Erosion and Sediment Control Practices

Part B outlines minimum criteria for the design, construction and implementation of a range of erosion and sediment control measures commonly used on earthworks sites and on other Land Disturbing Activities. These measures form one aspect of erosion and sediment control on any site, and should always be used in conjunction with the measures outlined in the *Ten Commandments of Erosion and Sediment Control* in Part A of these Guidelines.

The most effective form of erosion control is to minimise the area of disturbance, retaining as much existing vegetation as possible. This is especially important on steep slopes or in the vicinity of watercourses, where no single measure will adequately control the erosion and transport of sediment, and where receiving environments may be highly sensitive.

The criteria outlined are the minimum standard for each measure. Each Land Disturbing Activity must be assessed on an individual basis, and in many cases higher standards may be required.

For every practice, these Guidelines outline the following.

- Definition
- Purpose
- Application
- Design/Construction Specifications
- Comments
- Maintenance

Symbols shown alongside controls are listed in Appendix C.

1.1 Runoff Diversion Channel/Bund

R — R —

Plate 1.1 Runoff Diversion Channel/Bund

Definition

A non erodible channel or bund for the conveyance of runoff constructed to a site-specific cross section and grade design.

Purpose

To either protect work areas from upslope runoff (clean water diversion), or to divert sediment laden water to an appropriate sediment retention structure.

Application

Runoff Diversion Channels/Bunds are used in the following situations.

- To divert clean upslope water away from areas to be worked (clean water diversion).
- To divert sediment-laden runoff from disturbed areas into sediment treatment facilities.
- At or near the perimeter of the construction area to keep sediment from leaving the site.
- In either temporary or permanent situations.
- Keep permanent diversions in place until the disturbed area is permanently stabilised against erosion.
- Stabilise Runoff Diversion Channels/Bunds (where necessary) before use.

Design

There are many designs for Runoff Diversion Channels/ Bunds. The following outlines design criteria requirements.

- Design the Runoff Diversion Channel to carry the flow from the 5% AEP rainfall event (plus freeboard).
- Restrict use to grades to no more than 2% unless armoured.
- Construct with a trapezoidal cross sectional shape with internal side slopes no steeper than 3:1, and external slopes no steeper than 2:1.
- Construct Runoff Diversion Bunds with side slopes no steeper than 3:1.

- Survey all gradients on the site.
- Ensure earth embankments used to construct Runoff Diversion Channels/Bunds are adequately compacted.
- Flow velocities greater than 1 o/s will cause the Runoff Diversion Channel/Bund to erode. Incorporate stabilisation measures (such as geotextile, vegetative stabilisation or rock check dams) to prevent erosion.
- Incorporate a stable erosion-proof outfall (such as a level spreader) in order to reduce water velocities and prevent scour at the outlet.
- Ensure the Runoff Diversion Channel/Bund outlet -
  - functions with a minimum of erosion,
  - directs clean runoff onto an undisturbed/ stabilised area,
  - directs flows containing sediment into a sediment retention structure,
  - is located in such a position that ideally suits the field conditions.

Considerations:

- Consider designing an emergency overflow section or bypass area to limit damage from storms that exceed the design storm.
- Avoid abrupt changes in grade which can lead to sediment deposition and overtopping, or erosion.

Maintenance

Runoff Diversion Channels/Bunds need regular maintenance to keep functioning throughout their life. Regular maintenance consists of the following.

- Inspect after every rainfall and during periods of prolonged rainfall for scour and areas where they may breach.
- Repair immediately if required to ensure that the design capacity is maintained.
- Remove any accumulated sediment deposited in the Runoff Diversion Channel/Bund due to low gradients and velocities.
- Carefully check outlets to ensure that these remain free from scour and erosion.

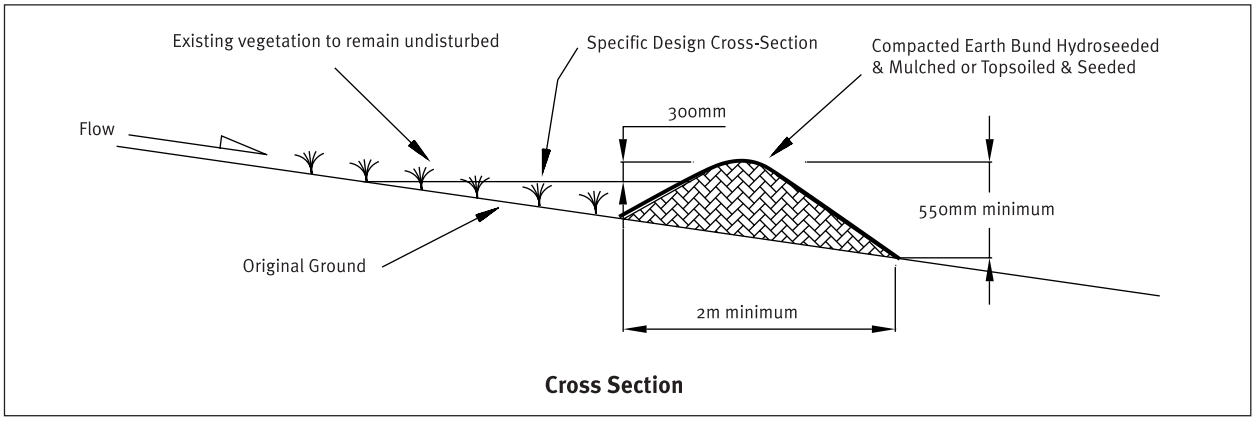


Figure 1.1.1 *Cleanwater Runoff Diversion Bund*

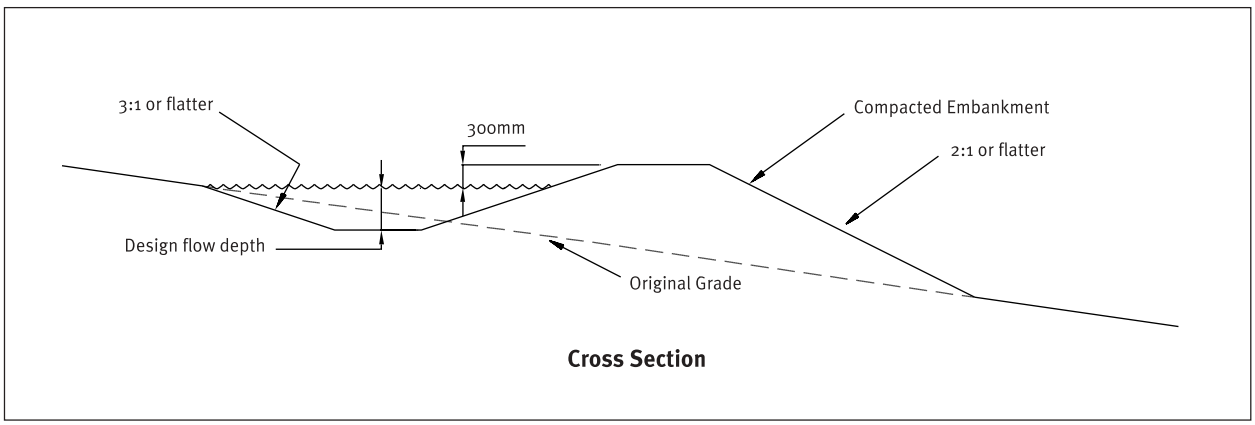


Figure 1.1.2 Runoff Diversion Channel

1.2 Contour Drain

CD

Plate 1.2 Contour Drain

Definition

A temporary ridge or excavated channel, or combination of ridge and channel, constructed to convey water across sloping land on a minimal gradient.

Purpose

To break overland flow down disturbed slopes by limiting slope length and thus the erosive power of runoff, and to divert sediment laden water to appropriate controls or stable outlets.

Application

Use Contour Drains in the following situations.

- At intervals across disturbed areas to shorten overland flow distances.
- As temporary or daily controls.
- To split and direct flow from disturbed areas to Runoff Diversion Channels/Bunds.

Design

Ensure gradients are no greater than 2% and the Contour Drains are kept as short as practicable in order to minimise erosion. The positioning of Contour Drains is often determined by the necessity for stable outfalls, but in general the following spacing applies:

Table 1.2 Positioning of Contour Drains

Slope of Site (%)	Spacing of Contour Drains (o)
5	50
10	40
15	30

Maintenance

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

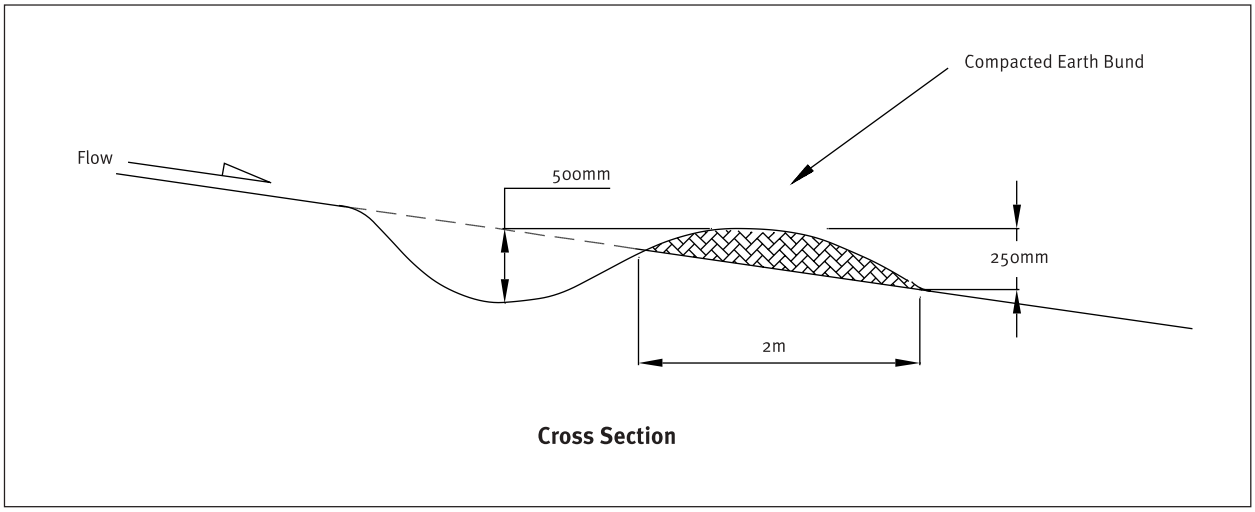


Figure 1.2 Contour Drain

1.3 Benched Slope

Plate 1.3 Benched Slope

Definition

Modification of a slope by reverse sloping to divert runoff to an appropriate conveyance system.

Purpose

To limit the velocity and volume, and hence the erosive power, of water moving down a slope and therefore minimising erosion of the slope face.

Application

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 the 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.

Table 1.3 Benched Slope Design

Slope Angle (%)	Vertical Height (o) Between Benches
50	10
33	15
25	20

Design

- Provide Benched Slopes for slopes exceeding 25% – see Table 1.3.
- Locate Benched Slopes to divide the slope face as equally as possible and convey the water from each bench to a stable outlet. Soil types, seeps and location of rock outcrops need to be taken into consideration when designing Benched Slopes.
- Ensure Benched Slopes are a minimum of 2 o 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 o. Keep the gradient of each Benched Slopes to its outlet below 2 %, unless design, stabilisation and calculations demonstrate that erosion is minimised.
- Keep the flow length along a Benched Slope to less than 250m unless design and calculations can demonstrate that erosion is minimised.
- Divert surface water from the face of all cut and/or fill slopes of Benched Slopes by the use of Runoff Diversion Channels/Bunds except where:
  - the face of the slope is not subject to any concentrated flows of surface water such as from natural drainage, channels or other concentrated discharge points, and
  - the face of the slope is protected by special erosion control materials including, but not limited to, approved vegetative stabilisation practices, rip-rap, or other approved stabilisation methods.
- Provide subsurface drainage where necessary to intercept seepage that would otherwise adversely affect slope stability or create excessively wet site conditions. Check the requirements of the city or district council.
- Do not construct Benched Slopes close to property lines where they could endanger adjoining properties without adequately protecting such properties against sedimentation, erosion, slippage, settlement, subsidence or other related damages. Check the requirements of the city or district council.
- Stabilise all disturbed areas.

Construction Specifications

- Compact all fills to reduce erosion, slippage, settlement, subsidence, or other related problems.
- Keep all Benched Slopes free of unconsolidated sediment during all phases of development.
- Permanently stabilise all graded areas immediately on completion of grading.

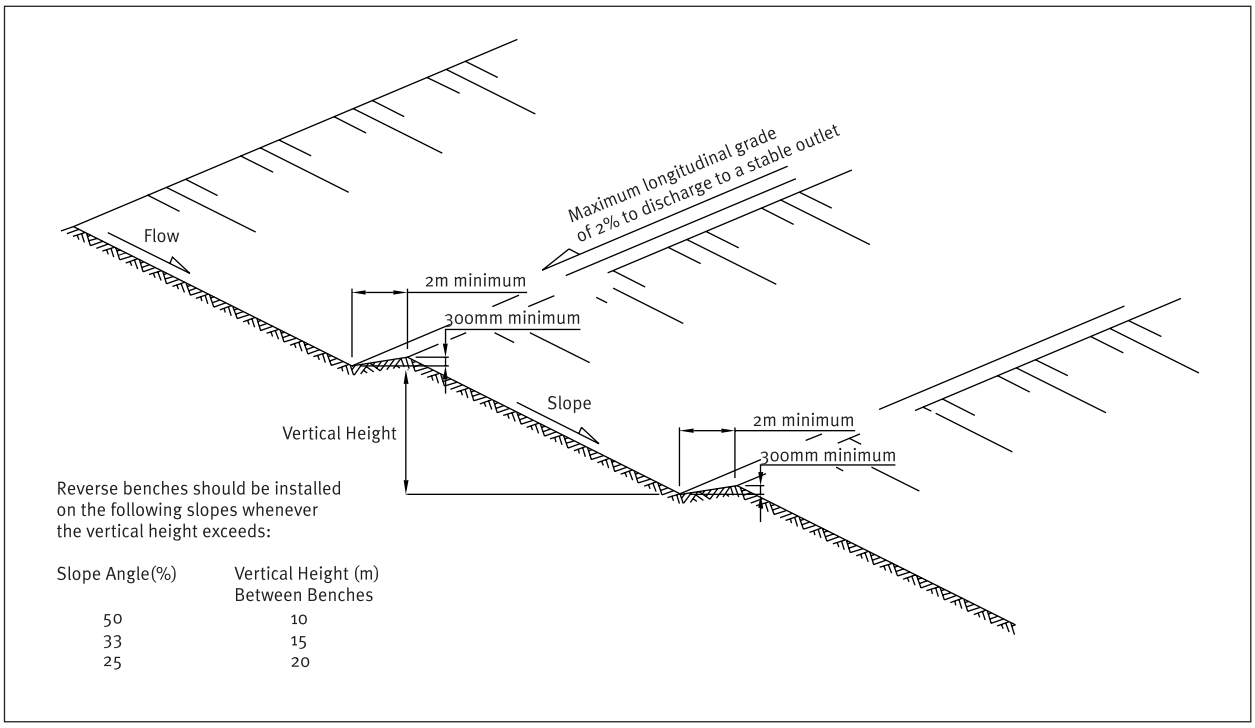


Figure 1.3 Benched Slope

1.4 Rock Check Dam

Plate 1.4 Rock Check Dam

Definition

Small temporary dam constructed across a channel (excluding perennial watercourses), usually in series, to reduce flow velocity. May also help retain sediment.

Purpose

To reduce the velocity of concentrated flows, thereby reducing erosion of the channel. While trapping some sediment, they are not designed to be utilised as a sediment retention measure.

Application

This practice applies primarily to earthworks sites where it is necessary to slow velocity of flows in order to prevent erosion. Do not use Rock Check Dams in a perennial watercourse. Specific applications include the following.

- Temporary channels which, because of their short length of service, are not suitable for non-erodible lining but still need some protection to reduce erosion.
- Permanent channels which for some reason cannot receive a permanent non-erodible lining for an extended period of time.
- Temporary or permanent channels which need protection during the establishment of a vegetative cover.

Design

- Ensure the catchment in question has a contributory drainage area of less than 1.0 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 o) 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.

Table 1.4 Rock Check Dam Design

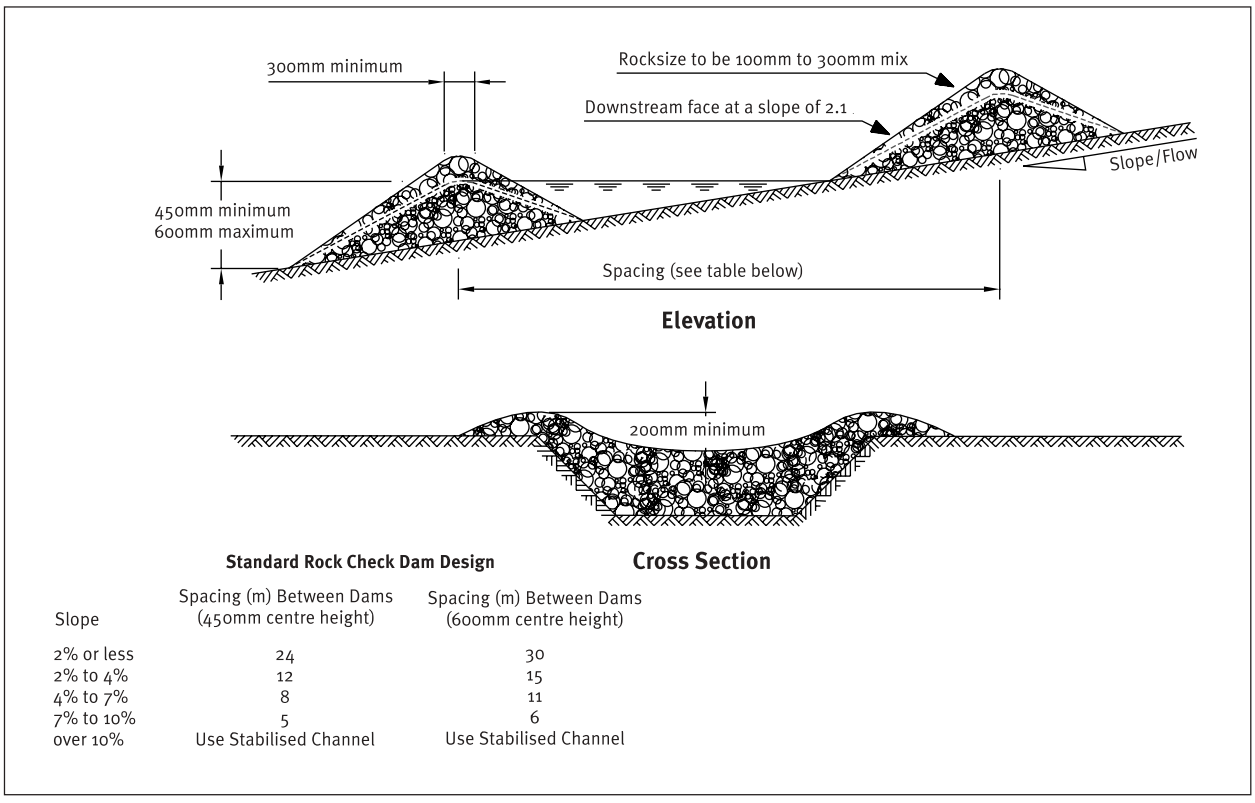
Slope	Spacing (o) Between Dams	
	450 mm Centre Height	600 mm Centre Height
2% or less	24	30
2% to 4%	12	15
4% to 7%	8	11
7% to 10%	5	6
Over 10%	Utilise Stabilised Channel	

- Supply specific design and calculations if Rock Check Dams are to be used on catchments greater than 1.0 ha.

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.

When temporary channels are no longer needed, remove Rock Check Dams and fill in the channel. In permanent channels, remove Rock Check Dams when a permanent lining can be installed. In the case of grass lined ditches, Rock Check Dams may be removed when grass has matured sufficiently to protect the channel. The area beneath the Rock Check Dams needs to be seeded and mulched or stabilised with appropriate geotextile immediately after removing the dams.



Standard Rock Check Dam Design

Slope	Spacing (m) Between Dams (450mm centre height)	Spacing (m) Between Dams (600mm centre height)
2% or less	24	30
2% to 4%	12	15
4% to 7%	8	11
7% to 10%	5	6
over 10%	Use Stabilised Channel	Use Stabilised Channel

Figure 1.4 Rock Check Dam

1.5 Top Soiling

Definition

The placement of topsoil over a prepared subsoil prior to the establishment of vegetation.

Purpose

To provide a suitable soil medium for vegetative growth for erosion control while providing some limited short term erosion control capability by protecting subsoils and absorbing water.

Application

Top Soiling is recommended in the following situations.

- Where the texture and/or the organic component of the exposed subsoil or parent material can not produce adequate vegetative growth.
- Where the soil material is so shallow that the rooting zone is not deep enough to support plants or furnish continuing supplies of moisture and plant nutrients.
- Where high quality turf and landscape plantings are to be established.

Generally Top Soiling is combined with vegetation establishment and is not seen as an erosion control measure in itself. Top Soiling as a short term standalone 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.

When staging within an earthworks operation, Top Soiling as a treatment in itself is not acceptable and other means of stabilisation such as revegetation will also be required.

Design

Not Applicable.

Construction Specifications

Once site shaping work has been completed, evenly spread a minimum of 100 mm of topsoil before revegetating. On steeper sites (over 25%), scarify the subsoils to a depth of a least 100 mm to ensure bonding between topsoil and subsoil before applying topsoil.

Incorporate Surface Roughening into all Top Soiling operations in accordance with these Guidelines.

In general topsoil has a beneficial effect in light rain because it can hold more moisture than the underlying clay material. However, during heavy rain, topsoil will become saturated and rill erosion and slumping can result. For this reason it is important to establish a full vegetative cover as soon as possible and retain all sediment retention facilities on the site until a vegetative cover is fully established.

Maintenance

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

surface roughening.

1.6.1 Temporary and Permanent Seeding

TS PS

Definition

The planting and establishment of quick growing and/or perennial vegetation to provide temporary and/or permanent stabilisation on exposed areas.

Purpose

Temporary Seeding is designed to stabilise the soil and to protect disturbed areas until permanent vegetation or other erosion control measures can be established. It may be used where the area to be stabilised is not yet up to final grade and requires further earthworks, but needs temporary stabilisation.

Permanent Seeding is designed to permanently stabilise soil on disturbed areas to reduce sediment and runoff to downstream or off-site areas.

Application

Temporary Seeding

Use on any cleared or unvegetated areas which are subject to erosion and will not be earthworked for a period of 14 days or more. Temporary stabilisation is normally practised where the vegetative cover is required for less than one year. In some circumstances straw mulching may be used as an alternative (see Part B, Section 1.6.3 of these Guidelines).

Permanent Seeding

This practice applies to 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.

Design

Not Applicable.

Construction Specifications

- ***Site Preparation***

  Before seeding, install all required erosion and sediment control practices such as diversion channels and sediment retention structures. Grade the site as necessary to permit the use of conventional equipment for soil preparation, seeding and maintenance.

- ***Seed Bed Preparation***

  Prepare a good seed bed to ensure successful establishment of vegetation. Take care to ensure that the seed bed is free of large clods, rocks and other unsuitable material. Apply topsoil at a minimum depth of 100 mm to allow for a loose and friable soil surface.

- ***Soil Amendments***

  Apply fertiliser as outlined in Table 1.6 of these Guidelines. This fertiliser application rate can be varied with the approval of the Auckland Regional Council.

  For large sites or unusual site conditions it is advisable to have soil fertility tests done. Some soils may require the addition of lime to improve pH.

- ***Seeding***

  Apply seed at a mixture and rate as in Table 1.6 of these Guidelines. This seeding rate can be varied with approval from the Auckland Regional Council. Apply the seed uniformly and sow at the recommended rate. Seed that is broadcast must be covered by raking and then lightly tamped into place. If Hydroseeding is required, then it can be utilised in accordance with Part B Section 1.6.2 of these Guidelines.

- ***Mulching***

  When working on steep sites (greater than 25%) or during the winter period (between 30 April 30 and 1 October) mulching will need to be applied in accordance with Part B Section 1.6.3 of these Guidelines immediately following seeding.

- ***Irrigation***

  Adequate moisture is essential for seed germination and plant growth. Irrigation can be very helpful in establishing vegetation during dry or hot weather conditions or on adverse site conditions.

  Irrigation must be carefully controlled to prevent runoff and subsequent erosion. Inadequate or excessive irrigation can do more harm than good.

Maintenance

Reseed where seed germination is unsatisfactory or where erosion occurs. In the event of unsatisfactory germination after 30 April, the area will also require the application of Mulch in accordance with Part B Section 1.6.3 of these Guidelines.

Depending on site conditions it may be necessary to irrigate, fertilise, oversow or re-establish plantings in order to provide vegetation for adequate erosion control. See Table 1.6 of these Guidelines for details of maintenance fertiliser applications.

Protect all revegetated areas from traffic flows and other activities such as the installation of drainage lines and utility services.

Table 1.6 Grass Seed and Fertiliser Application Rates

	Mix	Rate (kg/ha)	Comments
Seeding	Temporary Annual Rye Grass (ie. Tama) and Clover Seed mix Permanent Perennial Ryegrass and Brown Top with a Red/White Clover mix	300 Perennial – 120 Brown Top – 45 Clover – 45	Annual Rye Grass mix is more suitable for colder times of the year when ground temperatures are low.
Fertiliser Application	D.A.P (Di-Ammonium Phosphate) N P K S 18:20:0:2	240	D.A.P is an ideal fertiliser for the rapid development of grass cover whilst neither damaging seed or inhibiting seed germination.
Maintenance Fertiliser Application	Straight Nitrogen eg Urea (46% N)	120	Urea provides an efficient means of encouraging further development of grass cover.

1.6.2 Hydroseeding HS

Definition

The application of seed, fertiliser and paper or wood pulp with water in the form of a slurry, sprayed over the area to be revegetated.

Purpose

To establish vegetation quickly while providing a degree of instant protection from rain drop impact.

Application

This practice applies to any site where vegetation establishment is important for the protection of bare earth surfaces. For example:

- Critical areas on the site prone to erosion such as steep slopes and Sediment Retention Pond batters.
- Critical areas on the site that cannot be stabilised by conventional sowing methods.
- Around watercourses or Runoff Diversion Channels where rapid establishment of a protective vegetative cover is required before introducing flows.

Design

Not Applicable.

Construction Specifications

The seed generally adheres to the pulp which improves the microclimate for germination and establishment. This method allows vegetation to establish on difficult sites and can extend into cooler winter months provided it is utilised with Mulching.

- ***Site Preparation***

  Before Hydroseeding, install any needed erosion and sediment control practices such as Runoff Diversion Channels. Scarify any steep or smooth clay surfaces to improve retention of the Hydroseeding slurry.

  Hydroseeding specifications need to be verified by the Auckland Regional Council prior to implementation, with recommended seeding and fertiliser application rates outlined in Table 1.6 of these Guidelines.

- ***Watering***

  Hydroseeding requires moisture for germination and growth. Because Hydroseeding is often used for difficult sites the timing of the application to get favourable growing conditions is an important factor.

Maintenance

Heavy rainfall can wash Hydroseeding away, particularly from smooth clay surfaces and overland flowpaths. Where vegetation establishment is unsatisfactory the area will require Hydroseeding again. In the event of unsatisfactory germination after 30 April, the area will also require Mulching in accordance with Part B, Section 1.6.3 of these Guidelines.

Protect all revegetated areas from traffic flows and other activities such as the installation of drainage lines and utility services.

1.6.3 Mulching

M

Plate 1.6.3.1 Mulching

Definition

The application of a protective layer of straw or other suitable material to the soil surface.

Purpose

To protect the soil surface from the erosive forces of raindrop impact and overland flow. Mulching also helps to conserve moisture, reduce runoff and erosion, control weeds, prevent soil crusting and promote the establishment of desirable vegetation.

Application

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 the 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.

Mulching is used during the winter months (30 April to 1 October) to provide immediate stabilisation. Because grass germination will be too slow to establish effective grass cover using conventional sowing methods.

Design

Not Applicable.

Construction Specifications

Site Preparation

Before Mulching install any needed erosion and sediment control practices such as Runoff Diversion Channels and sediment retention structures.

Mulching

When Mulching, use unrotted small grain straw applied at a minimum rate of 6000 kg per ha.

Ensure the material is free of any noxious plants as identified under Auckland Regional Council policy. Call Enviroline on 0800 80 60 40 for an up-to-date list of plant pests.

Mulching needs to be spread uniformly and secured to the soil surface. For smaller areas hand spreading of mulch material can be adequate. For larger sites, apply mulch mechanically to ensure even spread and appropriate application.

Apply fertiliser with Mulching as outlined in Table 1.6 of these Guidelines.

Alternatives such as wood chips and chemical soil binders can be utilised where appropriate.

Wood chips are suitable for areas that will not be closely mowed around such as ornamental plantings. They do not require the application of a tackifier and if readily available can be a relatively inexpensive mulch. They are slow to break down and normally require nitrogen application to prevent nutrient deficiency in plants. Do not use woodchips around watercourses or in areas where water can pond.

To avoid water contamination, any alternative to straw mulch must be approved by the Auckland Regional Council.

A wide range of synthetic mulching compounds are available to stabilise and protect the soil surface. These include emulsions, acrylimides and dispersions of vinyl compounds. They do not insulate the soil or retain moisture when used alone and therefore do little to aid seed establishment. They are also easily damaged by traffic, decompose relatively quickly and can be quite expensive in comparison to organic mulches.

Rovings, another alternative, are fibres that are teased out from spools of yarn by compressed air and woven onto the surface of the land. They are then stabilised with a tackifier, with seed sown beforehand. These alternatives may be acceptable in certain circumstances but should be discussed in detail with the Auckland Regional Council prior to their implementation.

Anchoring Mulch

Anchor Mulch in place immediately after application to avoid or minimise loss by wind or water. Numerous methods are available. Generally, although the Mulch is 'settled' in place by the first rainfall, the Auckland Regional Council also requires it be retained by crimping into the soil with discs or spraying a tackifier with the Mulch. When using some chemical tackifiers, take care to avoid adverse offsite effects of runoff.

Plate 1.6.3.2 Mulch Crimping