

3.0 ENVIRONMENTAL/HERITAGE PROTECTION & EROSION/SEDIMENT CONTROL

3.1 INTRODUCTION

Environmental/heritage protection and erosion/sediment control requirements apply to all engineering works which entail the disturbance of the soil surface and vegetation, including grasses, shrubs and trees, and any relic, material, evidence of settlement etc., covered by the Heritage Act.

It will be necessary to install all environmental protection and erosion control measures prior to any development work (including initial clearing and under scrubbing) being carried out on site. All control works, plus the location of all trees and vegetation to be preserved, will be indicated on the environmental/revegetation protection plan,

All environmental protection works are to be carried out in accordance with the Department of Conservation and Land Management's "Urban Erosion and Sediment Control" Handbook, 1992, and the Department of Housing's "Soil and Water Management for Urban Development, 1993" as references,

In relation to trees, the following information is required in urban areas:

- (a) The location of all trees with a trunk diameter of 300mm or greater and indicate on the plans the diameter at 1 m above ground level.
- (b) Indicate the canopy spread of all individual trees shown, unless the tree forms part of a group planting, in which case show the group canopy spread.

Because circumstances may change during construction, the developer will be required to carry out such control works as Council's Engineer may consider necessary.

Such works shall be completed in accordance with the directions and time limits given by Council's Engineer and carried out by contractors experienced in such work.

It is Council's desire to retain as much native vegetation in new developments as possible.

Minimisation of soil disturbance will result in a reduction in restoration works because of less erosion, sediment deposition, siltation and better control of overland flow. Additionally, sediment controls will be more effective, require less maintenance, and may be less substantial in size requirements.

3.2 REQUIREMENTS PRIOR TO ANY SITE WORKS

- (a) Prior to commencing any work on site, including underscrubbing and clearing, the developer must have development approval and have submitted engineering plans for approval.

- (b) An application to remove trees in accordance with Council's Tree Preservation Order must be submitted to Council and approved in writing before clearing begins. Initial clearing shall be restricted to road reserves and service corridors and the type of machinery used shall be limited to rubber tyred plant to minimise site disturbance.
- (c) A soil and water management plan shall be submitted as part of the engineering plans. This shall detail the works during the construction phase and stabilisation of the development site upon completion, and conservation measures for trees and vegetation.
- (d) A performance bond in the form of a Bank Guarantee shall be lodged with Council to ensure effective environmental control measures are implemented. This bond will be required prior to the release of the approved engineering plans and will be released upon submission of the maintenance bond. The value of this bond will be in accordance with Council's Fees and Charges.
- (e) Prior to the commencement of work the developer shall physically mark out, by fencing, the limits of the contract and any vegetation to be retained. Access outside or into these areas will not be permitted unless approved by Council. Fenced areas shall be clearly signposted "No Access Area".
- (f) In the event of these control measures not being implemented prior to works, Council reserves the right to enter onto the land and carry out these measures.
- (g) The cost of any such measures stated in (f) above shall be fully recouped from the developer prior to any further development works proceeding.

Where the value of the bond is insufficient to cover these costs, any outstanding costs must be paid prior to any further work proceeding.

3.3 DEVELOPER RESPONSIBILITIES

3.3.1 Heritage Conservation & Protection

Items of the built or natural environment which have heritage significance are protected by either the Heritage Act, 1977 (administered by the Heritage Council) or a Local Environmental Plan (administered by Cessnock City Council). Items of Aboriginal heritage are protected by the National Parks and Wildlife Act, 1974.

Where a known item or site is affected by or adjacent to a development, there will be specific conditions of consent which require protection measures during construction. These must be strictly adhered to or severe penalties (fines or imprisonment or both) may result from action under Section 156 of the Heritage Act, Section 125 of the Environmental Planning and Assessment Act, or Sections 86 and 90 of the National Parks and Wildlife Act.

Where in the course of undertaking development works, a person uncovers or discovers a relic (within the meaning of the Heritage Act) or Aboriginal relic or place, they shall:-

- (a) Cease work on the site.
- (b) Take appropriate measures to secure and protect the site or relic, including fencing.
- (c) Contact the subdivision supervisor.
- (d) Notify either the Heritage Council or the National Parks and Wildlife Service, as appropriate, of the discovery as required by Section 146 of the Heritage Act or Section 91 of the National Parks and Wildlife Act.

For the purposes of the Heritage Act, a relic is any object or material evidence of settlement of the area which is 50 or more years old, but specifically excluding aboriginal relics.

The purpose of these provisions is not to restrict development unnecessarily, but to ensure that valuable historical or cultural information or items are not lost or destroyed. In the majority of cases, work will be able to proceed once data on the item or place has been recorded or the relic excavated. There is therefore no advantage to be gained by ignoring the above provisions and proceeding with works which result in destruction of items or places of heritage significance.

In any event, failure to comply with the provisions of the Heritage Act or National Parks and Wildlife Act in this regard may result in severe penalties (fines or imprisonment or both).

3.3.2 Statutory Responsibility

The developer or owner is reminded of his statutory responsibilities under the Clean Waters Act, the Soil Conservation Act, Environmental Protection Act, and Environmental Planning and Assessment Act, various other regulations and ordinances, including the Local Government Act. The developer must be fully conversant of his responsibilities under such legislative requirements.

3.4 REPAIR OF DAMAGE

The developer shall restore to original conditions, at his own expense, any vegetation or property altered or damaged by him during the course of construction, or caused as a direct consequence of development works, including clearing of Council drains or gutter affected by siltation from the construction works. Any materials moved from drains or gutters must be disposed of to the site approved by Council's Engineer. The disposal of spoil on sites outside the area of the approved development requires separate development approval. Enquiries should be made prior to disposal.

3.5 INSPECTIONS

Inspections for environmental control will be required by Council's Engineer for the following items:-

- (a) Installation of environmental control works and their continued maintenance during the development.

- (b) Clearing - before commencement. when completed.
- (c) During each stage of construction works.
- (d) Upon completion of the total development works - final inspection.

3.5 CLEARING/SLASHING

Underscrubbing shall be carried out with minimal site disturbance. Approved underscrubbing shall be carried out by rubber tyred machinery. All general clearing, i.e. removal of rubbish, vegetable matter, organic debris, scrub, timber, rubble and the like, shall be restricted to road pavement areas unless otherwise specified and approved by Council's Engineer

3.7 ENVIRONMENTAL PROTECTION

3.7.1 Fire Protection

The developer shall comply with the relative statutory requirements and ordinances that prohibit the lighting of fires during gazetted fire restriction periods or where damage to the environment could result. Council's approval must be obtained prior to any on site burning, refer Clause 5.5.

3.7.2 Noise Control

The developer shall comply with the statutory regulations and take all practicable precautions to minimise noise levels from the development site. All construction equipment shall be fitted with the recommended noise suppressor in accordance with the statutory requirements.

3.7.3 Disposal of Refuse

The developer shall be responsible for the removal and proper disposal of all site refuse, including food scraps and the like, from the development. The refuse shall be handled in a manner so as to confine the material completely and prevent dust emission, vermin attraction etc.

3.7.4 Disposal of Contaminants

The developer shall properly dispose of all solids, liquids and gaseous contaminants in accordance with all statutory requirements.

3.7.5 Dust Control

The developer shall comply with the statutory regulations and shall restrict the dust level caused by the development to the recommended levels. Necessary watering/dust reduction outside specified hours will require Council approval.

3.7.6 Transportation of Materials

Any conveying of soil, earth, sand, loose debris and any loose materials to or from the development site shall be in a manner that will prevent the dropping of material on surrounding streets. The developer shall ensure that the wheels, tracks and body surface of all vehicles and plant leaving the site are free of mud and that mud is not carried onto adjacent streets or other areas. Refer also to haul route detail, Clause 2.14

3.7.7 Existing Flora

All areas of existing flora to be retained are to be properly fenced and protected from all construction operations. See Clause 3.2(e).

3.7.3 Trees

- (a) Trees to be removed - All removals in urban areas or large tracts of rural areas are to be approved by Council.

Trees to be removed in urban areas are to be clearly marked with a yellow painted "X" to correspond with those trees shown on the engineering plans.

Removal of trees is to be executed so that no damage occurs to trees to be retained. This may mean that precision felling by chainsaws is necessary instead of machine felling.

Council's Parks Manager may, if necessary, nominate an appropriate felling method where damage to trees is likely to occur during felling.

- (b) Disposal of Trees & Stumps - Dispose of all tree wastes at the time of clearing by either:
- (i) Chipping on site at the time of clearing.
 - (ii) Pit burner under Environmental Planning & Assessment Licence.
- (c) Work on Trees - If it is considered necessary to perform any work on trees, including trimming, pruning, root cutting, repair and removal, Council approval and instructions must be obtained. Any work permitted to be carried out on trees to be retained shall be performed by an approved arborist.
- (d) Replacement - If so directed, the developer shall provide, plant and establish, at no cost to Council, a replacement tree of similar species and size or a tree of a species and size nominated by Council.
- (e) Tree Enclosures - All trees and shrubs liable to damage during construction shall be properly protected by an approved protective enclosure as detailed at the end of this chapter. The tree enclosure shall be kept intact and in good repair during the construction period and removed at practical completion.
- (f) Work Near Trees - It is essential to protect the trees to be retained from damage by ground works. Do not store, stockpile, dump or otherwise place under or near trees bulk materials and harmful materials, including oil, paint, waste concrete, clearings, boulders and the like. Do not place spoils from excavations against tree trunks, even for short periods.

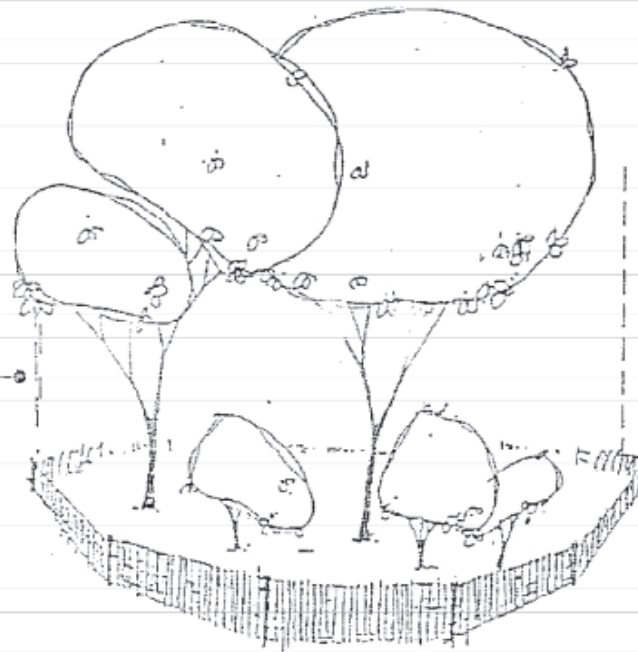
The developer shall prevent damage to tree bark, refer to protection details at the end of this chapter. Do not attach stays, guys and the like to trees. Do not remove topsoil from within the drip zone of a tree unless otherwise specified. Open excavations under the tree canopy must be for as short a period as possible. Do not cut tree roots exceeding 50mm diameter unless permitted by the Superintendent and Council's Engineer. Where it is necessary to cut a tree root, use a chainsaw or similar means such that the cutting does not unduly disturb the remaining root system. Any trenching or excavation near a tree which will remain exposed for a period longer than one month shall require the construction of a root curtain to stop the root system drying out. Details are available from Council. Avoid compaction of the ground under trees. Any compacted soil shall be loosened by coring.

- (g) Penalties for Tree/Shrub Damage - In the event of damage to any existing tree or shrub, the developer shall notify the Superintendent immediately. All necessary remedial work shall be at the contractor's cost and any appropriate penalties for the destruction of trees and shrubs are as detailed in Council's Tree Preservation Order.

3.7.9 Storage on Site

- (a) General - The location of materials and equipment stored on site shall be approved by Council in order to prevent damage to the site and minimise hazards to persons, materials and equipment.
- (b) Equipment - All plant equipment and vehicles are not to be stored within the drip zone of any tree shown on the plans for retention. Approval may be obtained from Council if the appropriate ground treatment is provided.

DRIP LINE



PROTECTIVE FENCING
AS SPECIFIED

GROUPING

DRIP LINE

PROTECTIVE FENCE -
CONSTRUCTED OF R.T.A
TYPE WEBBING,
2 STEEL MESH
WOODEN SLATS

1500
mm

750
mm



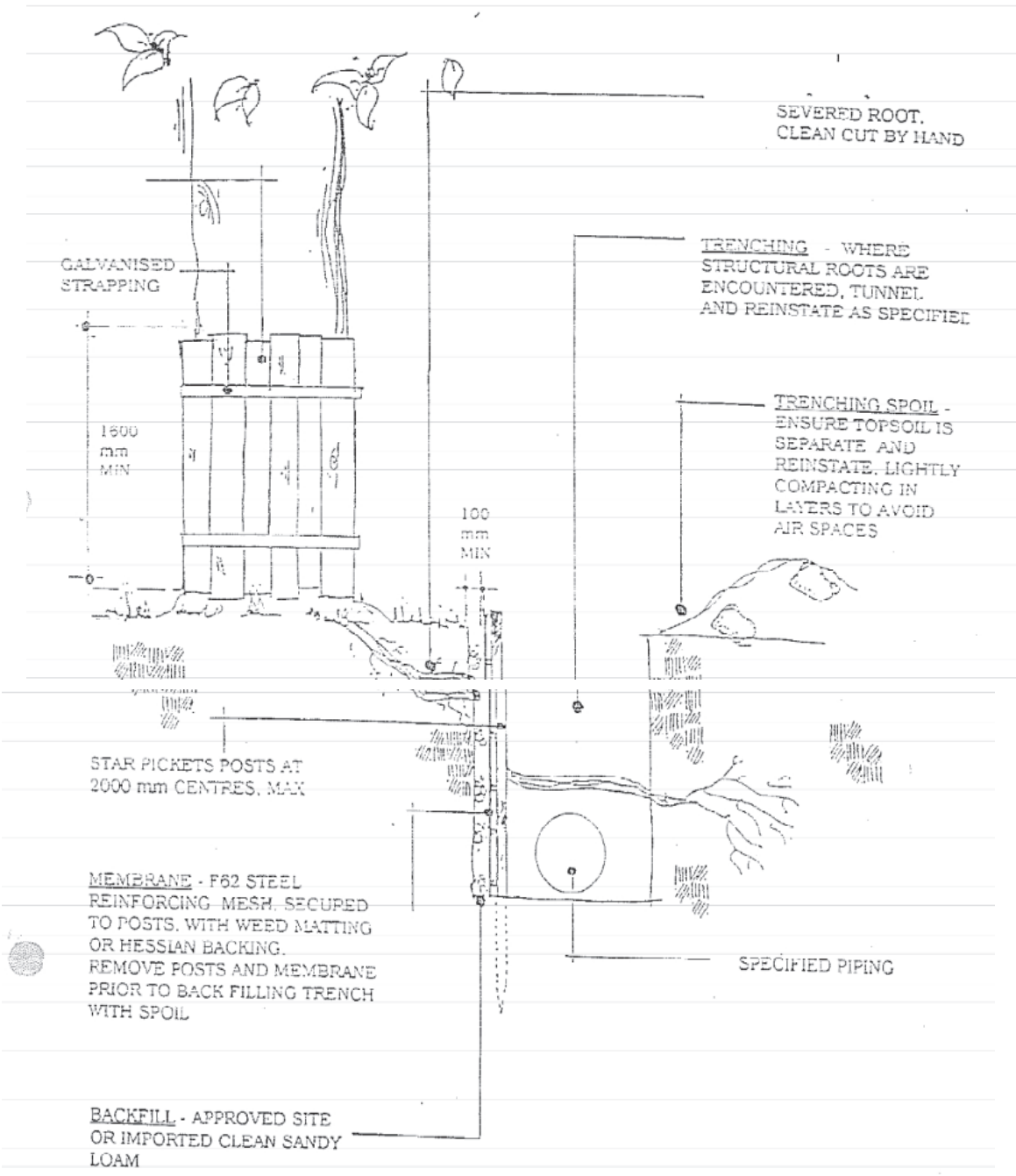
STAR PICKET POSTS
WITH 2 STRAINS OF
HIGH TENSILE WIRE
FOR WEBBING/MESH
SUPPORT

INDIVIDUAL

TREE PROTECTION DETAIL

No 1
FENCING

NOT TO SCALE



TREE PROTECTION DETAIL

No 2
TRENCHING NEAR TREES

NOT TO SCALE



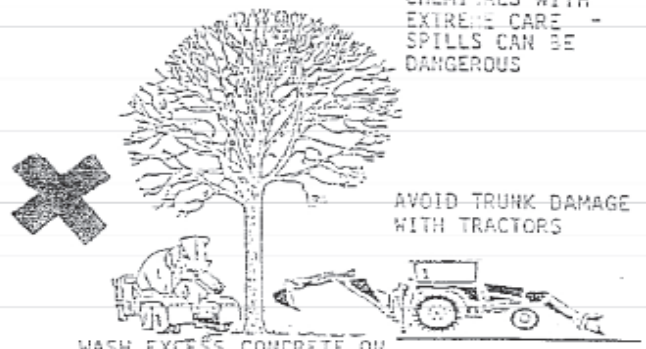
AVOID LOCATING SITE SHEDS DIRECTLY UNDER TREES



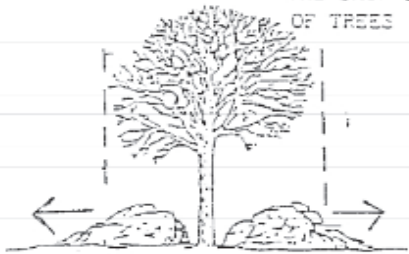
TREAT ALL TOXIC CHEMICALS WITH EXTREME CARE - SPILLS CAN BE DANGEROUS



NO TIPPING UNDER TREES



AVOID TRUNK DAMAGE WITH TRACTORS

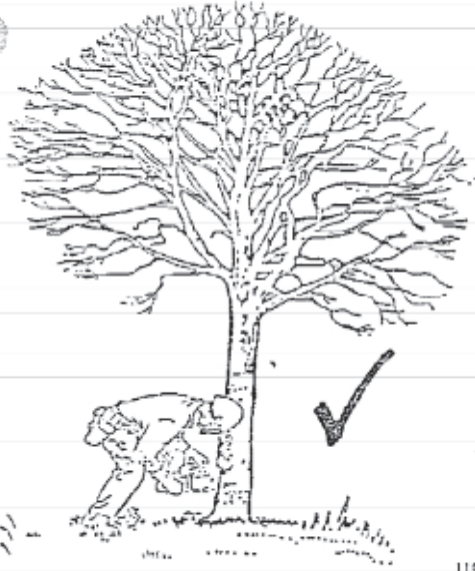


NO FIRES IN THE DRIP ZONE OF TREES

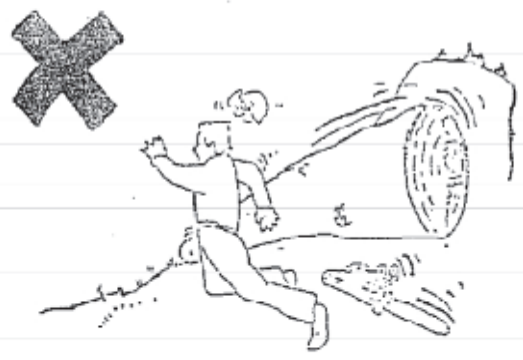
SOIL SHOULD NOT BE STOCKPILED UNDER TREES
KEEP STOCKPILES OUTSIDE THE DRIP ZONE

WASH EXCESS CONCRETE ON CONSTRUCTION SITE, NOT UNDER TREES

3. Employ properly trained and equipped persons on tree felling works.



MANY PLANT OPERATORS ARE INJURED WHEN ATTEMPTING TO FELL TREES BY PUSH/PULL WITH A MACHINE



USE PROPERLY TRAINED AND EQUIPPED PERSONNEL TO FELL TREES

3.8 EROSION/SEDIMENT CONTROL

3.8.1 Philosophy of Erosion & Sediment Control

Virtually all construction activity which requires the disturbance of the soil surface and the existing vegetation, naturally predisposes the construction site to erosion. This in turn leads to sediment loss in the resultant run-off water.

Since such soil disturbance is a necessary part of development, it is essential therefore to develop measures which reduce the erosion hazard of any particular construction activity. Having done that, run-off water must be controlled, which carries the sediment, in such a way as to reduce the amount of that sediment leaving the site.

Briefly, this is achieved by:

- (a) Limiting the amount of site disturbance.
- (b) Control run-off and sediment movement at its point source rather than only at one final point.
- (c) Progressive revegetation of the site, where possible, during on-going construction to reduce the area contributing sediment. This in turn increases the efficiency and effectiveness of the entire sediment control system.
- (d) Construction of larger sediment trapping systems of a size relevant to the catchment of the site and soil structures.
- (e) Filtering of the sediment in the trapped water prior to its release to the drainage system.

Minimum requirements are:

- (a) On site controls throughout the entire works to ensure minimum erosion and sediment loss.
- (b) Ensure least disturbance to site. ("No Go Areas" refer Chapter 3).
- (c) As each area is completed, that entire area is to be immediately/progressively seeded and fertilised. Silt fence, hay bales or other controls need to be provided until the site is stable. Should this approach not be practical, the progressive revegetation of individual areas will be required.
- (d) After backfill behind kerb and gutter is completed, turf strips are to be placed behind kerb and gutter to an equivalent minimum width of 1.2 metres. Where the footpath is sloping, turf strips will need to be angled across the footpath and additional strip turfing may be required. Damaged or dead turf shall be replaced immediately.
- (e) Where there is grade on other areas of the site that may lead to erosion, further turfing strips or other appropriate treatment is to be located to control erosion.

- (f) The provision and maintenance of sediment traps (ponds, dams, basins) will be necessary for most developments during the construction phase and for future use. Such sediment basins must be accessed by a permanent, all weather road to enable cleaning operations to be done during periods of wet weather.
- (g) Any sediment collected in gutters or other areas outside the site shall be immediately removed and the area restored (Refer Clause 3.4).

3.8.2 Revegetation

All areas disturbed during construction shall be revegetated as soon as possible after completion of the work or as directed by Council's Engineer. Council's Engineer may direct that temporary stockpiles or areas which are likely to be re-disturbed may be temporarily stabilised by revegetation using a cereal such as black winter rye-corn or oats (autumn/winter) or Rhodes Grass (spring/summer) and the application of fertiliser.

3.8.3 Topsoil

All disturbed areas, including fill areas, must be top dressed with topsoil to a minimum depth of 50mm. Should Council's Engineer consider the topsoil material stockpiled on site is not suitable, he may direct the developer to import approved material as topsoil. Once top-soiled, the area must be sown with seed and fertilised as shown on the plan or as directed by Council's Engineer. Topsoil on batters shall be no deeper than 50mm and shall be placed over ripped or scarified ground.

3.8.4 Hydromulching (Hydroseeding)

All disturbed areas specified shall be sown with seed and fertiliser by the hydromulching technique using experienced personnel, at rates and materials specified below. This is to immediately follow completion of earthworks on each section of the works.

Seed and other materials shall be brought to the site in bags and mixed under the superintendent's supervision. 24 hours notice is to be given in writing prior to any hydromulching taking place. Mix is to be continuously agitated during spray operations. The superintendent will require samples of seeds for identification.

- (a) Preparation - Where applicable, spread topsoil over area to provide a minimum thickness of 50mm, married into the subgrade by scarifying to a depth of 100mm. Elsewhere, scarify soil surface and hydroseed.
- (b) Materials - Mulch to be of wood fibre applied at the rate of 2.5 tonnes/ha. Binder to be POLYMER BINDER applied at the rate of 250 litres/ha. Seed mixture and fertiliser as specified.

3.8.5 Hay Mulching Specification

- (a) Surface Preparation - Where applicable, spread topsoil over the area to provide a minimum thickness of 50mm, married into the subgrade by scarifying to a depth of 100mm.

- (b) Sow seed and fertiliser using the hydromulching technique and rates. Use wood pulp at 100kgs/ha only and omit polymer binder.
- (c) Hay, to be applied, must be free of thistle or other woody species, must be of acceptable market quality and not affected by rain.
- (d) Hay is to be applied at the rate of 5 tonnes/ha evenly over the soil surface. The hay is tacked with anionmic bitumen emulsion at the rate of 2,500 litres/ha.

3.8.6 Seed

- (a) Spring/Summer -
 - 8 kilograms per hectare of Perennial rye grass.
 - 3 kilograms per hectare of Red Clover.
 - 3 kilograms per hectare of White Clover.
 - 5 kilograms per hectare of Hulled Couch.
 - 5 kilograms per hectare of Rhodes Grass.
 - 5 kilograms per hectare of Couch.
- (b) Autumn/Winter -
 - 15 kilograms per hectare of Oats.
 - 10 kilograms per hectare of Wimmera rye grass.
 - 5 kilograms per hectare of Red Clover.
 - 5 kilograms per hectare of White Clover.

The above seed mixtures are appropriate for urban areas only. Where any 'bush' areas or reserves are to be seeded with native species, these will be determined by Council.

3.8.7 Fertiliser

'Starter 18' or similar at rate of 250 kilograms per hectare.

The use of gypsum, lime or equivalent products is required as part of the revegetation works to condition unsuitable soil strata.

3.8.8 Watering

The developer shall be responsible for the adequate watering of all revegetated areas to ensure its natural regrowth from the time of planting through to the end of the maintenance period.

3.8.9 Fill Areas

Runoff and sediment loss from the areas of fill must be controlled during and after construction before revegetation takes place using barriers such as silt fences or hay bales, diversion drains or other approved methods as directed by Council's Engineer to direct water from the disturbed areas. Other measures shall be carried out as directed by Council's Engineer and/or as shown on the plans.

Fill area MUST be stripped of topsoil and this topsoil removed from the area BEFORE any filling occurs.

3.8.10 Construction of Road Batters

Batters shall be cut in accordance with the batters given on the approved plans. All batters to lots shall commence 0.5 metres inside the block boundary. All cut and full batters, except rock batters, are to be topsoiled with on-site material to a depth of 50mm immediately following construction and before the batter surface becomes sealed over. Should the batter become sealed over, Council's Engineer may require the surface to be disturbed to break such seal. The surface of cut batters should not be graded off to a shaved surface, but left untrimmed by the grader and topsoil applied immediately.

3.8.11 Drainage Construction

All drainage conduits and related structures, including energy dissipaters, wing walls for headwalls etc., or any other erosion and sediment control works as specified, must be fully completed before the conduit is commissioned to protect both the upstream and downstream ends of the drainage system from erosion.

Excavated material from the trench shall not be placed on the road or kerb and gutter. Refer to Chapter 7 also.

3.8.12 Backfilling of Trenches

When any trench is being opened up, the topsoil should be isolated. After installation, the backfill must be compacted and any overburden removed from site. The area disturbed during construction should then be topdressed with the topsoil previously isolated and seeded or turfed if required. Refer to Clause 3.8.2.

3.8.13 Open Drains

Permanent or temporary open concrete or earth drains are to be constructed as indicated on the plan or as directed by Council's Engineer for the protection of adjoining work or property during construction. These drains are to be constructed in accordance with standard practice. All open earth drains must be protected from scouring as indicated on the approved plans or as directed by Council's Engineer in a regular progressive manner during the works.

3.8.14 Stockpiles

Council's Engineer shall approve of the proposed location of the various stockpiles prior to commencement of works. Location of stockpiles shall be indicated on the approved engineering plans.

Site topsoil shall be isolated from subsoil material in separate stockpiles.

Stockpile sites shall be located away from existing or proposed drainage lines or areas likely to be disturbed during construction. Stockpile sites shall not be located within the drip zone of trees.

Stockpile sites must be protected from erosion and sediment loss by installation of diversion drains, revegetation of the pile using a cereal only seed mix (oats or black winter rye corn in autumn/winter and Japanese millet in spring/summer) or the use of silt fences/hay bales or other approved controls.

Various combinations of the use of fences and other materials to achieve sediment control are attached at the end of this chapter.

3.8.15 Sediment Traps/Ponds/Dams/Basins

These are temporary or permanent barriers or holding dams to trap sediment on the development site.

The location of the sediment traps must be shown on the engineering design plans, together with their proposed capacity. A capacity of 200m³/ha to 250m³/ha of disturbed site is required. Where upstream areas from developments are not disturbed, constant natural erosion takes place. An allowance in the sediment basin capacity of up to 50m³/ha is required if diversion banks are not used to direct upstream water away from construction areas (refer to Clause 3.9). This will be subject to the available space, the scope of the development, and the type of soil conditions at the site. This will be determined by Council Engineer.

Where it is considered a situation exists which constitutes a danger to the public, sediment traps must be adequately fenced, including lockable gates for maintenance access.

All sediment traps must be properly maintained to provide ongoing effectiveness and must be pumped out at regular intervals or as directed by Council's Engineer.

Council's Engineer must inspect the trap prior to pumping out to ensure that the water quality is acceptable. The traps may require dosing with gypsum to flocculate suspended material and allow settlement.

3.8.16 Cleaning Sediment Control Structures

The developer shall empty and/or clean out the sediment control structures as required. Council's Engineer may direct such works whenever the trap has reached full water capacity or the accumulated sediment has reduced the capacity to below 70%. The removal of the sediment shall be done in such a manner so as not to damage the sedimentation structure.

Council's Engineer may also direct the cleaning out of sediment control structures immediately downstream of the construction site.

3.8.17 Maintenance of Existing Drains

Where construction work interferes with existing drains or gutters, these shall be immediately cleared and maintained to avoid sediment problems and potential flooding.

3.9 SOIL EROSION TECHNIQUES

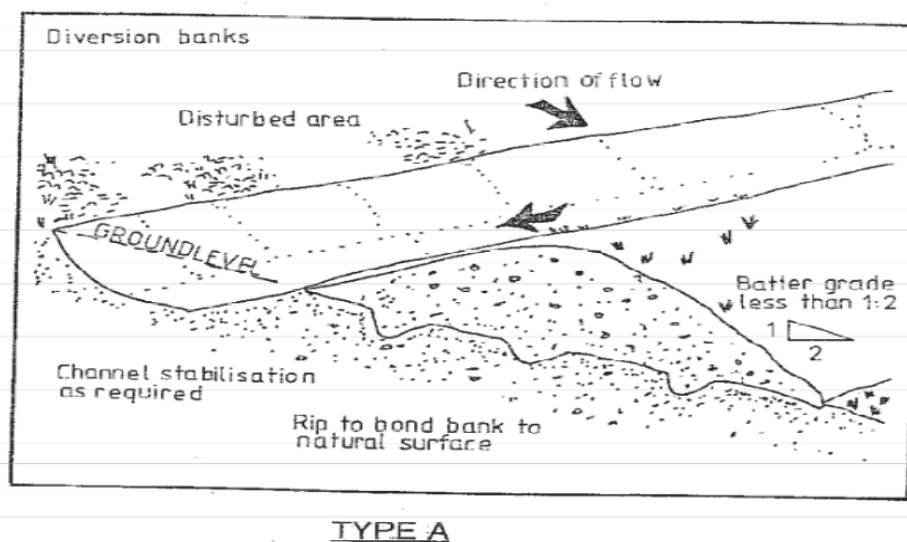
3.9.1 Diversion Banks, Catch Drains, Table Drains

- (a) Description - Diversion banks are channels, berms or ridges of soil. They may also be formed using sandbags.
- (b) Usage - Diversion banks run across the slope intercepting, containing and directing runoff to stable outlets. They can also be used to:-
- * Divert non-polluted runoff away from disturbed areas.
 - * Divert polluted runoff to sediment trapping devices.
 - * Reduce slope lengths, thereby creating less erosive segments.
- (c) Installation - Diversion banks are designed to carry peak flows at non-erosive velocities in bare soil or vegetated channels. They should be marked out by surveying the line. The base of the bank should be ripped parallel to the survey line to achieve a bond between the bank and the existing ground.
- (d) Basic Design Criteria - The channel must be large enough to carry a one in ten year peak discharge for the catchment. The channel should be preferably dish shaped with batter grades of less than 1:2. The bank must drain to a stable outlet. See Type A below.

Generally, the channel should be lined with turf as per Council specification. However, where velocities are designed in excess of 2m per second, non-erosive linings such as concrete, grouted rock etc. are required. On slopes of 2% or less, the diversion bank can be constructed by placing the excavated material on the high side of the trench and using the existing vegetated area as the channel base. See Type A example.

Where the bank is of a temporary nature, the channel can be lined with a geotextile fabric.

- (e) Maintenance - Diversion banks should always be inspected after rainfall. Sediment deposits should be removed to maintain freeboard. Channels and outlets should be cleared of obstructions.

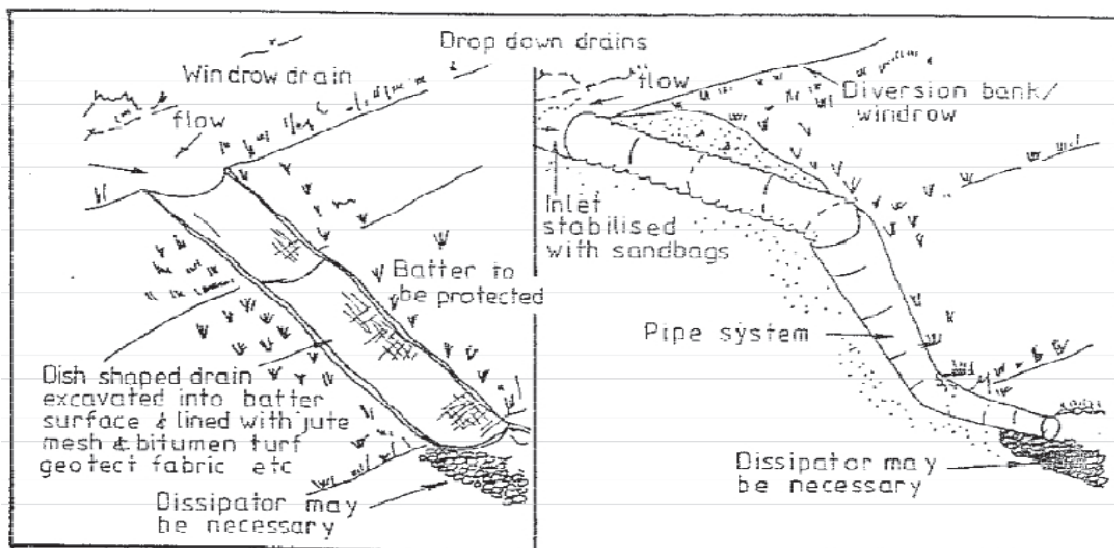


3.9.2 Drop Down Drains

- (a) Description - These are drains which convey runoff from a road or extraneous catchment down slopes such as road batters without causing erosion. They may consist of a dished earth drain smoothly shaped and consolidated and lined with a number of materials such as turi, jute mesh and bitumen, geotextile fabric temporary measure only) or concrete, rock and slurry, or a flexible/rigid pipe or half round pipes.
- (b) Usage - Drop down drains consisting of rigid or flexible pipe are very effective as a temporary measure during road construction used in association with an earth windrow (or bund wall) along the top edge of the batter. Runoff flowing along the windrow is directed to the pipe by which water is conveyed down the batter. It is a simple matter to extend the pipe as the batter rises.

Drop down drains should be large enough to carry runoff without washing out. To prevent failure around the inlet, the soil should be compacted or the area stabilised using sand bags. Energy dissipaters may be required to reduce the flow velocity at the outlet.

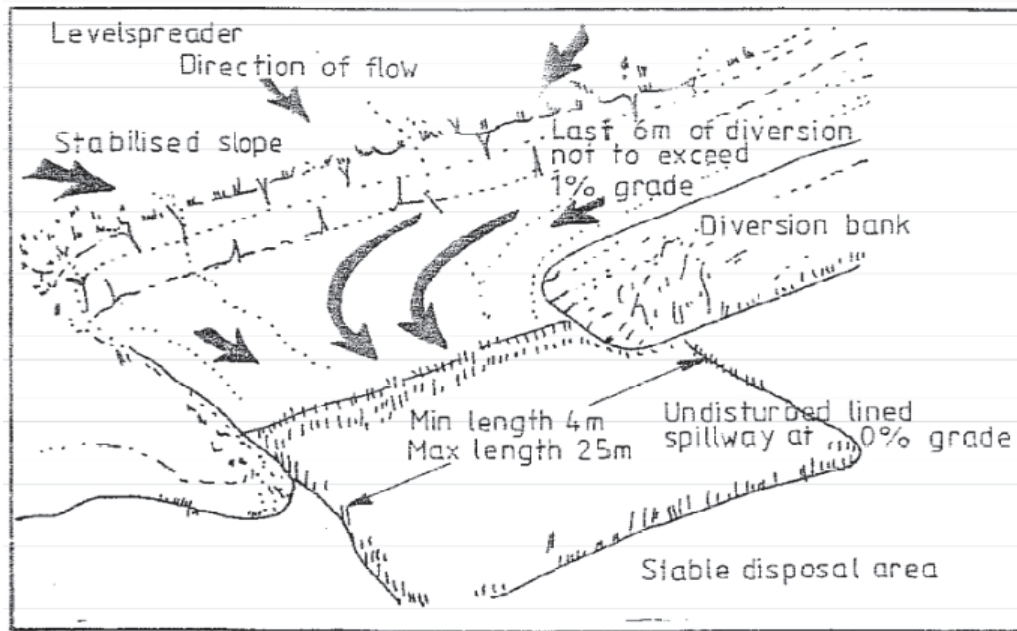
- (c) Maintenance - The inlet and outlet must be checked regularly to ensure they are not obstructed.



3.9.3 Level Spreader

- (a) Description - Level spreaders are outlets or sills' having a level cross section. They convert erosive channel flow into non-erosion sheet flow.
- (b) Usage - Level spreaders can only be used to dissipate flow from small catchments. The area below the outlet should be stable and of even cross section so that the water will not re-concentrate into channels.
- (c) Installation - The outlet or 'sill' width depends on contributing catchment, slope and ground conditions. The minimum width should be four metres, and the maximum width 25 metres. Final discharge should be over a level surface, which may require stabilising by turfing or seeding and fertilising or perhaps lining with a geotextile fabric or similar.

- (d) Maintenance - Spreaders should be checked periodically to ensure that they are not damaged. There should be no scouring of the sill or vegetation damage below the spreader.



3.9.4 Channel Stabilisation

- (a) Description - Channels can be stabilised by providing a lining that withstands high flow velocities.
- (b) Usage - Channels should be stabilised when high flow velocities will cause erosion and scouring of the channel base.
- (c) General Requirements - The technique to be employed in stabilisation is dependent on the velocity of the flow which is expected, and the materials for stabilisation should be chosen accordingly. For example, for very high, fast flows, the channel must be lined with something such as concrete, rock and grouting, rock mattress etc., all of which will carry higher velocity flows than will a channel stabilised with turf only. However, such a grassed channel will carry a higher velocity than a bare earth channel.

Flow velocities may be further reduced by the use of grade stabilising structures (see later section).

- (d) Techniques of Stabilisation -

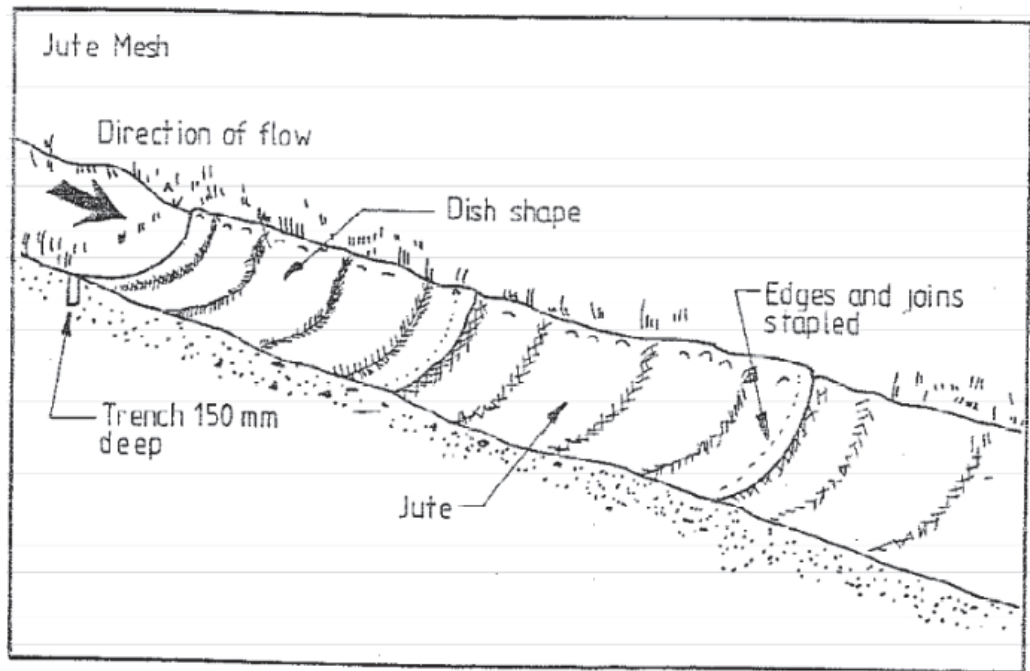
* Jute Mesh

- (i) Description - Jute mesh is suitable for channels of lower gradients. It can be used to line table, median, berm, drop down and other drains.
- (ii) Installation - The mesh is laid after the channel has been formed by shaping, top soiling and compacting, and the area sown and fertilised. The area must be free from rocks and clods.

The top edge of each jute strip should be buried at least 150mm and secured with staples. When joining rolls of jute, the upstream roll should overlap the downstream roll by at least 100mm, and the overlay should be stapled.

Undiluted bitumen emulsion applied at the rate of 4.5 litres per linear metre of jute completes the protection.

Channels may be further stabilised and flow velocities reduced using grade stabilising structures.



- (iii) Maintenance - After heavy rainfall, the channels should be inspected to ensure they have not been scoured. Any subsequent damage shall be reinstated in the approved manner.

* **Turf Laying**

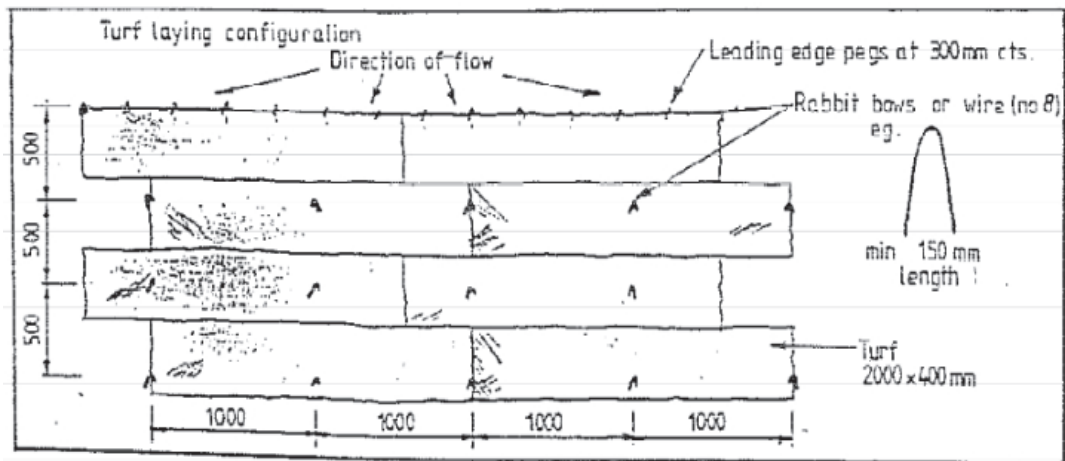
- (i) Description - Turf or grass sods should consist of 25mm of dense, well rooted, vigorous growth turf with 25mm of topsoil. The sods should be free of noxious weeds, soil pests and diseases. The sods shall be cut by an approved sod cutter in long lengths of uniform width of not less than 300mm and shall be in a sound unbroken condition.
- (ii) Installation - Turf sods shall butt hard against each other so that there are no gaps. The outside edge should be left staggered to form an uneven edge.

Turf should be watered regularly for at least a week after it has been laid to ensure maximum rate of establishment. After that, watering should be carried out as necessary for the duration of the work or contract.

Laying of turf should be scheduled so that each section is rolled or tramped immediately it has been laid to obtain a key with the underlying soil. All areas should be scarified and then topsoiled prior to the placement of turf. The turf section should be butted firmly together where strip turfing is not proposed. On batters it is essential that the turf sections be laid on the contour, while in drains turf sections should be laid across the drain at right angles to the direction of flow. The turf should be anchored with wire netting pinned with rabbit bows or staples (approximately 150mm long, on steep sites or drains to ensure stability (see drawing).

The rabbit bows should be made from No. 8 wire or, if the soil profile is hard, making penetration difficult, lengths of reinforcing mesh, cut to size, should be used.

It is essential that these bows, or rods, pin the netting hard against the grass sods. It is better to shorten the bows etc. to achieve this than have the bows 'flatten out' where penetration to the depth of the bows cannot be achieved. Removal of netting and bows is required after establishment where later maintenance, such as mowing, will be carried out.



* **Use of Geotech Fabric Liner for Stabilisation of Temporary Earth Drains or Channels.**

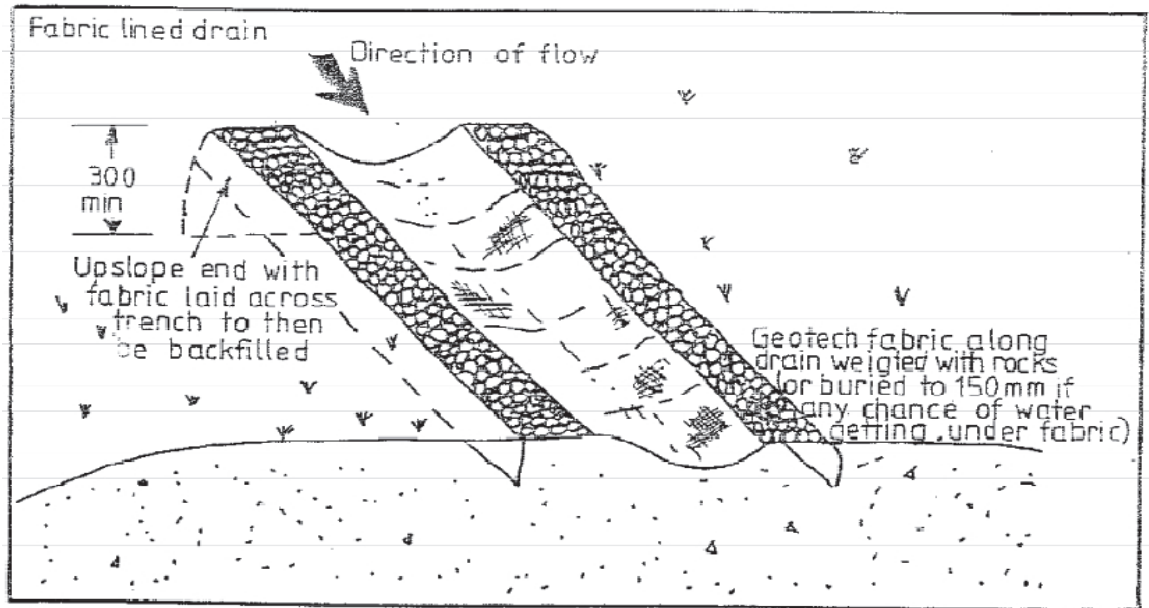
(i) Description - Quite frequently a temporary dish shaped earth drain is required to divert water flow during construction of a subdivision or a building etc. Many times this drain becomes eroded and sediment is formed.

This problem can be overcome by lining the drain with a properly installed geotextile fabric.

(ii) Installation -

1. Shape the drain to a smooth, compacted finish.
2. Dig a trench across the upslope end of the drain, lay the fabric flat on the floor of the trench, backfill and compact.
3. Lay the fabric along the drain and trim to size.

4. Hold down the outside edges of the fabric with rocks, or if there is any chance of run-on water getting under the sides of the fabric and creating possible erosion, then the sides of the fabric should be buried in a trench some 150mm or so deep. The backfill must be compacted.



* **'Plastic' Fabrics, Plastic/Natural Fabrics Etc.**

- (i) **Description** - These are manufactured products consisting generally of a combination of natural and plastic fibres woven to form a mat.

Detailed information is available on each product from the manufacturer. It is up to the individual to determine the suitability of a particular product for their particular requirements.

- (ii) **Installation** - Each manufacturer gives explicit directions for the installation of their product. It is essential for the successful use of any of those products that these directions are adhered to.

Brochures on some of these products are available from Council's offices or landscape and garden suppliers.

* **Concrete Linings, Rock/Rock Grouting, Rock Mattresses, Gabions Etc.**

- (i) **Description** - These linings are well known and provide permanent scour protection for outlets.

- (ii) **Installation** - For successful operation of such linings it is essential to ensure the lining cannot be undermined by runoff water getting under the lining, creating erosion. This can be achieved by:-

1. The construction of a cutoff wall at the upslope start of the lining. Also ensure that the capacity of and configuration of the channel itself will not allow water to go over the side of the lining and erode the soil beneath.

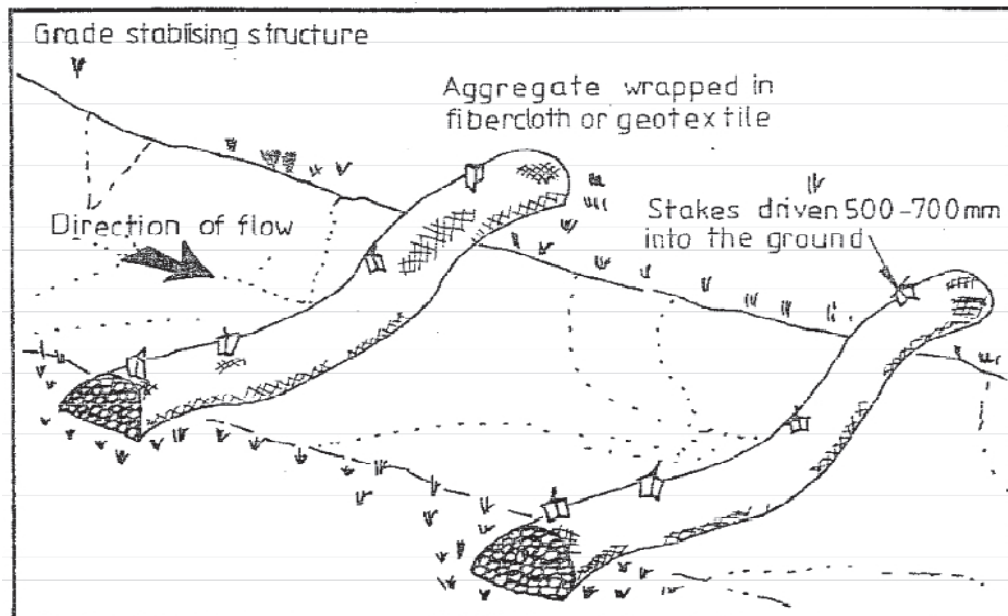
2. Line the floor of the channel or drain with geotextile fabric before installing rock mattresses or gabions. It is best for such fabric to be buried in a trench some 300mm deep at the upstream edge of the lined channel.

* **Grade Stabilising Structures**

- (i) Description - Grade stabilising structures are erosion-resistant structures installed across a channel to promote non-erosive velocities in the downstream channel.

Spacing of the structures should be such as to ensure the crest of the downstream structure is the same level as the ground immediately below the next upstream structure.

- (ii) Usage - Grade stabilising structures are generally built as overfalls or chutes and can be made from wood, concrete, sheetmetal piling's, gabions, bags filled with sand cement mix, or geotextile fabric sausages filled with blue metal. They must be constructed to ensure that runoff flow is retained in the channel and does not overflow around the edges of the structure. The channel itself must be protected from erosion.
- (iii) Maintenance - Grade stabilisers should be regularly inspected for inlet and outlet damage, or obstruction and channel scouring.



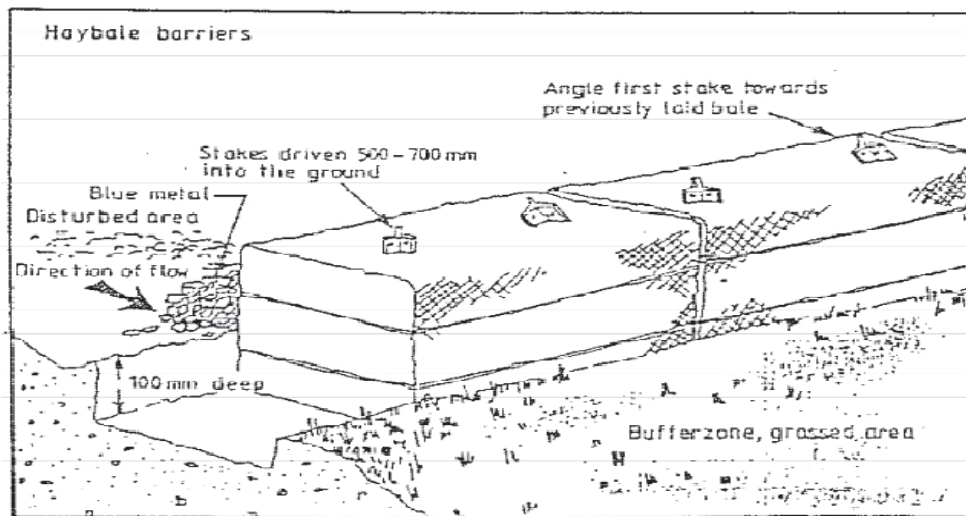
3.9.5 Hay Bale Barriers

- (a) Description - A temporary barrier of hay bales placed around the perimeter of a disturbed area.
- (b) Usage - Hay bale barriers are used to desilt contaminated water,

- (c) Installation - Hay bales are only effective on sites of less than half a hectare. The bales should be placed lengthwise in 100mm deep trenches with their binding rope horizontal to the ground.

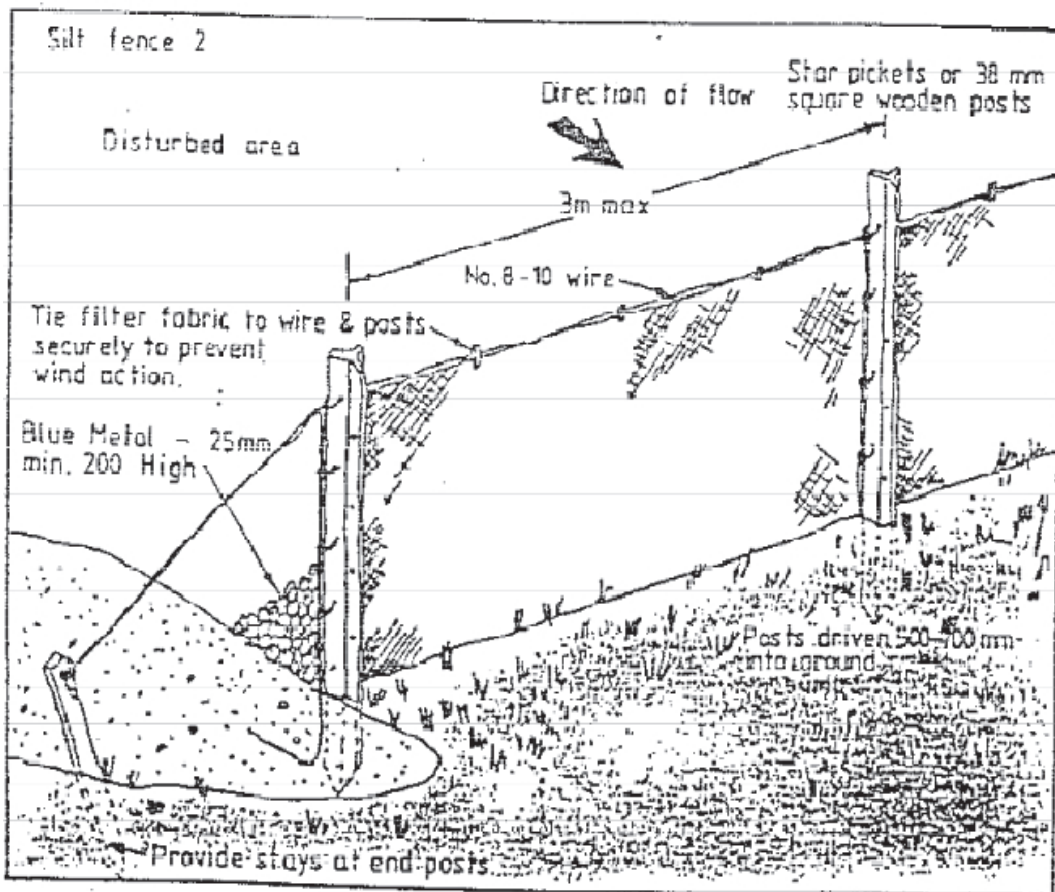
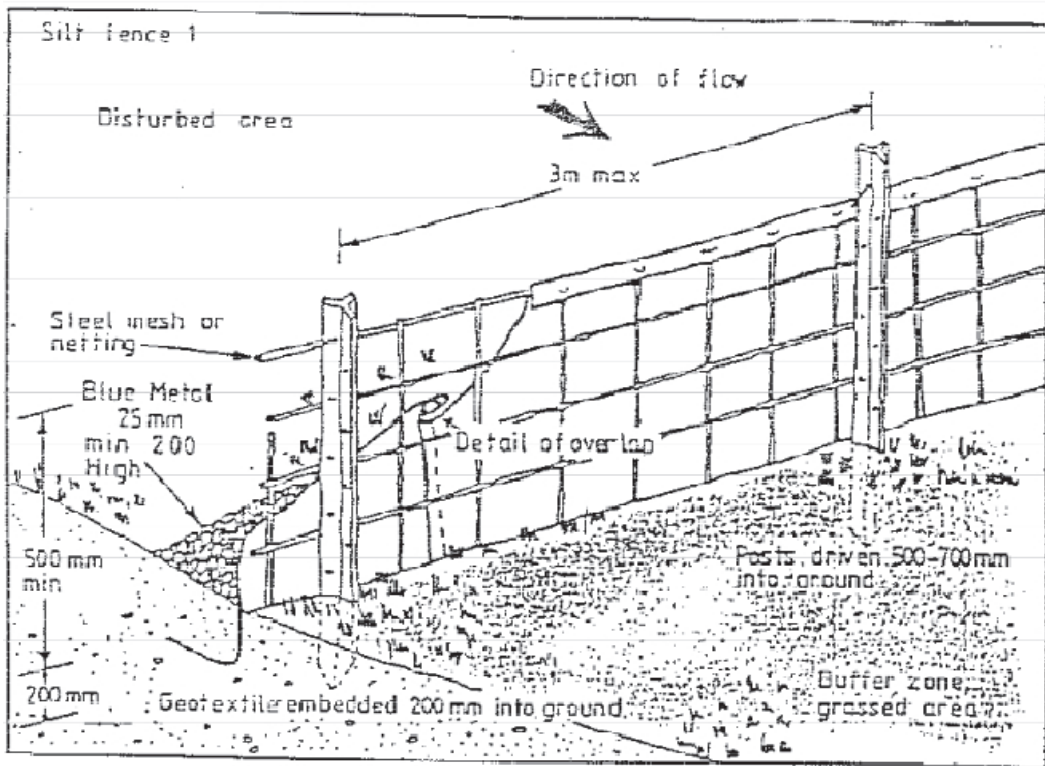
The bales should be connected and anchored to the ground by driving two star pickets or posts through each bale. The first stake must be driven towards the adjoining bale at a 45 degree angle to force the bales together.

- (d) Maintenance - After rainfall, hay bale barriers should be inspected and sediment removed. Damaged bales should be repaired or replaced. Bales have a life expectancy of three to six months.
- (e) Alternatives - Blue metal of nominal size 25mm placed some 150-200mm deep against the upslope toe of the hay bale barrier greatly improves the efficiency of the system.



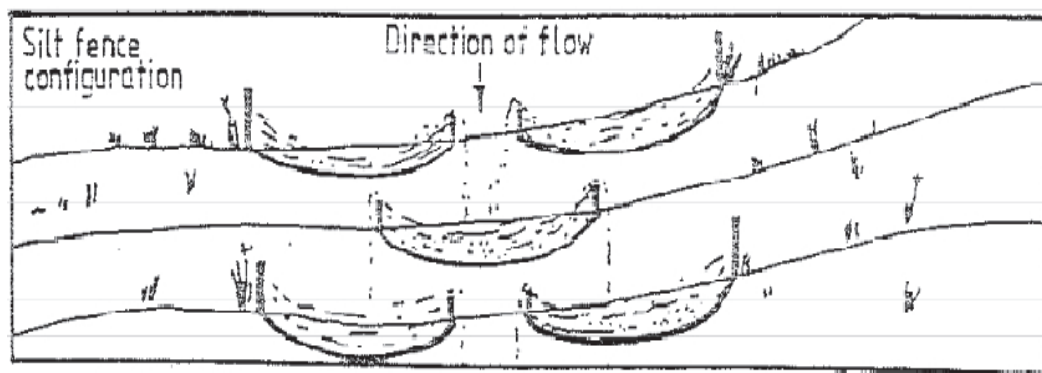
3.9.6 Silt Fences

- (a) Description - Silt fences are temporary barriers made from filter cloth, hay bales, blue metal or a combination of these.
- (b) Usage - Silt fences filter runoff leaving the site, trapping the sediment and allowing clean filtered water to pass. Silt fences are normally placed on the contour or slightly convex to the contour. If on the contour, each end of the fence should be turned up to create a 'stilling pond' up slope of the fence. Where possible, a silt fence system should consist of a series of overlapping fences. Each fence should be no longer than about 20 metres. They should not intercept large concentrated or channelized flows.
- (c) Installation - The area below a silt fence must be undisturbed or stabilised. Silt fences should also have a stable outlet or overflow point in case the flow rates exceed the fence's capacity to filter water. The individual diagrams give specific requirements for each type of silt fence construction (see below for more information).
- (d) Maintenance - Silt fences require regular maintenance. Trapped sediments should be removed, pickets straightened, filter cloth resecured and tightened, and blue metal replaced when heavily contaminated with silt.



* **Silt Fence Installation**

1. Dig a trench along the line of the intended fence. The trench is most effectively constructed using a ditch witch or similar machine. For preference, any length of fence should not exceed about 20 metres, and where a barrier is to be formed over any distance, the fence should consist of a series of overlapping fences, i.e.



The line of the fence should be slightly convex to the water flow and the ends turned up to create a stilling effect.

2. Lay out the silt fence fabric on the uphill side of the trench.
3. Drive 38mm square wooden pegs or star pickets along the downhill slope of the trench.
4. Stand the fence fabric against the posts and pull taut. Place bottom of silt fence fabric in the trench, backfill and compact. Ensure there is 150-200mm of the fabric in the trench at least.
5. Secure fabric to the fence using wire staples. If wooden posts are used, further support can be given to the fence by nailing a narrow wood strip through the fabric to the post.

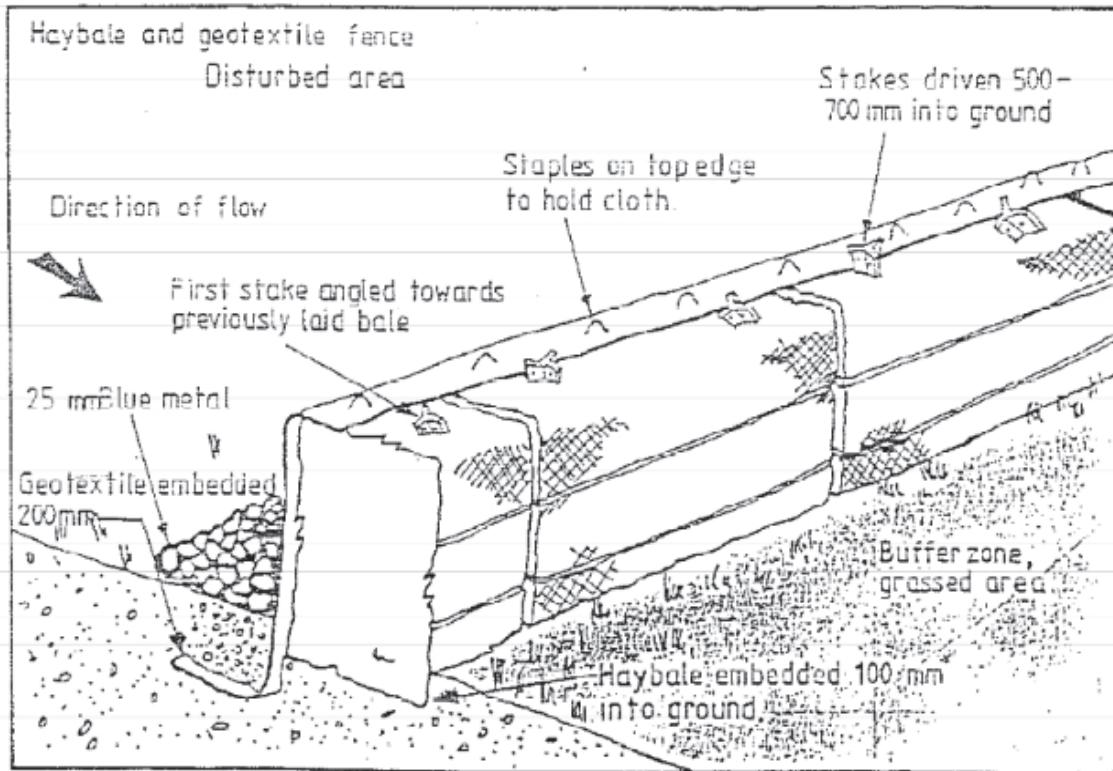
If it is not possible to dig a trench, the posts should be driven along the line of the fence and the bottom 150mm or so of the fabric laid on the ground of the upslope side of the fence after all vegetation has been removed and any uneven surfaces have been levelled.

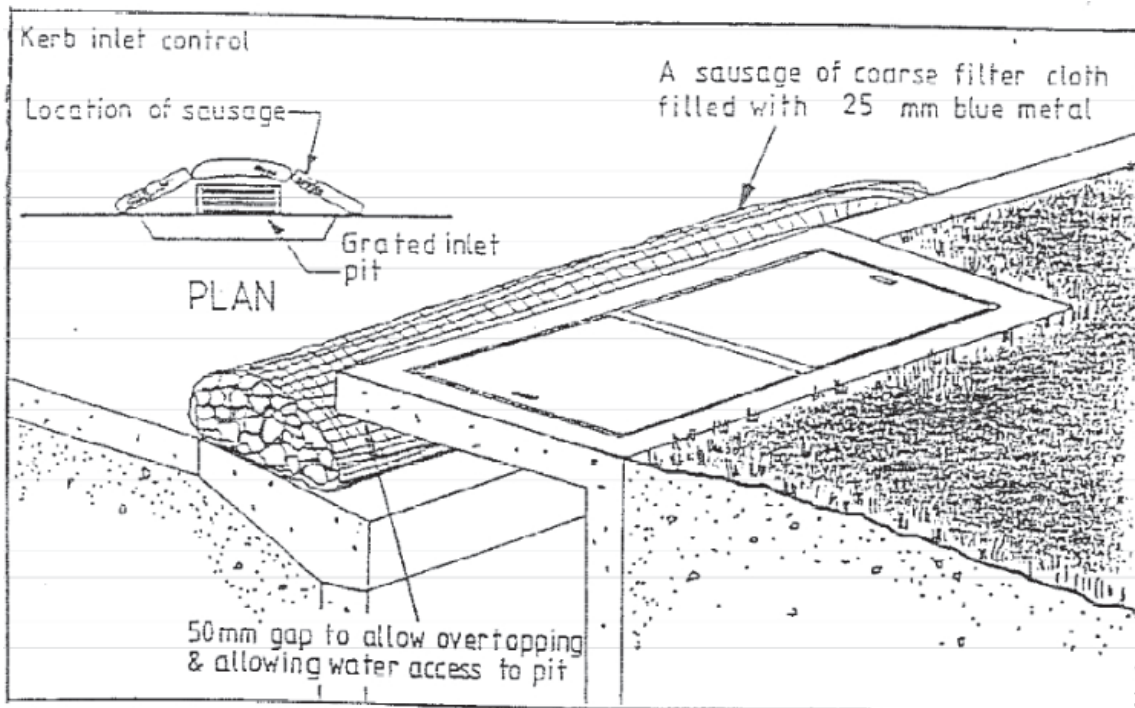
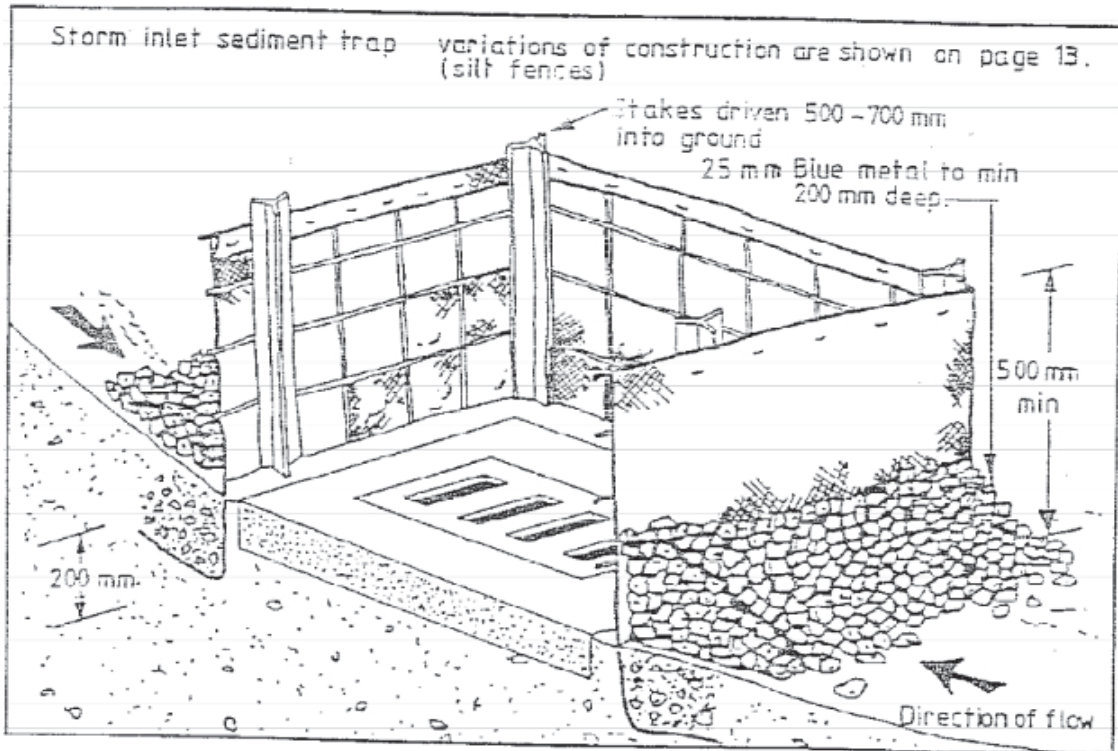
The tail should then be completely covered with blue metal at least 200mm deep. The use of blue metal with any silt fence system greatly improves the filtering capacity of the fence.

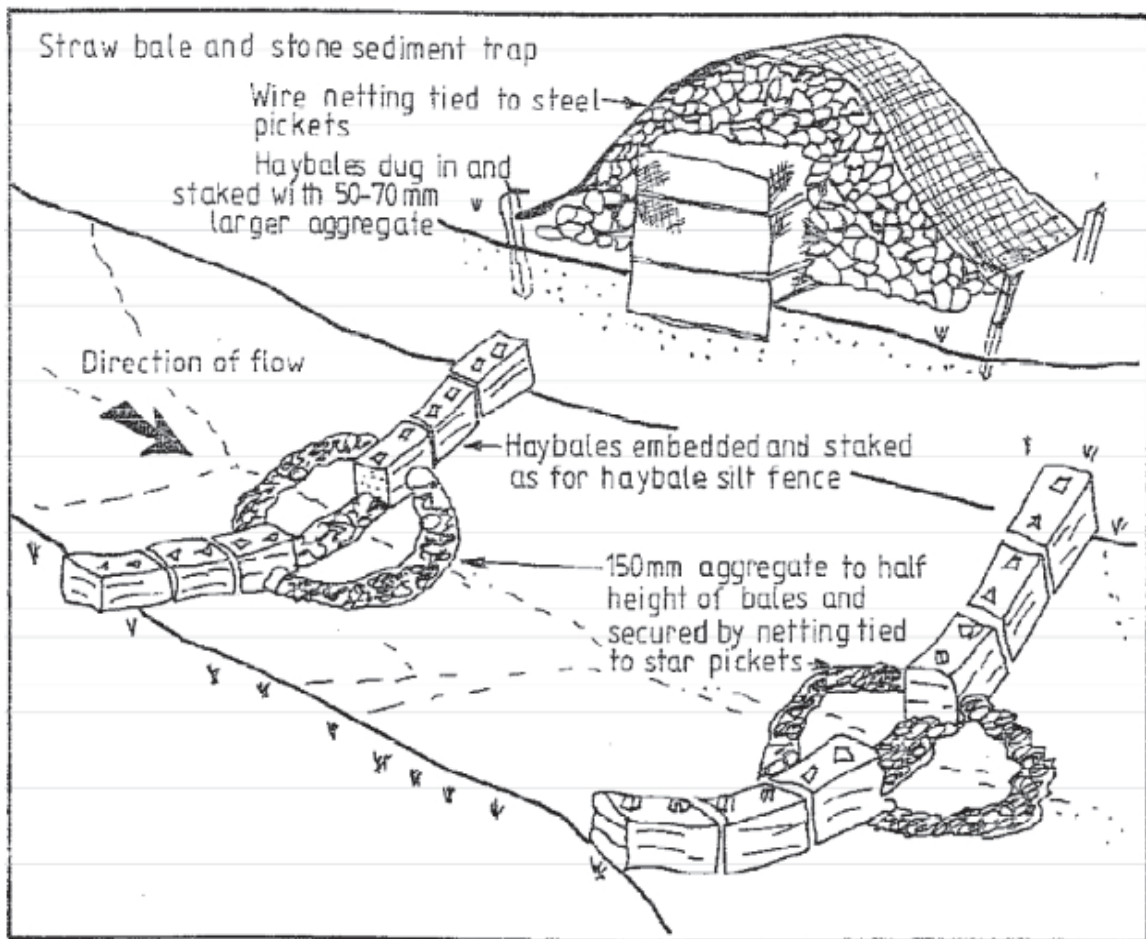
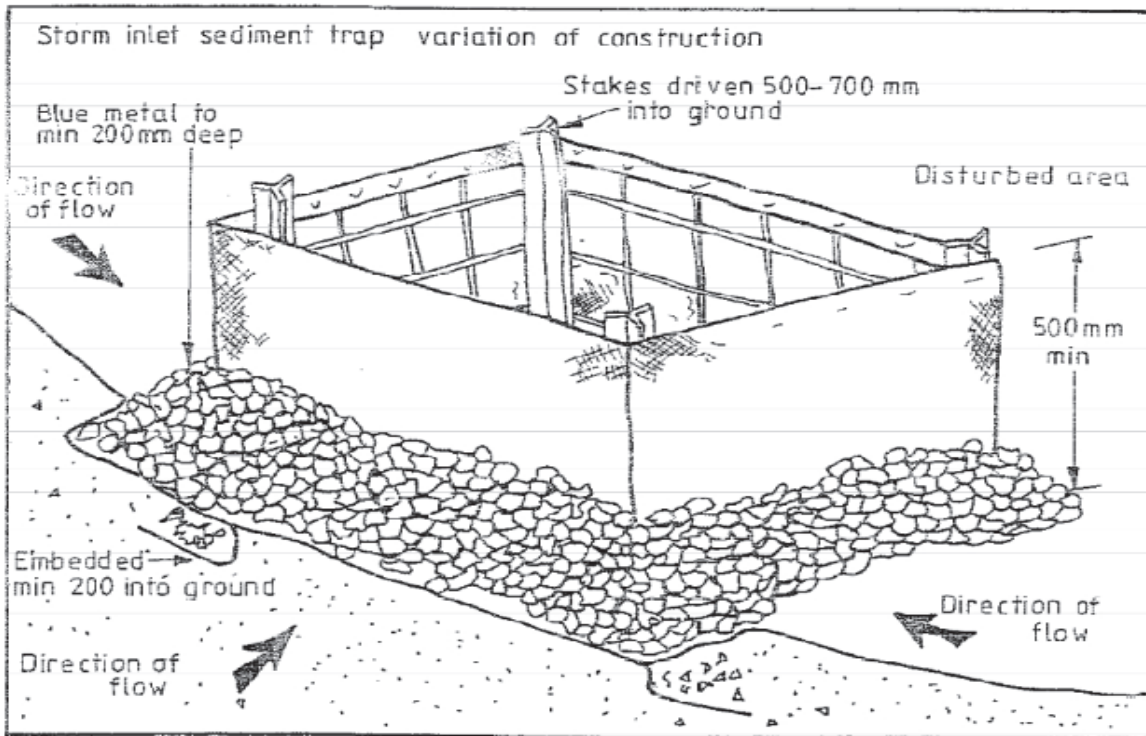
* **Sediment Traps for Minor Catchment Areas**

- (a) Description - These are temporary de-silting structures.
- (b) Usage - Such sediment traps are used at stormwater inlets and outlets, culvert entries and points where runoff from disturbed catchments such as construction sites is discharged.

- (c) General Requirements - Sediment traps are built from hay bales, washed gravel, abions or sandbags (or sarlon type materials) filled with blue metal. The choice of material or type of structure depends on the size of the drainage area, and the physical structure surrounding the sediment trap.
- (d) Maintenance - Sediment traps should be regularly maintained and restored to their original dimensions when the sediment has accumulated to half of the designed capacity. The outlet should be constructed and maintained to ensure erosion does not occur.



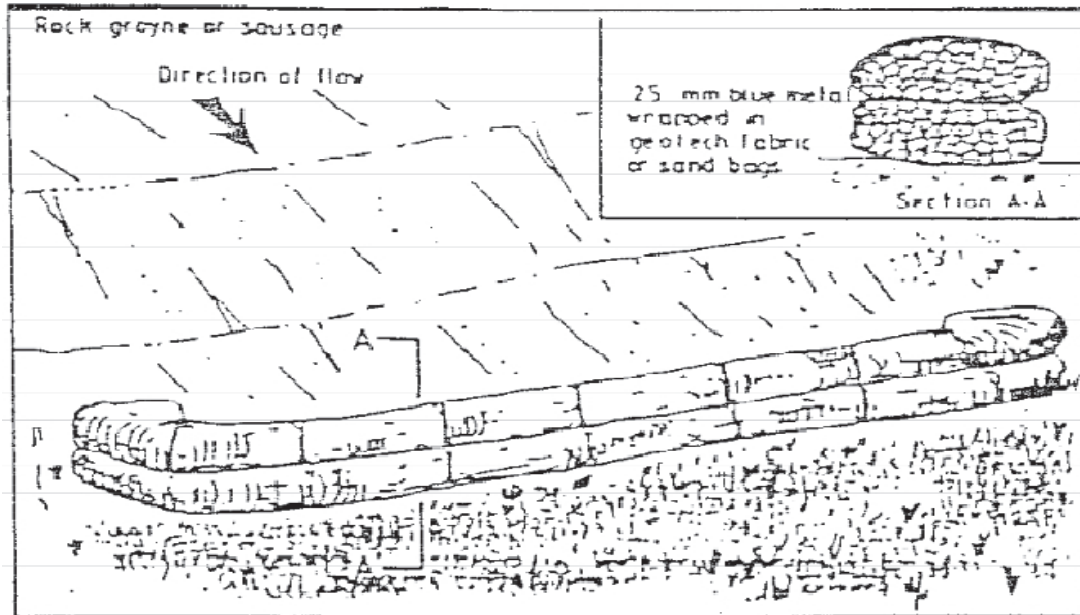




* **Rock/Blue Metal Groyne or 'Sausage'**

- (a) Description - The groyne comprises a sausage of shade cloth or other pervious fabric, some 200mm diameter, filled with 25mm blue metal and closed both ends.
- (b) Installation - The sausage is laid on the ground on the contour similar to a silt fence. Generally the sausage should be laid two high to obtain enough filter area.

The advantage of this type of sediment barrier, particularly on a building site, is its flexibility and ease of replacement following trenching or similar building/construction activity.



3.9.7 Sediment Traps (Sediment Ponds, Silt Traps, Sediment Control Structures - these are all synonymous)

- (a) Description - Sediment traps are sediment control devices that intercept sediment and runoff usually at the final discharge point. They are formed by excavation and/or by building embankments, and they must be kept empty and treated as a dry basin by the provision of a low flow filtered outlet (where levels permit) or they are pumped out.
- (b) Usage - Sediment basins are used when catchments are so large that other filtering devices cannot handle the anticipated runoff and sediment volume.
- (c) General Requirements - The volume of a sediment trap measured at the crest of the outlet should be 150 cubic metres per hectare of disturbed area or as determined by

The primary outlet may be a vertical pipe or box type riser joined to a pipe extending through the embankment and discharging below the base of the embankment. These outlets allow automatic dewatering through the perforations in the pipe riser which, however, must be filtered using fabric and blue metal of 25mm size. However, on flat land where the capacity of the trap is below ground level, it is necessary to dewater the trap by pumping (or syphoning if possible) after the water has been deflocculated.

A secondary or emergency spillway must be built to prevent overtopping of the structure. The sediment trap should be surrounded by man-proof fence.

- (d) Operation - Water levels in sediment traps should be kept as low as possible so they are always ready to run off from rainfall.

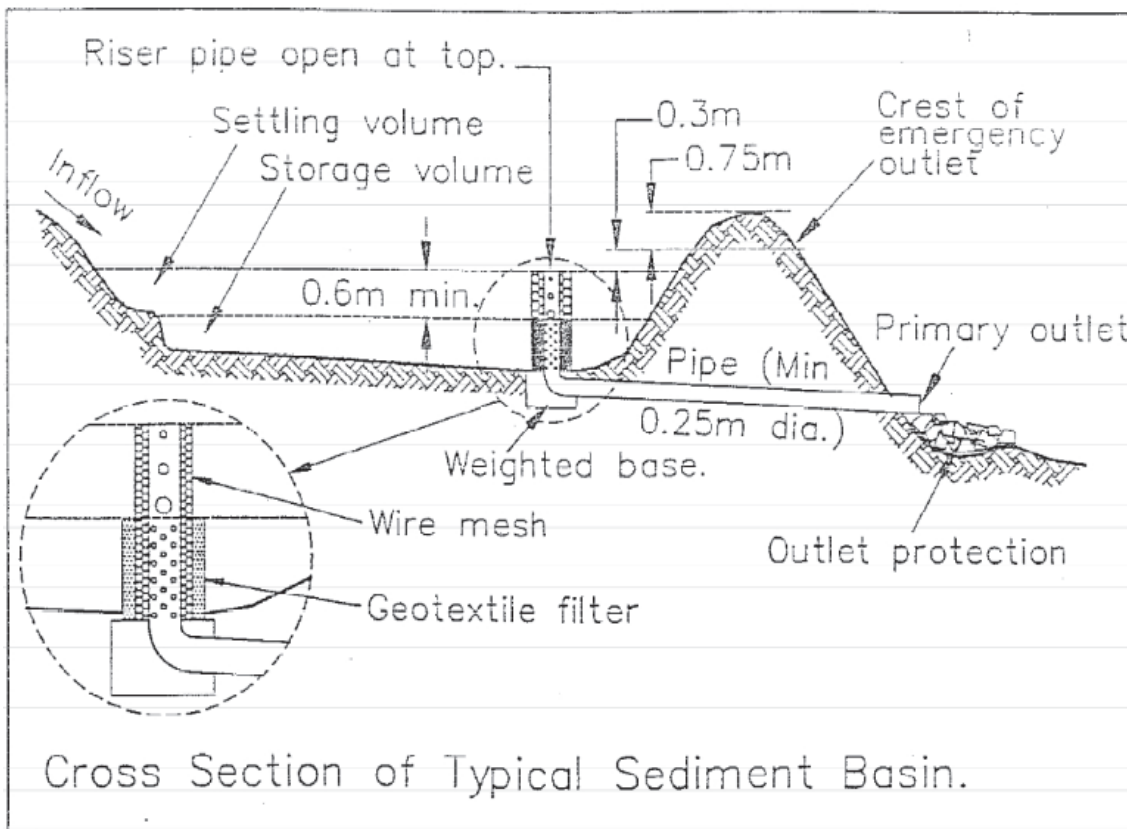
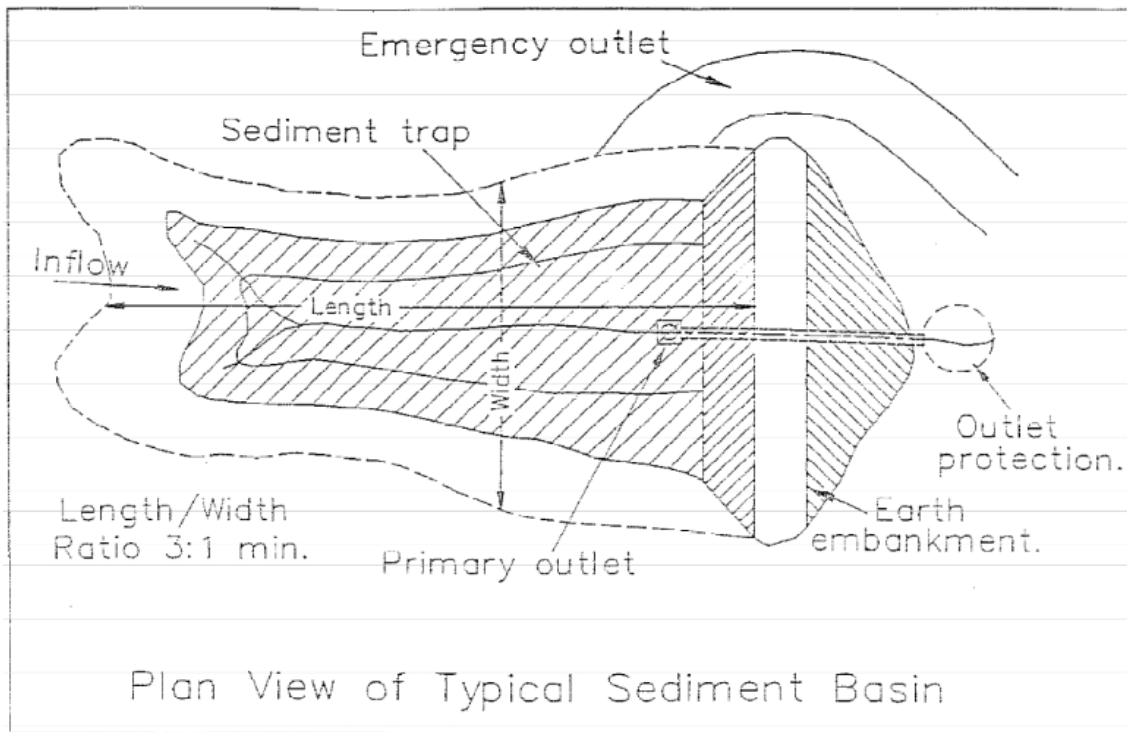
Silt traps must be discharged after each significant rainfall event or as directed by the Superintendent.

The invert level of the sediment trap outlet should be below or level to the invert of any pipe or drain system emptying in to the trap.

- (e) General Specifications - Batter slopes should have a maximum grade of 1:3, a minimum top width of 2.5 metres, and a freeboard of 1 metre, unless the spillway size exceeds design capacity.

However, should the trap be a 'wet basin' or unfenced, at least three sides should have batter grades of approximately 1:8.

- (f) Maintenance - Sediment basins should be inspected regularly, and scouring and damage to the inlet, outlet and spillway should be repaired and the vegetation on the embankment maintained. The basin shall be cleaned out (desilted) when the accumulated sediment has reduced the capacity to below 70%.



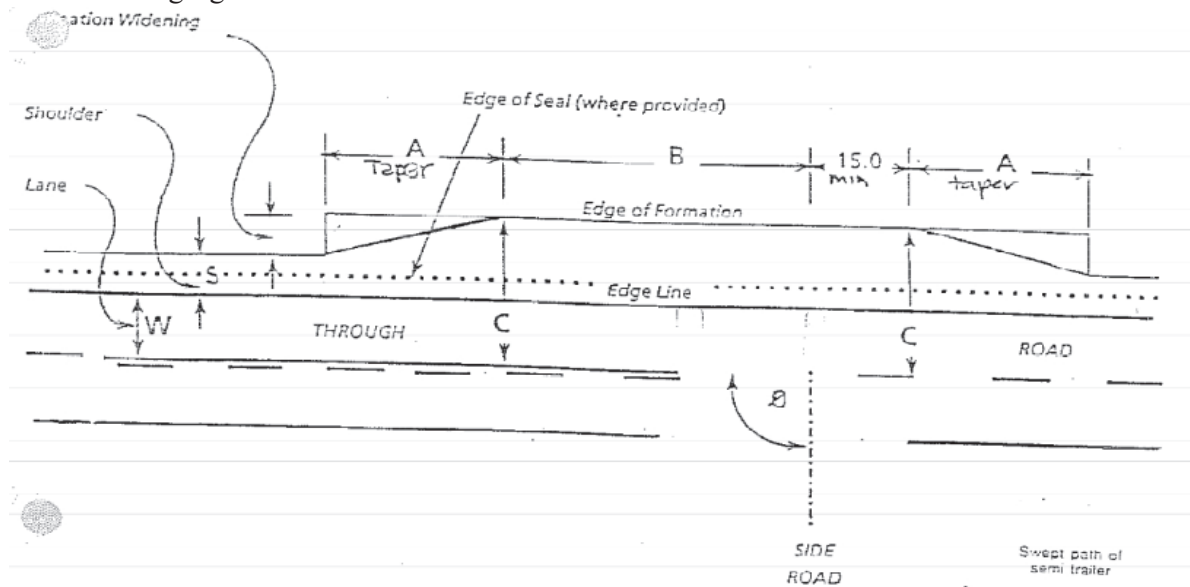
CESSNOCK CITY COUNCIL

RIGHT TURN TREATMENT FOR RIJRAL ROAD CONDITTONS
TO COMPLY WITH AUSTRROADS STANDARD TYPE A.

PREPAPED BY:- Road Safety Manager,
Cessnock City Council
Revised January 1993.

EASIC RIGHT TURN – MINIMUM TREATMENT

This is the minimum treatment for right turn movements from a through road to side roads and local access points. This treatment provides sufficient trafficable width for a heavy vehicle (17.5m long) to pass at a substantially reduced speed on the left of a stationary vehicle turning right.



Formation widening = C-W-S

$$A = \frac{0.5 \times \text{Speed (km/h)} \times \text{formation widening}}{3.6}$$

B - 28m @ 60kph

B - 39m @ 80kph

B - 42m @ 100kph

W - 3.0m (min) to 3.5m

S - 1.0m (min) to 3.0m (adjacent to barrier line)

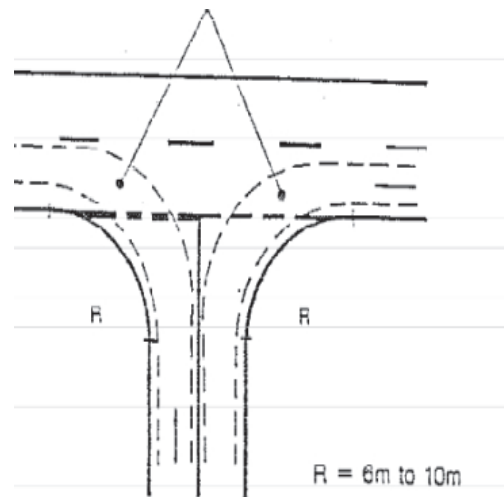
C - (min on straight) = 6.0m

C - (min on curve) = 2 x 3.0 lane + corresponding widening for curve radius

Ø- (min angle 70°)

Ø- (max angle 110°)

Should the through road be sealed, then the passing lane will be required to be sealed

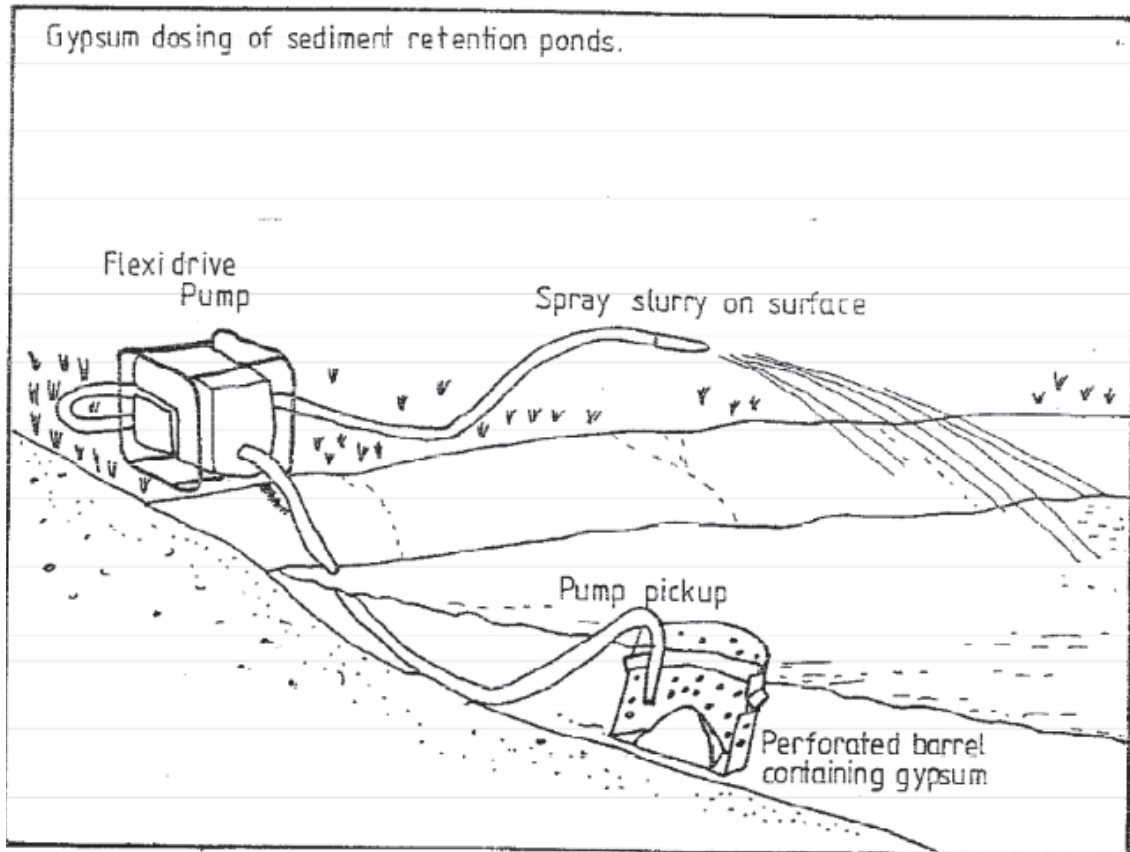


* Discharge of Water

Before discharge, the waters should be tested for suspended solids. A practical test adopted at this stage by Council to set a water standard for discharge is where it is possible to clearly see through to the other side of a bottled water sample. This is a very arbitrary test and initially it is necessary for the contractor/developer to have water sample standards approved by an officer of Council prior to any water discharge.

If the water does not meet the prescribed standards, it must be treated with gypsum to settle out suspended solids. In smaller capacity silt traps, the suspended solids in the impounded water can be settled out by broadcasting gypsum by hand over the entire water body surface. It is absolutely essential that the gypsum be broadcast evenly over the entire surface for this method to be successful.

The most effective treatment technique, particularly for larger structures, is to mix the gypsum into a slurry with water and then spray the slurry on the pond surface. Effective mixing is best achieved by continual movement of a flexidrive pump in the barrel of gypsum and water. To achieve the prescribed level of suspended solids within 24-36 hours, gypsum should be used at a rate no less than 32 kilograms per 100 cubic metres of water impounded. The water should be tested after this period in the method described, and if the standard is met, it may be discharged. If the water does not meet the standard, a longer settlement time may be required or the pond may need to be treated again.



3.9.8 Stabilised Entrances to Construction Sites

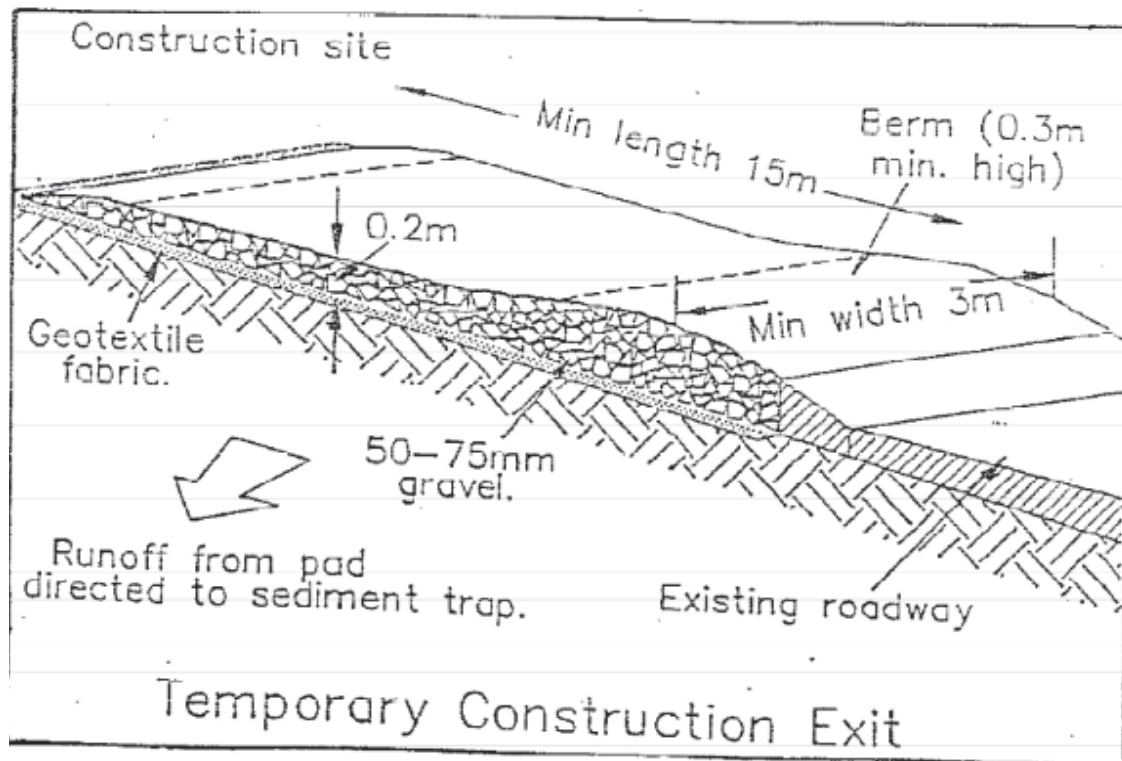
- (a) Description - A bed of aggregate on filter cloth or a cattle grid located at any point where traffic enters or leaves a construction site. Stabilised entrances reduce or eliminate tracking of sediments onto public rights of way or streets.
- (b) Usage - Stabilised construction entrances should be used at all points where Construction vehicles enter or leave sites and enter existing roadways.
- (c) Installation - Grade the entrance way so that it is at least 15 metres long with a minimum width of 3 metres for a one-way entrance and 6 metres for a two-way entrance.

Place a filter cloth over the entire area, and cover it with 150mm of 50mm aggregate, river gravel or a recycled or reclaimed concrete equivalent.

Surface water flowing to the entrance must be piped under the entrance, or a berm constructed to direct surface flow away from the road.

If a cattle grid is used, this should be so placed as to ensure the vehicles when crossing the grid have sufficient speed on to 'shake the mud' or other contaminants, such as gravel, from the vehicle. It must not be placed where the vehicle is slowing to enter a roadway.

The Contractor, under Section 16 of the Clean Waters Act, is liable for the deposition of any contaminants deposited on roadworks after leaving the construction site.



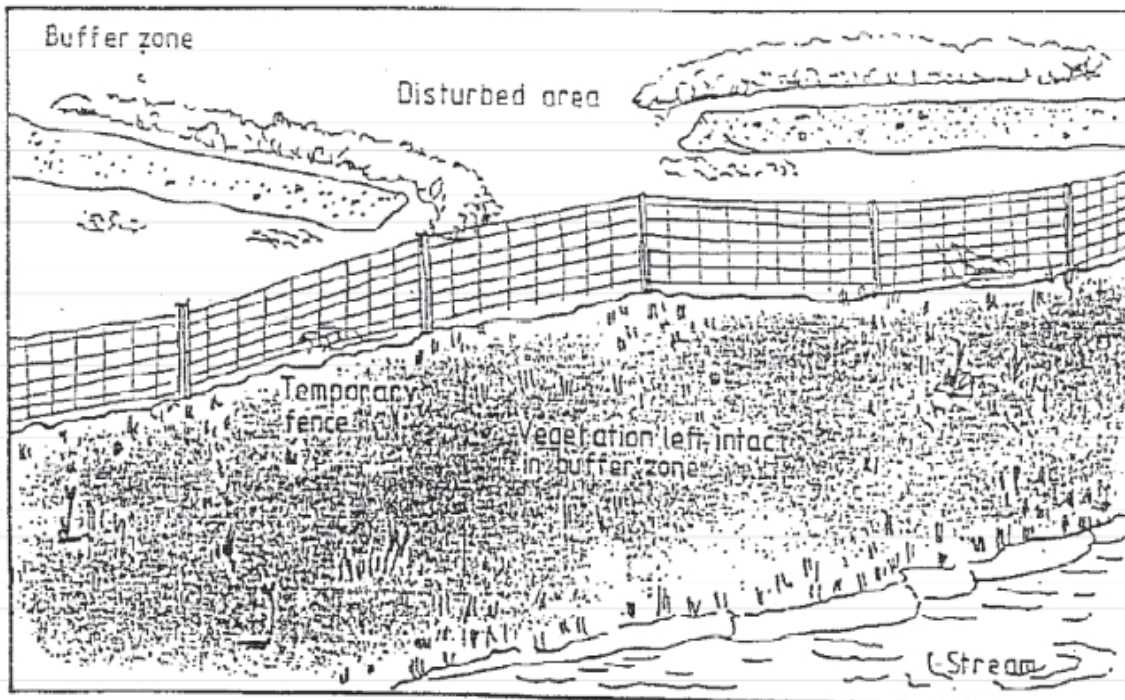
3.9.9 Buffer Zones

- (a) Description - Buffer zones are corridors of vegetation adjacent to waterways or disturbed areas. The vegetation filters suspended solids and reduces the nutrient levels in runoff. Wetlands, streams and rivers adjacent to construction sites should be protected by buffer zones.
- (b) Requirements - Buffer zone performance increases as catchment area and slope gradient decreases. Thirty metre wide buffer zones generally provide adequate protection.

Slope%	Buffer Length in Meters
2	15
4	20
6	30
8	40
10	50
12	60
14	70

Buffer zones can reduce the need for other erosion and sediment control measures. However, contaminated water in concentrated form will require treatment, both at its source point and final disposal.

- (c) Maintenance - A fence should be used to exclude traffic from buffer zones to prevent damage to the vegetation, particularly during any construction phase.



REFERENCES & ACKNOWLEDGEMENTS

- * CONSERVATION & LAND MANAGEMENT "URBAN EROSION & SEDIMENT CONTROL" HANDBOOK, 1992.

- * GOLDRICK, D.A. (1992) "UBAN DEVELOPMENT - AN INTEGRATED APPROACH FOR EFFECTIVE EROSION AND SEDIMENT CONTROL", PROCEEDINGS INAUGURAL I.M.E.A. (N.S.W. DIVISION) CONFERENCE, PENRITH, N.S.W., pp.57-64.

- * DEPARTMENT OF HOUSING "SOIL AND WATER MANAGEMENT FOR URBAN DEVELOPMENT", 1993.