will be installed;
- describe specific construction details, notes and operating procedures;
- contain detailed design information including sizing and location, for key drainage controls such as sediment basins, waterways and energy dissipaters;
- be given a sequential number and recorded in a register for progressive ESCPs; and

- be controlled and distributed in accordance with the contractor's quality system procedure for document control.

The Contractor will ensure that the Progressive ESCPs are regularly reviewed and changes implemented to manage the erosion hazard and prevent pollution at the site. Additional erosion and sediment control works will be installed as might become necessary, for example due to unforseen events or site conditions. This may be particularly relevant to initiate repairs after severe rain events.

All subcontractors will be informed of their responsibilities in minimising the potential for soil erosion and pollution to downslope areas. Appropriate training will be provided during site inductions and tool-box talks.

4.3. Erosion Control Measures

Erosion prevention is a preferred option over sediment control where this is practicable. The control of raindrop and sheet erosion minimises the amount of sediment that is mobilised during a rainfall event. This follows the age-old principle of "prevention is better than the cure," meaning that if erosion is minimised, water quality impacts will be largely prevented so reducing the reliance on downstream sediment trapping and other water quality control devices to protect the offsite receiving environment.

The Project will adopt management and mitigation measures to minimise soil erosion impacts during construction. Relevant controls include:

- prepare, review and implement PESCPs before works commence in individual areas, so that opportunities for erosion control are maximised;
- stage the construction program so that the amount of disturbed soil exposed at one time is minimised, to the fullest extent practicable. This would include undertaking earthworks progressively in phases. Where vegetation clearing and topsoil stripping is required, this should be delayed as long as possible in the construction program in accordance with this phasing of earthworks;
- plan construction works to limit the amount of disturbed area at any one time;
- delay any clearing along watercourses as long as possible and preferably only clear immediately prior to major works in the area (ie for culvert installation);
- limit disturbance to two metres beyond the edge of any essential construction activity;
- construct a stabilised access point to the construction site (refer SD6-14) to prevent tracking of sediment to adjoining roadways and improve trafficability in these high traffic areas. Incorporation of a wheel wash or submerged cattle grid will be considered to provide control of sediment tracking to sealed roads;
- stabilise haul roads and light vehicle access tracks to minimise dust and sediment generation. Haul roads will be provided with a durable, non-erodible pavement surface to minimise dust and sediment generation while improving operational life;
- during windy weather unsealed roads will be kept moist (not wet) by sprinkling with water to reduce wind erosion;
- limit vehicular access to the site to that essential for construction work, ensure vehicles remain on formed roadways only, and ensure all vehicles park in designated areas that have been suitably stabilised (e.g. with road base);
- clearly visible and sturdy barrier fencing will be erected as shown in the PESCPs and elsewhere at the discretion of the Site Superintendent to define essential construction areas and help minimise unnecessary disturbance. Barrier fence will be installed upfront and before construction works commence in any given area. Employ fencing and signage to identify construction areas for clearing and "No-Go" zones;
- divert clean stormwater from upslope of disturbed areas using earth banks or catch drains, and using energy dissipaters or level spreaders at their outlets as appropriate. Discharge stormwater in safe areas, avoiding erosion and flooding hazards;

- before construction, strip topsoil and stockpile this for later use in rehabilitation;
- to prevent the spread of weeds, ensure weed-infested topsoil is kept separate from clean (weed-free) topsoil, is marked accordingly, and not used in rehabilitation;
- stockpiles of topsoil (refer SD 4-1) will be located at least 5 m from areas of likely concentrated or high velocity flows, particularly earth banks and roads. An additional buffer of 40 m should be provided between stockpiles and natural waterways;
- all areas of concentrated flow (diversion banks and waterways) will be designed by a suitably qualified person to convey and remain stable during the design storm event. All construction waterways other than temporary diversion banks will be designed as trapezoidal channels in accordance with SD 5-6 (Earth bank high flow). Stabilisation may be required (eg using jute matting, rock lining or vegetation) and stabilisation methods would be outlined in the PESCPs;
- on completion of major works and before revegetation, reinstated subsoils should be left with a loose surface to encourage water infiltration and help with keying topsoil later. This will be very important on steeper slopes;
- rehabilitate the site progressively upon conclusion of works in individual areas, and use temporary stabilisation when works areas are expected to remain idle for more than 20 days;
- annual cover crops will be used to provide temporary cover and undersown with the desired mix of perennial species. For plant establishment supplementary watering may be required, particularly during spring and summer. Revegetation details will be provided in the Progressive ESCPs and/or landscape plans.

Stabilisation requirements for temporary and permanent protection are identified in the Blue Book and would be adhered to during this project. Table 3 outlines these minimum requirements.

Table 3 Maximum Acceptable C-factors at Nominated Times During Works

Lands	Maximum C-factor	Remarks
Waterways and other areas subject to concentrated flow, post construction	0.05	Applies after ten working days from completion of formation and before they are allowed to carry any concentrated flows. Stabilisation of waterways would be undertaken to keep bed and banks stable in flows up to the 20-yr ARI, time of concentration storm event. Maximum C-factor of 0.05 equals 70% groundcover
Stockpiles, post construction	0.1	Applies after ten working days from completion of formation. Maximum C-factor of 0.10 equals 60% ground cover
All lands, including waterways and stockpiles during construction	0.15	Applies after 20 working days of inactivity, even though works might continue later. Maximum *C*-factor of 0.15 equals 50% ground cover

Note: Adapted from Table 7.1 in the Blue Book

4.4. Stormwater Management

The following stormwater management controls will be implemented as part of the erosion and sediment control program:

- divert clean stormwater away from areas to be disturbed by construction activities using earth banks or catch drains. For temporary banks construction is to follow SD 5-5 for earth banks (low flow). For permanent banks, construction is to follow SD 5-6 for earth banks (high flow). Clean water diversion banks shall be installed upfront and before any earthworks commence in the areas they protect. Permanent diversion banks will be sized by a suitably qualified person. Note that wherever possible drains should have trapezoidal or parabolic cross-sections. Avoid V-drains which are much more prone to erosion.

- collect dirty water in earth banks or catch drains for diversion to sediment control structures as shown in the PESCPs. For temporary banks, construction is to follow SD 5-5 for earth banks (low flow). For permanent banks, construction is to follow SD5-6 for earth banks (high flow);
- install temporary earth diversion banks (refer SD 5-5) at the direction of the site manager to mitigate against unforseen erosion hazards, particularly when rain is forecast. These shall be used to shorten slope lengths, or to divert localised run-on away from high hazard areas such as unstable batters or clean water drainage lines;
- energy dissipaters shall be placed at the outlets from all diversion banks, culverts and waterways;
- install temporary culverts beneath access tracks where required to retain the passage of clean and dirty water flow lines.
- check dams (SD 5-4) using rock aggregate, sandbags or geotextile "sausages" may be installed within drains and diversion channels to help reduce erosion, especially on steep sections. Care will be taken to ensure there is adequate provision for a spillway that allows flows to be retained within the diversion channel and not escape thereby potentially causing scouring and/or flooding of adjacent lands;
- maintain slope lengths no greater than 80 metres in disturbed areas. To reduce slope lengths in construction areas install temporary earth diversion banks following SD 5- 5. On roads consider the use of cross banks and mitre drains to shed water from the surface, improve drainage and reduce erosion;
- ensure roof water from site infrastructure is discharged in suitably stabilised locations to prevent erosion. Where buildings are without gutters, the ground surface beneath the roof drip-line should be stabilised with gravel or suitable non-erodible material.

4.4.1. Clean Water Diversion Drains

Capture and conveyance of upslope run-on "clean water" would be achieved using new diversion drains approximately as indicated in the Conceptual SWMP Drawing. These drains shall be designed by an appropriately qualified person based on consideration of their catchment areas, indicative slope gradients, estimated peak flows and velocities. Stabilisation requirements shall also be determined based on consideration of these factors. These drains are to be trapezoidal channels of the type described in Blue Book Standard Drawing SD5-6 (Earth Bank, High Flow). All constructed "clean water" channels, drains, spillways and their outlets will be designed to at least the 20-yr ARI flow (or higher as required by Council for the permanent drainage system) and stabilised to a C-factor of 0.05 (equivalent to 70% grass cover) after 10 working days from completion and prior to accepting flows, in accordance with the Blue Book.

For design of channel stabilisation refer to guidance given in Table 5.2 of the Blue Book. It is assumed that as a minimum all drains will be finished with topsoil, sown with suitable mat-forming grass (eg kikuyu) then lined with jute mesh.

Installation of clean water diversion drains shall be undertaken before major land disturbance and bulk earthworks.

4.4.2. Dirty Water Diversion Drains

"Dirty" water is defined as runoff from disturbed construction areas that is likely to be contaminated with sediment and possibly other pollutants. A key element of this SWMP is the capture and conveyance of dirty runoff to sediment traps, and only once treated, back to clean water drainage lines.

The major dirty water drains should be engineered structures, designed to convey flows in a stable fashion up to the 10-yr ARI storm for the catchments they collect, and constructed in accordance with SD5-6. The location, size and stabilisation of permanent dirty water diversions would be outlined in the PESCPs. An indicative location for dirty water diversion banks is provided in the Conceptual SWMP Drawing (Appendix A). Dirty water catchment areas may change as works progress and PESCPS would be updated to reflect any changes to site drainage.

Installation of dirty water drains and their associated sediment traps shall be undertaken before major land disturbance and bulk earthworks.

4.5. Sediment Control

While erosion control will be prioritised in all areas of work, it is recognised that these measures will not always be 100% effective and some erosion may be expected to occur. Sediment controls will be employed downslope of all disturbed areas to treat and retain sediment laden runoff. Sediment traps must be installed prior to disturbance within the areas they protect.

Sediment traps shall be installed to treat dirty water runoff from disturbed areas and retain sediment as close as possible to its source. Sediment traps work most effectively by damming water and allowing sediment to settle under gravity in relatively quiescent conditions. As such, they will generally be installed in areas of sheet flow. Construction of sediment traps in areas of concentrated flow (eg drains, waterways) is not favoured, as they have limited effectiveness in these areas and can lead to scouring and unwanted damage.

Sediment trap types include sediment fence, mulch bunds, rock weirs, check dams, informal shallow sumps and sediment basins. A range of materials may be used to construct sediment traps, such as woven geotextiles, earth, rock, mulch or crushed concrete. Certified weed-free straw bales may also be used, but hay bales will be avoided as they provide a potential source of weed seeds. When installing sediment traps, materials will be firmly anchored to the ground to prevent water passing under them.

Adequate provision must be allowed for water to bypass sediment traps during larger storms without causing flooding or erosion of adjoining areas.

Because the site soils contain significant proportions of fine particles such as silt and clay, extended detention times or assistance with flocculation will be required to achieve efficient sediment capture. In this case wet sediment basins are the most effective form of sediment trap. A single sediment basin is proposed on this site as the major form of water quality control.

A discussion of key sediment trap types follows.

4.5.1. Sediment fence

Sediment fence (SD6-8) when used correctly is an effective primary sediment control. At a minimum, sediment fence would be installed downslope of disturbed areas that do not drain to a sediment basin. Sediment fence is also useful as a source control to minimise the quantity of sediment transported to sediment basins.

Situations where sediment fencing will be considered for use include:

- around stockpiles;
- as boundary control downslope of disturbed areas that do not drain to a sediment basin;
- around the construction compound and laydown areas;
- adjacent to unsealed roads;
- around culvert headwalls; and
- between works areas and clean water drains.

Sediment fencing shall be installed downslope of disturbed areas as shown on the PESCPs and elsewhere at the discretion of the Site Superintendent or Site Environment Officer.

Sediment fences will have a return of 1 metre upslope at intervals not exceeding 20 metres and cut-through weirs will be installed where required as a means of controlling discharge. Returns are installed to subdivide the catchment area of the sediment fence, to improve its effectiveness and help prevent structural damage during peak flows. Ideally, the catchment area of each section of fence should be small enough to limit flow if concentrated at one point to less than 50 L/s in the 10-year ARI storm event.

4.5.2. Shallow Excavated Sediment Traps

Informal shallow excavated sediment traps may be a useful method of capturing sediment laden runoff especially from relatively small catchments. This form of control is typically not subject to any detailed design; however, as with any sediment trap their size should be assessed according to the catchment they serve and suitable inlet and outlet controls employed to minimize erosion from concentrated flows. Shallow excavations may be used in isolation or along with other controls such as sediment fence and rock filter dams to increase the water and sediment storage capacity.

4.5.3. Sediment Basin

The need for a sediment basin was assessed using calculations as described in the Blue Book, including soil loss calculations which were detailed earlier in Section 3.1. The estimated soil loss is 84 tonnes/ha/yr, or approximately 65 m^3/ha/yr. The area of disturbance during early works is estimated as approximately 3.0 ha, giving an estimated annual soil loss from the site of 195 m^3. This is larger than the 150 m^3 threshold below which the Blue Book suggests that sediment basins are unnecessary; therefore, a sediment basin is recommended. The proximity to a sensitive receiving environment further promotes the need for a sediment basin, to provide an adequate level of water quality control that will avoid degradation of the adjoining Biodiversity Corridor.

The required sediment basin is a wet basin for Type D soils. The basin shall be designed to capture dirty stormwater from as much of the disturbed site areas as practicable, and store this water until such time as an acceptable water quality has been obtained via a combination of natural settling processes and assisted flocculation when required. It is expected that flocculation will be required to achieve acceptable water quality within the design 5-day management period. Only after acceptable water quality is obtained will the basin be manually dewatered. Dewatering can be achieved by pumping, or use of a syphon system with lockable gate valve at the outlet.

The basin has been designed around a 5-day management period. This means that following the cessation of a rain event that causes dirty water runoff to the basin, basin water should be treated, tested and discharged within 5 days in readiness for future rain events.

A schematic drawing of a wet sediment basin is provided in Standard Drawing SD6-4.

Basin Sizing

The sediment basin was sized using the methods outlined in the Blue Book. The total basin volume is the sum of a sediment storage zone and sediment settling zone.

Table 4 provides a summary of key basin details. Appendix E provides a printout of the basin sizing spreadsheets.

An indicative basin location is shown in the Conceptual SWMP Drawing. Prior to basin construction ground truthing is to be undertaken by the Site Superintendent to confirm the exact position for the basin bearing in mind the siting considerations discussed below.

Table 4 Sediment Basin Details

Name	Catchment Area	20-yr ARI Peak flows	Basin volumes			Indicative dimensions at top water level		
			Sediment strorage	Sediment settling	Total	Depth	Width	Length
	ha	m^3/s	m^3	m^3	m^3	m	m	m
B1	3.0	1.0	33	460	493	2.0	13	31

Basin Siting, Design and Operational Considerations

When siting and designing sediment basins consider the following important points:

- Locate so as to optimise capture of dirty water while avoiding critical construction areas as far as possible;
- Ensure inlet invert levels allow for dirty water capture through the life of the project, allowing for changing levels due to cut and fill earthworks;
- Locate clear of clean water flow lines. As a general rule basins should be located no closer than 10 m from the top of bank of any clean water flow line;
- Design the basin so that the length to width ratio is at least 3:1, with the inlet and outlet at opposite ends. Where this cannot be achieved install flow control baffles in the basin to maximise the flow path of water between inlet and outlet;
- Basins shall employ a primary outlet for managed discharge as well as an emergency spillway to allow bypass of excess flows during high rain events. Emergency spillways will be designed to the 20-yr ARI storm;
- Typical basin operating depth is 2m to the top of the emergency spillway. A freeboard of 0.5 m is recommended between the spillway invert and dam crest;
- Install one or more pegs within the basin floor to indicate the top level of the sediment storage zone, so that it will be evident when sediment needs removal;
- Ensure access is readily available for maintenance, including for cleaning out of captured sediment;
- Sediment removed from sediment basins will be placed in a location where it will not present further erosion hazard;
- Sediment basins will be flocculated as necessary to achieve water quality criteria prior to discharge. Advice for flocculation is contained in Appendix E of the Blue Book. Gypsum shall be trialled initially; however if ineffective flocculants such as alum or polyacrylamides will be used subject to any necessary approvals and the development of management plans for the use of these chemicals.

Further detail on design and construction of sediment basins is contained in the Blue Book and IECA (2008).

Water Quality criteria

Typical discharge limits that apply to construction sites in NSW are shown in Table 5.

Table 5 Discharge Limits

Parameter	Acceptance criteria
Oil and grease	Not visible
pH	6.5 – 8.5
Total suspended solids (TSS)	< 50 mg/L

Exceeding the limits specified above for pH and TSS for discharges from the sediment basins is acceptable if the discharge occurs solely as a result of rainfall measured at the premises exceeding the design storm event.

4.5.4. Drop Inlet Protection

Sediment traps would be employed around structures such as drop inlets and grated drains, until such time as their catchment areas are fully stabilised and the structures are no longer receiving sediment-laden runoff from the development site. Options for installing sediment traps at stormwater inlets include use of sand bags, woven geofabric (sediment fence) and gravel sausages.

General arrangement drawings for sediment traps at drop inlets are provided in Appendix B, Standard Drawings SD6-11 and SD6-12.

4.6. Rehabilitation

Temporary rehabilitation of the site may be required after conclusion of earthworks, if there is likely to be a significant delay before commencement of major construction. Rehabilitation should also be undertaken of any areas disturbed by early works that are not likely to be further disturbed at a later stage.

The preferred site stabilisation method will be identified on a site by site basis and included within the Progressive ESCPs. Advice from a soil conservationist should be sought during this process.

Final site stabilisation can be achieved using vegetation, mulch, rock armouring, paving, concrete, synthetic or natural fibre geofabrics, spray on synthetic soil binders or any other cover that protects the ground surface against erosion.

When selecting stabilisation methods a key factor for consideration is the form of water runoff over the stabilised area. Areas subject to concentrated flow (ie watercourses and drains) will require different stabilisation techniques to those subject to sheet flow. In areas of sheet flow vegetation will generally be acceptable.

Successful revegetation requires:

- availability of acceptable soil materials and correct site preparation (refer SD4-2);
- selection of an appropriate establishment technique;
- selection and application of appropriate plant species, fertilisers and soil ameliorants;
- application of sufficient water for germination and establishment if rainfall is inadequate;
- maintenance, and replanting if revegetation is not successful.

When replacing topsoil on batters lightly scarify the subsoil materials first along the contour to assist in keying the topsoil in. Replace topsoil to the depths indicated in SD4-2, noting that it can be very difficult to achieve successful topsoil replacement and revegetation on slopes greater than 2(H):1(V). Specialised measures may be required in such areas.

It is common practice to use annual species as a fast growing and highly effective temporary cover crop. However, these plants will die within one season, providing almost no surface protection thereafter. For longer term protection a mixture of perennial and annual species is best. While the perennial species are usually slower to establish, they will grow under the annual species and succeed them to provide a permanent surface protection.

Suitable cover crops for different times of the year, as recommended in the Blue Book, are presented in Table 6.

Table 6 Cover Crops

Growing season	Seed mix
Autumn/winter	Oats @ 40kg/Ha Japanese millet @ 10 kg/ha
Spring/summer	Japanese millet @ 20 kg/ha Oats @ 20kg/Ha

4.7. General Waste Management and Pollution Control Measures

Trade waste receptacles will be provided for the safe and efficient storage of all construction and miscellaneous wastes. Recyclable materials shall be separated and recycled where possible. Otherwise, disposable wastes will be removed from site regularly and disposed by approved means.

Potentially contaminating materials used or stored on the site (e.g. fuel, oils) shall be prevented from entering the groundwater or surface water systems. This will be achieved through storage in designated secondary containment areas (e.g. internally bunded shipping containers or purpose built structures). Bulk storage areas for fuels, oils and chemicals used during construction will be contained within an impervious bund to retain any spills of more than 110% of the volume of the largest container in the bunded area.

Any spillage will be immediately contained and absorbed with a suitable absorbent material. Storage will comply with *AS 1940- 1993 The Storage and Handling of Flammable and Combustible Liquids*. Emergency spill clean up kits will be maintained on-site in agreed locations that are accessible and known to all site workers. Spill kits will be used in the event of inadvertent spills of fuels, oils, hydraulic fluids and other hazardous wastes, to contain the spill and avoid contamination of waters. Workers will be trained in the use of spill kits. Contaminated soils shall be excavated and disposed by means to be authorised by the Site Superintendent.

Material Safety Data Sheets (MSDS) for all chemicals stored on-site will be maintained by the Site Safety and Environment Officer and made available to site personnel. Site personnel will be informed of their location as a part of the site induction.

Refuelling of equipment on-site or any other activity which could result in a spillage of a chemical, fuel or lubricant will be undertaken away from drainage/stormwater lines. A designated refuelling area should be established with drip trays installed and spill kits on stand-by.

4.8. Training and Awareness

All Project personnel, subcontractors and consultants will receive training on environmental obligations during the Project induction, toolbox talks and specific training.

All Project personnel will undergo a general Project induction prior to commencing work. This will include a soil and water quality component to reinforce the importance of management and the measures that will be implemented to protect soil and water quality.

Project inductions will include:

- Site specific erosion and sediment control procedures;
- ‘Clean’ and ‘dirty’ water on the Project site; and
- Spill response.

Site inductions and toolbox talks will highlight the specific environmental requirements and activities being undertaken, which will include relevant soil and water management matters.

4.9. Inspection and Maintenance

An adequate inspection and maintenance program is essential to successful implementation of the erosion and sediment control plan. Inspections, particularly during storms, will show whether devices are operating effectively. Where a device proves inadequate, it should be quickly redesigned and/or repaired to make it effective.

4.9.1. During Construction

The site superintendent or delegate (eg site environment officer) will inspect the site at least weekly paying particular attention to:

- ensuring PESCPs are prepared and approved before commencing works in individual areas and are maintained up to date as the site and nature of work change;
- ensuring barrier fencing is maintained and exclusion zones are being observed by all site workers and contractors;
- waste receptacles are emptied regularly in a manner approved by the site superintendent;
- ensuring progressive and prompt rehabilitation of lands, that rehabilitation has effectively reduced the erosion hazard and that repairs or upgrades are initiated as appropriate;
- constructing additional erosion and/or sediment controls to ensure the desired erosion and sediment control is achieved, i.e. make ongoing changes to the Plan;
- maintaining erosion and sediment control measures in a functioning condition until all earthworks are completed and the site is rehabilitated;
- removing trapped sediment and disposing this in safe areas;
- maintaining stability of creek crossings and protection of clean water flow lines; and
- removing temporary soil conservation structures as the last activity in the rehabilitation program.

4.9.2. Post Construction

Upon completion of construction the site should be inspected at least monthly and until such time as a stable landscape is returned, vegetation is growing well and there is minimal evidence of active erosion.

Inspect revegetation areas regularly, investigate failures and replant in failed areas. Ensure an adequate watering and fertilising system is maintained in revegetation areas. Identify any areas of localised soil erosion and implement preventative measures. This might include:

- planting additional stabilising vegetation;
- stabilising soils with a mulch or alternative soil binder; or
- taking steps to minimise any concentrated stormwater flows.

References

Hazelton, P.A. & Murphy, B.W (2007). Interpreting soil test results: What do all the numbers mean? (2^{nd} ed.). CSIRO, Melbourne.

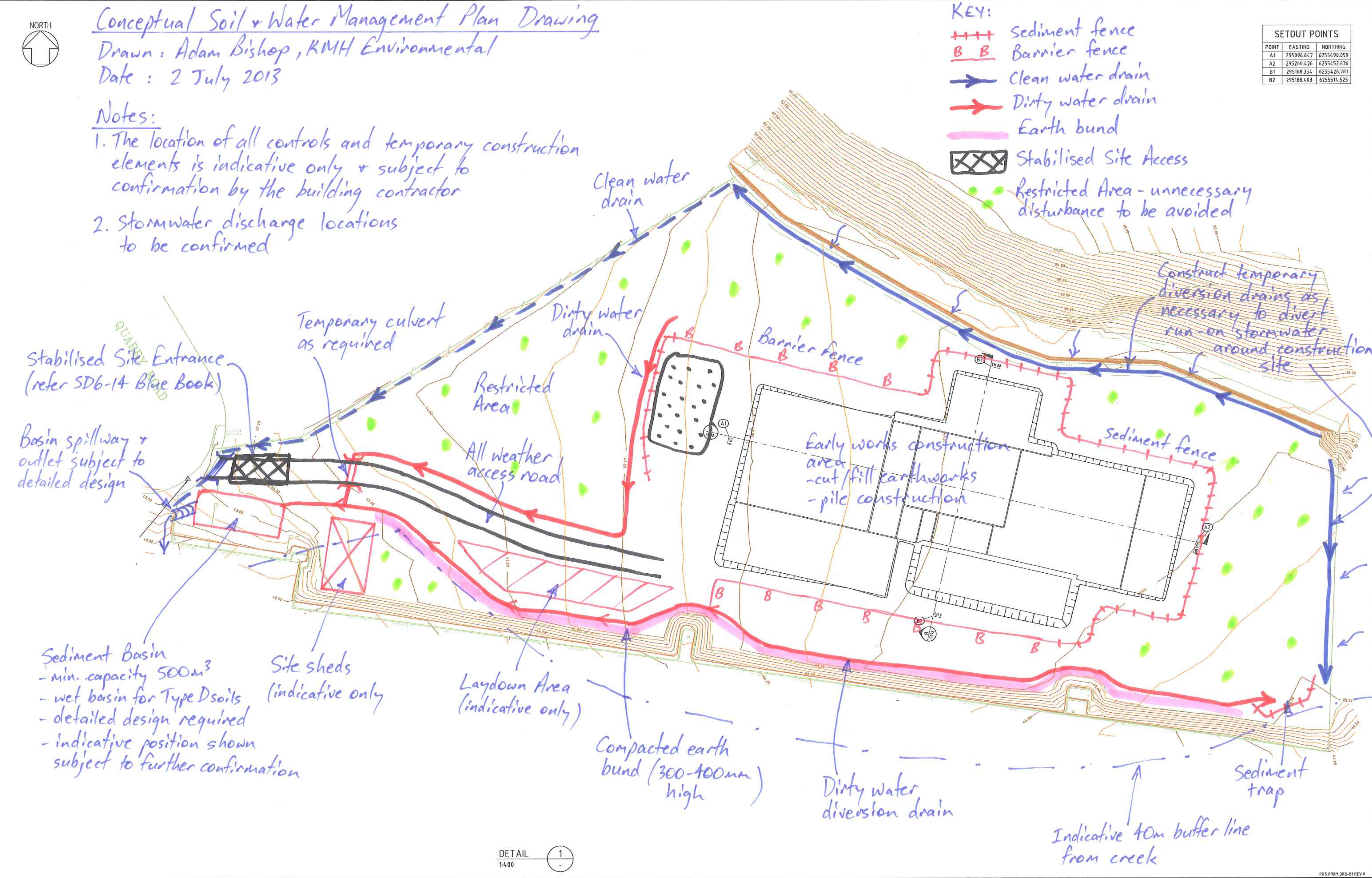
Landcom (2004). Managing Urban Stormwater: Soils and Construction (Volume 1, 4th edition)

DECC (2008). Managing Urban Stormwater: Soils and Construction (Volume 2D, Main Road Construction). NSW Department of Environment and Climate Change, Sydney

IECA (2008). Best Practice Erosion and Sediment Control. International Erosion Control Association.

Appendix A

Conceptual SWMP Drawing



SETOUT POINTS		
POINT	EASTING	NORTHING
A1	295096.647	6255490.059
A2	295260.426	6255452.636
B1	295168.354	6255426.787
B2	295188.403	6255514.525

P&S FORM DRG-B1 REV 0

DRAWING REVISION HISTORY

No.	DESCRIPTION	DRAWN	DESIGNED	REVIEWED	DATE
B	EXISTING CONTOURS ADDED	SP	KD	JS	28.06.13
A	PRELIMINARY	SP	KD	JS	28.06.13
		SP	KD	DC	JUNE 2013

APPROVED
ORIGINAL COPY ON FILE "e" SIGNED BY
D CONLEY
SIGNED
DATE 28.06.2013

SCALE (PLOTTED FULL SIZE) 1:400
SHEET SIZE B1

REDUCED SCALE PLOT

CAUTION: THIS DRAWING MAY NOT COMPLY WITH AS1100 IF PLOTTED AT A REDUCED SCALE

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CLIENT: MURRAY GOULBURN
CONTRACT TITLE: PROJECT INVERLOCH - NSW
STATUS: **PRELIMINARY**

DRAWING TITLE: EARLY WORKS SITE LAYOUT
DATUMS: AHD / MGA PLANE
CLIENT No. C001
DRAWING No. ML13007-C001
REVISION B

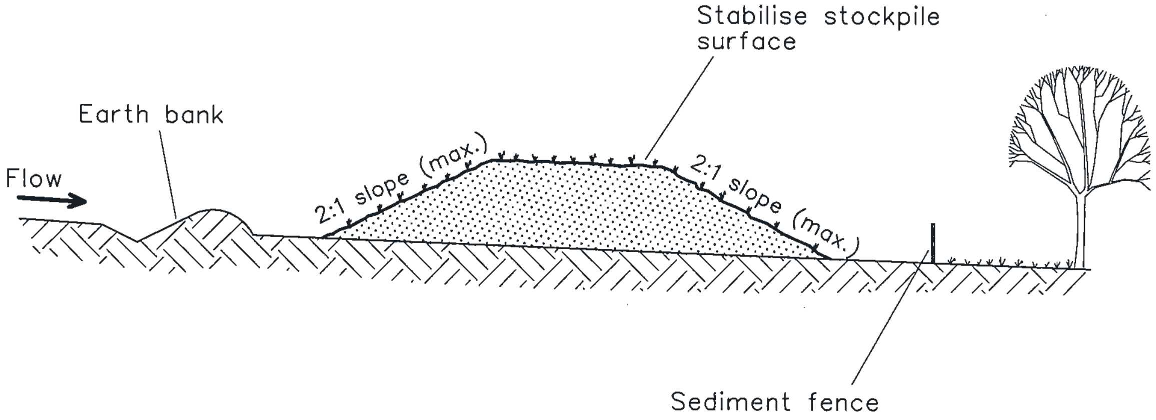
Jun. 28, 13 - 08:58:35 Name: ML13007-C001.dwg Updated By: Selwyn Pendergast

Appendix B

Standard Drawings

Erosion and Sediment Control Standard Drawings

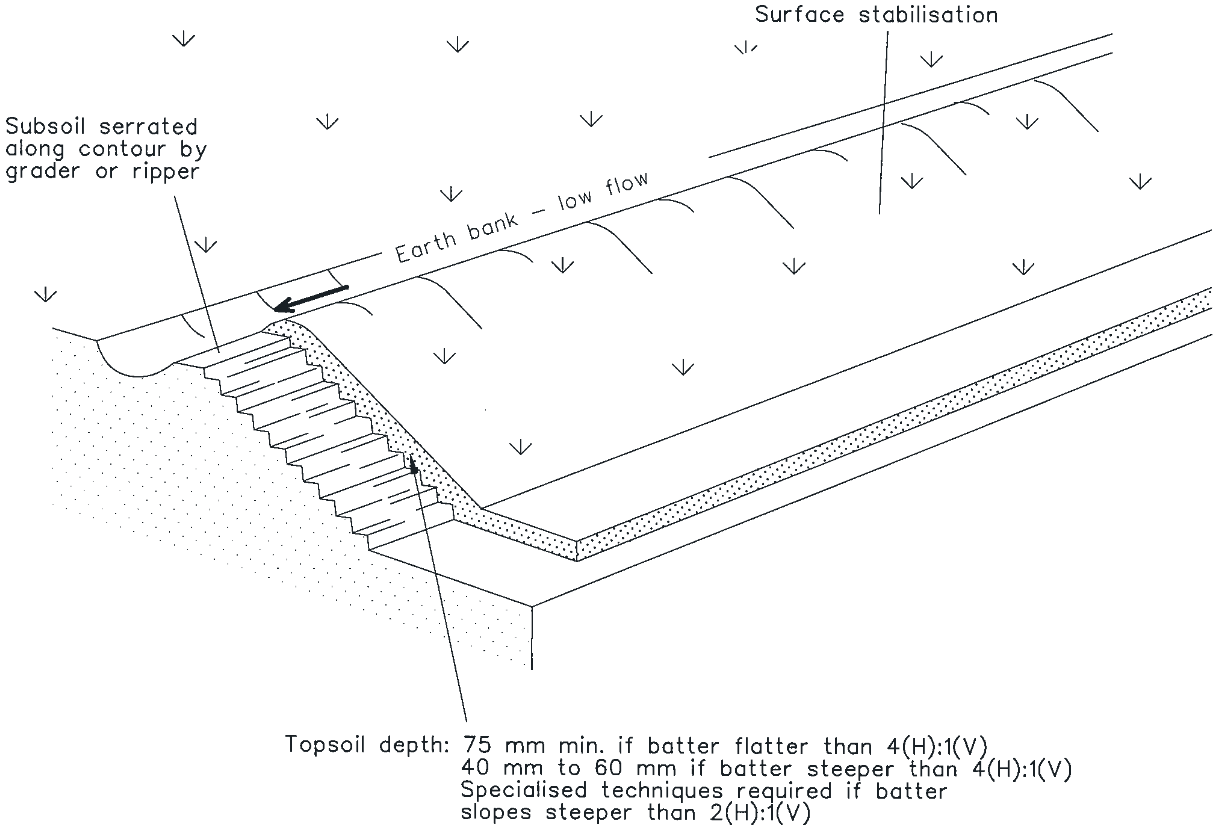
taken from the Blue Book - *Managing Urban Stormwater: Soils and Construction* (Landcom, 2004)



Construction Notes

1. Place stockpiles more than 2 (preferably 5) metres from existing vegetation, concentrated water flow, roads and hazard areas.
2. Construct on the contour as low, flat, elongated mounds.
3. Where there is sufficient area, topsoil stockpiles shall be less than 2 metres in height.
4. Where they are to be in place for more than 10 days, stabilise following the approved ESCP or SWMP to reduce the C-factor to less than 0.10.
5. Construct earth banks (Standard Drawing 5-5) on the upslope side to divert water around stockpiles and sediment fences (Standard Drawing 6-8) 1 to 2 metres downslope.

STOCKPILES **SD 4-1**



Construction Notes

1. Scarify the ground surface along the line of the contour to a depth of 50 mm to 100 mm to break up any hardsetting surfaces and to provide a good bond between the respread material and subsoil.

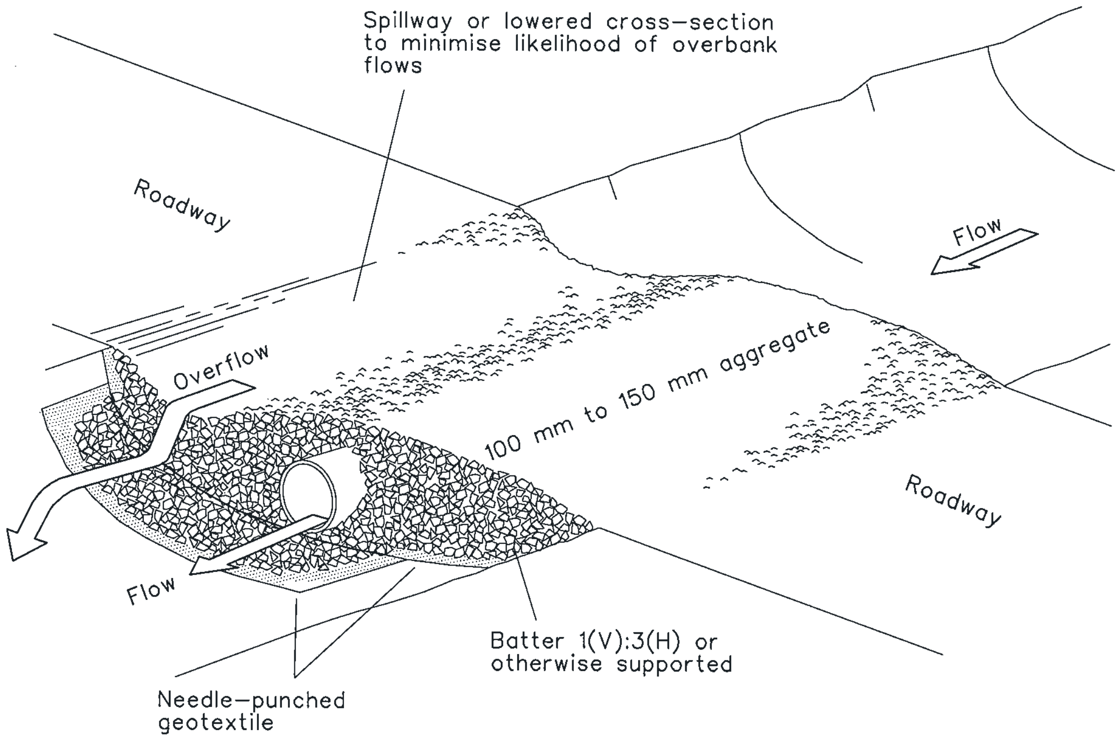
2. Add soil ameliorants as required by the ESCP or SWMP.

3. Rip to a depth of 300 mm if compacted layers occur.

4. Where possible, replace topsoil to a depth of 40 to 60 mm on lands where the slope exceeds 4(H):1(V) and to at least 75 mm on lower gradients.

REPLACING TOPSOIL

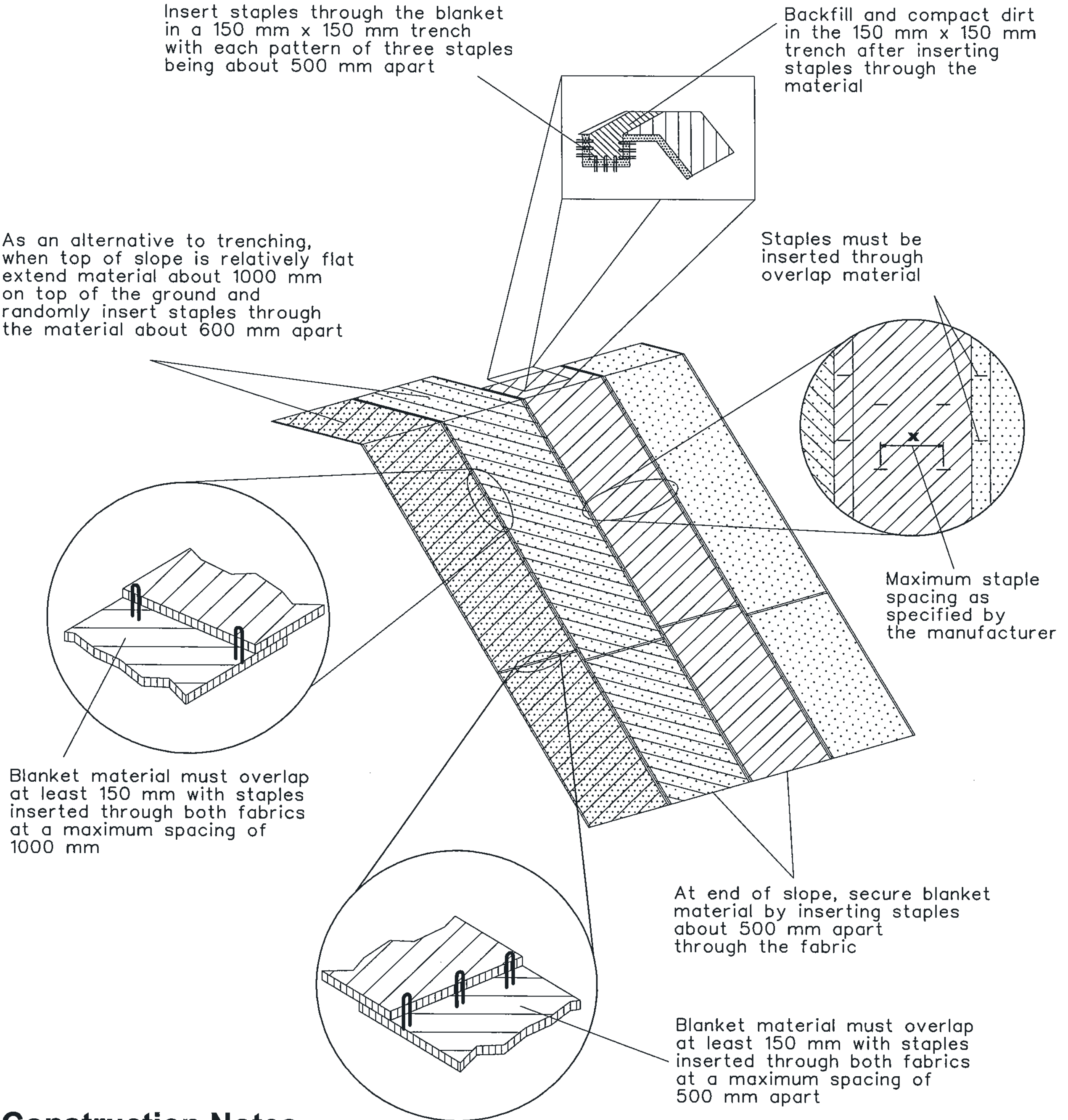
SD 4-2



Construction Notes

1. Prohibit all traffic until the access way is constructed.
2. Strip any topsoil and place a needle-punched textile over the base of the crossing.
3. Place clean, rigid, non polluting aggregate or gravel in the 100 mm to 150 mm size class over the fabric to a minimum depth of 200 mm.
4. Provide a 3-metre wide carriageway with sufficient length of culvert pipe to allow less than a 3(H): 1 (V) slope on side batters.
5. Install a lower section to act as an emergency spillway in greater than design storm events.
6. Ensure that culvert outlets extend beyond the toe of fill embankments.

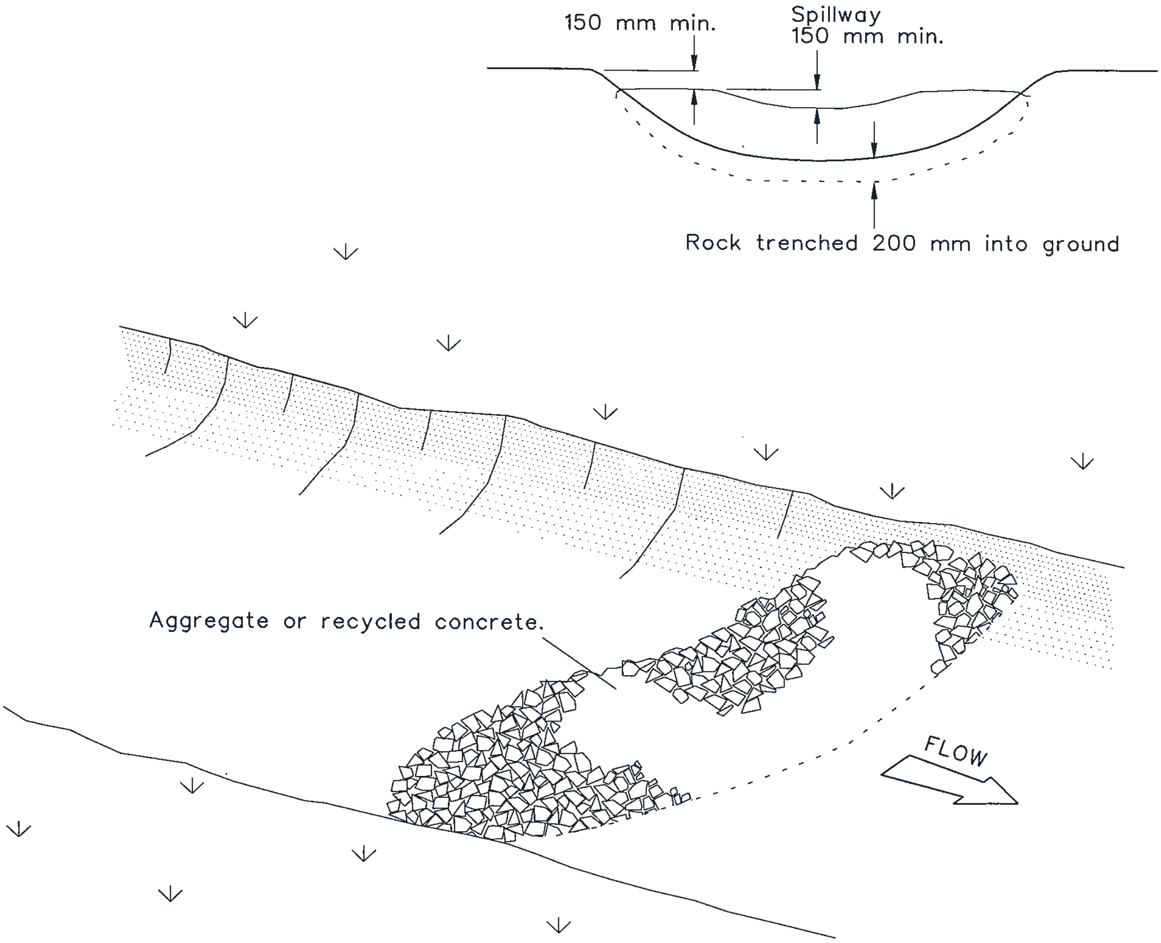
TEMPORARY WATERWAY CROSSING — SD 5-1



Construction Notes

1. Remove any rocks, clods, sticks or grass from the ground surface before laying the matting.
2. Spread topsoil to at least 75 mm depth.
3. Where appropriate, complete fertilising and seeding on a properly prepared seedbed (Standard Drawing 7-1) before laying the matting.
4. Ensure the fabric can be continuously in contact with the soil by grading the surface carefully first.
5. Lay the matting in "shingle-fashion" with the ends of each upstream roll overlapping the next roll downslope.
6. Ensure sufficient staples are used to maintain a good contact between the soil and the matting.

RECP : SHEET FLOW **SD 5-2**



Spacing of check dams along centreline and scour protection below each check dam to be specified on SWMP/ESCP

Construction Notes

1. Check dams can be built with various materials, including rocks, logs, sandbags and straw bales. The maintenance program should ensure their integrity is retained, especially where constructed with straw bales. In the case of bales, this might require their replacement each two to four months.

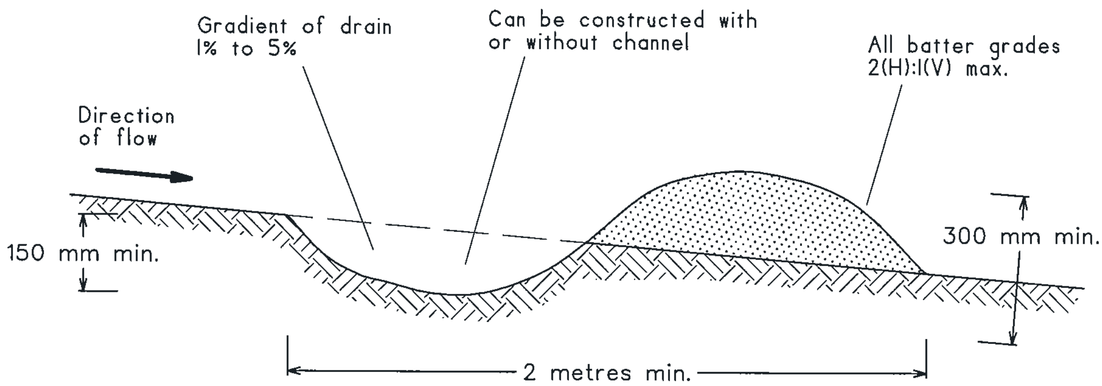
2. Trench the check dam 200 mm into the ground across its whole width. Where rock is used, fill the trenches to at least 100 mm above the ground surface to reduce the risk of undercutting.

3. Normally, their maximum height should not exceed 600 mm above the gully floor. The centre should act as a spillway, being at least 150 mm lower than the outer edges.

4. Space the dams so the toe of the upstream dam is level with the spillway of the next downstream dam.

ROCK CHECK DAM

SD 5-4

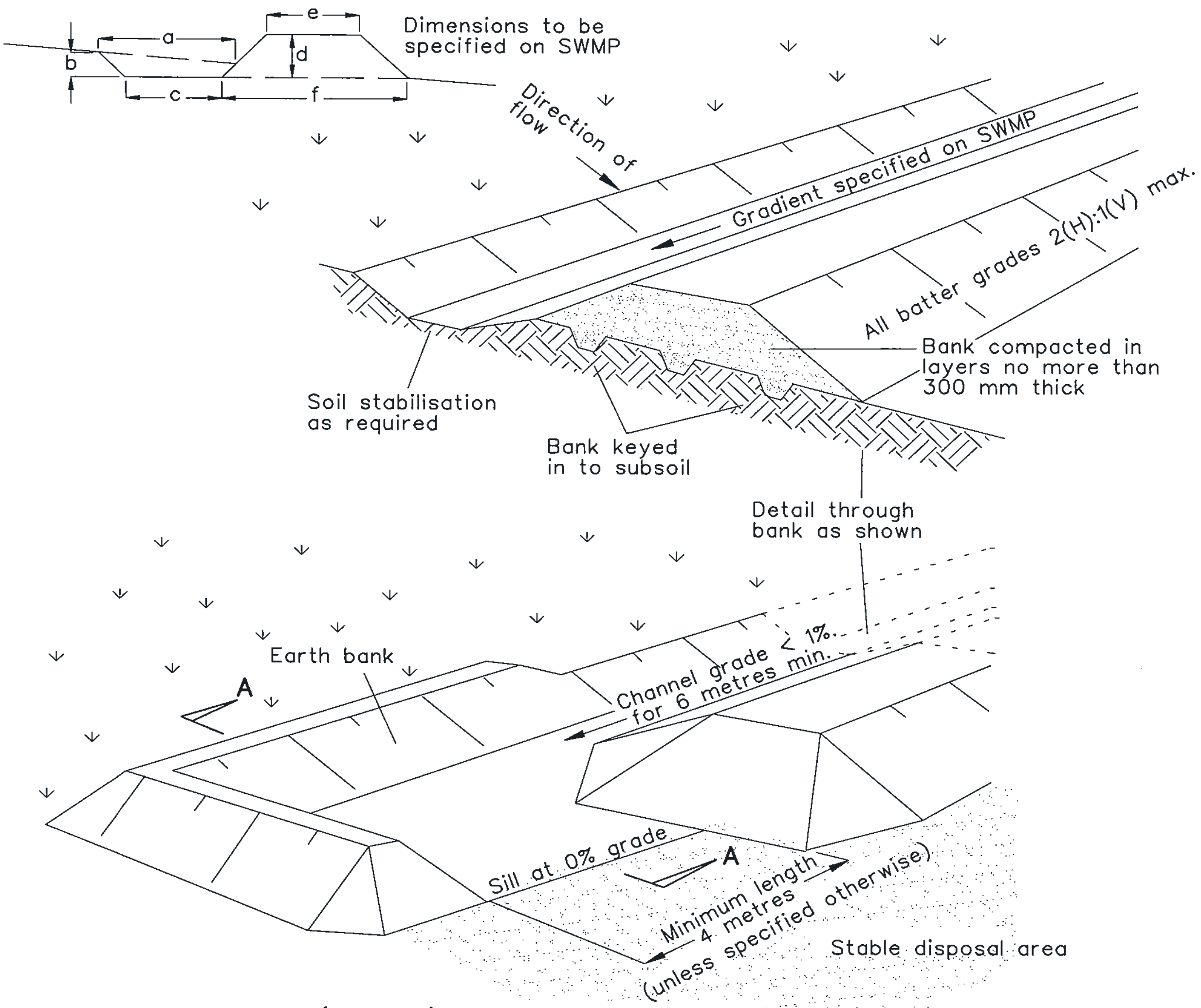


NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

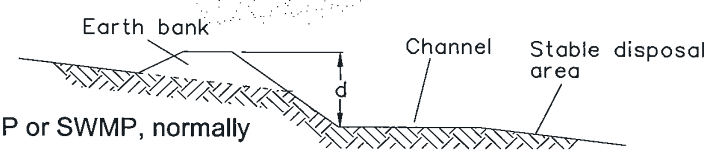
Construction Notes

1. Build with gradients between 1 percent and 5 percent.
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V shaped.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction.

EARTH BANK (LOW FLOW) SD 5-5



Level Spreader (or Sill)

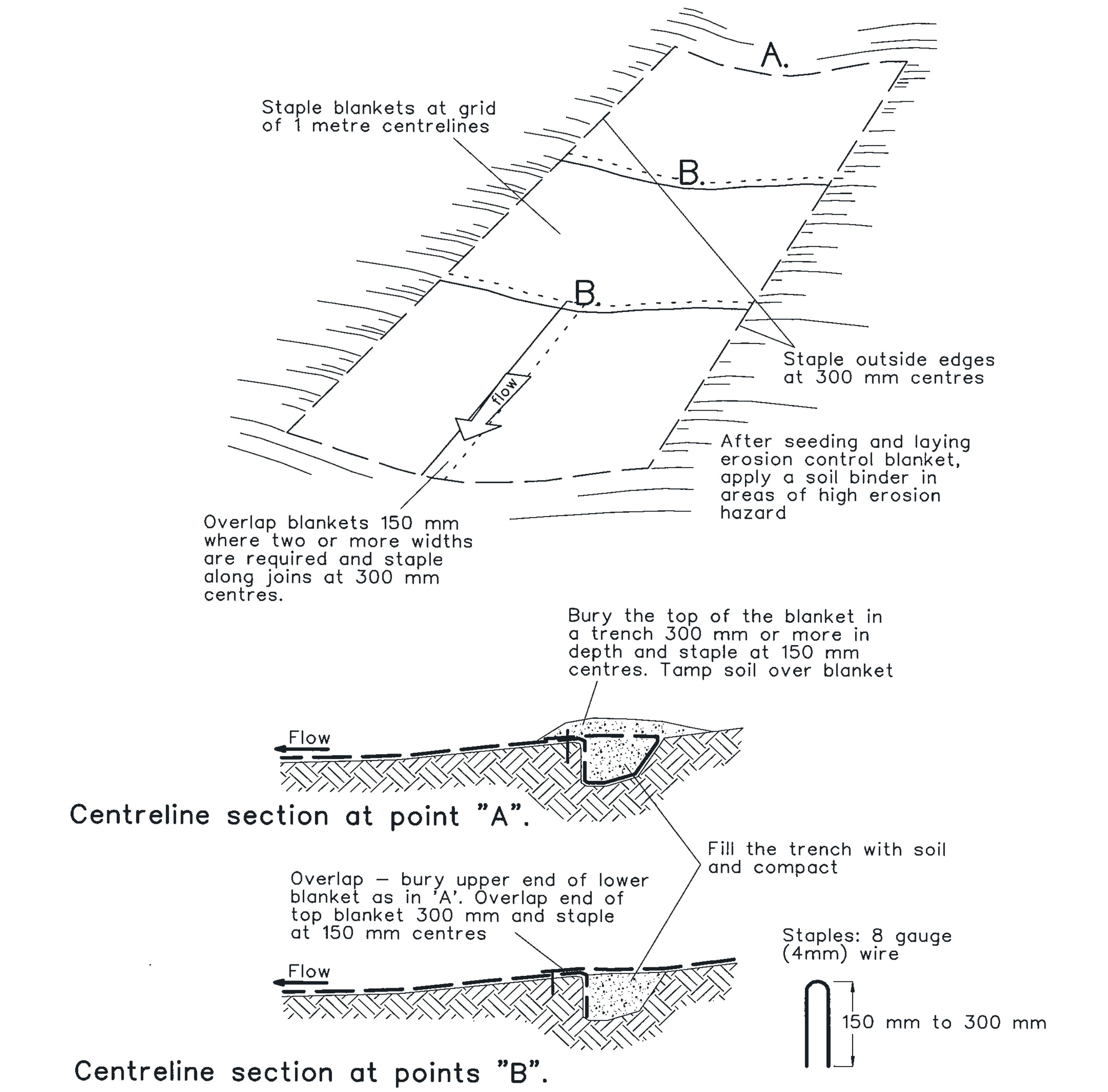


Section AA

Construction Notes

1. Construct at the gradient specified on the ESCP or SWMP, normally between 1 and 5 percent
2. Avoid removing trees and shrubs if possible - work around them.
3. Ensure the structures are free of projections or other irregularities that could impede water flow.
4. Build the drains with circular, parabolic or trapezoidal cross sections, not V-shaped, at the dimensions shown on the SWMP.
5. Ensure the banks are properly compacted to prevent failure.
6. Complete permanent or temporary stabilisation within 10 days of construction following Table 5.2 in Landcom (2004).
7. Where discharging to erodible lands, ensure they outlet through a properly constructed level spreader.
8. Construct the level spreader at the gradient specified on the ESCP or SWMP, normally less than 1 percent or level.
9. Where possible, ensure they discharge waters onto either stabilised or undisturbed disposal sites within the same subcatchment area from which the water originated. Approval might be required to discharge into other subcatchments.

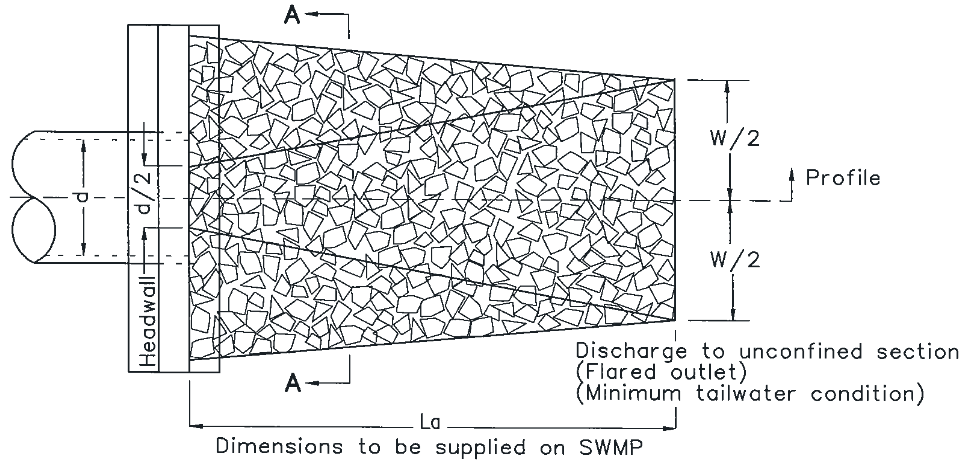
EARTH BANK (HIGH FLOWS) SD 5-6



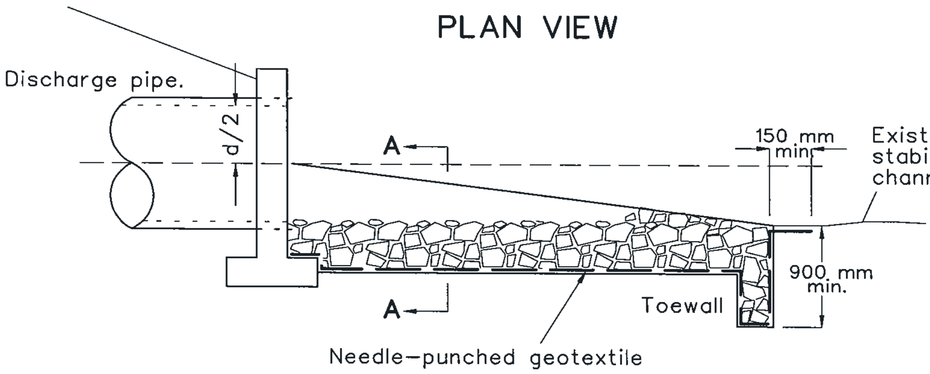
Construction Notes

1. Remove any rocks, clods, sticks or grass from the surface before laying matting
2. Ensure that topsoil is at least 75 mm deep.
3. Complete fertilising and seeding before laying the matting.
4. Ensure fabric will be continuously in contact with the soil by grading the surface carefully first.
5. Lay the fabric in "shingle-fashion", with the end of each upstream roll overlapping those downstream. Ensure each roll is anchored properly at its upslope end (Standard Drawing 5-7b).
6. Ensure that the full width of flow in the channel is covered by the matting up to the design storm event, usually in the 10-year ARI time of concentration storm event.
7. Divert water from the structure until vegetation is stabilised properly.

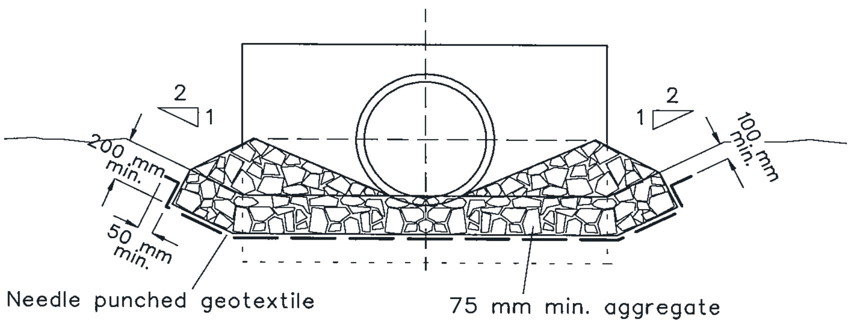
RECP : CONCENTRATED FLOW **SD 5-7**



PLAN VIEW



PLAN VIEW

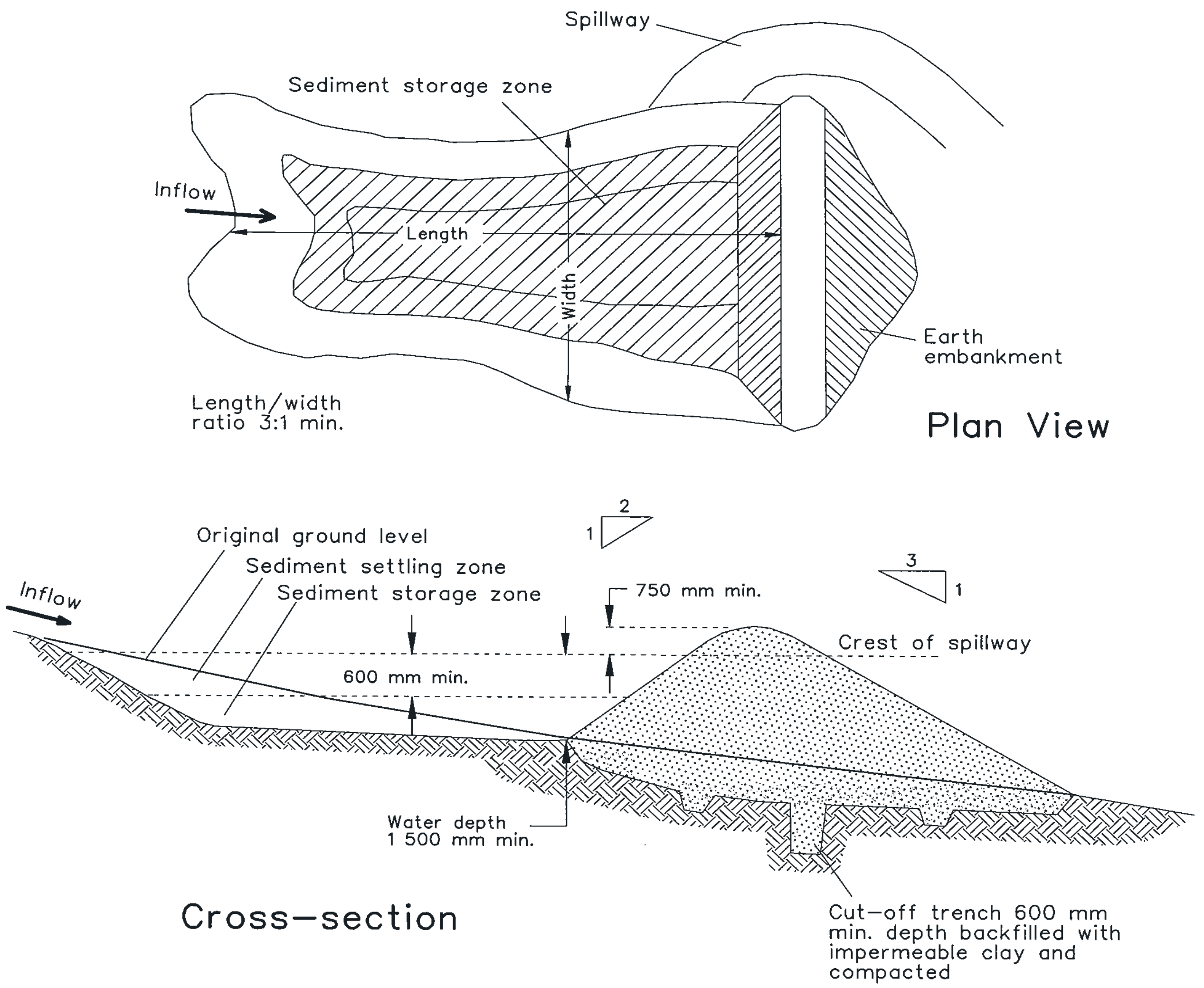


CROSS SECTION AA

Construction Notes

1. Compact the subgrade fill to the density of the surrounding undisturbed material.
2. Prepare a smooth, even foundation for the structure that will ensure that the needle-punched geotextile does not sustain serious damage when covered with rock.
3. Should any minor damage to the geotextile occur, repair it before spreading any aggregate. For repairs, patch one piece of fabric over the damage, making sure that all joints and patches overlap more than 300 mm.
4. Lay rock following the drawing, according to Table 5.2 of Landcom (2004) and with a minimum diameter of 75 mm.
5. Ensure that any concrete or riprap used for the energy dissipater or the outlet protection conforms to the grading limits specified on the SWMP.

ENERGY DISSIPATER **SD 5-8**



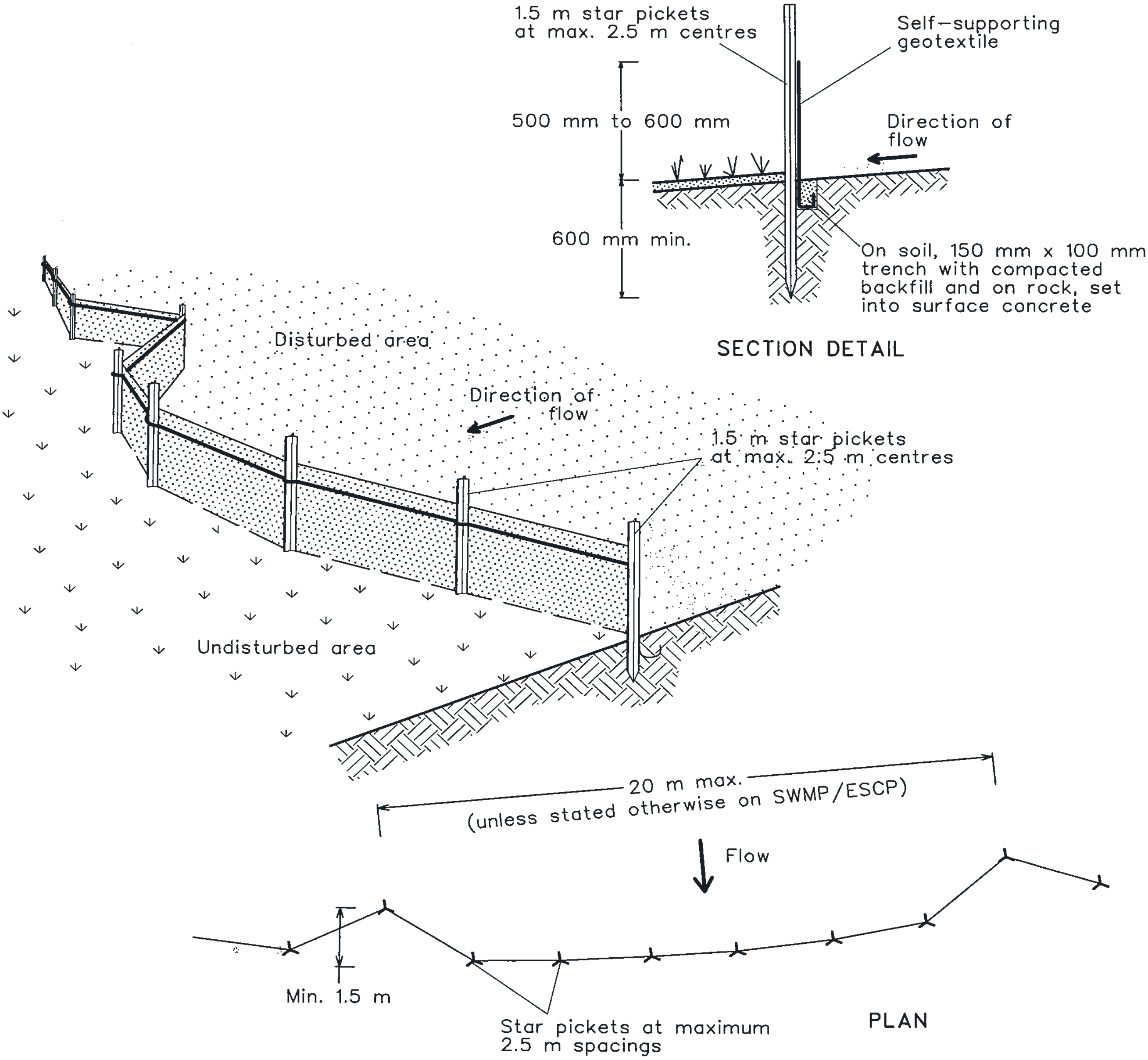
Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET

(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

SD 6-4



Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.

2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.

3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.

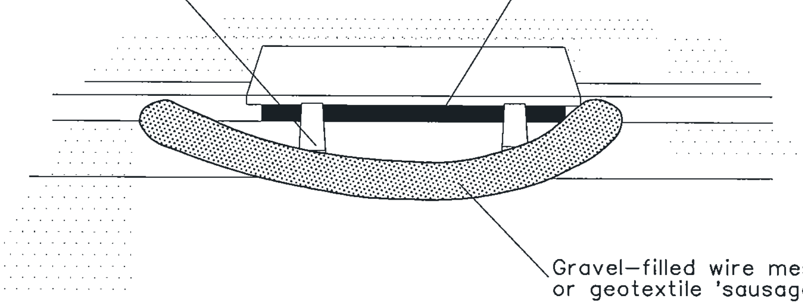
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.

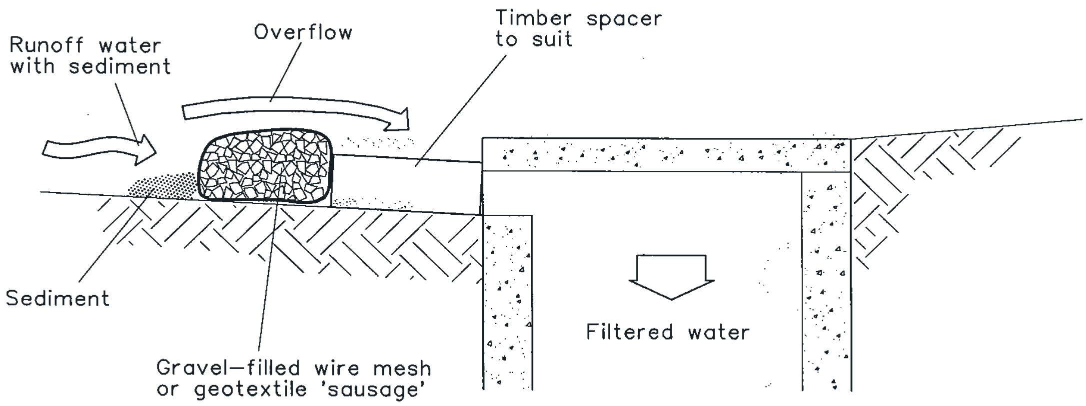
5. Join sections of fabric at a support post with a 150-mm overlap.

6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE

SD 6-8



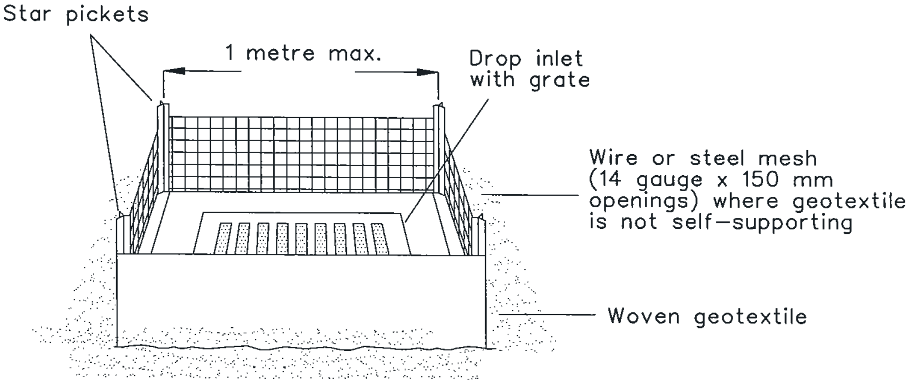


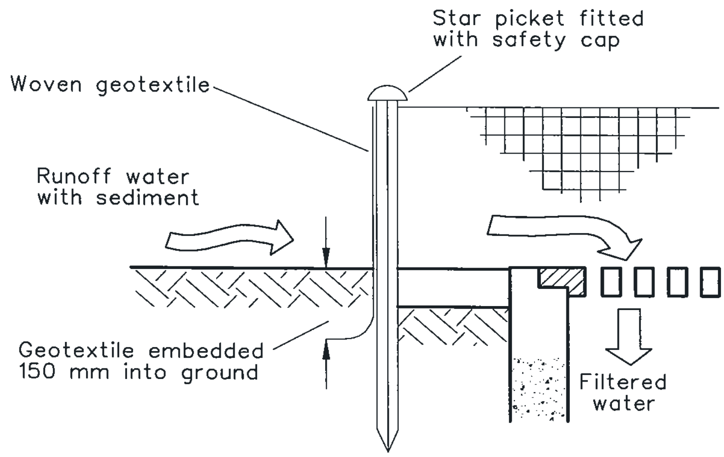
NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

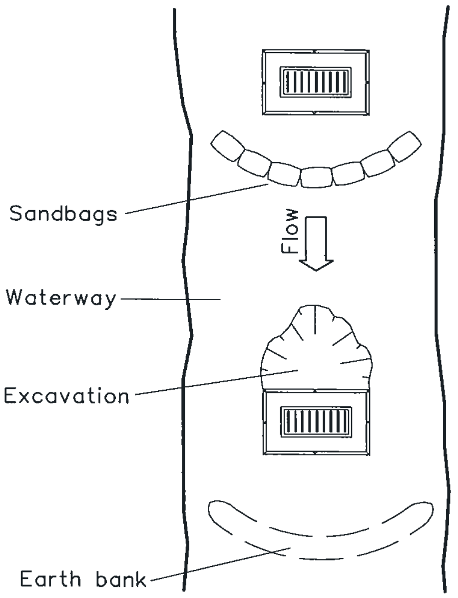
Construction Notes

1. Install filters to kerb inlets only at sag points.
2. Fabricate a sleeve made from geotextile or wire mesh longer than the length of the inlet pit and fill it with 25 mm to 50 mm gravel.
3. Form an elliptical cross-section about 150 mm high x 400 mm wide.
4. Place the filter at the opening leaving at least a 100-mm space between it and the kerb inlet. Maintain the opening with spacer blocks.
5. Form a seal with the kerb to prevent sediment bypassing the filter.
6. Sandbags filled with gravel can substitute for the mesh or geotextile providing they are placed so that they firmly abut each other and sediment-laden waters cannot pass between.

MESH AND GRAVEL INLET FILTER **SD 6-11**





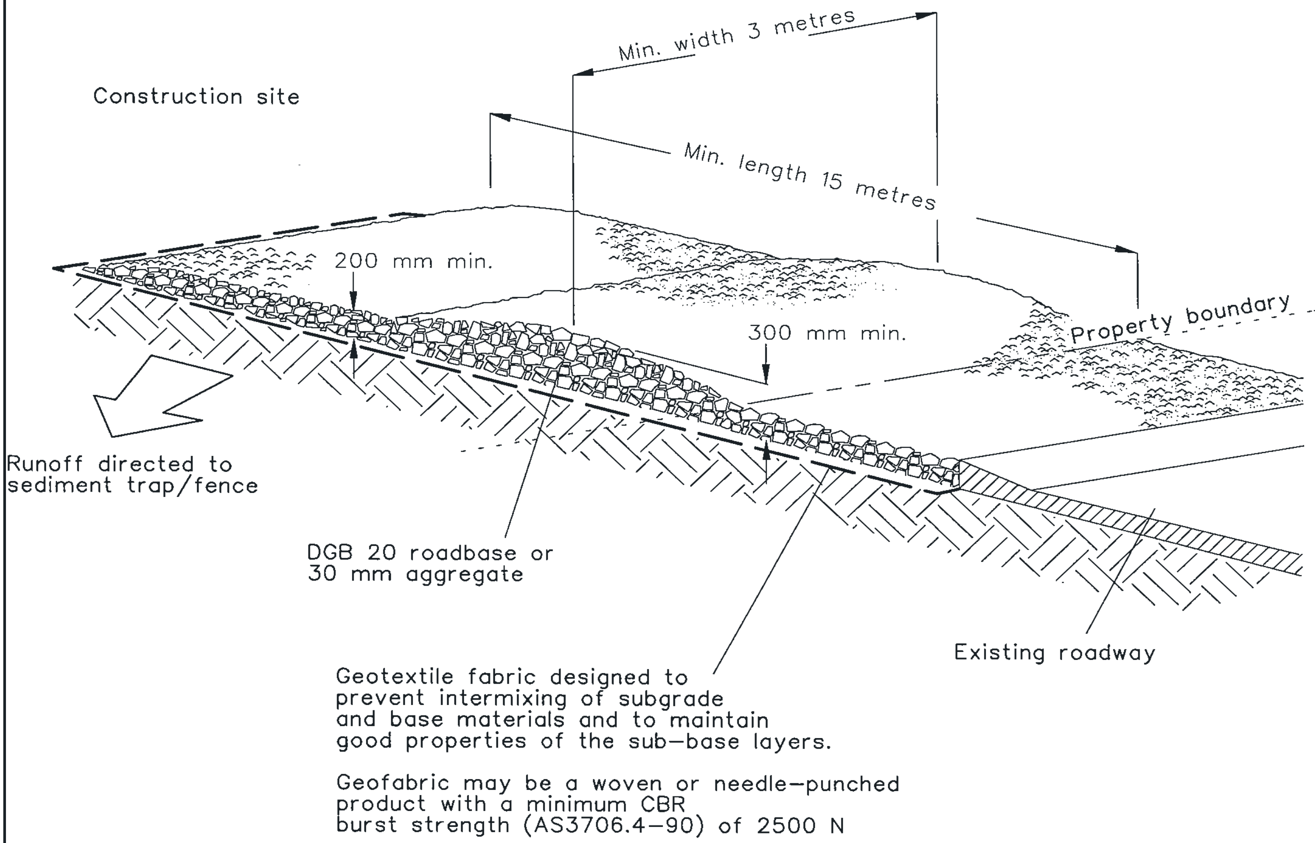


For drop inlets at non-sag points, sandbags, earth bank or excavation used to create artificial sag point

Construction Notes

1. Fabricate a sediment barrier made from geotextile or straw bales.
2. Follow Standard Drawing 6-7 and Standard Drawing 6-8 for installation procedures for the straw bales or geofabric. Reduce the picket spacing to 1 metre centres.
3. In waterways, artificial sag points can be created with sandbags or earth banks as shown in the drawing.
4. Do not cover the inlet with geotextile unless the design is adequate to allow for all waters to bypass it.

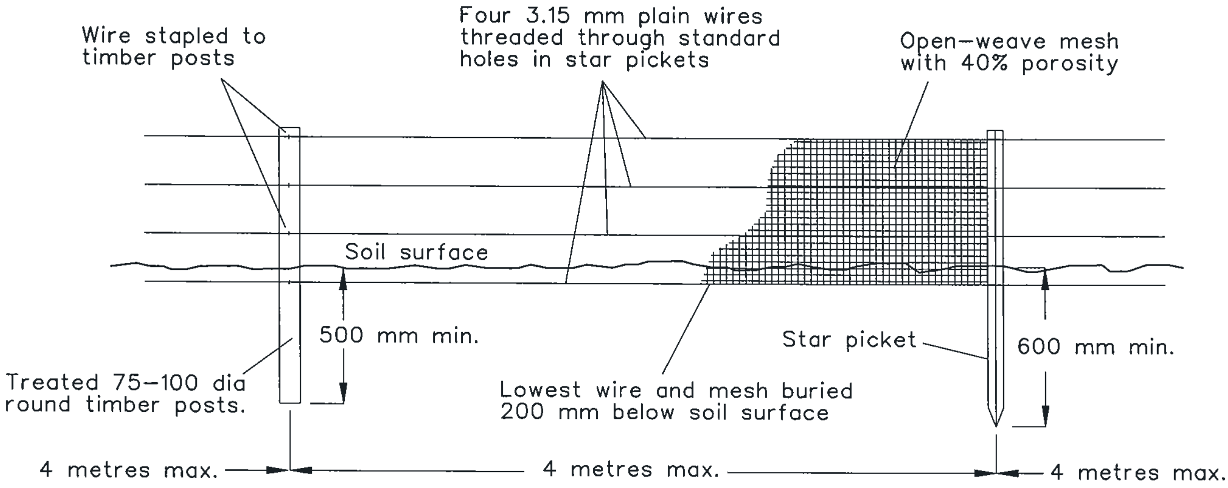
GEOTEXTILE INLET FILTER   SD 6-12

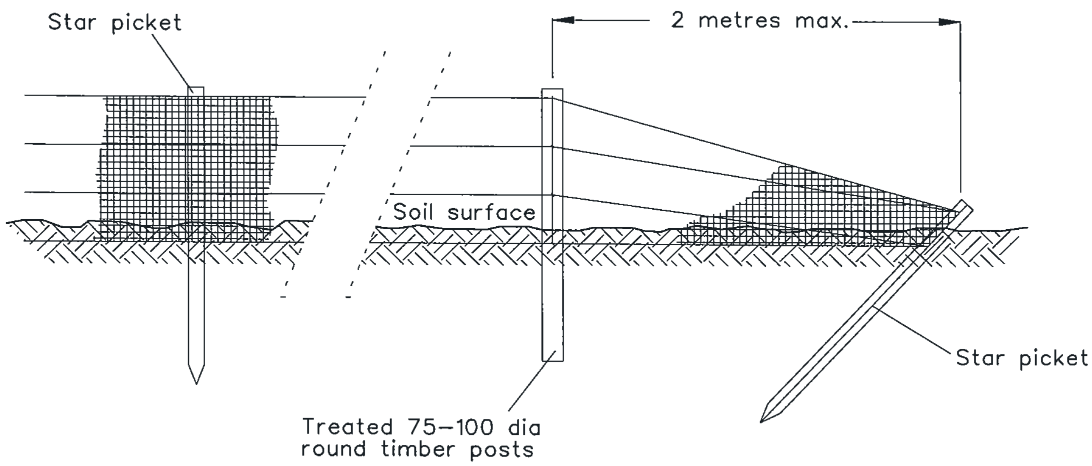


Construction Notes

1. Strip the topsoil, level the site and compact the subgrade.
2. Cover the area with needle-punched geotextile.
3. Construct a 200-mm thick pad over the geotextile using road base or 30-mm aggregate.
4. Ensure the structure is at least 15 metres long or to building alignment and at least 3 metres wide.
5. Where a sediment fence joins onto the stabilised access, construct a hump in the stabilised access to divert water to the sediment fence

STABILISED SITE ACCESS **SD 6-14**

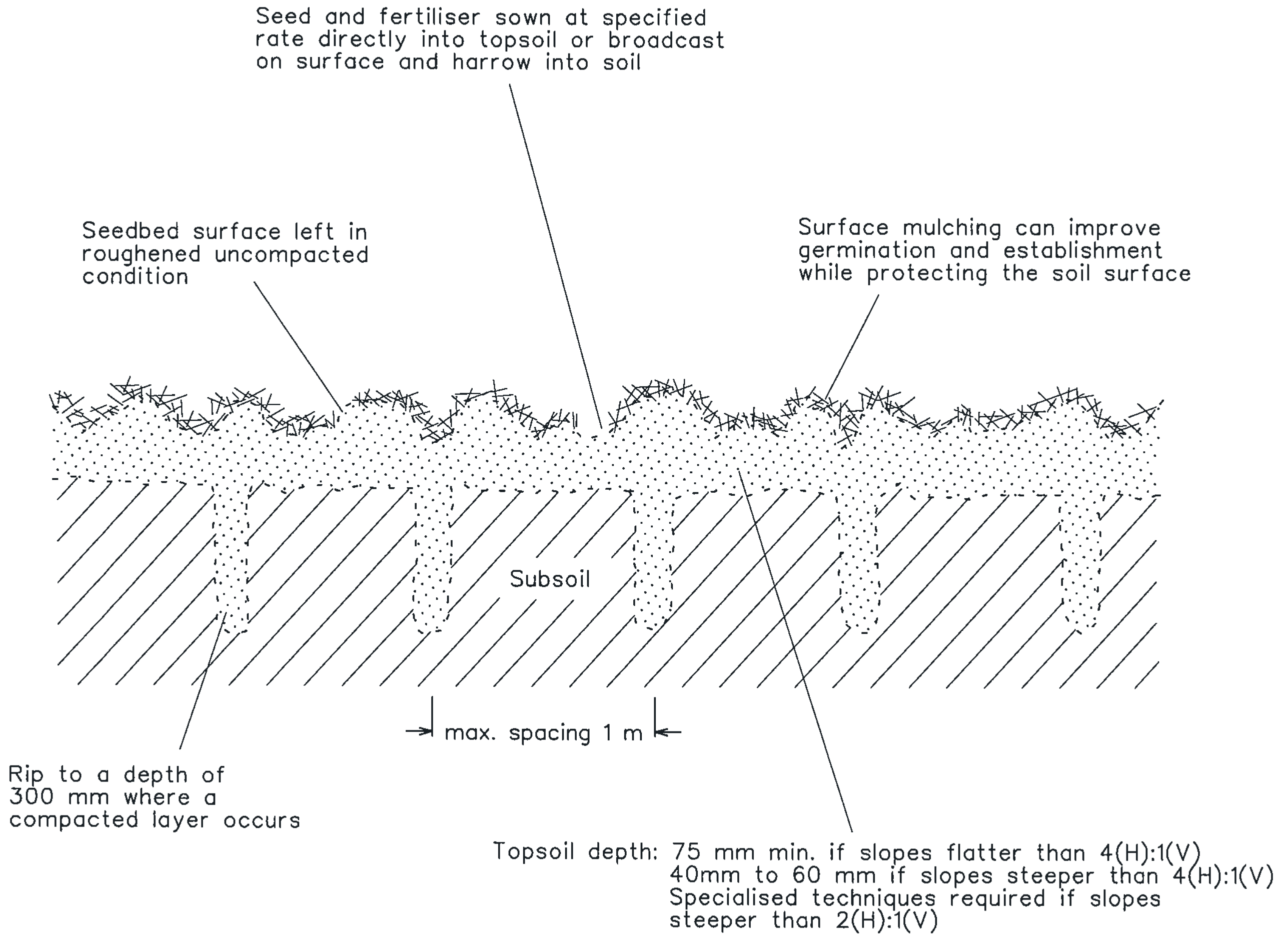




Construction Notes

1. Install the fence to the height specified in the ESCP/SWMP.
2. Cut a channel 200 mm deep along the fence line.
3. Place wire and light resistant, open-weave polymer mesh with 40 percent porosity on the prevailing wind side of fence.
4. Fasten the mesh to all wires using ring fasteners at 100 mm to 150 mm intervals on top wire and 300 mm intervals on other wires.
5. Use one 75-mm to100-mm diameter treated round timber post every 20 metres.
6. Where star pickets are used, ensure they are fitted with safety caps.

CONTROL OF WIND EROSION **SD 6-15**



Construction Notes

1. Loosen compacted soil before sowing any seed. If necessary, rip the soil to a depth of 300 mm. Avoid rotary hoe cultivation.
2. Work the ground only as much as necessary to achieve the desired tilth and prepare a good seedbed.
3. Avoid cultivation in very wet or very dry conditions.
4. Cultivate on or close to the contour where possible, not up and down the slope.

SEEDBED PREPARATION **SD 7-1**

Appendix C

Sediment Basin sizing Spreadsheets

Note: These "Detailed Calculation" spreadsheets relate only to high erosion hazard lands as identified in figure 4.6 or where the designer chooses to use the RUSLE to size sediment basins. The "Standard Calculation" spreadsheets should be used on low erosion hazard lands as identified by figure 4.6 and where the designer chooses not to run the RUSLE in calculations.

1. Site Data Sheet

Site Name: **Proposed Milk Processing Facility**

Site Location: **Quarry Road, Erskine Park**

Precinct:

Description of Site:

Site area	Sub-catchments						Remarks
	A	B	C	D	E	F	
Total catchment area (ha)	3						
Disturbed catchment area (ha)	3						
Soil analysis (enter sediment type if known, or laboratory particle size data)							
Sediment Type (C, F or D) if known:	D						From Appendix C
% sand (fraction 0.02 to 2.00 mm)							Soil texture should be assessed through
% silt (fraction 0.002 to 0.02 mm)							mechanical dispersion only. Dispersing
% clay (fraction finer than 0.002 mm)							agents (e.g. Calgon) should not be used
Dispersion percentage							E.g. enter 10 for dispersion of 10%
% of whole soil dispersible							See Section 6.3.3(e). Auto-calculated
Soil Texture Group	D						Automatic calculation from above
Rainfall data							
Design rainfall depth (days)	5						See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	80						See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	27.4						See Section 6.3.4 (h)
Rainfall R-factor (if known)							See Appendix B
IFD: 2-year, 6-hour storm (if known)	10						See IFD chart for the site
RUSLE Factors							
Rainfall erosivity (*R*-factor)	2210	2210	2210	2210	2210	2210	Auto-filled from above
Soil erodibility (*K*-factor)	0.045						
Slope length (m)	80						
Slope gradient (%)	3						RUSLE LS factor calculated for a high
Length/gradient (*LS*-factor)	0.65						rill/interrill ratio.
Erosion control practice (*P*-factor)	1.3						
Ground cover (*C*-factor)	1						
Calculations							
Soil loss (t/ha/yr)	84						
Soil Loss Class	1						See Section 4.4.2(b)
Soil loss (m^3/ha/yr)	65						
Sediment basin storage volume, m^3	33						See Sections 6.3.4(i) and 6.3.5 (e)

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,\,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,\,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent. Place an x in the appropriate column below to automatically halve the time of concentration for that sub-catchment.

Peak flow calculations, 1

Site	A (ha)	Place an x here to halve tc	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
				$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
A	3		12	53.5	89.5	101.5	117.2	137.9	153.8	0.9
B										
C										
D										
E										
F										

Peak flow calculations, 2

ARI (yrs)	Frequency factor (F_y)	Peak flows						Comments
		A (m^3/s)	B (m^3/s)	C (m^3/s)	D (m^3/s)	E (m^3/s)	F (m3/s)	
1 yr,tc	0.62	0.249						
5 yr,tc	0.88	0.591						
10 yr,tc	1	0.762						
20 yr,tc	1.12	0.985						
50 yr,tc	1.25	1.294						
100 yr,tc	1.38	1.593						

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{x\text{-day},\ y\text{-\%ile}}\ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

$R_{x\text{-day},\ y\text{-\%ile}}$ = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the detailed calculation on Soil Loss Classes 1 to 4 lands, the sediment storage zone can be taken as 50 percent of the settling zone capacity. Alternately designers can design the zone to store the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)). However, on Soil Loss Classes 5, 6 and 7 lands, the zone must contain the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(iii)).

Place an "X" in the box below to show the sediment storage zone design parameters used here:

	50% of settling zone capacity,
X	2 months soil loss calculated by RUSLE

Total Basin Volume

Site	C_v	$R_{x\text{-day},\ y\text{-\%ile}}$	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
A	0.56	27.4	3	460.32	33	493.32
B						
C						
D						
E						
F						

Note that designers should achieve a minimum 3:1 length:width ratio in Type D or F basins