# Guidelines for Earthworks in the Taranaki Region

October 2006

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# 1. INTRODUCTION

## Background

Earthworks expose the soil to the forces of gravity and rain/water which accelerate natural erosion processes. Sediment and other contaminants may enter water and cause environmental damage, unless preventative measures are put in place.

Under the Resource Management Act 1991 (RMA) discharges from earthworks to water, or onto land where the discharge may enter water, are not allowed unless they are provided for in a regional plan, a resource consent or a regulation.

The *Regional Fresh Water Plan for Taranaki* contains policies, methods and rules to avoid, remedy or mitigate the adverse effects on water of discharges from earthwork activities. One method to achieve this is to promote industry recognised guidelines for good soil conservation practices. Under the *Fresh Water Plan*, discharges from earthworks to water, or onto land in circumstances where the discharge may enter water, are permitted provided certain conditions are met.

Where those conditions cannot be met, a resource consent from the Taranaki Regional Council is required. A resource consent will have conditions to prevent or minimise adverse effects on the environment from the discharge.

This document is a guide to practical, cost effective measures that can be applied to earthwork activities to prevent or minimise the adverse effects of those activities on the environment, particularly on water quality. The guidelines will assist road controlling authorities, consulting engineers, surveyers and contractors in meeting the requirements of the Act and the *Regional Fresh Water Plan for Taranaki*.

## Purpose of these guidelines

The purpose of these guidelines is to:

provide guidance to consulting engineers and contractors working within the Taranaki region, on practical measures to help them meet the conditions of the earthwork activities rules contained in the *Regional Fresh Water Plan for Taranaki*.

- promote good erosion and sediment control management practices for earthworks, by outlining the general principles of erosion and sediment control, and providing a range of cost-effective erosion and sediment control practices that can be used for various earthwork activities.
- minimise the adverse environmental effects on water quality of soil disturbance from earthwork activities in the Taranaki region.

## Structure and content of these guidelines

These guidelines contain eight sections. Section 1 introduces the guidelines and their purpose, structure and content. Section 2 outlines the framework for managing the environmental effects of soil disturbance activities associated with earthworks, including a discussion of the environmental effects of earthwork activities, the provisions of the Resource Management Act 1991 and the statutory requirements of the relevant regional plans.

Section 3 sets out general principles to follow for erosion and sediment control. Section 4 provides more specific guidance on erosion control methods, Section 5 provides specific guidance on sediment control methods while Section 6 provides guidance on working in watercourses and temporary crossings. Where appropriate, diagrams have been included to illustrate particular control methods and to show relevant design features such as slope, height and depth. Section 8 contains a glossary of terms used in the guidelines.

## 2. MANAGING THE ENVIRONMENTAL EFFECTS OF EARTHWORKS

### Potential environmental effects

Sediment-laden runoff from earthworks can lead to the degradation of water quality, impacts on ecological values, and increased flood risk where the sediment is deposited on the river bed.

Taranaki soils differ from other regions and generally have high silt or sand components. Different soil types have different properties. For example, Taranaki soils have a lower proportion of clay compared to Auckland soils. This means that the sediment will settle out quicker as the silt and sand particles do not require as much time or slow flows to settle out.

Sediment in waterways can cause the following adverse ecological effects:

- modified or destroyed instream values
- modified estuarine and coastal habitats
- smothering of aquatic flora and fauna
- changes in food sources and the interruption of life cycles.

Sedimentation can completely change the freshwater ecolology and instream communities, and recovery is likely to take years rather than months. Sediment can also damage water pumps and other structures, reduce water supply quality, build up in wetlands and reduce flood capacity, cause localised flooding and reduce the recreational and aesthetic appeal of the waterbody.

### Resource Management Act 1991

Under the Resource Management Act the Taranaki Regional Council has responsibility for the sustainable management of Taranaki's natural and physical resources.

The Council's responsibility for the discharge of contaminants to water and onto land is particularly relevant for earthwork activities. Any discharge of contaminants from earthworks to water or onto land where the discharge may enter water is not allowed under the RMA unless it is permitted by a rule in a regional plan, a resource consent or regulations.

The Act also provides for enforcement action to be taken where activities contravene the Act, a plan or resource consent. A person has a general duty to avoid, remedy or mitigate adverse effects on the environment, arising from an activity carried by or on behalf of that person and an enforcement order or abatement notice may be made or served to:

- require a person to cease, or prohibit a person from commencing, anything that, in the opinion of an enforcement officer, is or is likely to be noxious, dangerous, offensive, or objectionable to such an extent that it has or is likely to have an adverse effect on the environment; or
- require a person to do something that, in the opinion of an enforcement officer, is necessary in order to avoid, remedy, or mitigate any actual or likely adverse effect on the environment caused by, or on behalf of, that person.

Abatement notices are issued pursuant to section 322 of the Act. An enforcement officer may serve an abatement notice if there is reasonable grounds for believing that action needs to be taken or certain activities stopped.

An abatement notice may therefore be issued to cease activities or stop the commencement of activities that contravene the Act, a rule in a plan or a resource consent, or require actions to be taken to comply with the Act, a rule in a plan or resource consent, in order to avoid, remedy or mitigate an adverse effect on the environment. An abatement notice may be made subject to such conditions as the enforcement officer serving it thinks fit.

Under the Act financial penalties of up to $200,000 and/or $10,000/day for a continuing offence are available.

## Regional Fresh Water Plan for Taranaki

The region's fresh water resources are used for drinking and domestic uses, for industries and agriculture and for a wide range of recreational pursuits. For the Tangata Whenua of the region, the waterways have unique spiritual and cultural values. Overall, the Taranaki region has plentiful supplies of fresh water with the quality of fresh water improving significantly in the last two decades.

The Council has prepared a *Regional Fresh Water Plan for Taranaki* to improve and maintain the quality of the region's freshwater resources.

The *Regional Fresh Water Plan* sets out rules and policies that govern the environmental effects of various activities and resource consent requirements. However, it also enables many activities to be regularly carried out with minimal restrictions and without the need for a resource consent and undue cost to the resource user. A copy of the Plan can be found on our website www.trc.govt.nz.

The *Regional Fresh Water Plan* defines soil disturbance activities as including earthworks associated with roading and tracking, formation of skid or landing sites, subdivision, pipeline trenching and land contouring, but not including land disturbed for cultivation, cropping and harvesting (including logging), or industrial and trade premises.

The Plan controls the discharge of stormwater from earthworks to address the adverse effects on water quality from the discharge of contaminants from point sources. Point source discharges are from an identifiable location and include direct discharges to water or onto land where the contaminants could reach water.

## Consents and Permitted Activities for earthworks

Some earthworks activities require consents from the Taranaki Regional Council. Consents may be required where earthworks are near streams, lakes, wetlands, coastal waters; or where the works are on steep land; or for stormwater discharges from earthworks sites. Large-scale vegetation clearance (such as forest harvesting) and quarry operations may also require consents.

Activities that do not require consents are called Permitted Activities. The *Regional Fresh Water Plan for Taranaki* also has conditions for Permitted Activities which may apply to earthworks projects. It is very important that where earthworks are being undertaken as Permitted Activities, all the conditions of the Permitted Activity Rules are complied with.

Under the Fresh Water Plan a resource consent is not needed for the discharge of stormwater from earthworks into water or onto land as long as:

- the discharge is not into any of the significant wetland areas listed in the *Regional Fresh Water Plan*
- the working area is small (less than 1 ha)
- the volume of disturbed material is less than 3,000 $m^3$
- the area is stabilised as soon as possible after the earthworks have been completed
- the runoff does not contain a lot of silt
- there are unlikely to be significant adverse effects on the quality of water.
- The major exception is in the Stony River catchment where it is prohibited to discharge any stormwater (or contaminants) into any surface water.

If earthworks extend over an area between 1 ha and 8 ha a resource consent is not needed for the discharge of stormwater into water or onto land as long as:

- the works are not within a Defined Urban Catchment (Eltham, Hawera, Kaponga, Manaia, Normanby, Ohawe Beach, Opunake, Patea, Waverley, Stratford, Bell Block, Egmont Village, Inglewood, Lepperton, New Plymouth, Oakura, Onaero, Okato, Urenui, Waitara)
- the other requirements listed above can be met

- the work is not being done during winter (between 1 May and 31 October)
- the volume of soil disturbed is less than 24,000 $m^3$.

If all of the above requirements cannot be met or if it is likely that the discharge may be into one of the significant wetland areas listed in the *Fresh Water Plan*, you may be required to take some action to reduce problems and comply with the Plan or be required to apply for a resource consent.

Earthworks activities are controlled (a resource consent is required) if:

- they are in a Defined Urban Catchment and extend over an area greater than 1 ha or the volume of the soil disturbed is greater than 3,000 $m^3$
- they extend over an area greater than 8 ha or the volume of soil disturbed is greater than 24,000 $m^3$
- the work is being done during winter (between 1 May and 31 October).

For these situations a site erosion and sediment control management plan must be submitted to the Taranaki Regional Council to prevent or minimise environmental effects of the earthworks.

The site erosion and sediment control management plan must set out the control of site erosion and sediment from the anticipated earthworks and contain a work programme including the extent, location and timing of works, cuts, batters, slopes of roads and volume of sediment disturbed, sediment and silt control structures, and details of site restoration and rehabilitation works proposed.

The Council must approve the management plan and will control other consent conditions including:

- conditions relating to the adverse effects on water quality and the values of the waterbody
- the timing of the works
- any measures necessary to reinstate the land following the completion of the activity
- monitoring and information requirements
- the duration of the consent
- the review of the conditions of the consent and its timing and purpose
- administrative charges and financial contributions.

***If you have any doubts about the requirements for earthwork activities, you should contact the Taranaki Regional Council.***

## When is erosion and sediment control required?

All projects involving soil disturbing activities in the Taranaki Region must incorporate erosion and sediment controls as an integral part of development. On all projects, erosion and sediment controls should be in place before earthworks commence and should be removed only after the site has been fully stabilised to protect it from erosion. The principles and practices within these guidelines should be referred to, and staff at the Taranaki Regional Council contacted for further advice if required.

### Works within a watercourse

Any works within a watercourse must be carefully planned because controlling sediment generation from these activities is difficult. These guidelines include a number of erosion and sediment control measures that can used for realignment, piping, culverting and stabilisation works. Techniques for minimising sediment generation and discharge when undertaking works within a watercourse are outlined in Section 6 of these guidelines. As stated in the introduction, consents may be required when undertaking such works, and contact should be made with Taranaki Regional Council staff to discuss the specific details of the proposed activity.

## Regional Soil Plan for Taranaki

Clearing vegetation from land is covered by the *Regional Soil Plan for Taranaki*. This is to reduce soil erosion and to maintain water quality. If only small areas of vegetation (less than 5 ha) are being disturbed and it is on land that is less then 28 degrees slope, then a resource consent is not needed.

A consent is also not needed from the Taranaki Regional Council for disturbing vegetation with an area greater than 5 ha (carried out within one year), and where the slope is greater than 28 degrees as long as:

- the Taranaki Regional Council is informed at least 15 working days before starting work
- no more than 10% of the soil is exposed at any one time
- the area is revegetated as soon as possible
- there are no significant environmental effects or effects on stock water supply
- the vegetation is felled in a direction away from any stream
- no vegetation is dragged through any streambed.

If any of these requirements cannot be met then you may be required to take some action to meet the conditions of the Soil Plan, or you may need to apply for a resource consent. The consent will be granted as long as a site plan covering management of erosion and sediment control is prepared and forwarded to the Taranaki Regional Council.

## 3. THE 'TEN COMMANDMENTS' OF EROSION/SEDIMENT CONTROL

### Minimise disturbance

- Fit land development to land sensitivity
- Some parts of a site should never be worked and others need very careful working. Watch out for and avoid areas that are wet, have steep or fragile soils or are conservation sites or features.
- Adopt a minimum earthworks strategy - ideally only clear areas required for structures or access.

### Stage construction

- Carrying out bulk earthworks over the whole site maximises the time and area of soil that is exposed and prone to erosion. Construction Staging where the site has earthworks are undertaken in small units over time with progressive revegetation, limits erosion.

### Protect steep slopes

- Existing steep slopes should be avoided. If clearing is absolutely necessary, runoff from above the site should be diverted away from the exposed slope to minimise erosion. If steep slopes are worked and need stabilisation, traditional vegetative covers like top soiling and seeding may not be enough.

### Protect watercourses

- Existing streams, watercourses, and proposed drainage patterns need to be mapped. Works that cross or disturb the watercourse may require resource consent.

### Stabilise exposed areas rapidly

- The ultimate objective is to fully stabilise disturbed soils with vegetation after each stage and at specific milestones within stages. Methods are site specific and can range from conventional sowing through to straw mulching. Mulching is the most effective instant protection.

### Install perimeter controls

- Perimeter controls above the site keep clean runoff out of the worked area – a critical factor for effective erosion control. Perimeter controls can also retain or direct sediment-laden runoff within the site. Common perimeter controls are diversion drains, silt fences and earth bunds.

### Employ detention devices

- Even with the best erosion and sediment practices, earthworks will discharge sediment-laden runoff during storms. Along with erosion control measures, sediment retention structures are needed to capture runoff to allow the sediment generated to settle out. Ensure that the control measures used are appropriate for the project and adequately protect the receiving environment.

### Experience and training

- A trained and experienced contractor is an important element to the success of any project. These people are responsible for installing and maintaining erosion and sediment control practices. Such staff can save project time and money by identifying threatened areas early on and putting into place correct practices.
- At each earthworks site, there should be a person whose responsibility it is to oversee the erosion and sediment control practices. It is often useful for Taranaki Regional Council monitoring staff to meet with this person for a pre-construction meeting, for regular inspection visits, and a final inspection.

### Make sure the plan evolves

- An effective site erosion and sediment control plan is modified as the project progresses from bulk earthworks to project completion. Factors such as weather, changes to grade and altered drainage can all mean changes to planned erosion and sediment control practices.
- Update the erosion and sediment control plan to suit site adjustments in time for the pre-construction meeting and regular monitoring inspections, and make sure it is regularly referred to and available on site.

### Assess and adjust

- Inspect, monitor and maintain control measures.
- Assessment of controls is especially important following a storm. A large or intense storm will leave erosion and sediment controls in need of repair, reinforcement or cleaning out. Repairing without delay reduces further soil loss and environmental damage.
- Assessment and adjustment is an important erosion and sediment control practice and must figure in the erosion and sediment control plan.
- Assign responsibility for implementing the erosion and sediment control plan.

## Types of land disturbing activities undertaken

The main types of soil disturbing activities undertaken in the Taranaki Region, which may require the use of erosion and sediment controls, are:

a. trenching
b. watercourse works
c. small sites (such as house lots)
d. earthworks/projects (major cut to fill)
e. roading/tracking

The following is a brief summary of key considerations for minimising adverse environmental effects of these activities that are not detailed in the description of erosion and sediment control measures in the guidelines.

### Trenching

Trenching, usually for installing utility services, often happens towards the end of the bulk earthworks phase of a project. When trenching consider that:

- The project needs to be undertaken in appropriately sized stages such that the area exposed can be fully stabilised within an acceptable timeframe.
- If trenching affects existing erosion and sediment control measures that are part of the overall development, those measures should be reinstated as soon as possible. Contingency measures should be put in place until the original measures are reinstated or replaced.
- All trenching operators working within a larger site must be familiar with the overall erosion and sediment control plan for the site and must comply with this approved plan.
- Independent erosion and sediment control measures detailed in these guidelines should be employed for the trenching operation.
- Topsoil and subsoils should be stockpiled separately adjacent to the trench so that at the completion of the operation, these soils can be replaced in the appropriate order and vegetation established.
- When trenching through overland flow paths, give special consideration to the diversion of any flows, which may occur during trenching, as well as reinstating and stabilising the overland flow path.

### Works within a watercourse

Wherever possible avoid working within a watercourse as they will create sedimentation downstream. If watercourse works are unavoidable:

- Have all alternatives been considered?
- Install a stabilised diversion so that works can be undertaken in the dry and reinstate the stream flow only after these areas have been appropriately stabilised. If a diversion is not a viable option, then ensure alternative options are fully considered.
- Carry out works during a dry time of the year when stream flows are low and the likelihood of a storm is low.
- Keep the duration of works short.
- Identify in-stream values so as to avoid critical periods such as fish spawning periods.
- Consider the direct short and long-term impacts of culverts or in-stream structures and install appropriately designed fish-pass provisions.
- Be sure to inform all downstream users, for example water-users, of potential downstream sediment discharges.

### Small sites

The cumulative impact from small sites can be considerable and in some areas may cumulatively discharge as much sediment as large earthworks sites. Often, stormwater systems are in place but there are no, erosion and sediment controls on the site or they are minimal. This results in sediment discharging through the stormwater system directly to the receiving environment.

When undertaking small site development:

- Erosion and sediment controls should be installed either on an individual site-by-site basis or on a combination of the sites, according to these guidelines.
- Stormwater runoff from small sites needs careful planning in terms of the location of roof down pipes so that runoff across bare sites does not scour soils.
- Areas of exposed soils should be stabilised upon completion of earthworks, including topsoil and subsoil stockpiles, lawn areas and accessways.

### Earthworks

Earthworks include a wide range of activities from cleanfilling operations through to earthworks associated with industrial, commercial and residential developments. Earthworks have a major potential to generate large amounts of sediment, and if not controlled appropriately, can lead to large sediment discharges. Planning of these developments is critical to ensure that the activity is undertaken appropriately, and in a controlled manner to avoid unnecessary impacts on receiving environments. The ‘Ten Commandments’ outline the critical features of an earthworks operation.

When undertaking earthworks operations contractors should be aware of the following:

- Emphasis should be placed on erosion control, rather than sediment control, because preventing sediment generation is the best means of preventing sediment discharge from earthworks sites.
- Always produce an erosion and sediment control plan (E & SCP) for an earthworks operation. Be sure that all parties involved with the operation, including subcontractors, are familiar with and have access to a current copy of this plan.
- Always update the E & SCP with major variations on the site. Keep this up-to-date version in the site office at all times.
- Plan ahead and undertake consultation with necessary parties as required.
- Install appropriate controls in accordance with the E & SCP and be sure that the design specifications are appropriate for the operation.
- Install subsurface drainage as required (to an agreed methodology) to divert subsurface clean water past control structures and areas of disturbance as appropriate.

### Roading/Tracking

Like trenching, the linear nature of roading poses challenges for erosion and sediment control. Measures need to be carefully planned to ensure controls are successful. Often the operation can be undertaken sequentially, stabilising worked areas as they are completed. This minimises the total sediment generating area of the proposal and helps prevent unnecessary road maintenance. When working through a roading proposal:

- Provide enough room for effective erosion and sediment control measures. Often the road corridor itself can involve the whole designation area and no room remains for such controls. Where space is a constraint, make sure that the erosion and sediment controls will give the necessary protection to downstream receiving environments.
- Incorporate stormwater design into the E & SCP. This removes the need to revisit the area to install stormwater systems and the unnecessary extra earthworks that their construction would require.
- Limit the areas of road corridor exposed at any one time so they can be practically stabilised with hardfill or by vegetative means, to minimise the exposed area at risk.
- When crossing watercourses, look for alternative routes and alternative designs and implement the option which provides the best environmental alternative.
- Control all upslope catchment runoff, diverting clean water around or safely through the area of disturbance.

*Silt fencing*

# 4. EROSION CONTROL METHODS

The key principle for undertaking erosion control is that if erosion is minimised, then the amount of sediment-laden runoff to be dealt with will also be minimised. The following erosion control methods may be of help when preparing your erosion and sediment control plan.

## Minimise exposed areas

- The best way to minimise erosion and control sediment discharge is by disturbing as little soil as possible at any one time and maintaining as much vegetative cover as possible. This needs planning to stage disturbance and stabilise exposed areas as soon as possible.
- Preventative measures reduce cost and effort - unexposed soil cannot erode and does not need sediment control measures to capture it.

## Runoff diversion channels and bunds

Channels and bunds have the same purpose, but bunds are more appropriate where sub-soils are erosion-prone or where surplus earthworks material is available to build bunds. Channels and bunds are suitable for diverting clean up slope water away from areas to be worked, to divert sediment-laden runoff from disturbed areas into sediment treatment facilities, or at or near the perimeter of the construction area to keep sediment from leaving the site. Restrict use to grades of no more than 2 % unless armoured with geotextile or rock check dams.

- Design runoff diversion channels and bunds to carry the flow from a five-year storm event.
- Ensure that earth used to construct embankments or bunds is adequately compacted.
- Stabilise channels and bunds where necessary, before use.
- Flow velocities greater than 1 m/sec will cause erosion, therefore incorporate stabilisation measures (eg vegetative stabilisation, geotextiles or rock checks).
- Construct a stable erosion–proof outfall (eg level spreader) to reduce water velocities and scour at the outlet.
- If runoff contains sediment, the flows should be diverted into a sediment retention pond.
- Channels and bunds require regular maintenance to function correctly, therefore:
    - Inspect after every rainfall and during periods of prolonged rainfall for erosion or where the channel or bund may be breached.
    - Clear sediment that builds up after rain or during prolonged storms.
    - Check outlets carefully to ensure they remain stable from erosion.
    - Repair immediately if required to ensure that the design capacity is maintained.
    - Carefully check outlets to ensure that these remain free from scour and erosion.
    - Keep channels and bunds in place until the disturbed area is permanently stabilised against erosion, then they can be removed if need be.

See Figure 1 for the design of a runoff diversion channel, and Figure 2 for the design of a runoff diversion bund.

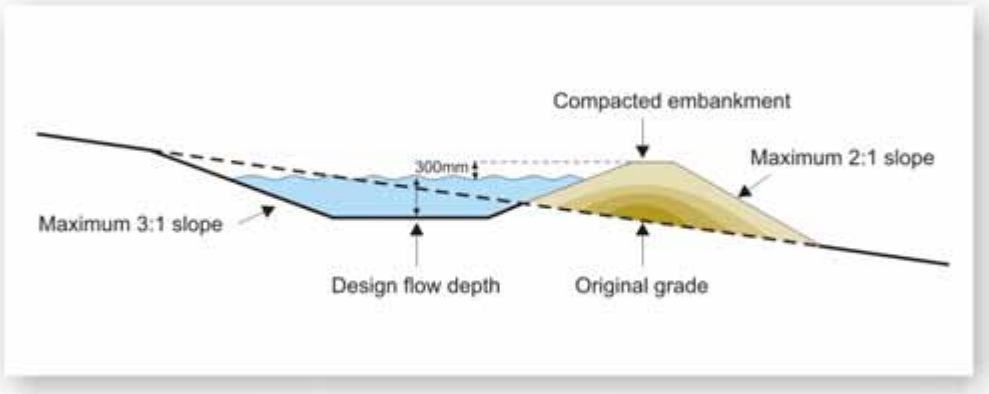



***Figure 1*** *Cross section of a runoff diversion channel*

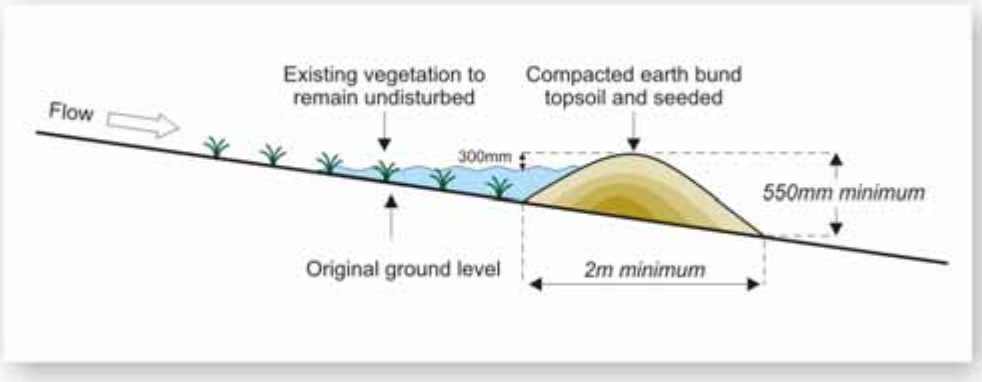



***Figure 2*** *Cross section of a runoff diversion bund*

## Contour drains

Contour drains are used to break overland flow down disturbed slopes by limiting slope length and thus the erosive power of runoff; to direct flow from disturbed areas to diversion channels and bunds or sediment ponds; and at intervals across disturbed areas to shorten overland flow distances.

| Slope site (%) | Slope length (m) |
|---|---|
| 5 | 25 |
| 10 | 20 |
| 15 | 15 |

- Keep contour drains as short as possible to minimise erosion. The positioning of contour drains is often determined by the necessity for stable outfalls but in general the spacing for the positioning of contour drains in the table applies. The spacing of the drains is also related to expected rainfall, state of the area, and soil type.
- See Figure 3 for the design of contour drains.
- For best results, drain depth is 500 mm but 300 mm is sufficient for temporary contour drains.
- Ensure the grade is no more than 1 %.
- Ensure a stable erosion-proof outfall.

### Maintenance

- Install contour drains at the end of each day.
- Undertake maintenance at the end of each day and inspect after every rainfall and during periods of prolonged rainfall.
- Inspect contour drains after every rainfall and during periods of prolonged rainfall.
- Immediately carry out any maintenance that is required.

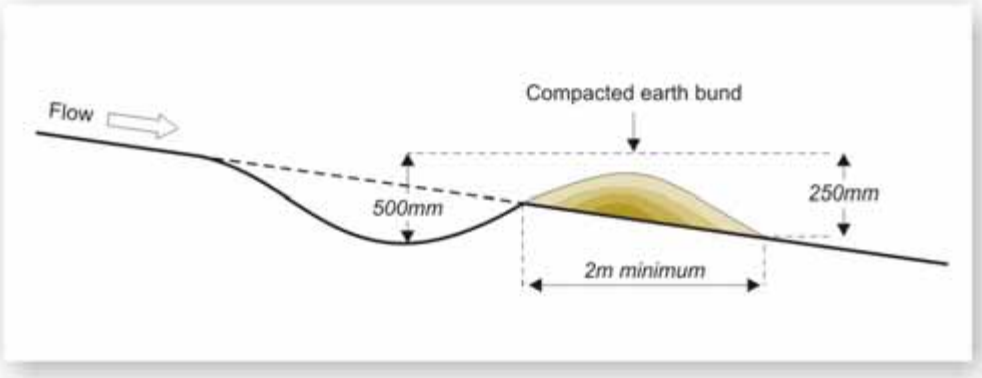



***Figure 3*** *Cross section of a contour drain*

## Cutoffs

This practice involves constructing small ditches laid across a slope at regular intervals to provide drainage of surface water from a carriageway to a stable outfall. This practice applies primarily to low use roading and tracking where storm flows arising upslope of the road and carriageway itself need to be conveyed to an erosion proof outfall.

- Cut-offs can be used on all tracks and roads to control runoff where the soil erodibility, slope and risk of high rainfall intensities increase.
- Cut-offs should be less than 1 m deep.

## Rock check dams

Rock check dams are used to reduce the velocity of concentrated flows, thereby reducing the erosion of the channel. While trapping some sediment, they are not designed to be used as a sediment retention measure. Do not use rock check dams in watercourses.

**Use check dams in:**

- Temporary channels. Because of their short length of service it is not suitable to install non-erodible lining, but some protection is still needed.
- Permanent channels, which will not receive a non-erodible lining for an extended period.
- Temporary or permanent channels, which need protection during vegetative cover establishment.
- Ensure the catchment in question has a contributory drainage area of less than 1 ha.
- Direct all flows over the centre of the rock check dam.
- Construct each rock check dam with a maximum centre height of 600 mm. Build the sides 200 mm higher than the centre to direct flows to the centre. Do not use rock check dams as a primary sediment trapping facility. Ensure that any sediment-laden runoff passes through a sediment trapping device or devices before being discharged from the site.
- Place a mix of 100 mm to 300 mm diameter washed rock to completely cover the width of the channel. In steeper catchments use larger sized rock (0.5 - 1.0 m) on the downstream side of the rock check dam.
- Ensure rock batter slopes are 2:1.
- Locate rock check dams at a spacing so that the toe of the upstream dam is equal in height elevation to the crest of the downstream one.
- Ensure the toe of the upstream dam is never higher than the crest of the downstream dam.
- See Figure 4 for the design of a rock check dam.

**Maintenance**

While this measure is not intended to be used primarily for sediment trapping, some sediment can accumulate behind the rock check dams. Remove this sediment when it has accumulated to 50 % of the original height of the dam.

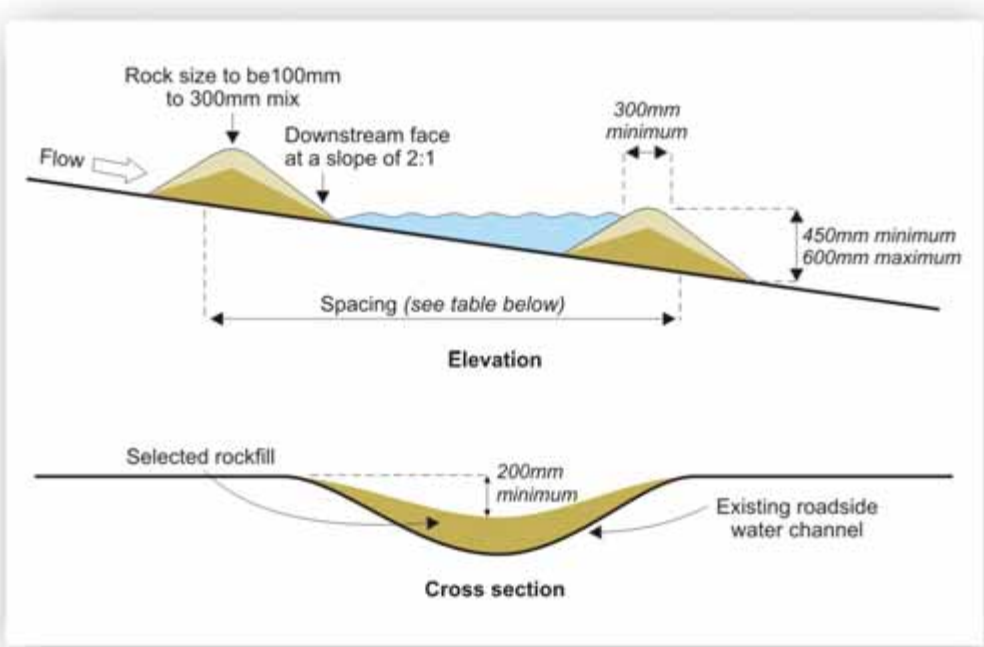



***Figure 4*** *Elevation and cross section of a rock check dam*

## Stabilising disturbed ground

After soil is disturbed, stabilise as soon as possible with straw or hay mulch or aggregate. Where appropriate grass should be sown as soon as works are completed.

## Slope stabilisation

After earthworks have been completed, stabilise the slope as soon as possible using, for example, top soiling and re-vegetating or hydro-seeding.

*Benched slope*

## Benched slope

Benched slopes are primarily used on long slopes and or steep slopes where rilling may be expected as runoff travels down the slope. Consider benched slopes on all slopes, however, ensure that consideration of soil structure and stability occurs. The spacing of benched slopes and the specific conditions for which they apply depend on slope, height and angle. The primary purpose is to prevent the concentration of runoff which, in turn, increases erosion. Use benched slopes on long or steep slopes where erosion may occur as runoff moves down slope.

- Soil types, seeps and location of rock outcrops need to be taken into account in designing bench slopes.
- Locate benches equally and convey the water to a stable outlet.
- Ensure benched slopes are a minimum of 2 m wide for ease of maintenance.
- Design benched slopes with a reverse slope of 15 % or flatter to the toe of the upper slope and with a minimum depth of 0.3 m. Keep the gradient of each benched slope to its outlet below 2 % unless design, stabilisation and calculations demonstrate that erosion risk is minimised.
- Proved subsurface drainage where necessary to intercept seepage that would otherwise adversely affect slope stability or create excessively wet site conditions. Check the requirements of your district council.
- Keep the flow length along the bench slope to less than 250 m unless it can be shown that erosion will be minimised.
- Divert surface water from the face of the slope by the use of diversion channels or bunds except where the face is not subject to concentrated flows of surface water or the face is subject to special erosion control methods.
- Do not construct benched slopes so they could endanger adjoining properties without adequately protecting such properties against sedimentation.
- Provide benched slopes for slopes exceeding 25 %
- See Figure 5 for the design of a benched slope.

Stabilise all disturbed areas and permanently stabilise all graded areas immediately on completion of grading. In general Spacing is dependent on slope angle and height, (see table)

| Slope angle (%) | Vertical height (m) between benches |
|---|---|
| 50 | 10 |
| 33 | 15 |
| 25 | 20 |

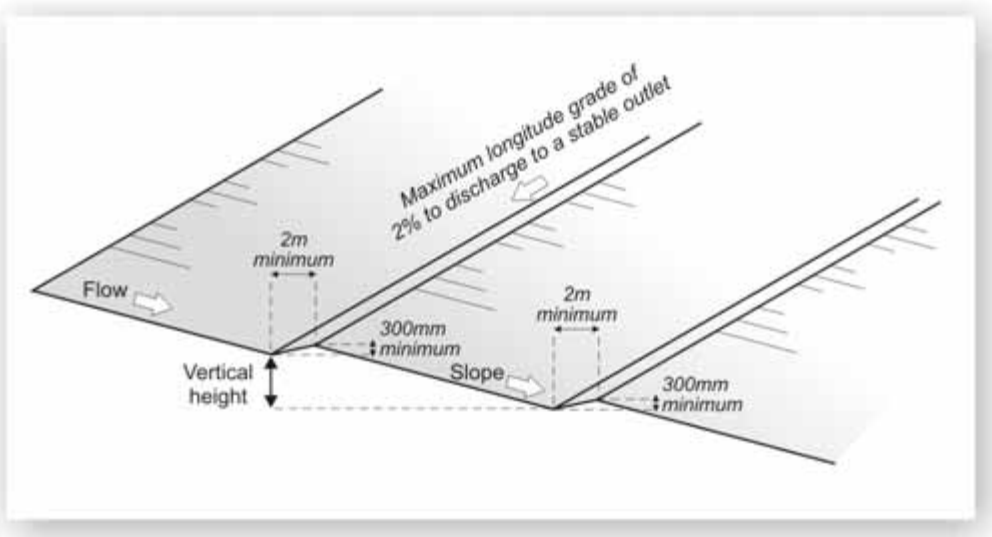



***Figure 5*** *Benched slopes for stabilisation*

## Top soiling

Generally, topsoiling is combined with vegetation establishment and is not seen as an erosion control measure in itself. Top soiling as a short term stand alone erosion control measure is limited to sites with an average slope of less than 5 % with contour drains installed as per these guidelines and for periods of less than two weeks only. Top soiling alone will not provide sufficient erosion protection to allow sediment control measures to be removed. Topsoiling is generally combined with vegetative planting and is not seen as an erosion control measure in itself.

- Ideally, carry out topsoiling as each part of the works is completed.
- Topsoil should be spread to at least 100 mm depth, and on steep soils it should be lightly worked into the subsoil and quickly replanted.
- If not enough topsoil is available, improve the subsoil with the use of fertilisers as an economic alternative.
- Topsoiling will not provide sufficient erosion protection to allow sediment control measures to be removed until vegetation has become established.

### Maintenance

Check the condition of the topsoil on a regular basis and regrade and/or replace where necessary to always maintain the 100 mm minimum depth of topsoil and surface roughening.

## Re-vegetating (including hydro-seeding)

Permanent seeding should be considered on any site where establishing permanent vegetation is important to protect bare earth. It may also be used on rough graded areas that will not be brought to final grade for a year or more. Hydro-seeding should be considered at any site where vegetation establishment is important for the protection of bare earth surfaces. Both types of seeding also offer good dust suppression once grass is established.

- Soil preparation is important and includes top soiling and fertilising.
- Ideally re-vegetation is carried out as each part of the works is completed.
- Grass seeding is the most common and economical method, hydro-seeding is also an option.
- If greater stability is required, shrubs or trees with deeper root systems can be planted.

*Hydro-seeding*

## Mulching

This practice applies to any site where vegetation establishment is important for the protection of bare earth surfaces. Mulching can be used at any time where instant protection of the soil surface is desired. Mulching can be used in conjunction with seeding to establish vegetation, or by itself to provide temporary protection of the soil surface.

- Mulch can be a layer of straw, compost, bark, gravel or synthetic material on the soil surface.
- It is particularly useful in hot and dry times of the year, on dry faces or steep slopes.
- Mulch (such as hay) can also be beneficial in providing a seed source.
- Place mulch where shrubs and trees are planted, or after seeding.

*Mulching*

## Geosynthetic erosion control systems (GECS)

There are two categories of GECS - temporary degradable and permanent non-degradable.

### Temporary Degradable GECS

These are used to prevent the loss of seedbed and to promote vegetation establishment where vegetation alone will be sufficient for site protection once established. Common temporary GECS are erosion control blankets, open weave meshes/matting and organic erosion control netting.

### Permanent Non-Degradable GECS

These are used to extend the erosion control limits of vegetation, soil, rock or other materials. Common permanent GECS are three dimensional erosion control and revegetation mats, geocellular confinement systems, reno mattresses and gabions.

Use geosynthetic erosion control systems:

- on short steep slopes
- in areas of highly erodible soil
- for armouring of channels
- where there has not been enough room to implement adequate silt retention controls
- for critical erosion-prone areas such as sediment retention pond outlets and inlet points
- in areas that may be slow to establish an adequate vegetative cover
- where a high value downstream environment is at risk and rapid stabilisation is required.

- Large numbers of geotextile products are available for any situation. It is important that the product is designed for its end use and installed and maintained according to its specifications.
- High-risk areas such as spillways and diversions, should have the geotextile pinned down on a 0.5 m grid or in accordance with the manufacturer's specifications.
- Inspect after every rainfall and undertake any maintenance required immediately.
- See Figure 6 for the placement of geosynthetics to minimise erosion.
- See Figure 7 as an example to minimise erosion at a culvert outlet.

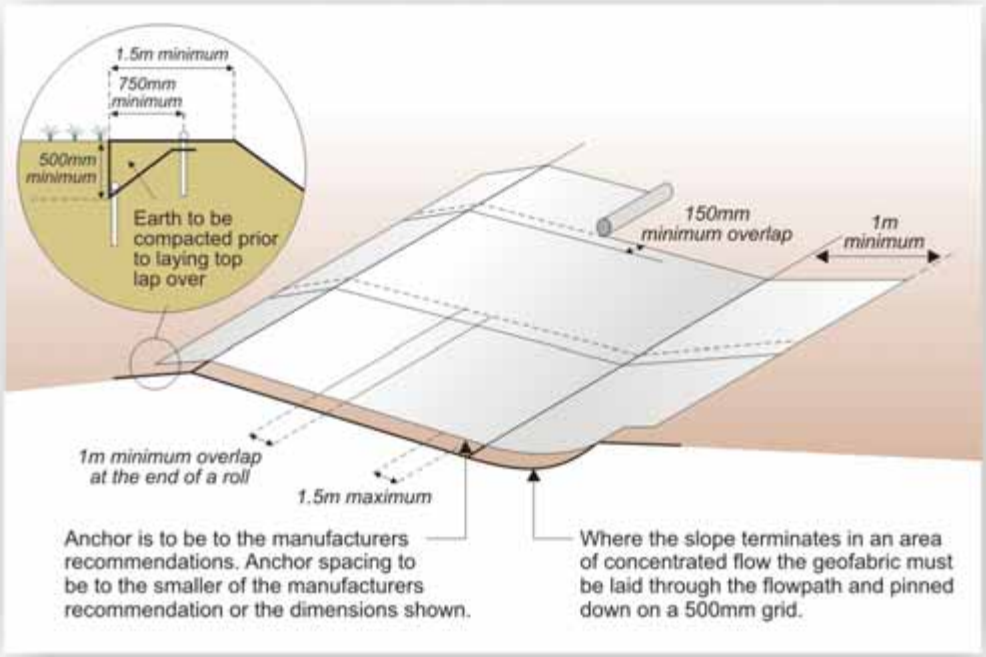



***Figure 6*** *Geosynthetic erosion control systems*

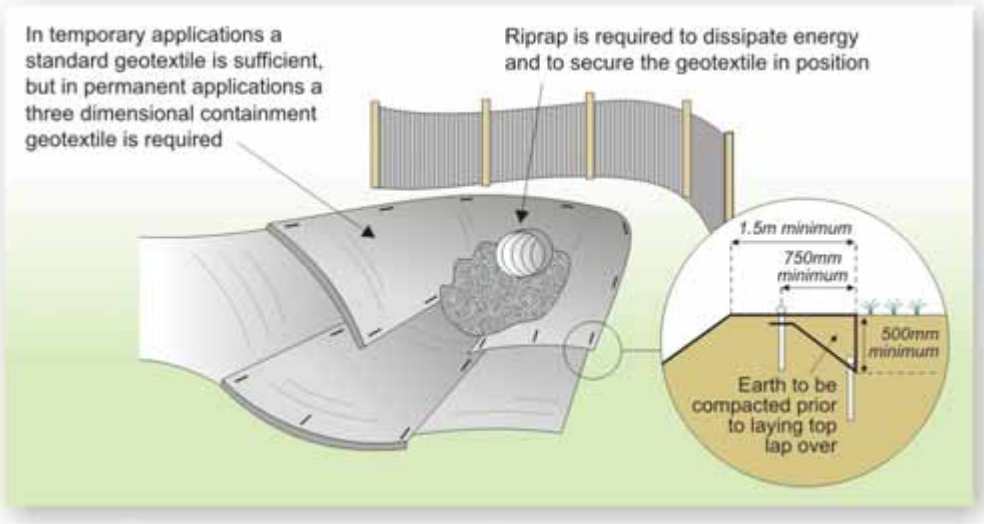



***Figure 7*** *Geotextile at culvert outlet*

## Stabilised construction entrance

The stabilised entranceway should be the first works to occur on site as soil is transferred to the roadway by vehicles will be washed into the stormwater system. All vehicles should use it for site entry and exit.

An entranceway constructed from a generous spread of aggregate will be sufficient on small sites. Use a stabilised construction entrance at all points.

- See Figure 8 for the design of a stabilised construction entrance.
- Clear the entrance and exit area of all vegetation, and other unsuitable material and properly grade it.
- Provide drainage for runoff to sediment control measures.
- Place aggregate to the specifications in Figure 8 below and smooth it.

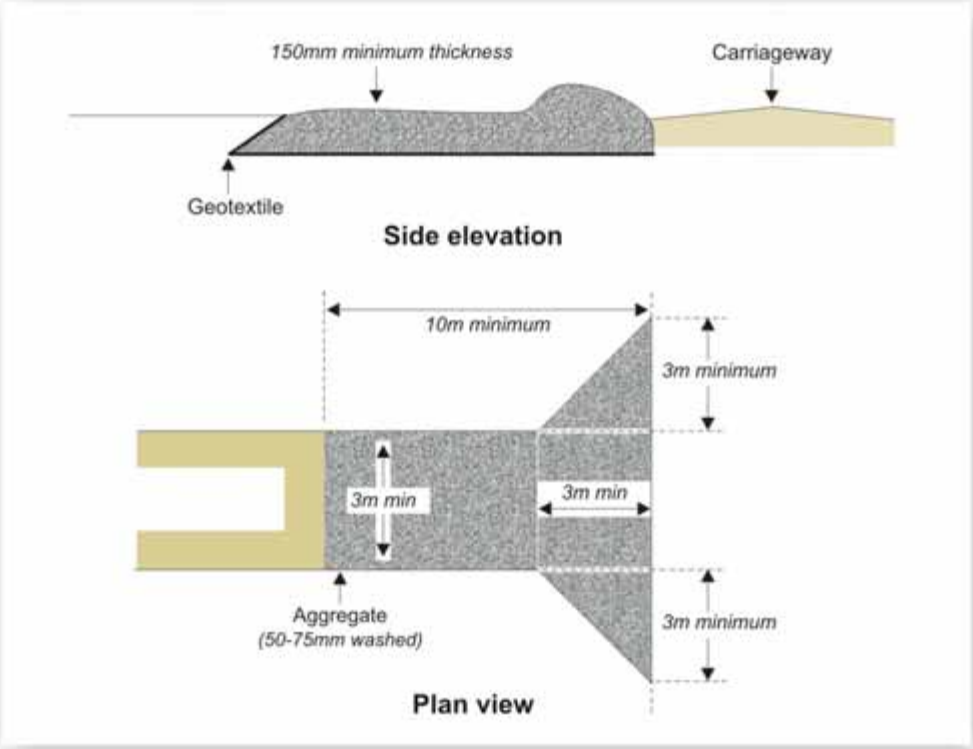



***Figure 8*** *Stabilised construction entrance*

## Pipe drop structure (PDS) or flume

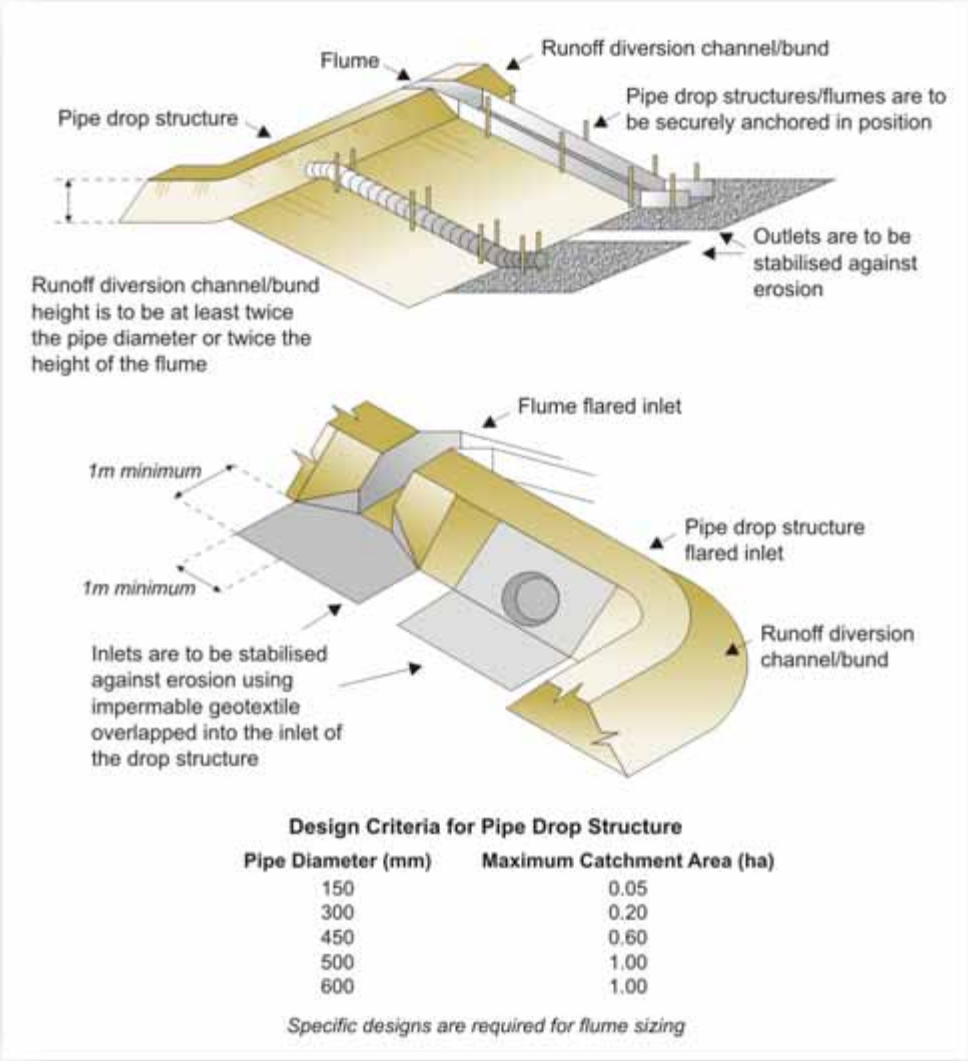
Drop structures are used in conjunction with runoff diversion channels/bunds. The runoff diversion directs surface runoff to the drop structure which conveys concentrated flow down the face of a slope. If pipe drop structures are being considered:

- Limit the catchment area of each pipe or flume to 1 ha.
- Construct all PDS or flumes of watertight materials.
- Extend the PDS or flume beyond the toe of the slope and adequately protect the outlet from erosion.
- Ensure that at the PDS or flume inlet, the height of the runoff diversion channel is at least twice the pipe diameter or height of the flume as measured from the invert.
- Install a flared entrance section of compacted earth to prevent erosion, and place impermeable geotextile fabric into the inlet. The fabric is to extend a minimum of 1 m in front of, and to the side of the inlet and up the sides of the flared inlet. The geotextile is to be keyed 150 mm into the ground all along the edges.
- When the catchment area is disturbed, ensure that the pipe or flume discharges into a sediment retention system or a stable conveyance that leads to a pond.
- When the catchment area is stabilised, ensure that the structure discharges onto a stabilised area at a non-erosive velocity.

- The point of discharge may be protected by rock rip rap.
- Ensure that the structure has a minimum slope of 3 %.
- Place PDS on undisturbed soil or well-compacted fill.
- Inspect the PDS or flume regularly and after each rain event. Carry out any maintenance required immediately.
- See Figure 9 for the design of PDS and flume structures.

## Pipe drop structures

- Secure the pipe drop structure to the slope at least every 4 m, use no less than two anchors equally spaced along the length of the pipe.
- Ensure that all pipe connections are watertight.
- If flexible pipe material is used then ensure that it is pinned in place in the required position.
- Immediately stabilise all disturbed areas following construction.
- A common cause of failure of pipe drop structures is water saturating the soil and seeping along the pipe where it connects to the runoff diversion channel/bund. Backfill properly around and under the pipe with stable material in order to achieve firm contact between the pipe and the soil at all points to eliminate this type of failure.




**Design Criteria for Pipe Drop Structure**

| Pipe Diameter (mm) | Maximum Catchment Area (ha) |
|---|---|
| 150 | 0.05 |
| 300 | 0.20 |
| 450 | 0.60 |
| 500 | 1.00 |
| 600 | 1.00 |

*Specific designs are required for flume sizing*

***Figure 9*** *Pipe drop structures and flume structures*

## Flumes

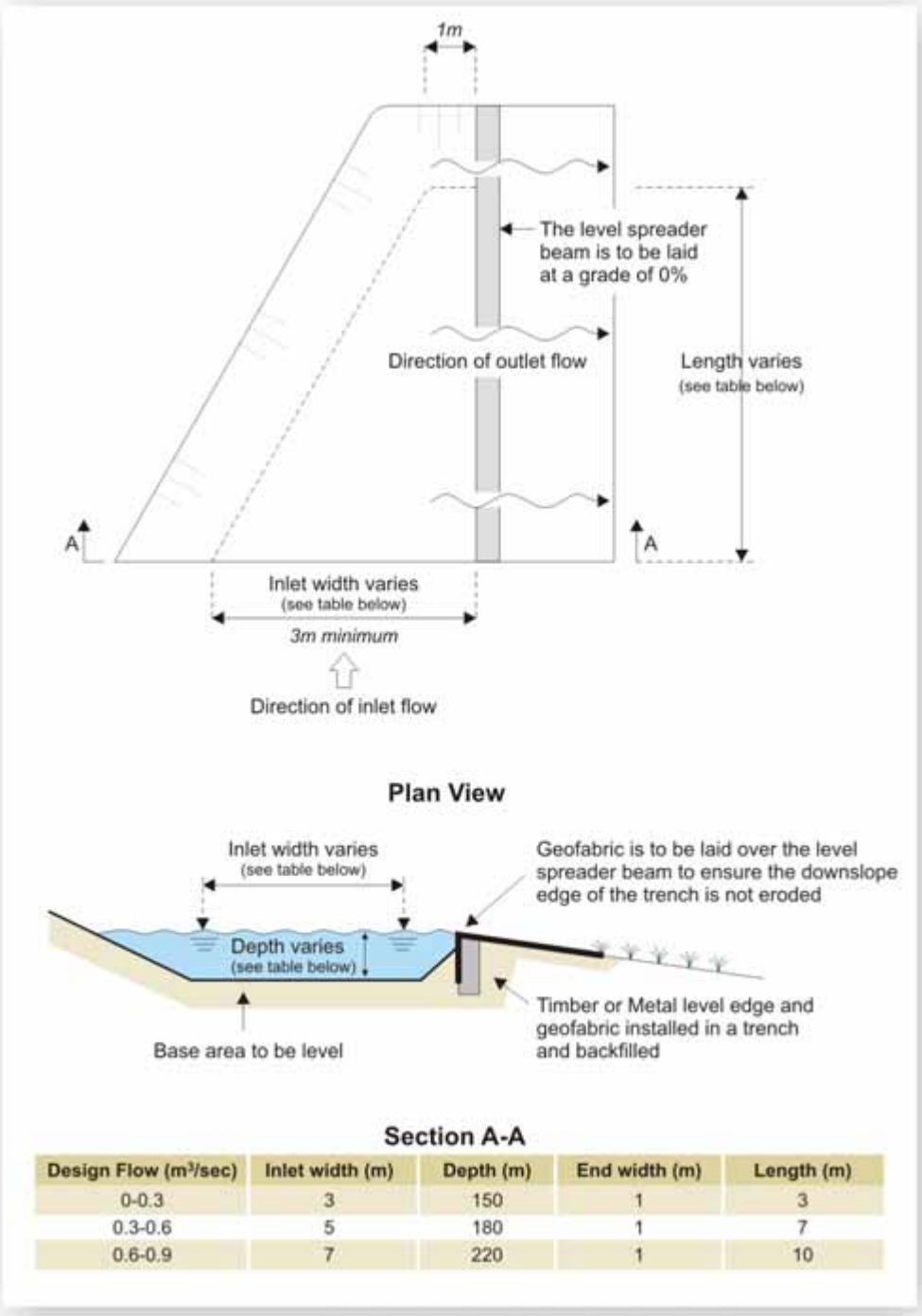
Outflanking of the flume entrance or scouring of the invert into the flume is a common cause of flume failure. Therefore waterproof the entrance to the flume by trenching in an appropriate impervious geotextile or plastic liner so that all flow is directly channelled into the flume. Flumes can be constructed from corrugated steel, construction ply, sawn timber or halved plastic piping. Construct the flume to ensure that there are no leaks, where leakage is likely extend an impervious liner down the full length of the flume structure. Fasten the flume to the slope using waratahs or wooden stakes placed in pairs down the slope at 4 m spacing, depending on the flume material used. Fasten the flume to the waratahs or wooden posts using wire or steel strapping.

## Level spreader

The level spreader provides a relatively low cost option, which can release concentrated flow where site conditions are suitable. Particular care is needed to ensure the level spreader outlet lip is completely level and is in stable, undisturbed soil or is well armoured.

- Can be used for sediment free runoff being released over stabilised slope without causing erosion, or for sediment-laden overland flow to be released across the inlet into a sediment retention pond.
- Use where the area below the level spreader lip is uniform with the slope of 10 % or less and/or is stable for the anticipated flow conditions.
- There should be no traffic over the level spreader.
- Level spreader outlet lip shall be completely level as any depressions will re-concentrate flows resulting in further erosion.
- Level spreader should be in stable, undisturbed soil or well armoured with geotextiles.
- Ensure that the disturbed area is seeded and fertilised for vegetation establishment.
- Determine the capacity of the level spreader by estimating peak flow from the 20 - year storm.
- Inspect level spreaders after every rainfall until vegetation is established and undertake prompt repairs.
- See Figure 10 for the design of a level spreader.


*Design of level spreader*




| Design Flow ($m^3$/sec) | Inlet width (m) | Depth (m) | End width (m) | Length (m) |
|---|---|---|---|---|
| 0-0.3 | 3 | 150 | 1 | 3 |
| 0.3-0.6 | 5 | 180 | 1 | 7 |
| 0.6-0.9 | 7 | 220 | 1 | 10 |

***Figure 10*** *Level spreader cross section and plan view*

# 5. SEDIMENT CONTROL METHODS

Divert roadside water into grassy areas before it can enter a waterbody, thereby reducing the impact of stormwater runoff that may occur immediately after heavy rainfall.

## Hay bale barriers

Hay bales can be used to divert sediment-laden water to treatment devices such as decanting earth bunds, or to divert water to a protected cesspit. It is important that they are installed correctly and are not used as a filter device as they are easily overtopped or scoured out.

- Only use hay bales to meet short term needs (less than one month) as they deteriorate quickly and require frequent maintenance.
- Drainage area should be no more than 0.3 ha per 100 m of hay bales.
- Place hay bales along the contour with bales in a row tightly butted together.
- Dig each bale into the ground 100 mm and place so the bale bindings are horizontal.
- Do not place bales more than one high.
- Only use bale barriers to intercept sheet flow.
- Do not use them as velocity checks in channels or place them where they will intercept concentrated flow.
- Do not use hay bales on slopes exceeding 20 %.
- See Figure 11 for the instalment of hay bales as a barrier.

### Maintenance

Inspect hay bales regularly and after each rain event. Undertake maintenance as necessary. Remove all bales when the site has been fully stabilised.

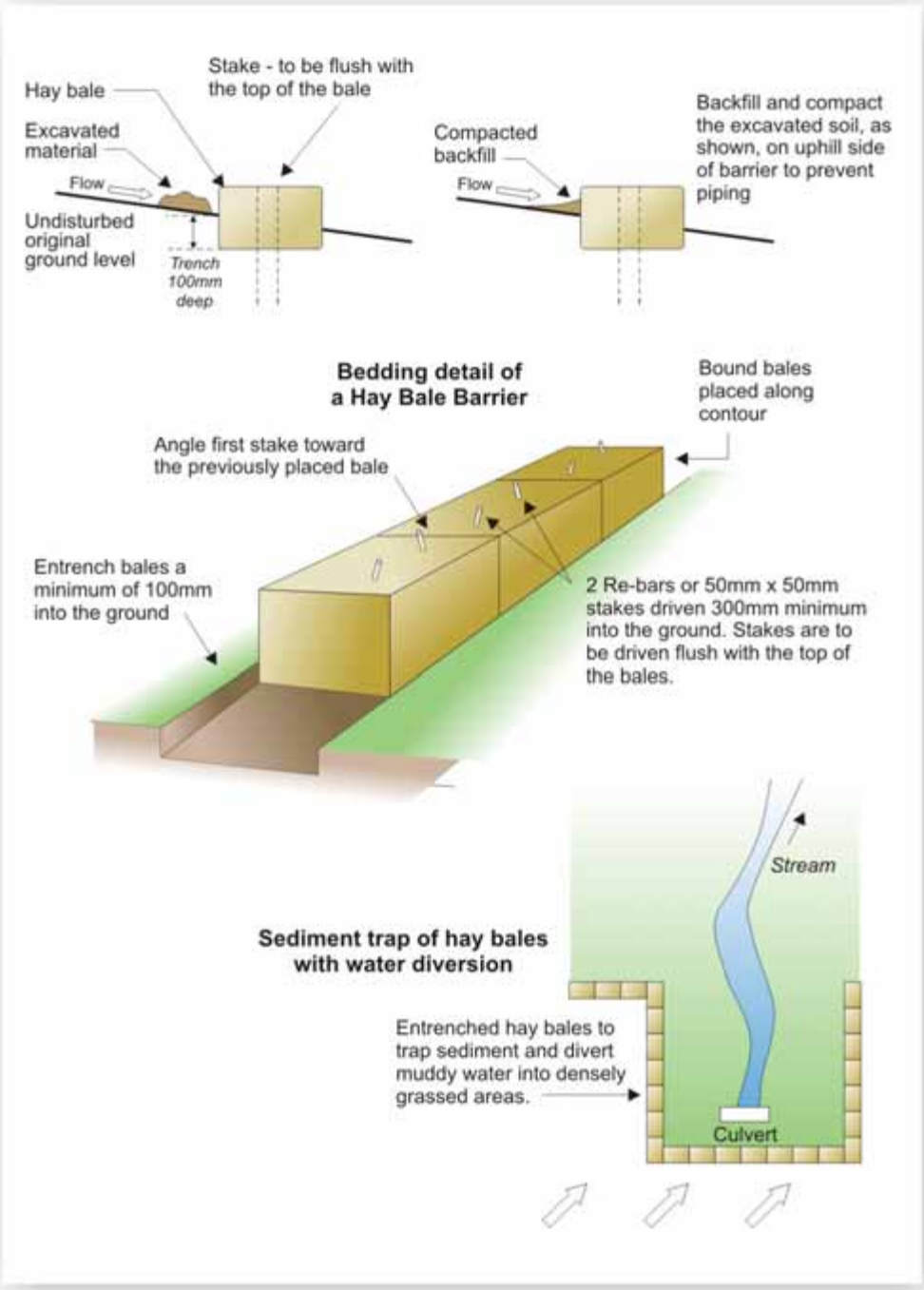



***Figure 11*** *Hay bale barriers*

## Silt fences

Silt fences are useful for small-disturbed areas or sloping areas. For steep slopes, use more than one silt fence and decrease the spacing between fences as the slope increases. Ensure that the ends of the fences come back up the slope 2 m to prevent water going around the edges.
NOTE: Do not install in concentrated flows or in watercourses as silt fences only work with sheet flows. Use silt fences:

- on low gradient sites or for confined areas where the catchment is small, eg around watercourses.
- to delineate the limit of disturbance on an earthworks site such as riparian areas or bush reserves.
- to store runoff behind the silt fence without damaging the fence or the submerged area behind the fence
- Ensure drainage area is no greater than 0.3 ha per 100 m of fence.

- Ensure silt fence height is a minimum of 400 mm above ground level.
- Place supporting posts/waratahs for silt fences no more than 2 m apart unless additional support is provided by tensioned wire (2.5 mm HT) along the top of the silt fence. Where a strong woven fabric is used in conjunction with a wire support, the distance between posts can be extended up to 4 m. Double the silt fence fabric over and fasten to the wire and posts with wire ties or cloth fastening clips at 150 mm spacing. Ensure supporting posts/waratahs are embedded a minimum of 400 mm into the ground.
- Always install silt fences along the contour. Where this is not possible or where there are long sections of silt fence, install short silt fence returns, projecting upslope from the silt fence to minimise concentrations of flows. Silt fence returns are a minimum of 2 m in length, can incorporate a tie back and are generally constructed by continuing the silt fence around the return and doubling back, to eliminate joins.
- Join lengths of silt fence by doubling over fabric ends around a wooden post or batten or by stapling the fabric ends to a batten and butting the two battens together as shown in Figure 11
- Use of silt fences in catchments of more than 0.5 ha requires careful consideration of specific site measures, and other control measures may be better, such as super silt fence.
- Where water may pond behind the silt fence, provide extra support for the silt fence with tie backs from the silt fence to a central stable point on the upward side. Extra support can also be provided by stringing wire between support stakes and connecting the filter fabric to this wire.
- Reinforce the top of the silt fence fabric with a wire support made of galvanised wire of a minimum diameter of 2.5 mm. Tension the wire using permanent wire strainers attached to angled waratahs at the end of the silt fence.
- Where ends of silt fence fabric come together, ensure they are overlapped, folded and stapled to prevent sediment bypass.
- Maximum slope length and angle for which a silt fence is applicable is shown in table
- See Figure 12 for the construction of silt fences.

| Slope site (%) | Slope length |
|---|---|
| 5 | 25 |
| 10 | 20 |
| 15 | 15 |

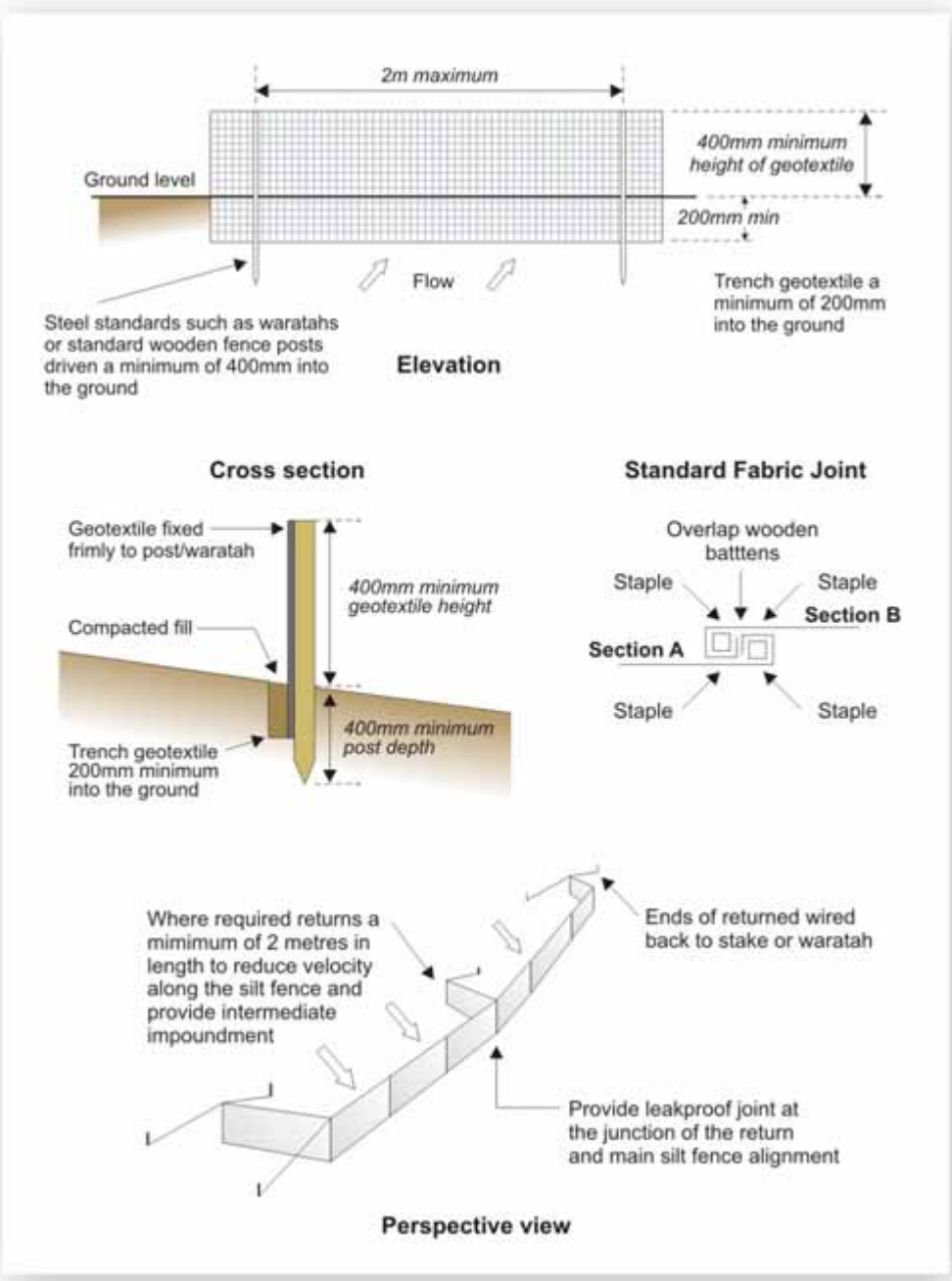



***Figure 12*** *Silt fence construction*

## Super silt fences

Super silt fences are temporary barriers of geotextile fabric over chain link fences. They are used to intercept flows, reduce velocity and impound sediment-laden runoff from small catchment areas.

A super silt fence provides a much more robust sediment control than a standard silt fence and allows up to four times the catchment area to be treated than by an equivalent length of standard silt fence.

When considering Super Silt Fence installation for larger catchments (greater than 0.5ha), carefully consider the specific site conditions and other alternative control measures available. The length of the Super Silt Fence is based on the limits shown in the table below. Limits imposed by ultraviolet light affect the stability of the fabric and will dictate the maximum period that the Super Silt Fence can be used. Where the ends of the geotextile fabric come together, overlap, fold and staple the fabric ends to prevent sediment bypass. Super Silt Fence:

- Provides a barrier that can collect and hold debris and soil, preventing the material from entering critical areas, watercourses and streets.
- Can be used where the installation of an Earth or Topsoil Bund would destroy sensitive areas such as bush and wetlands.
- Should be placed as close to the contour as possible. No section of the fence should exceed a grade of 5 % for a distance of more than 15 m.

**Super silt fence design criteria:**

| Slope % | Slope Length (0) (maximum) | Super Silt Fence Length (0) (maximum) |
|---|---|---|
| 0-10 | Unlimited | Unlimited |
| 10-20 | 60 | 450 |
| 20-33 | 30 | 300 |
| 33-50 | 30 | 150 |
| >50 | 15 | 75 |

Specifications

- Use a Silt Fence fabric that is appropriate to the site conditions and fits the manufacturer's specifications.
- Excavate a trench 100 mm wide by 200 mm deep along the line of the Super Silt Fence.
- Position the posts (No. 3 rounds, No. 2 half rounds or waratahs) at no greater than 3.0 m centres on the down slope side of the trench. While there is no need to set the posts in concrete, ensure the 1.8 m long posts are driven to an appropriate depth (1 m minimum).
- Install tensioned galvanised wire (2.5 mm HT) at 400 mm and again at 800 mm above ground level using permanent wire strainers.
- Secure chain link fence to the fence posts with wire ties or staples, ensuring the chain link fence goes to the base of the trench.
- Fasten two layers of geotextile fabric securely to the Super Silt Fence with ties spaced every 60 cm at the top and mid section of the super silt fence.
- Place the two layers of geotextile fabric to the base of the trench (a minimum of 200 mm into the ground) and place compacted backfill back to the original ground level.
- When two sections of geotextile fabric adjoin each other, ensure they are doubled over a minimum of 300 mm, wrapped around a batten and stapled at 75 mm spacing to prevent sediment bypass.

**Maintenance**

Inspect regularly and before and after storm events. Undertake maintenance as needed and remove silt build-ups when bulges develop in the Super Silt Fence or when sediment deposition reaches 50 % of the Super Silt Fence height.

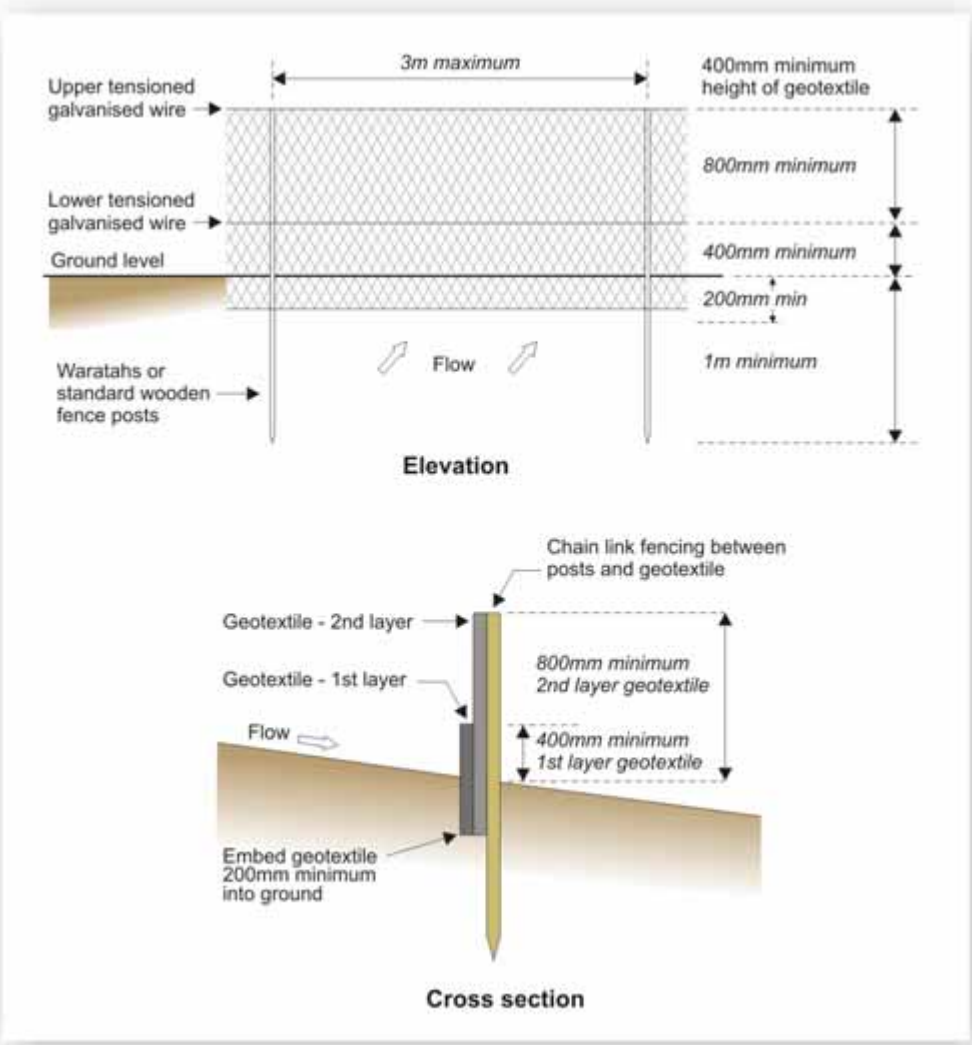



***Figure 13*** *Super silt fence construction*

## Sediment traps and retention ponds

Sediment retention ponds and sediment traps are appropriate where treatment of sediment laden runoff is necessary. Sediment retention ponds and sediment traps are generally considered the appropriate control for exposed catchments of more than 0.3 ha. It is vital that both types of controls are maintained until the disturbed area is fully protected against erosion by permanent stabilisation. The location of the structures needs to be carefully considered in terms of the overall project, available room for construction and maintenance.

- For areas less than 0.3 ha, for very steep areas, or long narrow road sites that are currently being worked, it can be impractical to install sediment traps or ponds, in those instances install another method of sediment control (eg silt fencing).
- Install at the start of site development and retain until works are completed and the site is protected from runoff by permanent stabilisation measures.
- Place small sediment traps at strategic places such as at site boundaries or culvert pipe inlets, before runoff enters a waterbody.
- Do not place sediment retention facilities within watercourses.
- Sediment retention facilities operate to capture a significant portion of the design runoff event, and to provide still conditions which promote the settling of suspended materials. The sediment retention facility design is such that very large runoff events will receive at least partial treatment and smaller runoff events will receive a high level of treatment. For this to occur, the energy levels at the inlet need to be low so as to minimise re-suspension of sediment, and low energy at the exit

point so that potential for water currents is minimised. In addition, the size of the facility must provide sufficient detention time for the suspended sediment to settle out.

- Design the pond with a minimum volume of 1 % of the contributing catchment.
- See Figure 14 for the design of a sediment retention pond, and Figure 15 for a sediment pond embankment.

**Example calculation for a 1 % pond 1 m deep:**

For every 1 hectare of catchment area, 100 $m^3$ is required in the pond.

- Ensure that the pond length to width ratio is greater than 2:1 to improve trapping efficiency and that inflows enter the pond as far from the outlet as possible.
- Ponds are generally 1 - 2 m deep but no deeper than 2 m.
- Install a level spreader into the inlet to spread inflow velocities and therefore dissipate the inflow energy.
- Dead storage is the component of runoff captured that does not decant and remains in the sediment retention trap or pond. It is important for dissipating inflow energy and should be 30 % of the total sediment retention trap or pond storage ability.
- De-water the trap or pond so as to remove the relatively clean water without removing any of the settled sediment and without removing any appreciable quantities of floating debris.
- Ensure that trap and pond embankments are well compacted and not made of porous material, eg sand.
- Traps and ponds should be designed to automatically de-water for safety reasons.
- Preferably, locate traps and ponds so that they discharge over undisturbed, well vegetated ground.
- Check traps and ponds after every rainfall and during periods of heavy rain.
- Remove sediment when the trap or pond is half-full.
- All weather access to traps and ponds to enable cleaning out is essential.
- Check traps and ponds after every rainfall and during periods of heavy rain.
- All weather access to traps and ponds to enable cleaning out is essential.

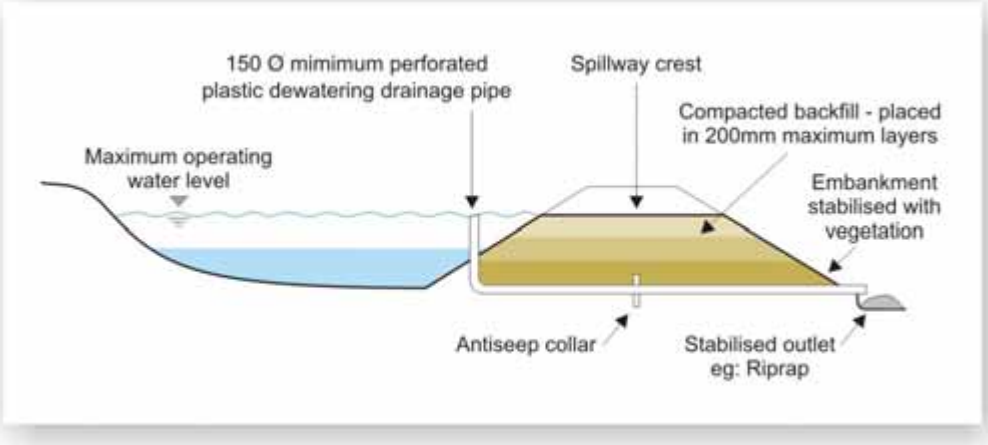



***Figure 14*** *Cross section of a sediment pond embankment*

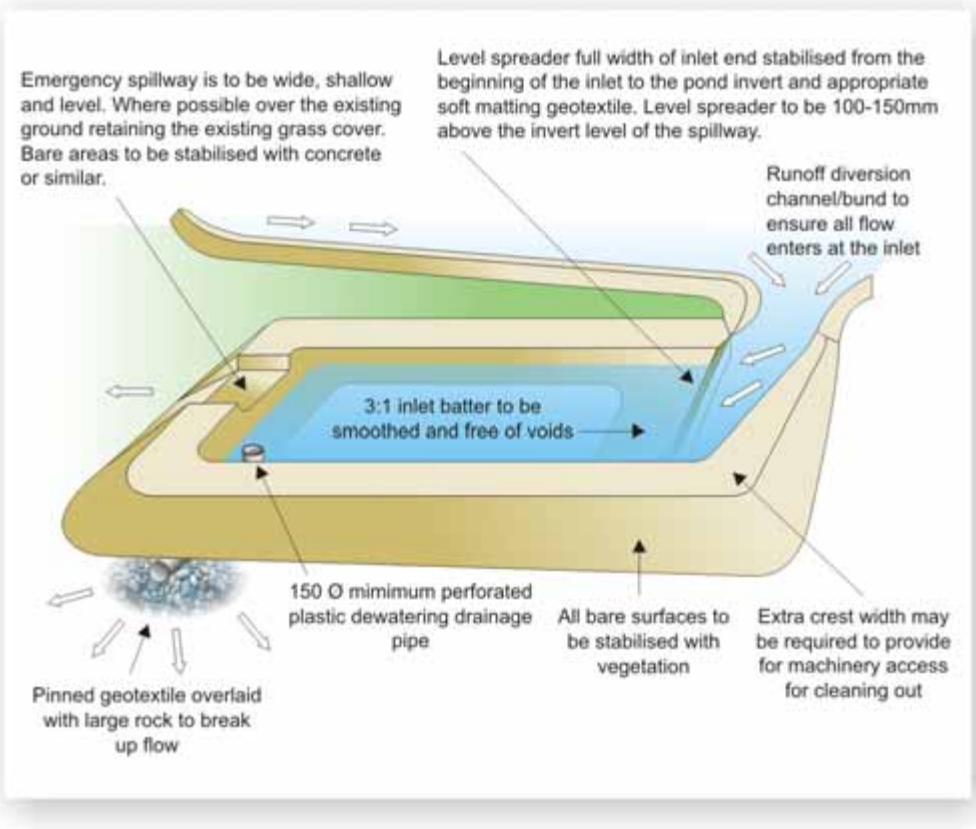



***Figure 15*** *Perspective view of a sediment retention pond*

*Sediment trap*

## Stormwater inlet protection

Sediment-laden runoff is intercepted and filtered via a cesspit before it enters a reticulated storm water system. This prevents sediment-laden flows from entering receiving environments. The protection may take various forms depending upon the type of inlet to be protected. Stormwater inlet protection is a secondary sediment control device and must only be used in conjunction with other erosion and sediment control measures.

If good erosion and sediment control measures are in place on the site, then stormwater inlet protection will not be required. Use only in small catchments of less than 0.5 ha.

Filter cloth across cesspits may be used on a temporary basis as a last resort for sediment control. However, this is not an effective control measure as filters block quickly and are difficult to install and maintain. Cesspit inserts can be brought which are geotextile lined cages which sit under the cesspit grate. The filters need to be replaced after each rain event and the cages can be used on any site.

There are various designs options for stormwater inlet protection as in Figure 16 and below:

**Silt fence design**: involves a silt fence being erected around the inlet. This method is appropriate where cesspits have been connected to a stormwater system and are collecting runoff from disturbed soil surfaces.

**Filter media design:** two common methods use geotextile and scoria or gravel to treat sediment-laden flows. All points where the runoff can enter the cesspit must be protected with suitable geotextile fabric.

**Check dams:** place a series of low sandbag check dams up the gutter from cesspits to act as a series of sediment traps. The check dams require a spillway lower than the kerb to ensure that runoff does not encroach onto the berm area and cause scouring. Construct check dams out of up to six sandbags laid end to end with no gaps in an arc away from the kerb and up the road to create a series of impoundment areas.

- Excavated inlet protection: excavating around a stormwater inlet creates storage capacity where suspended material can settle out. Ensure that seepage holes allow for filtered dewatering and that storage capacity of 1 % of the drainage catchment should be provided for around the inlet (ie 1 $m^3$ of capacity per hectare of contributing catchment).
- Inspect all stormwater inlet protection measures following any rainfall event and maintain as necessary to ensure that they operate effectively.
- Maintenance requirements for cesspit protection measures are high because they clog easily. When clogging occurs, remove accumulated sediment and clean or replace the geotextile fabric and aggregate.

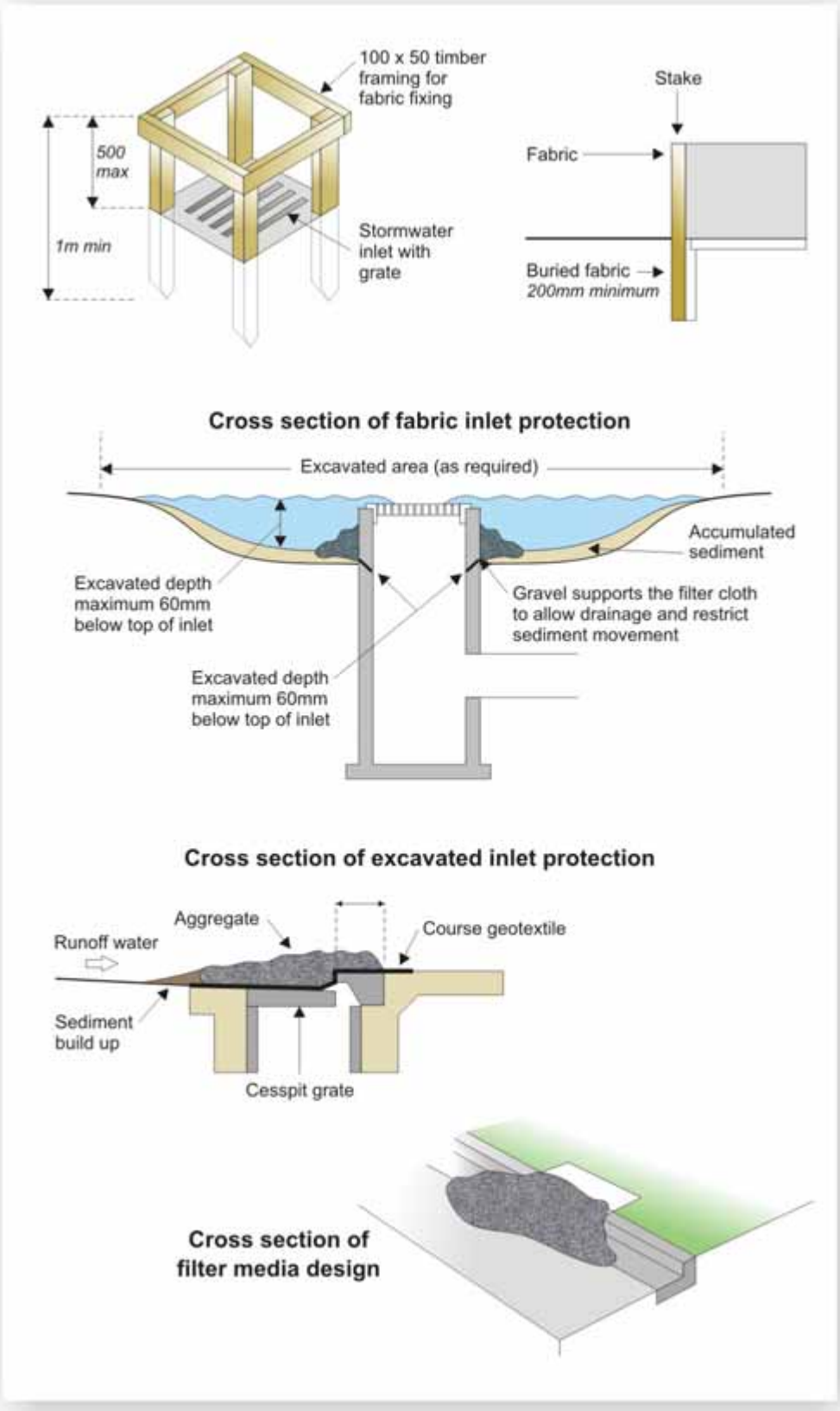



***Figure 16*** *Various types of stormwater inlet protection*

## Decanting earth bund

Earth bunds can be constructed across disturbed areas and around construction sites and subdivisions. Keep them in place until the disturbed areas are permanently stabilised or adequately replaced by other means. Earth bunds can assist the settling of sediment-laden runoff. Earth bunds are particularly useful for controlling runoff after topsoiling and grassing before vegetation becomes established. Where works are occurring within the berm area, compact the topsoil over the berm area as bunds adjacent and parallel to the berm. This will act as an impoundment area and controlled outfall while also keeping overland flow away from the construction area.

- Earth bunds need a constructed outlet structure and spillway as designed for sediment retention ponds. Alternatively, construct an outlet of perforated pipe connected to a non-perforated pipe that passes through the earth bund. Ensure that the section of pipe within the impoundment area is supported by means of a rigid post, allowing filtration to occur.
- Ensure the top opening of the perforated pipe is 100 mm lower than the stabilised spillway.
- Ensure the section of pipe leading through the earth bunds and continuing down slope below the earth bunds is non-perforated.
- Construct the earth bunds such that the maximum contributing catchment does not exceed 0.3 ha.
- Position the decant inlet to provide 50 % live storage volume with a minimum distance of 5 m of flat ground from the inlet. Otherwise, raise the inlet so the dead storage level extends out at least this far.

### Maintenance

Inspect and maintain earth bunds regularly and after each rainfall event to check for accumulated sediment, which may cause overtopping. Check any discharge points for signs of scouring and install further armouring or other stabilisation if scouring is evident.

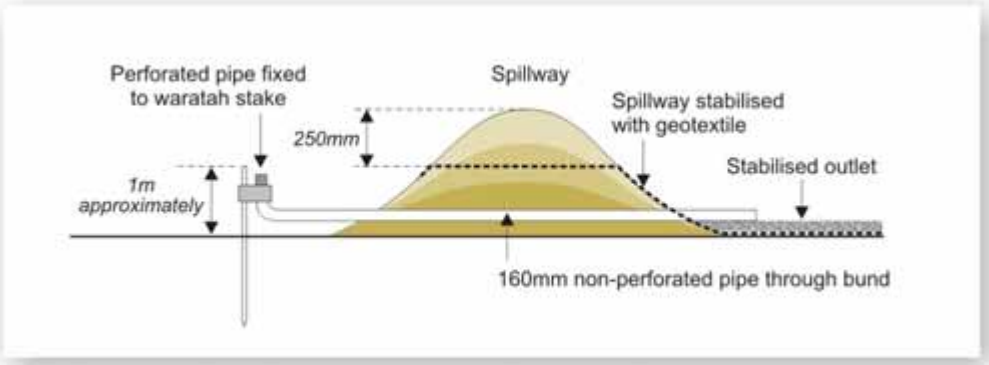



***Figure 17*** *Cross section of an earth bund*

# 6. WORKS WITHIN A WATERBODY

Works within watercourses have very high potential for erosion and discharge of sediment. Flowing water is the major cause of erosion. It causes ongoing scour and provides the transport mechanism to allow sediment to be dispersed downstream of the works and ultimately into marine environments.

Such works may also require a range of control measures additional to those detailed below. These other measures are described in other sections of these guidelines and include both erosion control and sediment control techniques.

## Temporary watercourse diversion

Temporary watercourse diversions are used as temporary measures to allow any works to be undertaken within permanent watercourses. A short term watercourse diversion will allow works to occur within the main watercourse channel under dry conditions without moving sediment into the watercourse.

- Divert all flow via a stabilised system around the area of works and discharge it back into the channel below the works to avoid scour of the channel bed and banks. Figure 18 shows the suggested steps to minimise sediment generation and discharge from works within a watercourse.
- Excavate the diversion channel leaving a plug at each end so that the watercourse does not breach the diversion. Size the diversion channel to allow for five-year storm event. Stabilise the diversion channel appropriately to ensure it does not become a source of sediment. Anchor suitable geotextile cloth in place to the manufacturer's specifications, which will include trenching into the top of both sides of the diversion channel to ensure that the fabric does not rip out. Open the downstream plug and allow water to flow up the channel, keeping some water within the channel to reduce problems when the upstream plug is excavated. Open the upstream plug and allow water to flow into the channel.
- Immediately place a non-erodible dam in the upstream end of the existing channel. Construct the dam as specified in Figure 14, where a compacted earth bund has shotcrete/concrete placed, or appropriate geotextile pinned over it, with rock rip-rap extending over the upper face and adjacent to the lower face for scour protection.
- Immediately install a non-erodible downstream dam to prevent backflow into the construction area. Drain the existing watercourse by pumping to a sediment retention pond where treatment of the ponded water can occur prior to re-entering the live section of the watercourse. Construct the structure and complete all channel work.
- Remove the downstream dam first, allowing water to flood back into the original channel. Remove the upstream dam and fill in both ends of the diversion channel with non-erodible material. Pump any sediment-laden water to a sediment retention pond. Fill in the remainder of the diversion and stabilise.

### Maintenance

Any works within a watercourse will require ongoing and vigilant maintenance to minimise sediment generation. To achieve this, identify and correct any aspects that may indicate potential problems. Make repairs immediately.

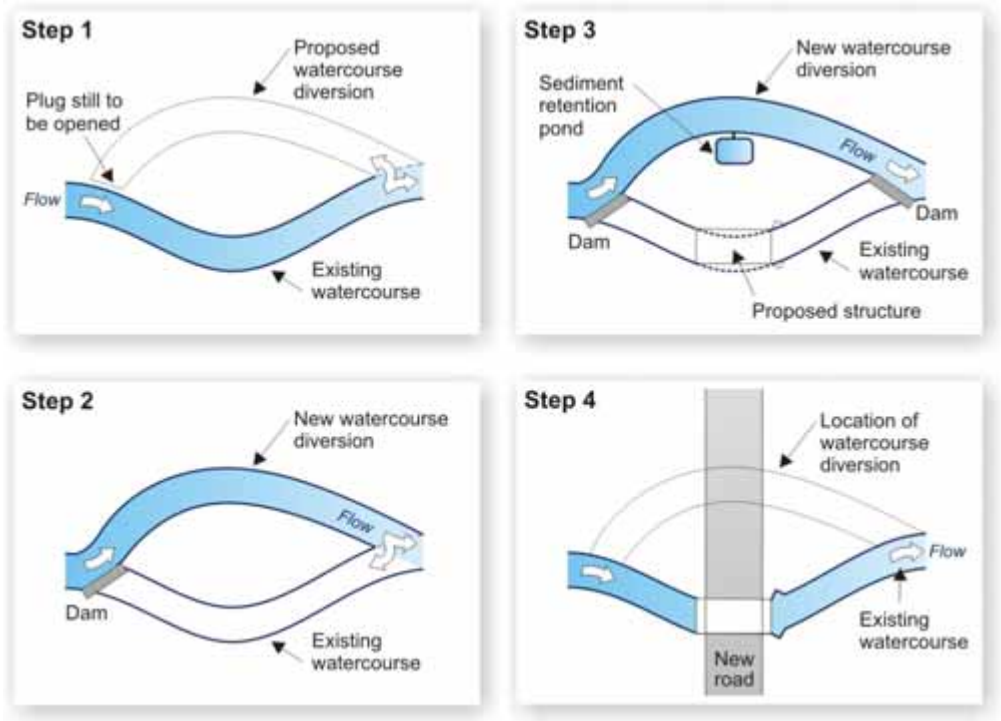



***Figure 18*** *Temporary watercourse diversion*

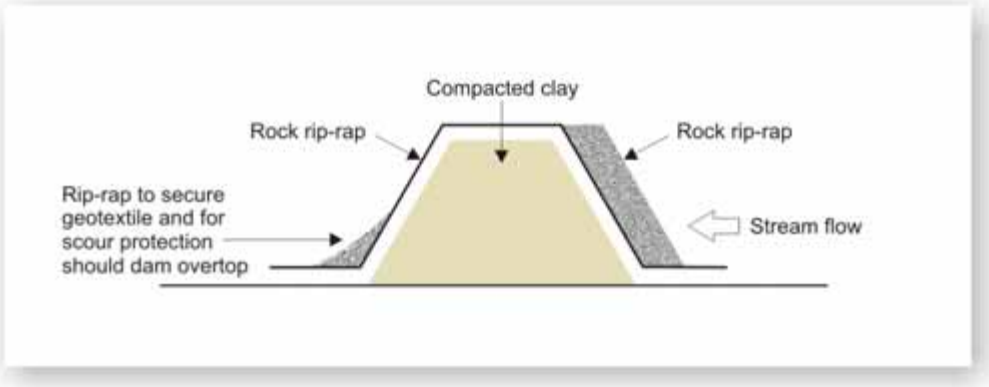



***Figure 19*** *Cross section dam detail*

## Temporary watercourse crossing

Temporary watercourse crossings such as bridges or culverts are used where heavy equipment is required to be moved from one side of a watercourse to the other; or where traffic must cross the watercourse frequently for a short period of time without moving sediment into the watercourse or damaging the bed or channel

Careful planning can minimise the need for watercourse crossings. Wherever possible, avoid crossing the watercourses by completing the development separately on each side of the channel, thus leaving the watercourse in its natural state.

- If no other option exists and a watercourse crossing is required, select a location where the potential effects of the crossing (including construction) are minimised.
- Plan watercourse crossings well before you need them and if possible, construct them during periods of dry weather.
- Complete construction as rapidly as possible and stabilise all disturbed areas immediately during and following construction.

The two main types of crossing are bridges and culverts.

**Bridges -** where available materials and designs are available to bear the expected loadings, bridges are the preferred temporary watercourse crossing method. They provide the least obstruction to flow and fish migration, cause little or no modification of the bed or banks and generally require little maintenance. It should be noted, however, that bridges can be a safety hazard if not designed, installed and maintained appropriately.

**Culvert Crossings -** culverts are the most commonly used type of temporary watercourse crossing, and can be adapted to most site conditions. The installation and removal of culverts, however, causes damage to watercourses and can create the greatest obstruction to flood flows.

As well as erosion and sediment control measures, structural stability, utility and safety must also be taken into account when designing temporary watercourse crossings. Any temporary crossing must comply with the technical requirements of the various agencies involved and any specific requirements imposed by the Taranaki Regional Council.

When the structure is no longer needed, remove the structure and all material from the site. Immediately stabilise all areas disturbed during the removal process by re-vegetation or artificial protection as a short term control measure. Keep machinery clear of the watercourse while removing the structure.

### Maintenance

Inspect temporary watercourse crossings after rain to check for blockage in the channel, erosion of the banks, channel scour or signs of instability. Make all repairs immediately to prevent further damage to the installation.

## Rock outlet protection

This practice applies where discharge velocities and energies at the outlets of pipes, culverts or flumes are sufficient to cause erosion. This involves the placing of rock (rip-rap) at the outfall of channels or culverts.

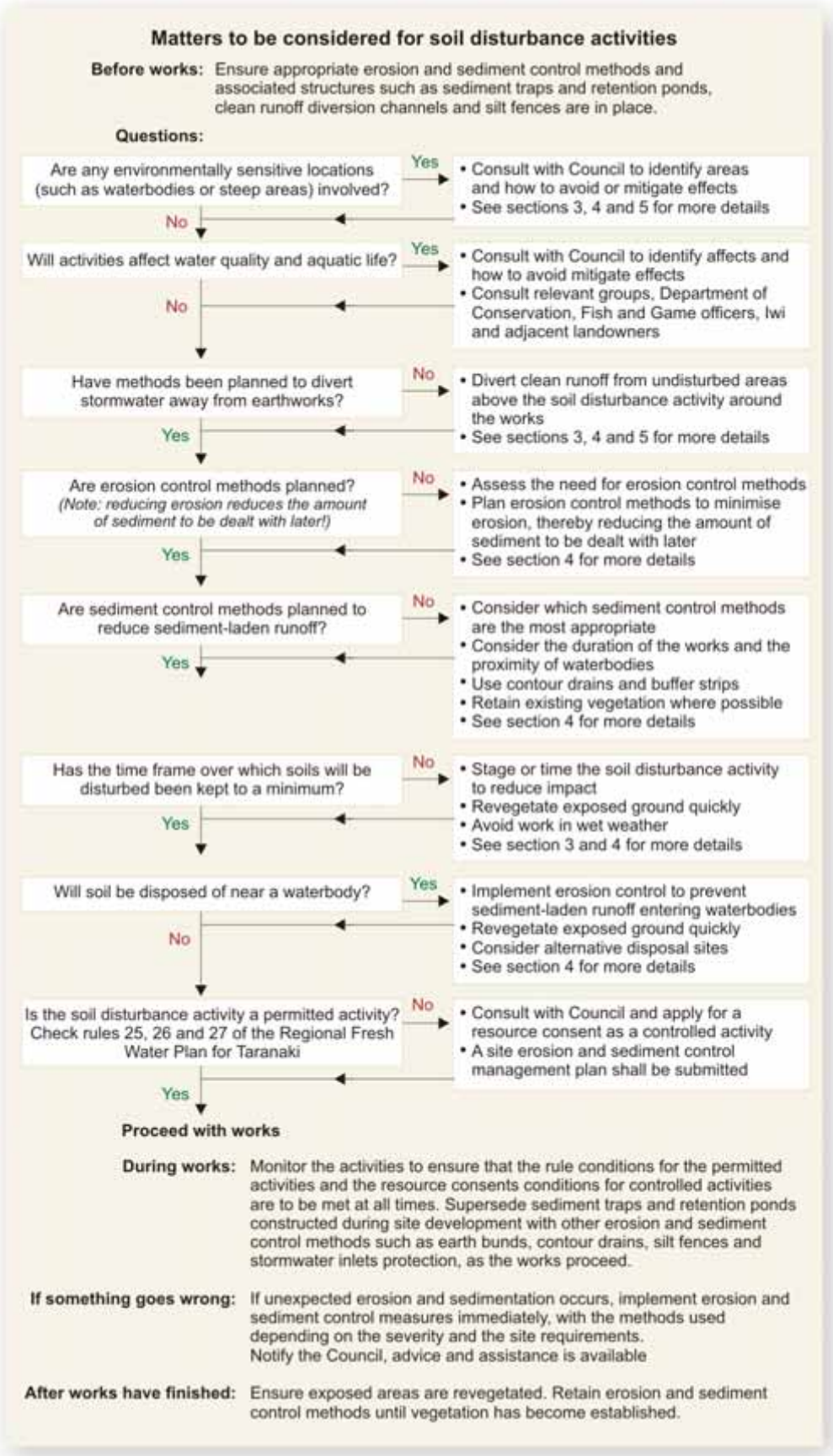
- Detailed design of rock outlet protection depends on the location.
- Do not use rock outlet protection to protect pipe outlets at the top of cuts or on slopes steeper than 10 % without further armouring of the receiving channel.
- Ensure correct rock sizing such that there is minimum movement during maximum flow velocity.
- Remove soft material down to a firm bed and smooth and level the outfall area to eliminate voids.
- Ensure rip-rap is composed of a well graded mixture of washed rock if required and has an appropriate geotextile placed underneath to prevent soil movement into and through the rip-rap.
- Rock containments systems such as gabion baskets and reno-mattresses provide greater risk management and can provide additional batter support. They should be considered for all outlets where flow velocities are high.
- Construct gabion baskets using heavy galvanised steel wire. Ensure foundation conditions for the gabion baskets/reno mattresses are the same as for rock rip-rap and place filter cloth beneath all gabion baskets. In some circumstances a key may be needed to prevent undermining of the main gabion structure.
- Design the structure and use materials within the relevant manufacturer's and engineering specifications.
- Reno-mattresses may require pinning to the apron of the headwall or the substrate to prevent downstream movement.
- Remember that works within a watercourse such as the placement of rock rip-rap or gabion baskets may require a resource consent from Taranaki Regional Council**.** Contact us well ahead of time so that any consents needed may be obtained before works are due to start.

### Maintenance

Once installed, the maintenance requirements of such structures is very low. Inspect after high flows to check scour and dislodgement and make repairs immediately.

## 7. EROSION AND SEDIMENT CONTROL CHECKLIST

Below is a checklist that we recommend you consider when undertaking soil disturbance activities.



## 8. GLOSSARY

| | |
|---|---|
| **Bund** | A mound or embankment of earth or other material. |
| **Contour** | A line across a slope connecting points of the same elevation. |
| **Controlled activity** | This is an activity which;<br>a) is provided for, as a controlled activity, by a rule in a plan;<br>b) complies with standards and terms specified in a plan for such activities;<br>c) is assessed according to the matters the consent authority has retained control over in the plan; and<br>d) is allowed only if a resource consent is obtained in respect of that activity. |
| **Dam** | A barrier or embankment which confines water. |
| **Drainage** | The removal of excess surface water or groundwater from land by means of surface or subsurface drains. |
| **Embankment** | A long mound of earth or the exposed face formed when soil is excavated or deposited. |
| **Erosion** | The natural process of wearing away of the land surface (including soil, regolith or bedrock) by natural agents and the transport of the derived material. |
| **Fill** | Material, usually excavated soil or on an area. |
| **Geotextile fabric** | A woven or non-woven, impermeable or semi-permeable material generally made of synthetic products such as polypropylene and used in a variety of engineering, stormwater management, and erosion and sediment control applications. |
| **Hydroseeding** | The spraying of a slurry of seed, fertiliser and paper or wood pulp over a surface to be re-vegetated. |
| **Level spreader** | A device used to convert concentrated flow into sheet flow. |
| **Mulch** | Covering on the surface of soil to protect it and enhance certain characteristics, such as protection from rain drop impacts and improving germination. |
| **Permitted activity** | An activity that that is allowed by a plan without resource consent if it complies in all respects with any conditions specified in the plan. |

| | |
|---|---|
| **Road works** | Disturbance of the landscape in order to construct or maintain a road. |
| **Runoff** | Surface discharge or flow of water. |
| **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. |
| **Soil** | The unconsolidated mineral and organic material on the surface of the earth that serves as a natural medium for the growth of land plants.<br><br>Earth and rock particles resulting from the physical or chemical disintegration of rocks, which may or may not contain organic matter. Includes fine material, sand and gravel. |
| **Soil disturbance activities** | Includes earthworks associated with roading and tracking, formation of skid or landing sites, subdivision, pipeline trenching and land contouring, but do not include land disturbed for cultivation, cropping and harvesting (including logging), or industrial and trade premises. |
| **Spoil** | Earth brought up in excavation or dredging. |
| **Surface water** | All water with it's surface exposed to the atmosphere. |
| **Topsoil** | Fertile or desirable soil material (suitable organic and structural properties) used to top-dress road banks, sub-soils and parent material to provide a suitable medium for plant growth. |
| **Waterbody** | Means fresh water or geothermal water in a river, lake stream, pond, wetland, or acquifer, or any part thereof, that is not located within the coastal marine area. |
| **Wetland** | Includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystems of plants and animals that are adapted to wet conditions. |

# Appendix I
# Rules 25-27 from the Regional Fresh Water Plan for Taranaki.
# Discharge of stormwater

| Activity | Rule | Standards/Terms/Conditions | Classification | Notification | Control/Discretion | Policy Reference |
|---|---|---|---|---|---|---|
| Discharges of stormwater and sediment deriving from soil disturbance activities of 1 hectare or less;<br>• into surface water (excluding those wetlands listed in appendix II and/or<br>• onto or into land in circumstances where sediment from soil disturbance may enter water. | 25 | • The discharge shall not derive from an area of soil disturbance greater than 1 hectare; [1]<br>• The discharge shall not derive from a volume of soil disturbance greater than $3000m^3$; [1]<br>• Soil stabilisation shall be undertaken as soon as practicable after the completion of the works;<br>• Discharge to surface water shall contain less than $100gm^{-3}$ suspended solids;<br>• Discharge to surface water shall not give rise to any or all of the following effects in the receiving water after reasonable mixing:<br>(a) The production of any conspicuous oil or grease films, scums, or foams, or floatable or suspended materials;<br>(b) Any conspicuous change in the colour or visual clarity;<br>(c) Any emission of objectionable odour;<br>(d) The rendering of fresh water unsuitable for consumption by farm animals;<br>(e) Any significant adverse effects on aquatic life. | Permitted | | | |

[1] *For the purpose of this rule the area/volume of soil disturbance is defined as the total area of uncompacted and/or unvegetated exposed soil on any particular property or contiguous properties within the control of any particular person or persons.*

# Discharge of stormwater (continued)

| Activity | Rule | Standards/Terms/Conditions | Classification | Notification | Control/Discretion | Policy Reference |
|---|---|---|---|---|---|---|
| Discharges of stormwater and sediment deriving from soil disturbance activities of between 1 and 8 hectares;<br>• Into surface water (excluding those wetlands listed in appendix II) and/or<br>• onto or into land in circumstances where sediment from the soil disturbance may enter water. | 26 | • The discharge shall not derive from an area of soil disturbance greater than 8 hectares; [2]<br>• The discharge shall not derive from a volume of soil disturbance greater than 24,000$m^3$ ;[2]<br>• The discharge shall not derive from soil disturbance which takes place between 1 May and 31 October;<br>• The discharge shall not derive from soil disturbance which takes place within a defined urban catchment;[3]<br>• Soil stabilisation shall be undertaken as soon as practicable after the completion of the works;<br>• Discharge to surface water shall contain less than 100$gm^{-3}$ suspended solids;<br>• Discharge to surface water shall not give rise to any or all of the following effects in the receiving water after reasonable mixing:<br>(a) The production of any conspicuous oil or grease films, scums, or foams, or floatable or suspended materials;<br>(b) Any conspicuous change in the colour or visual clarity;<br>(c) Any emission of objectionable odour;<br>(d) The rendering of fresh water unsuitable for consumption by farm animals;<br>(e) Any significant adverse effects on aquatic life. | Permitted | | | |



[2] *For the purpose of this rule the area/volume of soil disturbance is defined as the total area of uncompacted and/or unvegetated exposed soil on any particular property or contiguous properties within the control of any particular person or persons.*

[3] *Defined urban catchments are shown in Appendix IX of the Regional Fresh Water Plan for Taranaki.*

# Discharge of stormwater (continued)

| Activity | Rule | Standards/Terms/Conditions | Classification | Notification | Control/Discretion | Policy Reference |
|---|---|---|---|---|---|---|
| Discharge of stormwater and sediment into surface water (excluding those wetlands listed in appendix II), or onto or into land in circumstances where sediment from soil disturbance may enter water, from soil disturbance activities that do not come within or comply with the conditions of rules 25 or 26. | 27 | • A site erosion and sediment control management plan shall be submitted to the Taranaki Regional Council. | Controlled | May be non-notified without written approval | • Approval of a site erosion and sediment control management plan and the matters contained therein;<br>• Setting of conditions relating to adverse effects on water quality and the values of the waterbody;<br>• Timing of works;<br>• Any measures necessary to reinstate the land following the completion of the activity;<br>• Monitoring and information requirements;<br>• Duration of consent;<br>• Review of conditions of consent and the timing and purpose of the review;<br>• Payment of administrative charges and financial contributions. | 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.1.7, 3.2.1,3.2.2, 3.2.3, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 5.1.1, 6.2.1, 6.2.2, 6.2.3, 6.2.4 |

# Appendix II

## Application of rules 25, 26 and 27 of the Regional Fresh Water Plan for Taranaki