2.1 Sediment Retention Pond

Plate 2.1.1 Sediment Retention Pond Showing Decant Systems

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 runoff 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 runoff is necessary, and are generally considered the appropriate control measure for exposed catchments of more than 0.3 ha. 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. This eliminates the problem of installing and maintaining Stormwater Inlet Protection throughout the latter stages of a development.

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

- Generally use Sediment Retention Ponds for bare areas of bulk earthworks of 0.3 ha or greater.
- Restrict catchment areas to less than 5.0 ha per Sediment Retention Pond. This limits the length of overland flowpaths 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, Runoff Diversion Channels and Contour Drains.
- Locate Sediment Retention Ponds to allow access for removing sediment from the pond.
- Wherever possible, locate Sediment Retention Ponds to allow the spillway to discharge over undisturbed, well vegetated ground.
- Keep the Sediment Retention Pond life to less than two years. If a longer term is required then further measures to ensure stability and effectiveness are likely to be needed.
- 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 antiseep collars, will keep the system robust.

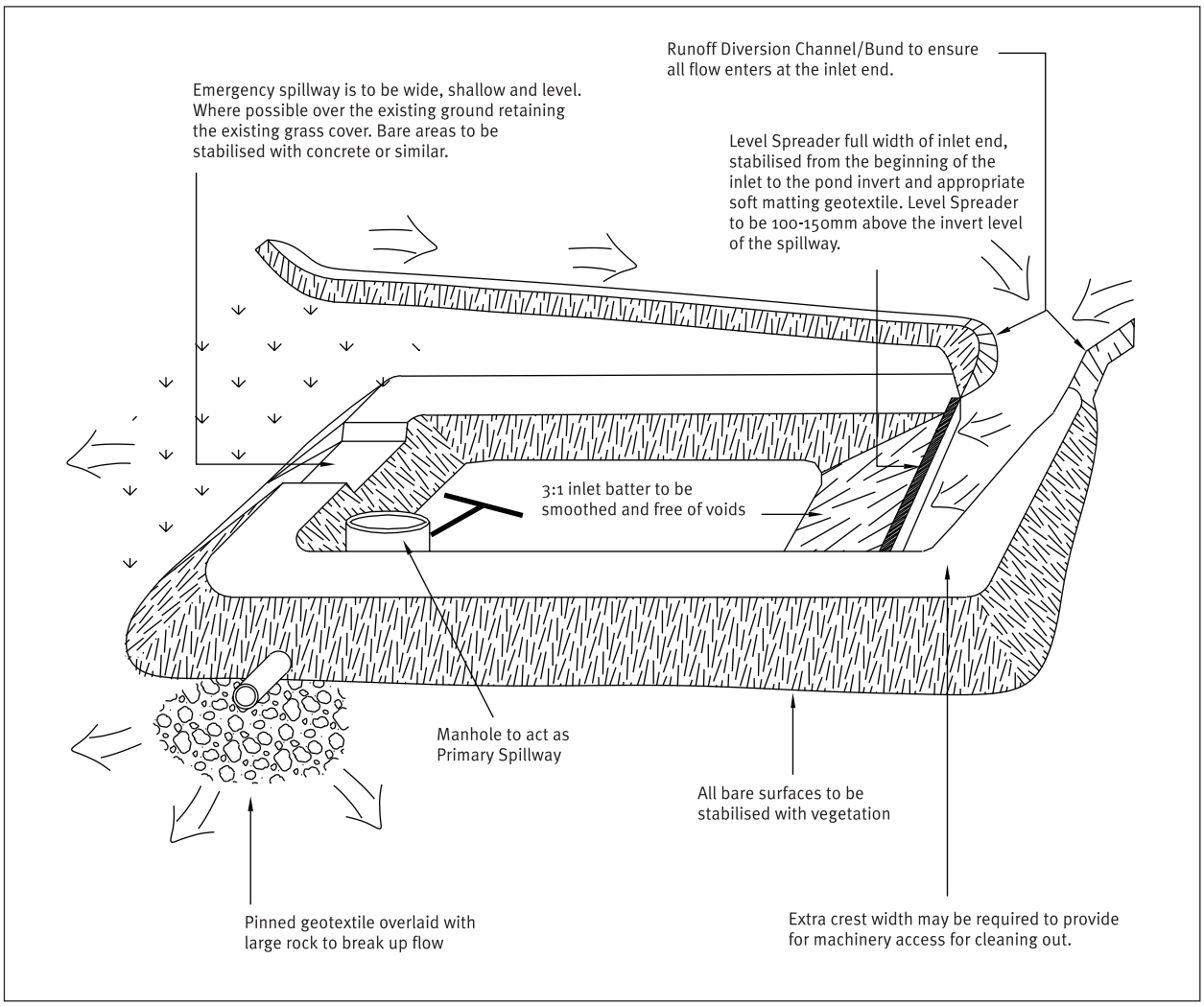


Figure 2.1.1 Sediment Retention Pond

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 outlet riser. The following design criteria apply.

- On earthwork sites with slopes less than 10% and less than 200m in length, construct a Sediment Retention Pond with a minimum volume of 2% of the contributing catchment (200m^3 for each ha of contributing catchment).
- On sites with slopes greater than 10% and/or 200 o in length, construct Sediment Retention Ponds with a minimum volume of 3% of the contributing catchment (300m^3 capacity for each ha of contributing catchment).
- The slope angle is determined by that slope immediately above the Sediment Retention Pond or by the average slope angle over the contributing catchment, whichever is the greater.
- For sand soils (less than 8% clay and less than 40% silt) the size of the Sediment Retention Pond may be calculated using the following formula –
  - Pond Surface Area (square metres) = 1.5 x Peak Inflow Rate (litres per second),
  - calculate the inflow rates using the 5% AEP rainfall event. Ensure the Sediment Retention Pond has a minimum depth of 1.0m,
  - alternatively, construct Sediment Retention Ponds with a minimum volume of 1% of the contributing catchment (100 m^3 capacity for each ha of contributing catchment).
- On sites that are particularly steep or have sensitive downstream environments, a greater Sediment Retention Pond volume may be required.
- Clean out Sediment Retention Ponds when the volume of sediment accumulated within them reaches 20% 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 30% of the total Sediment Retention Pond storage by positioning the lowest decant 0.4 – 0.8m above the invert of the Sediment Retention Pond.
- The approved decant design detailed in these Guidelines allows the lower decant arm to be raised as sediment deposition increases, thereby maintaining the percentage volume of dead storage.

Design – Live Storage (Decant Storage)

- Live storage is the volume between the lowest decant outlet level and the crest of the Sediment Retention Pond primary spillway.
- Ensure that the live storage volume capacity is 70% 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.

Design – Decanting/Outlet Dewatering Device

- Dewater the Sediment Retention 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.
- Various dewatering devices are available, however the Auckland Regional Council prefers the use of a floating T-bar dewatering device, which allows for the decanting of the cleaner surface water from the top of the water column. Substantiated performance design will need to be submitted to the Auckland Regional Council for decant systems other than the floating T-bar dewatering device.
- The recommended 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 2.1.5 for various sized catchments. For simplicity, give preference to producing a standard T-bar decant that provides a decant rate of 4.5 litres/second per decant which can be added in discrete increments to accommodate various sized catchments.
- To achieve a decant rate of 4.5 litres/second per decant, drill 6 rows of 10mm diameter holes at 60mm spacings (200 holes) along the 2m long decant arm.
- For catchments of less than 1.5ha, seal off the appropriate number of holes to achieve a 3 litres/second/hectare discharge rate.
- Single 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% 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 as detailed in Figure 2.1.4.
- 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 holes 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 tying 5mm nylon cord through decant holes at either end of the decant arm and fastening it to waratahs driven in on either side of the decant.
- Lay the discharge pipe at a 1 – 2% 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 1.0m; 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 – 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 1.0m.
- 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 can not 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 invert as described below to promote the even and gradual dissipation of the heavier inflow water across the full area of the Sediment Retention Pond.

Design – Level Spreader

- Incorporate a Level Spreader into the inlet design to spread inflow velocities, thereby allowing rapid dissipation of inflow energies. Combine the 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 Level Spreader is level, non-erodible and spans the full width of the Sediment Retention Pond.
- 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. This timber weir also serves to toe in any geotextile protection which may be required. Sediment accumulated behind the Level Spreader may require periodic removal.
- Position the top of the Level Spreader weir 100 – 200 mm above the invert of the emergency spillway.
- The shape of the Level Spreader will vary with the direction and volume of the inlet diversion, but the entrance to the Level Spreader must be widened and flared to promote even flow, as in Part B, Section 1.10 of these Guidelines.

Design – Baffles

- Incorporate baffles in the Sediment Retention Pond design where the recommended pond shape cannot be achieved. Extend baffles the full depth of the Sediment Retention Pond and place them to maximise dissipation of flow energy.
- Generally, baffles are in the form of a wing to direct inflows away from the outlet and maximise the stilling zone. A series of compartments within the pond can be used to achieve this, although care must be taken to avoid creating in-pond currents and resuspension of light particulates.

Plate 2.1.2 Sediment Retention Pond Showing Baffle to Lengthen Flowpath and Create Correct Length:Width Ratio

- Baffles may be constructed from various materials ranging from solid shutter boards to braced geotextile curtains.

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 – Embankment

- 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.
- Thoroughly compact the Sediment Retention Pond embankment, with material laid in 150 mm layers and compacted to engineering standards.
- 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 place over winter.

Design – Primary Spillway

- For larger catchments (greater than 1.5ha) the Sediment Retention Pond requires a piped primary spillway (refer Figures 2.1.3 and 2.1.4).
- For catchments up to 1.5ha, decant flows can be piped using the same diameter piping as the decant system (100mm PVC smooth bore) directly through the Sediment Retention Pond wall to discharge beyond the toe of the Sediment Retention Pond wall.
- 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 and/or the long term stability of the Sediment Retention Pond emergency spillway is questionable (for example, built in fill) then consideration should be given to incorporating a concrete manhole riser and larger diameter pipe outlet as a primary spillway sufficient to accommodate the 5% AEP rainfall event.
- 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.
- Where possible, install the piping through the embankment as the embankment is being constructed.

Design – Emergency Spillway

- An emergency spillway is essential for all Sediment Retention Ponds.
- Emergency spillways must be capable of accommodating the 1% AEP event without eroding.
- The outer emergency spillway crest and batter requires a very high standard of stabilisation with the fill material of the spillway batter well compacted.
- Construct the emergency spillway as a stabilised trapezoidal cross section with a minimum bottom width of 6m or the width of the pond floor, whichever is the greater.
- When utilising geotextile for emergency spillway stabilisation purposes, the batter face must be smooth and all voids eliminated.
- If geotextile is used, a soft neddle punch geotextile is laid first and then covered with a strong woven low permeability 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.
- If the emergency spillway is constructed on bare soil, provide complete erosion protection by means such as grouted riprap, asphalt, erosion matting/ geotextile or concrete.
- Construct the emergency spillway with a minimum of 300mm freeboard height above the primary 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% higher than the design height to allow for settlement of the material. Install appropriate pipe work and antiseep collars during the construction of the embankment and compact around these appropriately.
- Install 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 antiseep collars.
- Install baffles if required.
- Check Sediment Retention Pond freeboard for differential settlement and rectify as necessary.
- Stabilise both internal and external batters with vegetation and the emergency spillway in accordance with the site's approved Erosion and Sediment Control Plan.

Pond Maintenance and Disposal of Sediment

- Clean out Sediment Retention Ponds before the volume of accumulated sediment reaches 20% of the total Sediment Retention Pond volume. To assist in gauging sediment loads, clearly mark the 20% 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.
- The Erosion and Sediment Control Plan 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 Erosion and Sediment Control Plan.
- Inspect Sediment Retention Ponds every day and before every forecasted rainfall event. Inspect for correct operation after every runoff 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.

Recent trials have identified a simple and effective chemical dosing system that does not require a power supply. This system uses poly aluminium chloride (PAC) and has been found to be particularly effective in settling fine particulate such as fine silts and clays. Other chemicals may become available as more trial data is obtained.

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 where the cumulative effects of sediment discharge are significant.

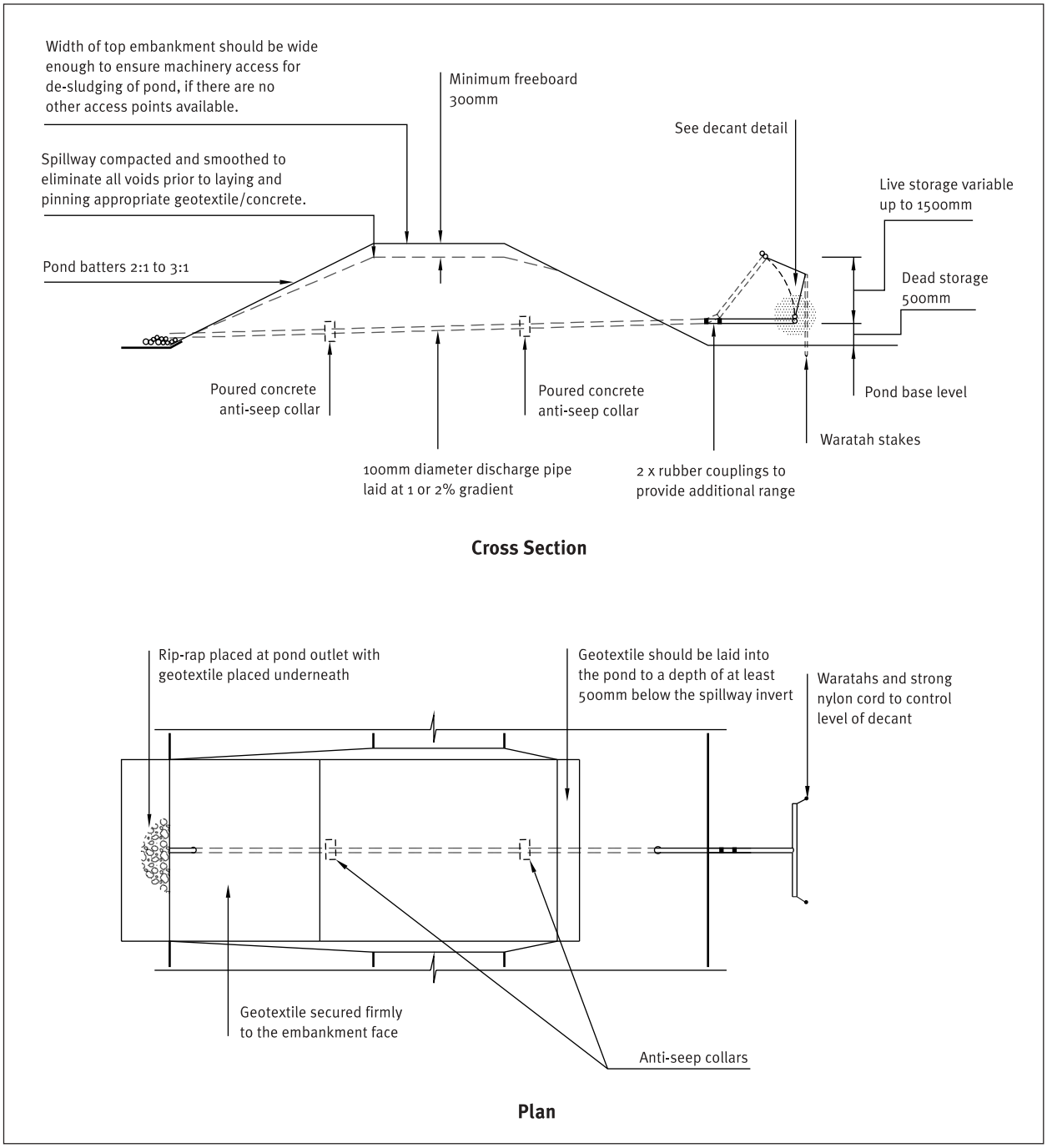
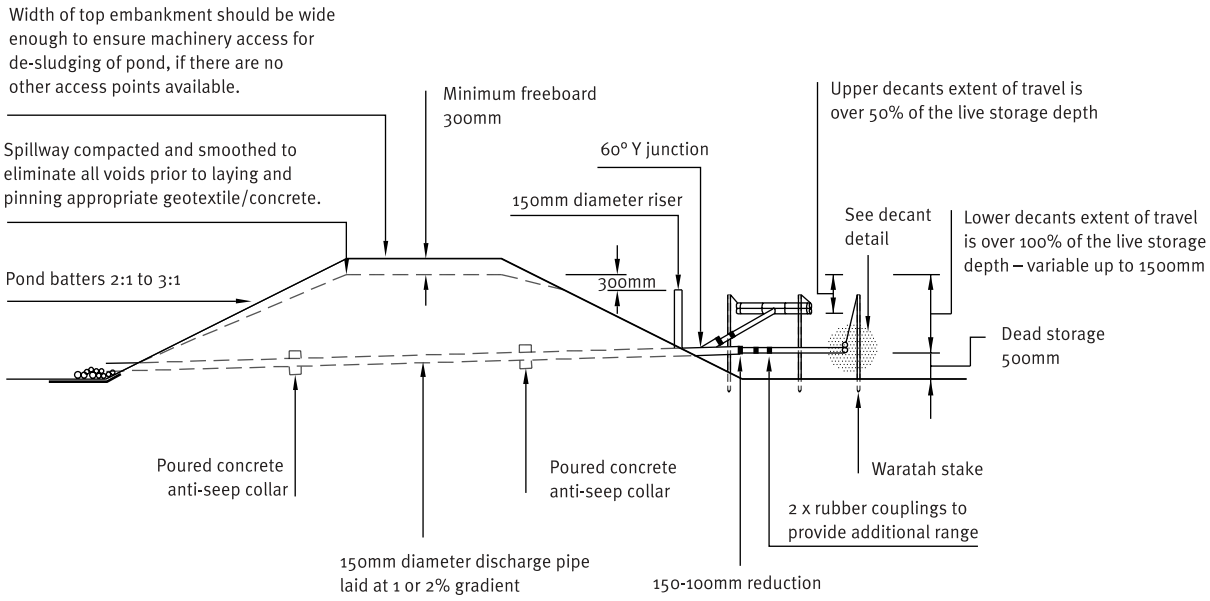


Figure 2.1.2 Sediment Retention Pond for Catchments up to 1.5 ha



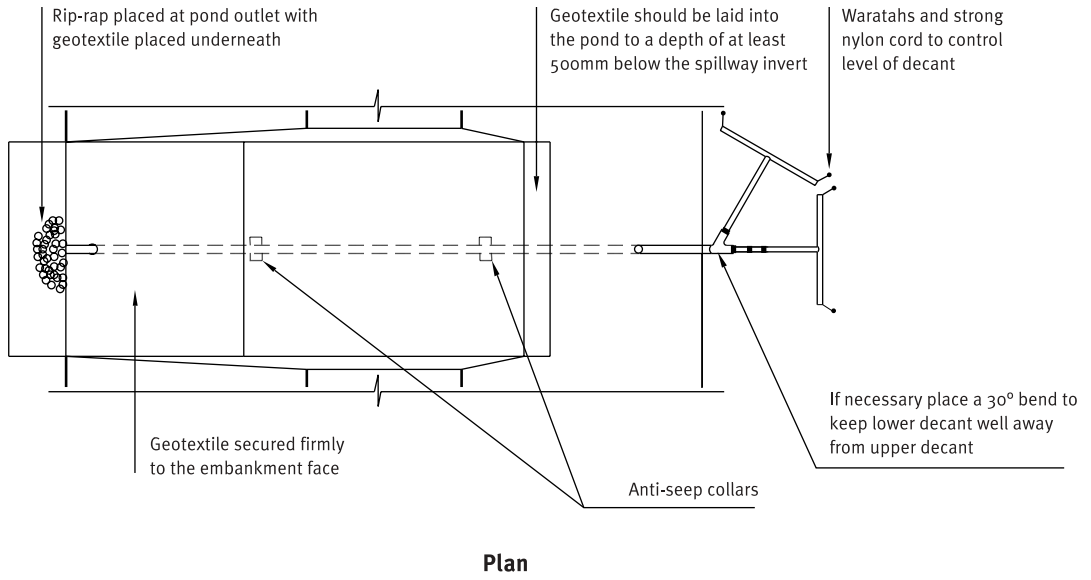


Figure 2.1.3 Sediment Retention Pond for Catchments Between 1.5 and 3 ha

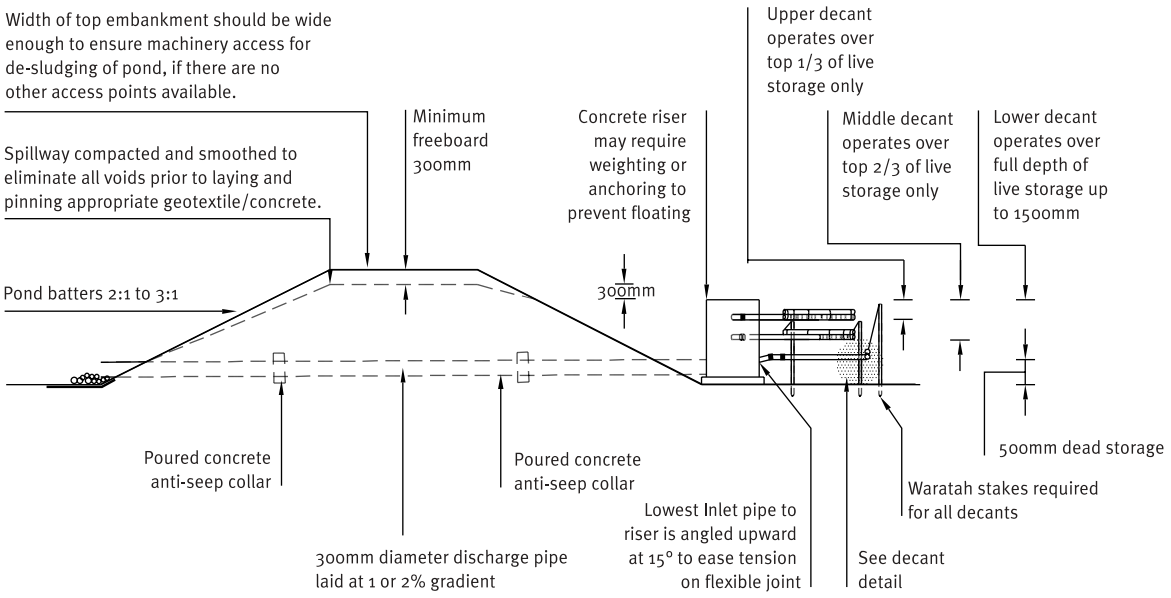


Figure 2.1.4 Sediment Retention Pond for Catchments Between 3 and 5 ha

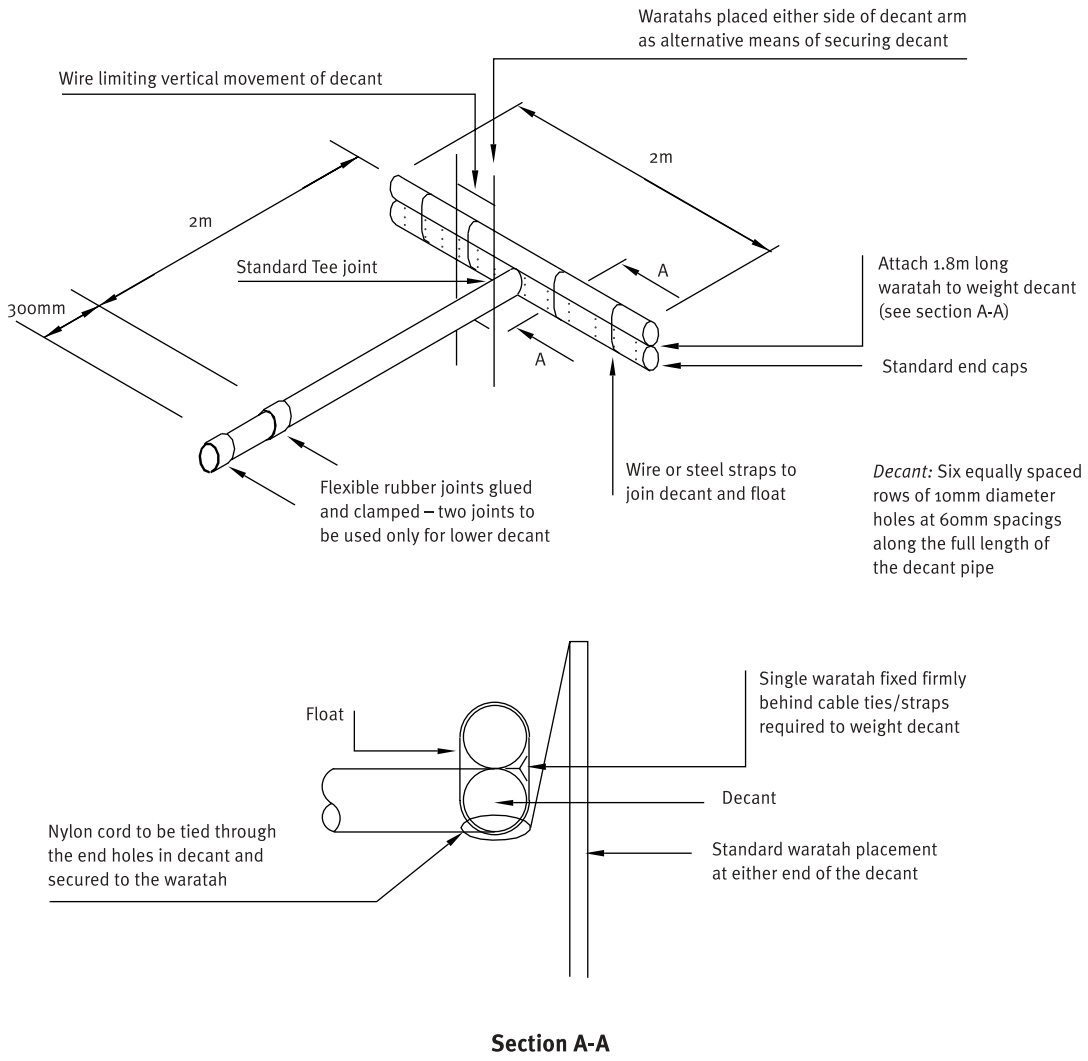


Figure 2.1.5 Sediment Retention Pond – Decant Detail