11.3 Appendix 3: Revised Universal Soil Loss Equation

While assessment of runoff is commonplace in the urban planning process, estimating possible soil loss is not. Nonetheless, estimates of soil loss have four important applications to soil and water management. These are to:

- assess the erosion risk at a site
- identify suitable measures to overcome the erosion risk
- estimate the required capacity of sediment retarding basins
- compare the effectiveness of various erosion control measures.

Therefore, by estimating likely soil loss levels, land planners can gear erosion and sediment control measures to each part of any development site. Consequently, they can mitigate possible soil erosion and consequent sediment pollution to downslope lands and waterways.

The Revised Universal Soil Loss Equation (RUSLE) is designed to predict the long term, average, annual soil loss from sheet and rill flow at nominated sites under specified management conditions. The predicted losses are empirically derived. The original application is described by Wishchmeier and Smith (1978) and revised by Renard, Foster, Weesies and Porter (1991) and Renard, Foster, Weesies, McCool and Yoder (1997). It has been adapted to urban sites and modified for Australian conditions in a computer program called SOILOSS (Rosewell, 1993). The equation is represented by:

$$A = RKLSPC$$

where, A = computed soil loss (tonne/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 factors.

Typical values are given in Table 5.

Because the RUSLE takes into consideration all major components likely to affect sheet erosion, it is the most widely used (and abused) soil loss equation available. While it does have great practical value, its limitations should be recognised and understood.

The main limitations of the RUSLE are that it:

(i) only predicts sediment entrained in the erosion process and does not predict sediment yields into particular sediment basins; [1]

(ii) predicts average annual soil loss and not that for a particular storm event;

(iii) is effective for erosion through sheet and rill flow only on short slopes (<300 m) and not for concentrated flow or long slopes; and

[1] In most situations, not all the sediment entrained on eroding lands is transported away from the site. However, at urban development sites where sediment trapping devices are very close to areas of erosion and most fine particles are flocculated, it can be assumed that most sediment entrained can be trapped.

(iv) does not adequately take into account soil dispersibility in assessment of the *K*-factor.

Despite these matters, the RUSLE has its benefits and should be applied at all urban development sites, even at a cursory level, provided that any unmeasured factors are on the conservative side.

Table 5 Factors Used in the Interpretation of the RUSLE

Factors	Remarks
R - rainfall erosivity	Rainfall erosivity is a measure of the erosive force and intensity of rain in a normal year. In NSW, it varies from 500 to 9,500 while at the subject site it is 4,200 (Appendix 2)
K - soil erodibility	Soil erodibility is a measure of the susceptibility of soil particles to detachment and transport by rainfall and runoff. It can be normally expected to range from 0.005 to 0.02 on soils with low erodibility, from 0.021 to 0.04 to soils with moderate erodibility, and from 0.041 to 0.07 on soils with high erodibility.
LS - slope length and gradient	Both slope length (metres) and gradient (per cent) have major effects on possible soil loss. They should be recorded as typical upper values for the site or unit in question. In the RUSLE, slope and length criteria are normally treated as a single entity, *LS*. On construction sites the *LS*-factor commonly ranges from 0.10 (flat, short slopes) to 5.0 (steep, long slopes).
P - erosion control practice	The erosion control practice is reflected in the roughening or smoothing of the soil surface by machinery, i.e. those practices that can reduce both the velocity of runoff and the tendency of runoff to flow directly downhill. *P*-factors normally range from 0.8 (low) to 1.3 (high). On construction sites assuming a worst case scenario of 1.3 is normal.
C - cover	The cover or *C*-factor, is the ratio of soil loss from land under specified crop or mulch conditions to the corresponding loss from tilled, bare soil and taken as 1.0 — typical of urban construction sites. It normally ranges from about 0.005 on very well vegetated lands to 1.0 where the vegetation has been completely removed.

Table 6 and Figure 2 provide indicative *C*-factors for some cover types. Tables A3 and D1 from the Blue Book are also appended here, both of which should be used when selecting erosion control products or ground cover types for rehabilitation.

Table 6 *C*-factors for Various Cover Types

Type of cover	*C*-factor
No mulching or seeding, no plant roots	1.00
Little or no above-ground plant material but roots still intact and undisturbed (see figure A1)	0.45
Open-weave jute mesh (<40% coverage of soil surface)	0.40
Straw anchored * *to the soil at:*	
(i) 2.2 tonnes/ha and	
(a) 6-10% slope, up to 30 m long	0.20
(b) ≤5% slope, up to 60 m long	0.20
(ii) 4.5 tonnes/ha and	
(a) 34-50% slope, up to 10 m long	0.20
(b) 26-33% slope, up to 15 m long	0.17
(c) 21-25% slope, up to 22.5 m long	0.14
(d) 16-20% slope, up to 30 m long	0.11
(e) 11-15% slope, up to 45 m long	0.07
(f) 6-10% slope, up to 60 m long	0.06
(g) ≤5% slope up, to 120 m long	0.06
Woodchip applied at:	
(I) 16 tonnes/ha and	
(a) 16-20% slope, up to 15 m long	0.08
(b) ≤15% slope, up to 22.5 m long	0.08
(ii) 27 tonnes/ha and -	
(a) 21-33% slope, up to 22.5 m long	0.05
(b) 16-20% slope, up to 30 m long	0.05
(c) ≤15% slope, up to 45 m long	0.05
(iii) 56 tonnes/ha and -	
(a) 34-50% slope, up to 22.5 m long	0.02
(b) 21-33% slope, up to 30 m long	0.02
(c) 16-20% slope, up to 45 m long	0.02
(e) ≤15% slope, up to 60 m long	0.02
Woven straw blanket	0.08
Seeding grasses after 60 days (average conditions using perennial rye, small grains, millet or Sudan grass)	0.05
Bitumen emulsion (12,000 l/ha)	0.02
Jute fine mat (100% coverage of soil surface)	0.01
Sod (turf)	<0.01
Undisturbed native vegetation or well-established exotic grasses providing 100% cover	<0.01

* Rill erosion might occur beneath the mulch if it is not properly anchored. Accordingly, the soil loss factors could double those shown, especially on moderate or steep slopes and soils with moderate erodibilities.

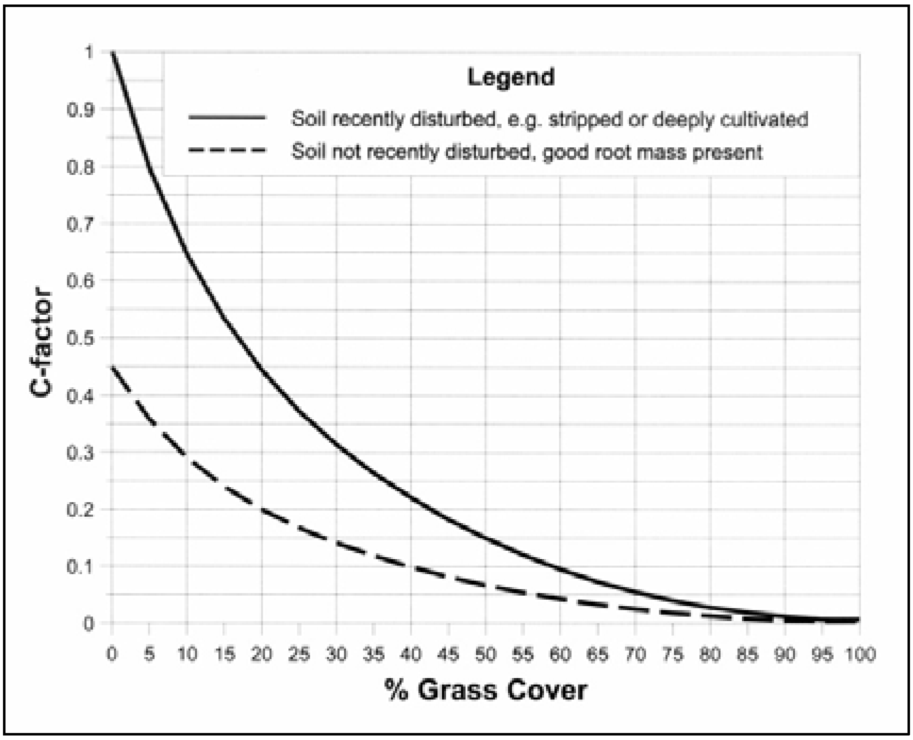


Figure 3 C-factors for established grass cover

Class	Type	Suitable for Vegetation Type [1]	Design Life (months)	Use in Concentrated Flow [2]	Availability (days) [3]	Relative Cost Bracket [4]	Residual Impact [5]	C-factor [6] <33%, <8m	C-factor <33%, 8-15m	C-factor <33%, >15m	C-factor 33-50%, <8m	C-factor 33-50%, 8-15m	C-factor 33-50%, >15m
BIODEGRADABLE MULCHES [7]													
Straw (anchored)	4.5 tonnes per hectare	Grass	1 to 6	No	< 5days	Low	Moderate	0.17	0.17	0.20	0.20	0.30	0.30
Wood Chip	16 tonnes per hectare	Grass/Shrubs	1 to 6	No	< 5days	Low	Moderate	0.08	0.08	0.08	No data		
Wood Chip	27 tonnes per hectare	Shrubs	1 to 6	No	< 5days	Low	Moderate	0.05	0.05	0.05	No data		
Wood Chip	56 tonnes per hectare	Shrubs	1 to 6	No	< 5days	Low	Moderate	0.02	0.02	0.02	0.02	0.02	0.02
Hydromulching	1.5 tonnes mulch + 300 litres binder per hectare	Grass	1 to 3	No	< 5days	Low	Low	0.00	0.03	0.07	0.03	0.06	0.10
Bonded Fibre	5 tonnes fibre per hectare	Grass	1 to 6	No	< 5days	Low	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
Blown compost, bonde	Minimum 50 mm blanket	Grass/Shrubs	6 to 18	No	<5days	Medium	Low	0.00	0.03	0.07	0.03	0.06	0.10
ROLLED EROSION CONTROL PRODUCTS (RECPs) [7]													
Biodegradable	Jute mesh	Grass	6 to 12	Yes	< 5days	Low	Moderate	0.10	0.20	0.40	0.20	0.40	0.60
	Coconut fibre mesh (~400 gsm)	Grass	24	Yes	< 5days	Low	Moderate	0.10	0.20	0.40	0.20	0.40	0.60
	Coconut fibre mesh (~700 gsm or more)	Grass	48	Yes	< 5days	Medium	Moderate	0.10	0.10	0.20	0.10	0.15	0.20
	Curled wood fibre	Grass	6 to 12	Yes	< 5days	Medium	Moderate	0.01	0.05	0.10	0.10	0.15	0.20
	Jute matting (~350 gsm)	Grass	6 to 18	Yes	< 5days	Medium	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
	Jute matting (~600 gsm)	Shrubs	12 to 24	Yes	< 5days	Medium	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
	Coconut fibre matting (~400 gsm)	Grass	12 to 18	Yes	< 5days	Medium	Moderate	0.00	0.03	0.07	0.03	0.06	0.10
	Coconut fibre matting (~900 gsm)	Shrubs	18 to 24+	Yes	< 5days	Medium	Moderate	0.00	0.01	0.07	0.03	0.06	0.10
Photodegradable	Mesh (< 5 mm openings)	Grass	1 to 6	Yes	< 5days	Low	Moderate	0.01	0.05	0.10	0.10	0.15	0.20
Non Biodegradable TRMs, all categories	Plastic fibres with netting	Grass	> 48	Yes	< 5days	High	High	0.00	0.05	0.10	0.03	0.05	0.10
	Composite with biodegradable	Grass/Shrubs	> 12	Yes	< 5days	High	High	0.00	0.03	0.07	0.03	0.06	0.10
HYDRAULIC SOIL STABILISERS [7]													
	Polymers/Polyacrylamide (rate depends on type)	Grass	1 to 6	No	< 5days	Low	Low	0.01	0.05	0.10	0.10	No data	
	Bitumen emulsion (12,000 l/ha)	Grass	1 to 6	No	< 5days	Low	Low	0.01	0.05	0.10	0.10	No data	
TEMPORARY SEEDING													
	Annual	NA	6 to 12	No	< 5days	Low	Low	0.05	0.05	0.10	0.10	No data	
	Perennial	NA	> 12	No	< 5days	Low	Low to moderate	0.05	0.05	0.10	0.10	No data	
INSTANT TURF [7]													
	Kikuyu	Grass	> 12	Yes	< 5days	Medium	Low	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Reinforced turf (pregrown)	Grass	> 12	Yes	5 - 15 days	High	High	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes

1 Whether vegetation is required and its type if so, will affect the technique used. Biodegradable mulches, RECPs and hydraulic soil stabilisers can all be used on their own to provide short term protection. However, their effectiveness is less when used in isolation than when used with vegetative growth. Most techniques are used to help establish vegetative growth using sown grasses. Should the client specify shrubs (primarily planted as tubestock), then thicker mulches, RECPs or biodegradable mulches should be used. Non biodegradable RECP's are used to reinforce grasses (turf) permanently. They are not suitable for use with individual shrubs. They can work synergistically with the established grass to increase its resistance to shear stress and, therefore, increase its resistance to erosion by concentrated flow.

2 Products might or might not be suitable for use in areas of concentrated flow. All products are suitable for sheet flow conditions, although some would be over designed in such cases.

3 Whether or not a product is readily available is critical to the selection process. Many RECP and hydraulic soil stabiliser techniques use products that might be "off the shelf" and available from several suppliers. Biodegradable mulches can be affected by seasonal variation, although they might also be available on site after initial clearing and grubbing. Temporary seeding might also be seasonal.

4 For any given technique, cost can vary greatly depending on geographic location, size of project and installation requirements. In addition, costs can vary over time. Because of these factors, giving accurate installed costs is not possible. However, if a product is relatively inexpensive to purchase and install close to its point of manufacture, it will still be relatively inexpensive to purchase and install remote from it.

5 This criterion relates to the impact that a particular practice might have on construction activities once they are resumed on an area that was temporarily stabilised.

6 The performance of an erosion control technique is quantified by assigning it with a C-factor (Appendix A). The C-factor will vary from close to zero for full cover, to 1.0 for no cover on highly disturbed soils. The C-factor strongly affects the soil loss calculation (RUSLE) and users need to be careful in specifying its value, particularly when values <0.01 are quoted. Note that the C-factor does not apply to concentrated flow.

Values for the C-factor are given for various slopes gradients and lengths and show that it can change dramatically with them. The values given are compiled from existing data and from inference between products of a similar nature. They are given as a guide only and do not profess to be accurate in all respects. Overall, accurate C-factors are only available for manufactured products, primarily from the USA (RECP's in particular) where extensive independent testing has been undertaken. Unfortunately, very little data is available for the "lower cost" options such as biodegradable mulches, jute mesh and hydraulic soil stabilisers. Wherever possible, the manufactures should be contacted for their latest data on acceptable C-factors.

For the RECP's in particular, the C-factors given here are for the product as installed with no vegetation. Note however that lower C-factors can be expected if vegetation is promoted with many RECP's. Indeed, non biodegradable RECP's are designed to work synergistically with turf and must be used with it.

7 For information on trade names and suppliers of these products, please phone the office of Australasian Chapter of the International Erosion Control Association on 1800 354 222 or (+61 2) 4677 0901.

Table A3 from Landcom, 2004.

Erosion control practice (generic type) [1]	Type	Effect on vegetation				Controlling erosion and pollution				Structural Performance						Constraints
		enhances germination of grass seeds	controls weeds	enhances growth of tubestock	reinforces root-holding ability	protects soil surfaces	reduces runoff	filters or traps sediment	stops seepage	reinforces steep slopes	resists waves	stable in low (<2 m/sec) channel flows	stable in moderate (2-5 m/sec) channel flows	stable in high (5-7 m/sec) channel flows [2]	stabilises pavements	
ORGANIC PRODUCTS (can be recycled)																Might need anchoring
Composted Coarse Mulch	18 tonnes per hectare	1	1	1	0	3	3	2	0	0	0	0	0	0	0	
Composted Coarse Mulch	27 tonnes per hectare	0	2	3	0	3	3	3	0	0	0	0	0	0	0	
Composted Coarse Mulch	56 tonnes per hectare	0	3	3	0	3	3	3	0	0	0	0	0	0	0	
Composted soil conditioner	100 L per m² (max)	3	1	3	2	1	1	0	0	0	0	0	0	0	0	Product needs incorporation into existing soil
Manufactured soils	150 L per m² (max)	3	1	3	2	1	1	0	0	0	0	0	0	0	0	
SPRAY ON PRODUCTS																
Hydromulching	2.0 tonnes mulch + 300 litres binder per hectare	3	0	0	0	3	1	1	0	0	0	0	0	0	0	
Bonded Fibre	5 tonnes fibre per hectare	3	1	1	0	3	2	1	0	0	0	0	0	0	0	
ROLLED EROSION CONTROL PRODUCTS (RECPs)																Ensure RECP's have intimate contact with subsoils (good preparation), are well anchored and have check slots in conditions of concentrated flow
Biodegradable **ECB's**	Jute mesh	2	1	0	1	2	1	0	0	0	0	1	1	0	0	
	Coconut fibre mesh (400gsm)	2	1	0	1	2	1	1	0	0	0	1	1	0	0	
	Coconut fibre mesh (700gsm)	2	1	1	1	2	1	1	0	0	0	2	2	0	0	
	Curled wood fibre in plastic mesh	3	1	1	1	3	2	1	0	0	0	1	1	0	0	Nets might trap fauna
	Jute matting (~350 gsm)	3	1	1	1	3	2	1	0	0	0	2	1	0	0	Allows weed growth
	Jute matting (~600 gsm)	0	3	3	0	3	2	1	0	0	0	2	1	0	0	Not for grass growth
	Coconut fibre matting (~400 gsm)	3	1	1	1	3	2	1	0	0	0	2	1	0	0	Allows weed growth
	Coconut fibre matting (~900 gsm)	0	3	3	0	3	2	1	0	0	0	2	1	0	0	Not for grass growth
Photodegradable **ECB's**	Mesh (< 5 mm openings)	2	0	0	1	2	1	0	0	0	0	1	0	0	0	Little moisture retention
	Super light weight nonwoven (~30gsm)	2	0	0	1	2	1	0	0	0	0	1	1	0	0	Little moisture retention; net (if included) can trap fauna
Non Biodegradable **TRM's**	Plastic fibres with netting	2	1	0	3	3	2	1	0	0	3	3	3	0	0	Soil-filled and vegetated
	Light performance 3D welded fibres	2	1	0	3	3	2	1	0	0	1	3	2	0	0	Soil-filled and vegetated
	Medium performance 3D welded or woven fibres	2	1	0	3	3	2	1	0	0	2	3	3	0	0	Soil-filled and vegetated
	High performance 3D woven fibres	2	1	0	3	3	2	1	0	0	3	3	3	3	1	Soil-filled and vegetated
	Med. perform. composited with degradable material	2	1	0	3	3	2	1	0	0	2	3	3	0	0	Soil-filled and vegetated
HYDRAULIC SOIL STABILISERS																
	Polymers/Polyacrylamide (rate depends on type)	0	0	0	0	2	0	0	0	0	0	1	0	0	0	Needs water supply for application
	Bitumen emulsion (12,000 l/ha)	0	0	0	0	2	0	0	0	0	0	1	0	0	0	Environmental concerns
TEMPORARY SEEDING																
	Annual	0	1	0	0	3	2	2	0	0	0	1	0	0	0	Minimum 28 days to establish
	Perennial	0	2	0	0	3	2	2	0	0	0	1	0	0	0	Needs water supply
INSTANT TURF																
	Kikuyu	0	1	0	0	3	2	2	0	1	0	1	0	0	0	Needs water supply
	Reinforced turf (pregrown)	0	1	0	3	3	2	2	0	1	1	2	2	0	0	Needs water supply
OTHER PRODUCTS																
Straw (anchored)	4.5 tonnes per hectare	3	1	1	0	3	3	2	0	0	0	0	0	0	0	
Weed mat		0	3	1	0	3	0	0	0	0	0	0	0	0	0	Restricts air and moisture
Geotextile		0	1	1	1	2	0	2	0	2	0	2	1	0	3	See general note for RECP's above if used in channels
Sediment fences		0	0	0	0	0	1	2	0	0	0	0	0	0	0	
Earth-filled geotextile tubes		0	0	0	0	0	0	3	0	0	0	0	0	0	0	Low profile
Floating sediment barriers		0	0	0	0	0	0	3	0	0	1	0	0	0	0	
Grout injected mats		0	1	0	0	3	0	0	1	0	2	3	3	3	0	Rigid structure
Gabion Mattresses		0	0	0	0	3	0	0	0	0	3	3	3	3	1	
Articulated concrete mats		0	0	0	0	3	0	0	0	0	3	3	2	2	0	
Reinforced armouring systems		0	0	0	0	3	0	0	0	0	3	3	2	2	0	
Cellular soil confinement (synthetic)		2	0	0	0	3	1	0	0	2	2	2	2	0	2	Anchor on steep slopes
Wind barrier fencing		0	0	0	0	2	0	1	0	0	0	0	0	0	0	
Flexible waterproof membranes		0	0	0	0	0	0	0	3	0	0	0	0	0	0	
Vertical soil moisture barriers		0	0	0	0	0	0	0	3	0	0	0	0	0	0	
Geosynthetic clay liners		0	0	0	0	0	0	0	3	0	0	0	0	0	0	
Prefabricated subsurface drainage		1	0	1	0	1	1	0	3	2	0	0	0	0	2	
Pipe inlet sediment barriers		0	0	0	0	0	0	3	0	0	0	0	0	0	0	Clean regularly
Wattles and logs		0	0	0	0	2	1	2	0	0	1	1	0	0	0	Needs pinning

Key to Rating System
0 – not designed for, and has no expected performance in this application
1 – not specifically designed for, but can enhance performance of other measures in this application
2 – generally designed for this application in conjunction with other applications, but performance is less able to deal with the range of conditions met by specific purpose materials
3 – specifically designed to meet a full range of requirements for this application

[1] There can be considerable differences bewteen products within any generic type. For further information products, including trade names and suppliers, please phone the office of Australasian Chapter of the International Erosion Control Association on 1800 354 322 or (+61 2) 4677 0901.

[2] The designer should check shear stress as well as velocity. Shear stress becomes determining as slope gradient increases.

Table D1 from Landcom, 2004

11.4 Appendix 4: Flocculation

Gypsum (calcium sulfate) will be applied to sediment basins within 24 hours of the conclusion of each rainfall event more than 5 mm by mixing it into a slurry with water (Figure 3) and then spraying it over the basin surface. It is essential that the flocculating agent be spread evenly over the entire basin surface for proper treatment of water unless local experience or other criteria suggest differently.

The gypsum will be applied at a rate of at least 32 kilograms per 100 cubic metres of stored water, with the actual rate being determined by the ability of the agent to reduce non filterable residues to 50 milligrams per litre of water or less. The supernatant waters can be discharged from each basin once these levels have been reached. If the gypsum is applied properly, 50 milligrams per litre of water or less should be achieved within 36 to 72 hours from application.

A discharge system will be established that:

(i) has a floating inlet to prevent flocculated sediments being removed as well — any materials from the sediment layer must not be discharged in the pumping process; and

(ii) permits drainage of the pond in less than 24 hours.

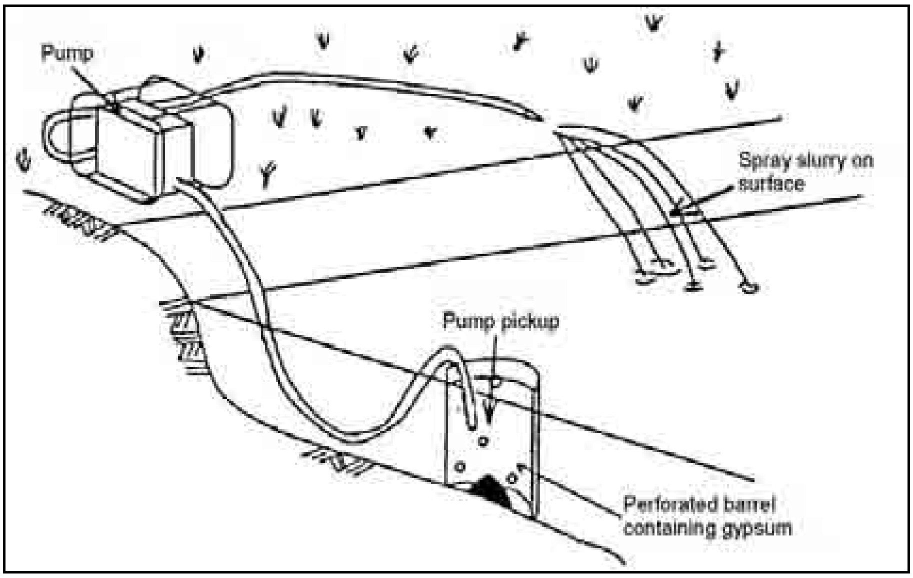
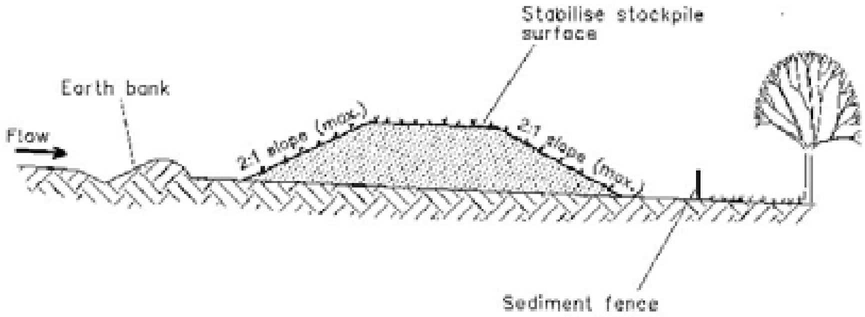


Figure 6 Application of gypsum. The drum will have about a 50 litre capacity with holes of about 25-mm diameter drilled on a 150-mm grid so pond water can enter.

Normally, discharge will be completed with five working days from the conclusion of a rainfall event. However, in the case of repeated high intensity storms, the gypsum dosage rates will be doubled so flocculation can be achieved within 24 hours from the conclusion of a storm and allowing discharge within three days.

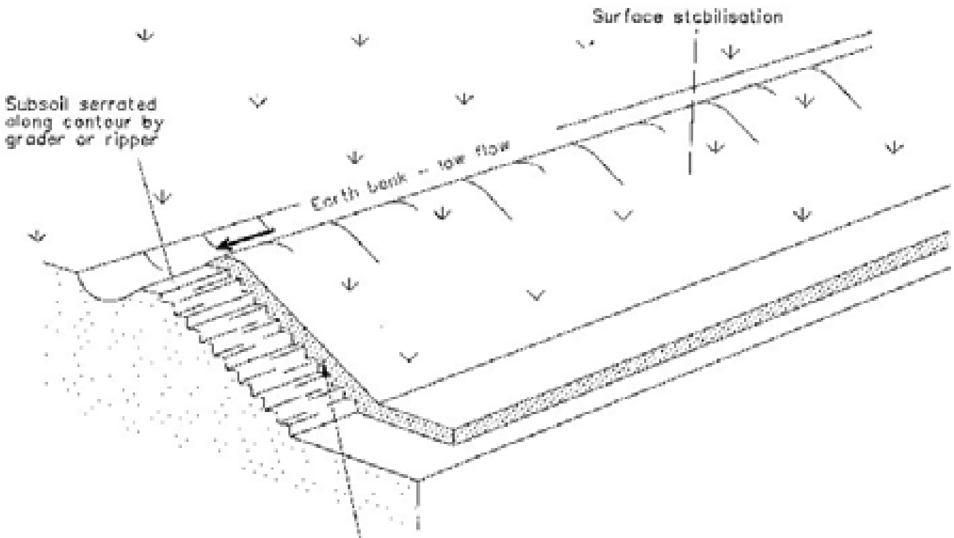
11.5 Appendix 5: Standard Drawings (from Landcom, 2004)



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.

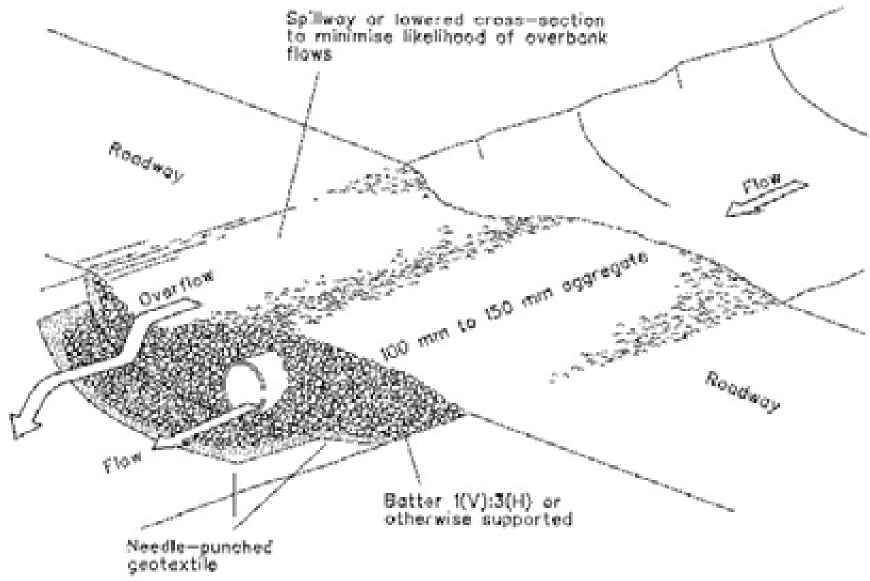
STOCKPILES **SD 4-1**



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.

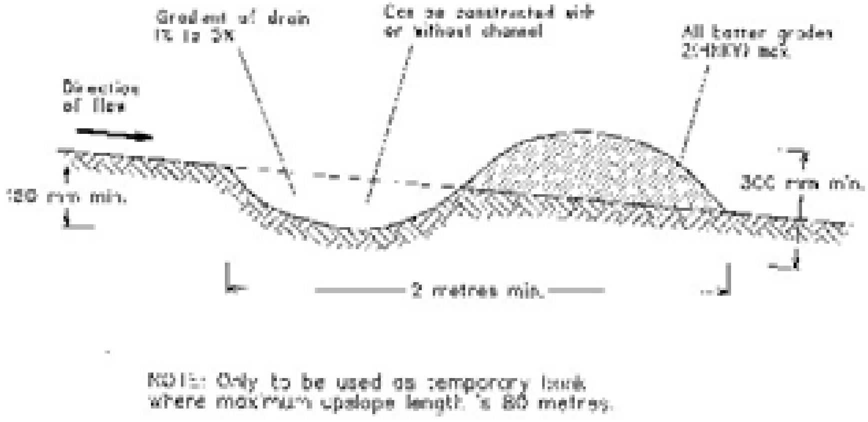
REPLACING TOPSOIL **SD 4-2**



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.

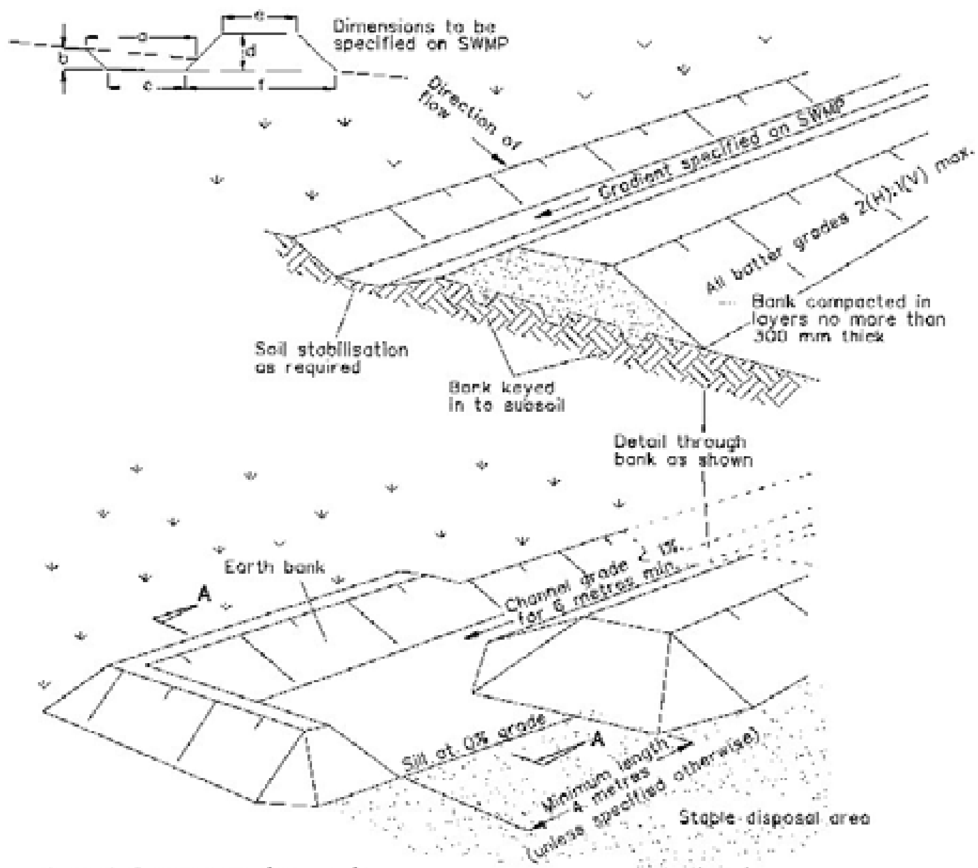
TEMPORARY WATERWAY CROSSING **SD 5-1**



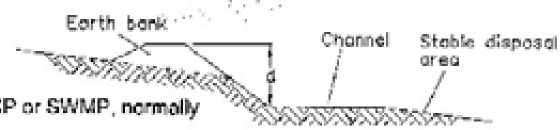
Construction Notes

1. 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)

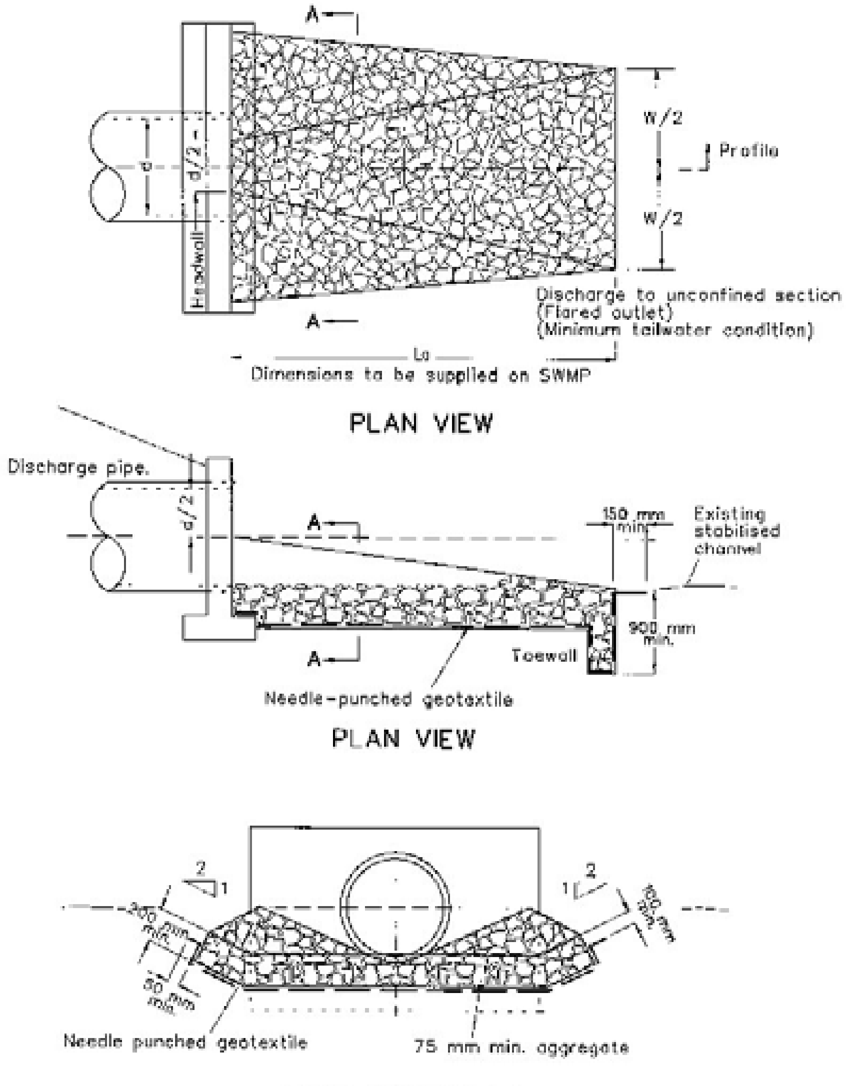


Section AA

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**

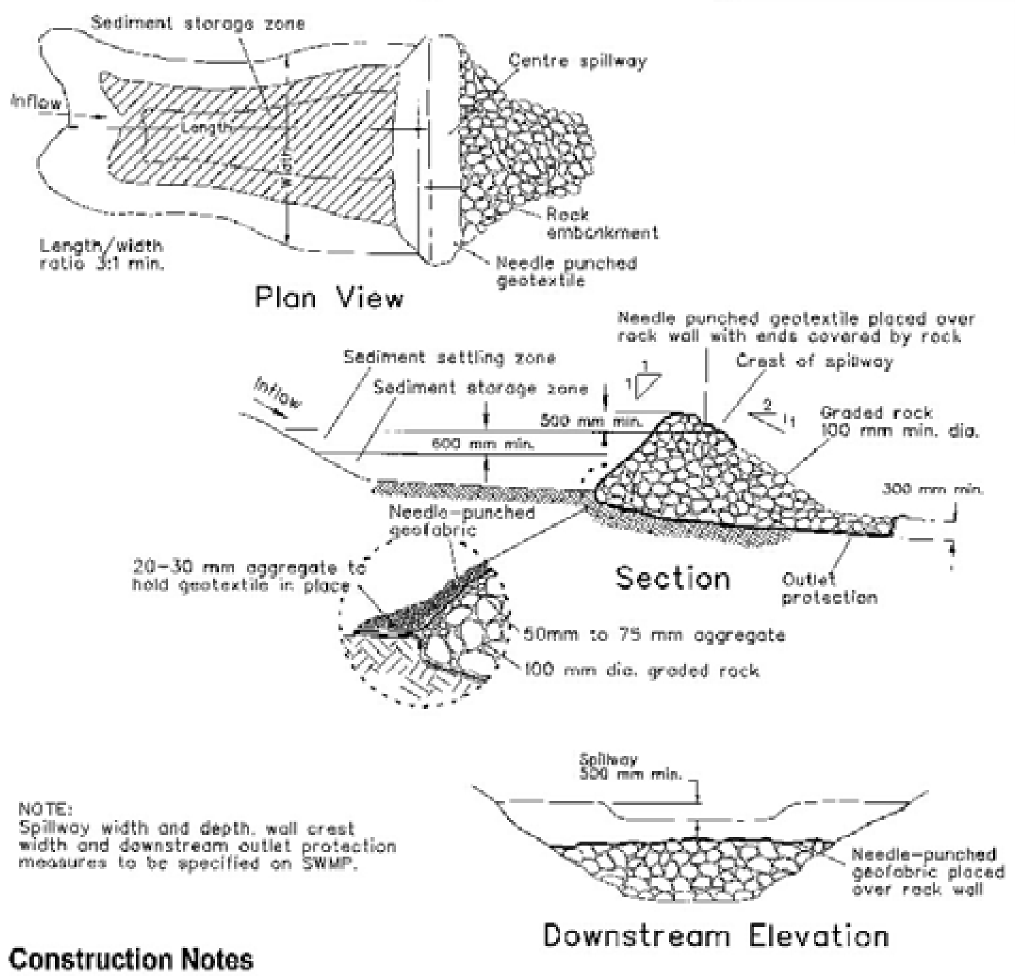


CROSS SECTION AA

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**



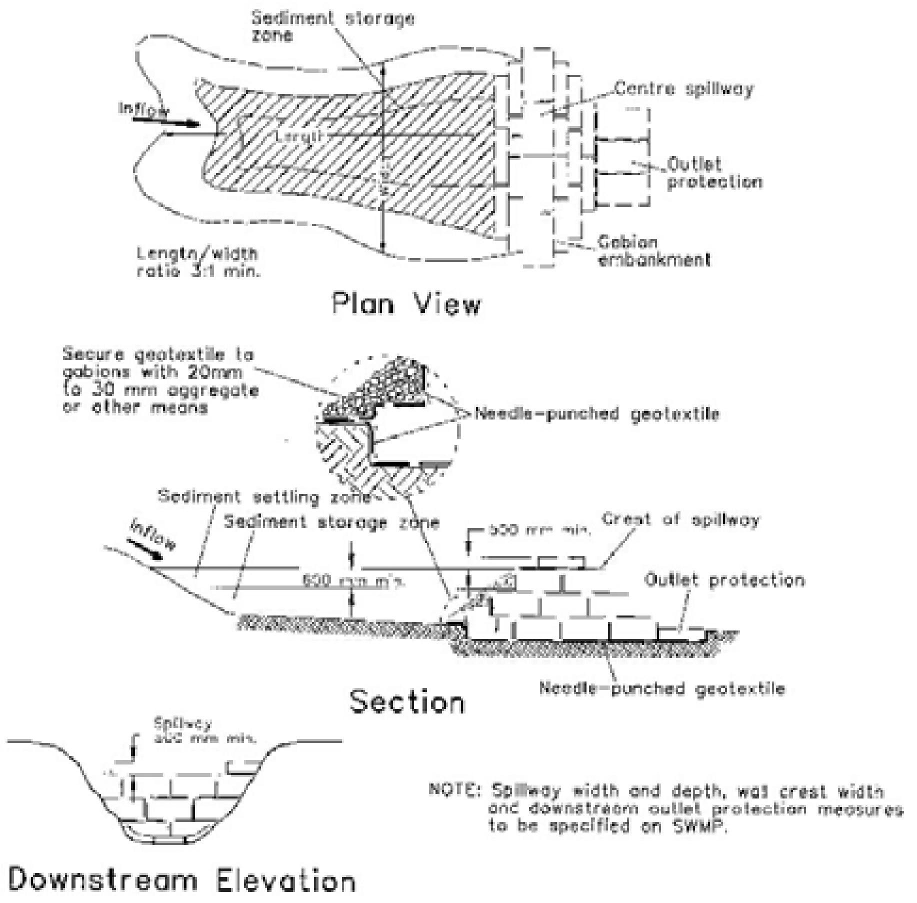
Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Excavate to 300 mm depth for base of the dam wall.
3. Line the excavation with a needle-punched geotextile allowing sufficient to line below the wall, and over the upstream rock and the spillway to 500 mm below the spillway exit on the downstream face.
4. Make up the wall profile and outlet protection with100 mm (min.) diameter graded rock. Spread a layer of 50 mm to 75 mm diameter aggregate over the upstream batter for a more even surface, and add 100 mm to 150 mm of 20 mm to 30 mm gravel over the 50 mm to 75 mm diameter aggregate.
5. Lay geotextile over the upstream batter and through the spillway, fixing in place with 100 mm rock.
6. Place a "Full of Sediment" marker to show when less than design capacity occurs and sediment removal is required.
7. Replace the upstream geotextile layer each time sediment is removed

ROCK SEDIMENT BASIN

(APPLIES TO 'TYPE C' SOILS ONLY)

SD 6-1



Construction Notes

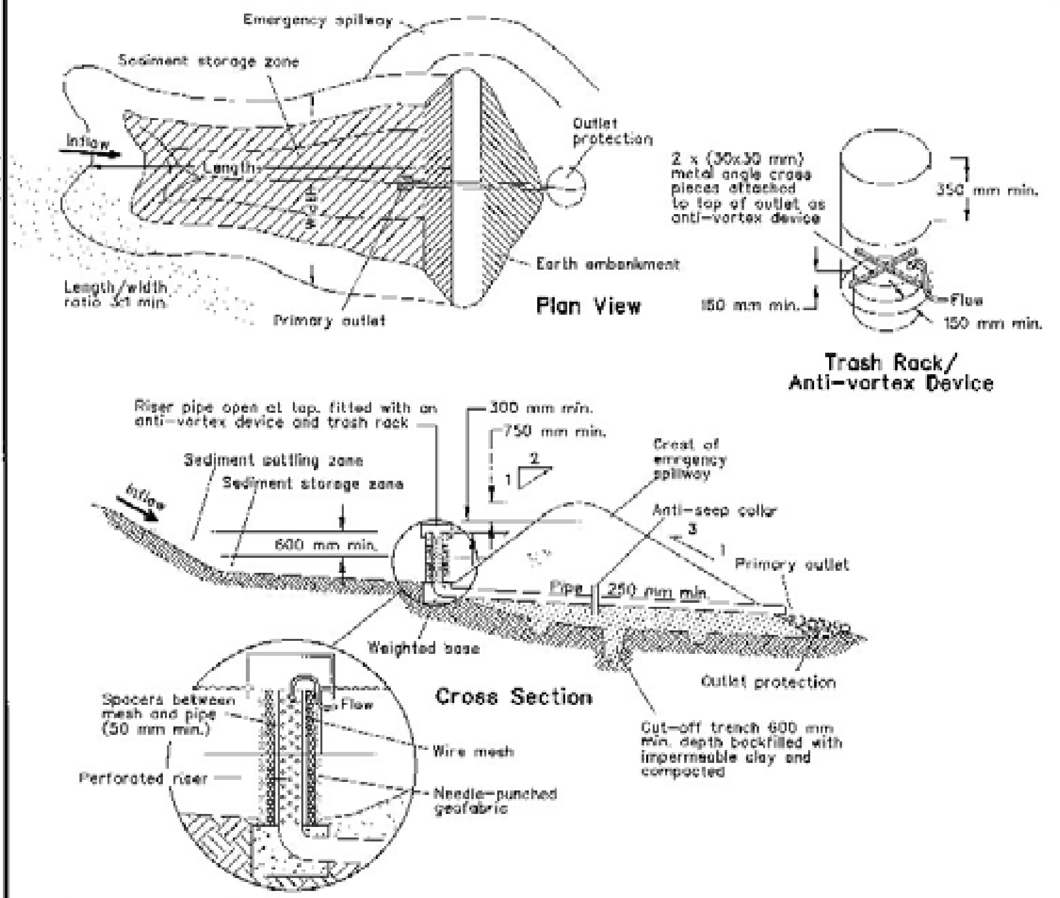
(Applies to Type C soils only)

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Excavate to 300 mm depth for the base of the dam wall and form a level platform for the gabions.
3. Line the excavation with a needle-punched geotextile allowing sufficient to line below the wall, and over the upstream gabions and spillway to 500 mm below the spillway exit on the downstream face.
4. Make up the wall profile and outlet protection with gabion units filled with graded rock as specified on the SWMP.
5. Construct a spillway 500 mm below the crest of the dam and for the width specified on the SWMP.
6. Lap the geotextile over the upstream face and through the spillway and fix it in place with the top row of gabions.
7. Cover the upstream face of the wall with 20 mm to 30 mm gravel and geotextile (Standard Drawing 6-2b)
8. Place a 'Full of Sediment' marker to show when less than design capacity occurs and sediment removal is required.
9. Replace the upstream geotextile layer when sediment is removed if a dry basin is required.

GABION SEDIMENT BASIN

(APPLIES TO 'TYPE C' SOILS ONLY)

SD 6-2

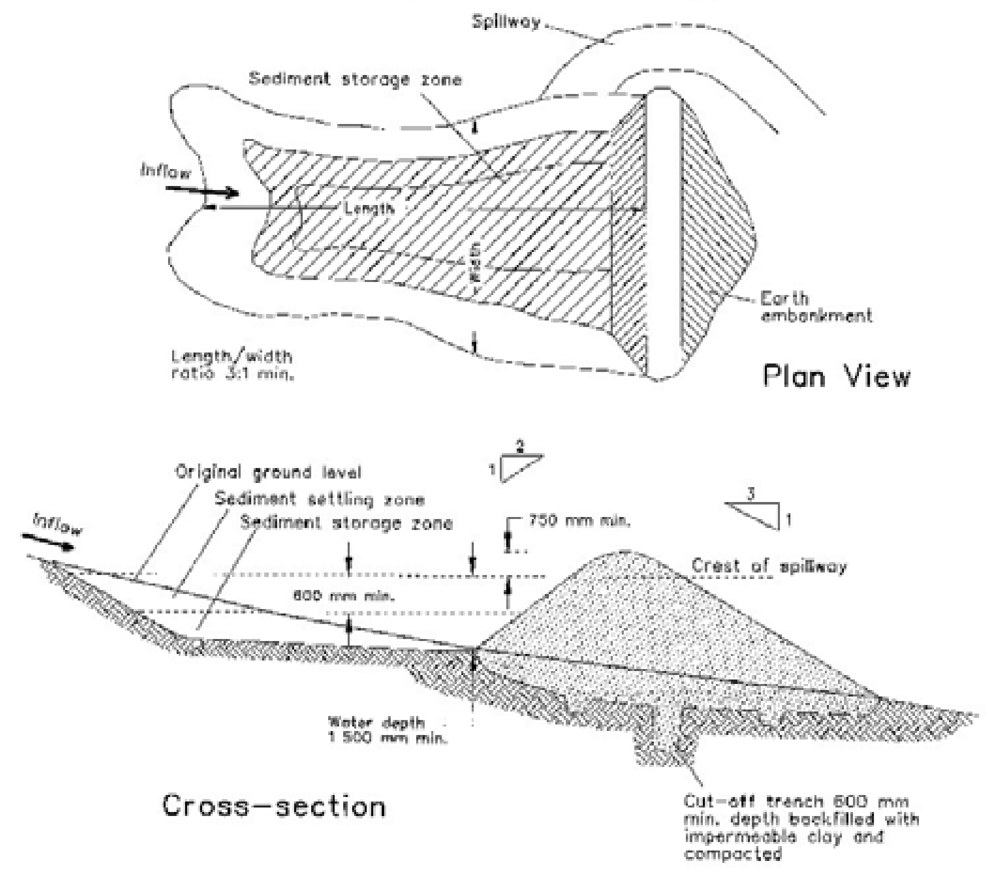


Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Form a cut off trench under the centreline of the embankment 600 mm deep and 1,200 mm wide, extending to a point on the watercourse wall above the riser sill level.
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 according to the SWMP that is free from 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 the 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. Install the pipe outlet with seepage collars as specified in the SWMP and Standard Drawing 6-3b.
8. Form batter grades at 2(H):1(V) upstream and 3(H):1(V) downstream or as specified in the SWMP

EARTH BASIN - DRY
(APPLIES TO 'TYPE C' SOILS ONLY)

SD 6-3



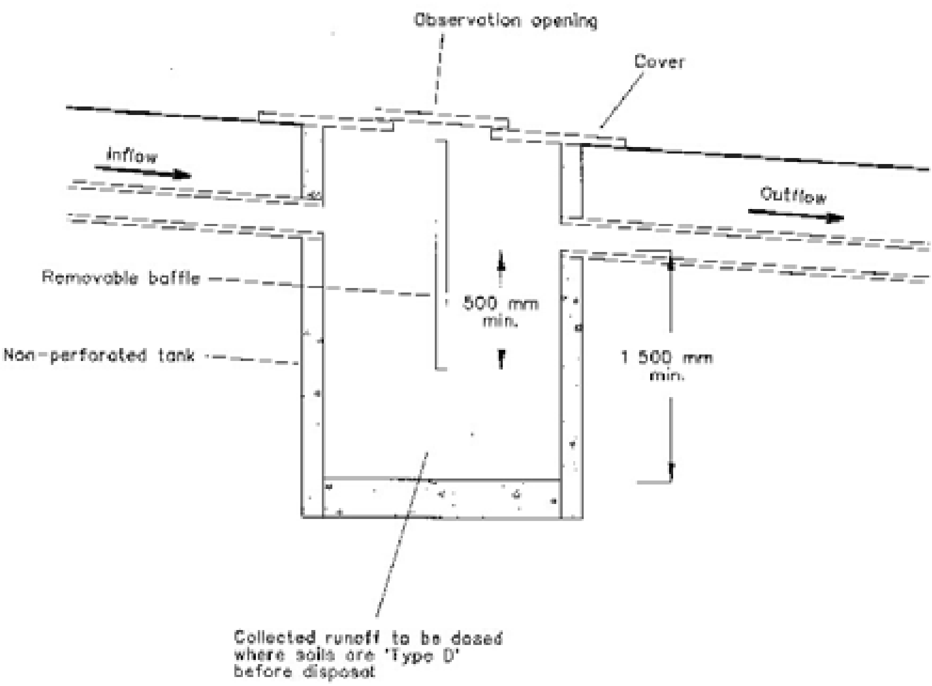
Construction Notes

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)

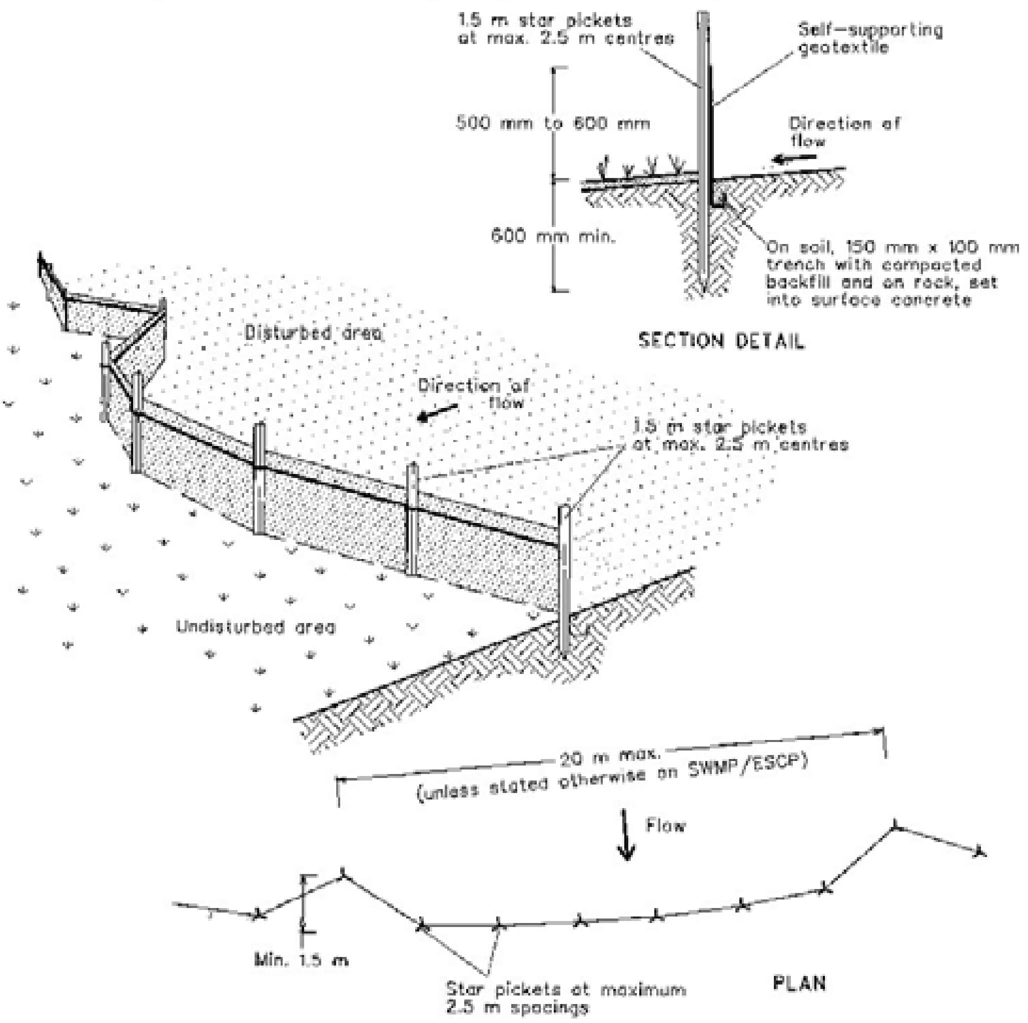
SD 6-4



Construction Notes

1. Join the inlet to the stormwater, taking any suitable steps to remove bulky or coarse material before it can enter the tank.
2. Connect the outlet to a safe disposal area following the SWMP.
3. Install a removable baffle, central to the inflow/outflow and normal to the direction of flow, ensuring that it reaches 500 mm below the invert of the outlet pipe.
4. Install a cover over the pit with an observation port and access cover.

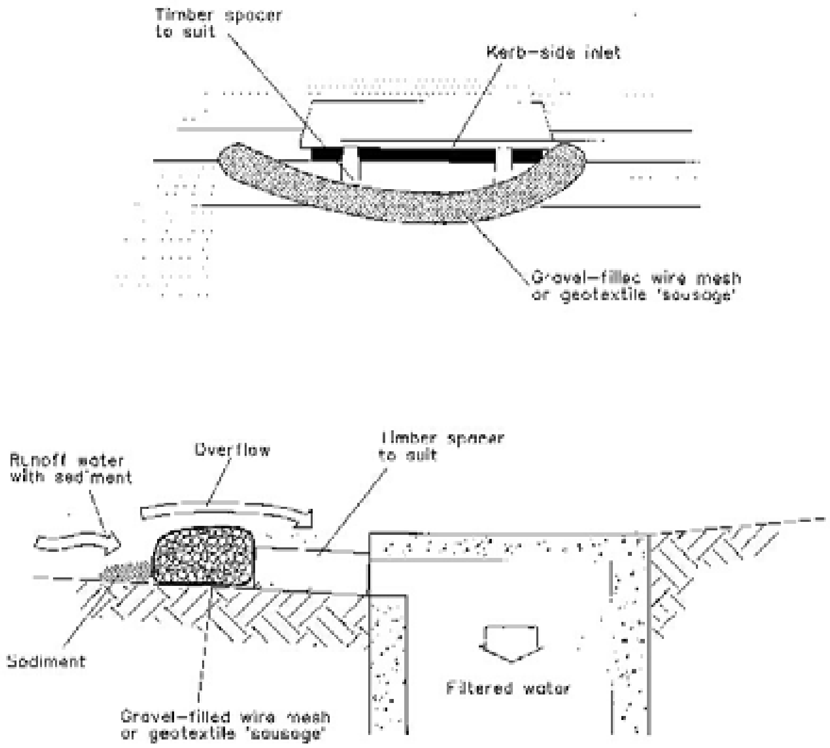
LINED TANK **SD 6-5**



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**

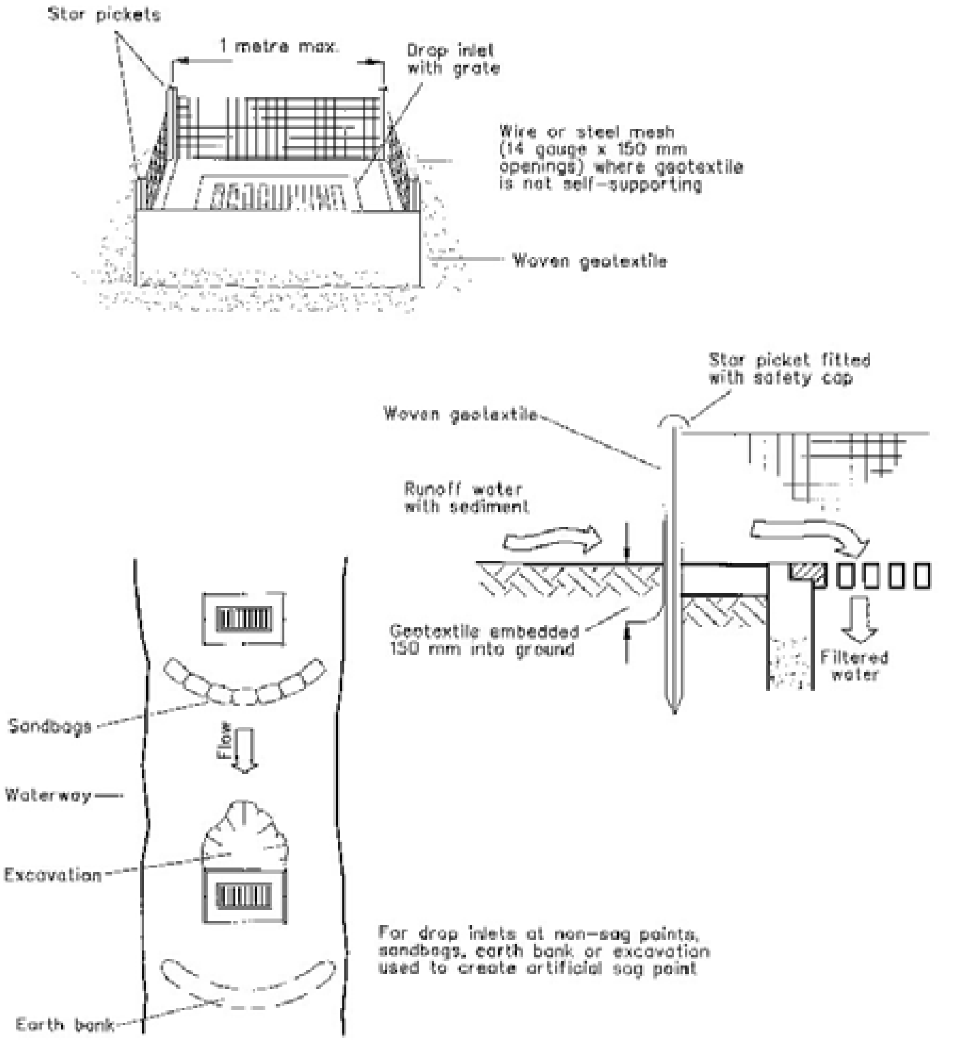


NOTE: This practice only to be used where specified in an approved SWMP/ESCP.

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.

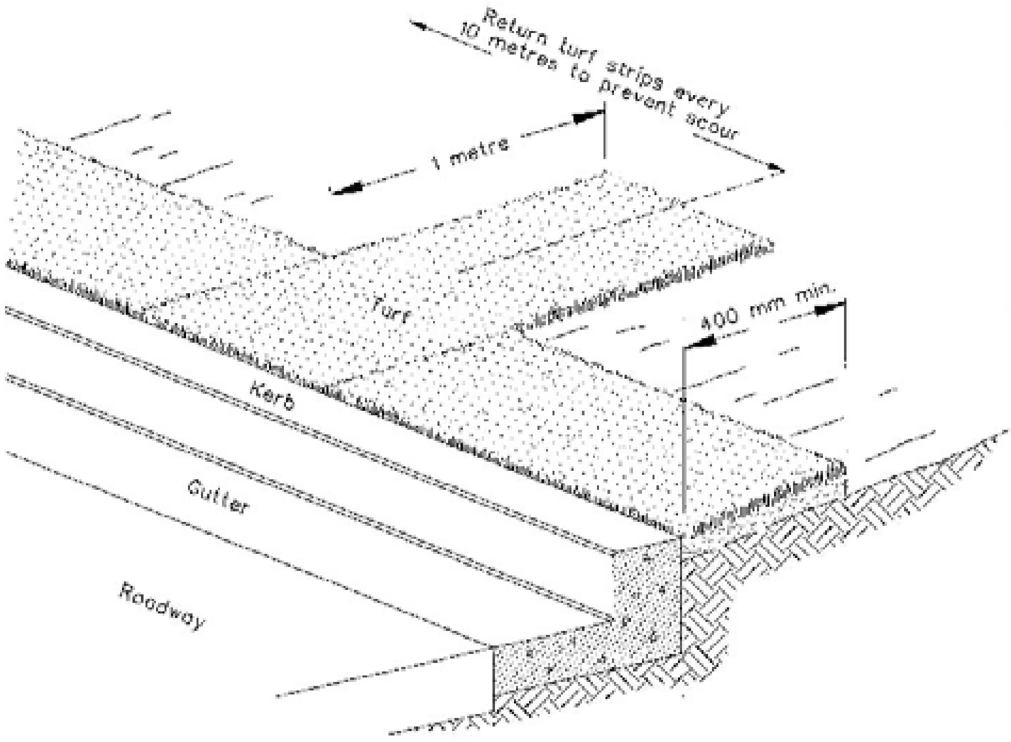
MESH AND GRAVEL INLET FILTER **SD 6-11**



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.

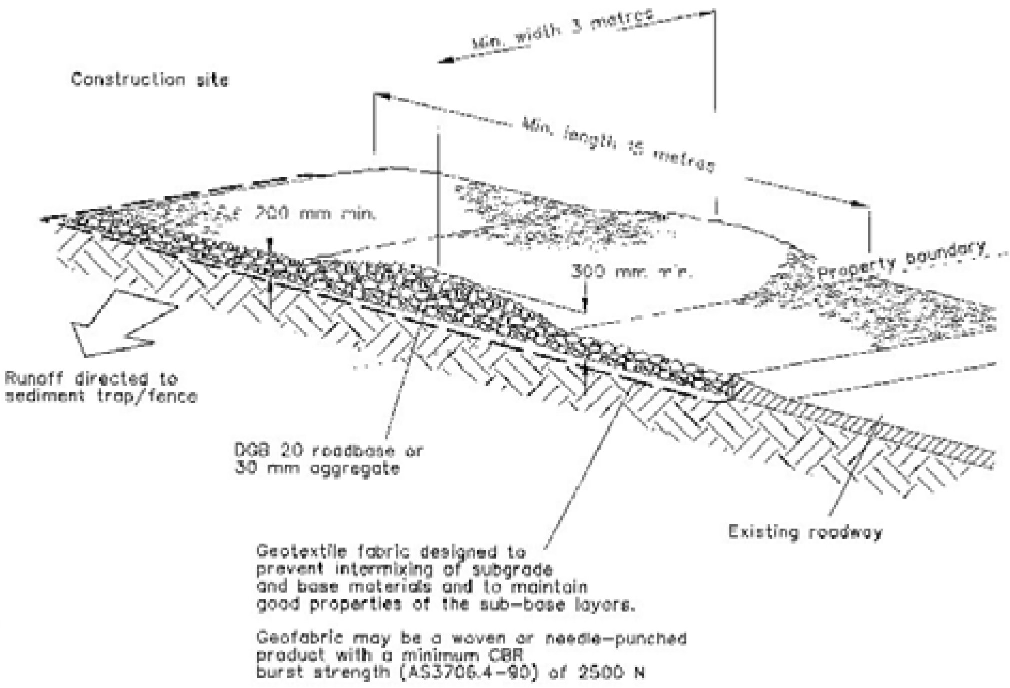
GEOTEXTILE INLET FILTER **SD 6-12**



Construction Notes

1. Install a 400-mm minimum wide roll of turf on the footpath next to the kerb and at the same level as the top of the kerb.
2. Lay 1.4 metre long turf strips normal to the kerb every 10 metres.
3. Rehabilitate disturbed soil behind the

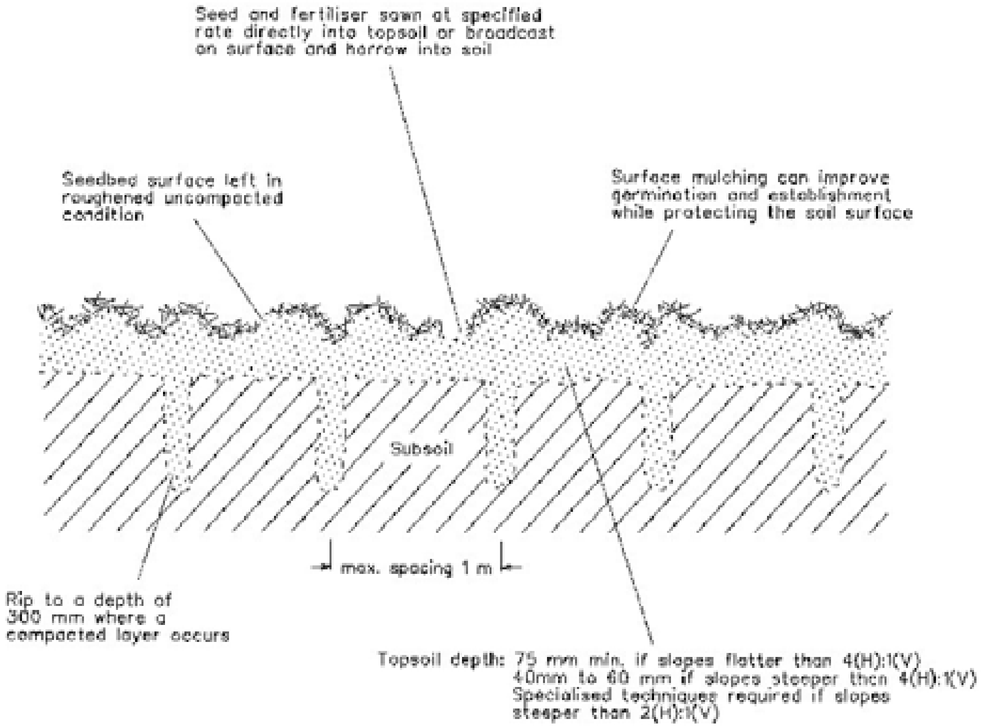
KERBSIDE TURF STRIP **SD 6-13**



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. 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**

11.6 Appendix 6: Table 5.2 from Landcom, 2004

Material: Type	Material: Thickness (m)	Material: Aggregate size (mm)	Critical velocity (m/second)	
Gabions and reno mattresses	0.50	120-250	6.4	
	0.50	100-200	5.8	
	0.30	100-150	5.0	
	0.30	70-120	4.2	
	0.25	70-100	3.6	
	0.17	70-100	3.5	
		Weight each (kg)	**Turbulent flow**	**Normal flow**
Loose rock (assume 100 percent soil cover)		1,000	4.8	6.6
		500	4.2	5.7
		100	3.3	4.5
		50	2.8	3.8
		10	2.3	3.0
		Form		
Revetment mattresses		Storm mattress	>6.0	
		200 mm fp	6.0	
		125 mm fp	4.0	
		100 mm fb	2.0	

Assume that all soils with 10 percent or more dispersible fines have high erodibilities. Of those with less, soils with *K*-factors below 0.02 have low erodibilities, those between 0.02 and 0.045 have moderate erodibilities, while those above 0.045 have high erodibilities.

In addition, the figures here assume slope gradients of less than 10 percent and, where appropriate, good (>80 percent) ground cover. If good ground cover is not expected to be maintained properly (might die back seasonally or during short periods of drought) and is critical to the system, reduce all velocities by 1.0 metre per second. Alternately, seek the manufacturer's advice if these conditions are unlikely to be met.

Material	Inundation <6 hours: Low	Moderate	High	Inundation <12 hours: Low	Moderate	High	Inundation <24 hours: Low	Moderate	High	Inundation <48 hours: Low	Moderate	High
	Soil erodibility			Soil erodibility			Soil erodibility			Soil erodibility		
High performance bonded plastic fibres (vegetated)	7.0	7.0	7.0	6.0	6.0	6.0	5.0	5.0	5.0	4.0	4.0	4.0
Plastic fibres with netting	5.0	5.0	5.0	4.3	4.3	4.3	3.6	3.6	3.6	3.0	3.0	3.0
Mesh reinforced pregrown turf	3.0	2.7	2.4	2.8	2.3	2.0	2.3	2.0	1.8	2.0	1.8	1.6
Kikuyu	2.5	2.2	1.9	2.1	1.9	1.6	1.9	1.7	1.4	1.6	1.4	1.2
Jute or coir mesh (close weave, bitumen sprayed)	2.3	2.0	1.7	1.9	1.7	1.5	1.7	1.5	1.3	1.5	1.3	1.1
Coconut/jute fibre mats	2.3	2.0	1.7	1.9	1.7	1.5	1.7	1.5	1.3	1.5	1.3	1.1
Couch, carpet grass, Rhodes grass, etc.	2.0	1.8	1.4	1.7	1.5	1.2	1.5	1.4	1.1	1.3	1.2	0.9
Bare soil	0.7	0.5	0.3	0.6	0.4	0.3	0.5	0.4	0.2	0.4	0.3	0.2

Table 5.2 from Landcom, 2004.