

Sediment Retention Pond (SRP)



DEFINITION

A temporary pond formed by excavation into natural ground or by the construction of an embankment, and incorporating a device to dewater the pond at a rate that will allow suspended sediment to settle out.

PURPOSE

To treat sediment-laden run off and reduce the volume of sediment leaving a site, thus protecting downstream environments from excessive sedimentation and water quality degradation.

APPLICATION

Sediment retention ponds are appropriate where treatment of sediment-laden run off is necessary, and are the appropriate control measure for exposed catchments of more than 0.3ha. It is vital that the sediment retention pond is maintained until the disturbed area is fully protected against erosion by permanent stabilisation.

The location of the sediment retention pond needs to be carefully considered in terms of the overall project, available room for construction and maintenance and the final location of any permanent stormwater retention facilities that may be constructed at a later stage.

Another major consideration is whether drainage works can be routed to the sediment retention pond until such time as the site is fully stabilised.

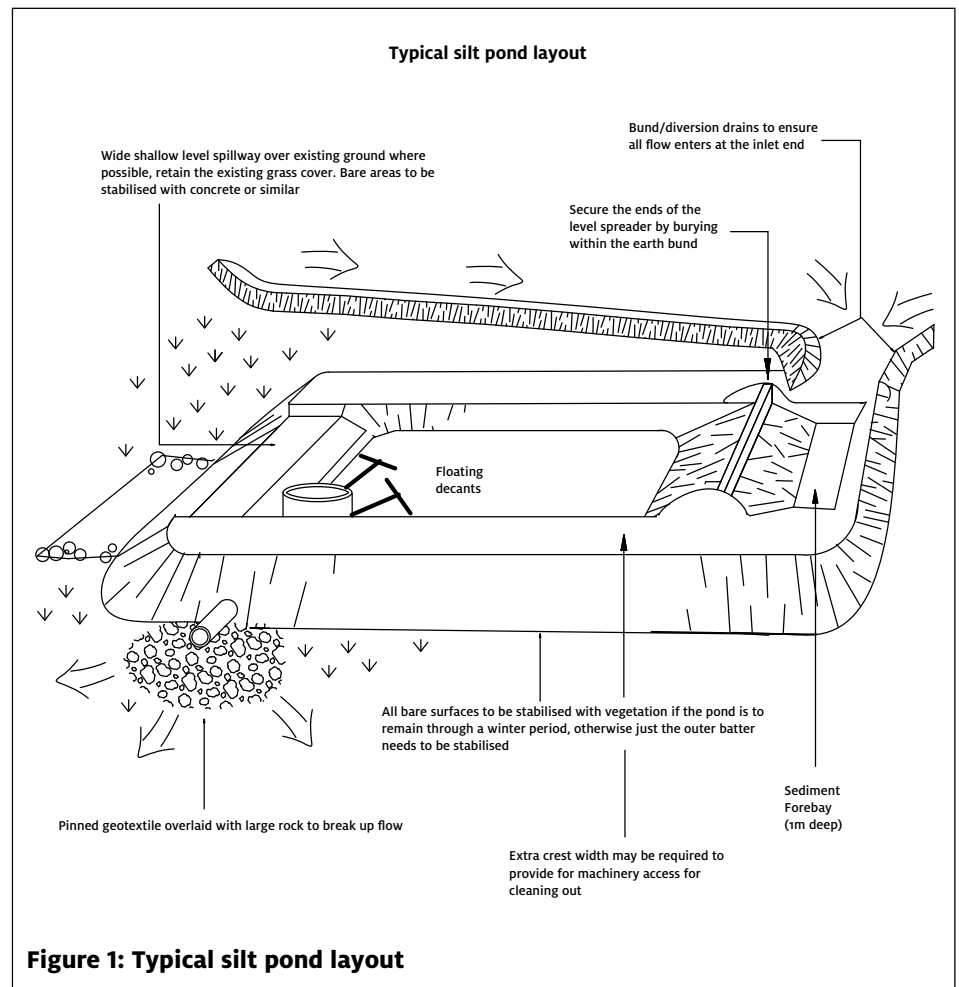
The general design approach is to create an impoundment of sufficient volume to capture a significant proportion of the design run off event, and to provide quiescent (stilling) conditions, which promote the settling of suspended sediment.

The sediment retention pond design is such that very large run off events will receive at least partial treatment and smaller run off events will receive a high level of treatment. To achieve this, the energy of the inlet water needs to be low to minimise re-suspension of sediment and the decant rate of the outlet also needs to be low to minimise water currents and to allow sufficient detention time for the suspended sediment to settle out.

Specific design criteria are discussed below, but can be summarised as the following:

- Use sediment retention ponds for bare areas of bulk earthworks of 0.3ha or greater.
- Restrict catchment areas to less than 5.0ha per sediment retention pond. This limits the length of overland flow paths and reduces maintenance problems.

- Locate sediment retention ponds so as to provide a convenient collection point for sediment laden flows from the catchment area. This will require strategic use of cut-offs, run off diversion channels and contour drains.
- Locate sediment retention ponds to allow access for removing sediment from the pond.
- Locate sediment retention ponds to allow the spillway to discharge over undisturbed, well vegetated ground.
- Do not locate sediment retention ponds within watercourses.
- Embankment and spillway stability are generally the weak point in sediment retention pond construction. Correct compaction, particularly around emergency spillways, discharge pipes and anti-seep collars, will keep the system robust.



DESIGN - SIZE OF THE POND

Calculate the volume of the sediment retention pond using the depth measured from the base of the sediment retention pond to the top of the primary spillway. The following design criteria apply:

- On earthwork sites with slopes less than 10 per cent and less than 200m in length, construct a sediment retention pond with a minimum volume of 2 per cent of the contributing catchment (200m³ for each ha of contributing catchment).
- On sites with slopes greater than 10 per cent and/or more than 200m in length, construct sediment retention ponds with a minimum volume of 3 per cent of the contributing catchment (300 m³ capacity for each ha of contributing catchment).
- An additional 10 per cent of this volume is to be used as a sediment forebay.
- The slope angle is determined by the steepest slope within a 50m radius of the sediment retention pond inlet or by the average slope angle over the contributing catchment, whichever is the greater.
- On sites that are particularly steep, have a high clay content or have sensitive downstream environments, a greater sediment retention pond volume and/or the use of chemical treatment may be required.
- Clean out sediment retention ponds when the volume of sediment accumulated within them reaches 20 per cent of the design volume.
- Clearly show the sediment retention pond dimensions necessary to obtain the required volume, as detailed above, on the site's erosion and sediment control plan(s).

DESIGN - DEAD STORAGE (PERMANENT STORAGE)

Dead storage is the component of impoundment volume that does not decant and remains in the sediment retention pond. It is important for dissipating the energy of inflows.

- Ensure dead storage is a minimum of 30 per cent of the total sediment retention pond storage by positioning the lowest decant 0.54 - 0.8m above the invert of the sediment retention pond.

DESIGN - LIVE STORAGE (DECANT STORAGE)

- Live storage is the volume between the lowest decant outlet level and the top of the sediment retention pond primary spillway.
- Ensure that the live storage volume capacity is 70 per cent of the total sediment retention pond storage.
- The approved decant design detailed in these guidelines allows the decant system to be raised as sediment deposition increases, thereby maintaining the percentage volume of live storage.

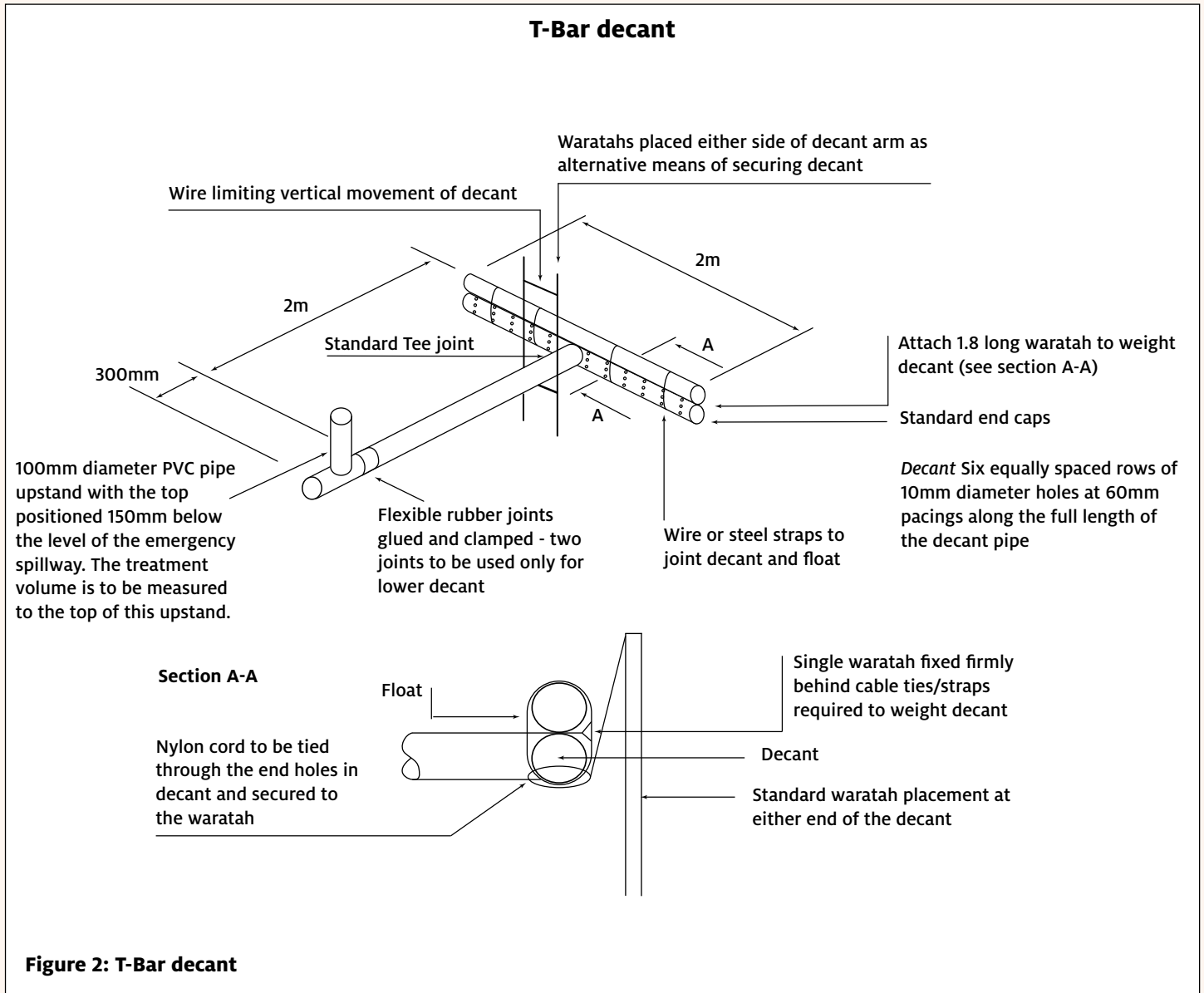


Sediment retention pond showing decant system.

DESIGN - DECANTING/OUTLET DE-WATERING DEVICE

- De-water the sediment retention pond to remove the relatively clean water without removing any of the settled sediment, and without removing any appreciable quantities of floating debris.
 - The use of a floating T-bar de-watering device, which allows for the decanting of the cleaner surface water from the top of the water column, is required.
 - The required decant rate from a sediment retention pond is 3 litres/second/ha of contributing catchment. This rate ensures that appropriate detention times are achieved.
 - A standard T-bar design is detailed in figure 2 for various sized catchments. Single decant without manhole riser needs to have a primary spillway (upstand riser) installed.
 - To achieve a decant rate of 4.5 litres/second per decant, for a 1.5 ha catchment, drill 200 10mm diameter holes positioned evenly over the decant. Holes can be blocked as required for smaller catchments. Block out 65 holes if a decant rate of 3 l/sec is required.
 - T-bar decants must be able to operate through the full live storage depth of the sediment retention pond.
- If two decant systems are required, ensure the lower T-bar decant operates through the full live storage depth of the sediment retention pond. The upper T-bar decant is to operate through the upper 50 per cent of the live storage depth of the sediment retention pond only.
 - If three decant systems are to be used, then the lower T-bar decant operates through the full live storage depth and the second T-bar decant through the upper two thirds of live storage depth of the sediment retention pond. The upper T-bar decant operates through the upper one third of live storage depth of the sediment retention pond.
 - Ensure that the T-bar decant float is securely fastened with steel strapping directly on top of the decant arm, and weight it to keep the decant arm submerged just below the surface through all stages of the decant cycle. This will also minimise the potential for blockage of the decant slots by floating debris. The most successful method found to date is to weight the decant arm by strapping a 1.8m long waratah between the float and the decant (approximately 4kg of weight).
 - Position the T-bar decant at the correct height by supporting the decant arm between warratahs as detailed in figure 2.
 - Lay the discharge pipe at a 1 - 2 per cent gradient, compact the fill material around it using a machine compactor and incorporate anti-seep collars with the following criteria:
 - Install collars around the pipe to increase the seepage length along the pipe with a spacing of approximately 10m.
 - The vertical projection of each collar is 1m.
 - Ensure all anti seep collars and their connections are watertight.
 - Use a flexible thick rubber coupling to provide a connection between the decant arm and the primary spillway or discharge pipe. To provide sufficient flexibility (such as is required for the lower decant arm) install two couplings. Fasten the flexible coupling using strap clamps and glue.

- Where a concrete riser decant system is utilised, ensure the lower decant connection is positioned on an angle upwards from the horizontal so as to split the operational angle that the decant works through. This will reduce the deformation force on the coupling used.



DESIGN - FOREBAY

- Construct a forebay with a volume equal to 10 per cent of the pond design volume. On sites with slopes less than 10 per cent and lengths less than 200m this equates to a forebay volume of 0.2 per cent of the contributing catchment area - 0.2 m³ per 100 m² of contributing catchment. On sites with slopes greater than 10 per cent and lengths greater than 200m, forebay volume is equivalent to 0.3 per cent of the contributing catchment area ie: 0.3 m³ per 100 m² of contributing catchment.
- The forebay is to extend the full width of the main pond and is to be 0.5 to 1m deep.
- All inlets into the forebay are to be stabilised.
- Access to the forebay is to be maintained at all times to allow easy and frequent removal of accumulated sediments by an excavator. Sediment should also be removed after every large storm event.

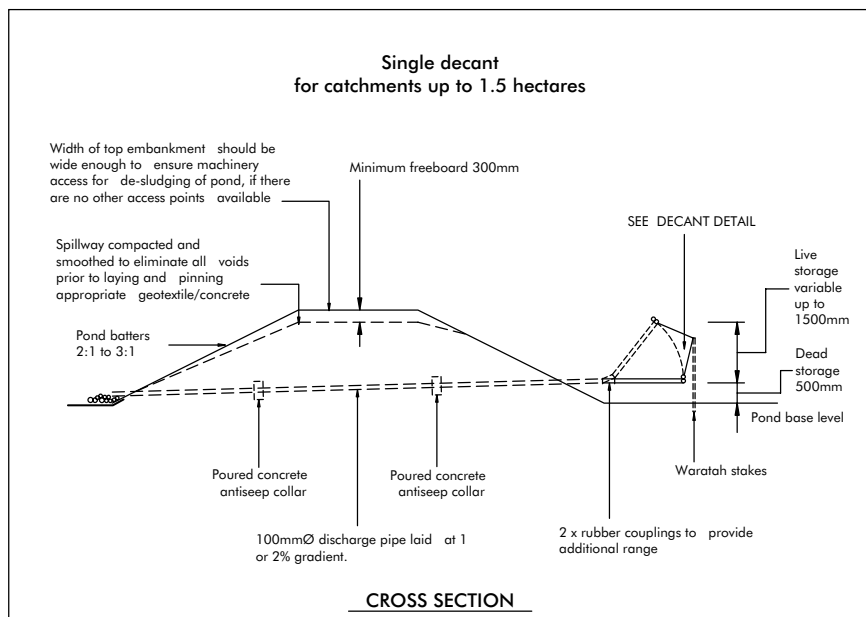


Figure 3: Cross section of single decant

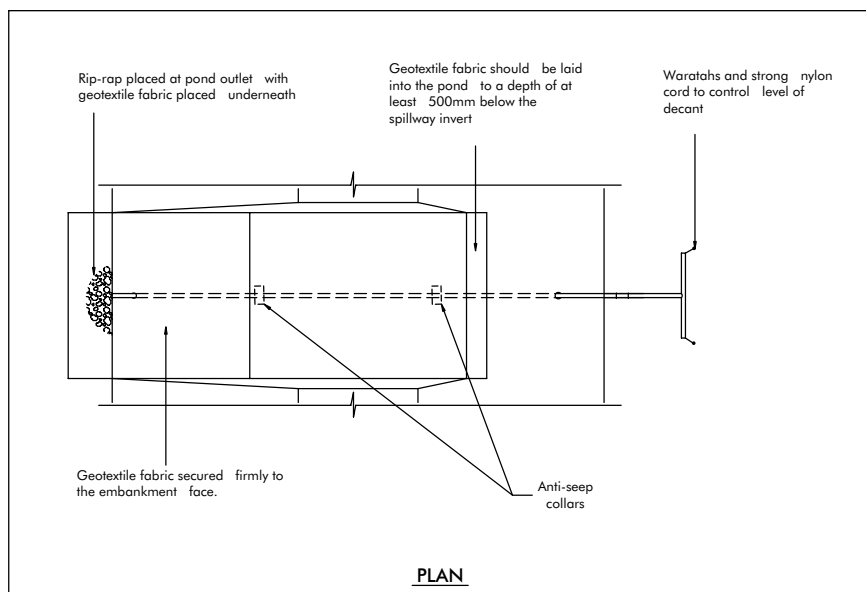


Figure 4: Plan view of decant

DESIGN - SHAPE OF THE POND

- Ensure the length to width ratio of the sediment retention pond is no less than 3:1 and no greater than 5:1. The length of the sediment retention pond is measured as the distance between the inlet and the outlet (decant system). A 2:1 ratio may be used if the pond depth is no greater than 1m.
- Maximise the distance between the inlet and the outlet (including the emergency spillway) to reduce the risk of short circuiting and to promote quiescent conditions. If this cannot be achieved by correctly positioning the inlet and outlets, install baffles to achieve the appropriate length to width ratio design.
- Ensure that the sediment retention pond has a level spreader as described in figure 5 to promote the even and gradual dissipation of the heavier inflow water across the full area of the sediment retention pond.

DESIGN - EMBANKMENT

- Thoroughly compact the sediment retention pond embankment, with material laid in 150mm layers and compacted to engineering standards.
- Before building a sediment retention pond, install sediment controls such as silt fences below the construction area and maintain them to a functional standard until the sediment retention pond batters are fully stabilised.
- Where possible, install the discharge pipes through the embankment as the embankment is being constructed.
- Fully stabilise the external batter face by vegetative or other means immediately after construction.
- Ensure all bare areas associated with the sediment retention pond (including internal batters) are stabilised with vegetation if the sediment retention pond is to remain in use over winter.

DESIGN - POND LEVEL SPREADER

- Incorporate a pond level spreader between the forebay and the main pond to spread inflow velocities, thereby allowing rapid dissipation of inflow energies. Combine the pond level spreader with a well compacted and smoothed inlet batter (no steeper than a 3:1 gradient), stabilised over its entire area. The essential design feature is to ensure the pond level spreader is completely level, non-erodible and spans the full width of the sediment retention pond.
- Stabilise the level spreader and inlet embankment to the base of the pond with a layer of strong woven low permeability geotextile overlaid with a layer of soft non-woven needle punched geotextile. Pin at 500mm centres.
- To ensure even inflows, install a trenched and pegged 150mm x 50mm timber weir or similar across the full width of the inlet. Bund the edges with compacted earth to prevent outflanking and line to prevent erosion. This timber weir is haunched using site concrete which also serves to toe in the geotextile protection that will be required.
- Position the top of the pond level spreader weir 100 – 200mm above the invert of the emergency spillway.

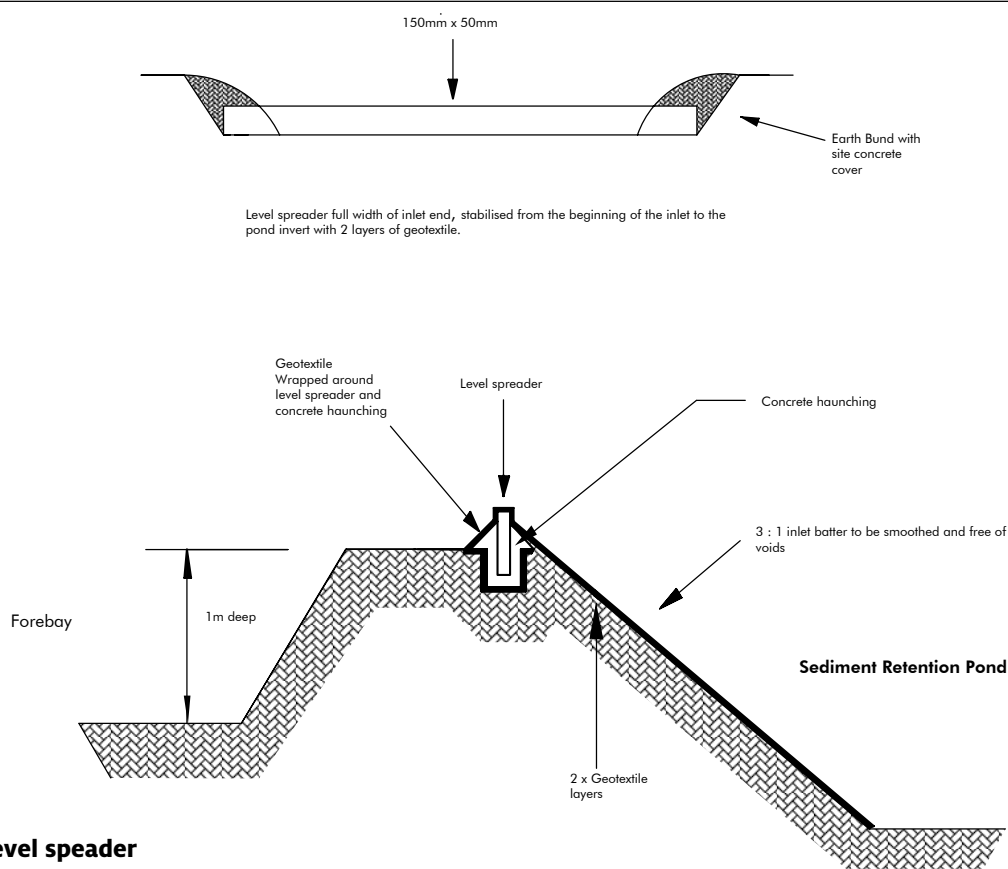


Figure 5: Pond level spreader

OPTIONAL ENHANCEMENTS

- Install one or more silt fences accross the width of the sediment retention pond.
- Slope the base of the pond towards the inlet end. This will reduce sediment travelling to the decant end of the pond.

DESIGN - DEPTH OF POND

- Sediment retention pond depths may be 1 - 2m deep, but no deeper than 2m. Deeper ponds are more likely to cause short circuiting problems during larger storm events and require specifically designed floating decant systems.
- The decant design in these guidelines operates through a maximum live storage range of 1.5m.

DESIGN - PRIMARY SPILLWAY

- For catchments up to 1.5ha use a discharge and primary spillway pipe diameter of 100mm.
- For contributing catchments between 1.5 and 3ha in area, use a discharge and primary spillway pipe diameter of 150mm.
- Where contributing catchments are 3ha or greater a concrete manhole riser and a minimum 300mm diameter outlet pipe must be used as a primary spillway. The concrete manhole riser must have a sealed bottom and be weighted to prevent floating.
- If the sediment retention pond is to operate over the winter and the contributing catchment is fully stabilised, disconnect the T-bar decant to reduce the frequency of emergency spillway activation and consequent erosion.
- Where a primary spillway upstand riser is used, place the top of the riser a minimum 600mm lower than the top of the sediment retention pond embankment and a minimum 300mm lower than the emergency spillway crest. Ensure the riser and the discharge pipe connections are all completely watertight.

SPILLWAY

- An emergency spillway is essential for all sediment retention ponds.
- Emergency spillways must be capable of accommodating the critical 1 per cent AEP event without eroding.
- Emergency spillways must discharge onto stabilised ground. The emergency spillway must be located at the outlet end of the pond behind or beside the decant system.
- The emergency spillway crest and outer batter requires a very high standard of stabilisation with the fill material well compacted.
- Construct the emergency spillway as a stabilised trapezoidal cross section. The trapezoidal cross sections need to be continued down the outside batter to avoid flows outflanking the geotextile.
- When utilising geotextile for emergency spillway stabilisation purposes, the batter face must be smooth and all voids filled.
- If geotextile is used, a strong woven low permeability geotextile is laid first and then covered with a soft non-woven needle punched geotextile. Ensure the geotextile is pinned at 0.5m centres over the full area of the emergency spillway.
- Where possible, construct emergency spillways in well vegetated, undisturbed ground (not fill) and discharge over long grass.
- Construct the emergency spillway with a minimum of 300 mm freeboard height above the primary spillway invert.

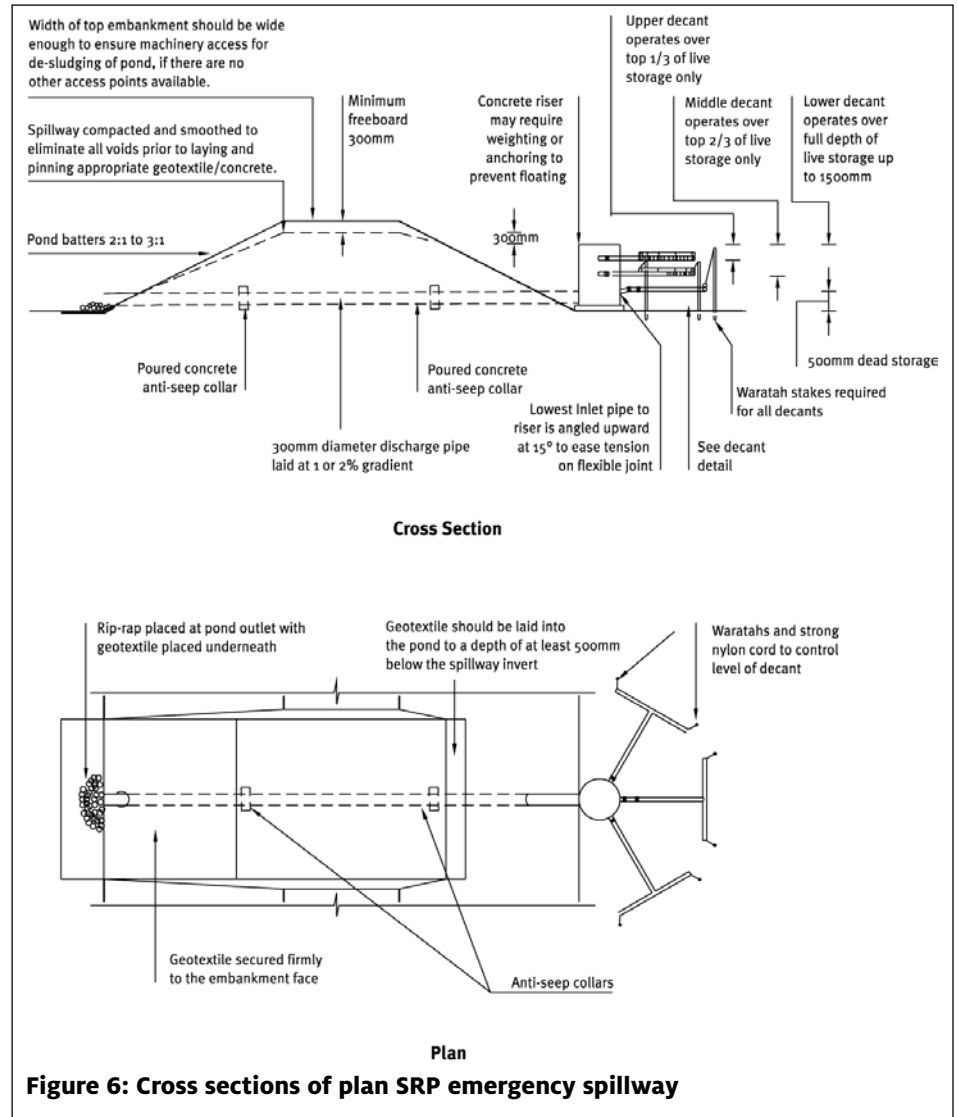


Figure 6: Cross sections of plan SRP emergency spillway

CONSTRUCTION SPECIFICATIONS

- Construct a fabric silt fence across the downslope end of the proposed works.
- Clear areas under proposed fills of topsoil or other unsuitable material down to competent material. Large fill embankments may need to be keyed in.
- Use only approved fill.
- Place and compact fill in layers as per the engineer's specifications.
- Do not place pervious materials such as sand or gravel within the fill material.
- Construct fill embankments approximately 10 per cent higher than the design height to allow for settlement of the material. Install appropriate pipe work and anti-seep collars during the construction of the embankment and compact around these appropriately.
- Install and stabilise the emergency spillway.
- Install and stabilise the level spreader.
- Securely attach the decant system to the horizontal pipework. Make all connections watertight. Place any manhole riser on a firm foundation of impervious soil.
- Do not place pervious material such as sand or scoria around the discharge pipe or the anti-seep collars.
- Check sediment retention pond freeboard for differential settlement and rectify as necessary.
- Stabilise both internal and external batters with vegetation.

POND MAINTENANCE AND DISPOSAL OF SEDIMENT

- Clean out sediment retention ponds before the volume of accumulated sediment reaches 20 per cent of the total sediment retention pond volume. To assist in gauging sediment loads, clearly mark the 20 per cent volume height on the decant riser.
- Clean out sediment retention ponds with high capacity sludge pumps, or with excavators (long reach excavators if needed) loading onto sealed tip trucks or to a secure area immediately adjacent to the pond.
- The erosion and sediment control plan (ESCP) should identify disposal locations for the sediment removed from the sediment retention pond. Deposit the sediment in such a location so that it does not lead to a direct discharge to receiving environments. Stabilise all disposal sites as required and approved in the site's ESCP.
- Inspect sediment retention ponds a minimum of once per week and before every forecasted rainfall event. Inspect for correct operation after every run off event. Immediately repair any damage to sediment retention ponds caused by erosion or construction equipment.

SAFETY

Sediment retention ponds are attractive to children and can become safety hazards if not appropriately fenced and if safety rules are not followed. Low gradient pond batters provide an additional safety measure. Check the safety requirements of the city or district council authority and the Occupational Safety and Health branch of the Department of Labour.

CHEMICAL TREATMENT

Some chemicals can be used successfully to promote flocculation (clumping together) of suspended solids in the sediment retention pond to increase the particle mass and speed the rate of settling:

- Poly Aluminium Chloride (PAC)
- poly-DADMAC
- Haloklear
- Crystalfloc

Chemical dosing systems are likely to be required where the design sediment retention pond volume cannot be achieved because of site constraints and/or where a high level of treatment is required because of the sensitivity of the receiving environment. Chemical treatment is also more likely to be required where the clay component is high or when specifically requested by council.

All chemical treatments require flocculation management plans to be submitted and approved by Waikato Regional Council before commencing any flocculation method.