QPRC

QUEANBEYAN PALERANG REGIONAL COUNCIL

DEVELOPMENT DESIGN SPECIFICATION

D7

EROSION CONTROL AND STORMWATER MANAGEMENT

VERSION 1 – DECEMBER 2018

Amendment Record for this Specification Part

This Specification is Council's edition of the AUS-SPEC generic specification part and includes Council's primary amendments.

Details are provided below outlining the clauses amended from the Council edition of this AUS-SPEC Specification Part. The clause numbering and context of each clause are preserved. New clauses are added towards the rear of the specification part as special requirements clauses. Project specific additional script is shown in the specification as italic font.

The amendment code indicated below is 'A' for additional script 'M' for modification to script and 'O' for omission of script. An additional code 'P' is included when the amendment is project specific.

Amendment Sequence No.	Key Topic addressed in amendment	Clause No.	Amendment Code	Author Initials	Amendment Date
VERSION 1	Development types amended	D7.01.4	A	KD	19/04/10
	WSUD publication added	D7.03	A		
	TP & TN retention increased to 65%	D7.21.10	A		
	Maintenance period for GPT reduced to 1 year	D7.25.6	A		
	Use of swales as bio-retention facilities clarified	D7.29.3	A		
	Deemed to Comply omitted	D7.31	O	CS	17/12/18
	Reference documents and standards updated.	D7.03	M	TR	19/12/18

EROSION CONTROL & STORMWATER MANAGEMENT – VERSION 1

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EROSION CONTROL & STORMWATER MANAGEMENT – VERSION 1

GENERAL

D7.01 SCOPE

1. Virtually all construction activity which requires the disturbance of the soil surface and the existing vegetation, naturally predisposes the construction site to erosion. This in turn leads to sediment loss in the resultant run-off water.

Erosion

2. Since such soil disturbance is a necessary part of development, it is essential therefore to develop measures which reduce the erosion hazard of any particular construction activity. Having done that, it is necessary to control run-off water, which carries the sediment, in such a way as to reduce the amount of that sediment leaving the site to an acceptable level.

Reduce Sedimentation

3. After construction is complete and the site fully rehabilitated, permanent water quality control structures and features commence their role. These include trash racks, gross pollutant traps, wet retention basins and the creation of, or increase in size of wetlands.

Water Quality

4. Works covered by this specification include any land development or use including Private, Council or other authority works which may impact on the quality of runoff discharging from the development site to any watercourse. It includes, but is not limited to, the development of:

Land Development and Authority Works

- Subdivisions;
- Buildings, structures and surrounds; and
- Road works, car parks, site works, landscaping, earthworks, dams and lakes.

D7.02 OBJECTIVES

1. The objectives of erosion control and stormwater management design are as follows:

- To provide detailed design provisions in line with the principles of Ecologically Sustainable Development (ESD), Water Sensitive Urban Design (WSUD) and Total Water Cycle Management (TCM);

Principles

- To retain and enhance natural watercourses, aquatic habitat and riparian vegetation;

Retain natural watercourses

- To provide stormwater runoff quality specifications for the construction and occupation phases of a development;

Stormwater quality

- To promote scenic, landscape and recreational values for stream corridors through the integration of stormwater treatment techniques into the landscape by incorporating multiple use corridors that maximise the visual and recreational amenity of developments;

Integration

- To provide an effective major and minor stormwater system, incorporating water quality controls that has effective life cycle costs in terms of capital, operational and maintenance costs.

Effective Stormwater System

2. In pursuit of these objectives, the following principles shall apply:

Design Principles

- Limit/minimise the amount of site disturbance.

Site Disturbance

- Isolate the site by diverting clean upstream "run-on" water around or through the development where possible. ***Diversion Works***
- Control runoff and sediment movement as its point source rather than at one final point. ***Point Source***
- Stage earthworks and **progressively revegetate** the site where possible to reduce the area contributing sediment. This in turn increases the efficiency and effectiveness of the entire sediment control system while decreasing the number and size of controls required. ***Progressive Revegetation***
- Retain topsoil for effective revegetation works. ***Topsoil***
- Locate sediment and quality control structures and measures where they are most effective and efficient. ***Quality Controls***

D7.03 REFERENCE AND SOURCE DOCUMENTS

(a) Council Specifications

DQS	-	Quality Assurance Requirements for Design – Version 1
D5	-	Stormwater Drainage Design – Version 1
C211	-	Control of Erosion and Sedimentation – Version 1
C273	-	Landscaping – Version 1

(b) NSW State Legislation

Environment Planning and Assessment Act 1979
Environment Planning and Assessment Regulations 2000
Protection of the Environment Operations Act, 1997
Dams Safety Act, 1978
Soil Conservation Act, 1938
Water Act, 1912
Water Management Act 2000

(c) Government Publications

"Guidelines for Erosion and Sediment Control on Building Sites"
Prevent Pollution from Residential Building Sites (Brochures)
Field Guide - Erosion and Sediment Control
Australian Journal of Soil and Water Conservation - Vol 3, Number 1
Environment Protection Guidelines for Construction and Land Development in the ACT

(d) State Authorities

NSW Office of Environment and Heritage (OEH)
- *Managing Urban Stormwater, Soils and Construction*, 4th Ed., Mar 2004, Landcom

Roads and Maritime Services (RMS)
- *Erosion and Sedimentation Design Considerations*.
- Technical Guideline: Temporary stormwater drainage for road construction.

Soil Conservation Service (SCS)
- *Erosion and Sediment Control - Model Policy and Code of Practice* (Discussion Paper).

NSW Department of Land and Water Conservation (DLWC)
- *Urban Erosion and Sediment Control: Field Guide.*
- *Constructed Wetlands Manual*

(e) Others

The Institution of Engineers, Australia
- *Australian Runoff Quality: A guide to Water Sensitive Urban Design* 2006 (ARQ)

Joint Steering Committee for Water Sensitive Cities
- *Evaluating Options for Water Sensitive Urban Design – a national guide*, July 2009

D7.04 PLANNING AND CONCEPT DESIGN

1. Assess the physical characteristics and limitations of soils, landform and drainage of the site and plan the subdivision or development accordingly. ***Site Characteristics***

2. A concept design shall be submitted with the development application to Council for all developments. This will assist in assessing the impact of the development on the site. ***Concept Design Submission***

3. The Development Consent will nominate that either an Erosion and Sediment Control Plan (ESCP) or a Soil and Water Management Plan (SWMP) is required for the detailed design. In general, an ESCP is required for sites of less than 2500 square metres of disturbed area and a SWMP for areas greater than 2500 square metres. Reference should be made to the Landcom publication *Managing Urban Stormwater, Soils and Construction*. ***Development Consent Nomination***

D7.05 DETAILED DESIGN

1. After development consent is given, if an ESCP/SWMP is required it shall be prepared as part of the detailed engineering design for approval and receipt of a Construction Certificate. This plan shall give all details for erosion, sediment and pollution controls and shall be site specific and not a generalisation of erosion control philosophy. It also forms part of the contract specifications for a contractor to comply with during construction. ***Site Specific***

2. The ESCP/SWMP shall include scaled drawings (no larger than 1:1000) and detailed specifications/diagrams which can be readily understood and applied on site by supervisory staff. All Drawings shall be in accordance with the minimum drafting requirements in the Specification for QUALITY ASSURANCE REQUIREMENTS FOR DESIGN.

Items to be included, but not limited to, shall be:

- existing and final contours
- the location of all earthworks including roads, areas of cut and fill and re-grading
- location of access haulage tracks and borrow pits
- location and design criteria of erosion and sediment control structures
- location and description of existing vegetation
- proposed vegetated buffer strips and "no access" areas
- location of critical areas (vegetated buffer strips, drainage lines and structures, water bodies, unstable slopes, flood plains and seasonally wet areas)
- type and location of diversion works to direct uncontaminated run-on around areas to be disturbed
- revegetation program

- procedures for maintenance of erosion and sediment control
- details for staging of works

3. No site works shall commence prior to receipt of the Construction Certificate. All works are to be carried out in accordance with any approved ESCP/SWMP. Its implementation must be supervised by personnel with appropriate qualifications and/or experience in soil conservation on construction sites. ***Approval***

4. The ESCP/SWMP and its associated control measures shall be constantly monitored, reviewed and modified as required, by the Developer, to correct any deficiencies. Council has the right to request changes if, in its opinion, the measures that have been put in place are inadequate. ***Additional Works***

5. If required, examples of proposed subdivisions or developments detailing locations of water quality structures, sediment and erosion control devices may be obtained from Council and used as a guide when preparing an ESCP/SWMP. ***Example Design***

6. Unless advised elsewhere in this specification, works to capture pollutants from stormwater runoff shall be designed to accommodate a design storm equivalent to a 3 month ARI storm event. ***Design ARI***

7. Erosion and sediment control works and stormwater quality management works shall be designed in accordance with *Managing Urban Stormwater - Soils and Construction*, (Landcom) and *Australian Runoff Quality* (ARQ). ***References***

D7.06 MODELLING METHODS

1. The following three methods or a combination thereof are recommended to determine the requirements to maintain or enhance stormwater quality. ***Modelling Methods***

   a. Best Management Practices (BMP).

   b. An estimation of the average annual pollution loads from stormwater in kilograms of pollutant exported per year, relating land use, annual rainfall, catchment runoff characteristics and average pollutant concentrations to estimate the annual pollutant load generated from the catchment under both pre and post development conditions (refer to D7.06.8). Once the increase in pollutant loads is determined appropriate Stormwater Quality Improvement Devices (SQID's) shall be selected to conform to the criteria specified in Table D7-7.

   c. Comparison of water quality discharging from a proposed development catchment to predetermined water quality as set out in table 6.2 of ARQ. The design of Stormwater Quality Improvement Devices (SQID's) will enable conformance to the required water quality objectives.

2. Best Management Practices (BMP) for erosion and sediment control during construction are required for all works. Requirements are as set out in this specification and in Landcom's "*Managing Urban Stormwater, Soils and Construction*". ***BMP Construction***

3. For development or development proposals which require a SWMP modelling approaches as listed in Chapter 13 of ARQ if appropriate to the requirements of water quality objectives may be used. ***Water Quality Models***

4. Modelling parameters including rainfall IFD information will be in accordance with specification D5 STORMWATER DRAINAGE DESIGN. ***Modelling Parameters***

5. For preliminary calculations, checking purposes and determination of pollutant loads for the modelling technique using constant concentration levels may be used. The following formula shall apply. ***Preliminary Calculations***

$L = PC_VCA$

Where L = average annual load (kg)

P = average annual rainfall (mm)

C_v = annual average volumetric runoff coefficient (dimensionless)

A = catchment area (km^2)

C = average event mean pollutant concentration (EMC) (mg/L) (refer to Chapter 3 of ARQ for landuse & predicted pollutant loads).

D7.07 TOTAL WATERCYCLE MANAGEMENT PLAN

1. A Total Water Cycle Management Plan shall be required for developments consisting of either 100 lots or more and/or with an area greater than 8 hectares. ***Water Cycle Management Plan***

EROSION CONTROL

D7.08 BUFFER ZONES

1. Buffer zones are corridors of vegetation adjacent to waterways or disturbed areas. The vegetation filters suspended solids and reduces the nutrient levels in run-off. Wetlands, stream and rivers adjacent to construction sites shall be protected by buffer zones. ***Filters***

2. Buffer zone performance increases as catchment area and slope gradient decreases. Thirty-metre-wide buffer zones generally provide adequate protection. Minimum buffer zones shall be as set out in Table D7.1 ***Performance***

Slope %	Buffer Width in Metres
2	15
4	20
6	30
8	40
10	50
12	60
14	70

Table D7.1 Buffer Zone Widths

3. Buffer zones can reduce the need for other erosion and sediment control measures. However, contaminated water in a concentrated form will require treatment both at its sources point and final disposal. ***Contaminated Water***

4. A fence shall be used to exclude traffic from buffer zones to prevent damage to the vegetation, particularly during any construction phase. ***Fencing***

D7.09 "NO ACCESS" AREAS

1. It is Council's Policy to conserve as much existing vegetation in new developments as possible. ***Conserve Vegetation***

2. The landscape plan shall incorporate as much existing native vegetation as possible.

3. The "no access" fence locations shall be shown on the ESCP/SWMP. These locations will be approximate only as machinery type, topography etc will determine actual on site location. ***No Access***

4. Fenced areas shall be clearly signposted "No Access Area".

D7.10 DIVERSION WORKS

1. Diversion works may be in the form of earth drains and banks, haybales, sand bags or even pipelines and may be permanent or temporary. ***Diversion Types***

2. Such techniques are used to divert the upstream run-on water around the site. Such flows shall discharge to a formal drainage point or open areas where level spreader banks should ensure a broad water spread. ***Discharge Point***

3. Pipelines may also be used to convey such run-on through the development site, and discharge the flow to a formal drainage point/dissipater if necessary. Such pipelines may also form part of the overall final drainage system. ***Pipelines***

4. Design of the diversion system should suit the following:-

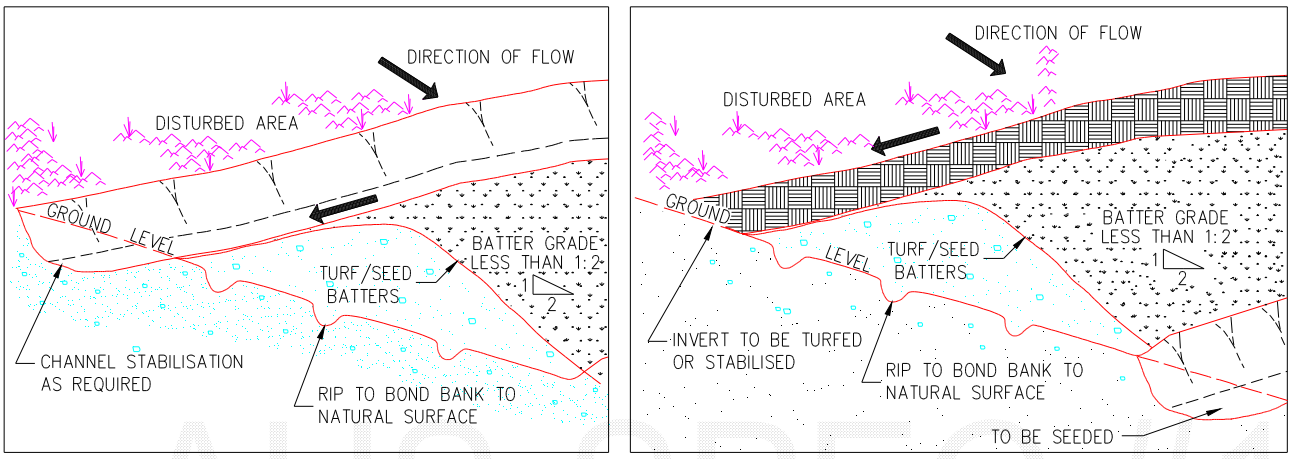
   (a) The drain should preferably be dish shaped with batter grades of less than 4:1 ***Drain Shape***

   (b) If a piped system is selected its design capacity shall be a minimum of the capacity nominated in the Specification for STORMWATER DRAINAGE DESIGN. ***Pipe Capacity***

5. Diversion works are designed to carry peak flows at non-erosive velocities in bare soil, vegetated or lined drains/banks. ***Peak Flows***

6. Generally, the channel should be lined with turf. However, where velocities are designed in excess of 2m per second, non erosive linings such as concrete, geotextiles, grouted rock etc or velocity reducers (check dams etc) are required. ***Non-Erosive Linings***

7. Typical arrangements of diversion drains and banks are shown in Figure D7-1.



DIVERSION DRAIN DIVERSION BANK

Figure D7-1 - Diversion Drains/Banks

D7.11 DROP DOWN DRAINS

1. These are temporary or permanent drains which divert concentrated run-off down slopes such as road batters without causing erosion. They usually consist of a dished earth drain smoothly shaped, consolidated and lined with a variety of materials or they may be a flexible/rigid pipe or half pipe. ***Lined Drains***

2. Drop down drains consisting or rigid, or flexible, pipes are very effective as a temporary measure during road construction used in association with an earth windrow (or bund wall) along the top edge of the batter. Run-off flowing along the windrow is directed to the pipe by which water is conveyed down the batter. It is a simple matter to extend the pipe as the batter rises. ***Piped Drains***

3. Drop down drains shall have sufficient capacity for a minimum 1 in 5 year peak flow without eroding. Energy dissipators may be required to reduce the flow velocity at the outlet of the drop down drain. ***Capacity***

D7.12 STOCKPILES

1. Location of stockpiles shall be indicated on the approved engineering Drawings.

2. Stockpile sites shall be located: ***Location***

   (a) Clear of existing or proposed drainage lines.

   (b) Clear of areas likely to be disturbed during construction.

   (c) Clear of the drip zone of trees.

   (d) Preferably on reasonably flat areas.

3. Stockpiles must be protected from erosion and sediment loss by: ***Erosion Protection***

   (a) The installation of diversion works.

   (b) The use of silt fences, haybales etc or other approved controls on the downstream side.

   (c) Compaction.

   (d) Revegetation if left exposed for longer than 30 days (refer to the Construction Specification for LANDSCAPING – Version 1 for seed mix).

4. Site topsoil shall be isolated from subsoil material in separate stockpiles. ***Separate Stockpiles***

D7.13 SEDIMENT BASINS/TRAPS/DAMS

1. Sediment traps are either permanent or temporary sediment control devices that intercept sediment and run-off usually at the final discharge point of the site or at a location to protect a downstream watercourse, wetland, riparian vegetated area or receiving water. Preferably they are to be located off line. ***Sediment Control***

2. They are formed by excavation and/or by constructing embankments. ***Construction***

3. There are two types, wet and dry basins. ***Types***

4. Preferably sediment traps shall not be located directly upstream of residential areas. ***Location***

5. Basin design must be in accordance with "*Managing Urban Stormwater, Soils and Construction*" (Landcom)and meet the following: ***Design Criteria***

(a) All disturbed areas including batters shall be topsoiled and seeded.

(b) In areas known to be affected by high groundwater tables and/or salinity of groundwater, basins shall be designed to be water retentive so that surface drainage water does not leak to the subsurface, recharging groundwater.

(c) Where eroding soils contain more than 10% of dispersible fines:

- All waters captured in sediment basins must be treated with an approved flocculating agent to ensure that discharges contain no more than 50mg/l of total suspended solids;
- Sediment retention basins must be maintained at a low water level in readiness for treatment and discharge of further runoff. All sediment captured in basins must be treated and discharged within 5 days of the cessation of a rainfall event;
- A minimum stockpile of flocculating agents must be retained onsite to provide for at least three complete treatments.

6. A marker must be placed within each sediment retention basin to show the design capacity level.

7. Permanent wet basin designs slightly vary from the above. Refer to the Stormwater Management Section of this Specification. ***Permanent Wet Basins***

D7.14 SEDIMENT TRAPS/ BARRIERS FOR MINOR CATCHMENTS

1. These are silt retention/filtering structures of a temporary nature used in situations where the catchment does not exceed 0.5ha. ***Filtering Structures***

2. Such sediment traps/barriers generally consist of: ***Barrier Types***

(a) silt fences

(b) hay bales

(c) "blue metal" groynes/sausages

(d) filter fabric located beneath stormwater grates

(e) gabions

(f) or a combination of the above.

3. The choice of material and type of treatment will depend on the size of the catchment the location and the structure being treated such as: ***Location of Structure***

(a) surface inlet pits

(b) kerb inlet pits

(c) catch drain disposal areas

(d) culvert inlets and outlets

(e) minor construction/earthwork sites

(f) check dams/velocity reducers etc.

4. The design of sediment traps shall be in accordance with "*Managing Urban Stormwater Soils and Construction*" (Landcom).

5. Sediment shall be removed and disposed/reused in accordance with Council and EPA guidelines after each rainfall event. Weirs shall be regularly maintained and cleaned to ensure effective operational condition. Hay bales and silt fence geotextiles shall be replaced when damaged or permanently blocked.

D7.15 LEVEL SPREADERS

1. Level spreaders are outlets or "sills" having a level cross section. They convert erosive channelised flows into non-erosive sheet flow. ***Convert Flows***

2. Level spreaders can only be used to dissipate flows from small catchments. The area below the outlet should be stable and of even cross section so that the water will not re-concentrate into channels. ***Location***

3. To reduce flow velocity before the spreader, the channel grade shall not exceed 1 per cent for a minimum of 8 metres. The outlet or "sill" width depends on contributing catchment, slope and ground conditions. The minimum width should be four metres, and the maximum width 25 metres. Final discharge should be over a level surface, which may require stabilising by turfing or seeding and fertilising or perhaps lining with a geotextile fabric or something similar. ***Design Criteria***

D7.16 THE LOCATION OF SHAKEDOWN AREAS AND ACCESS STABILISATION

1. Access to construction sites shall be limited to a maximum of two locations. ***Number of Accesses***

2. Such access locations shall require Council approval. ***Location Approval***

3. Shakedown areas or access stabilisation shall comprise a bed of aggregate on filter cloth or a metal bar cattle grid located at any point where traffic enters or leaves a construction site. Stabilised accesses reduce or eliminate tracking of sediments onto public rights of way or streets. Should such tracking occur the contaminants must be swept off the road way each day and before rain. Clean off draw bars etc after dumping and before starting journey. ***Types***

4. If a shaker grid is used, this should be so placed as to ensure the vehicles when crossing the grid have sufficient speed to "shake the mud" or other contaminants such as gravel from the vehicle. It must not be placed where the vehicle is slowing to enter a roadway. Cattle grids shall be a minimum length of 7 metres. ***Cattle Grid***

5. A stabilised access comprises a vehicular pathway suitably constructed to facilitate the collection of any site debris in order to prevent such material leaving the site. Stabilised accesses are generally used on small sites. The entrance shall be at least 15 metres long with a minimum width of 3 metres for a one way entrance and 6 metres for a two way entrance. ***Stabilised Access***

6. Surface water flowing to the street entrance/exit must be piped under the access, or a berm constructed to direct surface flow away from the exit. ***Flow Control***

D7.17 WIND EROSION/DUST CONTROL

1. Research has demonstrated average dust emission rates of over 2½ tonnes per hectare per month at urban construction sites. This erosion rate is unacceptable. ***Erosion Rate***

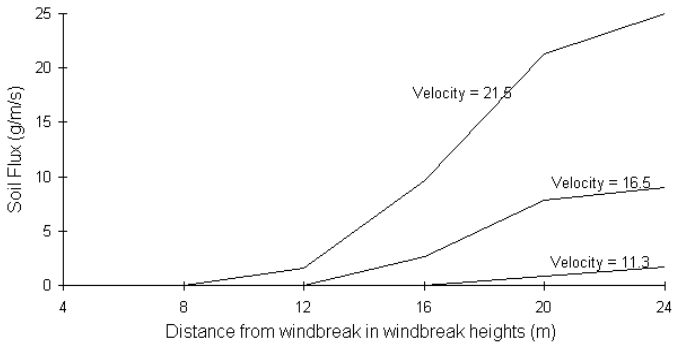
2. Various measures are available to minimise such emissions, including:- ***Treatments***

   (a) limiting the area of lands exposed to erosive forces through phasing works/progressive revegetation and/or provision of a protective ground cover and/or keeping the ground surface damp (not wet); and/or

   (b) on building sites, installing a barrier fence on the windward side - effective to a distance of 15 times its height, assuming an acceptable soil flux of 5 grams per metre per second. See Figure D7-2.

   (c) the use of water sprays, application of dust suppressants, surface stabilisation or covering of exposed surfaces.

3. Dust control measures must be used on site at all times including outside normal working hours.



Effect of distance from windbreak on soil loss, wind blowing at less than 90 to the windbreak.

Figure D7-2 - Pollution Control

D7.18 REQUIREMENTS FOR BUILDING SITES

1. The clearing of vegetation and preparation of building pads is to be undertaken in the last stages of the development when the majority of the site has been effectively revegetated. ***Site Clearing***

2. When the development calls for the construction of a number of buildings, the sediment trap/s and other appropriate sediment controls shall remain operational. ***Development Control***

3. Cross/catch drains shall be installed on long or steep unpaved driveways, disposing run-off to stable areas. ***Driveway Control***

4. Where a majority of the lot is disturbed the following minimum controls or measures shall be undertaken, but not limited to: ***Lot Control***

(a) Silt fences, located around the downstream sides of the lot.

(b) Sediment traps/barriers to be provided to all on-site and adjacent stormwater inlets.

(c) Only one site access to be provided. This may require treatment to prevent soil being tracked from the site.

(d) All subsurface drainage for roofing must be in place prior to the installation of the roof and gutter so downpipes can be immediately connected.

D7.19 EXTERNAL SITE REQUIREMENTS

1. Sediment control devices or stabilising works shall be provided outside construction sites where necessary or as directed by the Superintendent. ***Necessary Controls***

2. Where increased stormwater run-off is likely to accelerate erosion of any downstream watercourse, the necessary remedial work shall be provided concurrently with other sediment and erosion requirements. ***Accelerate Erosion***

3. Where sediment is likely to be transported from the site, all immediate downstream drainage inlets shall have appropriate controls installed. ***Downstream Controls***

4. If such works require entry onto private property, written permission shall be obtained prior to the entry and commencement of such works. ***Written Permission***

5. All disturbed areas on private property to be reinstated to original condition and to the satisfaction of the owner. ***Reinstated***

STORMWATER MANAGEMENT

D7.20 STORMWATER TREATMENT MEASURES

Main Components

1. Most developments mean a change in land use and are usually accompanied by a decline in stormwater quality. This applies to the long term as well as during the short term construction phase. The main components required to enhance stormwater quality are as follows:-

   a. Vegetated Buffer Zones (VBZ) and filter strips, porous pavements, grass swales in landscaped areas or similarly treated areas to facilitate the natural assimilation of water pollutants and reduce run-off. Swales are not preferred as a substitute for kerb and gutter where on street parking is required.

   b. Where required, gross pollutant/sediment traps shall be designed to intercept litter, oil and debris to maintain visual quality in downstream waterways, and to reduce the coarse sediment load on downstream water management structures.

   c. Wet retention ponds/permanent sediment ponds shall be designed to allow particulate matter to settle out operating under both sedimentation and macrophyte regimes.

   d. Wetland (Nutrient) Filters shall be designed to enhance the removal of fine sediment and nutrients from stormwater run-off, (which are largely dependent on biochemical removal mechanisms).

   e. Infiltration systems shall be designed to focus on the control of pollutants and the retention of stormwater.

   f. Selection of stormwater quality enhancement devices and practises shall be based on current environmental guidelines and best practise management procedures.

Excess Nutrients

2. Excess nutrients (N,P) lead to eutrophication of waterways. This can cause uncontrolled growth of algae, water weeds etc, which can deplete oxygen levels, kill resident flora and fauna, and reduce recreational appeal. However waterways do have a natural capacity to assimilate nutrients in small to moderate amounts as initial flows have.

D7.21 WATER QUALITY

1. . Development or works that do not include water quality or quantity controls have the potential to increase pollutant loads of receiving waters, relative to those occurring under pre-development conditions

2. An assessment of water quality impacts and control measures to mitigate or improve the water quality shall be a carried out by the following process.

   a. Identify the Water Quality Objectives (WQO).

   b. Determine the Risk Category of the proposal.

   c. Determine the type and condition of the receiving water ecosystem.

   d. Determine the pollutant loads generated by the proposed works.

   e. Determine the types of treatment measures to be used to mitigate or improve the water quality from the proposed works.

Water Quality Objectives

3. Water Quality Objectives (WQO) are used to describe the quality of water that is needed in a receiving water to protect or enhance Environmental Values (EV). Environmental Values are those values that a community believe a particular waterway should hold e.g.: ability to safely swim in a river or adjacent ocean beach, or the ability of a waterway to sustain healthy aquatic ecosystems.

Water quality objectives in this specification are based on the guidelines as specified in Chapter six (6) of the AQR. Aquatic ecosystem values are to be used as a base to determine the protection level required for a specified development, unless determined otherwise by Council.

4. Water quality objectives shall be evaluated over the full range of rainfall events to maintain the long-term protection of the pre determined Environmental Values (EV).

Low Risk Development

5. Water quality objectives shall be determined based on a developments "RISK" to the environment. Low Risk development (e.g.: single dwelling construction) will not be required to identify relevant water quality objectives for down stream receiving waters but will be required to follow Best Management Practices (BMP) in relation to the control of erosion, sediment and stormwater quality as outlined in this specification and in accordance with *Managing Urban Stormwater, Soils and Construction,* Chapter 9 – Urban Construction sites.

High Risk Developments

6. High Risk developments are classified according to the following criteria. Any development or development proposal:

a. Located in a waterway corridor.

b. Located within the catchment of a wetland area.

c. Consisting of multiple dwellings or commercial uses with an impermeable surface area (including roof area) in excess of 2500m² and / or

d. Subdivisions greater than 6 lots and / or

e. Industrial activities that are not impact assessable and at least 1000m² in uncovered storage/working space.

f. Uncovered car parks > 100 spaces.

Ecosystem Type

7. The long-term water quality sustainability of a high-risk development shall be based on viable protection levels of aquatic ecosystems. The classification of protection levels of aquatic ecosystems is defined as:

a. Pristine ecosystem or **unmodified ecosystem**, having high conservation values and 'protection' status.

b. **Slightly to moderately modified ecosystem**, where the ecosystem is largely intact (habitats, limited catchment clearing) such that some 'restoration' of the original values is viable.

c. **Highly modified ecosystem**, where the original ecosystem is so disturbed that it cannot be restored to a slightly to moderately disturbed condition, but is capable of sustaining some ecological and conservation values with appropriate 'management'. (Ref: ARQ Chapter 6).

Council shall confirm determination of the classification of the receiving ecosystem.

8. Estimation of Sustainable Average Annual Export Load (SAAEL) is to be a risk-based process where the export loads are compared to the trigger level for the receiving waterway (ref: ARQ 6.3.1 ARQ approach to estimating sustainable catchment loads). The median insitu water quality indicator must be below the trigger level of a receiving waterway to comply with this specification.

Sustainable Average Annual Export Load

9. The assessment of potential water quality impacts shall be based on.

a. Changes in water quality discharging from a catchment and proposed management techniques to ensure no increase of or an improvement in water quality.

b. Increase in the average annual load of key pollutants, above that occurring under existing conditions or to levels compliant with predetermined water quality objectives.

10 Stormwater treatments shall be designed to meet the minimum level of pollutant load objective in accordance with table D7.2

Pollutant Retention

Pollutant	Objective
Suspended Solids SS	80% retention of average annual load
Sediment	100% retention of sediment greater than 0.125mm for flows up to the 3 month ARI peak flow
Oil & Grease	No visible oils for flows up to the 3 month ARI peak flow
Litter	100% retention of litter greater than 5 mm for flows up to the 3 month ARI peak flow
Total Phosphorus (TP)	65% retention of average annual load
Total Nitrogen (TN)	65% retention of average annual load

Table D7.2 Stormwater Treatment Pollutant Load (ARQ)

STORMWATER QUALITY IMPROVEMENT DEVICES

SQID's

D7.22 SELECTION OF STORMWATER QUALITY IMPROVEMENT DEVICES

1. The appropriate selection of Stormwater Quality Improvement Devices. (SQID's) will assist Developments meet Councils Water Quality Objectives (WQO). In selecting an appropriate SQID or combination of SQID's the following process shall be followed:

a. Risk Category – identify whether the proposed development is 'low risk' e.g.: Single dwellings & Dual Occupancy <6 Lots or < 2500m² or 'high risk' e.g.: Development >6 Lots and/or 2500m².

b. Pollutant Type – identify the target stormwater pollutants for the proposed land use for the construction and occupational phases of the development.

c. Construction Phase – during this phase the primary contaminant of concern is usually sediment. To identify the appropriate Best Management Practices (BMP) the guidelines contained within *Managing Urban Stormwater, Soils and Construction (Landcom)* shall be used.

d. Occupational Phase ('low risk') – if the development is 'low risk' Water Quality Objectives (WQO) need not be identified. Table D7.3 shall be used to select which type of quality control device is appropriate.

e. Occupational Phase ('high risk') – if the development is 'high risk' WQO's shall be identified as outlined in section 7.06 of this specification. Table D7.3 may be used to determine the appropriate types of devices, but detailed analysis shall be required to determine pollutant export loads and demonstrate that the device selection meets relevant WQO's for receiving waters.

f. Maintenance Plan – where SQID's are selected as an appropriate treatment device a maintenance plan shall be required as specified in table D7A-4 (Appendix A).

g. Documentation – the Stormwater Management Plan is to include details of the SQID's selected their location, the timing for installation, and the maintenance regime. An evaluation of costs shall be submitted stating the initial establishment costs and the annual maintenance costs

Management Device	Litter	Coarse Sediment	Suspended Solids	Nutrients (N& P)	Oxygen Demanding Substances	Hydro carbons	Pathogens	Heavy Metals
Source Controls								
Street Sweeping	H – M	M	–	-	L	-	-	L
Rubbish Bins	H – M	-	-	-	L	-	-	-
Education	L	L	L	L	L	L	L	L
Primary Treatments Small Scale								
Litter Baskets	L – M	L	-	-	L	-	-	-
Grates & Entrance Screens	L	-	-	-	-	-	-	
Side Entry Pit Traps	L – M	L	-	-	L	-	-	-
Baffle Pits	L	L – M	L	L	L	-	-	L

Management Device	Litter	Coarse Sediment	Suspended Solids	Nutrients (N& P)	Oxygen Demanding Substances	Hydro carbons	Pathogens	Heavy Metals
Catch Pits	L	L – M	L	L	L	-	-	L
Oil & Grit Separators	L	L – M	L	L	L	L – M	L	L
Nets	H	-	-	-	-	-	-	-
Medium Scale Devices								
Litter & Trash Racks	M	L	-	-	L	-	-	-
Downwardly inclined screens	H	-	-	-	-	-	-	-
Floating Litter Booms	L – M	-	-	-	-	-	-	-
In Ground GPT	H – VH	H	L	L	L – M	L	-	L
In Line Separators	M	L – M	-	-	-	-	-	-
Large Scale Devices								
Open Gross Pollutant Traps	M – H	H	L	L	L	L	L	L
Sediment Traps	L	H	L	L	L	L	L	L
Secondary Treatments								
Filter Strips	M	H	M	L – M	L	L	M	L
Grass Swales	L – M	M – H	M	L – M	L	L	M	M
Sand Filters	-	M – H	M – H	M	M	M	M	M
Infiltration Trench / Basin	-	M – H	M	M	M	M	M	M – H
Porous Pavement	-	H	M – H	M	M	M	H	M – H
Extended Detention Basins	-	M – H	L – M	L	L	L	M	L
Tertiary Treatments								
Water Quality Ponds	M – VH	H	L – M	L – M	L	L	L	L – M
Constructed Wetlands	M – VH	H	M	M	L	M	M	H

Legend:
- = Neglible benefit
L = 10 – 30 % Pollutant reduction efficiency
M = 30 - 50% Pollutant reduction efficiency
H = 50 – 75 % Pollution reduction efficiency
VH = 75 - 100% Pollution reduction efficiency

Table 7.3 Pollutant Reduction Efficiencies
From Brisbane City Council Design Guidelines for Stormwater Quality Improvement Devices Final Draft, 1999

D7.23 WET RETENTION BASINS/PONDS

1. Basins designed for water quality control should maximise the extent of settling. In general quiescent conditions and infiltration should be maximised. ***Maximise Infiltration***

2. A wet retention basin can be located either on-line or off-line as shown in Figure D7-3. Its capacity however needs to be considerably greater if it is located on-line. The wet retention basin usually has some form of energy dissipation at the inlet or a sufficient length-to-width ratio (greater than 2:1) to prevent short circuiting of flow across the pond, although its shape may vary considerably. It should be located such that the basin does not locally raise the subsurface water table under circumstances that might lead to a salinity problem. . Refer to Chapter 11 of ARQ for details of appropriate design procedures to be adopted. Basins may be installed as smaller multiple units (in series) or as large single units. ***Location and Size***

3. Other design guides that will make the basin efficient in removing particles and provide for public safety, include the following. ***Basin Efficiency***

(a) The minimum depth should be not less than 1.5 metres with an average depth of 2.5 metres. This discourages macrophyte growth in the deeper portions of the pond and also the breeding of mosquitoes.

(b) The basins should have side slopes of approximately 1 in 8. This provides for safety and encourages microphyte growth around edges facilitating nutrient uptake. If side slopes are steeper than 1 in 6 the basin/pond shall be enclosed by a child proof security fence

(c) The maximum velocity through the pond based on a 1 in 1 year storm should not exceed 0.3 metres per second (at 2.5 metres depth, this is the maximum practical flow velocity at which optimum sediment removal can be achieved).

(d) A minimum freeboard of 0.3 metres should be provided between a restricted discharge outlet for the pond and a storm overflow weir. This discharge outlet should be designed so that the weir overtops on average three times per year.

(e) Inlet and outlet structures should be located at extreme ends of the basin, with short circuiting of flow further minimised by the use of baffles.

(f) Depth indicators shall be provided indicating maximum depth in the basin spillway.

(g) Appropriate hazard signage shall be provided for the basin and spillway.

(h) Protection of the low flow intake shall be provided to prevent blockage and to prevent the risk of people being trapped.

(i) Basins shall be designed so that no ponding of water occurs on to private property or roads

4. Basins should be constructed prior to the commencement of any site clearing or construction works, and should be de-silted when the level of sediment reduces the average water depth to less than 1.5 metres. ***Construction and Maintenance***

5. (a) It may be desirable for the designer of an urban retention basin to incorporate an outlet device that enables dewatering of the basin. This simplifies de-silting, enabling earthmoving equipment to be used for de-silting operations. ***Outlet Design***

(b) An all weather access track shall be provided to the basin for maintenance works. ***Access Track***

(c) The basin spillway will not be located directly upstream of urban areas.

6. It is generally necessary to incorporate a gross solids trap and trash rack facility on major discharges into the retention basin. This prolongs the life of the basin and prevents the accumulation of litter. ***Trash Racks***

7. Basins should be surrounded by buffer zones, typically comprising grassed foreshores of not less than 20 metres between the nearest development and the basin. This allows for some infiltration of drainage from developments, permits the drainage authority scope to develop aesthetic surrounds and reduces the likelihood of over the fence dumping of rubbish. ***Buffer Zones***

8. The settling velocity of particles should service as the basis for design. This, of course, can only be found by conducting standard settling tests or from a knowledge of local soil characteristics. The surface area of the required basin can then be determined from design settling velocities (Randall et al 1982). ***Particle Settling***

9. Wet retention basins are regarded as impoundments and normal dam safety requirements should be met. A dam may be prescribed under the Dams Safety Act, 1978, depending on the recommendations of the NSW Dams Safety Committee. A dam is normally prescribed if it is: ***Basin Classification***

(a) 10 metres or more in height and has a storage capacity of more than 20 megalitres; or

(b) 5 metres or more in height and has a storage capacity of 50 megalitres or more.

10. If the wet retention basin is a prescribed dam, the Dams Safety Committee will maintain an interest in the dam, will seek information from its owner and will require that reports be prepared on the dam and submitted to the Committee. ***Dam Safety Committee***

D7.24 TRASH RACKS

1. Trash racks are usually permanent structures which intercept trash and other debris to protect the aesthetic and environmental quality of water. Where appropriate, construct them upstream of all permanent retarding basins and/or wetlands which have a capacity greater than 5,000 cubic metres, and elsewhere as required by Council. ***Environmental Quality***

2. Generally, their design criteria should ensure: ***Design Criteria***

(a) vertical bar screens with bar spacing of 65mm clear;

(b) the length of the rack is consistent with the channel dimension and cause minimal damage when overtopped;

(c) they are as large as practicable while considering all other design criteria - a maximum height of 1.2 metres is suggested;

(d) a structure which remains stable in at least the 20 year ARI event, and is unlikely to cause flooding on adjacent lands as a result of the rack becoming completely blocked in the 100 year ARI event (analysis should include investigation of backwater effects and any consequent flooding);

(e) the structure drains by gravity to a dry condition;

(f) adequate access for maintenance and which permits the use of mechanical equipment;

(g) water can still flow past when the rack is fully blocked; and

(h) appropriate egress provision shall be included if steep side slopes exist adjacent to the trash rack.

3. Where associated with outlet structures for small sediment basins or constructed wetlands, they can be relatively simple in design. ***Associated Structures***

4. Trash racks may be incorporated in the design of gross pollutant traps. ***Gross Pollutant Trap***

5. A maintenance schedule for any trash racks shall be included in the SQID's Maintenance and Operations Procedures. ***Maintenance***

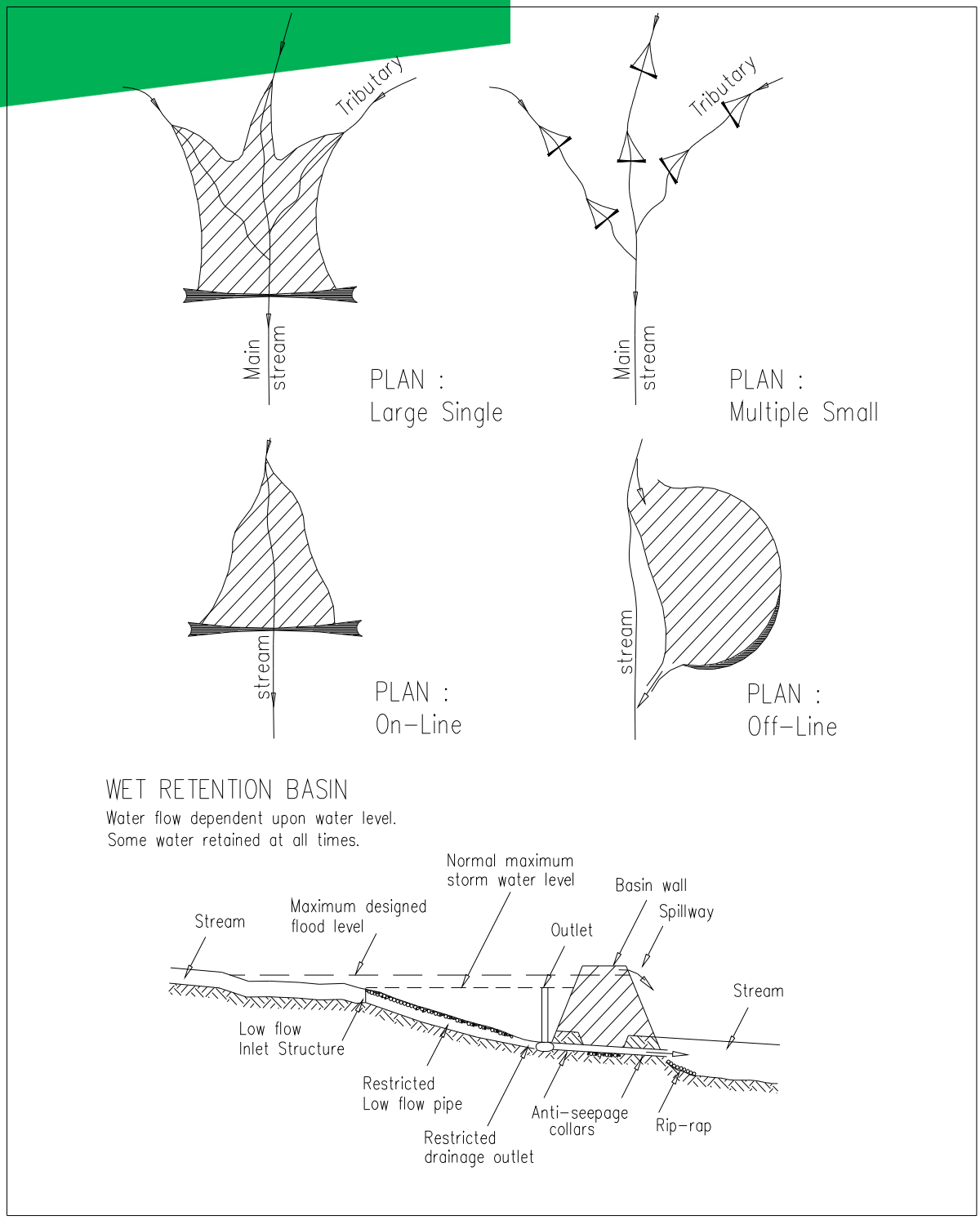


Figure D7-3 - Configuration and Design of Wet Retention Basins

D7.25 GROSS POLLUTANT TRAPS

Description

1. Gross pollutant traps (GPTs) are permanent structures used to trap coarse sediments, trash, litter, and other floating materials. Usually, they are located upstream of constructed wetlands and receiving waters. They consist of an energy dissipater at the upper end, concrete sediment trap and trash rack at the lower end. Sometimes a "mini" wetland is incorporated at the downstream end.

Applications

(HP)

2. These traps have restricted application and each should be justified on individual merits. Selection of the size and type of GPT shall be based on information and guidelines contained in Chapter 8 of ARQ. Confirmation from Council shall be required when a GPT type is selected to ensure consistency and conformance with catchment management plans. This action constitutes a **HOLD POINT**. [see C223.11 (1)]

Definition

3. GPTs can be defined as major or minor:

(a) major gross pollutant traps can be located on major floodways and waterways to intercept medium to high flows; and

(b) minor, enclosed gross pollutant traps can be located at heads of major floodways and/or where stormwater discharges into floodways or water bodies.

Sediment Interception

4. Design traps to intercept at least 75 per cent of sediment with a grain size of 0.04mm or greater under average annual runoff conditions. Further, ensure peak flow velocities are less than 0.3 metres per second in the 1 year ARI storm event, and taking into account any likely backwater effect from a blocked trash rack.

Capacity

5. The structure should have sufficient capacity and stability to discharge the inlet flow with the trash rack fully blocked without flooding adjacent properties.

Maintenance Requirement 1 year

6. Ensure GPTs are capable of gravity drainage to a dry condition for periodic cleaning and maintenance if at all possible. The maintenance period for GPTs shall be one year from the date it is first brought into full service until handover. All GPTs shall be thoroughly cleaned prior to handover. A bond will be required for the maintenance period.

D7.26 LITTER BASKETS

Description

1. Litter baskets are proprietary devices primarily designed to capture litter and gross pollutants.

Application

2. These traps have restricted application and should be justified on individual merits. Selection of the type and location of Litter Baskets shall be based on information and guidelines contained in Chapter 8 of ARQ. An intention to utilise Litter Baskets shall be approved by Council at the concept stage of a development.

3. Litter Baskets are typically located within stormwater side entry drainage pits and are designed to collect and retain a range of pollutants including 95% of all solids greater than 2 mm.

Design

4. Design loads and capture capacity shall be verified for each pit proposed. Provision for access and OHS issues shall comply with current Australian standards.

Maintenance

5. All costs relating to design installation and maintenance shall be provided.

D7.27 CONSTRUCTED WETLANDS AND PONDS

Design

1. Constructed wetlands and ponds shall be designed in accordance with the requirements of:

   a) The primary reference documents shall be ARQ, Chapter 12, AUSTROADS AP – 232, - Technical report 00/1 2000 CRC.

   b) Pollutant loads to target levels contained within this specification.

   c) Care shall be taken to avoid situations that recharge the groundwater and elevate the water table so as to develop local salinity problems

Typical Elements

2. Figure D7.4 shows a typical wetland arrangement.

The major elements include pre-treatment, inlet zone, ephemeral zone and microphyte zone or wetland zone.

Pre Treatment Zone

3. A pre-treatment zone is required to remove litter and organic matter from inflows to allow easy collection by maintenance crews. A litter trap shall be capable of retaining litter of a size greater than 5 mm for all flows up to a flow rate of 1 in 3 month ARI (the design rainfall event). A sediment trap may also be located within this zone.

Inlet Zone

4. An inlet zone has the primary functions of energy dissipation and sedimentation. Details of methods of sizing of sediment basins may be found in the specified reference documents. The inlet zone shall have the capacity to remove 95% of all suspended sediment down to 125um during the design rainfall event. If a natural stream is used to convey the waters to a downstream wetland a 1in 2 Year ARI event shall be the design rainfall event. When the Inlet Zone is to be a pond structure the following shall apply:

   a. The length to width ratio shall be between 5:1 and 10:1 with sufficient energy dissipation to reduce velocities to below 1.0m/s. The maximum width shall be 14m to allow access for maintenance plant.

   b. Maximum depth between 1.5 – 2.0 m

   c. The preferred top water level shall be 0.5m above the downstream wetland zone.

   d. Bypass facilities shall be included in the design to allow the water level to be lowered by at least 0.5m for maintenance of the pond.

   e. Access ramps and tracks must be capable of supporting maintenance plant.

   f. Batter slopes shall be a maximum of 1 in 6.

Ephemeral Zone

5. . The Ephemeral zone or marsh shall be used to trap leaf and other organic material prior to entering the wetland zone reducing the likelihood of anaerobic decomposition within the wetland zone. The design requirements are:

a. The total area shall be 250m² / m³/sec of the design flow

b. A shallow rock lined channel shall meander to maximise length of travel and allow event flows to inundate adjacent areas planted with ephemeral marsh plants.

c. Raised mounds consisting of topsoil positioned at 45° to the flow of water shall be included in the design. It is preferable to form the mounds by removing material from the location of the mounds rather than stripping the entire area and building the mounds.

d. Marsh plantings shall be arranged in offline cells to form a herringbone pattern.

e. A porous rock wall or similar shall be provided across the downstream end of the ephemeral zone to allow flow attenuation during the design flow event.

Wetland Zone

6. The wetland Zone shall be designed to remove sediment less than 125 um and dissolved pollutants. Design criteria shall be as outlined in the reference documents, and shall include the following specific requirements.

a. Treatment shall be obtained by retaining runoff in a macrophyte-dominated wetland.

b. A residence time in the wetland shall be at least 72 hours for the design stored event volume.

c. The maximum stored water level shall be 450mm above the normal top water level unless Council gives specific approval.

d. Provision shall be made to minimise the velocity through wetland to less than 0.2m/s during the initial stages of a storm event.

e. An accessible outlet control shall be designed to be blockage free and able to change flow rates to allow initial plant establishment and for maintenance purposes.

f. A minimum of 80% vegetated marsh is to be arranged in bands across the flow path. The remaining area shall be allowed for submerged marsh or open water areas.

Vegetation

7. Emphasis in planting design should be given to species growing naturally in local wetland remnants. A vegetation and weed maintenance program of at least 24 months after the initial planting of the wetland shall be incorporated in the maintenance and operation procedures.

A variety of plant species should be planted in artificial wetlands to achieve efficient colonisation and maximise pollutant removal. Establishment of plants should be through transplantation of seedlings during spring and early summer

8. Safety considerations shall be included in the design of all structures. The following requirements shall be used as a minimum in the design. ***Safety***

a. Operational depths of sediment ponds to be from 1.5 to 2.0m. Shallow marsh areas, depths to 200mm, deep marsh areas 200mm to 350mm with a periodic maximum up to 600mm.

b. Minimum offset to any allotment boundary to be 15m and up to 30m where access is available.

c. Batter slopes shall not exceed 1 in 6

d. No formal access points to water shall be included in the design unless there is appropriate safety benching.

e. All edges to waterbodies and wetlands shall have safety benches of at least 1.5m to 3.0m wide from the normal top water level except where transitions to culverts or waterways occur. Safety benches shall have maximum slopes of 1 in 8 for the first 1.5m to 3.0m, a transition to 1 in 5 over 0.5m (min.) prior to steeper grades up to 1 in 3. The safety bench shall be densely planted with emergent macrophytes to preclude access.

9. Interim fencing is recommended between the construction and vegetation establishment where water depths exceed 350mm. ***Fencing***

Permanent fencing combined with dense impenetrable plantings shall be used adjacent to water depths exceeding 350mm (normal top water level) areas where safety benches do not conform to the width criteria, adjacent to unsafe structures, areas of high velocities or where batters are steeper than 1 in 6.

Maintenance access areas shall be signed, fenced and gated where the safety measures above are not met.

10. Natural wetlands shall not be used for improvement of urban run-off quality. ***Natural Wetlands***

Where wetlands are natural, the provisions of State Environmental Planning Policy No 14 – Coastal Wetlands, should be consulted. This policy protects wetlands from clearing, construction of levees, draining and filing, but does not prevent wetlands being used for run-off control, provided safeguards and operation control ensures their continued viability.

11. Wetlands are primarily to be designed to capture the ARI 3 month storm (deemed to be 40% of the ARI one year event), however overflow structures and flow paths are to be provided to allow passage of the ARI 100 year storm event ensuring no damage to the wetland or associated drainage or other ancillary works and no re-mobilisation of captured sediments. ***Efficiency***

12. Where possible, small islands or shoals should be constructed in the upstream areas of the wetland to reduce water velocities, prevent short-circuiting and promote aquatic plant growth. ***Short Circuiting***

These areas are best planted with vegetation native to the area, but they can be used as grassed areas and as an aesthetic feature.

13. Wetlands will serve other purposes than just improving a quality of urban run-off. They will serve to attract a large range of biota and bird habitat. In areas where they have been installed, they have become an aesthetic feature. Indeed, this may present problems as surrounding communities may resist efforts by the controlling authority to de-silt the wetland. ***Aesthetic Feature***

14. To minimise mosquito problems, limit expanses of water with more than 50 per cent shading and ensure no sections of water become isolated from the main body. ***Insect Problems***

15. Islands are highly beneficial as wildlife refuges, especially for birds. Their design should consider the effects on changes in water tables. ***Wildlife Refuge***

16. Ponds May be stocked with selected native fish to improve the water quality (not for sport), especially species which will control mosquito larvae and select zooplankton in preference to phytoplankton. Avoid use of fish which are bottom feeders. Any fish stocking programme must be approved by Council. ***Native Fish***

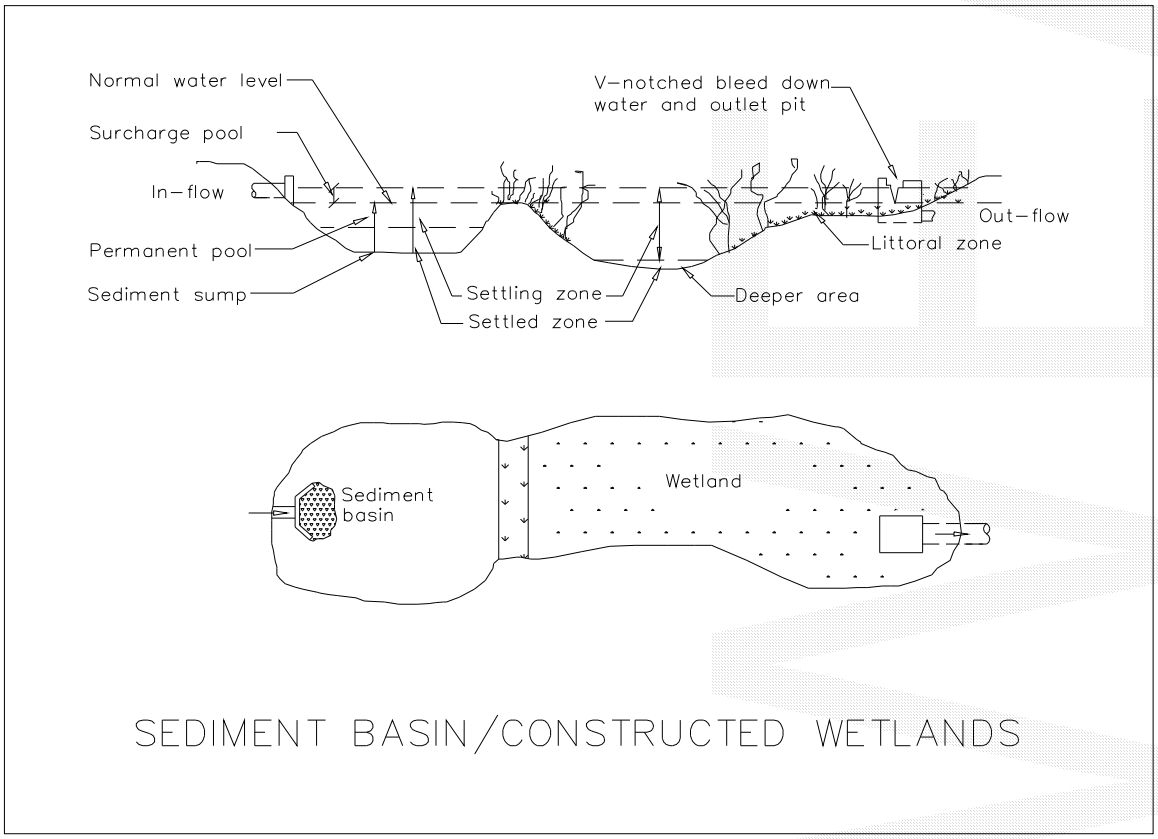


Figure D7-4 - Sediment Trap/Constructed Wetland

D7.28 INFILTRATION SYSTEMS

1. Infiltration systems are best utilised as part of a treatment train consisting of elements such as grassed surfaces, vegetated strips, swales, sand filters, gravel based reed beds,' treatment train' tanks and geotextile filters. Infiltration systems are to follow the guidelines in Chapter 10 of ARQ. Infiltration systems are to be designed to achieve the following:

a. Reduce the peak flow and volume of storm runoff

b. Minimise pollution conveyance from urban catchments to downstream waterways and receiving waters.

c. To harvest and use storm runoff as a "second quality" water resource.

2. The design capacity of infiltration systems can range from designs catering for the minor system flows to the major system flows.

3 Infiltration components can be constructed from the following:

a. Single sized gravel.

b. Slotted pipes – circular or semi-circular.

c. Proprietary recycled drainage cell.

4. Types of suitable infiltration systems include:

a. “Leaky” wells: typically concrete or PVC or similar pipe with perforated walls covered with non-woven geotextile fabric. The well is to be surrounded with gravel, enclosed in non-woven geotextile.

b. Trenches may be gravel or gravel with a slotted pipe, drainage cell or a combination of all. All trenches embedded in host soil must be encased in non-woven geotextile fabric. Maximum floor level below ground is to be 1.5m, top of gravel should be covered with 0.3m of backfill.

c. “Soakaways” similar to trenches having a large plan area with depths ranging from 0.3m to 0.5m constructed of similar materials as trenches.

d. Infiltration “dry” ponds are structures similar in design to small-scale retention wetlands. They are suited to sandy or sandy clay sites only with the screening of gross pollutants required upstream of the structure. Safe water depths during runoff events are critical in the design of this type of structure.

5. Appropriate types of runoff suitable to be directed to infiltration structures include:

a. Storm runoff from roofs, cleared of leaves or other litter may be passed into a rainwater tank(s) and the overflow piped directly into an in ground device.

b. Storm runoff from paved or hardstand areas (courtyards, walkways, carparks etc.) are not to pass directly to devices 4.a,b,c as described above. Such runoff must first pass across buffer zones or treatment devices such as 4.d above.

c. Storm runoff from suburban scale areas are to be passed through a series of treatment devices (e.g.; litter screens, soakaways or similar) before entering into aquifers, urban waterways or receiving waters.

d. During construction of infiltration systems appropriate measures are to be undertaken to ensure sediment is regularly removed prior to the infiltration system becoming operational.

6. The existing soil classification, permeability and water reactivity is to be determined by a geotechnical engineer or other suitably qualified person to determine how soil conditions at the project site will affect detailed design. Table D7.4 shows typical soil permeability and appropriate infiltration system types.

Soil Type	Hydraulic Conductivity		Clearance to structures or boundaries	Recommended infiltration system
	m/s	mm/hr	m	
Deep confined or unconfined Sands	5×10^{-5}	180	1 – 2	Leaky wells, trenches, soakaways
Sandy clays	$1x10^{-5}$ to $5x10^{-5}$	36 – 180	2	Trenches, soakaways
Medium clays	$1x10^{-6}$ to $1x10^{-5}$	3.6 – 36	4	Leaky wells
Heavy clays	$1x10^{-8}$ to $1x\ 10^{-6}$	0.036 – 3.6	5	Dry pond ,soakaways
Constructed clays	$1x10^{-10}$ to $1x10^{-8}$ 0	.0004 – 0.036	5	Soakaways
Shallow soil over rock (sandstone)	$1x10^{-6}$ to $1x10^{-5}$	3.6 – 36	2	Leaky wells

Table D7.4 Soil Permeability & System Selection Table

7. Conditions on selection of infiltration devices include the following:

   a. Leaky wells and gravel filled trenches are not to be used in areas of wind blown sands or Aeolian sands.

   b. Infiltration devices in areas of rock or shale of zero or near zero permeability are deemed to be unsuitable.

   c. Areas consisting of shallow soils over rock or lower permeable sands (e.g.; coffee rock) detailed investigations are to be carried out to determine the existence of stored water near the lower level layers (i.e. Perched water table) and the location of the emergence point of stored water. The impact on downstream areas is to be assessed in the selection of infiltration devices in these areas.

   d. A maximum slope of 5% and soil depth of at least 3m throughout a down slope area is required before infiltration devices are to be considered in areas of steep terrain.

   e. Infiltration devices are not to be used in areas of high or rising water table.

   f. Infiltration devices are not to be used in areas adjacent to underground carpark areas or lower basement areas unless seepage from such devices is adequately catered for by sump pumps or similar design to transfer flows to an appropriate drainage system or lower aquifer.

   g. The location of infiltration devices is to be assessed to determine the impact of upstream infiltration devices on valley floor water tables.

D7.29 VEGETATED SWALES

1. Swales are open vegetated channels that can be used as an alternative stormwater conveyance system to conventional kerb and gutter only with the approval of Council.

2. Vegetation of the swale can range from grass to native shrubs, depending on hydraulic requirements.

3. Criteria for the design of vegetated swales that form part of the bio-retention system is to include but not confined to the following:

   a. The swale dimensions or catchment ratio should be designed so as to ensure 1 year ARI peak velocities do not exceed 0.5 m/s and 100 year ARI velocities do not exceed 1 m/s. In some situations, a high-flow bypass channel or underground pipe may be

required.

b. Longitudinal gradients shall be in the range from 1% min. to 4% max.

c. The swale shall be integrated into the landscape character to enhance its aesthetic value.

d. The application of swales shall match the target pollutant characteristics. Where very fine particulates, or soluble material are of concern, other treatment measures such as infiltration systems or small wetlands shall be considered.

e. Swale profiles of triangular cross section are not acceptable, wide uniform flow shall be a design objective. Maximum width shall be 2.5m unless structural measures are used to ensure uniform spread of flow.

f. Manning's 'n' value shall be between 0.15 and 0.3 for low flow conditions where the depth of flow is below the height of the vegetation. For the major storm event the Manning's 'n' value shall be a lower value (e.g.: 0.03) where flow is above the vegetation level.

D7.30 BIORETENTION SYSTEMS

1. Bioretention systems are designed to provide treatment of stormwater through fine filtration, extended detention and some biological uptake.

Treatment Processes

2. Runoff is filtered through a fine media layer as it percolates downward into a perforated pipe or similar and discharged either directly or via conventional stormwater conduit system.

An even flow distribution is required to allow water to infiltrate the filter media evenly and thus suited to flat terrain of less 2%.

Filtration Soil Media

3. Selection of filter media is a function of the infiltration rate required, refer to Table D7.9, and the type of vegetation utilised.

Soil type	Particle Size (mm)	Saturated Hydraulic Conductivity (mm/hr)	(m/s)
Gravel	2	36000	1×10^{-2}
Coarse Sand	1	3600	1×10^{-3}
Sand	0.7	360	1×10^{-4}
Sandy Loam	0.45	180	5×10^{-5}
Sandy Clay	0.01	36	1×10^{-5}

Table 7.5 Soil Hydraulic Conductivity

Vegetation Requirements

4. Vegetation shall be selected to complement the landscape of an area and to discourage movement and traffic over the bioretention area.

Plants selected shall be suitable to tolerate periods of inundation.

Plants having extensive fibrous root systems or a spreading, rhizomatous or suckering habit are required for efficient performance.

Plants with a clumped above ground habit shall not be used due to problems incurred by channelling, erosion and preferential flow paths.

SPECIAL REQUIREMENTS

D7.31 RESERVED

D7.32 RESERVED

D7.33 RESERVED