ENVIRONMENTAL MANAGEMENT FOR ROADING CONTRACTORS

II. PROVISIONAL GUIDELINES FOR EROSION & SEDIMENT MANAGEMENT DURING ROAD WORKS

Transfund New Zealand Research Report No. 131

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MONTGOMERY WATSON NZ LTD

Transfund New Zealand Research Report No. 131

ISBN 0-478-11089-8
ISSN 1174-0574

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Montgomery Watson Ltd. 1999. Environmental management for roading contractors. II. Provisional guidelines for erosion and sediment management during road works. *Transfund New Zealand Research Report No. 131.* 34pp.

Keywords: construction, environment, erosion, guidelines, maintenance, management, New Zealand, roads, road works, sediment control, sedimentation, traffic, water quality

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EXECUTIVE SUMMARY

Introduction

A project, *Environmental Management for Roading Contractors*, was undertaken in 1997-98 to prepare two sets of provisional environmental guidelines for roading contractors carrying out road works in New Zealand.

Its objectives were to:

- provide specific and simple policies and guidelines about the environmental effects of road works, particularly those related to construction, and aimed for use by roading contractors;
- assist roading contractors to understand the environment within which they work, and
- improve the environmental image of roading contractors.

Structure of Project

The results of the project are presented as three reports:

I. Overview & Case Study: *Transfund New Zealand Research Report No. 130.*
II. Provisional Guidelines for Erosion & Sediment Management during Road Works: *Transfund New Zealand Research Report No. 131.*
III. Provisional Guidelines for Environmental Management during Road Works: *Transfund New Zealand Research Report No. 132.*

The first task of the project was to carry out a literature review of relevant guidelines, and undertake a case study with an associated environmental effects assessment. Transfund New Zealand Research Report No. 130, *I. Overview & Case Study,* describes the initial work used to develop the guidelines.

The guidelines, which form parts II and III of the project (Transfund New Zealand Research Reports 131 and 132), have been developed in order to minimise adverse effects of erosion and sediment run-off created by construction of roads and to improve environmental management by roading contractors. They are to help contractors achieve a favourable environmental outcome and also to help promote compliance with the Resource Management Act 1991 (RMA).

In this report, *II. Provisional Guidelines for Erosion and Sediment Management during Road Works,* some practical erosion prevention and sediment control measures are outlined. Such measures should be considered for each roading project on a case by case basis.

Undesirable environmental effects may include: visual effects, destruction of habitats, and pollutants. These effects, if they occur, may result in additional costs for clean-up and litigation.

Legal requirements under the RMA and other Acts are discussed, and sources for advice are suggested. Use of the guidelines is explained, and a checklist provides the steps to follow in order to manage and avoid erosion and sedimentation.

Erosion management methods that are described include:
earth bunds, contour drains, run-off diversion channels, check dams, cutoffs, slope stabilisation by topsoiling, stabilising steep batters, re-vegetation, mulching, and by use of geotextiles and soil binders.

Sediment management methods described include:
grass-filter strips, silt fences, hay-bale barriers, sediment traps and retention ponds, stormwater inlet protection, rock and geotextile sediment traps.

ABSTRACT

A project, *Environmental Management for Roading Contractors*, was undertaken in 1997-98 to prepare two sets of provisional environmental guidelines for roading contractors carrying out road works in New Zealand.

Objectives of the project were to:

- provide specific and simple policies and guidelines about the environmental effects of road works, particularly those related to construction, and aimed for use by roading contractors;
- assist roading contractors to understand the environment within which they work, and
- improve the environmental image of roading contractors.

The results of the project are presented as three reports:

I. Overview & Case Study: *Transfund New Zealand Research Report No. 130.*
II. Provisional Guidelines for Erosion & Sediment Management during Road Works: *Transfund New Zealand Research Report No. 131.*
III. Provisional Guidelines for Environmental Management during Road Works: *Transfund New Zealand Research Report No. 132.*

Part I is an overview of the project, and a case study with associated environmental effects assessment used to develop the guidelines. The guidelines which form this part II, and part III, of the project have been developed in order to minimise the adverse effects of road works associated with erosion and sediment run-off caused by construction of roads. They are also to help improve environmental management, and promote compliance with the Resource Management Act 1991, by roading contractors.

1. INTRODUCTION

1.1 Purpose of Guidelines

This project was undertaken in 1997-98 to prepare two sets of provisional guidelines for roading contractors - one for managing any erosion and sediment movement that may occur during road works, and the other for environmental management during road works. The guidelines aim to provide clear sets of principles and methods to ensure that the environmental effects of road works on the surrounding environment can be minimised by roading contractors. They are intended to be used primarily by roading contractors.

The results of the project are presented as three reports:

I. Overview & Case Study: *Transfund New Zealand Research Report No. 130.*

II. Provisional Guidelines for Erosion & Sediment Management during Road Works: *Transfund New Zealand Research Report No. 131.*

III. Provisional Guidelines for Environmental Management during Road Works: *Transfund New Zealand Research Report No. 132.*

The first task of the project was to carry out a literature review of relevant guidelines, and undertake a case study which identified associated environmental effects. The project included input from users and regulatory authorities. The first report, *I. Overview & Case Study,* describes the initial work used to develop the guidelines.

These guidelines have initially been produced as provisional to provide the opportunity for refinement following their trial use by roading contractors. They are not substitutes for resource consents or for any additional conditions or rules used by regulatory authorities. Instead, they are a practical tool to alert contractors of the legal context in which they are working and of the potential for adverse environmental effects arising from their activities. The provisional guidelines also identify ways to avoid, remedy and mitigate potential adverse effects.

Transfund New Zealand is committed to minimising the adverse effects of the road infrastructure on the environment. Part of this commitment included developing these guidelines to inform roading contractors of their responsibilities under the Resource Management Act 1991 (RMA), thereby avoiding costly measures to clean up any adverse effects, and also the costs of possible litigation.

The guidelines are to help roading contractors to protect soils, waterbodies (such as rivers, lakes, water races, drains and wetlands) and associated ecosystems, thereby minimising adverse effects on the environment.

By following the guidelines, contractors should achieve a favourable environmental outcome and adverse effects of sediment run-off during road construction and maintenance will be minimised, and compliance with the RMA will be promoted.

Possible litigation and costly clean-up measures can also be avoided.

To prevent erosion of soil and to keep sediment on site with appropriate control methods, some practical erosion prevention and sediment control methods are outlined in these guidelines. The actual methods used during road works however should be considered on a case by case basis.

1.2 The Environment and Roading

The environment includes vegetation, soil, water, air, landforms, people and communities; natural and physical resources, scientific and scenic values. Care is needed to ensure that the environment is managed and sustained for future generations.

A significant source of sediment run-off which enters and is deposited in waterbodies (called sedimentation) is from eroding access tracks and soil disturbed during road works. Sedimentation and erosion often remain after works have finished, especially where roadside drains have not been stabilised or adjacent areas not re-vegetated.

Road works which can cause erosion and sedimentation include:

- Earthworks in or near waterbodies, including shorelines;
- Vegetation clearance near waterbodies;
- Dumping of fill and spoil.

Undesirable environmental effects are:

- **Visual effects** where sediment run-off may discolour water. People are very aware of the importance of clean water, and often complain if works activities are visibly contaminating a water body.
- **Physical effects** such as smothering, reduction of light penetration, scouring and abrasion cause adverse living conditions for water animals and plants, which have to struggle to survive. Fish breeding can be affected.
- **Pollutants** can attach to sediment particles and be carried into waterbodies, resulting in contamination.

Such works-related environmental impacts can cause other undesirable effects:

- **Additional costs** for roading contractors as a result of extra work, blocked drains, mud on roads, site clean-up, and more downtime.
- **Litigation** under the RMA in cases of serious negligence, especially with non-compliance of resource consent conditions.

1.3 Legal Requirements

1.3.1 Resource Management Act 1991

The legislation that is most relevant to roading contractors carrying out road works is the RMA. Its purpose is to promote sustainable management. This includes protecting the environment, especially air, water, soil, and ecosystems.

The RMA seeks to control activities, such as road construction, and their environmental effects by means of regional and district plans. These plans contain rules about how to carry out activities, and also state which activities require resource consents.

1.3.2 Resource Consents under the RMA

Various consents may be required by some regulatory authorities for road construction and maintenance, including:

- building a new road;
- doing earthworks;
- road works adjoining the coast;
- placement of spoil or clean fill;
- crossing streams and rivers or taking water from them;
- sediment dams and diversions;
- dust from areas of large scale excavations;
- chemical spraying;
- pavement burning;
- gravel extraction;
- abrasive blasting to remove road markings.

Activities requiring resource consents need to be identified before work commences. Contractors may also have to obtain some resource consents for associated activities (e.g. spoil disposal sites).

As contractors are often required to operate within the conditions of the consents already obtained for their activity, they therefore need to take responsibility for familiarising themselves with the consents.

Compliance with these Transfund New Zealand guidelines does not constitute consent under the RMA.

If in doubt, talk to your local council.

1.3.3 Liability of Roading Contractors for Environmental Damage

If the RMA is not followed, and rules in district and regional plans are broken, the people responsible (including workers and their managers) in cases of serious harm to the environment can incur fines up to $200,000 and/or be imprisoned for up to 2 years.

Councils can also serve abatement notices and enforcement orders requiring the activity to be stopped and improvements to be made before carrying on. This also has cost implications.

Therefore read and understand the resource consents for your project, to avoid liability. Find out what the conditions are. Discuss these with the council and other affected parties.

In addition, contractors are recommended to develop their own standard operating procedures based around or in addition to the *Provisional Guidelines for Environmental Management during Road Works* contained in part III of this project. Using the guidelines in this way may help to reduce liability if difficulties are encountered in complying with the RMA.

1.4 Regulatory Authorities Responsible for Administering the RMA

Three types of councils work within the framework of the RMA: Regional Councils, District (and City) Councils, and Unitary Authorities.

- **Regional Councils** are responsible for the formation of regional policy statements and plans (including rules) and for the management of water, soil (including soil conservation), geothermal resources, pollution control, natural hazard mitigation and hazardous substances (with district councils) and coastal management (together with the Minister of Conservation).

- **District and City Councils** are responsible for the formation of district plans (including rules) and for the management of land use (including subdivision). They complement the role of regional councils on some issues such as natural hazard mitigation and management of hazardous substances.

- **Unitary Authorities** perform the functions of both regional and district councils.

These Councils' functions are outlined in Table 1.1, as they relate to roads and to the types of consents required for constructing roads. These functions should be identified by contractors before work commences.

Table 1.1 Functions of regulatory authorities concerning road works.

Regulatory Authority	Functions	Examples of Roading Consents Required
District /City Council	• Control effects of land use and land subdivision • Control and mitigate noise and its effects • Control effects of activities on surfaces of rivers and lakes	• New development of a road • Machinery noise near urban settlements • Activities adjoining lakes or rivers
Regional Council	• Control use of land for soil conservation, maintenance and enhancement of water quality and quantity, avoidance and mitigation of natural hazards, management of hazardous substances • Control, in coastal marine areas, use of land resources, water, discharges of contaminants, hazardous substances, noise and activities on the water surface • Control use, retention and diversion of water • Control discharges of contaminants into or onto land, air or water • Control introduction of plants to waterbodies	• Stormwater discharge • Culverts, bridges, and other structures in waterbodies • Removal of vegetation • Earthworks and land disturbance • Spoil disposal • Works in beds or banks of lakes or rivers • Taking water • Damming water • Discharge of water to surface water & to groundwater • Works adjacent to coast

1.5 Sources of Further Advice

1.5.1 Councils

Your first point of contact for advice will probably be your local regional or district council.

Telephone and ask the receptionist to put you through to the relevant person, e.g. the person who deals with disturbance to streams by earthworks. Council staff are there to help. They prefer to be asked for advice openly about practices that may potentially have adverse environmental effects.

Identifying, at the initial stages of the project, the environmental issues and the methods to avoid adverse environmental effects, ensures compliance with the RMA and saves time and money.

Councils can also help you identify the people and organisations that you need to discuss the proposal with.

Some councils identify, on plans, sites of special sensitivity, such as significant wetlands, native vegetation, outstanding natural features and landscapes, provision of public access, etc.

Make sure you understand any resource consent conditions. Council staff welcome enquiries as it is easier and cheaper for everyone concerned to prevent problems occurring, rather than trying to fix them up later.

1.5.2 Department of Conservation (DOC)

DOC staff have detailed knowledge of local conservation values and, for example, of areas that contain rare plants and wildlife. If you have any doubts about the values of certain streams, they can advise you of the streams that should be avoided at certain times of the year, and how to carry out works in and near waterbodies in an environmentally sound way.

DOC consent is required for any activities on DOC land (e.g. reserves). It has powers under the Conservation Act 1987, which has the purpose of promoting the conservation of natural and historic resources.

DOC has responsibilities, also under the Conservation Act 1987 for fresh-water fisheries. The discharge of contaminants into fresh water may be an offence under the RMA or Conservation Act. Substantial fines can be levied for discharging or casting any material into fresh water that will adversely affect fish or fish habitats.

If in doubt, call your local DOC office. As with Councils, DOC staff appreciate being questioned in advance, and can give you appropriate advice.

1.5.3 Fish and Game Council

Another good source of advice are local Fish and Game Council officers. They also have knowledge of local conservation values, specifically about streams and special fish areas as their interests are protecting fish and game for anglers and hunters. They are very approachable, and can often give advice over the telephone.

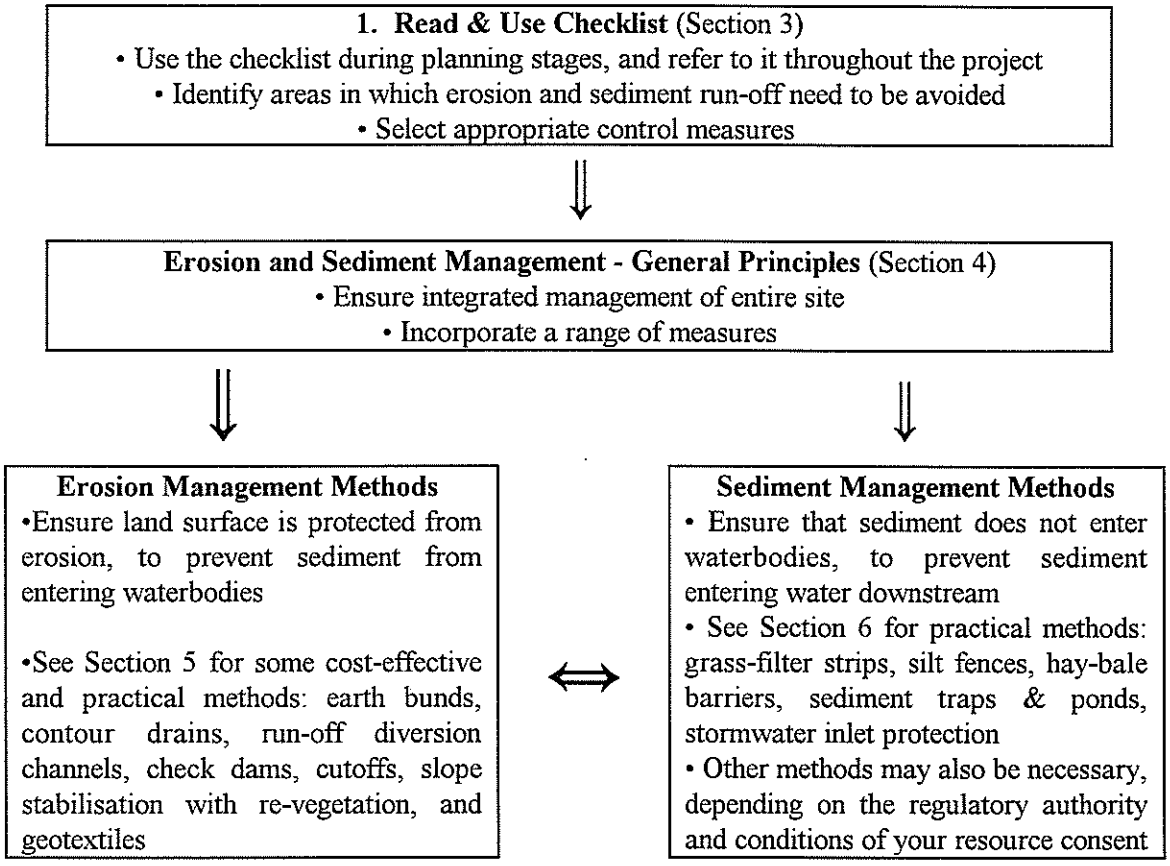
For example, if obstructions, like culverts, have to be constructed in waterbodies, consult with Fish & Game Councils.

1.5.4 Other Contacts

Landowners and the local iwi should be contacted and informed of the proposed road works as part of the procedures. They can or will often provide useful information and advice, especially about local conditions. The regulatory authorities can assist you in establishing contact with these people.

2. HOW TO USE THESE GUIDELINES

These guidelines provide some simple and practical ideas and methods to prevent erosion and to manage sedimentation created during construction and maintenance of roads.

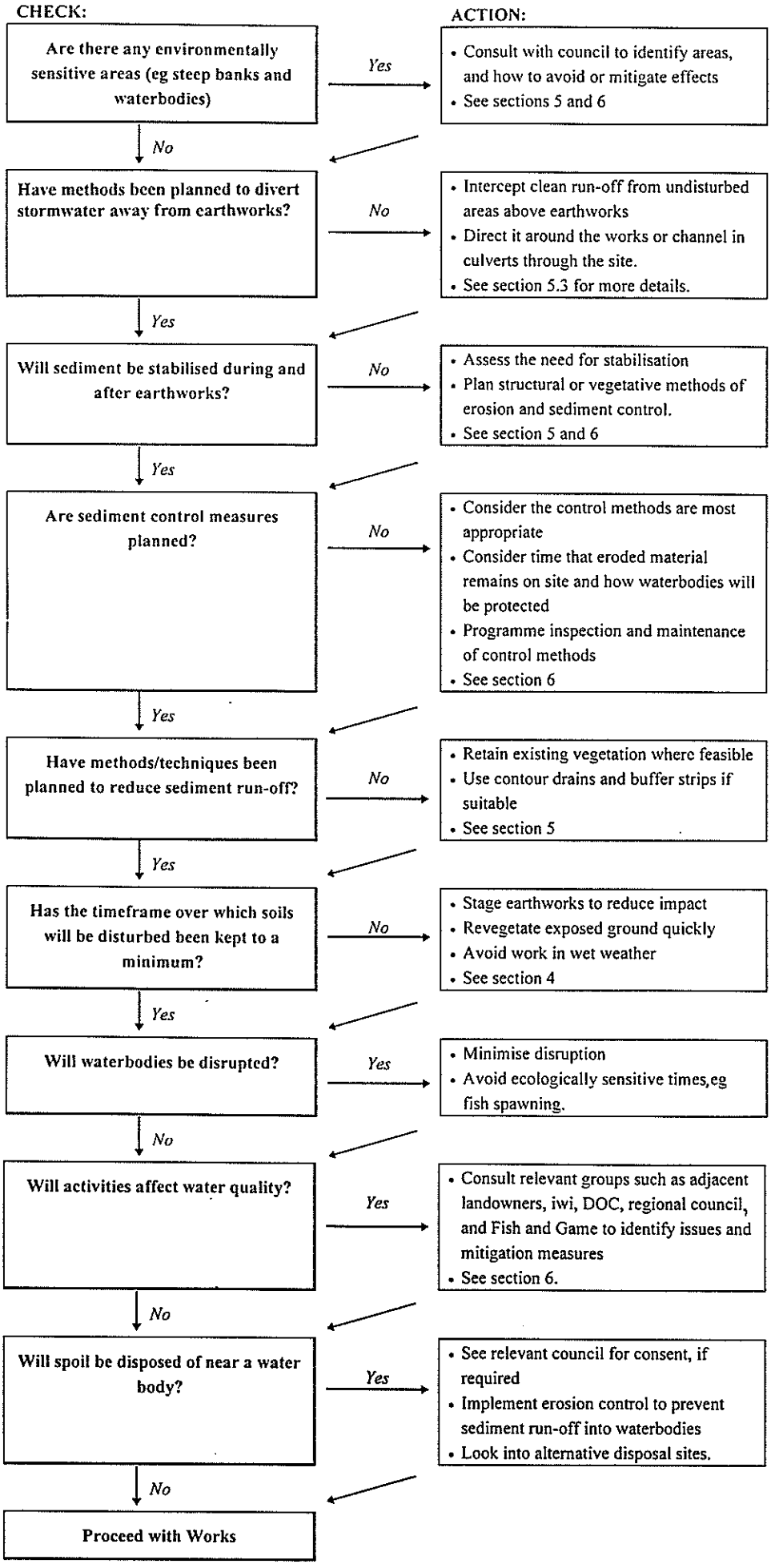


3. SEDIMENT MANAGEMENT CHECKLIST

The roading contractors are responsible for managing the effects of road construction and maintenance activities, such as earthworks, track work, water table formation, dumping of fill, waterway crossings, and earthworks near waterbodies. Different types of earthworks have different erosion problems.

- Use the checklist as a reminder of the main issues that need to be considered.
- Using the checklist is important on every job so if, or when, something goes wrong, the contractor can show that reasonable steps had been taken to avoid, remedy, or mitigate adverse effects.
- Bear in mind the site conditions and the type of operation to be undertaken.
- **If you think there may be a problem, talk to your council.**

SEDIMENT MANAGEMENT CHECKLIST:



4. EROSION AND SEDIMENT MANAGEMENT - GENERAL PRINCIPLES

The key to preventing sedimentation is to prevent erosion

4.1 Plan Carefully

Plan the project carefully, before work starts.

- The success of erosion and sediment management depends on careful planning before work starts.
- Avoid erosion-prone areas or take actions to avoid sediment run-off.
- Have contingency plans in place for the whole site, e.g. extra bunding to cope with unexpected large rainstorms.
- Check with the relevant council, DOC, and others, before a project begins, to discuss the planned works and identify any needs for sediment control.

  Talking helps during the planning and preparation stages of the project, promotes compliance with the RMA, and saves time and money later.

4.2 Stage the Works

- Depending on the scale of works, stage the project in sequential chunks, to minimise extent and duration of exposure of bare soil during construction.
- Stabilise each disturbed area quickly.
- Re-vegetate as each stage is completed (see Section 5 in this report for methods).

4.3 Time the Works

- Avoid earthworks involving earth disturbance in wet weather, when run-off of water can erode soil and wash it into waterbodies (i.e. cause sedimentation).
- Check the daily weather forecast.
- Avoid earthworks in wet seasons. Some councils have a set season within which earthworks are to be carried out.
- Check with council staff, DOC, and others, which streams have particular fish or other conservation values, e.g. during spawning.
- Check with councils for sites of special sensitivity such as significant wetlands, significant vegetation, outstanding natural features and landscapes, public access provision, etc.

4.4 Avoid Environmentally Sensitive Locations

- Avoid earthworks in sensitive site conditions, e.g. swampy areas, very steep and unstable slopes, proximity to waterbodies.
- In unstable areas, implement erosion control practices on site before erosion and sediment run-off occurs.
- When working near a stream or other water body, place fill and spoil so that it will not enter a waterway.

4.5 Stabilise Disturbed Areas Quickly

- Stabilise disturbed areas as soon as possible once earthworks are completed.
- Direct water away from exposed soil, and dissipate run-off.
- Use both structural (e.g. run-off diversion channels) and re-vegetation methods.

4.6 Reduce Run-off onto Site

- Direct clean overland flow from above-site safely away from earthworks (e.g. with diversion channels or with culverts through the site).
- Do this to avoid erosion of exposed soils and contamination of nearby waterbodies, especially important when dealing with larger sites, sites near waterbodies and for protecting stored spoil.

4.7 Control Run-off from Site

- Establish a control system for run-off as soon as possible, in the initial stage, to minimise sediment-laden stormwater discharging directly into waterbodies.
- As some erosion is unavoidable, trap sediment on site (see Section 6 in this report for some control measures).
- Stabilise all road and track surfaces, e.g. by maintaining a hard surface of compact gravel.
- Stabilise roadside drains preferably with crushed rock.

4.8 Control Run-off Velocities from Site

- Establish protection measures, short slopes and low gradients to keep run-off from the site at low velocities, and therefore reduce erosion.

4.9 Inspect and Maintain Control Measures

- Maintain and inspect control measures regularly, and after heavy rainfall.
- Some control measures cause more harm than they prevent if they are not properly maintained.

4.10 Retain Vegetation and Buffer Strips by Waterbodies

- Retain vegetated buffer strips (riparian vegetation) beside waterbodies, wetlands and lakes, between earthworks and the waterbody.
- Vegetation filters sediment from overland flow and keeps machinery clear of ecologically sensitive areas.

4.11 Design Good Structures for Stream Crossings

- Design structures to cross streams at right angles. Bridges are preferred to culverts, which are preferred to fords.
- Keep machinery out of running water.
- Try to leave the banks and bottoms of streams undisturbed.
- Observe the legal requirement to provide for fish passage through any structure placed in a stream. Liaise with DOC and/or Fish & Game Council.
- Obtain the necessary resource consents.

4.12 Monitor the Works

- Monitor the outcome you are achieving to ensure that it complies with Resource Consent conditions.
- Walk around the site, looking for signs of erosion, sediment run-off and, in particular, visual evidence of sediment entering water.
- Take immediate action to stop a problem as soon as it is spotted.

5. EROSION MANAGEMENT METHODS

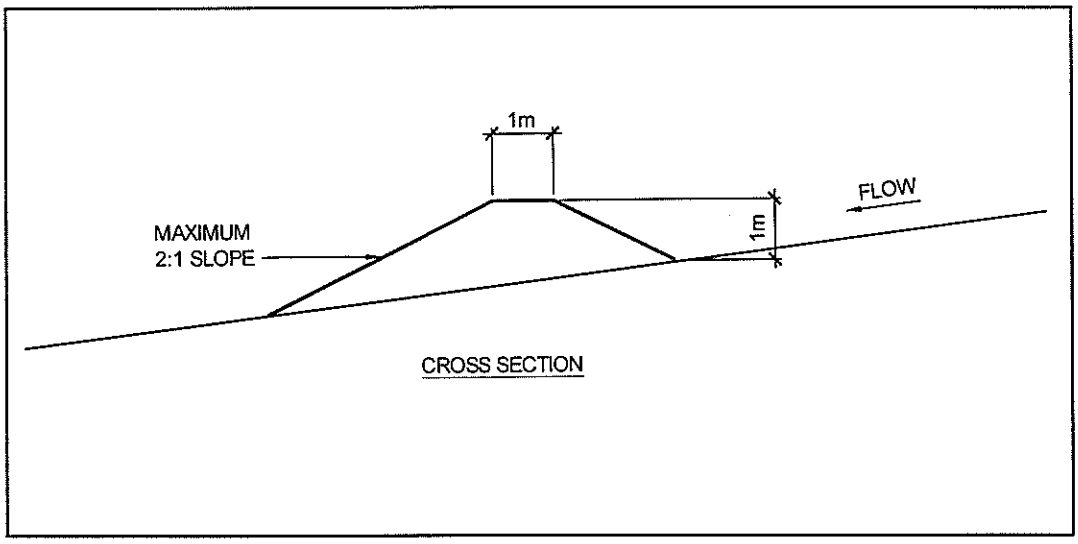
Preferably avoid erosion, so that there will be little erosion and subsequent sedimentation to manage. Some basic erosion management methods are described in this Section 5.

5.1 Earth Bunds

Earth bunds are temporary dam-like embankments used to direct run-off and keep sediment-laden water on-site

- Bunds are particularly useful to control run-off just after topsoiling and grass seeding.
- They are a temporary measure to keep sediment-laden waters on site.
- Build bunds near the boundary of the site, or across the slope to divert sediment-laden water to sediment traps.
- They have a purpose similar to diversion channels, but are of more use where subsoils are more erosion-prone or where surplus earthworks material is available to build the bund.
- Site bunds carefully, to avoid erosion when the water builds up.
- Provide a stable outfall, such as sediment retention ponds or stormwater inlet protection measures.
- Clear sediment that builds up after rains or during prolonged storms.
- Bunds can be removed later (e.g. spread between a footpath and road), or left in place (especially on sloping areas near waterbodies) provided they are vegetated.

Figure 5.1 Earth bund.



5.2 Contour Drains

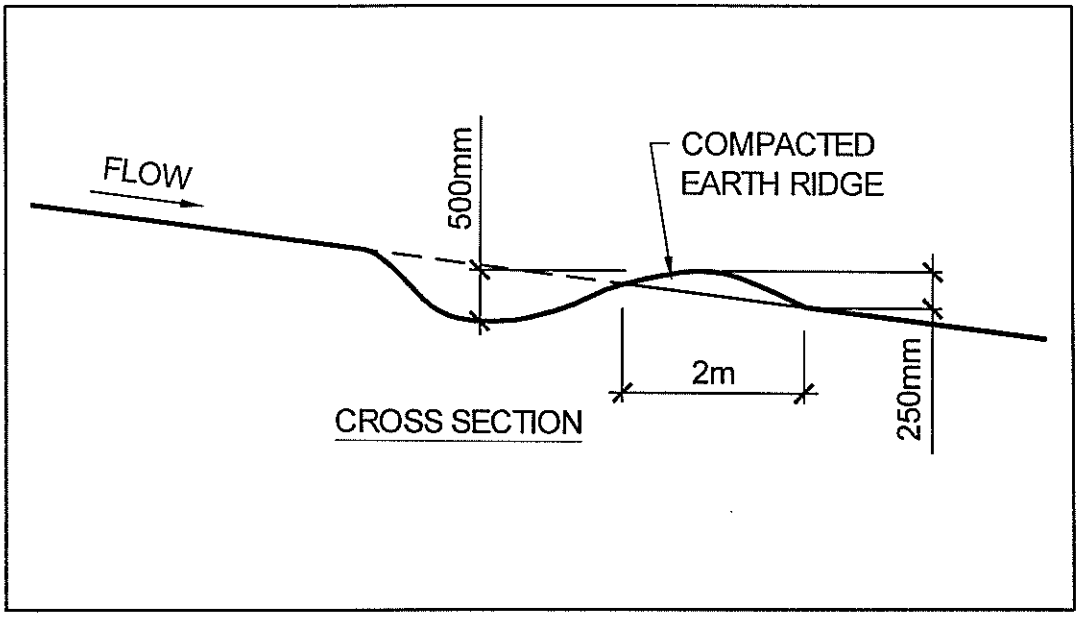
Contour drains stop, or at least reduce, surface erosion by diverting water run-off to diversion channels spaced over the road works site.

- Generally contour drains are used on large areas of soil disturbance, particularly for temporary erosion protection, e.g. at night, weekends or when rain is coming.
- For temporary erosion drains, a grader cut to a depth of 300 mm is sufficient.
- They are commonly used on long, narrow sloping areas to control run-off by diverting it to run parallel to the slope.
- They are constructed to a grade of no more than 1 to 100.
- They should be as short as possible, built on slight grades and flow to diversion channels or sediment ponds.
- They should be spaced as follows:

Slope of site	Spacing of contour drain (m)
1:20	50
1:10	40
1:6.6	30

- The spacing of the drains will also be dependant on expected rainfall, state of the area, soil type(s), etc.
- For best results, a contour drain will be 500 mm deep (including the compacted earth ridge adjacent and downslope of the excavated drain).

Figure 5.2 Contour drain.

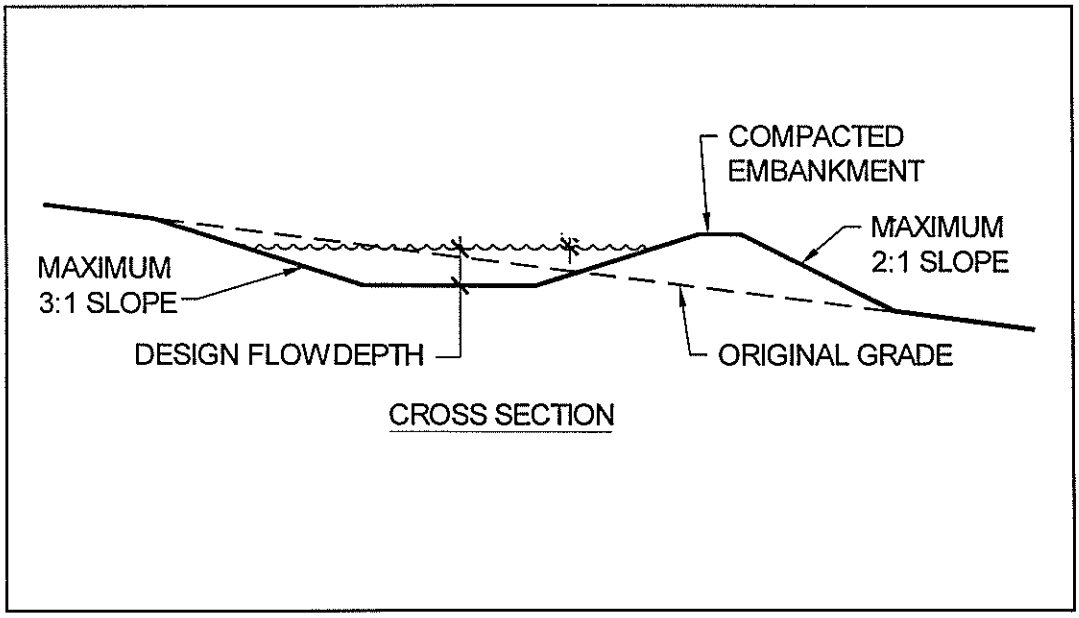


5.3 Run-off Diversion Channels

Run-off diversion channels divert run-off to sediment traps or intercept clean run-off above the works site and divert it around the works area.

- A diversion channel is one of the easiest and cheapest methods for preventing erosion and sediment run-off.
- Use these channels where the areas of disturbance are greater than 5000 m^2 (0.5 ha).
- They are designed to carry the flow from a five-year storm.
- The channel floor width should be 1 m, and depth approximately 400 mm (to drain an area up to 1 ha).
- Excavated material is compacted adjacent to and downslope of the channel, to act as an earth bund.
- Diversion channels can be temporary or permanent.
- An erosion-proof outfall must be constructed, as diversion channels concentrate water flow and increase erosion potential.
- Channels should be constructed on a slope of no more than 1 to 100.
- If run-off contains sediment, then flows should drain into a sediment retention pond.
- Diversions should be checked after every rainfall and during long storms, and cleaned when needed.

Figure 5.3 Run-off diversion channel.

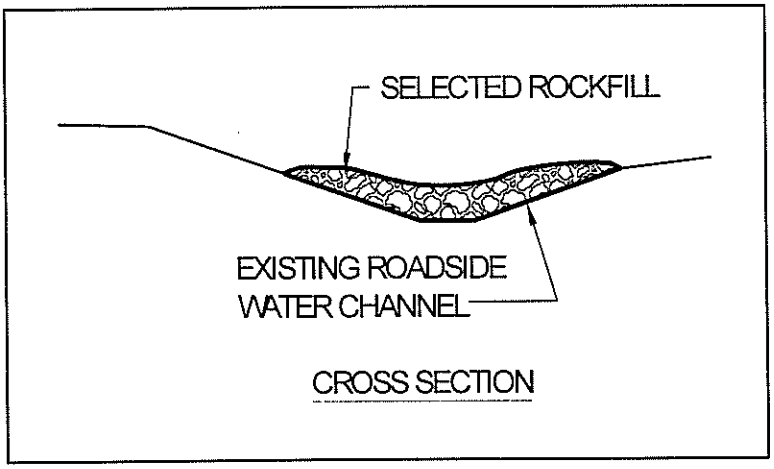


5.4 Check Dams

Check dams are small, temporary dams built across drainage channels to reduce the speed of water and erosion. They can be used where drainage channels are steep, carry high flows or might be unstable.

- Check dams can be made of graded rock (100 - 200 mm diameter), hay bales, or filter fabric such as used for silt fences.
- They are usually no more than 1 m high and spaced so that the toe of the upstream dam is at the same elevation as the crest of the downstream dam.
- Water flows over the centre of the dam, so the sides should be higher than the centre to ensure run-off does not flow around it.
- Maintenance of each dam is essential, as the failure of one of them can affect the whole series.

Figure 5.4 Check dam.



5.5 Cutoffs

Cutoffs minimise the scouring damage and sediment-carrying capacity of surface run-off from tracks and roads. They are small ditches laid across a slope and are designed to intercept stormwater run-off.

- These ditches can be simply constructed using hand tools or diggers, and should be less than 1 m deep.
- They can be used on all tracks and roads, to control run-off where the soil erodibility, slope, and risk of high rainfall intensities increase.

5.6 Slope Stabilisation

After the completion of any road works, implement means that will stabilise the slope as soon as possible. Means of doing so include topsoiling and re-vegetation.

5.6.1 Topsoiling

Topsoiling is essential for quick establishment of grass.

- Carry out topsoiling to establish vegetation cover when site work has finished, ideally as each part of the works is completed.
- Topsoil should be spread to at least 100 mm deep, and on steep sites it should be lightly worked into the subsoil, and quickly replanted.
- If not enough topsoil is available to achieve the minimum 100 mm depth, improve the subsoil by liming and fertilising as an economic alternative (e.g. 2 tonnes/ha lime and 300 kg/ha 30% Potassic Super).
- Adverse effects such as algal blooms may result from fertiliser entering waterbodies. Therefore take care to ensure fertiliser doesn't wash off after application.

5.6.2 Stabilising Steep Batters

Stabilising topsoil on steep batters is important, even if difficult to do so.

- Retain topsoil by installing horizontal boards, mesh, branches or logs held in place by stakes.
- Use fibre mesh or mulch pinned firmly onto batters to help trap topsoil.

5.6.3 Re-vegetating

Re-vegetation reduces erosion of exposed soil, and is a top priority job.

- Grass seeding is the most common and economical method.
- If greater stability is required as that afforded by a deeper root system, shrubs and trees can be planted.
- In areas of native bush, or near waterbodies, a complete layer of cut manuka branches with seed capsules, pegged on steeper slopes, can be an effective way of protecting the soil surface and allowing seeding to occur.
- If manuka is unavailable or inappropriate, geotextiles are suitable (see 5.6.5).
- Soil preparation is important, and includes topsoiling and fertilising (see 5.6.1).
- Ideally, re-vegetation is carried out after each part of the site works is completed.

- As earthworks may be done in dry seasons, some re-seeding may be needed when moisture conditions are better, i.e. spring or autumn.
- Hydroseeding can be very successful, and sometimes the most economical for steep sites, especially as mulch, seed and fertiliser can be applied at once. Generally grass can be sown up to 30 April, and hydroseeding until 31 May, although this may differ throughout the country.
- Keep full sediment control measures in operation on site until grass can be mown.
- Where removal of riparian vegetation alongside waterbodies is required, replant it straight after, preferably with native species where appropriate or required.
- Keep slash and debris out of waterbodies.
- On exposed slopes, retain strips of grass or windrows of shrub material along contours, to reduce run-off velocities and trap sediment.
- Also windrows should be located along the contour of exposed slopes at about 20 m intervals. If put in place immediately after vegetation clearance they are particularly useful if earthworks are to be delayed.
- Make sure the plant types used for re-vegetation are compatible with the area they are being planted in. For example, plantings in Scenic Reserves and National Parks require special care.

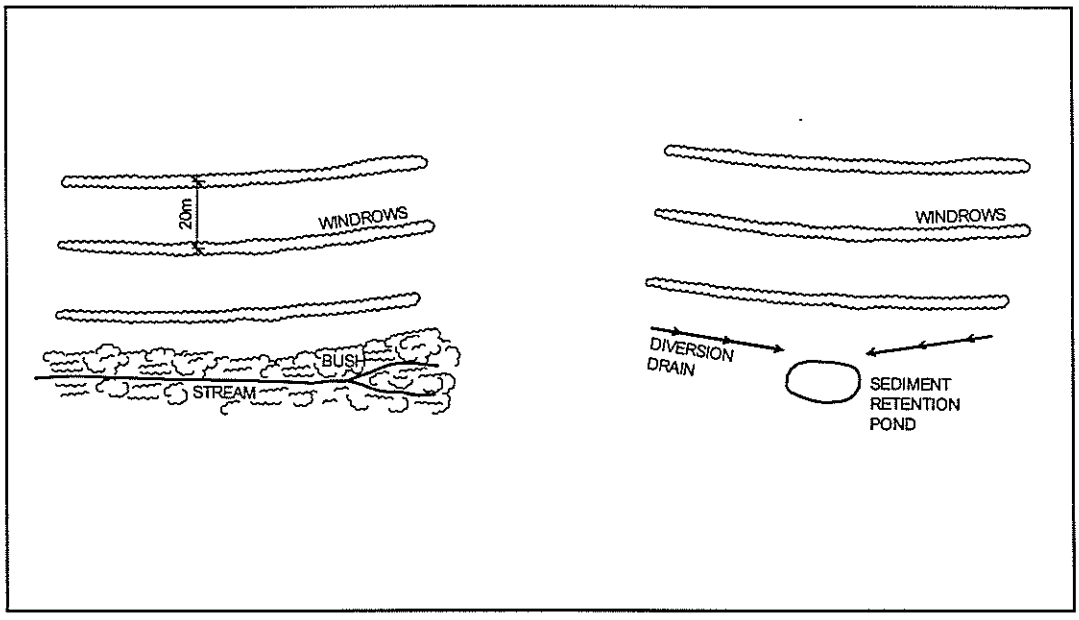


Figure 5.5 Windrows.

5.6.4 Mulching

Mulch protects exposed soil from rain and helps vegetation grow by retaining moisture and suppressing weed growth.

- Place mulch where shrubs and trees are planted, or after seeding.
- Mulch can be a layer of hay, compost, bark, gravel or synthetic material on the soil surface. It is specially useful in hot and dry times of the year, on dry faces and steep slopes.
- Alternatively, use hydromulching on steep slopes.

5.6.5 Geotextiles and Soil Binders

Geotextiles, i.e. synthetic fabrics, can be used to protect soil while grass establishes beneath them. They are useful on steep batters and alongside waterbodies.

- Geotextiles are mostly used after works has finished, where they can remain in place or left to biodegrade.
- Soil binders can be used for temporary erosion control. They tack soil particles together and can be used in conjunction with seeding and hydroseeding.

6. SEDIMENT MANAGEMENT METHODS

If erosion and sediment management fails, sedimentation results.

Sediment management is required for controlling discharges to the marine environment as well as to fresh waterbodies. Measures for trapping sediment before it enters waterbodies are described in this Section 6 of the report.

6.1 Grass-Filter Strips

Grass-filter strips are used to filter low rates of overland flow, on low gradient areas where grassed areas are extensive enough for stormwater to spread over before entering a waterbody.

- Divert roadside water into grassy areas (e.g. an adjacent paddock) before it can enter a waterbody. This will minimise the impacts of stormwater run-off that may occur immediately after road works.
- Grass-filter strips will not be able to handle high run-off from storm flows.

6.2 Silt Fences

Silt fences are temporary measures, and are excellent for retaining sediment on small areas of low gradient and low flows, or for diverting run-off water to deposition areas.

- A fence 100 m length will serve an area of 0.3 ha (Figure 6.2a). It should be no higher than 0.5 m.
- Make fences of filter fabric stretched and supported on posts or waratah standards no more than 1 m apart.
- Provide additional support by a wire mesh backing.
- Bury the bottom of the fence in a narrow trench 250 mm deep.
- In operation, the fence becomes clogged and develops a pond behind it. The water should be diverted to deposition areas (Figure 6.2b).
- Although expensive, silt fences should last six months. They often fail through undercutting or overtopping and constant maintenance is required to avoid this.

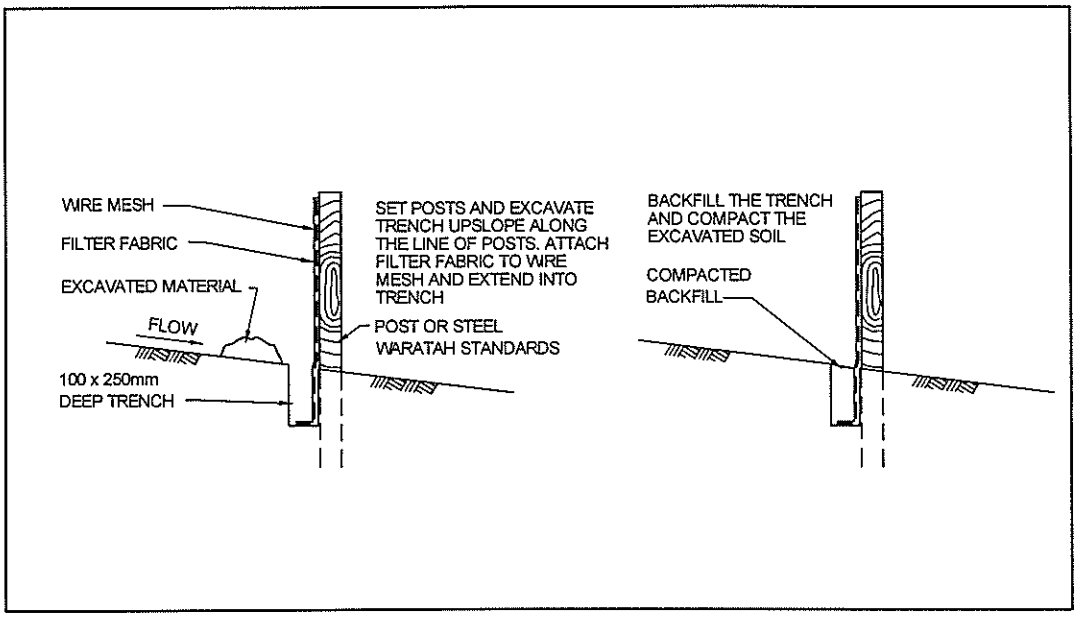


Figure 6.2a Silt fence construction.

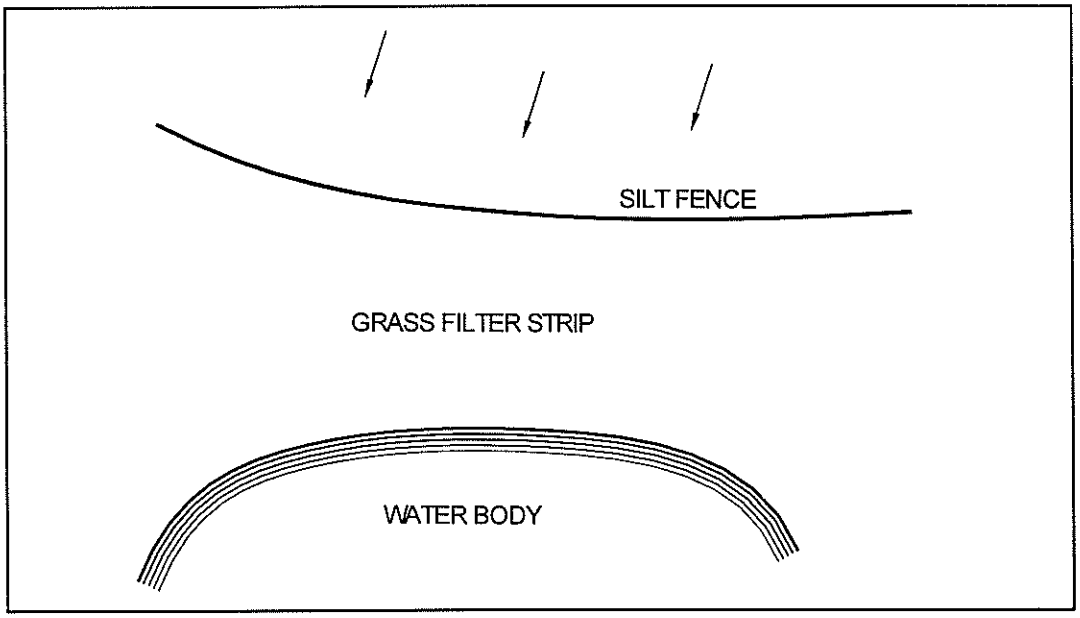


Figure 6.2b Position of silt fence for protecting a waterbody.

6.3 Hay-Bale Barriers

Hay bales can be used as a temporary sediment barrier on small, low flow sites. They are specially useful for very small one-off problem areas (as long as hay bales are not appropriated for other uses).

- A barrier of 100 m of hay bales will serve an area of 0.3 ha.
- Hay bales should be dug 100 mm into the ground, tightly laid together end-on-end and anchored with stakes.

- They should be no more than 1 bale high.
- They play a similar role to silt fences, and like them they are not effective where run-off has concentrated.
- They should be functional for at least three months.
- Regular inspection and maintenance are essential.
- One advantage is that once the site has stabilised and the bales are no longer needed, they can be left in place compost as a good mulch for re-vegetation purposes.

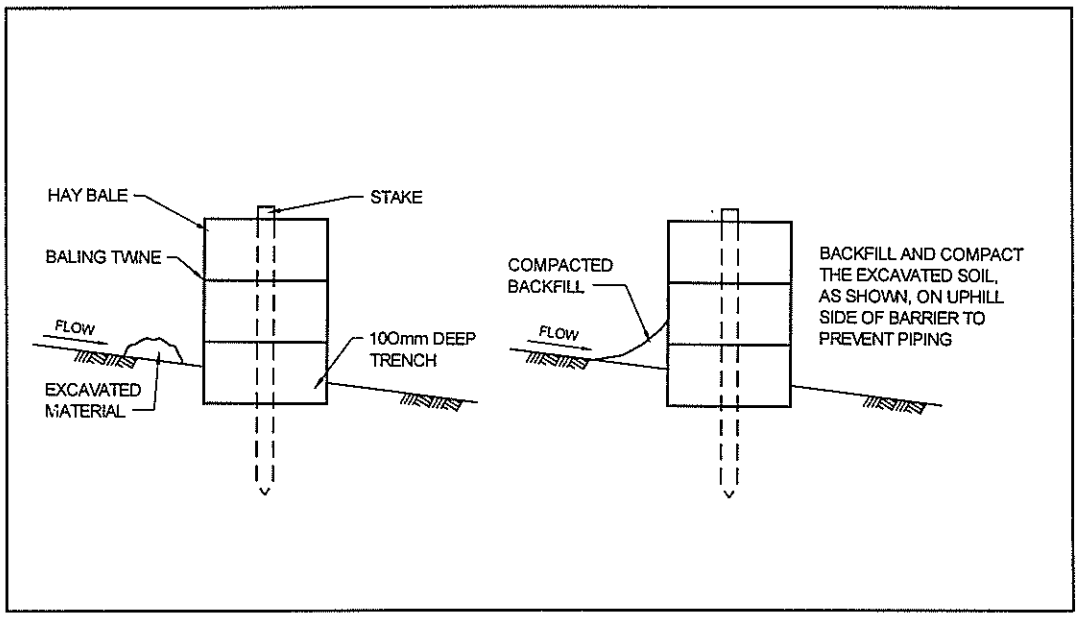


Figure 6.3a Hay-bale barrier.

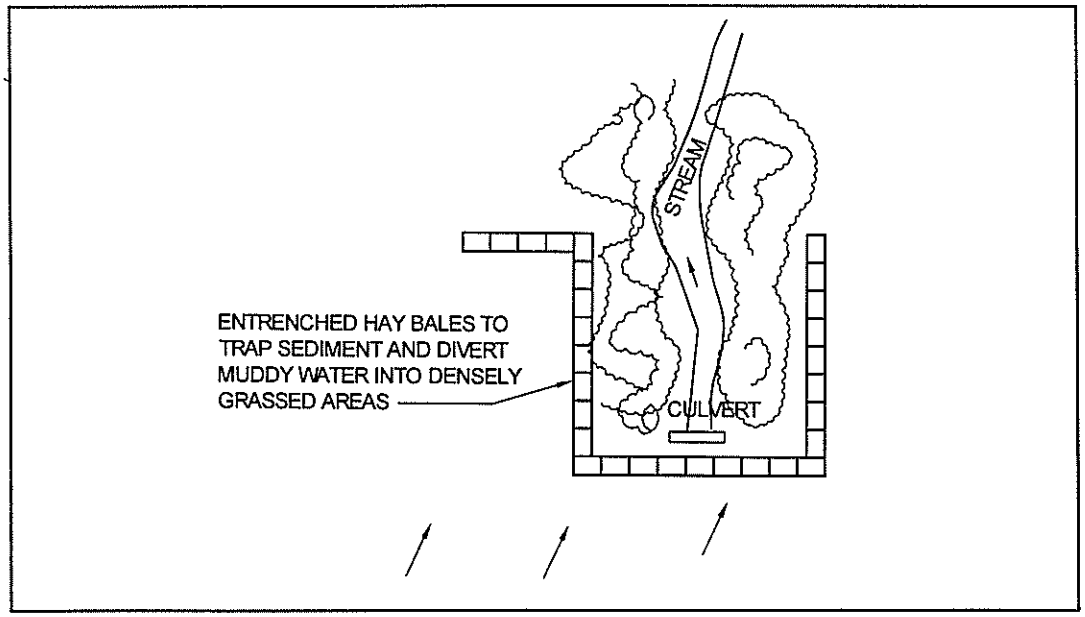


Figure 6.3b Sediment trap of hay bales with water diversion.

6.4 Sediment Traps and Retention Ponds

Sediment traps and retention ponds are used to trap sediment running off disturbed land.

- Locate small sediment traps at strategic places such as site boundaries or culvert pipe inlets, before run-off enters waterbodies.
- Install them at the start of site development, and retain them after works have finished, and until the site is protected from sediment run-off by re-vegetation.
- Although sediment traps are usually simply excavated holes or large ponds, construct them properly.
- For very steep terrain, or for small areas, use another method of silt control, e.g. silt fences.
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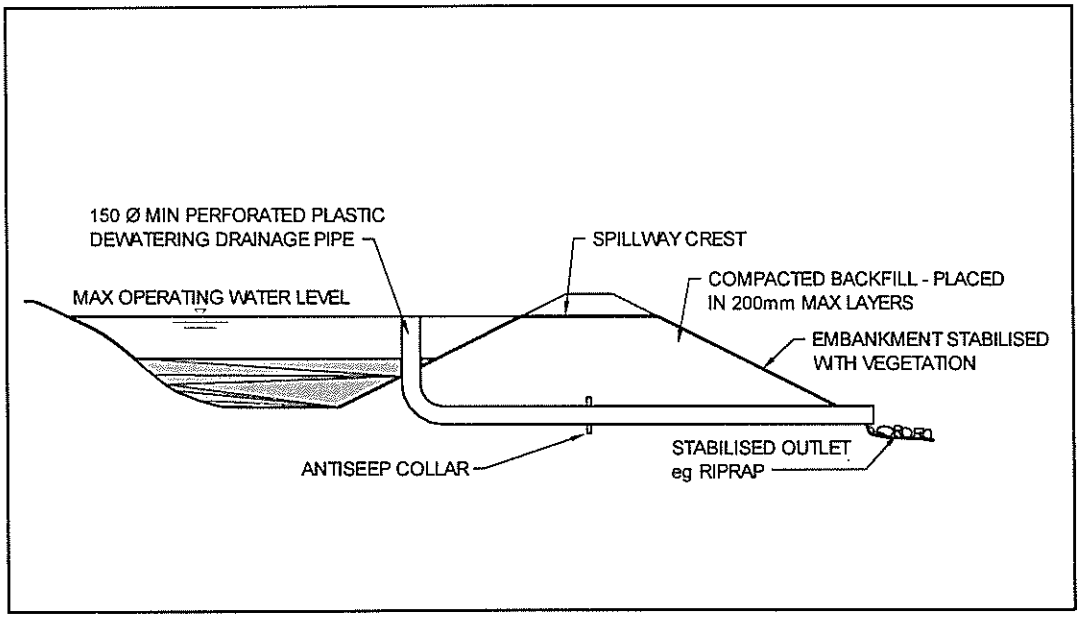

Figure 6.4 Sediment pond embankment.

- Construction of sediment retention ponds that are large enough to be effective on long narrow road sites, and are constantly being worked, can be impractical.
- Nevertheless as control of run-off may be all-important on narrow road sites, use additional measures, such as silt fences.
- Wherever possible, use more substantial measures such as sediment traps and ponds, as they are almost always better and often cheaper in the long term.
- Provide all-weather access to sediment traps and ponds to enable cleaning out, and remove sediment when the trap is half full.
- Check them after every rainfall and during long periods of heavy rain.

- Design sediment ponds to automatically de-water (e.g. with a de-watering pipe) for safety reasons.
- Check local council for their standard design specifications
- Put up warning signs and fences to prevent children, and stray motorists, from falling into sediment ponds.

6.5 Stormwater Inlet Protection

Stormwater inlet protection prevents sediment from entering stormwater drainage systems.

- These protective devices are often of limited capacity
- Use only in small catchments (less than 0.5 ha area).

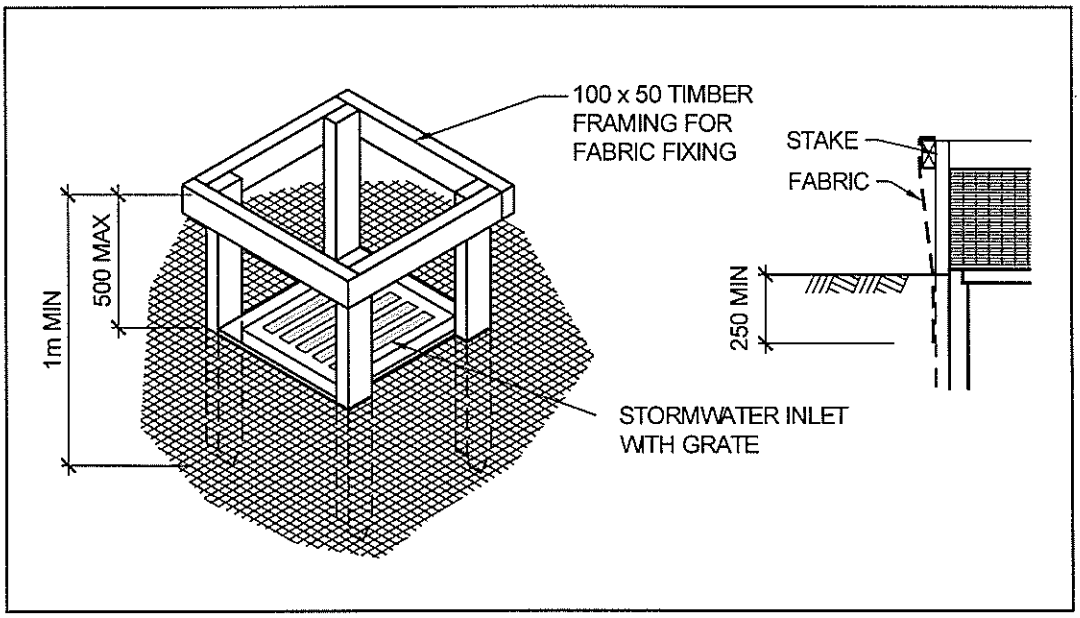

Figure 6.5 Stormwater inlet fabric protection.

- Erect either a silt fence around the stormwater system inlet, or lay gravel against it to allow run-off to filter through.
- Use hay bales also if they are well staked.
- Maintenance of these structures, to remove built-up sediment is essential.

6.6 Rock- and Geotextile-Sediment Traps

Rock- and geotextile -sediment trap structures are simply shaped from rock that is available on site, and geotextile is draped over their entire wetted surface. The textile is held in place by covering its edges with gravel or rock.

- Use as a temporary sediment control in shallow depressions and in flow lines that are likely to carry coarse sediment.

- Use in areas which have small drainage catchments.

7. WHAT TO USE WHEN

- **Before works**

Before road works start, put in erosion control methods and associated structures, such as earth bunds, contour drains, diversion channels.

- **During works**

Construct sediment traps and retention ponds usually during site development. Then supersede them with other measures, such as compacted earth bunds, contour drains, silt fences and stormwater inlet protection, etc., as works proceed.

- **If something goes wrong**

If unexpected erosion and sedimentation occur, e.g. as a result of a slip or unexpectedly heavy rain, implement sediment traps, hay-bale barriers, silt fences, or other appropriate measures, depending on the severity of erosion and the requirements of the site.

- **After works**

When road works have finished, ensure that the area is grassed and/or re-vegetated. Some erosion and sediment management measures may need to be kept in place until vegetation takes hold.

8. GLOSSARY

Bund	mound or embankment of earth or other material
Dam	a barrier or embankment which confines water
Earthworks	the disturbance of land surface by blading, contouring, ripping, moving, placing or replacing soil or earth, or by excavation, or by cutting or filling operations
Embankment	long mound of earth or the exposed face formed when soil is excavated or deposited
Endhauling	spoil is removed by truck to end of road
Erosion	the wearing away of the earth's surface (rock, soil or loose material by wind, water or ice)
Fill	material, usually excavated soil or rock, deposited on an area
Pollutant	material or substance that alters the properties of the environment in such a way as to create a hazard or potential hazard to the health, safety or welfare of any living species
Road Works	disturbance of landscape in order to construct or maintain a road
Run-off	surface discharge or flow of water that is laden with sediment
Sediment	mineral or organic material that has been eroded then deposited; the term "suspended sediment" is sometimes used for soil which has become suspended in water
Sedimentation	the deposition of sediment from suspension in water
Side Casting	spoil is pushed off the side of the road
Silt	sediment made up of predominantly small earth particles (0.02-0.004 mm)
Spoil	earth brought up in excavation or dredging
Waterbody	includes streams, rivers, lakes, wetlands, aquifers, water races, drains, estuaries, and sea
Wetland	includes permanently or intermittently wet areas, shallow water, and land water margins which support natural ecosystems of plants and animals that are adapted to wet conditions

9. ACKNOWLEDGMENTS

The comments and advice received from organisations and contractors during the review process are gratefully acknowledged. In addition, these guidelines could not have been prepared without the co-operation and assistance of contractors with case studies in the field.