Erosion Control Mats

DRAINAGE CONTROL TECHNIQUE

Low Gradient	✓	Velocity Control		Short Term	✓
Steep Gradient	✓	Channel Lining	✓	Medium-Long Term	✓
Outlet Control		Soil Treatment		Permanent	[1]

[1] Also refer to the fact sheet on *Turf Reinforcement Mats*.

Symbol 

Photo 1 – Temporary jute mesh with emerging grass

Photo 2 – Permanent, synthetic reinforced erosion control mat

Key Principles

1. Erosion control mats (ECMs) have been developed for application to a wide range of flow conditions from low velocity sheet flow to high velocity channel flow. The principal hydraulic design parameter is either the allowable flow velocity or allowable shear stress.
2. The key operational issues include provision of appropriate anchorage (significantly greater than that required for *Erosion Control Blankets*), the provision of intimate contact with the soil, and the prevention of flow passing between the mat and the soil.
3. Longevity is reliant on the type of mat and the establishment and retention of vegetation across the mat.
4. The key to successful revegetation is good soil condition, good surface preparation, and intimate contact between the mat and the soil.
5. Synthetic reinforced mats can entrap wildlife such as lizards, snakes and birds.
6. Consideration should be given to the risk and consequences of damage by grass fires.

Fabric-based *Erosion Control Blankets* (ECBs), *Erosion Control Meshes,* and *Erosion Control Mats* (ECMs) all fall under the general category of "Rolled Erosion Control Products" (RECPs). The exception being "hydraulically applied blankets", such as *Bonded Fibre Matrix*.

Erosion control blankets are generally applied to soils subject only to sheet flow such as road batters. Erosion control mats and meshes are generally applied to soils subject to concentrated flow such as within drainage channels.

Erosion control mats can be divided into three main groups:

- Short-term 100% readily biodegradable mats (organic-based products)
- Long-term, non UV-stabilised, synthetic reinforced mats
- Permanent turf reinforcement mats (TRMs)

(i) Short-term, 100% readily biodegradable mats (Photos 1, 6, 8 & 12)

These mats are generally not suited to areas subject to significant overland flow with respect to either volume or velocity. The allowable shear stress can be improved by anchoring the mat with a reinforcing mesh (such as jute mesh), or stabilising the mat with a bitumen spray or other suitable tackifier.

(ii) Long-term, non UV-stabilised synthetic reinforced mats (Photo 9)

These mats usually consist of a biodegradable blanket reinforced with a **non** UV-stabilised synthetic mesh that provides temporary anchorage and reinforcing during the vegetation establishment phase.

Caution should be taken when using certain synthetic reinforced mats in bushland areas as ground dwelling animals, such as lizards, snakes, and granivorous (seed-eating) birds, can become tangled in the fine netting. In these areas, the use of 100% organic-based mats is preferred.

(iii) Permanent turf reinforcement mats (TRMs) (Photos 2, 7, 10, 11 & 13)

Permanent mats are usually distinguished by their dark colour, due to the inclusion of a black synthetic reinforcing mesh (the black colour identifying the inclusion of UV stabilising carbon). It is important to note which parts of a mat are permanent, and which parts are temporary (i.e. biodegradable).

Most permanent erosion control mats provide permanent root reinforcement; however not all turf reinforcement mats can provide adequate erosion control in the absence of vegetation (i.e. after grass dieback, fire, or during periods of drought). Some turf reinforcement mats provide only limited defence against the effects of raindrop impact. Such mats have an open structure and usually contain a biodegradable mulch layer.

Each product, whether a blanket or a mat, may contain one or more of the following features:

- Mulch layer or synthetic mulch substitute—to assist seed germination, control soil temperature, and protection the soil against raindrop impact and scour caused by surface flow.
- Mulch anchorage mesh—to limit displacement of loose mulch (such as wood shavings and coconut fibres) resulting from wind and surface flow.
- Root reinforcing/protection—to limit soil erosion around the root system of living plants/grass. Some turf reinforcement systems may also provide limited erosion protection to the soil during periods of drought or when vegetation cover is poor.
- Mat reinforcing to limit mat distortion in high flow velocity area, or areas of mass soil movement.

The various features listed above are displayed in Photos 6 to 13.

Design Information

When selecting an erosion control mat it is important to determine what features and attributes are required. Discussion on such attributes is provided in Tables 1a & 1b.

Some of the required attributes can be performed by both natural and synthetic materials. Some synthetic (plastic) materials can cause environmental concerns, but these features generally have a longer service life compared to organic-based materials.

It is noted that “hydraulic performance”, measured in terms of allowable flow velocity or shear stress, is just one of many issues requiring consideration when selecting the preferred erosion control mat.

With respect to hydraulic performance, selection and design should be based on manufacturer’s design specifications in circumstances where reliable data is available (i.e. data confirmed by laboratory testing). Table 2 can be used to identify the appropriate classification (Class) of mat.

Photo 6 – Organic mulch layer

Photo 7 – Synthetic "mulch" layer

Photo 8 – Jute/coir mesh can provide organic anchorage for loose mulch

Photo 9 – Synthetic mulch anchorage

Photo 10 – Synthetic root reinforcing with organic mulch layer

Photo 11 – Synthetic "mulch" layer also acting as the root reinforcing

Photo 12 – Jute mesh is effectively an organic mat reinforcing

Photo 13 – Mat with additional mat reinforcing supplied by the wire mesh

Table 1a – Desirable features and requirements of erosion control mats and blankets for various operational conditions

Operational conditions	Desirable features and requirements
Design life	•
Flow velocity or shear stress	•
Strong winds	•
Raindrop impact	•
Integration with separate mulch layer	•
Integration with vegetation	•
Short-term use without vegetation	•
Weed control	•

Table 1b – Desirable features and requirements of erosion control mats and blankets for various operational conditions

Operational conditions	Desirable features and requirements
Steep slopes	•
Temporary batter chutes	•
Impact on future reuse of topsoil	•
Site access	•
Wildlife	•
Grazing animals	•
Pedestrian traffic	•
Mowing	•
Risk of grass fires	•
Airports	•

Table 2 – Default selection guide for erosion control mats

Class	1						2			3			
Type	A	B	C	AX	BX	CX	A	B	C	A	B	C	D
Typical location	Rural			Urban			Embankment, chutes & drainage channels						
Maximum bank slope (X:1)													
Permissible shear stress (Pa)													
Allowable 'sheet' flow velocity (m/s)													
Allowable 'concentrated' flow velocity (m/s)													
Mowing required during plant establishment													
Pedestrian traffic likely to occur during plant establishment													
Wildlife friendly													
Within 9m of airport runways													

Erosion control blanket/mat classification system

A classification system for erosion control blankets and mats (e.g. Class 1, Type A) is provided in Table 3. In general terms, this classification system is based on the following distinctions.

Class 1 blankets:
Class 1 includes those temporary, light-duty Rolled Erosion Control Products (RECPs) that are primarily used in areas of "sheet flow" and that are termed *Erosion Control Blankets*. A further division is made by separating those products best used away from pedestrian areas (Type A, B & C), and those products used in areas where the blankets may be subject to foot traffic or are likely required to experience mowing during the service life of the blanket (Type AX, BX & CX).

Class 2 blankets/mats:
Class 2 includes those temporary, heavy-duty Rolled Erosion Control Products (RECPs) that are primarily used in areas of medium shear stress such as embankment higher than 3m in tropical areas, and drainage channels. These products may be termed *Erosion Control Blankets or Mats* depending on their use.

Class 3 mats:
Class 3 comprises permanent, heavy-duty Rolled Erosion Control Products (RECPs) that are primarily used in areas of high shear stress such as drainage channels and spillways/chutes. These products are typically termed *Erosion Control Mats*.

Class 3 - Type B, C and D Turf Reinforcement Mats (TRM) are permanent, 100% synthetic, open-weaved mats that shall be continuously bonded at the filament intersections. TRM mats shall be completely filled with topsoil immediately after installation. Loosely packaged discontinuous filaments are not permitted in this category.

To prevent initial soil loss, Class 3 TRM mats, Type B, Type C, and Type D, must be covered with either an approved soil stabiliser, or approved *Erosion Control Blanket* (Class 1 or 2) immediately following installation. These materials shall be considered incidental to the installation of Class 3 TRM mats.

Table 3 – Classification of erosion control blankets and mats

Class	1						2			3			
Type													
Typical location [1]													
Permissible shear stress (Pa) [2]													
Maximum slope [3] (X:1)													
RUSLE C-factor (maximum)													
Used in drainage channels													
Turf reinforce-ment mat (TRM)													
Minimum service life													
Thickness (mm)													
Able to withstand mowing [7]													
Able to withstand foot traffic [8]													
Wildlife friendly [9]													
Anchor pins													
Primary material													
Manufacture													
Netting													
Type													
% of weight (max)													
Photodegradable													
Biodegradable													
Stitching properties													

Notes:

[1] "Typical location" is a general classification. The primary objective is to ensure ongoing safety to pedestrian traffic potentially affected by rusty, metallic anchoring pins/staples. Note; galvanised pins/staples are generally not acceptable due to limited anchorage of the blanket/mat.

[2] Failure in shear is defined by either, separation of 10% of the blanket from the soil surface, and/or the equivalent loss of 12mm of soil from the treated area (as per ASTM D6460-99 or equivalent).

[3] Maximum slope applied only when significant rainfall is possible prior to plant establishment.

[4] Blankets/mats may be used within minor (low velocity) drainage channels or on the banks of waterways in locations where revegetation is expected to occur before subject to high flow velocity.

[5] Service life defined by the maintenance of a maximum Cover Factor (C) of 0.20 based on the Revised Universal Soil Loss Equation (RUSLE) prior to establishment of the required vegetation cover. A minimum 6 months service life may be required in locations where vegetation establishment is known to be slow, such as during winter months.

[6] Service life defined by either the maintenance of a maximum Cover Factor (C) of 0.20 based on the Revised Universal Soil Loss Equation (RUSLE) prior to establishment of the required vegetation cover, or separation of 10% of the blanket from the soil surface, and/or the equivalent loss of 12mm of soil from the treated area (as per ASTM D6460-99 or equivalent).

[7] Requirement to allow for mowing of the treated surface without causing damage to the blanket applies to those areas where mowing of the emerging grass may be required prior to establishment of the required (e.g 70% cover) vegetation cover.

Table 3 notes (continued):

[8] Requirement to allow for occasional foot traffic without causing damage to the blanket applies to those areas where occasional foot traffic is anticipated prior to establishment of the required (e.g 70% cover) vegetation cover.

[9] Requirement for the blanket to accommodate potential ground-dwelling wildlife is typically required when the blanket is placed adjacent to wildlife areas such as bushland, wildlife corridors, waterways, and land containing grazing animals.

[10] Turf reinforcement mats can potentially affect and/or be damaged by grazing animals.

[11] Anchorage pins/staples may be required to be biodegradable (e.g not metal) in order to minimise the risk of injury to humans, domestic animals, or wildlife following the long-term exposure of rusty or otherwise dangerous obstacles buried in the soil. Biodegradable anchorage pins/staples are also required on all blanket/mat installations within 9m of an airport runway. Note; it is the "rusting" of metal staples that provides much of their anchorage properties.

[12] Manufactured from 100% jute or coir fibres, or combination there of.

[13] The parent material of Class 2 Type B & C blankets/mats must have a maximum water absorption rate of 300%, by weight (ASTM D1117 or equivalent); and a maximum swell (wet thickness change) of 30% (as per ASTM D1777 or equivalent). The lignin content must be greater than 38% (as per Technical Assoc of the Pulp and Paper Industry test method T222 or equivalent).

[14] Jute and coir products may be either non-woven (thick blankets), or woven (mesh). Warning, jute mesh may not be able to achieve the 1-year service life if located within a [illegible] environment.

[15] Woven mats allowed with a maximum opening of 12mm.

[16] Woven or non-woven material allowed.

[17] Blanket can be reinforced with netting made from organic fibres only (e.g. jute or coir).

[18] Only organic fibres are allowed to avoid wildlife being trapped within the netting.

[19] Non-organic, photodegradable or biodegradable netting allowed.

Table 3 presents the flow stability properties of erosion control blankets and mats in terms of permissible shear stress measured in units of Pascals (Pa). Permissible shear stress is considered a more reliable measure of blanket's resistance to damage by water flow and is the measure typically used within Europe and USA; however, allowable flow velocity is more commonly used within Australia.

Table 4 defines the relationship between allowable shear stress (Pa) and allowable flow velocity (m/s) for various values of hydraulic radius (R) and assumed Manning's n roughness presented within the table. The table is appropriate for non-vegetated, three-dimensional turf reinforcement mat (TRM) such as Class 3, Types B and D mats.

Table 4 – Equivalent allowable flow velocity (m/s) for a given permissible shear stress (Pa) for non-vegetated turf reinforcement mats

Assumed Manning's roughness	Hydraulic radius (m)	Permissible shear stress (Pa)						
		[illegible]	70	95	100	150	170	240
0.06	0.05							
0.04	0.10							
0.036	0.15							
0.033	0.20							
0.031	0.25							
0.029	0.30							
0.026	0.40							
0.023	0.50							
0.02	1.0							
0.02	1.5							
0.02	2.0							
0.02	2.5							
0.02	3.0							

Table 5 – TRMs required minimum thickness and area holding capacity

TRM category	Minimum thickness (mm)	Minimum area holding capacity (L/m^2)
Type B		
Type C		
Type D		

Table 6 – Examples of Class 2, Type A erosion control blankets/mats

Products	Manufacturer

[1] Not all of the above products are available in Australia. The data is supplied simple as a guide to assist people in finding an equivalent local product.

[2] Preliminary classification (independent test results not observed).

Table 7 – Examples of Class 2, Type B erosion control blankets/mats [1]

Products	Manufacturer

Table 8 – Examples of Class 2, Type C erosion control blankets/mats [1]

Products	Manufacturer

Table 9 – Examples of Class 3, Type A erosion control mats for use in drainage channels [1]

Products	Manufacturer

Table 10 – Examples of Class 3, Type B erosion control mats for use in drainage channels [1]

Products	Manufacturer

Table 11 – Examples of Class 3, Type C erosion control mats for use in drainage channels [1]

Products	Manufacturer

Table 12 – Examples of Class 3, Type D erosion control mats for use in drainage channels [1]

Products	Manufacturer

[1] Not all of the above products are available in Australia. The data is supplied simple as a guide to assist people in finding an equivalent local product.

Figure 1 demonstrates the anchorage (trenching) of the upstream end of each mat.

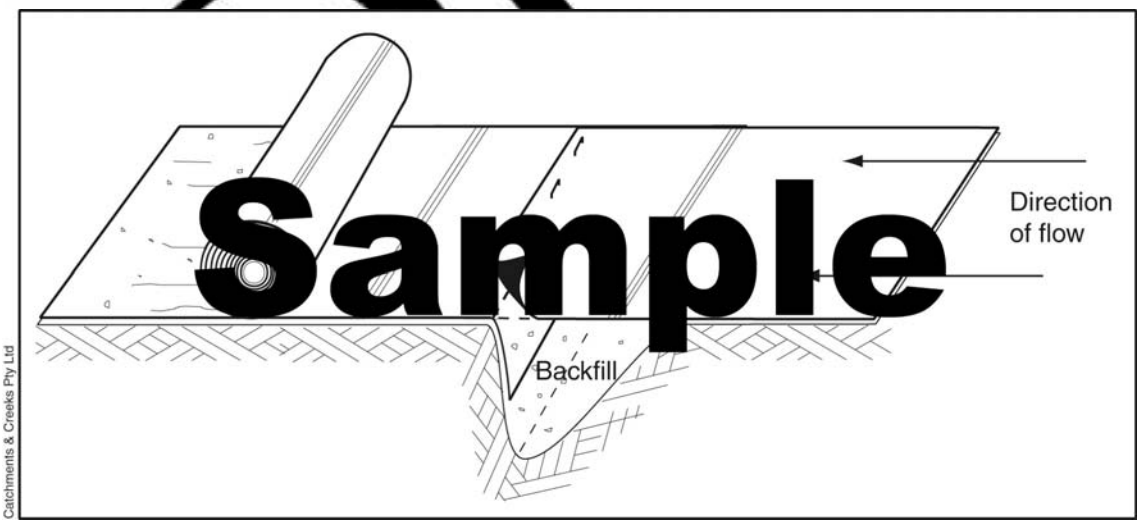

Figure 1 – Anchoring of upstream edge of mat

Tables 13 and 14 provide guidance on the selection of an allowable flow velocity for various geotextiles. Wherever possible, the allowable velocity and/or allowable shear stress should be obtained from the manufacturer/distributor of the chosen product.

Table 13 – Allowable flow velocity for various erosion control mats

Type	Description	Allowable velocity	Comments
Non-woven fabric	Filter cloth		•
	Thick jute blanket		•
	Coir blankets		•
	Blankets reinforced with synthetic mesh		•
Woven fabric	Sediment fence fabric and weed control mat		•
Erosion control mesh	Jute mesh		•
Permanent Turf Reinforcing Mats (TRMs)	Open face 2D synthetic mats		•
	Bio-degradable mulch mats rein[illegible] with UV-stabilised mesh		•
	3D, fully [illegible]nthetic, U[illegible]abilised [illegible]on veg[illegible]d grou[illegible]		•
	3D synthe[illegible] mats reinforced with rock fall netting		•

Table 14 – Allowable flow velocity for temporary channel linings [1]

Anticipated inundation =	Less than 6 hours			Less than 24 hours		
Soil erodibility =	Low	Medium	High	Low	Medium	High
Jute or coir mesh sprayed with bitumen, and Coconut/jute fibre mats						

[1] Source: Landcom (2004) *Soils and Construction – Managing Urban Stormwater*

Typical Manning's (n) values for various geosynthetic channel liners are provided in Table 15.

Table 15 – Manning's roughness for various channel linings

Material	Flow depth less than 150mm	Flow depth of 150 to 600mm	Flow depth greater than 600mm
Plastic sheeting [1]			
Concrete [1]			
Asphalt [1]			
Filter cloth on smooth earth			
Filter cloth on rough earth			
Jute mesh [1]			
Wood excelsior blanket [1]			
TRM – not vegetated [1]			

[1] Source: Fifield (2001) *Designing for Effective Sediment and Erosion Control on Construction Sites*

For low velocity .....
.....
.....
.....

Figure 2 demonstrates the placement of mats within wide channels that have an effective flow width greater than the width of a single mat.

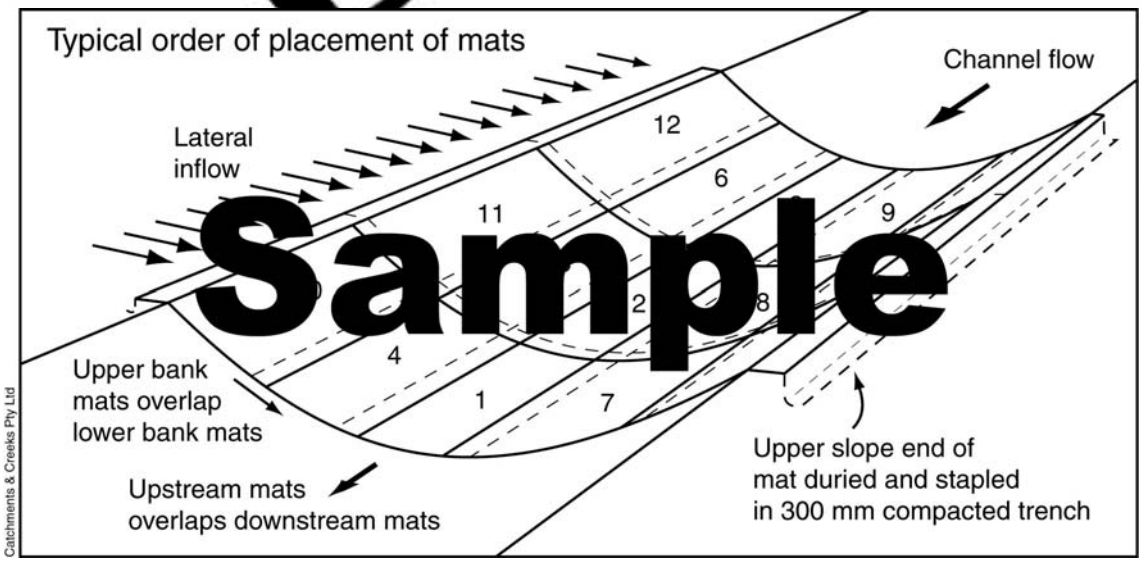

Figure 2 – Placement of mats along channel which received lateral inflow

Description

Erosion control mats usually consist of either a synthetic reinforced “blanket” or a biodegradable mesh made from jute or coir.

In many cases they are made from the same materials used to form *Erosion Control Blankets*; however, they are specifically designed for use in areas of concentrated flow.

Terminology: *mats* are normally used in areas of concentrated flow, while erosion control *blankets* are used in areas of sheet flow. A *mesh* is an open weave mat usually taking the form of a net.

Purpose

Typically used to provide temporary protection to drainage drains during the revegetation phase.

Limitations

Synthetic-based products have limited use in fauna inhabited bushland areas where ground-dwelling animals can become entangled in the mesh.

Biodegradable mats such as jute and coir mesh generally have .....

Advantages

Quick installation

Able to withstand medium to high flow velocities for between a few months to several years

Wide variety of commercially available products exist that are suitable for a variety of uses.

Most products provide instant erosion protection.

Disadvantages

Environmental problems can result from the use of non-biodegradable materials in bushland areas.

Some light mesh products can be difficult to walk across without the risk of entanglement or tripping.

Special Requirements

Four general requirements exist for effective protection against erosion:

- good contact must be achieved;
- seepage flow under the channel liner should be discouraged;
- surface irregularities removed;
- good anchorage must be provided.

Particular attention should be given to ....

Most erosion control mats are best used in partnership with vegetation.

Mats should not be .....
.....
.....
.....

Special attention needs to be given to the free movement of lateral inflows towards the invert of the channel. Lateral inflows may be deflected by the upper edge of the mat causing a build up form that may eventually undermine the mat.

The edges of the mats at the outer edges of the treatment area needs to be buried and stapled into a 300mm deep trench. The trench should not be backfilled flush with the surrounding ground to allow the free entry of water into the channel.

Site Inspection

Ensure the mat is adequately anchored to the soil.

Ensure the mats overlap in direction of flow.

Check that lateral inflows can freely enter the channel.

Check for rill erosion along the up-slope edge of the mats

Installation

The method of installation varies with the type of mat. Installation procedures should be provided by the manufacturer or distributor of the product. A typical installation procedure is described below, but should be confirmed with the product manufacturer or distributor.

1. Refer to approved plans for location, extent and construction details. If there are questions or problems with the location, extent, or method of installation contact the engineer or responsible on-site officer for assistance.
2. Erosion control mats shall be stored away from direct sunlight or covered with ultraviolet light protective sheeting until the site is ready for their installation.

3. Vehicles and construction equipment shall not be permitted to manoeuvre over the geotextile unless it has been covered with a layer of soil or gravel at least 150mm thick. Fill material shall not be mixed over the geotextile.
4. Clear away trash and large stones, and grade the surface smoothly to eliminate footprints, tracks and ruts.
5. If the channel is to be grassed, prepare a smooth seed bed of approximately 75mm of topsoil, seed, fertilise, water and rake to remove any remaining surface irregularities.
6. Excavate a 300mm deep by 150mm wide anchor trench along the full width of the upstream end of the area to be treated.
7. At least 300mm of the mat is anchored into the trench with the roll of matting resting on the ground up-slope of the trench.
8. Staple the fabric within the trench at 200 to 250mm spacing using 100mm wide by 150mm penetration length U-shaped, 8 to 11 gauge wire staples. Narrower U-sections may easily tear the matting when placed under stress.
9. In large drainage channel where the width of the channel is more than the width of one mat, lay each parallel mat such that mat higher up the channel bank always overlaps the mat lower down the bank by at least 300mm. This usually requires that mats located along the channel bed be unrolled first, followed by each consecutive parallel mat located higher up the channel bank.
10. When all mats have been anchored within the trench across the full width of the treated area, then the trench is backfilled and compacted. The mats are then unrolled down the slope such that each mat covers and protects the backfilled trench.
11. When spreading the mats, avoid stretching the fabric. The mats should remain in good contact with the soil.
12. If the channel curves, then suitably fold (in a downstream direction) and staple the fabric to maintain the fabric parallel to the direction of channel flow.
13. Staple the surface of the matting at 1m centres. On irregular ground, additional staples will be required wherever the mat does not initially contact the ground surface.
14. At the end of each length of mat, a new trench is formed at least 300mm up-slope of the end of the mat such that the end of the mat will be able to fully cover the trench. A new roll of matting is then anchored within this trench as per the first mat. After this new mat has been unrolled down the slope, the up-slope mat may be pinned in place fully covering the new trench and at least 300mm of the down-slope mat. The process is continued down the slope until the required area is fully covered.
15. In high-velocity channels, intermediate anchor slots may be required at 10m intervals down the channel.
16. Anchor the outer most edges (top and upper most sides) of the treated area in a 300mm deep trench and staple at 200 to 250mm centres.
17. If the channel was grass seeded prior to placement of the mats, then the mats may be rolled with a suitable roller weighing 70 to 90kg/m, then watered.
18. The installation procedure must ensure that the blanket achieves and retains good contact with the soil.
19. Damaged matting shall be repaired or replaced.

Additional instructions for the installation of Jute Mesh (not jute blankets):

1. Ensure the jute mesh is laid on a firm earth surface that has been trimmed, topsoiled, watered, sown with seed and fertiliser.
2. The jute mesh is then either tamped or rolled firmly onto the prepared surface, avoiding stretching, watered to encourage the penetration of the bitumen emulsion, and finally sprayed with a top layer of bitumen at 1 to 3L/m^2.
3. The rate of emulsion application should be adjusted such that the emulsion just starts to pond in the mesh squares.

Additional requirements associated with use near airport pavements

1. Only erosion mats that are double netted shall be allowed within 3.0m of any airport pavement used by aircraft with the exception of airports classified as air carrier or corporate/transport. If the airport is classified as an air carrier or corporate/transport, there will be no erosion mats allowed within 9.0m of pavement used by aircraft.
2. Only biodegradable anchoring devices shall be allowed in the installation of any erosion mat for airport applications. No metal staples will be allowed.

Maintenance

1. All surface-laid fabrics should be inspected fortnightly during the construction phase and after significant rainfall.
2. Biodegradable mats should be inspected after the first few runoff-producing rainfall events.
3. Inspect the mats to see if:

- construction activity or falling debris have damaged the mats;
- runoff is undermining the mats;
- the mats are not in good contact with the soil;
- the mats do not have adequate overlap; and
- up-slope mats do not overlap down-slope mats.

4. If the matting is damaged, repair or replace the damaged section. If water is undermining the fabric, repair any holes or joints or bury the upper ends of the damaged sections.
5. Make necessary repairs within 48 hours but at least before the next expected rainfall event.

Removal

1. If the matting is temporary, it must be replaced/supplemented with permanent stabilisation measures as specified in the approved plan.
2. Temporary stabilisation works must be maintained until arrangements have been made to install the permanent stabilisation measures.
3. Dispose of the removed fabric in a manner that will not create an erosion or pollution hazard.