6.3.6 Check Dams

Photo 6.7 Check dam

Description/Purpose

Check dams are barriers placed across channels primarily to reduce runoff velocity. They can also retain sediment but this is not their primary function.

Catchment Area

Less than five hectares. Specific engineering design is required for larger catchments.

Construction

a) Locate the lowest check dam first. Clear any vegetation and topsoil from the footprint of the check dams and place in a location where it cannot be mobilised.
b) The sides of the check dam must be higher than the centre so that water is always directed over the centre of the dam (this avoids the dam being outflanked by the flow). Energy dissipation at the outfall is required (this is usually rock or fabric).

c) The maximum height of the check dam at its centre should be 1.0 metre and the outer edges should be least 0.2 m higher so that a spillway is formed over the centre.
d) The distance between dams is based on the toe of the upstream dam being at the same elevation as the crest of the downstream dam. The spacing between dams therefore varies with slope.
e) Make sure that the downstream channel is protected against scour and erosion by extending the rock 1 metre downstream of the lower dam, or by using fabric etc.

Construction Notes:

a) They can be constructed from a variety of material such as concrete, rock, fabric, sand/cement bags etc. Rock is the most common material used. Despite the variety of material that can be used, the following construction principles apply.
b) If using rock, angular rock is more suitable than rounded rock. Use 300 mm diameter graded rock and install a 300 mm thickness of finer grade rock on the upstream face. Make sure that rock batters are no steeper than 1 vertical: 2 horizontal.
c) If using a sand/gravel/cement mix in plastic bags, make sure that the bags are UV resistant.
d) Do not construct check dams in watercourses or permanently flowing streams[2] without specific design (because of possible restrictions to fish passage).
e) The drain may need to be increased in size to ensure that it's capacity is not reduced (if check dams are installed).

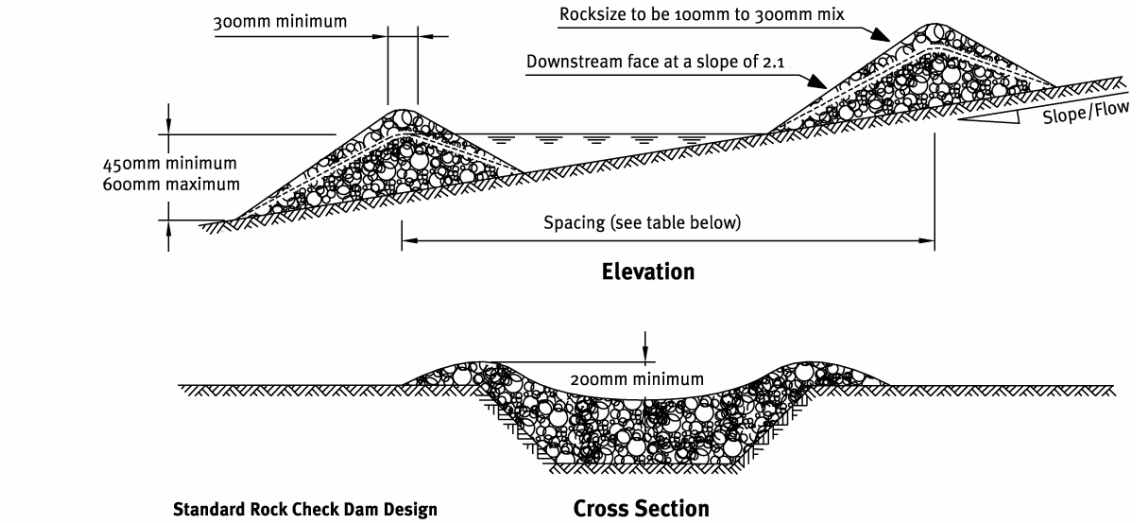
Maintenance

Develop a maintenance and monitoring schedule to ensure that these controls are operating effectively and, to look for any changes in the structure. Important details to check on are:

a) It is recommended that they are inspected regularly and after significant rainfall (when 15mm of rainfall has fallen in the preceding 24 hours).
b) Check to ensure that the flow is over the centre of the dam and not either under or around the dam.
c) Check that there is no erosion at the outfall.
d) Implement repairs to ensure the dams remain in good working order.
e) Construct additional check dams if there is scour along the channel.

[2] A resource consent from the Auckland Regional Council may be required for works in Category 1 (perennial) streams.

Drawing



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 6.7 Check dams

6.3.7 Surface Roughening

Photo 6.8 Surface roughening with bulldozer

Description/Purpose

This is the roughening of a bare surface to create horizontal grooves that will reduce the concentration of runoff, aid infiltration, trap sediment and aid vegetation establishment.

Catchment Area

In general small areas (less than 0.25ha) only as the practice will also require other forms of erosion and sediment control.

Construction

a) Run a tracked machine up and down the slope to roughen the surface

Construction Notes:
a) This technique helps stop the concentration of runoff. Once runoff has formed rills down a slope however, any advantages of the technique are lost.

Maintenance

a) Check the area for rills and washes. Rework and re-seed the area as necessary.

6.3.8 Log Corduroying

Photo 6.9 Log corduroying of a landing site

Description/Purpose

Corduroys are primarily used to provide a solid working platform where ground conditions are generally wet and or soft. Often this is within the processing area of landings and sometimes when tracking / roading across soft wet areas (not streams). This technique helps to keep soft areas from becoming 'bog holes' and minimises the generation of sediment. In most cases, sediment controls will be required to treat any runoff from these areas.

Catchment Area

Not Applicable

Construction

a) Place trimmed pulp logs neatly together over the ground being strengthened, to effectively 'bridge' the wet soft areas. The pulp logs should fit neatly together and not protrude into a water table.

Construction Notes:

a) Plan ahead, this technique is more effective if put in place to avoid or minimise areas becoming a "bog" rather than to continue working a "boggy area".

b) The less valuable pulp/malformed sections of the tree is generally used down to a size that will support heavy machinery without breaking up. If they breakup and or bend severely they will not achieve the desired outcome *ie* still generate fine sediment and will be high maintenance. The pulp logs should be pushed hard into the ground, essentially to refusal as they must be capable of holding up heavy machinery. Sometimes larger trees and or cross bearers may be necessary in extremely soft conditions.

Maintenance

a) Where possible check for broken pulp logs and replace, and or add on to as necessary. Any sediment generated from these areas must be placed in an area where this material can be contained, *ie* a pit in the ground and in extreme cases where side slopes make it difficult to contain, consider using a 'debris dam' and/or slash bund to help contain the sloppy material.

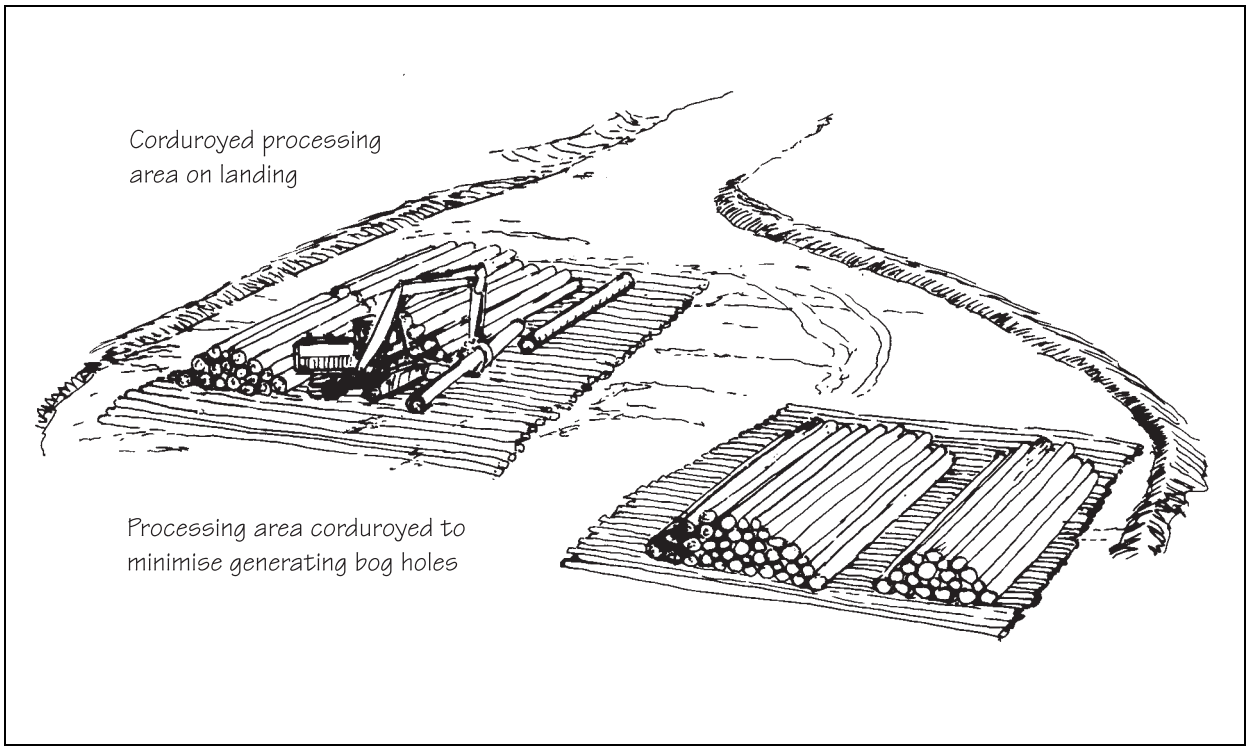


Figure 6.8 Schematic drawing of a corduroyed processing area

6.4 Stabilisation

A stabilised site is one that is resistant to erosion. Stabilisation is defined as applying measures, such as vegetative or structural, that will protect exposed soil and prevent erosion.

Common stabilisation measures include aggregate, grassing areas with either grass seed or hydroseed, applying slash or mulch, rock lining and the use of geotextiles.

Where aggregate is used, a 50 mm thickness (on non-trafficked areas only) is usually sufficient. It is preferable to use angular (broken faces) fragments as this provides better binding with the interlocking of the pieces.

In relation to geotextiles, there are many and varied different types and products. They range from those that physically shed water (e.g. plastic and polythene) through to those that incorporate seed and mulch and so encourage vegetative growth while protecting the bare soil against erosion.

Where vegetation is used, during the earthworking portion of forestry activities (eg construction of tracks, landing sites) the surface is considered stabilised once an 80% vegetation cover (density) has been established over the entire exposed area of earthworked areas. For areas associated with harvesting, a 75% vegetative density is required for all disturbed areas: adjacent to Category 1 (perennial) streams; all areas with an average slope greater than 15^{o} and all areas associated with ground based operations where the harvesting does not include limbing at the 'stump'.

Further detail is provided below on the common stabilisation measures used in the forest industry around the Auckland region. These are slash, mulch, grassing, hydroseeding, rock lining, and geotextiles.

Photo 6.10 Examples of stabilisation methods used on forestry roads specifically hydroseeding of road batters, rock armouring of watertables and aggregate layer on road.

6.4.1 Slash and Mulch

Photo 6.11 Slash used to stabilise an access track (dashed line indicates track alignment)

Description/Purpose

Both slash[3] and mulch[4] can be applied as protective layers to reduce rain drop impact and sheet erosion on bare areas.

Catchment Area

Not applicable. However neither surface cover is effective once runoff has concentrated into channelised flow.

Application

Hay or straw mulch

a) Place mulch around or over disturbed areas and to a depth so that the soil cannot be seen through the mulch.

[3] Slash is the off cuts such as branches, tree heads and bark removed from production logs.
[4] Mulch is a surface cover of bark, straw or hay.

b) Place mulch only on stable areas of land (mulch does not usually help with earth flows).
c) Place mulch to a density of 6,000 kg/ha.

Slash

a) Place slash around or over disturbed areas to a depth such that little, or no soil, or disturbed ground is visible.
b) Slash can be used on almost any surface.
c) Place slash to at least 100 mm thickness as a cover of exposed areas. For protection for tracking from an erosion and ground compaction perspective, up to 300mm slash cover may be required.

Construction Notes:

a) Install other erosion and sediment control measures before spreading slash or mulch.
b) Slash can be used for erosion protection of minor spillways and outfalls. It can also be useful for stabilising haul tracks.
c) Bark or woodchip may be more readily available and apply this instead.
d) Straw lasts longer than hay and doesn't contain undesirable weed species.
e) Straw or hay mulch can be spread by hand on small sites. A rule of thumb is to have 30 mm of mulch cover when freshly applied.
f) Add grass seed to all applications if long term stabilisation is required.
g) Mulch will generally not 'stick' on slopes greater than 30-40%.
h) These measures are usually immediately effective for stabilisation once applied.

Maintenance

a) Hay/Mulch has a relatively short life (about 3 months maximum) so reapplications may be necessary, particularly if grass seed is not used. Slash has a longer life but may also need to be supplemented.
b) Mulch can blow away if it is not sufficiently well "tacked" down (water/rain, tackifier etc).
c) Remove concentrations of slash from riparian areas and from the edges of landings.

Photo 6.12 An example of a stabilised landing site using slash

6.4.2 Grassing and Hydroseeding

Photo 6.13 Hydroseeding of road cut & fill embankments

Description/Purpose

This is the sowing of seed to establish a protective vegetative cover over exposed soil. Hydroseed is the application of seed and fertiliser in a slurry and allows revegetation of steep or critical areas that cannot be stabilised by conventional sowing methods.

Catchment Area

No limit

Application

a) Apply in either autumn or spring and allow sufficient time for the seed to germinate and establish. Applications in summer and winter may not be as successful (summer sowing is dependant on rainfall while that in winter will be slow because of cooler temperatures).

b) Rip or scarify smooth compacted clay surfaces and spread topsoil before sowing grass seed.

Construction Notes:

a) Install other erosion and sediment control measures before hydroseeding or sowing seed.

b) After the 30th April it may be necessary that the sowing of grass seed be supplemented with mulch or similar material (because grass growth becomes increasingly suppressed after this time by cooler temperatures).

c) Hydroseed is typically the only way a robust grass cover can be achieved on hard clay surfaces such as cut faces and landing surfaces.

d) Apply seed and fertiliser at rate according to Table 3. Annual rye grasses are more vigorous and cold tolerant than perennial rye grass. Fertiliser is essential. Sow preferably in March rather than later to take advantage of warm temperatures and rainfall.

e) When applying hydroseed or grass in earthworked areas, the ARC considers a site to be stabilised once 100% of the disturbed area has a robust grass cover (*ie* 80% coverage density). When using this technique for stabilising of harvested areas, refer to the appropriate rule(s) in the Regional Plan for coverage densities (generally 75% density).

f) The protective function of grass will usually need supplementing in steep channels (e.g. with fabrics etc).

Table 5 Grass Seed & 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

Maintenance

a) The site may need to be re-sown if germination is unsatisfactory (which can be caused by heavy rain washing seed away, bird predation etc).

6.4.3 Rock Lining of Channels

Photo 6.14 Rock lining of road watertable

Description/Purpose

To protect bare drains and roadside water tables in erosion prone soils against erosion when the gradient exceeds 2%.

Catchment Area

Less than 5 hectares. For areas greater than 5ha, specific engineering design will be required.

Construction

a) Construct a trapezoidal or "U" shaped channel to the required size. A finished channel size of 0.5 m channel base, 0.5 m high and with 1:1 sides will convey almost all flows from a 5 hectare catchment. Note that it will be necessary to over cut the channel slightly to maintain the capacity once the rock has been placed.

b) Use material comprising of at least 50% of 65mm to 150mm graded rock and place along the bottom and on channel sides[5]. Note that this sized rock will start to be washed out on grades that exceed 10 %. Larger rock, concrete etc will then be necessary).
c) Discharge to a stabilised outfall (e.g. not over fill).

Construction Notes:

a) Identify (or construct) an erosion proof outfall first. Outfall protection may be necessary (rock, fluming etc). Work back from this point.
b) Place the protective rock carefully and make sure that the capacity of the channel is retained.

Maintenance

a) Inspect after storm events. Remove debris and repair/replace stone. Check for scour at outlets and on outside bends.
b) Check the discharge point for erosion and repair as necessary.

[5] See Table 5 in section 9.1 for an assessment of stormwater velocities between clay and rock on different slopes.

Drawing

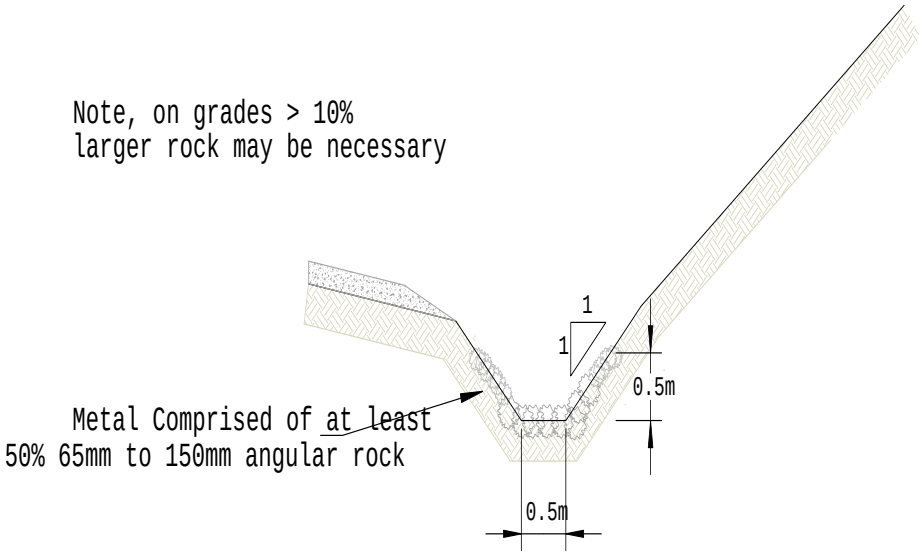


Figure 6.9 Rock lined channel

6.4.4 Geotextiles

Description/Purpose

Geotextiles are fabrics that are used to protect surfaces against erosion. Common uses are to line spillways and diversion channels.

Catchment Area

Different fabrics have different strengths and abilities to withstand erosive forces and so vary in the volumes and velocity of water that they can withstand. The manufacturer's instructions should be referred to determine the design limits of the fabric.

Drawing

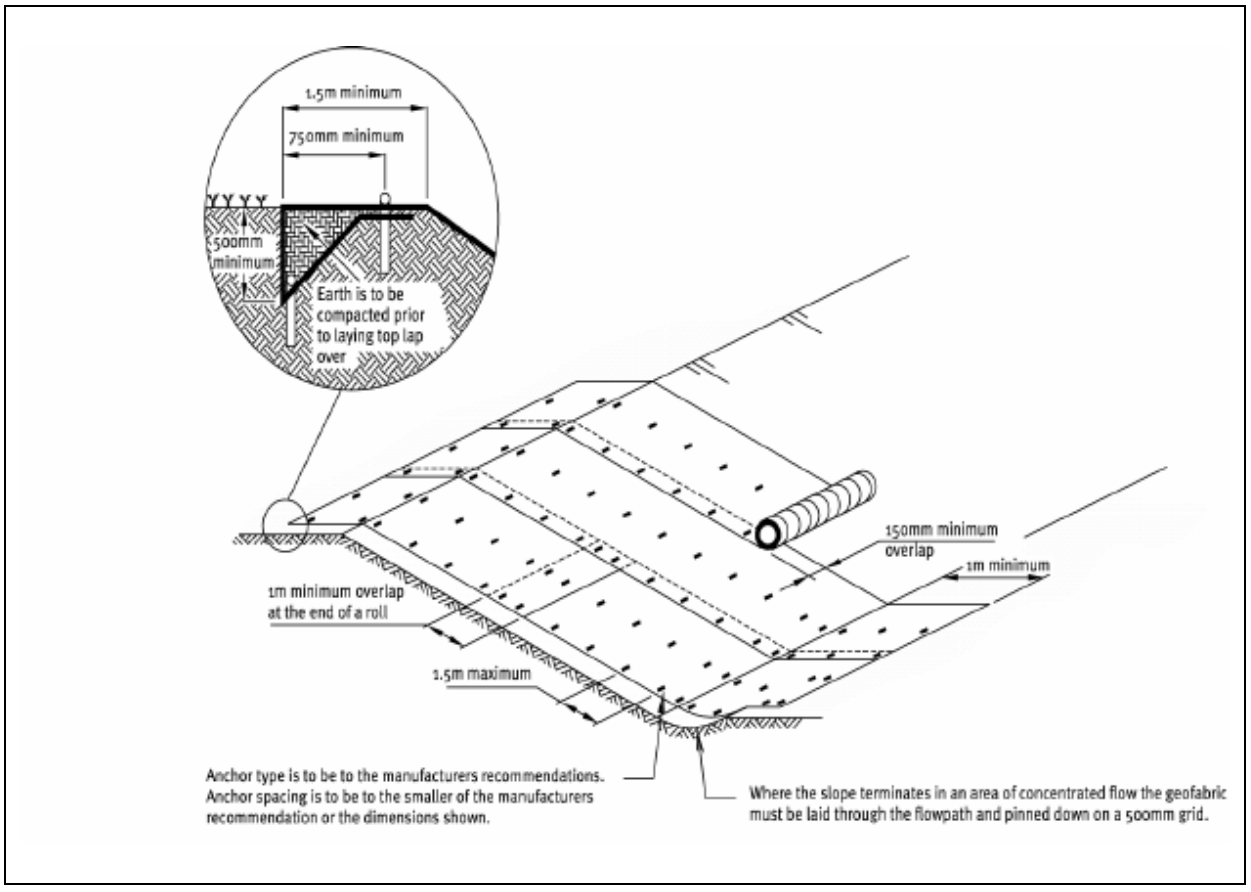


Figure 6.10 Geotextile laid on slope

Construction

a) Shape the area to its final shape and smoothen the surface as much as possible to minimise hollows under the fabric.
b) Lay the fabric and pin it in line with the manufacturer's instructions, or at about 0.5 m spacing in a grid pattern.
c) Dig the sides and top of the fabric into the earth and pin securely.

Construction Notes:

a) There are many different types of fabrics and care is needed in selection. Soft needle punched fabrics hug the ground but are permeable. Low permeable fabrics are more waterproof but are also generally less pliant and do not have such good ground contact. In some situations *eg* pond spillways both would be required.
b) Some fabrics are biodegradable and therefore have a limited life.
c) A smooth ground surface, a well anchored fabric at both top and sides, and good pinning are the keys to successful fabric installation and performance.
d) When used for channel lining, the strength of the pinning to the channel is critical.
e) Large "T"-shaped pins (10mm x 300mm) cut from sections of reinforcing steel are ideal.

Maintenance

The usual faults with fabric installation are that it is not fastened particularly well on the sides or that the entry point (to channels) is poorly secured.

a) Check the entry point for secure fastening and remedy as required.
b) Check the pinning and repair as necessary.
c) Check that the ground under the fabric is not being eroded by water seeping through the fabric. The fabric may need to be lifted, the land re-shaped, and the fabric re-laid.

Drawing

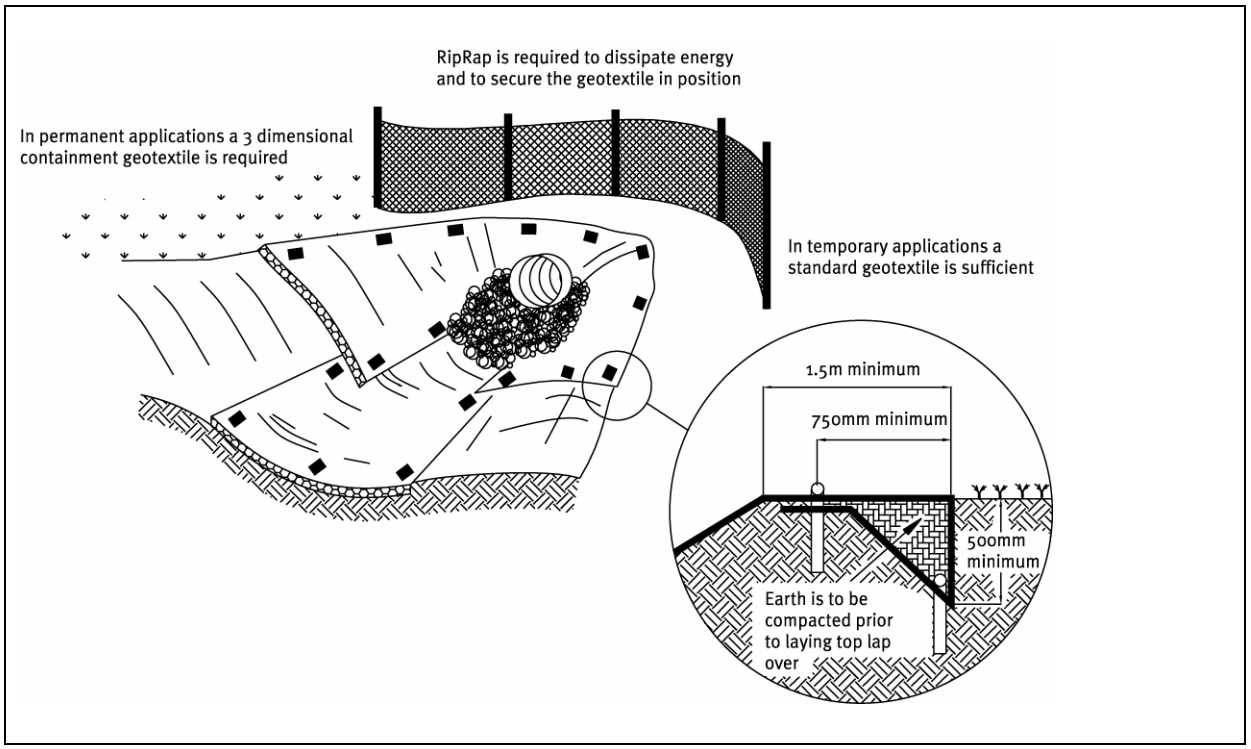


Figure 6.11 Geo-textile at culvert outlet.