Sediment Basins

SEDIMENT CONTROL TECHNIQUE

Type 1 System	✓	Sheet Flow		Sandy Soils	✓
Type 2 System		Concentrated Flow	✓	Clayey Soils	✓
Type 3 System		Supplementary Trap		Dispersive Soils	[1]

[1] Settlement of dispersive soils may be achieved through the flocculation of 'wet' sediment basins.

Symbol

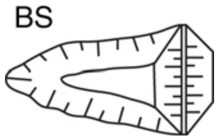

Photo 1 – Example of a 'dry' (Type C) sediment basin

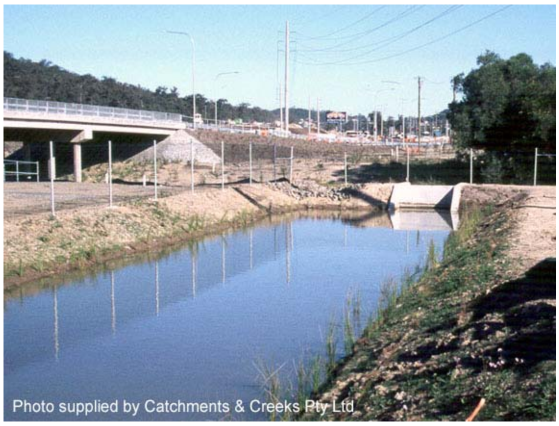

Photo 2 – Example of a 'wet' (Type F/D) sediment basin

Key Principles

1. Sediment trapping can be achieved by both particle settlement within the settling pond (all basin types), and by the filtration of minor flows passing through the aggregate or geotextile filter (dry basins).
2. For continuous flow basins (i.e. dry basins) the critical design parameter for optimising particle settlement is the 'surface area' of the settling pond. For plug flow basins (i.e. wet basins) the critical design parameter is the 'volume' of the settling pond.
3. The critical design parameter for the filtration process (dry basins) is the design flow rate for water passing through the filter, which is related to the depth of water (hydraulic head), and the surface area and flow resistance of the filter.
4. Even if a basin is full of water, it can still be effective in the removal of coarse sediment from any flows passing through the basin. Therefore, unlike permanent stormwater settling ponds, high flows resulting from storms in excess of the 'design storm' should **not** be bypassed around a construction site sediment basin.

Design Information

This fact sheet summaries design requirements for three types of temporary sediment basins, Type C for coarse-grained soils, Type F for fine-grained soils, and Type D for dispersive soils. Detailed design procedures are provided in Appendix B of the IECA (Australasia) "Best Practice Erosion and Sediment Control" document.

Sediment basins should be designed and operated in a manner that produces near clear-water discharges (i.e. total suspended solids concentrations not exceeding 50mg/L) during non-overtopping events, especially following periods of light rainfall.

Summary of design requirements

Table 1 provides a summary of the recommended design requirements.

Table 1 – Summary of sediment basin design requirements

Parameter	Type C basin	Type F & D basins
Soil characteristic	Less than 33% of soil finer than 0.02mm and no more than 10% of soil dispersive.	**Type F:** More than 33% of soil finer than 0.02mm. **Type D:** More than 10% of soil dispersive, or where turbidity control is essential.
Settling pond sizing, surface area (A_s), or settling volume (V_s)	$A_s = 3400\ H_e\ (Q)$ Q = 0.5 times 1 in 1yr flow	$V_s = 10\ R_{(Y\%,\ 5\text{-day})}\ C_v\ A$
Length to width ratio	Hydraulic efficiency factor (H_e) is reduce with increasing length to width ratio	L:W of 3:1 is highly desirable
Minimum depth of settling zone	0.6m	0.6m
Sediment storage volume	100% of settling volume	50% of settling volume
Use of inlet chamber	Desirable if length to width ratio is less than 3:1, or if inflow is concentrated with high flow velocity.	
Internal baffles	Desirable if length to width ratio is less than 3:1	
Use of outlet chamber	Essential if skimmer pipe outlet system is employed	Use depends on type of outlet system adopted
Control inflow conditions	Used to control erosion at inlets and, where practicable, ensure the inflow pipe invert is above the spillway crest elevation.	
Pre-treatment pond	Used to reduce the cost and frequency of de-silting operations.	
Primary outlet	Ensure choice of outlet system is compatible with basin type.	
Emergency spillway minimum design capacity	Less and 3 month design life: capacity of 1 in 10 year ARI. 3 to 12 months design life: capacity of 1 in 20 year ARI. Greater than 12 months design life: capacity of 1 in 50 yr ARI.	
Elevation from top of riser pipe outlet to spillway crest	300mm (min)	N/A
Freeboard from maximum pond water level to top of virgin soil bank	150mm (min)	150mm (min)
Freeboard from maximum pond water level to top of fill embankment	300mm (min)	300mm (min)
Minimum freeboard along spillway chute	300mm (min)	300mm (min)
Minimum embankment crest width	2.5m	2.5m
Maximum gradient of access ramp	6:1	6:1
Chemical flocculation	As required to satisfy water quality objectives.	**Type F:** As required to satisfy water quality objectives. **Type D:** Essential

Design procedure:

Step 1 – Assess the need for a sediment basin

Sediment basins are recommended for any sub-catchment with a catchment area exceeding 2500m^2 and an estimated soil loss rate that exceeds the equivalent of 150t/ha/yr.

Step 2 – Selection of the required type of basin

Selection of the type of sediment basin is governed by the site's soil properties as outlined in Table 2.

Table 2 – Selection of basin type

Soil and/or catchment conditions [1]	Basin type
Less than 33% of soil finer than 0.02mm (i.e. d_{33} > 0.02mm) and no more than 10% of soil dispersive. [2]	Type C basin
More than 33% of soil finer than 0.02mm (i.e. d_{33} < 0.02mm) and no more than 10% of soil dispersive. [2]	Type F basin
More than 10% of soil dispersive [2], or when a Stormwater Management Plan (SMP), or adopted Water Quality Objectives (WQOs) specify strict controls on turbidity levels and/or suspended solids concentrations for discharged waters.	Type D basin

[1] If more than one soil type exists on the site, then the most stringent criterion applies (i.e. Type D supersedes Type F, which itself supersedes Type C).

[2] The percentage of soil that is dispersive is measured as the combined decimal fraction of clay (<0.002mm) plus half the percentage of silt (0.002–0.02mm), multiplied by the dispersion percentage.

Step 3 – Determine the basin location

Sediment basins should be located within a sub-catchment so as to maximise its overall sediment trapping capabilities of that sub-catchment. Issues that need to be given appropriate consideration include:

- Locate all basins within the relevant property boundary.
- Locate sediment basins above the 1 in 5 year ARI flood level. Where this is not practicable, then all reasonable efforts should be taken to maximise the flood immunity of the basin.
- Avoid locating a basin in an area where adjacent construction works may limit the operational life of the basin.
- Ensure basins have suitable access for maintenance and de-silting.

Step 4 – Diversion of 'clean' water around a basin

Up-slope 'clean' water should be diverted around the sediment basin to decrease the size and cost of the basin and increase its efficiency. The adopted flow diversion systems may need to be modified for each stage of construction as new areas of land are first disturbed, then stabilised.

'Clean' water is defined as water that has not been contaminated within the property, or by activities directly associated with the construction/building works.

Step 5a – Sizing of the settling pond, Type C basins

The settling pond within a Type C sediment basin is divided (horizontally) into two zones: the upper *settling zone* and the lower *sediment storage zone* as shown in Figure 1.

The minimum volume of the upper settling zone is defined by Equation 1.

$$A_s = 3400\ H_e\ (Q) \qquad \text{(Eqn 1)}$$

where: A_s = Surface area of settling pond at the base of the settling zone [m^2]

H_e = Hydraulic efficiency correction factor

Q = design flow rate [m^3/s]

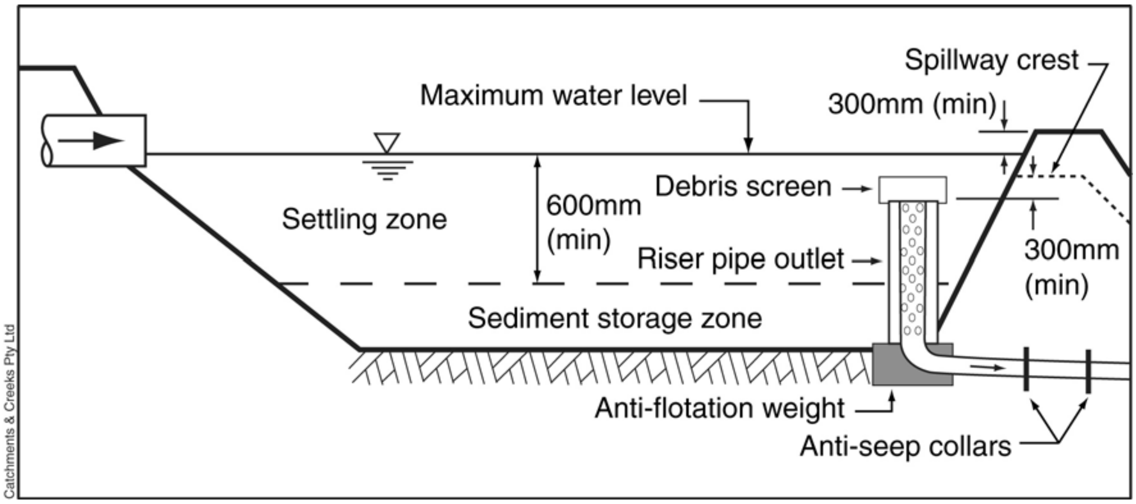

Figure 1 – Type C *Sediment Basin* with riser pipe outlet (long section)

Unless otherwise required by a regulatory authority, the design flow rate (Q) for a Type C sediment basin must be 0.5 times the peak discharge for the 1 in 1 year ARI storm.

The minimum recommended depth of the settling zone is 0.6m, or L/200 for basins longer than 120m (where L = effective basin length). Settling zone depths greater than 1m should be avoided if settlement velocities are expected to be slow.

The desirable minimum length to width ratio of 3:1, otherwise internal baffles need to be used wherever practicable to prevent short-circuiting of flows.

The hydraulic efficiency correction factor (H_e) depends on flow conditions entering the basin and the shape of the settling pond. Table 3 provides recommended values of the hydraulic efficiency correction factor.

Where available space does not permit construction of the ideal sediment basin, then a smaller basin may be used; however, erosion control and site rehabilitation standards need to be appropriately increased to a higher standard to compensate.

A Type C sediment basin that is less than the ideal size should be considered either a Type 2 or Type 3 sediment trap based on the effective particle settlement capabilities.

Table 3 – Hydraulic efficiency correction factor (H_e)

Flow condition within basin	Effective [1] length:width	H_e
Uniform or near-uniform flow conditions across the full width of basin. [2] For basins with concentrated inflow, uniform flow conditions may be achieved through the use of an appropriate inlet chamber arrangement.	1:1	1.2
	3:1	1.0
Concentrated inflow (piped or overland flow) primarily at one inflow point and no inlet chamber to evenly distribute flow across the full width of the basin.	1:1	1.5
	3:1	1.2
	6:1	1.1
	10:1	1.0
Concentrated inflow with two or more separate inflow points and no inlet chamber to evenly distribute flow across the full width of the basin.	1:1	1.2
	3:1	1.1

[1] The effective length to width ratio for sediment basins with internal baffles is measured along the centreline of the dominant flow path.

[2] Uniform flow conditions may also be achieved in a variety of ways including through the use of an inlet chamber and internal flow control baffles.

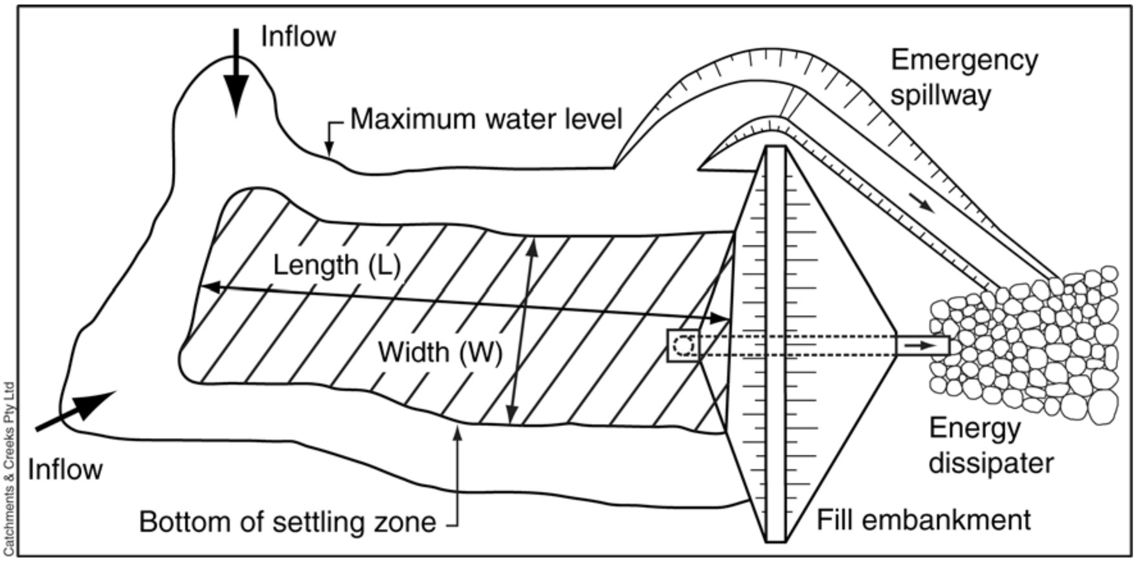

Figure 2 – Type C sediment basin with riser pipe outlet (plan view)

Step 5b – Sizing of the settling pond, Type F & D basins

The settling pond within a Type F or Type D sediment basin is divided (horizontally) into two zones: the upper *settling zone* and the lower *sediment storage zone* as shown in Figure 3.

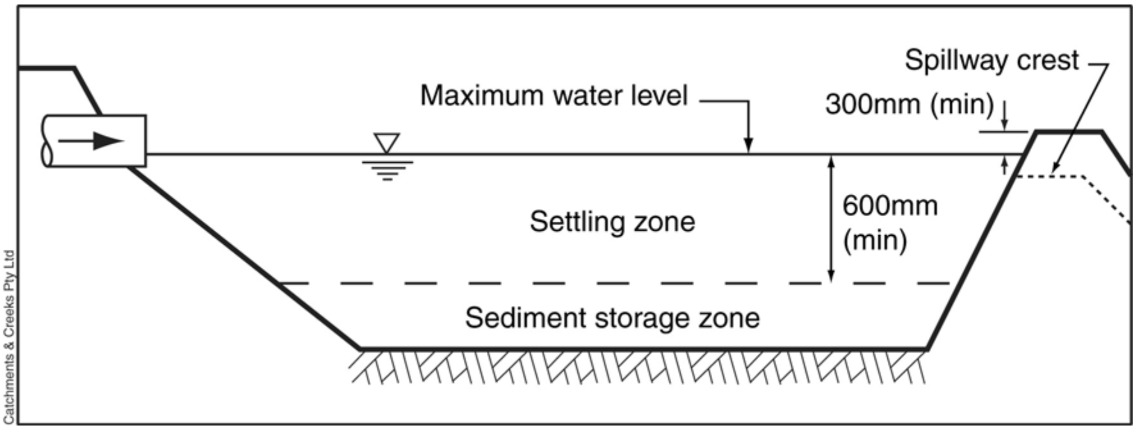

Figure 3 – Settling zone and sediment storage zone

The minimum volume of the upper settling zone is defined by Equation 2.

$$V_s = 10.\ R_{(Y\%,5\text{-day})}\ .\ C_v\ .\ A \qquad \text{(Eqn 2)}$$

where: V_s = volume of the settling zone [m^3]

$R_{(Y\%,5\text{-day})}$ = Y%, 5-day rainfall depth [mm]

C_v = volumetric runoff coefficient

A = effective catchment surface area connected to the basin [ha]

The regulatory authority should provide the required design rainfall probability (Y%) and rainfall depth (R) for a given location.

The minimum recommended depth of the settling zone is 0.6m, or L/200 for basins longer than 120m (where L = effective basin length). Settling zone depths greater than 1m should be avoided if settlement velocities are expected to be slow.

The desirable minimum length to width ratio of 3:1 is recommended for Type F and Type D basins. The length to width ratio is important for Type F and Type D basins because they operate as continuous-flow settling ponds (as per Type C basins) once flow begins to discharge over the emergency spillway.

Step 6 – Determination of sediment storage volume

The sediment storage zone lies below the settling zone as defined in Figure 4. The recommended sediment storage volume can be determined from Table 4.

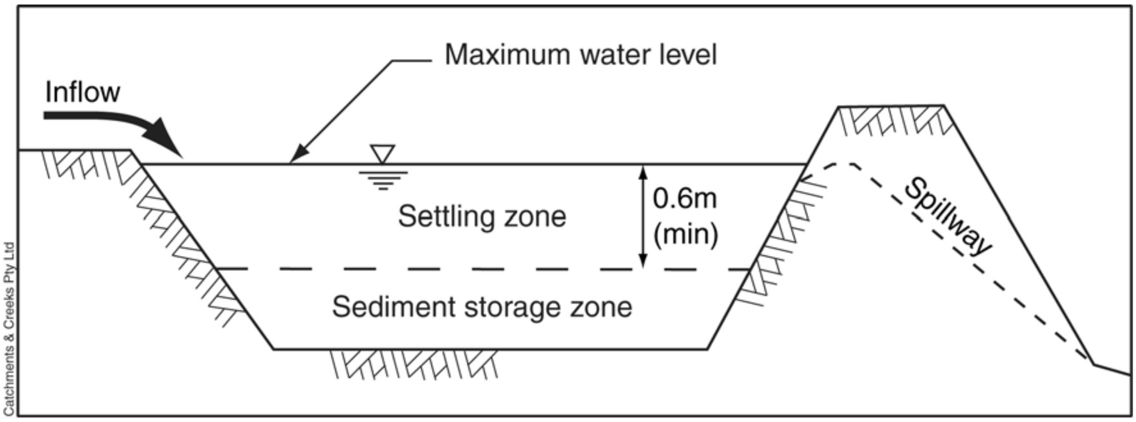

Figure 4 – Settling zone and sediment storage zone

Table 4 – Sediment storage volume

Basin type	Sediment storage volume
Type C	100% of settling volume
Type F and Type D	50% of settling volume

Alternatively, the volume of the sediment storage zone can be determined by estimating the expected sediment runoff volumes over the desired maintenance period, typically not less than 2 months.

Step 7 – Select internal and external bank gradients

Recommended bank gradients are provided in Table 5.

Table 5 – Suggested bank slopes

Slope (H:V)	Bank/soil description
2:1	Good, erosion-resistant clay or clay-loam soils
3:1	Sandy-loam soil
4:1	Sandy soils
5:1	Unfenced Sediment Basins accessible to the public
6:1	Mowable, grassed banks.

All earth embankments in excess of 1m in height should be certified by a geotechnical engineer/specialist as being structurally sound for the required design criteria and anticipated period of operation.

If public safety is a concern, and the basin is not to be fenced (not recommended), and the basin's internal banks are steeper than 5:1(H:V), then at least one bank should be turfed a width of at least 2m from top of bank to the toe of bank to allow egress during wet weather.

Step 8 – Design of flow control baffles

Baffles may be used for a variety of purposes including:

- energy dissipation (inlet chambers);
- the control of short-circuiting (internal baffles);
- minimising sediment blockage of the low-flow outlet structure (outlet chambers).

The need for flow control baffles should have been established in Step 5a based on the basin's length to width ratio. Both inlet baffles (inlet chambers) and internal baffles can be used to improve the hydraulic efficiency of the basin, and thus reduce the size of the settling pond through modification of the hydraulic efficiency correction factor.

(a) Inlet chambers

Flow control baffles or similar devices may be placed at the inlet end of a sediment basin to form an inlet chamber (Figures 5 & 6). These chambers are used to reduce the adverse effects of inlet jetting caused by concentrated, point source inflows. The objective of the inlet chamber is to produce near-uniform flow conditions across the full width of the settling pond.

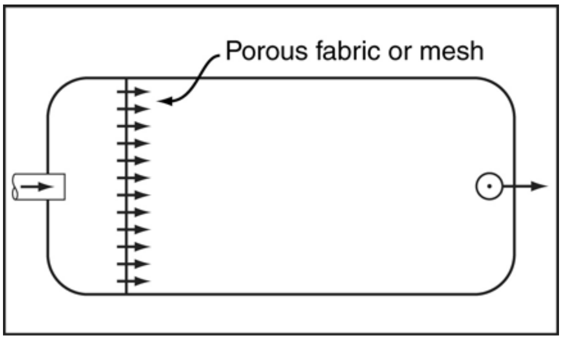

Figure 5(a) – Porous barrier inlet chamber

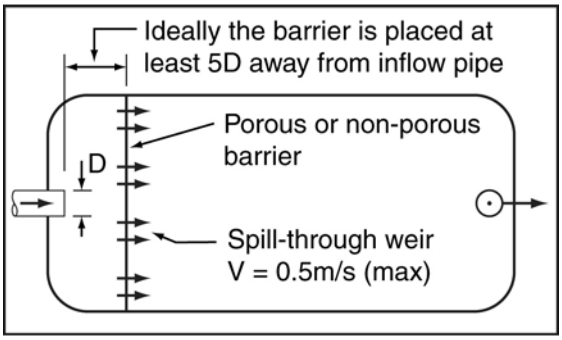

Figure 6(a) – Alternative inlet chamber design

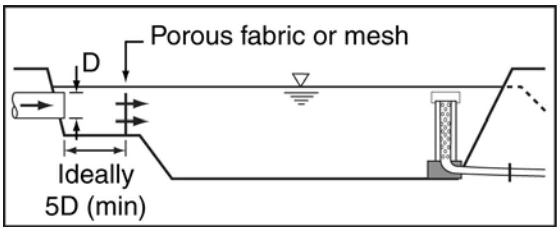

Figure 5(b) – Typical layout of inlet chamber with opposing inlet pipe (Type C basin)

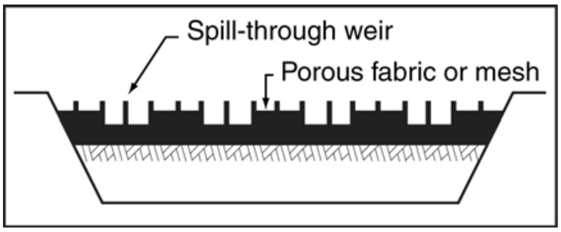

Figure 6(b) – Barrier with multiple spill-through weirs

The use of an inlet chamber is usually governed by the need to adopt a low hydraulic efficiency correction factor (H_e) in Step 5a. The incorporation of inlet baffles should be given serious consideration within Type C basins if the expected velocity of any concentrated inflows exceeds 1m/s.

Table 6 summaries the design of various inlet chambers.

Table 6 – Design of various inlet chambers

Baffle type	Discussion
Shade cloth	Typical spacing between support posts is 0.5 to 1.0m.
Perforated fabric	Heavy-duty plastic sheeting or woven fabric perforated with approximately 50mm diameter holes at approximately 300mm centres. Typical spacing between support posts is 0.5 to 1.0m.
Barrier with spill-through weirs	A porous or non-porous barrier constructed across the full width of the settling pond.

(b) Internal baffles

Internal baffles are used to increase the effective length-to-width ratio of the basin. Figure 7 demonstrates the arrangement of internal flow control baffles for various settling pond layouts.

If internal baffles are used, then the flow velocity within the settling pond must not exceed the sediment scour velocity of 0.2m/s for 0.02 to 0.10mm critical particle diameters respectively.

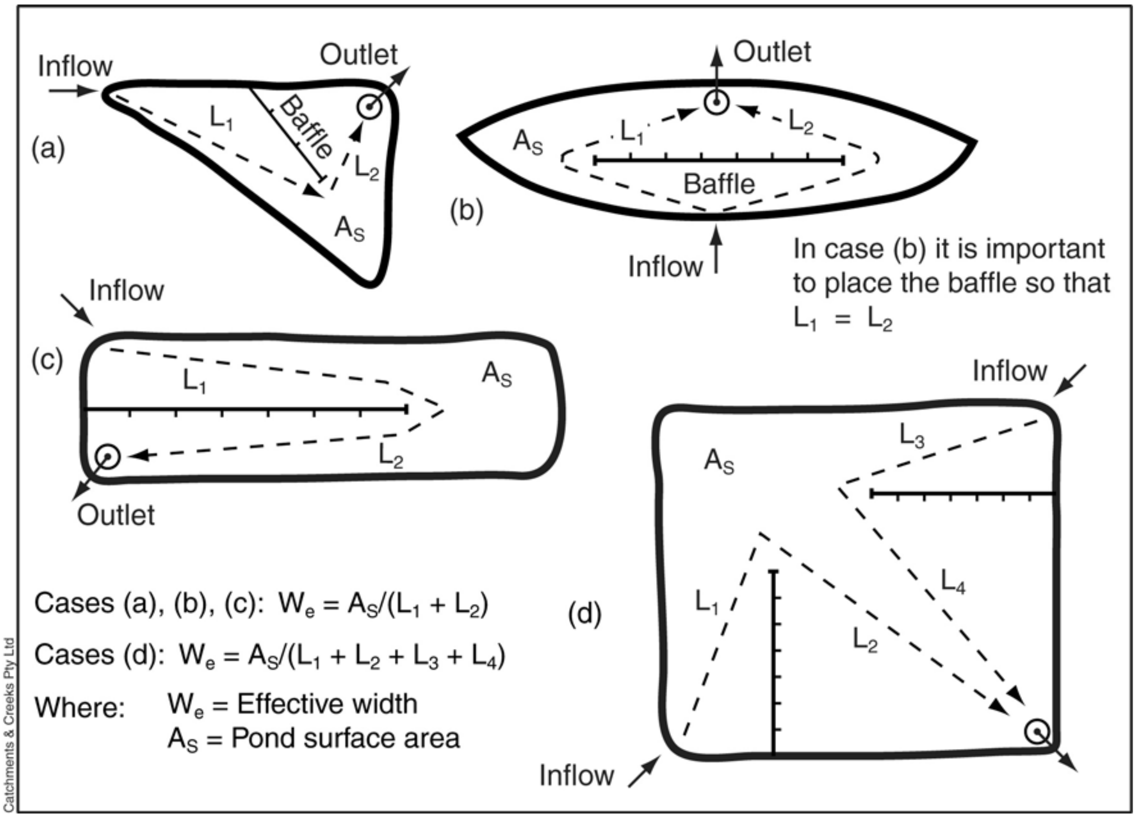

Figure 7 – Typical arrangement of internal flow control baffles (after USDA, 1975)

The crest of these baffles should be set level with, or just below, the crest of the emergency spillway. This is to prevent the re-suspension of settled sediment during severe storms (i.e. flows in excess of the basin's design storm should be allowed to overtop these baffles).

Photo 3 – Inlet chamber can also act as mixing chambers for the addition of flocculants

Photo 4 – Internal baffle extending the flow path between the basin inlet (left) and the basin outlet (right)

(c) Outlet chambers

Outlet chambers (Figures 8 & 9) are used to keep the bulk of the settled sediment away from certain low-flow outlet systems, particularly riser pipe outlets and flexible skimmer pipe outlets.

The use of an outlet chamber is mandatory when a flexible skimmer pipe outlet system is employed (Photo 6).

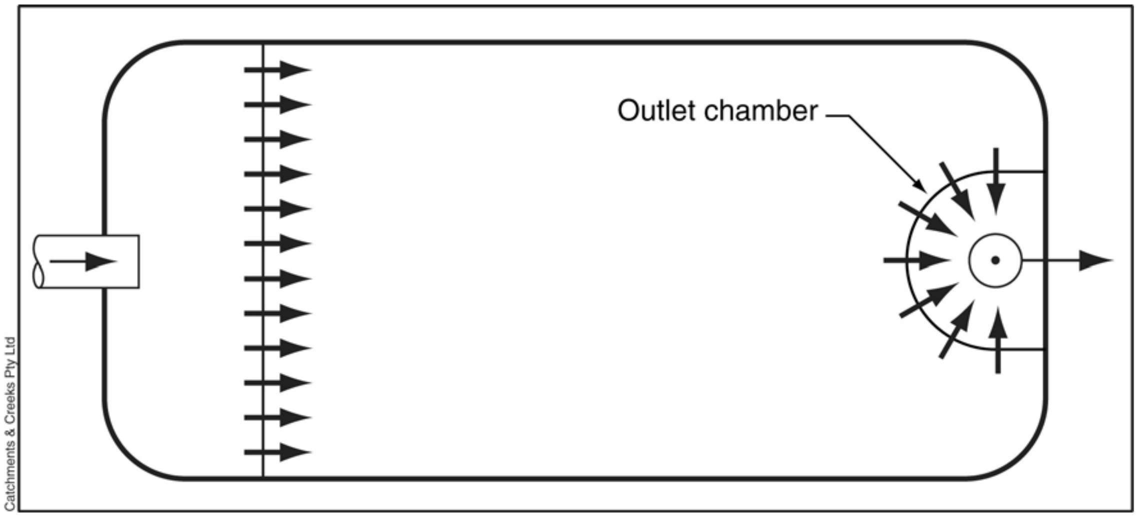

Figure 8 – Typical arrangement of outlet chamber (plan view)

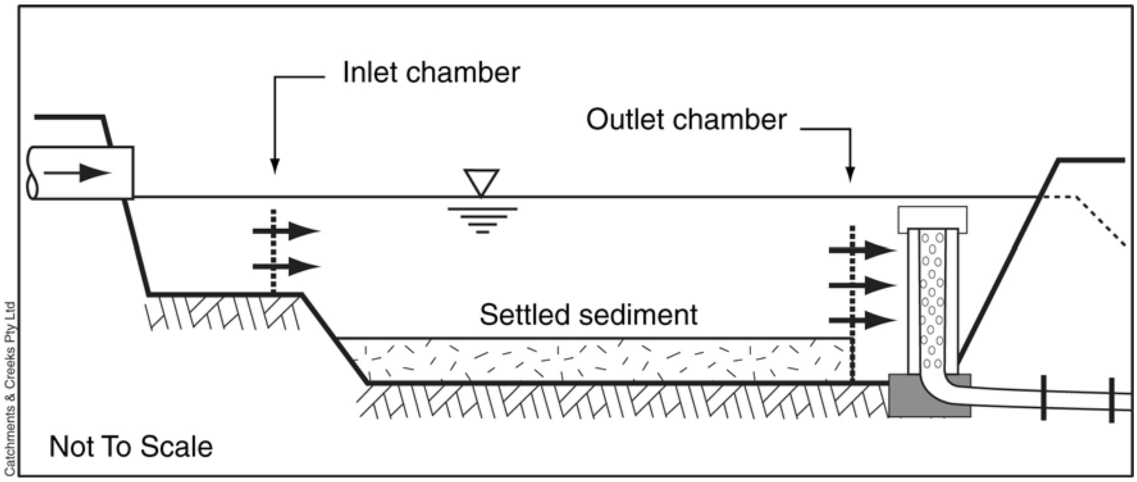

Figure 9 – Typical arrangement of outlet chamber (long section)

Photo 5 – Outlet chamber

Photo 6 – Outlet chamber surrounding a flexible skimmer outlet device

Step 9 – Design of the basin's inflow system

Surface flow entering the basin should not cause erosion down the banks of the basin. If concentrated surface flow enters the basin (e.g. via a *Catch Drain*), then an appropriately lined *Chute* (Photo 7) will need to be installed at each inflow point to control scour.

If flow enters the basin through pipes, then wherever practicable, the pipe invert should be above the spillway crest elevation to reduce the risk of sedimentation within the pipe. Submerged inflow pipes must be inspected and de-silted (as required) after each inflow event.

Constructing an appropriately designed pre-treatment pond or inlet chamber (Step 8) can be used to both improve the hydraulic efficiency of the settling pond, and reduce the cost and frequency of de-silting the main settling pond.

Where space is available, the construction of an inlet (pre-treatment) pond (Figure 10) or inlet chamber (Step 8) can significantly reduce the cost of regular de-silting activities for large and/or long-term basins.

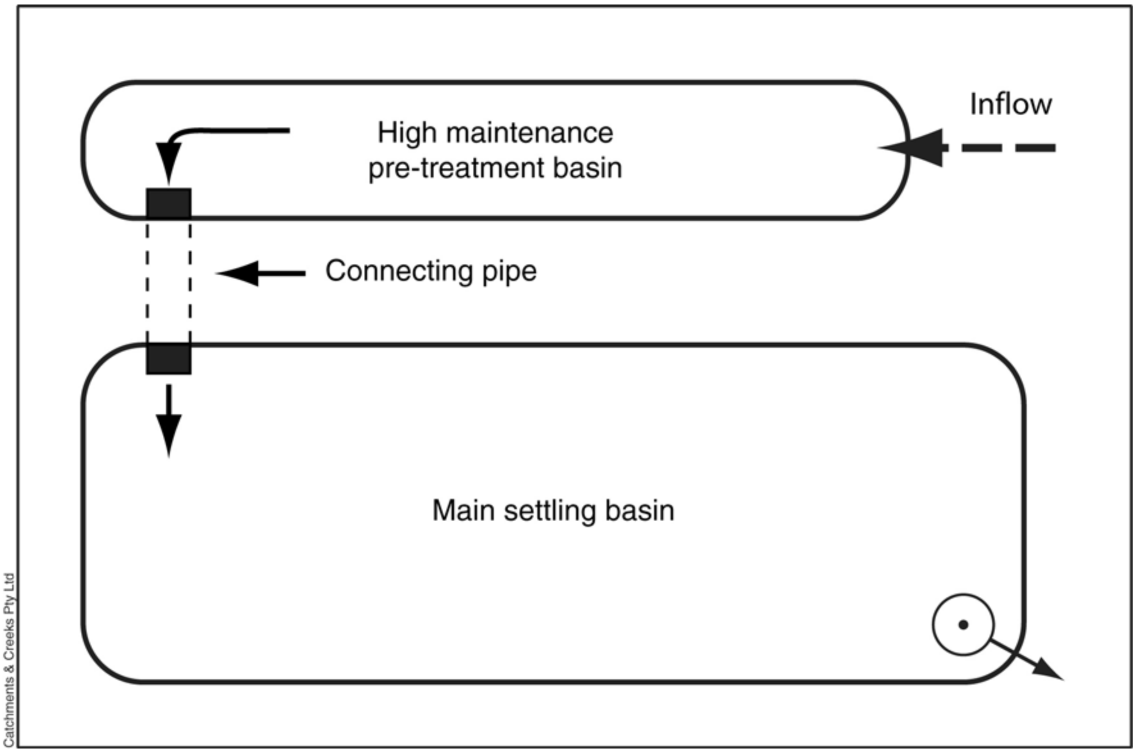

Figure 10 – Pre-treatment inlet pond

Photo 7 – Stabilise inflow chute

Photo 8 – Litter screen placed on inlet of permanent sediment basin

Step 10 – Design of the primary outlet system

Dry basins (Type C only) require a formal outlet system in the form of either a riser pipe outlet or floating skimmer system (Photo 11). Gabion wall, *Rock Filter Dam*, and *Sediment Weir* outlet systems are **not** recommended unless a Type 2 sediment retention system has been specified.

The hydraulics of a Type C basin's primary outlet system must ensure that the peak water level is at least 300mm below the crest of the emergency spillway during the basin's nominated design storm.

Wet basins (Type C, F or D) usually require a pumped outlet system. Alternatively, if a piped outlet exists, then a flow control valve must be fitted to the outlet pipe to allow full control of the basin discharge (note, Type C basins can be operated as wet basins with pumped outlets).

Photo 9 – Twin riser pipes in the process of being installed

Photo 10 – Riser pipe with aggregate filter and trash screen

Photo 11 – Skimmer outlet system

Photo 12 – Skimmer pipes must be protected from sediment build-up

Photo 13 – Low-flow sand filter outlet system on a permanent sediment basin

Photo 14 – Sand filter outlet system during installation

Step 11 – Design of the emergency spillway

All elevated sediment basins (i.e. not fully recessed below natural ground, Photo 17) require the construction of a formally designed emergency spillway. Spillways are critical engineering structures that need to be designed by suitably qualified persons.

The minimum design storm for sizing the emergency spillway is defined in Table 7.

Table 7 – Recommended design standard for emergency spillways

Design life	Minimum design storm ARI
Less than 3 months operation	1 in 10 year
3 to 12 months operation	1 in 20 year
Greater than 12 months	1 in 50 year
If failure is expected to result in loss of life	Probable Maximum Flood (PMF)

The crest of the emergency spillway is to be at least:

- 300mm above the primary outlet (if included);
- 300mm below a basin embankment formed in virgin soil;
- 450mm below a basin embankment formed from fill.

In addition to the above, design of the emergency spillway must ensure that the maximum water level within the basin during the design storm specified in Table 7 is at least:

- 300mm below a basin embankment formed from fill;
- 150mm plus expected wave height for large basins with significant fetch length.

The approach channel can be curved upstream of the spillway crest, but must be straight from the crest to the energy dissipater as shown in Figure 11. The approach channel should have a back-slope towards the impoundment area of not less than 2% and should be flared at its entrance, gradually reducing to the design width at the spillway crest.

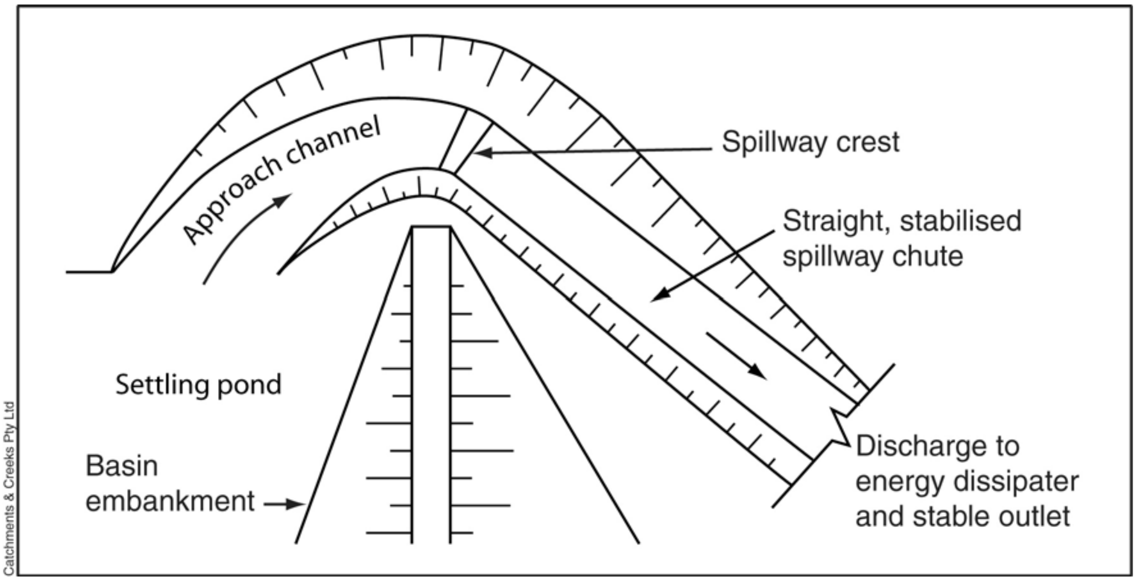

Figure 11 – Emergency spillway cut into virgin soil to side of fill embankment

All reasonable and practicable efforts must be taken to construct the spillway in virgin soil (Photo 16), rather than within a fill embankment (Photo 15). Placement of an emergency spillway within a fill embankment can significantly increase the risk of failure.

The downstream face of the spillway may be protected with grass, concrete, rock, rock mattresses, or other suitable material as required for the expected maximum flow velocity. Grass-lined spillway chutes are generally not recommended for sediment basins due to their long establishment time and relatively low scour velocity.

Photo 15 – Emergency spillway located within the fill embankment

Photo 16 – Emergency spillway located within virgin soil to the side of the embankment

For rock and rock mattress lined spillways, it is important to control seepage flows through the rocks located across the crest of the spillway. Seepage control is required so that the settling pond can achieve its required maximum water level prior to discharging down the spillway. Concrete capping of the spillway crest (Photo 18) can be used to control excess seepage flows.

Photo 17 – Fully recessed basin with natural ground forming the spillway

Photo 18 – Rock-lined spillway—note concrete sealing of the spillway crest

It is important to ensure that the spillway crest has sufficient depth and width to fully contain the nominated design storm peak discharge. Photo 20 shows a spillway crest with inadequate depth or flow profile.

Photo 19 – De-watering pipe intake <u>must</u> not rest on the basin floor

Photo 20 – Spillway crest with inadequate depth or profile

A suitable energy dissipater will be required at the base of the spillway. The recommended hydraulic freeboard down the spillway chute is 300mm to contain the turbulent whitewater.

Step 12 – Determination of the basin's overall dimensions

If a sediment basin is constructed with side slopes of say 3:1 (H:V), then the basin may be 5 to 10m longer and wider than the length and width of the settling pond determined in Step 5. It is important to ensure the overall dimensions of the basin can fit into the available space.

The minimum recommended embankment crest width is 2.5m, unless justified by hydraulic/ geotechnical investigations.

Where available space does not permit construction of the ideal sediment basin, then a smaller basin may be used; however, erosion control and site rehabilitation measures must be increased to an appropriate higher standard to compensate. If the basin's settling pond surface area/volume is less than that required in Step 5, than the basin must be treated as a Type 2 or Type 3 sediment control system.

Step 13 – Locate maintenance access (de-silting)

Sediment basins can either be de-silted using long-reach excavation equipment operating from the sides of the basin, or by allowing machinery access into the basin. If excavation equipment needs to enter directly into the basin, then it is better to design the access ramp so that trucks can be brought to the edge of the basin, rather than trying to transport the sediment to trucks located at the top of the embankment. Thus a maximum 6:1 (ideally 10H:1V) access ramp will need to be constructed.

If the sediment is to be removed from the site, then a suitable sediment drying area should be made available adjacent to the basin, or at least somewhere within the basin's catchment area.

Step 14 – Define the sediment disposal method

Trapped sediment can be mixed with on-site soils and buried, or removed from the site. If sediment is removed from the site, then it should be de-watered prior to disposal. De-watering must occur within the catchment area of the sediment basin.

Step 15 – Assess need for safety fencing

Construction sites are often located in publicly accessible areas. In most cases it is not reasonable to expect a parent or guardian of a child to be aware of the safety risks associated with a neighbouring construction site. Thus fencing of a sediment basin is usually warranted even if the basins are located adjacent to other permanent water bodies such as a stream, lake, or wetland.

Responsibility for safety issues on a construction site ultimately rests with the site manager; however, each person working on a site has a duty of care in accordance with the State's work place safety legislation. Similarly, designers of sediment basins have a duty of care to investigate the safety requirements of the site on which the basin is to be constructed.

Photo 21 – Sediment basin with poor access for de-silting operations

Photo 22 – Temporary fencing of a construction site sediment basin

Step 16 – Define the rehabilitation requirements for the basin area

The Erosion and Sediment Control Plan (ESCP) needs to include details on the required decommissioning and rehabilitation of the sediment basin area. Such a process may involve the conversion of the basin into a component of the site's permanent stormwater treatment network.

On subdivisions and major road works, construction site sediment basins often represent a significant opportunity for conversion into either: a detention/retention basin (Photo 23), bioretention system, wetland, or pollution containment system. In rural areas, basins associated with road works are often constructed within adjacent properties where they remain under the control of the landowner as permanent farm dams.

In some circumstances it will be necessary to protect newly constructed permanent (future) stormwater treatment devices from sediment intrusion during the construction phase. With appropriate site planning and design the protection of these permanent stormwater treatment devices is generally made easier if the sediment basin is designed with a pre-treatment inlet pond (Figure 10). The pre-treatment pond can remain as a coarse sediment trap during the maintenance and building phases, thus protecting the newly formed wetland or bioretention system located within the basin's main settling pond.

Continued operation of the sediment basin during the building phase of subdivisions (i.e. beyond the specified maintenance phase) is an issue for negotiation between the regulatory authority and the land developer on a case-by-case basis.

During the construction, decommissioning, rehabilitation, or reconstruction of a sediment basin, the basin area including settling pond, embankment and spillway, must be considered a construction site in its on right. Thus, these works must comply with normal drainage, erosion, and sediment control standards. This means that appropriate temporary sediment control measures will be required down-slope of the sediment basin during its construction and decommissioning.

Upon decommissioning of a sediment basin, all water and sediment must be removed from the basin prior to removal of the embankment (if any). Any such material, liquid or solid, must be disposed of in a manner that will not create an erosion or pollution hazard.

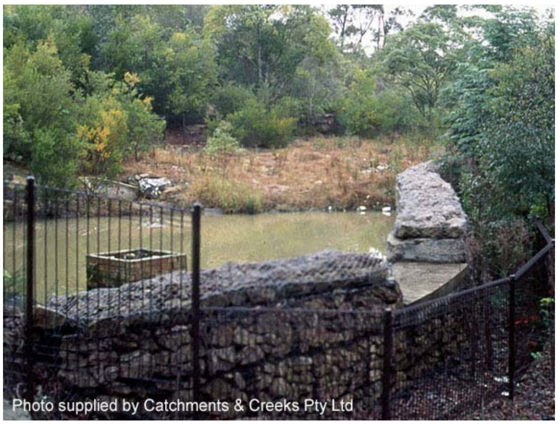

Photo 23 – Permanent sediment basin within residential estate

Photo 24 – Sediment basins converted to permanent stormwater treatment ponds on highway project

Under normal circumstances, a sediment basin must not be decommissioned until all up-slope site stabilisation measures have been implemented and are appropriately working to control soil erosion and sediment runoff in accordance with the specified ESC standard. This may require the basin to be fully operational during part of the maintenance and operational phases.

If an alternative, permanent, outlet structure is to be constructed prior to stabilisation of the up-slope catchment area, then this outlet structure must not be made operational if it will adversely affect the required operation of the sediment basin during the construction phase.

Step 17 – Specification of the basin's operational procedures

Sediment basins can be operated as either 'dry' or 'wet' basins as described below.

- Dry basins are free draining basins that allow water to commence discharging from the low-flow outlet system as soon as water enters the basin.
- Wet basins are designed to retain sediment-laden water for extended periods allowing adequate time for the gravitational settlement of fine sediment particles. Operation of these basins may be assisted through the use of chemical flocculants. Ideally these basins are not drained until a suitable water quality is obtained within the basin.

Type F and Type D basins must be operated as wet basins with the settled/treated water decanted from the basin as soon as a suitable water quality is achieved. Thus, as soon as conditions allow, the basin must be maintained in either a dry-bed condition, or with a water level no greater than the top of the sediment storage zone.

On each occasion when a Type F or Type D basin cannot be de-watered prior to being surcharged by a following rainfall event, the operator must record such an event and report it to the appropriate regulatory authority. Where appropriate, alternative operating procedures may need be adopted in consultation with the regulatory authority in order to achieve optimum environmental protection.

A Type C basin may be operated as either a dry basin or wet basin; however, when operated as a wet basin, the settled water does not necessarily need to be decanted from the settling pond after achieving the desired water quality. This means that the water can be retained on-site for revegetation purposes and dust control.

A Type C basin operating in a wet condition is still sized in accordance with the design requirements for a normal Type C basin; however, a low-flow drainage system is not necessarily incorporated into the basin, thus potentially saving significant construction and maintenance costs.

Table 8 provides a summary of the attributes of the various operational conditions.

Table 8 – Attributes of various types of *Sediment Basins*

Attribute	Type C dry basin	Type C wet basin	Type F and Type D wet basins
Soil type within catchment	Sandy soils	Sandy soils	Clayey or dispersive soils
Critical design parameter	Surface area at base of settling zone	Surface area at base of settling zone	Volume of settling zone
Desirable water level condition before a storm	Empty	Any condition	No greater than top of sediment storage zone
De-watering system	Low-flow piped drainage system (riser pipe)	Pumping	Pumping
Chemical flocculation	Only if specified water quality objectives fail to be achieved	Only if specified water quality objectives fail to be achieved	As necessary, but usually required for Type D basins

Type F and D basins are typically designed for a maximum 5-day cycle, that being the filling, treatment and discharge of the basin within a maximum 5-day period. In some tropical regions this may not be practicable, and either a shorter or longer time frame may be required. The use of a shorter time period usually requires application of fast acting coagulants, which may require a much higher degree of environmental management compared to gypsum.

Appropriate coagulation of sediment basins is required if the contained water does not achieve a specified water quality standard, usually 50mg/L. In cases where a poor discharge water quality is achieved, a Type C basin may need to be operated as if it was a Type F or Type D basin in order to satisfy specified water quality objectives.

Certification of Sediment Basin Construction

BASIN IDENTIFICATION CODE/NUMBER: . . . .

LOCATION: . . . .

Legend: ✓ OK ✗ Not OK N/A Not applicable

Construction:

Item	Consideration	Assessment
1	Sediment basin located in accordance with approved plans.	. . . .
2	Embankment material compacted in accordance with specifications.	. . . .
3	Critical basin and spillway dimensions and elevations confirmed by as-constructed survey.	. . . .
4	Required freeboard adjacent embankments and spillway confirmed by as-constructed survey.	. . . .
5	Placement of rock on chute and upstream face of spillway in accordance with design details and standards.	. . . .
6	Placement of rock within energy dissipation zone downstream of spillway in accordance with design details and standard.	. . . .
7	All other sediment basin requirements in accordance with design details and standards.	. . . .
8	As-constructed plan prepared for basin and spillway.	. . . .

INSPECTION OFFICER . . . . **DATE** . . . .

SIGNATURE . . . .

Geotechnical:

Item	Consideration	Assessment
9	Suitable material used to form all embankments.	. . . .
10	Appropriate compaction achieved in embankment construction (if observed).	. . . .
11	No foreseeable concerns regarding stability or construction of the basin and spillway.	. . . .

INSPECTION OFFICER . . . . **DATE** . . . .

SIGNATURE . . . .

Description

A purpose built dam designed to collect and settle sediment from sediment-laden runoff. It usually consists of a settling pond, a low-flow drainage or manual decant system, and a high-flow emergency spillway.

Purpose

Sediment basins generally perform two main functions: firstly the settlement of coarse-grained sediment particles (e.g. sand and coarse silt) from waters passing through the basin, and secondly either:

(i) the filtration of fine sediments (e.g. fine silt and clay) from waters passing through the filtration system attached to the low-flow outlet;

(ii) the settlement of fine-grained particles from those waters retained within the basin following a storm event.

Limitations

Generally used on catchments greater than 0.25ha.

The installation of a sediment basin does not replace the need for appropriate on-site drainage and erosion control measures.

Sediment basins operating in a free-draining mode (dry basins) have limited control over turbidity, especially that resulting from dispersive soils, unless chemical treated.

Advantages

Sediment basins need be designed and operated in a manner that produces near-clear water discharge (i.e. total suspended solids concentrations not exceeding 50mg/L), especially following periods of light rainfall.

It is the ability of sediment basins to reduce turbidity levels (wet basins) that allows these Type 1 sediment traps to significantly reduce the potential ecological harm caused by urban construction.

Even when a basin is full of water, it can still be effective in the removal of coarse sediment from any flows passing through the basin.

Very high capture rate for coarse sediments.

Can be an effective control of fine sediment and turbidity during the frequent 'minor' storms if suitably operated.

Can be converted into a permanent wetland or detention basin for ongoing stormwater management after completion of the construction phase.

Disadvantages

Chemical dosing of basins can be difficult to automate.

Basins are difficult and expensive to relocate if the construction or drainage layout changes.

Decommissioned and backfilled sediment basins generally attract lower land values and are best integrated into open space areas, or the site's permanent stormwater management system.

Common Problems

Sediment blockage of free-flow outlet systems (dry basins).

Difficulties in repairing the low-flow outlet system once sediment blockage has occurred.

Inadequate room made available to construct the sediment basin.

Poor access available to maintain the basin.

Poor hydraulic design and/or construction of the emergency spillway.

Special Requirements

The sediment trapping efficiency of a sediment basin can be increased by:

- reducing the energy (jetting) of inflow;
- construction basins as close as practicable to the ideal 10:1 length to width ratio;
- avoiding bends in the flow path of water through the settling pond that may cause secondary currents and dead-water areas;
- avoiding wind shear on large basins that could cause secondary currents and sediment re-suspension.
- where practicable, operating both wet and dry basins in a manner that allows them to fully drain before the next significant inflow event, thus allowing settled sediment to 'cement' together on the bed of the basin.

Early integration of the basin into the construction phase is essential.

Avoid constructing sediment basins in dispersive soils. Where this is unavoidable, the basin should be lined with a non-dispersive or treated soil, especially the banks.

Overland flow should enter the basin via a stabilised chute. It should not be allowed to cause erosion down the banks of the settling pond.

Medium to high velocity piped inflows may require an energy dissipater or inlet baffle to break-up the inflow jet.

Internal baffles may be required in 'dry' basins to improve the movement of water through the settling pond.

An outlet baffle or barrier may be required to reduce the build-up of sediment and mud around the primary outlet filter (dry basins).

Sediment basins should be fenced if a public safety risk exists.

Location

Basins need to be located such that they intercept runoff from the largest possible portion of the disturbed site.

Basins generally should not collect runoff generated from off-site areas.

Must be located so that construction and maintenance access is available.

Where practicable, an area of level land should be available adjacent to the basin to allow de-watering of excavated sediment.

Preferably located above the 1 in 5 year flood level if located on or near a watercourse floodplain.

Allow room between the toe of the embankment and the downstream property boundary for provision for safety fencing, the spillway outlet, and all necessary energy dissipation measures.

Site Inspection

Check the dimensions of the basin.

Check for scouring around, or damage to the inlets and outlets.

Check for damage to the emergency spillway and displacement of rocks.

Check the level of sediment build-up.

Check all internal and external banks for erosion.

Check the measures introduced to control inflow jetting (wet and dry basins).

Check for trash build-up on inlet screens.

Check for water passing through earth embankments that could lead to a piping failure and bank collapse.

Materials

- Earth fill: clean soil with Emerson Class 2(1), 3, 4, or 5, and free of roots, woody vegetation, rocks and other unsuitable material. Soil with Emerson Class 4 and 5 may not be suitable depending on particle size distribution and degree of dispersion. Class 2(1) should only be used upon recommendation from geotechnical specialist. This specification may be replaced by an equivalent standard based on the exchangeable sodium percentage.
- Riser pipe: minimum 250mm diameter.
- Spillway rock: hard, angular, durable, weather resistant and evenly graded rock with 50% by weight larger than the specified nominal (d_{50}) rock size. Large rock should dominate, with sufficient small rock to fill the voids between the larger rock. The diameter of the largest rock size should be no larger than 1.5 times the nominal rock size. The specific gravity should be at least 2.5.
- Geotextile fabric: heavy-duty, needle-punched, non-woven filter cloth, minimum 'bidim' A24 or equivalent.

Construction

1. Notwithstanding any description contained within the approved plans or specifications, the Contractor shall be responsible for satisfying themselves as to the nature and extent of the specified works and the physical and legal conditions under which the works will be carried out. This shall include means of access, extent of clearing, nature of material to be excavated, type and size of mechanical plant required, location and suitability of water supply for construction and testing purposes, and any other like matters affecting the construction of the works.
2. Refer to approved plans for location, dimensions, and construction details. If there are questions or problems with the location, dimensions, or method of installation, contact the engineer or responsible on-site officer for assistance.
3. Before starting any clearing or construction, ensure all the necessary materials and components are on the site to avoid delays in completing the pond once works begin.

4. Install required short-term sediment control measures downstream of the proposed earthworks to control sediment runoff during construction of the basin.
5. The area to be covered by the embankment, borrow pits and incidental works, together with an area extending beyond the limits of each for a distance not exceeding five (5) metres all around must be cleared of all trees, scrub, stumps, roots, dead timber and rubbish and disposed of in a suitable manner. Delay clearing the main pond area until the embankment is complete.
6. Ensure all holes made by grubbing within the embankment footprint are filled with sound material, adequately compacted, and finished flush with the natural surface.

Cut-off trench:

7. Before construction of the cut-off trench or any ancillary works within the embankment footprint, all grass growth and topsoil must be removed from the area to be occupied by the embankment and must be deposited clear of this area and reserved for topdressing the completing the embankment.
8. Excavate a cut-off trench along the centre line of the earth fill embankment. Cut the trench to stable soil material, but in no case make it less than 600mm deep. The cut-off trench must extend into both abutments to at least the elevation of the riser pipe crest. Make the minimum bottom width wide enough to permit operation of excavation and compaction equipment, but in no case less than 600mm. Make the side slopes of the trench no steeper than 1:1 (H:V).
9. Ensure all water, loose soil, and rock are removed from the trench before backfilling commences. The cut-off trench must be backfilled with selected earth-fill of the type specified for the embankment, and this soil must have a moisture content and degree of compaction the same as that specified for the selected core zone.
10. Material excavated from the cut-off trench may be used in construction of the embankment provided it is suitable and it is placed in the correct zone according to its classification.

Embankment:

11. Scarify areas on which fill is to be placed before placing the fill.
12. Ensure all fill material used to form the embankment meets the specifications certified by a soil scientist or geotechnical specialist.
13. The fill material must contain sufficient moisture so it can be formed by hand into a ball without crumbling. If water can be squeezed out of the ball, it is too wet for proper compaction. Place fill material in 150 to 250mm continuous layers over the entire length of the fill area and then compact before placement of further fill.
14. Place riser pipe outlet system, if specified, in appropriate sequence with the embankment filling. Refer to separate installation specifications.
15. Unless otherwise specified on the approved plans, compact the soil at about 1% to 2% wet of optimum and to 95% modified or 100% standard compaction.
16. Where both dispersive and non-dispersive classified earth-fill materials are available, non-dispersive earth-fill must be used in the core zone. The remaining classified earth-fill materials must only be used as directed by *[insert title]*.
17. Where specified, construct the embankment to an elevation 10% higher than the design height to allow for settling; otherwise finished dimensions of the embankment after spreading of topsoil must conform to the drawing with a tolerance of 75mm from the specified dimensions.
18. Ensure debris and other unsuitable building waste is not placed within the earth embankment.
19. After completion of the embankment all loose uncompacted earth-fill material on the upstream and downstream batter must be removed prior to spreading of topsoil.
20. Topsoil and revegetate/stabilised all exposed earth as directed within the approved plans.

Spillway construction:

21. The spillway must be excavated as shown on the plans, and the excavated material if classified as suitable, must be used in the embankment, and if not suitable it must be disposed of into spoil heaps.
22. Ensure excavated dimensions allow adequate boxing-out such that the specified elevations, grades, chute width, and entrance and exit slopes for the emergency spillway will be achieved after placement of the rock or other scour protection measures as specified in the plans.
23. Place specified scour protection measures on the emergency spillway. Ensure the finished grade blends with the surrounding area to allow a smooth flow transition from spillway to downstream channel.
24. If a synthetic filter fabric underlay is specified, place the filter fabric directly on the prepared foundation. If more than one sheet of filter fabric is required, overlap the edges by at least 300mm and place anchor pins at minimum 1m spacing along the overlap. Bury the upstream end of the fabric a minimum 300mm below ground and where necessary, bury the lower end of the fabric or overlap a minimum 300mm over the next downstream section as required. Ensure the filter fabric extends at least 1000mm upstream of the spillway crest.
25. Take care not to damage the fabric during or after placement. If damage occurs, remove the rock and repair the sheet by adding another layer of fabric with a minimum overlap of 300mm around the damaged area. If extensive damage is suspected, remove and replace the entire sheet.
26. Where large rock is used, or machine placement is difficult, a minimum 100mm layer of fine gravel, aggregate, or sand may be needed to protect the fabric.
27. Placement of rock should follow immediately after placement of the filter fabric. Place rock so that it forms a dense, well-graded mass of rock with a minimum of voids. The desired distribution of rock throughout the mass may be obtained by selective loading at the quarry and controlled dumping during final placement.
28. The finished slope should be free of pockets of small rock or clusters of large rocks. Hand placing may be necessary to achieve the proper distribution of rock sizes to produce a relatively smooth, uniform surface. The finished grade of the rock should blend with the surrounding area. No overfall or protrusion of rock should be apparent.
29. Ensure that the final arrangement of the spillway crest will not promote excessive flow through the rock such that the water can be retained within the settling basin an elevation no less than 50mm above or below the nominated spillway crest elevation.

Establishment of settling pond:

30. The area to be covered by the stored water outside the limits of the borrow pits must be cleared of all scrub and rubbish. Trees must be cut down stump high and removed from the immediate vicinity of the work.
31. Establish all required inflow chutes and inlet baffles, if specified, to enable water to discharge into the basin in a manner that will not cause soil erosion or the re-suspension of settled sediment.
32. Install a sediment storage level marker post with a cross member set just below the top of the sediment storage zone (as specified on the approved plans). Use at least a 75mm wide post firmly set into the basin floor.
33. If specified, install internal settling pond baffles. Ensure the crest of these baffles is set level with, or just below, the elevation of the emergency spillway crest.
34. Install all appropriate measures to minimise safety risk to on-site personnel and the public caused by the presence of the settling pond. Avoid steep, smooth internal slopes. Appropriately fence the settling pond and post warning signs if unsupervised public access is likely or there is considered to be an unacceptable risk to the public.

Maintenance of Sediment Basin

1. Inspect the sediment basin during the following periods:
   (i) During construction to determine whether machinery, falling trees, or construction activity has damaged any components of the sediment basin. If damage has occurred, repair it.
   (ii) After each runoff event. Inspect the erosion damage at flow entry and exit points. If damage has occurred, make the necessary repairs.
   (iii) At least weekly during the nominated wet season (if any) otherwise at least fortnightly.
   (iv) Prior to, and immediately after, periods of 'stop work' or site shutdown.
2. Clean out accumulated sediment when it reaches the marker board/post, and restore the original storage volume. Place sediment in a disposal area or, if appropriate, mix with dry soil on the site.
3. Do not dispose of sediment in a manner that will create an erosion or pollution hazard.
4. Check all visible pipe connections for leaks, and repair as necessary.
5. Check all embankments for excessive settlement, slumping of the slopes or piping between the conduit and the embankment; make all necessary repairs.
6. Remove all trash and other debris from the basin and riser.
7. Submerged inflow pipes must be inspected and de-silted (as required) after each inflow event.

Removal of Sediment Basin

1. When grading and construction in the drainage area above a temporary sediment basin is completed and the disturbed areas are adequately stabilised, the basin must be removed or otherwise incorporated into the permanent stormwater drainage system. In either case, sediment should be cleared and properly disposed of and the basin area stabilised.
2. Before starting any maintenance work on the basin or spillway, install all necessary short-term sediment control measures downstream of the sediment basin.
3. All water and sediment must be removed from the basin prior to the dam's removal. Dispose of sediment and water in a manner that will not create an erosion or pollution hazard.
4. Bring the disturbed area to a proper grade, then smooth, compact, and stabilise and/or revegetate as required to establish a stable land surface.