Technical Manual

Stormwater and Water Efficiency for Development

(Updated April 2019)

Stormwater and Water Efficiency for Development – Technical Manual
prepared by City of Newcastle

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Part 1 Preliminary information

This section contains general information about prospective applications and the philosophy behind the City of Newcastle's Stormwater management controls for development sites.

1.1 Introduction

1.1.1 Context

This technical manual supports the Newcastle Development Control Plan (DCP) 2012 and shall be read in conjunction with section 7.06 Stormwater Management, 7.07 Water Efficiency and 7.02 Landscape, Open Space and Visual Amenity, and provides detailed text, instructions and best practice guidelines on the management of stormwater run off from all public and private property within the City of Newcastle. The DCP and this technical manual are important tools that support the delivery of Water Sensitive Urban Design (WSUD) and improved stormwater and water efficiency throughout Newcastle.

In order to streamline the link between the DCP and this manual, each section will refer directly to provisions in the DCP. Further, technical guidance has been provided through extensive reference to best practice guidelines. They should be read in conjunction with one another when preparing a proposal or determining an application.

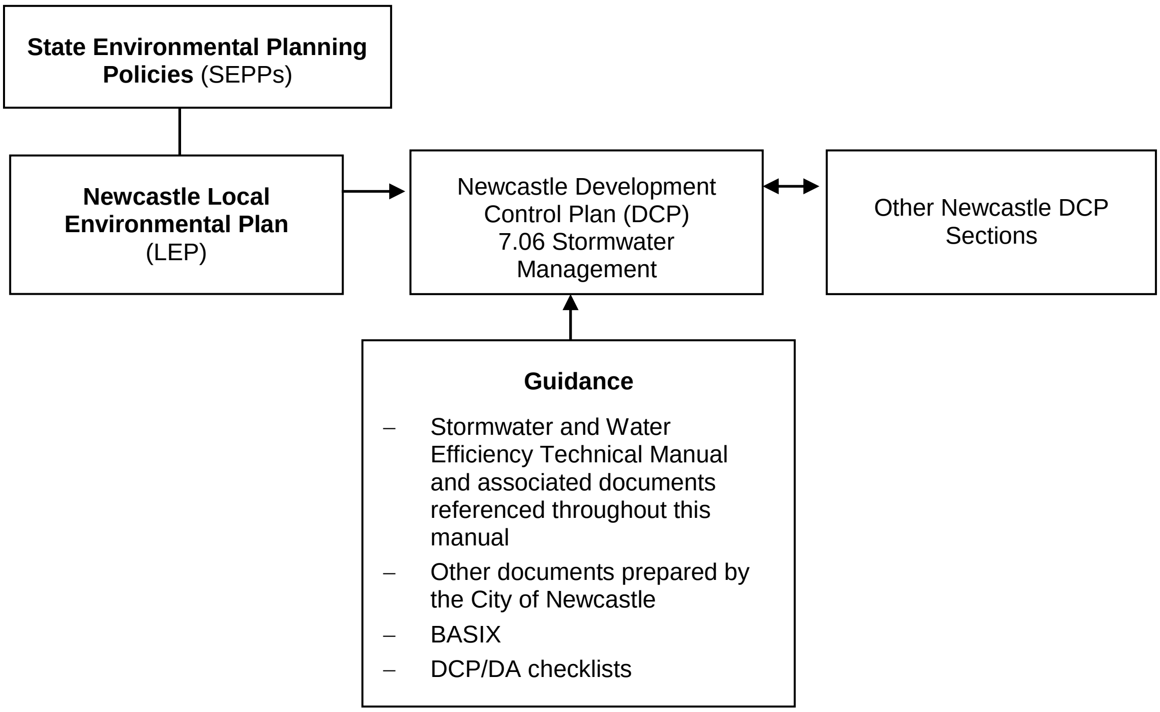


Figure 1.1 - The City of Newcastle document relationship flowchart for stormwater

1.1.2 Aims

The aims of this technical manual are:

- To outline Council's requirements for stormwater management.
- To ensure water efficiency is incorporated into development proposals.
- To provide additional guidance and assist in implementing the Newcastle Development Control Plan.

1.1.3 Design principles

In order to ensure that water receives due consideration during the planning stages of a proposed development, the following design principles have been provided:

Integrated water cycle management

- The water source used for a particular end use should reflect the quality required for that end use (fit for purpose).
- The roof area directed to a rainwater tank should be maximised, to both increase the effectiveness and reliability of the reuse system, and reduce the degree of stormwater treatment required for those areas not draining to the rainwater tank.
- Dual reticulation should be provided for all Greenfield and infill redevelopments which are located in existing or planned recycled water reticulation zones.
- Reduce hydrological impacts of development (as far as possible) by preserving interactions between surface and groundwater therefore delivering appropriate water to the right places for the right times.

Stormwater quality

- WSUD elements are to be integrated into landscaped areas to fit into the built environment of the development.
- WSUD elements are to be designed and located to maximise the impervious area that is treated.
- Consideration should be given to incorporation of multiple use of WSUD infrastructure (such as stormwater detention and treatment), where possible.
- WSUD elements should be incorporated to enhance ecological outcomes.
- Where WSUD elements are within areas of shallow groundwater tables, all assets are to be lined to prevent contamination of local groundwater sources unless it can be demonstrated that unlined systems will sufficiently protect groundwater quality.
- Integrate stormwater quantity management with quality management to optimise treatment performance and improve opportunities for re-use and groundwater management.

Stormwater flows (quantity)

- Disconnection of impervious areas from the drainage system can include directing run off from downpipes, rainwater tank overflows and impervious areas onto stormwater harvesting devices, infiltration measures and grassed and other landscaped areas designed to accept these flows.
- The physical nature of flows into receiving environments needs to be preserved. In particular, where the receiving environment naturally receives dispersed flows, concentration of flows should be avoided.

1.1.4 Relationship to flood risk management development controls

This policy aims to mitigate the effects from additional runoff generated by new development. However, even after full implementation of this policy, there will still be areas of Newcastle that will be prone to flooding. This is because:

- These areas would flood from time to time even if there were no development at all in the catchment. Flooding is a natural part of the geomorphological cycle. Catchment surfaces have a limited capacity to absorb rainfall. When that capacity is reached, further rainfall runs off. This is why the storage of a set volume of water is a close approximation of the hydrological regimes. It is also why the catchment floods after prolonged periods of rainfall when the catchment is “saturated”.
- There are still older parts of the catchment that were developed in earlier times under a different philosophy. It may be quite some time before the development cycle restores the current drainage philosophy to those areas.

The cornerstone of effective flood management is a separate flood risk management policy that addresses issues such as appropriate location of development, appropriate setting of floor levels and the provision of escape routes and refuges. The City of Newcastle has an adopted Flood Risk Management Policy and Newcastle City-wide Floodplain Risk Management Study and Plan including development controls. Please refer to the following documents/links for further details:

Newcastle City-wide Floodplain Risk Management Study and Plan
www.newcastle.nsw.gov.au/environment/flooding_and_waterways/draft_newcastle_city-wide_floodplain_risk_management_study_and_plan

1.1.5 How to use this technical manual

This technical manual provides guidance on how to achieve the ‘objectives’ and ‘targets’ for integrated water cycle management, water quality and stormwater flows through the DCP (the DCP allows some flexibility in the application of the controls where strict compliance is unreasonable given the circumstances of the applicant).

The target audience for this technical manual are developers, builders, plumbers and owner-builders. Some of the recommended controls are conservative in order to make them generally applicable.

Detailed guidance is provided throughout this manual for both small and large developments, however small developments (ie. less than or equal to 5,000m^2 as defined by the legal property description) have a more simplified process to complete, reflecting the lower risk from this scale of development while still remaining equitable with regards to managing their environmental impacts.

For large development proposals (ie. greater than 5,000m^2 as defined by the legal property description) it is recommended that the applicant seek advice from a practicing Civil Engineer, or suitably qualified professional, in the most efficient solutions to the development controls.

This technical manual is arranged in order of:

- Stormwater Collection
- Site discharge controls – small scale development (less than 5,000m^2)
- Site discharge controls – large scale development (greater than 5,000m^2)
- Site discharge controls – Council assets
- Overflow disposal.

It follows a logical progression from the point where rainwater is collected, to the site discharge controls, to the manner in which it may be discharged to the public drainage system.

There is also additional information explaining some of the technical terms and references on which this manual was based (refer to Glossary).

Included is a copy of event based rainfall data used in the City of Newcastle (refer to Appendix 1).

Finally, there is a series of drawings that add further detail to the technical guidelines, as outlined in this manual (refer to Part 4a for further details).

1.1.6 Applicability

This technical manual has been prepared to facilitate the application of best practice stormwater management, following the principles of Water Sensitive Urban Design (WSUD) in the Newcastle Local Government Area (LGA). The provisions of stormwater Development Control Plan 7.06 apply to all development in all areas in the City of Newcastle including single dwelling houses (the impervious area from houses forms approximately 40 – 50% of residential catchments and is a significant contributor to environmental and flooding issues).

Where the applicant can show that adequate measures are already in place to address stormwater issues, it may not be necessary to provide on-site detention and/or site discharge controls.

1.2 Planning

1.2.1 Development Applications

This manual supports the DCP section for stormwater management (7.06) and water efficiency (7.07). Development Applications will follow Council's normal process. Generally, an approved development application will have specific conditions requiring certain compliance with stormwater controls.

Where a consent does not require specific compliance, this manual should be regarded as best practice guidelines.

A development application or complying development certificate application (where required) is to be accompanied by a Stormwater Management Plan. A Stormwater Management Plan shall include the following items:

- The location of all buildings, driveways and impervious surfaces;
- The location of any watercourses or bushland passing through or adjacent to the property;
- Any overland flowpaths which drain through the property or adjacent to the property; and
- The location, size and depth of easements or drainage pipelines.

In addition, the Stormwater Management Plan is to show the appropriate design elements to achieve compliance with the requirements set out in the subclauses of DCP 7.06.

1.2.2 Development assessment checklist

WSUD needs to be considered during the planning stages of a proposed development, rather than as an additional feature to be included at the final stages of the process. In order to assist with the consideration of WSUD during the planning stage, Council has prepared an assessment checklist (refer to Table 1.1). A copy of the checklist shall be submitted to Council with each Development Application.

1.2.3 Comprehensive Water Cycle Management Plans

Water cycle management is part of the overall concept of ecologically sustainable development. Council requires ESD to be considered in all new development applications.

Development proposals that:

- incorporate 20 or more dwellings, or
- accommodate 50 or more employees or clients, or
- involve the use of more than 1 hectare of land for commercial, industrial or special use purposes,

should be designed and constructed in accordance with a comprehensive water cycle management plan.

Plans should detail the whole of the water cycle and identify where and how improved sustainability is to be achieved. Plans should address, but not be limited to:

- Supply
  - importation of mains water
  - collection of rain water
  - interception of groundwater
- Use
  - drinking, bathing, washing, cleaning, toilet flushing, industrial processing and irrigation as applicable
- Treatment
  - filters, ponds, chlorination, biocycles and heating as appropriate
- Discharge
  - sewer
  - stormwater
  - evapotranspiration
  - groundwater.

Plans should also consider the public health issues potentially associated with use and reuse of water. Where sewer is available, the disposal of black water to sewer is preferred. Grey water may also be disposed to sewer, or alternatively, other methods provided that the public health risk is considered.

A comprehensive water cycle management plan may include the storage and use of grey water, specification of the type of landscaping to be used and the installation of water efficient appliances.

Table 1.1 - Broad scale assessment checklist for WSUD

BROAD SCALE DEVELOPMENT ASSESSMENT CHECKLIST **Newcastle Development Control Plan 2012 – Section 7.06 Stormwater and Section 7.07 Water Efficiency**				
Site/Project Name:				
Applicant:				
Catchment Area	**1 2 3 4** (circle relevant catchment from Appendix 9)			
ITEM		**Y**	**N**	**NA**
1	**Integration of the whole water cycle**			
	Stormwater Management and WSUD principles have been integrated into the proposed development.			
	Opportunities for on site water re-use have been identified and utilised.			
2	**Management and minimisation of hydrologic impacts**			
	Hydrologic Objectives have been identified and addressed (impervious areas shown, design events indicated, conveyance requirements identified, peak flows shown, appropriately sized on-site retention etc.).			
	High flows have been catered for (bypass structures, overland flow paths, overflow disposal to legal point of discharge shown etc.).			
	Impacts upon receiving environment have been determined and minimised (erosion protection, dissipation of concentrated flows).			
3	**Management and minimisation of ecological impacts**			
	Water Quality Management Objectives have been identified and addressed (MUSIC modelling results submitted, site discharge controls in accordance with DCP)			
	A treatment train approach has been developed where practicable (larger developments).			
	Appropriate use of source controls to minimise the generation of excessive runoff/pollution at or near its source.			
4	**Maintenance and/or enhancement of visual and social amenity**			
	WSUD has been integrated into landscape form.			
	Multiple use assets and/or corridors are proposed (verge side swales, bio-retention ponds, constructed wetlands etc.).			
	Public health and safety issues considered and addressed (batter slopes, water depths/velocities, stagnant water etc.).			
5	**Minimisation of whole of life asset costs**			
	Maintenance requirements are considered (maintenance plans provided, maintenance access point for vehicles identified).			
	Asset life cycle cost determined.			
	Asset ownership and responsibility defined and agreed.			
	Cost effectiveness of strategy evaluated and maximised.			
6	**Provision of alternative sources of water/mains water use reduced**			
	Rainwater harvesting consistent with expected reuse opportunity & DCP (number of people using site, type of development etc.).			
	Water tank reticulated to new toilets, laundry and taps where appropriate (water reuse fit for purpose).			
	Water reused in industrial/commercial developments where practicable. (eg. vehicle washing, landscaping, irrigation).			

Erosion and sediment control plan
All builders/developers are required to prepare an Erosion and Sediment Control Plan showing how they will minimise soil erosion and trap sediment that may be eroded from the site during the construction of a building or development. The Plan must be prepared by a person with suitable qualifications, experience or ability in the preparation of such plans and that has a demonstrated knowledge of soil and water management. The complexity of the Plan depends upon the nature and scale of the particular development, especially the amount of land likely to be disturbed. In the Newcastle Local Government Area, proposals involving disturbed areas larger than 50m^2 require an Erosion and Sediment Control Plan.

Responsibilities for stormwater management arise from the *Protection of the Environment Operations* (POEO) *Act* 1997. Compliance with the POEO Act is achieved by preparing an Erosion and Sediment Control Plan that shows how the builder/developer will minimise stormwater pollution and implement the Plan after Council approval.

The Plan should be a stand-alone document consisting of both drawings and a commentary that can be understood easily by all site workers. Appendix 3 provides an example of the information to be contained in a Plan for a single residential allotment. The objective is to ensure everyone working on the site understands the Plan and how important it is not to pollute stormwater.

A more detailed Soil and Water Management Plan is required for larger-scale developments, where more than 5,000m^2 of land (in accordance with the legal property description) is to be disturbed in accordance with Council's Stormwater DCP 7.06.

Erosion and Sediment Control Plans and Soil and Water Management Plans are to be prepared in accordance with 'Managing Urban Stormwater: Soils and Construction - Volume 1, 4th edition 2004 (the 'Blue Book')'.

1.2.4 Constraints and opportunities

Careful site planning is the key to any successful development. The inherent flexibility of this policy is in the choice of site discharge controls. Some devices will suit certain physical site constraints, others will not. It is a matter for the applicant, in consultation with Council, to implement the most suitable solution for the site with regard to opportunities and constraints. Some of the relevant issues are:

- Urban design
- Geotechnical conditions
- Function and serviceability
- Available space
- Existing vegetation
- Building form
- Aesthetics
- Maintenance

1.2.5 Relationship to BASIX

Water conservation measures required for residential development is stipulated by the State Government's BASIX legislation. This is applicable to all residential development and is required to be submitted with the Development Application. BASIX is not covered by this document – for further details go to the Department of Planning's website www.basix.nsw.gov.au.

Compliance with BASIX will go towards meeting the requirements of the Deemed to Comply Provisions outlined in this Technical Manual (Refer to Part 4a).

1.2.6 References

To assist with the selection and implementation of appropriate stormwater management controls, this manual provides a series of references to best practice guidelines. These guidelines have been carefully selected to provide a suite of documents to assist with the selection of appropriate WSUD elements.

Where appropriate and available, detailed reference will be made to technical guidelines to assist with the selection process. The use of these best practice guidelines will assist both the applicant and Council to achieve the requirements listed in the DCP.

Part 2 Existing infrastructure

This section contains general information about dealing with existing road and drainage infrastructure, be it inside or outside the site boundaries.

2.1 Existing drainage systems

2.1.1 Application

In some circumstances, the site may be traversed by an existing drainage line. Existing lines may or may not be protected by drainage easements. Easements may be in favour of Council, Hunter Water Corporation or the upstream property owners.

2.1.2 Guidelines

The following guidelines give further detail in designing development so that existing drainage systems are not adversely affected.

- Structures (such as buildings, garages, impervious fences and pools) are not to be located within a drainage easement or, if there is no easement, within 1.5m of the centreline of a drainage pipe. Eave overhangs are permitted subject to at least 4.5m clearance to ground level.
- Carports or similar open-ended structures may be located over a piped drainage easement or drainage line subject to the following criteria:
  - A 2.5m wide clear zone with 2.5m clearance is at least provided through the structure along the length of the easement or pipe.
  - Footings do not encroach upon the easement.
  - Footings are carried down to the level corresponding to the underside of the stormwater pipe.
  - Existing ground levels over the easement or pipe are not substantially altered.
  - Existing overland flowpaths are maintained.
- Paving comprised of water-resistant materials such as reinforced concrete, clay or concrete bricks or asphalt may be located over a drainage line or easement. A suitable full depth expansion joint should be provided at the easement boundaries.
- Clearances between easement boundaries and proposed structures should be sufficient to:
  - prevent undue loads from bearing on drainage structures
  - prevent loss of foundation support in the event of future maintenance excavation works
  - allow conveyance of overland flows associated with the easement up to the 100 year Average Recurrence Interval (ARI) event

- Footings for buildings should not be founded on material that is shallower than a line drawn at 45 degrees to the vertical from the bottom edge of the existing drainage system. Refer to Figure 2.1.
- Where an existing structure is located over a drainage line or easement within the site, an access pit to the drainage system should be provided at both ends of the building.
- Where existing drainage lines traverse a site under the footprint of a proposed building, the drainage line should be relocated to an alternate route, not under the building.
- Retaining walls, cutting and filling is not to occur over easements benefiting Council.
- Where a development is likely to impact existing drainage (including construction practices), a pre and post construction drainage inspection is to be performed in accordance with Appendix 11 and submitted to Council.

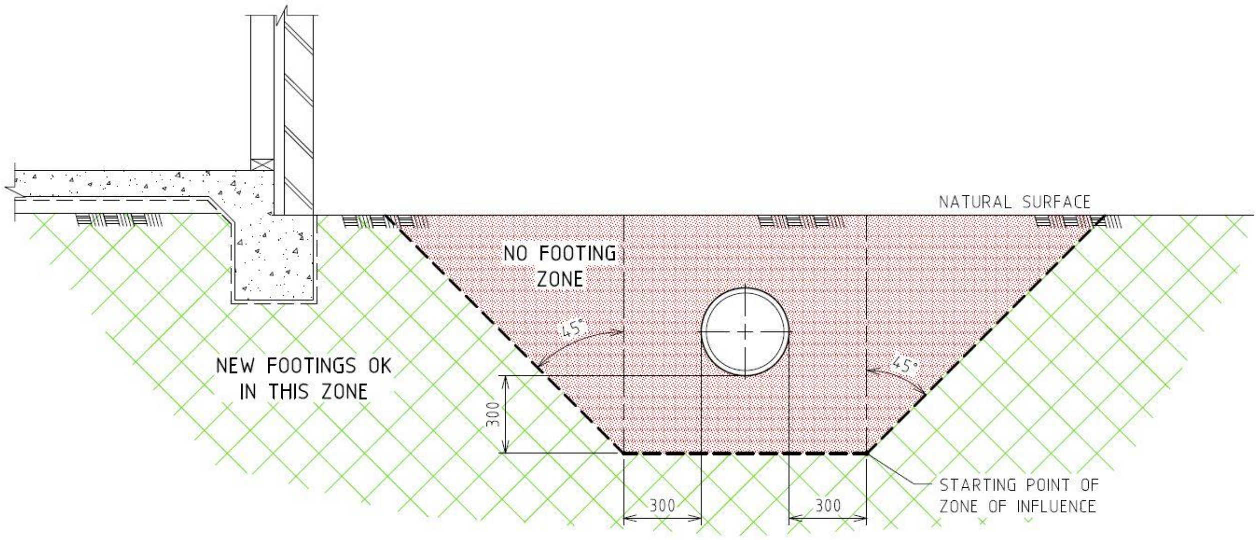


Figure 2.1 - Footing Zones

2.2 Roads Act (1993) approvals

2.2.1 Application

Most development requires a connection to the public drainage system at the street gutter or a stormwater pipe adjacent to the property. Any work carried out in a public road (for example, digging up the footway and laying pipes) requires the consent of the relevant roads authority under section 138 of the *Roads Act* 1993. In most cases the relevant roads authority is Council.

For minor works including driveway crossings, road restorations and stormwater pipes up to and including 150mm Diameter, Council issues “Road Opening Permits”. These are express approvals for the works and attract a minimal fee.

For major items over and above the scope of minor works, Council will issue a detailed approval under the Roads Act. Any major works will require detailed plans properly prepared by a Civil Engineer or Registered Surveyor and will attract the appropriate fees. Work as executed drawings will be required by Council at the conclusion of the works.

2.2.2 General

These approvals are separate to the development approval process and should be obtained:

- In the case of development that needs consent – prior to the issue of a Construction Certificate.
- In the case of complying development – prior to the issue of a Complying Development Certificate.

Note – Private certifiers cannot issue approvals under S138 of the *Roads Act 1993* for works in the public road reserve.

Applications for Opening Permits may be made to Council's Works Depot at Turton Road, Waratah on Ph. 4974 6000 between 7.30am and 3.30pm.

Applications for more major works may be made to Council's Development and Building Section at King Street, Newcastle on Ph. 4974 2030 between 8.30am and 5.00pm.

Part 3 Stormwater collection

Site drainage describes the acceptable methods and standards for the collection and the conveyance of stormwater through the site.

3.1 General requirements

3.1.1 Application

The site drainage system is the system that collects runoff from the place where rain falls and conveys it to the discharge point on the site. In most circumstances, there will be a site discharge control between the point of collection and the discharge point. The conveyance system to the site discharge controls should be designed in accordance with these standards.

3.1.2 Catchment

The catchment should be considered as the site plus all additional area that can generate surface water has the potential to cross over the boundary. All such water should be collected by the site drainage system and conveyed (via the site discharge controls if required) to the public drainage system. Water generated from outside the site should be considered in the application.

In addition, the development should not dam up water on the uphill side such that nuisance is created to the detriment of the uphill land occupier.

3.1.3 Capacity

Underground piped drainage, surface inlet pits, roof gutters and downpipes (the minor system) should be designed to cater for the 20 year ARI event without creating significant ponding or flows in trafficable areas.

There should be designed provision for overflows in extreme events (the major system) to convey stormwater to the discharge point of the site. In general, the design capacity of the major system should be the 100-year ARI event. In order that such flows do not present an unacceptable hazard, the depth-velocity product should be less than shown in equation 3.1, represented graphically in **Appendix 7**.

$$v \times d \leq 0.36 \text{ m}^2/\text{s}$$

where v = velocity
d = depth

Equation 3.1 – depth velocity hazard (derived from Keller and Mitsch 1992).

3.1.4 Upstream flows

Regardless of the drainage controls on the uphill property, the development site should be designed to cater for overflows and runoff from outside the site. Buildings, landscaping, fencing and site works should be designed to not impede the flow of upstream water to the detriment of any other property. Such water should be collected on site and conveyed to the public drainage system by a site system with adequate capacity in accordance with this standard.

3.1.5 Laneways

The conveyance of drainage off laneways is particularly important. Council does not guarantee that all water will be contained within laneways. It is the responsibility of the developer to ensure that excess water from laneways is adequately conveyed through the development site in accordance with the standards in this manual.

3.1.6 Pipe system requirements

Underground pipes for drainage inside the development site should meet the following criteria:

- Minimum internal diameter 90mm.
- For sites larger than 5,000m^2 or for pipes that are designed for more than 100 litres per second, the pipe systems should be designed by a consulting engineer using hydraulic grade line analysis.
- Longitudinal grades should be a minimum of 1% for pipe diameters up to 150mm and 0.5% for diameters of 225mm and larger.
- Pipe location, strength and other characteristics should be compatible with the proposed and possible future development.
- Surface inlet pits should meet the following criteria:
  - Pits should be provided at all changes in pipe direction exceeding 45 degrees, pipe junctions or property boundaries.
  - A minimum size 450mm square grated pit must be provided within the property at the road boundary prior to the nature strip or footway pipe crossing.
  - Pits should meet the dimensions shown in Table 3.1.
  - Step irons should be installed inside pits deeper than 1200mm.
  - Pit covers should be installed to provide access and to exclude litter where required. Covers should be removable, designed to appropriate loadings and constructed from galvanised steel, cast iron, concrete or infill cast iron.
  - Where pits are located in concrete driveway structures or other surfaces subject to heavy loading, pits should be constructed from concrete and suitably steel reinforced.

Table 3.1: Minimum pit dimensions

Minimum Pit Dimensions	
Depth (mm)	Dimension (mm^2)
< 300	300 x 300
300 - 600	450 x 450
600 - 900	600 x 600
900 - 1200	600 x 900
> 1200	900 x 900

Roof box gutters should be designed in accordance with AS3500.3.2-1998 – National Plumbing and Drainage.

Underground pipes underneath buildings are only permitted in the following circumstances:

- where there is no practicable alternative and pipes cannot be routed around the building
- where the number of pipes underneath the building is minimised as much as practicable
- where piping underneath buildings is straight with no bends or junctions
- inspection openings must be provided at all points of entry and exit under the building.

3.2 Litter

3.2.1 Application

All development sites with the exception of residential developments up to and including four dwellings should provide litter control in line with the site drainage scheme (refer Figure 3.1). Litter has the potential to block site discharge controls, rendering them ineffective. It is considered that small residential developments are less likely to be generators of large amounts of litter because of the owners' relationship with the property.

Litter should be directly filtered from stormwater using some form of screen or centrifugal action or both. There are a variety of litter traps available on the open market that will satisfy Council's criteria and selection will depend on available space and maintenance issues.

Figure 3.1 - Gross Pollutant Trap

3.2.2 Requirements

In general, Council's requirement is that all litter greater than 5mm is separated and removed from stormwater. Litter should not be stored in a wet vault type trap as these can have a propensity to further break down and cause eutrophication problems downstream.

3.2.3 Hydraulic performance

Litter traps should be designed to filter stormwater within the constraints of the site drainage system. Even when full, they should not cause the system to surcharge (overflow) in the design 5% AEP event.

3.2.4 Maintenance and cleaning

Adequate access needs to be provided for maintenance. This includes an all weather hard stand access for truck or backhoe if necessary. Step irons should be provided in pits that are intended for access and are deeper than 1.2m.

Litter traps should be inspected and cleaned on a regular basis. The final cleaning frequency will depend on the capacity of the trap, and the amount of litter generated by the development.

Part 4a Site discharge controls – small scale development (less than 5,000m^2)

Site discharge controls are designed to limit the number of runoff events and to lower the impacts of runoff events that do occur. The collected water is released back into the catchment or is disposed of in some other manner. The discharge rate is between 2mm per day and 2mm per hour.

All site discharge controls reduce the "directly connected impervious area" of the site and buffer the most frequent rainfall events. They also have the effect of reducing the total runoff from developed areas such that downstream drainage systems do not feel the effect of upstream developments. Figure 4.1 shows the changes in catchment hydrology associated with a natural (pre-development) and developed (post development) catchment. Best practice stormwater management is used to return the discharge to a natural flow.

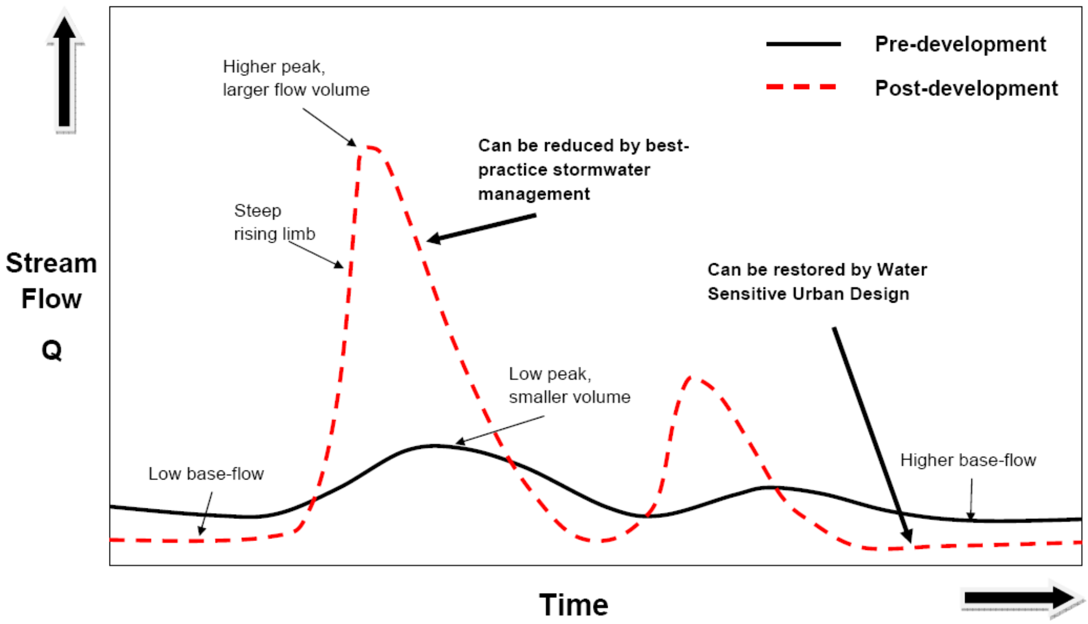


Figure 4.1 - Typical storm flow hydrograph pre and post development (after Wong et al 2011).

The site discharge controls are sized according to the volume of storage required; refer to DCP 7.06 for details of the storage requirements. Selection of the appropriate device is a matter of choice for the applicant and will depend on the site constraints including aesthetics, serviceability and geotechnical issues.

For subdivision of land involving site discharge controls and structures, the type of subdivision available depends on the location and type of device. Torrens Title lots must have individual systems. Strata Title or Community Title subdivision is required for shared systems with the system being located in the common property. This is generally only a consideration when subdividing urban housing and dual occupancy development.

The permitted site discharge and site storage provisions given in this section are deemed to satisfy Council's requirements for developments up to 5,000m^2 (as defined by the legal property description). For developments larger than this it will be necessary to undertake a more rigorous hydrologic and hydraulic assessment to demonstrate that the flooding and run off regime requirements are being satisfied. Please refer to Part 4b for further details on the requirements for large developments (ie. greater than 5,000m^2 as defined by the legal property description).

4.1 Rainwater tanks

4.2 Absorption trenches

4.3 On site retention (with sand filter)

4.4 Swales

4.5 Vegetated swales

4.6 Bioretention rain gardens

4.7 Bioretention swales

4.8 Porous paving

4.9 Sand filters within basins

4.10 Maintenance and signage

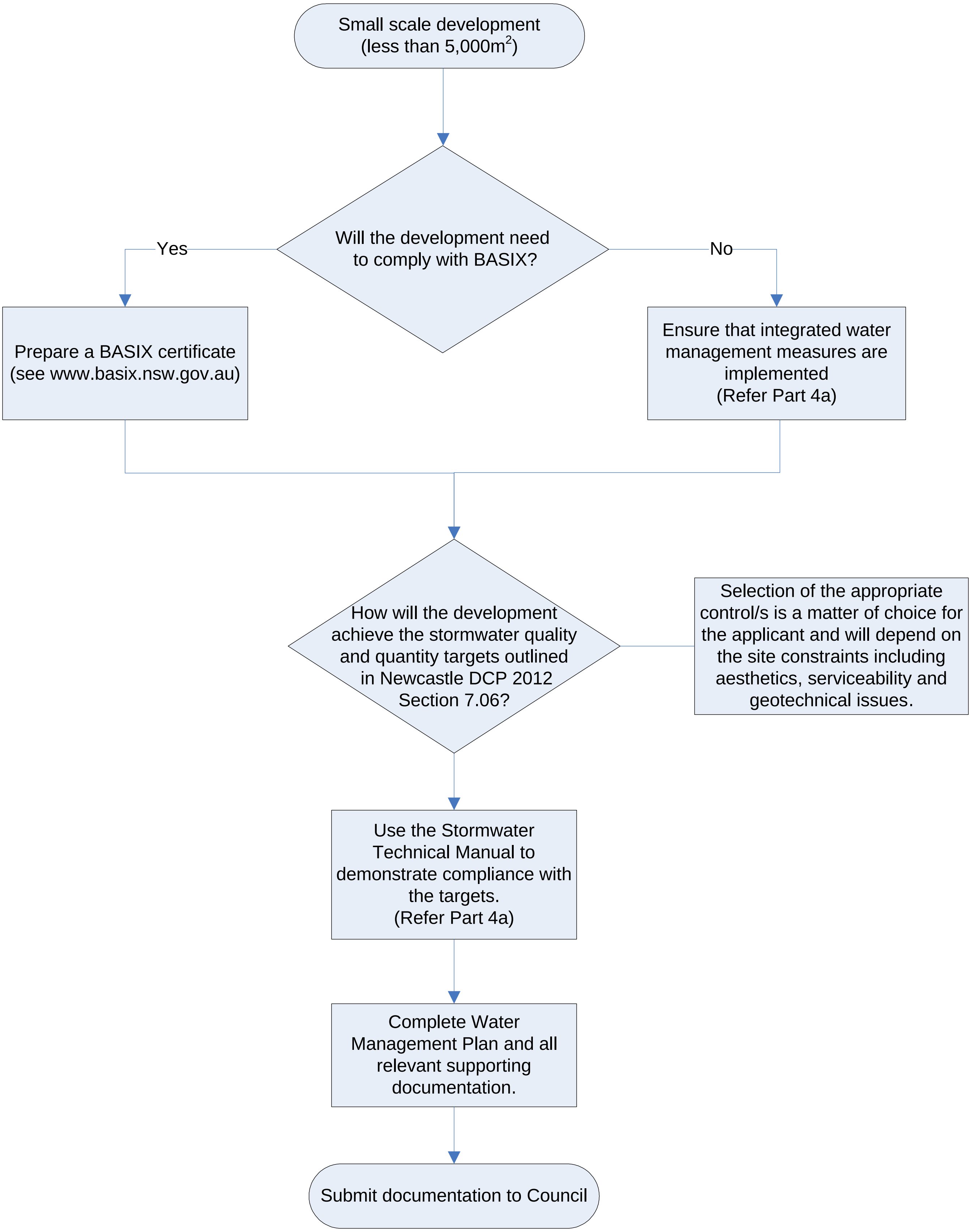


Figure 4.2 - Process flow chart – small scale development

4.1 Rainwater tanks

Rainwater tanks collect and store rainfall for later use. When designed appropriately, rainwater harvesting systems, such as tanks, slow and reduce runoff and provide a source of water for beneficial reuse within the development. These systems also help to reduce demands on increasingly limited water supplies.

4.1.1 Application

A rainwater tank is required in order to reduce mains water demand and to assist in minimising stormwater discharge from the site. They are to be implemented in accordance with the State Government BASIX requirement. In some cases a larger tank that will further reduce mains water demand, will be required. Overflows from the tank must be connected to other discharge controls, such as those outlined in this section of the technical manual (refer Figure 4.1.1).

NSW Health[1] advises that reticulated potable mains water remains the most reliable source of drinking water. However, other uses can be connected to rainwater tanks provided the home owner is aware of the issues involved and makes a conscious decision to utilise more rain water. More information on the health issues associated with rainwater tanks is available from NSW Health.

NOTE: Tanks with a capacity of less than 10,000 litres may be installed without consent of Council within the following parameters as per the State Environmental Planning Policy (Exempt and Complying Development codes) 2008. Refer to www.legislation.nsw.gov.au for the full suite of circumstances applicable for rainwater tanks to be exempt development.

4.1.2 Source of water

Rainwater can be collected from most types of rooves provided they have not been painted with lead based paints or coated with bitumen based materials. Lead flashing should be avoided.

Roof material manufacturers can provide more information on the suitability of their products for collection of rainwater.

All tanks must be fitted with a first flush device to prevent contaminates fouling water and to prolong the life of the tank.

4.1.3 Size of tank

A rainwater tank with a minimum capacity of 4,000 litres per dwelling is required. In some cases a larger tank that will further reduce mains water demand, will be required. Rainwater tanks come in many shapes and sizes and can be located above or below ground. There are also various options for re-use of the stored water, being indoor, outdoor or both. Table 4.1 gives the volume of rainfall that can be buffered depending on the size of dwelling and the services that are connected. Tanks should have an additional capacity of 10% to allow for peak demand during top up. Further additional capacity delivers a lower dependence on mains water for the connected uses and is encouraged.

[1] Visit www.health.nsw.gov.au and search for “tanks” or go to www.health.nsw.gov.au/pubs/2007/rainwater_tanks.html or Contact the NSW Department of Health for a brochure on rainwater tanks.

Table 4.1: Volume that can be disposed through connected uses

	Rural dwelling rainwater tank sole water supply				Urban dwelling reticulated water supply			
	Annual internal use in kilolitres (kL/yr/dwelling)							
No. of bedrooms[1]	**1 to 2**	**3**	**4**	**5**	**1 to 2**	**3**	**4**	**5**
Toilet (25%)	31	44	57	71	46	66	86	106
Toilet + laundry (50%)	60	88	115	142	91	131	172	212
Toilet + laundry + hot water (90%)	110	159	206	256	164	237	309	384
Toilet + laundry + hot water + other (100%)	122	175	230	283	183	263	343	424
	Daily internal use in kilolitres (kL/day/dwelling)							
No. of bedrooms[1]	**1**	**2**	**3**	**4**	**1 to 2**	**3**	**4**	**5**
Toilet (25%)	0.085	0.120	0.155	0.195	0.125	0.180	0.235	0.290
Toilet + laundry (50%)	0.165	0.240	0.315	0.390	0.250	0.360	0.470	0.580
Toilet + laundry + hot water (90%)	0.300	0.435	0.565	0.700	0.450	0.650	0.845	1.045
Toilet + laundry + hot water + other (100%)	0.335	0.480	0.630	0.775	0.500	0.720	0.940	1.160
	External and commercial / industrial use							
External residential use eg gardens	For a typical urban lot - 0.15 kL/day/dwelling or 55 kL/yr/dwelling							
Commercial / Industrial Use	Indicative 0.1 kL/day/1000 m^2 of roof area (internal use) & 20 kL/yr/1000 m^2 (external use) - Development-specific data may provide better reuse values							

Note 1 - Assume 3 bedrooms for subdivision cases where actual bedrooms are unknown

Source: Using MUSIC in Sydney's drinking water catchment, Sydney Catchment Authority 2012

The toilet cisterns and the washing machine tap should be connected to the tank using a separate reticulation system to that delivering the mains water. An external hose cock should also be connected to the tank. While garden irrigation is a significant benefit to the householder in owning a rainwater tank, there are few benefits to stormwater management due to the intermittent nature of garden watering (especially during rain).

All roof areas for proposed new works are to be connected to the rainwater tank.

Rainwater tanks are not required for additions to existing houses, however, where tanks are provided; the volume of the tank can be used to offset any additional discharge control storage that may be required.

For commercial and industrial developments rainwater tanks should be sized to allow for a 4 day period to fill the tank and a 20 day draw down period. Rainfall data should be sourced from the Bureau of Meteorology and based on Mean Annual Rainfall. For developments less than 5,000m^2 of land title area, generally a 5,000 litre rainwater tank per 5 staff would meet reuse requirements. For larger developments, a more rigorous analysis of rainwater reuse and rainwater tank sizing may need to be undertaken.

4.1.4 Mains backup

In order to ensure supply to the connected uses, there should be a float valve or solenoid connected to mains supply to maintain a minimum of 10% tank capacity. Other methods of ensuring supply are acceptable provided they meet Hunter Water Corporation approval.

Mains backup generally requires interconnection with Hunter Water Corporation mains and accordingly, must be installed by a licensed plumber to the relevant Australian Standards and Hunter Water Corporation’s requirements. Where top up is used, the valve should be set to open at 5% and to close of at 10% of the tank capacity.

4.1.5 Back flow prevention

AS3500 and Hunter Water Corporation specify certain backflow prevention methods in order to ensure protection of the mains water supply. Please check with Hunter Water Corporation in regard to the interconnection issues.

4.1.6 Location of tanks

Tanks can be located above ground or below ground. The design of tanks should take into account aesthetic and open space considerations. In general, best results will be achieved where tanks are an integral designed component of the building, rather than as an additional feature at the end of the design stage.

4.1.7 Pumps

A demand pump will generally be required to supply tank water to the internal plumbing fixtures. Where external pumps are fitted, they should be housed in a sound proof housing designed for easy maintenance. Noise emitted from the pump should not exceed 5dB(A) above the ambient background noise level when measured at any property boundary. Pumps may be located internally in order to meet the noise criteria.

In some cases, it may be possible to integrate the tank into the design of the building, so that it gravity feeds to its intended uses and not require a further energy source for pumping.

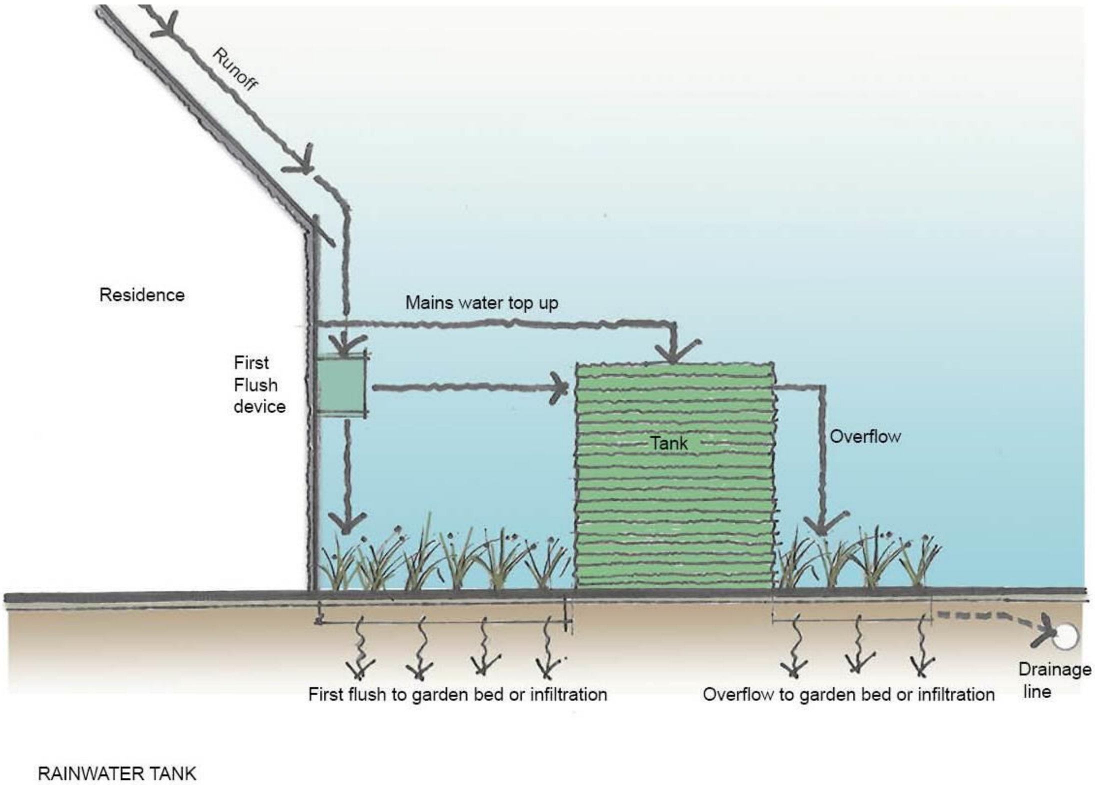
4.1.8 Overflows

An overflow drain should be installed to the tank and connected directly to the conventional drainage system. Overflows should not be allowed to drip onto the ground at the site of the tank.

4.1.9 Materials

Tanks should be of a prefabricated form in a robust material designed for the storage of water. The tank should be able to withstand the effects of weathering and where appropriate, ground chemical attack.

Figure 4.1.1 - Rainwater tank – one form of configuration.



4.1.10 Maintenance and cleaning

First flush devices and inlets should be cleaned regularly. Tanks may accumulate sediment from time to time and this will need to be removed periodically in order to keep the water clear. Tanks should be inspected for sludge every 2-3 years. If sludge is present, it may be removed by siphoning the bottom of the tank and disposing the water to garden or sewer. For further maintenance guidance refer to the references below.

Tanks should be fitted with appropriate mosquito proof mesh screens.

4.1.11 Further information

Further information on rainwater tanks can be found at:

- Australian Government, enHealth Council (2004). *Guidance on the use of rainwater tanks* www.health.gov.au/internet/main/publishing.nsf/Content/ohp-enhealth-raintank-cnt.htm
- Australian Standard 3500: 2003, 'Plumbing and Drainage', Standards Australia.
- Hunter and Central Coast Regional Environmental Management Strategy (2012) *How to maintain your rainwater tank - video and guides* see website http://www.hccrems.com.au/environmental-education/
- Hunter and Central Coast Regional Environmental Management Strategy (2013). *Water Smart Practice Note 4: Rainwater Tanks* website www.hccrems.com.au/product/water-smart-model-planning-provisions-and-practice-note-series-2012-kit/
- Hunter Water Corporation website www.hunterwater.com.au/Save-Water/Rainwater-tanks/Rainwater-Tanks.aspx

4.2 Absorption trenches

4.2.1 Application

Absorption trenches can be used to buffer the initial volume of rain falling on impervious areas of the site. Drainage from roof areas, driveways, parking and any other hard surfaces can be controlled. They are not intended to dispose of all stormwater and provision will need to be made for overflows. They differ from infiltration pits in that the rate of dispersal from absorption trenches is not capable of disposing of all peak rainfall events.

Absorption trenches will inject significant quantities of water into the ground, which may affect other properties due to changes in groundwater movements. Absorption trenches should only be used following appropriate geotechnical engineering advice where that advice shows the capacity for the soils to discharge water without detrimental effect to other properties. Likely issues include landslip potential, downstream seepage problems, structural footing damage due to reactive clay soils and salinity.

4.2.2 Overflow from rainwater tanks

Where the roof area of a proposed development is larger than the maximum roof area that can be directed to a rainwater tank, the difference in area can be treated in an absorption trench.

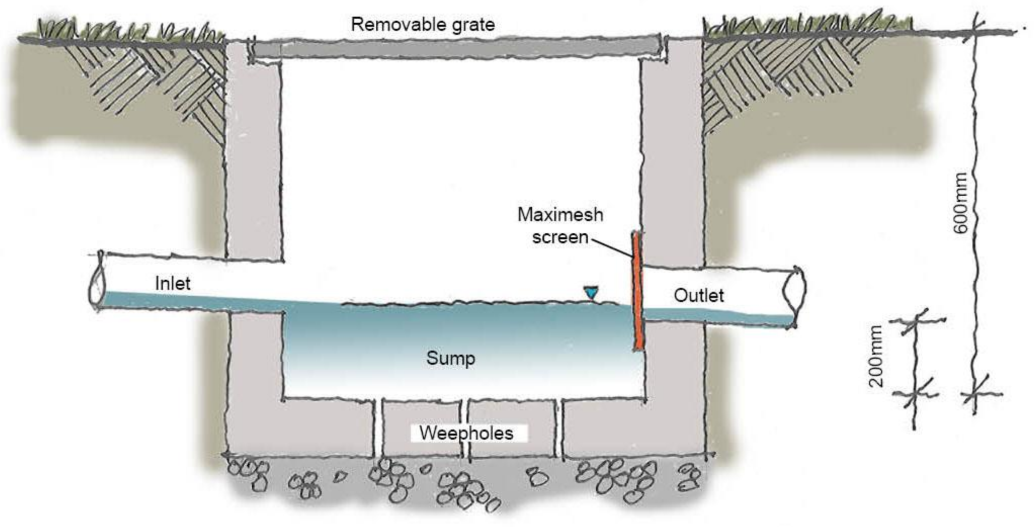
4.2.3 Volume

The trench should have a minimum void volume equal to the volume of storage required.

4.2.4 Pre-treatment

Absorption trenches are susceptible to blockages from fine sediments, litter and leaves. Any water originating from ground surfaces should be pre-treated in a sediment pit as shown in Figure 4.2.2. Grates should be provided across all inlet pits to ensure litter and leaves do not enter the system.

An appropriate screen should be placed across the outlet to the sediment pit to ensure no litter or leaves enter the absorption trench. Refer to Figure 4.2.2.



SUMP

Figure 4.2.2 - Sample sediment trap detail

4.2.5 Location of trenches

Absorption trenches should be located clear of any building footings, retaining walls and side property boundaries by a minimum of 4m. This may be reduced to 2m in sandy soils or less on favourable advice of a practicing geotechnical engineer. They should be installed across the contour of the land. Trenches may be installed under garden beds, lawns and courtyards. Attention may need to be given to the overflow drainage on the top surface of trenches, particularly in courtyard type areas to prevent the surface from becoming boggy. They are to be located in an area that it can be maintained or replaced, if needed. These are not to be located under driveways or parking areas.

In installations where the location of the entry pipe to the absorption trench will create a sealed air void, an air vent with an appropriate cover is to be provided.

A surface inlet pit is to be located at the pipe entry to the absorption trench.

A front boundary setback of 1.5m applies from the edge of the trench to the front boundary. The location of the absorption trench should not saturate services trenching located in the footpath area or saturate the verge area.

Trenches should not be located in rocky ground or on rock outcrops; they are generally not suitable in areas of slope of greater than 17% (10 degrees). Further advice on the location of trenches should be gained from a qualified professional geotechnical engineer.

4.2.6 Overflows

An overflow drain should be installed to the trench and connected directly to the conventional drainage system.

4.2.7 Materials

Efficient voids can be formed using proprietary products. These should be wrapped in permeable geofabric. Trenches may be filled with sand or double washed gravel provided that the fill material is the same size (road base or other graded material is not acceptable) and wrapped in a permeable geofabric. Filled trenches require a minimum volume of three times the volume required. Trenches in courtyard, lawn and garden areas should be covered with a 300mm thick layer of topsoil.

4.2.8 Maintenance and cleaning

Once established, access to absorption trenches is usually limited. This makes the provision of pre-treatment sediment pits essential. Sediment traps should be inspected and cleaned out on a regular basis, at least once per year.

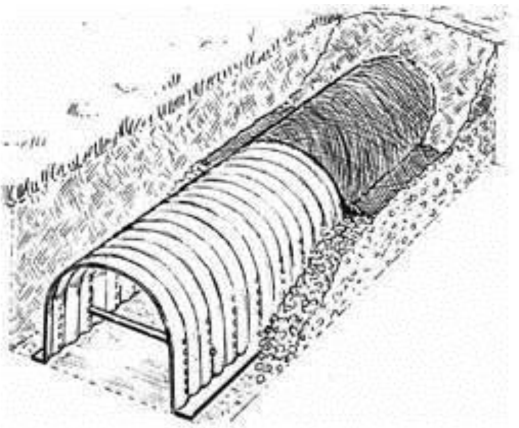


Figure 4.2.3 - Efficient void formation

4.3 On site retention (with sand filter)

4.3.1 Application

On site retention (OSR) is similar to on site detention, except that the permissible outflow rate is substantially reduced. In order to compensate for this, storage is marginally increased over previous on site detention policies. On site retention by itself has no pollutant trapping capacity; however, the low outfall rates lend themselves to filtering through a small sand filter in order to polish the discharge and greatly assist in meeting Council's site discharge water quality targets. In order to keep sand filters to a manageable size, the outfall rates have been reduced to give a total draw down time of 96 hours (4 days). A typical on site retention arrangement is presented in Figure 4.3.1.

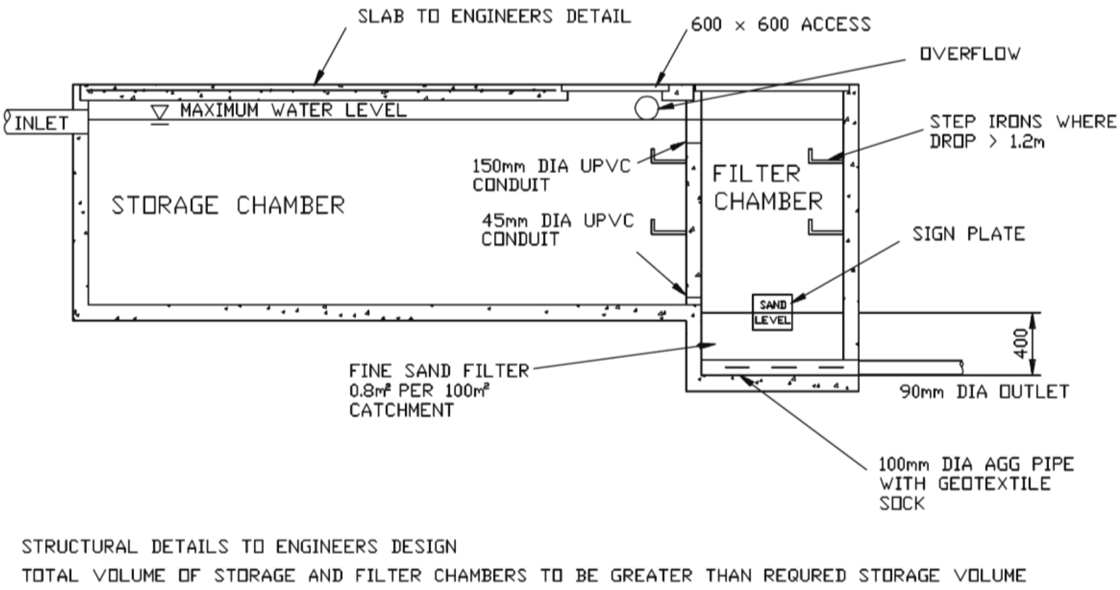


Figure 4.3.1 - On site retention with sand filter - typical arrangement

4.3.2 Permissible site discharge

In order to sufficiently polish the discharge rate from an on site retention system in the Newcastle LGA should be less than 7.2×10^{-3} litres per second per 100m^2 of contributing catchment. This can be achieved by using the sand filter as the flow control.

4.3.3 Site storage requirement

The on site retention system should have a volumetric capacity of more than the volume of storage requirement. The sand filter shall be sized based on 0.8m^2 per 100m^2 of contributing catchment.

4.3.4 Sediment control

The inherent stilling properties of on site retention systems mean that most suspended sediments are likely to drop out prior to discharge. For that reason, they should be designed with appropriate provision for flushing and cleaning. Where no such provision is made, a sediment trap as shown below should be provided upstream of the OSR system. Refer to Figure 4.3.2.

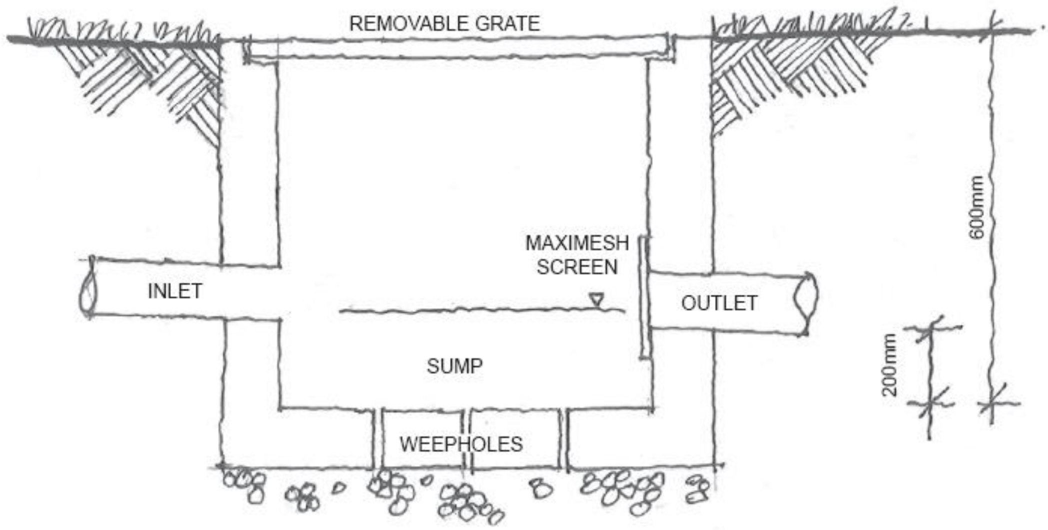


Figure 4.3.2 - Pre-treatment sediment trap detail

4.3.5 Location of storage

Due to the very low outfall rates, the on site retention system will fill to capacity at regular intervals. The draw down time will also be long (in the order of 4 days). It is therefore not acceptable to store the water in areas that are commonly used such as driveways, car parking areas and courtyards.

On site retention may be provided in underground tanks. These can be located under buildings, driveways, courtyards or any location within the development site subject to other constraints being met and adequate structural details provided. Any system using a ‘milk crate’ type chamber is to be located in an area that can be maintained, these are not to be located under driveways or parking areas.

4.3.6 Overflows

An overflow drain should be installed to the on site retention tank and connected directly to the conventional drainage system. The overflow drain should not be smaller than the drains leading into the system.

4.3.7 Materials

Where underground tanks are used they should be constructed of materials resistant to ground chemical attack, including low pH conditions.

The filter media is to be clean loamy sand in accordance with the *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC)..

4.3.8 Sand level plate

A durable sign, made from etched brass and similar to the detail shown in Figure 4.3.3 should be installed on the inside wall of the sand filter to indicate its intended purpose and to mark the level to which sand should be placed.

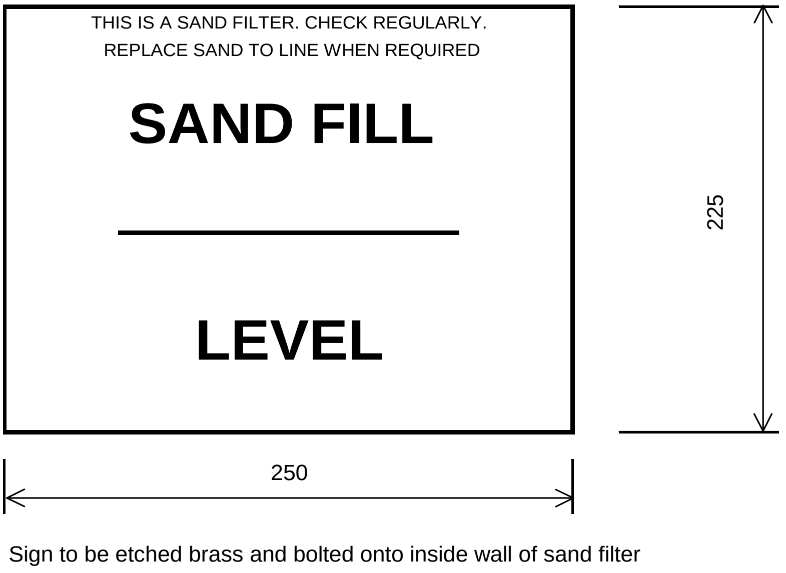


Figure 4.3.3 - Typical sand level plate detail

4.3.9 Maintenance and cleaning

Where sediment pits are provided upstream of on site retention systems, they should be inspected and cleaned out on a regular basis, at least once per year.

Maintaining the flow through a sand filter relies on regular inspection and removal of the top layer of accumulated sediment. Inspections should be conducted after the first few significant rainfall events following installation and then at least every six months following. The inspections will help to determine the long term cleaning frequency for the sedimentation chamber and the surface of the sand media.

Removing fine sediment from the surface of the sand media can typically be performed with a flat bottomed shovel or vacuum machinery. Tilling below this surface layer can also maintain infiltration rates. Access is required to the complete surface area of the sand filter and this shall be considered during design.

Sediment accumulation in the sedimentation chamber needs to be monitored. Depending on catchment activities (eg. building phase), sediment deposition can overwhelm the chamber, increase blinding of the device and reduce flow capacities.

Debris removal is an ongoing maintenance function. If not removed, debris can block inlets or outlets, and be unsightly if located in a visible location. Inspection and removal of debris / litter should be carried out regularly.

A Maintenance Manual for the sand filter is to be provided. The Manual is to address maintenance issues concerning the sand filter including routine monitoring and maintenance. Periodic monitoring and maintenance is to ensure the system functions as designed and meets water quality targets over the life cycle of the device.

4.4 Swales

4.4.1 Application

Swales are designed as temporary holding areas in landscaped garden beds and lawn areas. They allow rainfall to infiltrate into the soil. Swales can also be used to convey runoff to a destination.

4.4.2 Volume

Swales should be designed to retain at least the required volume of storage. The contributing catchment must include the area of the swale itself and any non-impervious areas that drain to it.

4.4.3 Dimensions

Swale dimensions can vary from site to site. The sample in this manual can be applied directly to a site; however applicants can vary the design to suit their circumstances provided that the basic volume objectives are met.

The sample swale shown on this page (Figure 4.4.1), when laid at a 1% grade and with 150mm high check dams at 15m spacings has a volume of 2.3m^3 per 15m segment.

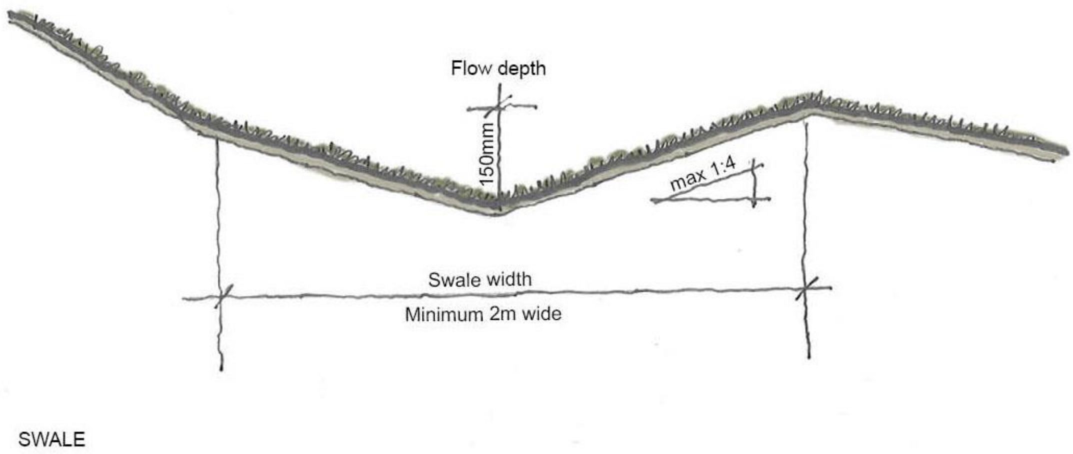


Figure 4.4.1- Sample swale dimensions

4.4.4 Slope

Swales should be constructed near parallel to the contour. The longitudinal slope of the swale should be 1% or should fall 10mm for every metre of run.

4.4.5 Check dams

Check dams should be installed across the swale at regular intervals to increase the storage capacity. The height of the dams should be such that the base of the dam is level with the crest of the next downhill dam (refer Figure 4.4.2). This will depend on the dam spacing and the bed slope of the swale.

Raised driveways as per Figure 4.4.3 may also be used as check dams.

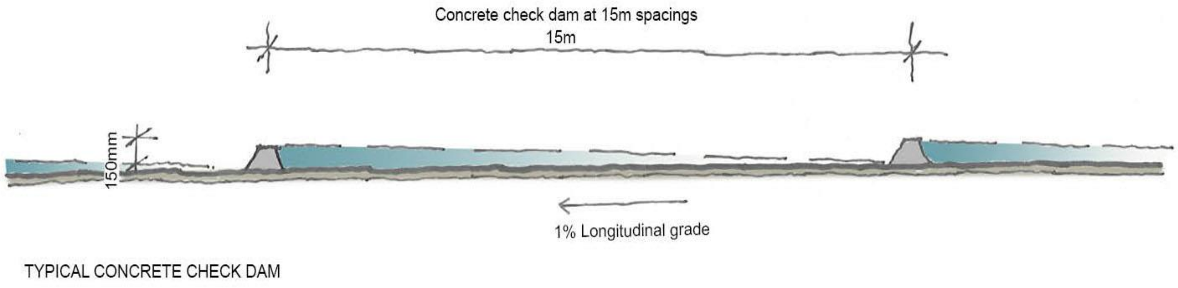


Figure 4.4.2 - Longitudinal arrangement using concrete check dams

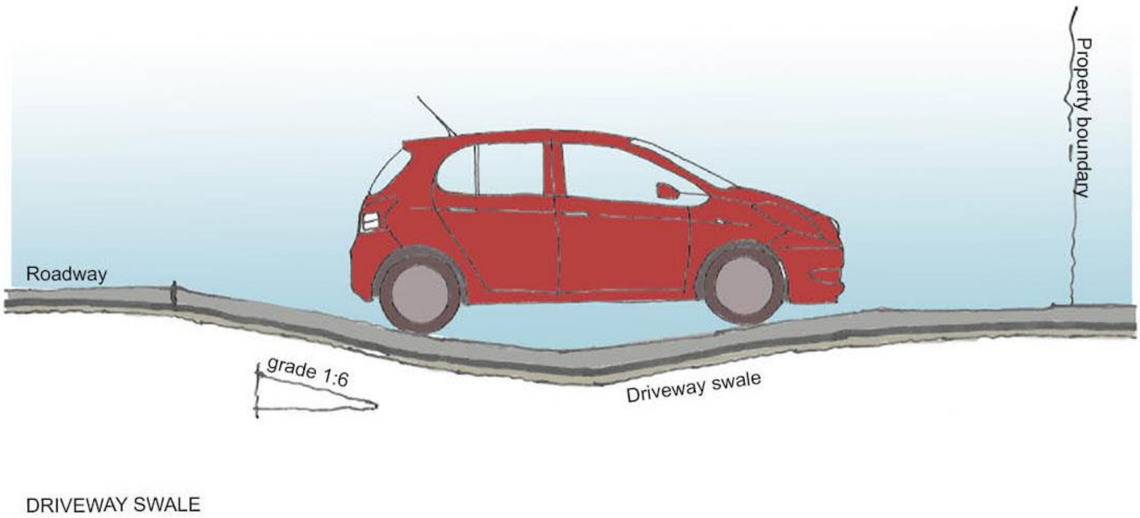


Figure 4.4.3 - Swale with driveway crossing

4.4.6 Overflows

The downstream end of the swale should end in a check dam. Overflows will cascade from one dam to the next. The final dam should be positioned to overflow to Council's drainage system or the interallotment drainage system as appropriate.

4.4.7 Materials

Swales should be excavated into the topsoil and turfed. Check dams can be formed from rock, concrete, garden edging or treated timber sleepers (refer Figure 4.4.2). Care should be taken during installation that swales are easily maintainable.

4.4.8 Maintenance

Turf swales should be designed to ensure access for maintenance equipment, such as mowers.

4.4.9 Further information

For further information on swales please refer to the following best practice guidelines:

- Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (South East Queensland Healthy Waterways Partnership, 2006) http://hlw.org.au/resources/documentsSection references:
  - 2.2. Design considerations for swales
  - 2.2.1 Landscape design
  - 2.2.3 Vegetation types
  - 2.4 Landscape design notes
- Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands Version 1.1 (South East Queensland Healthy Waterways Partnership, 2010) http://hlw.org.au/resources/documentsSection references:
  - 2.5 Landscape considerations and specifications

4.5 Vegetated swales

4.5.1 Application

Vegetated swales are similar to swales and can be used instead of pipes to convey stormwater and provide a 'buffer' between the impervious areas of a development and the receiving water. The key difference is that a vegetated swale may be used for steeper slopes with a maximum longitudinal grade of 4%. The interaction with vegetation facilitates an even distribution and slowing of flow, thus encouraging pollutant settlement and retention in the vegetation. A typical swale cross section is shown in Figure 4.5.1.

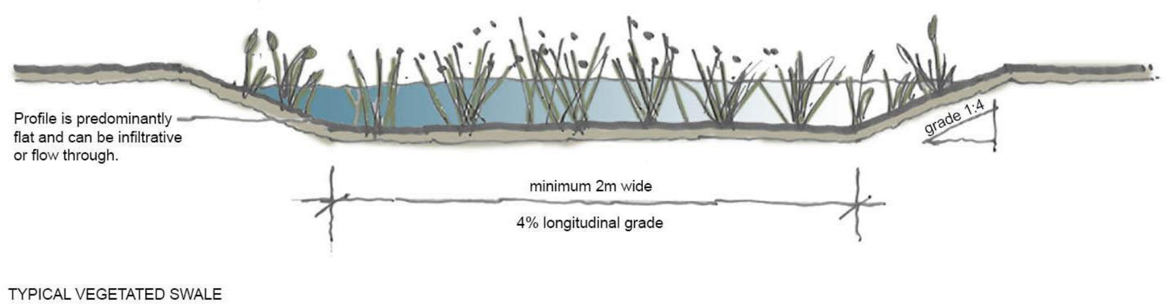


Figure 4.5.1 - Typical vegetated swale

4.5.2 Council's minimum requirements for vegetated swales

The minimum standards for vegetated swales are as follows:

- vegetated swales shall be sized according to the method in section 7.06 of the DCP
- the desirable maximum longitudinal grade of the swale is 4%
- the minimum longitudinal grade of the swale is 1%
- for longitudinal grades steeper than 4%, check dams (minimum 100mm high) are to be placed at regular intervals along the invert of the swale. The spacing of the check dams will depend on the grade of the swale (refer to Figure 4.4.2)
- swales can use a variety of vegetation including sedges and tufted grasses covering the whole width of the swale

- swales located within footpaths (ie. road verges) must consider the standard location for services within the verge and ensure access for maintenance of services
- velocities of flows within the swale component for both minor (2-10 year ARI) and major (50-100 year ARI) rainfall events are to be kept preferably below 0.5m/s and not more than 2.0m/s (for major flooding) to avoid scouring of the swale
- depth x velocity products shall not exceed 0.36m^2/s for all flows
- the extended detention depth above the base of the swale shall not exceed 0.3m
- driveway crossings constructed within swales at grade (refer Figure 4.4.3) shall be constructed at 1(V):6(H) and comply with Council's driveway specification
- the maximum batter grade within the vegetated swale between roadways and the swale shall be 1(V):3(H) and the opposing side of the swale shall be 1(V):3(H)
- a concrete flush edge restraint 0.2m wide x 0.3m (min) deep shall be provided at the interface between the road pavement and the batter of the swale in areas adjoining roads (as per Figure 4.5.2). For concrete roads, the edge restraint shall be integrated into the concrete pavement. A 40mm drop down from the surface of the edge restraint to the top of the landscaping is to be provided to prevent material moving onto the road surface
- all hydro carbons are to be removed upstream of the vegetated swale by the use of grease traps, oil/water separators or similar devices
- all swales are to be designed so that they do not require fencing.

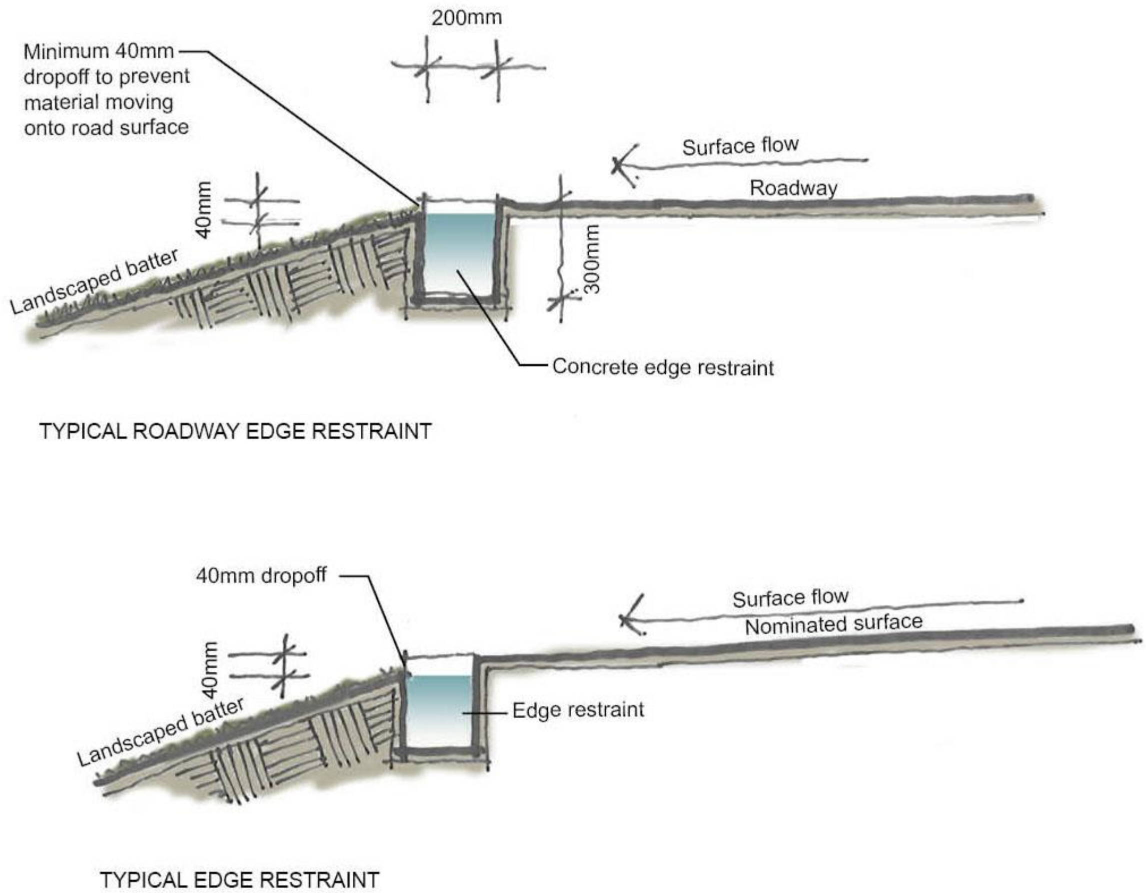


Figure 4.5.2 - Edge restraint

4.5.3 Water quality targets

The Water Quality Targets as described in Table 4: Section 7.06 'Controls', 6. (f) of Newcastle Development Control Plan 2012 are to be achieved post construction for the life of the device.

4.5.4 Public safety issues

The following is to be considered relating to public safety:

(a) maximum water depth shall be 0.3m in the 100 year ARI storm event

(b) maximum batter slopes should not exceed 1(V):3(H) or less

(c) swales should be designed so as not to require fencing

(d) the maximum velocity through the swale based on a 1 in 1 year storm should not exceed 0.3m/s

(e) surface water flowing in swales shall not impact upon road or footpath areas. Formalised discharge controls shall be provided to convey water under roads at areas such as road crossings and intersections

(f) appropriate hazard signage shall be provided where required

(g) swales shall be designed so that no ponding of water occurs on adjacent property or roads.

4.5.5 Further information

For further information on vegetated swales please refer to the following best practice guidelines:

- Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (South East Queensland Healthy Waterways Partnership, 2006)
- Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands Version 1.1 (South East Queensland Healthy Waterways Partnership, 2010) http://hlw.org.au/resources/documents

4.6 Bioretention rain gardens

4.6.1 Application

Rain gardens (also known as bioretention or bioinfiltration cells) are shallow, vegetated basins that collect and absorb runoff from impervious surfaces. Rain gardens mimic natural hydrology by infiltrating and evapotranspiring runoff. Rain gardens are versatile features that can be installed in almost any unpaved space.

Planter boxes are another form of urban rain gardens and they comprise vertical walls and open or closed bottoms that collect and absorb runoff from footpaths, parking lots, and streets. Planter boxes are ideal for space-limited sites in dense urban areas and as a streetscaping element.

Figure 4.6.1 - Bioretention rain garden

Table 4.7.1 shows the sizing scenarios that may be used to determine the size and location of a bioretention swale.

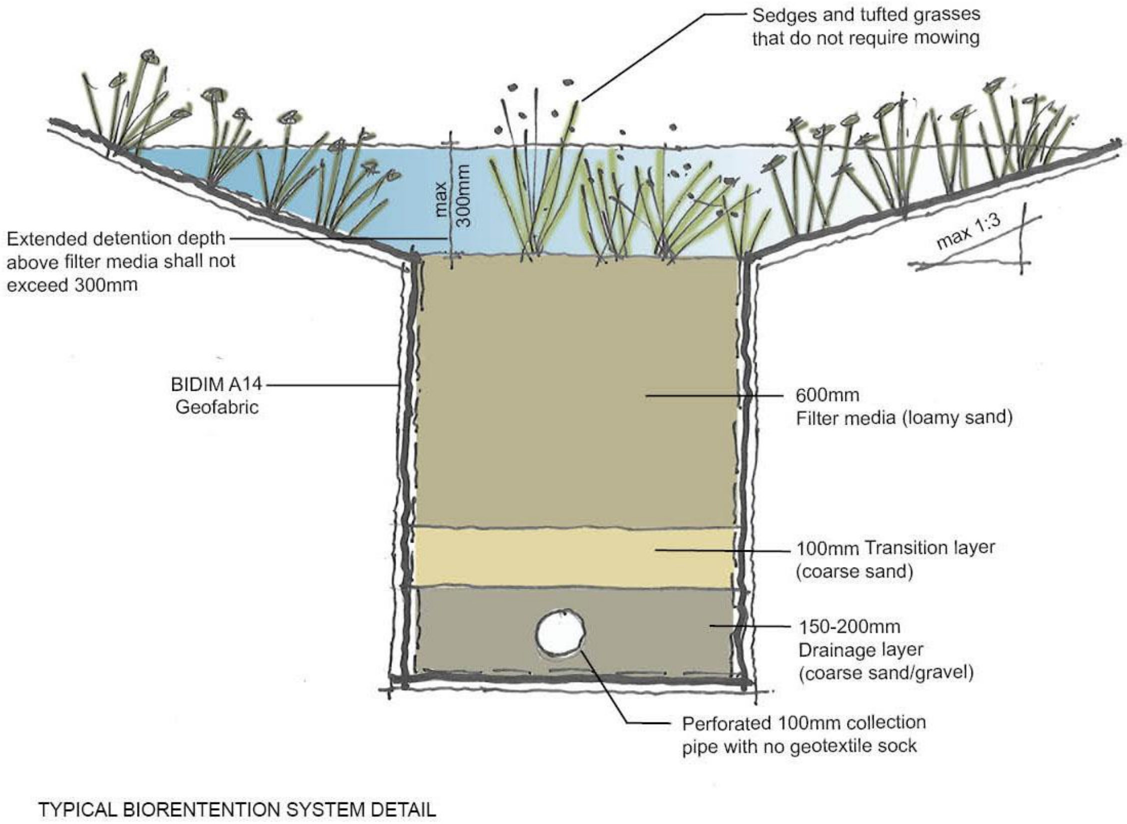
Table 4.7.1 - sizing scenarios to determine the size and location of bioretention swales

Scenario		Catchment	Extended Detention Depth (mm)	Filter Depth (mm)	Side batters
1	Shallow bioretention rain garden or swale	All of site drains to bioretention rain garden or swale	100	300*	Vertical
2	Standard bioretention rain garden or swale		200	600*	1 (V) : 3 (H)
3	Shallow or standard bioretention rain garden or swale	10% of residential lot bypasses bioretention rain garden or **catchment includes road or non-residential land uses**	As required to meet the constraints of the site		

4.6.2 Materials

A rain garden is a soil-based filter that consists of a specified loamy sand filter, with a gravel trench underneath that contains a slotted drain pipe (eg. pipe) that is connected to the drainage system. A typical system, looking through the side of the filter is shown below in Figure 4.6.2.

Rain gardens can be any shape to fit in with the remainder of the house and lot, as long as the area is consistent with the requirements set out in Table 4.6.2. For example, an 8m^2 system could be 4m long and 2m wide, or 8m long by 1m wide, or any other combination that gives the required size for the device relative to the site imperviousness.



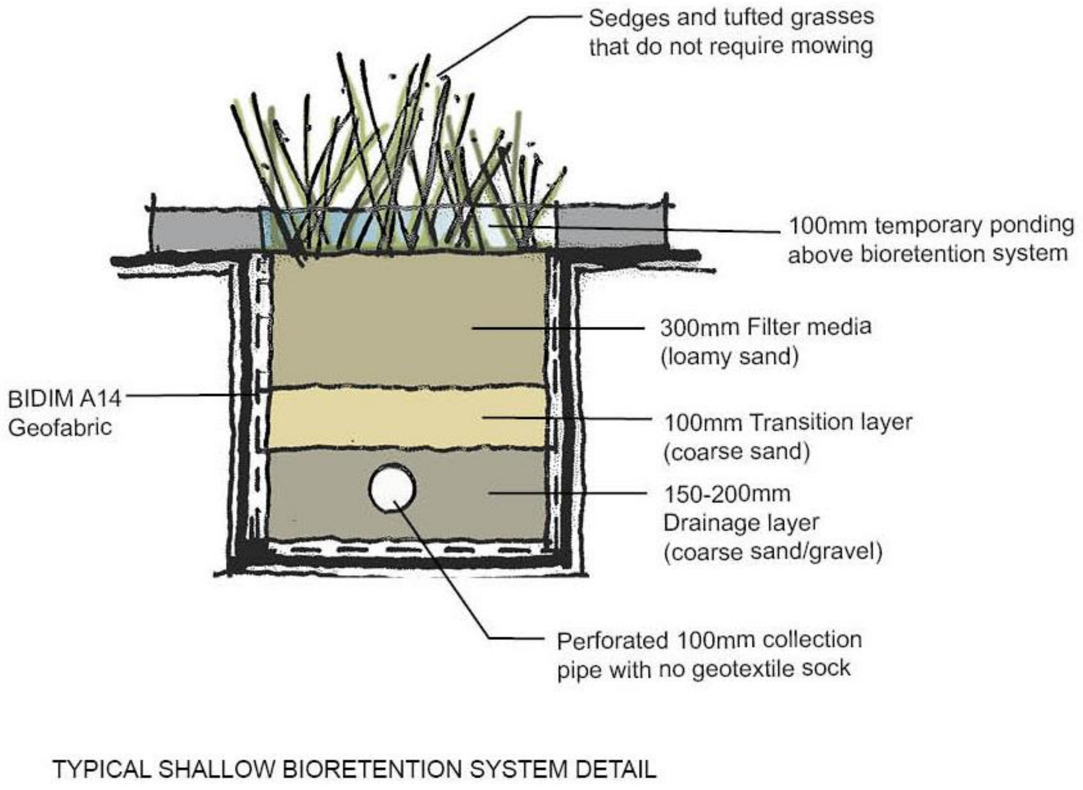


Figure 4.6.2 - Sample drawings of bioretention rain gardens

Table 4.6.2 - Rain garden area specifications

Site Imperviousness	Size of filter media footprint as a percentage of total site area excluding internal side batter slopes		
	1. Shallow	2. Standard	3. 10% of residential lot bypasses the rain garden or swale or catchment includes roads or non residential development
40%	0.7%	0.4%	1.0%
50%	0.7%	0.4%	1.0%
60%	0.7%	0.4%	1.0%
70%	0.8%	0.5%	1.1%
80%	1.0%	0.7%	1.3%
90%	1.2%	0.9%	1.5%

4.6.3 Location

In ground rain gardens should be set back from any boundary, building or other infrastructure by a minimum of 2m for sandy soils (sands, loamy sands, loams) and 4m for clay soils (clay loams, medium clays, heavy clays) to minimise any problems from infiltration (unless demonstrated by a practicing structural engineer or geotechnical engineer that there is no risk to current or future infrastructure).

Where rain gardens are within areas of shallow groundwater tables, all assets are to be lined to prevent contamination of local groundwater sources unless it can be demonstrated that unlined systems will sufficiently protect groundwater quality.

Where constructed in sand, rain gardens should have the sides lined to prevent exfiltration.

As outlined above, as much of the site as possible should drain to the rain garden, including the overflow from the rainwater tank, so the rain garden should be at the lowest point on the property. Allowance should be made to drain the system to the stormwater drainage system outside the property, so it may be necessary to seek advice from a hydraulic engineer or other professional to determine the best location for the rain garden.

In some circumstances, it may be necessary to raise the rain garden to achieve the desired outcomes and grade of the collection pipe to the site discharge pipe. An example of a raised rain garden is shown in Figure 4.6.3.

Figure 4.6.3 - Example of an above ground rain garden
(Source: Water Services Association of Australia)

4.6.4 Planting

Rain gardens should be densely planted with native species with high growth rates and dense root systems known to remove large amounts of nitrogen. For local plant selection and planting guidance please refer to Appendix 4.

4.6.5 Council's minimum requirements for rain gardens

The minimum standards for rain gardens are as follows:

- The finished surface of the bioretention filter media must be flat to ensure full engagement of the filter media by stormwater flows.
- The extended detention depth above the filter media shall not exceed 0.3m.
- Where possible, the overflow pit or bypass channel should be located near the inflow zone to prevent high flows passing over the filter media.
- Include a high flow bypass for major storms where flows should be directed around the raingarden to avoid scouring the vegetated surface. If the constraints of the location preclude the ability to by-pass high flows then design calculations shall be undertaken to meet the following velocity criteria.
- Velocities of flows within the rain water garden during both the minor (2-10 year ARI) and major (50-100 year ARI) rainfall events are to be kept preferably below 0.5m/s and not more than 1.5m/s (for major flooding) to avoid scouring of the device.
- All inlet and outlet structures are to be designed to avoid blockages and ensure flow conveyance.
- An impermeable liner to the bioretention filter is to be provided in areas where the saturated hydraulic conductivity of the bioretention filter media is less than 10 times that of the native surrounding soils.
- The preferred vegetation for the bioretention component of bioretention trench is sedges and tufted grasses that do not require mowing.

- The base and walls of the filter media is to be lined with BIDIM A14 Geofabric.
- The volume of stormwater for treatment shall be sized according to the method in section 7.06 of the DCP.
- The filter media is to be clean loamy sand in accordance with the *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).
- In accordance with FAWB, for biofiltration systems in a temperate climate the prescribed hydraulic conductivity will generally be between 100 – 300mm/hr in order to meet best practise water quality targets. In order to ensure that the system functions adequately at its eventual hydraulic conductivity, a safety factor of 2 should be used, ie. designs should be modelled using half the prescribed hydraulic conductivity. Any variation from these standards is to be supported by comprehensive laboratory testing.
- The transition layer is to consist of coarse sand 0.1m in depth.
- The drainage layer is to be 0.15-0.2m in depth. Drainage material is to be clean, fine gravel, such as 2-5mm washed screenings.
- A network of 100mm subsoil pipes will be provided over the base of the filter, have flush out surface points with concrete surrounds and caps and be connected to a receiving pit.
- The maximum batter grade within the rain garden is to be 1(V):3(H).
- All Batters are to be constructed to reduce scouring and fully landscaped.
- Rain gardens are to be designed so that they do not require fencing.
- Online upstream Gross Pollutant Traps are to be provided where appropriate. For example, downstream of commercial or industrial developments.
- A 40mm drop down from the surface of the edge of the rain water garden to the top of the select landscaping is to be provided to prevent material moving onto the adjoining surface.
- Where required, an overflow weir is to be provided with a minimum freeboard of 0.1m to the inlet of the receiving pit.
- All hydro carbons are to be removed upstream of the bioretention rain garden by the use of grease traps, oil/water separators or similar devices.
- Where required, a trafficable access is to be provided to the rain garden to council's standards for maintenance purposes.
- Off street parking bay for the Council Maintenance Truck is to be provided within 1m horizontal distance and 2m vertical distance from the GPT, diversion pit and sediment bays to facilitate cleaning of these devices.

4.6.6 Maintenance

A Maintenance Manual for the rain water garden is to be provided. The Manual is to address maintenance issues concerning the rain water garden including routine monitoring and maintenance. Periodic monitoring and maintenance is to ensure the system functions as designed and meets water quality targets over the life cycle of the device.

4.6.7 Water quality targets

The Water Quality Targets as described in Table 4: Section 7.06 'Controls', 6. (f) of Newcastle Development Control Plan 2012 are to be achieved post construction for the life of the device.

4.6.8 Public safety issues

Design is to consider the following aspects relating to public safety:

(a) Maximum water depth shall be 0.4m in the 100 year ARI storm event.

(b) The rain garden should have batter slopes of 1(V):3(H) or less.

(c) The rain garden should be designed so as not to require fencing.

(d) The maximum velocity through the pond based on a 1 in 1 year storm should not exceed 0.3m/s.

(e) A minimum freeboard of 0.1m should be provided between a restricted discharge outlet for the ponding area and a storm overflow weir. This discharge outlet should be designed so that the weir overtops on average not more than four times per year.

(f) All inlet outlet structures are to be designed to avoid blockages and ensure flow conveyance.

(g) Appropriate hazard signage shall be provided for the rain garden and weir spillway if required.

(h) Protection of the receiving pit shall be provided to prevent blockage and to prevent the risk of people being trapped.

(i) Rain gardens shall be designed so that no ponding of water occurs on to adjacent property or roads.

4.6.9 Further information

For further information on rain gardens please refer to the following best practice guidelines:

- Bioretention Technical Design Guidelines, Healthy Waterways Ltd, 2014. http://hlw.org.au/resources/documents
- Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (South East Queensland Healthy Waterways Partnership, 2006) http://waterbydesign.com.au/techguide/
  Section references:
  - 5.4 Landscape design notes
- Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands Version 1.1 (South East Queensland Healthy Waterways Partnership, 2010) http://waterbydesign.com.au/ceguide/
  Section references:
  - 3.1 Bioretention systems
  - 3.6 Landscape considerations and specifications
  - 3.9.3 Landscape establishment
- Guidelines for filter media in stormwater biofiltration systems, Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).

4.7 Bioretention swales

4.7.1 Application

Bioretention swales are shallow, vegetated basins that collect and absorb runoff from impervious surfaces. Bioretention systems filter stormwater runoff through a vegetated soil media layer. The treated stormwater is collected at the base of the system via perforated pipes, from where it flows to downstream waterways, constructed drainage or storages for reuse. Bioretention swales are very similar to rain gardens.

Table 4.7.1 shows the sizing scenarios that may be used to determine the size and location of a bioretention swale.

Table 4.7.1 - Bioretention swale scenarios

Scenario		Catchment	Extended Detention Depth (mm)	Filter Depth (mm)	Side batters
1	Shallow bioretention rain garden or swale	All of site drains to bioretention rain garden or swale	100	300*	Vertical
2	Standard bioretention rain garden or swale		200	600*	1 (V) : 3 (H)
3	Shallow or standard bioretention rain garden or swale	10% of residential lot bypasses bioretention rain garden or **catchment includes road or non-residential land uses**	As required to meet the constraints of the site		

4.7.2 Materials

A bioretention swale is a soil-based filter, that consists of a specified loamy sand filter, with a gravel trench underneath that contains a slotted drain pipe (ag pipe) that is connected to the drainage system. Bioretention swales must be sized in a manner that is consistent with the requirements set out in Table 4.7.2.

A typical system, looking through the side of the filter is shown below in Figure 4.7.2.

Table 4.7.2 - Bioretention filter media area specification

Site Imperviousness	Size of filter media footprint as a percentage of total site area excluding internal side batter slopes		
	1. Shallow	2. Standard	3. 10% of residential lot bypasses the rain garden or swale or catchment includes roads or non residential development
40%	0.7%	0.4%	1.0%
50%	0.7%	0.4%	1.0%
60%	0.7%	0.4%	1.0%
70%	0.8%	0.5%	1.1%
80%	1.0%	0.7%	1.3%
90%	1.2%	0.9%	1.5%

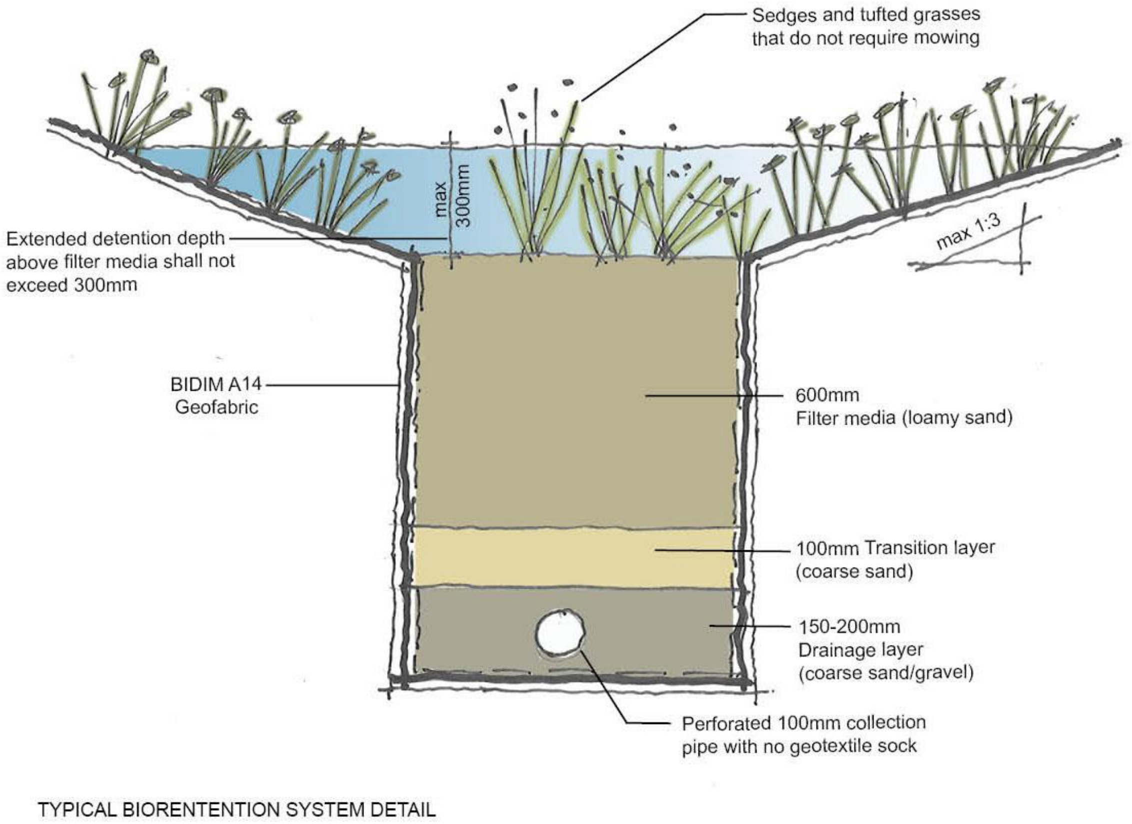


Figure 4.7.2 - Typical bioretention swale cross section for a standard bioretention swale

4.7.3 Location

Bioretention swales should be set back from any boundary, building or other infrastructure by a minimum of 2m for sandy soils (sands, loamy sands, loams) and 4m for clay soils (clay loams, medium clays, heavy clays) to minimise any problems from infiltration (unless demonstrated by a practicing structural engineer or geotechnical engineer that there is no risk to current or future infrastructure).

Where located within areas of shallow groundwater tables, all assets are to be lined to prevent contamination of local groundwater sources unless it can be demonstrated that unlined systems will sufficiently protect groundwater quality.

Where constructed in sand, bioretention swales should have the sides lined to prevent exfiltration.

As outlined above, as much of the site as possible should drain to the device, including the overflow from the rainwater tank, so the device should be at the lowest point on the property. Allowance also has to be made to drain the system to the stormwater drainage system outside the property, so it may be necessary to seek advice from a hydraulic engineer or other professional to determine the best location.

4.7.4 Planting

Bioretention swales should be densely planted with native species with high growth rates and dense root systems known to remove large amounts of nitrogen. For local plant selection and planting guidance please refer to Appendix 4.

4.7.5 Council's minimum requirements for bioretention swales

The minimum standards for bioretention swales are as follows:

- The desirable maximum longitudinal grade of the swale is 4% and bioretention should be constructed in a flat section of the swale, preferably in the most downstream extent.
- An impermeable liner to the bioretention filter is to be provided in areas where the saturated hydraulic conductivity of the bioretention filter media is less than 10 times that of the native surrounding soils.
- The preferred vegetation for the bioretention component of bioretention trench is sedges and tufted grasses (with potential occasional tree plantings) that do not require mowing.
- Bioretention trenches located within footpaths (ie. road verges) must consider the standard location for services within the verge and ensure access for maintenance of services.
- Velocities of flows within the swale component for both minor (2-10 year ARI) and major (50-100 year ARI) rainfall events are to be kept preferably below 0.5m/s and not more than 2.0m/s (for major flooding) to avoid scouring of the swale.
- The extended detention depth above the filter media shall not exceed 0.3m.
- The depth of the filter media is to be 0.6m.
- The bioretention filter media is to be clean loamy sand in accordance with the *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).
- In accordance with FAWB, for biofiltration systems in a temperate climate the prescribed hydraulic conductivity will generally be between 100 – 300mm/hr in order to meet best practise water quality targets. In order to ensure that the system functions adequately at its eventual hydraulic conductivity, a safety factor of 2 should be used, ie. designs should be modelled using half the prescribed hydraulic conductivity. Any variation from these standards is to be supported by comprehensive laboratory testing.
- The transition layer is to consist of coarse sand 0.1 in depth.
- The drainage layer is to be 0.15-0.2m in depth and consist of clean, fine gravel, such as 2-5mm washed screenings.
- The total depth of the filter media, transition layer and drainage layer shall be 1.0m in accordance with the *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).
- A 100mm diameter slotted agricultural pipe is to be installed at the base of the drainage layer. Inspection opening / cleanouts with inspection caps are to be provided at 30m centers and at the upstream terminal point of the pipe. The outlet end of the pipe is to be connected to a drainage pit or outlet structure.
- The trench is to be underlain by geotextile on sides and base and lapped to new surface by a minimum of 300mm with BIDIM A14 Geofabric.
- The maximum batter grades within the swale shall be 1(V):3(H) and vegetated with native vegetation.
- Depth x velocity products shall not exceed $0.36m^2/s$ for all flows.

- A concrete flush edge restraint 0.2m wide x 0.3m (min) deep shall be provided at the interface between the road pavement and the batter of the trench in areas adjoining roads (refer Figure 4.5.2). For concrete roads, the edge restraint shall be integrated into the concrete pavement. A 40mm drop down from the surface of the edge restraint to the top of the select landscaping is to be provided to prevent material moving onto the road surface.
- All hydro carbons are to be removed upstream of the bioretention swale by the use of grease traps, oil/water separators or similar devices.
- All bioretention devices are to be designed so that they do not require fencing.
- A driveway crossing constructed within bioretention swales at grade (refer Figure 4.4.3) shall be constructed at 1(V):6(H) and comply with Council's driveway specification.

4.7.6 Maintenance

A Maintenance Manual for the bioretention device is to be provided. The Manual is to address maintenance issues concerning the bioretention device including routine monitoring and maintenance. Periodic monitoring and maintenance is to ensure the system functions as designed and meets water quality targets over the life cycle of the device.

4.7.7 Water quality targets

The Water Quality Targets as described in Table 4: Section 7.06 'Controls', 6. (f) of Newcastle Development Control Plan 2012 are to be achieved post construction for the life of the device.

4.7.8 Public safety issues

The following is to be considered relating to public safety:

(a) maximum water depth shall be 0.3 m in the 100 year ARI storm event

(b) maximum batter slopes should not exceed of 1(V):3(H) or less

(c) trenches should be designed so as not to require fencing

(d) the maximum velocity through the pond based on a 1 in 1 year storm should not exceed 0.3m/s

(e) surface water flowing in bioretention trenches shall not impact upon road or footpath areas. Formalised discharge controls shall be provided to convey water under roads at areas such as road crossings and intersections

(f) appropriate hazard signage shall be provided where required

(g) bioretention trenches shall be designed so that no ponding of water occurs on to adjacent property or roads.

4.7.9 Further information

For further information on bioretention swales please refer to the following best practice guidelines:

- Bioretention Technical Design Guidelines, Healthy Waterways Ltd, 2014. http://hlw.org.au/resources/documents
- Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (South East Queensland Healthy Waterways Partnership, 2006)http://hlw.org.au/resources/documents Section references:
  - 5.4 Landscape design notes

- Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands Version 1.1 (South East Queensland Healthy Waterways Partnership, 2010) http://waterbydesign.com.au/ceguide/

  Section references:
  - 3.1 Bioretention systems
  - 3.6 Landscape considerations and specifications
  - 3.9.3 Landscape establishment
- *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).

4.8 Porous paving

4.8.1 Application

Porous paving and permeable pavements are an alternative to traditional impervious hard surfaces, such as driveways, roads, car parks and footpaths. Porous paving is not in itself a site discharge control because it does not treat runoff from another surface. They can be used to reduce the overall impervious surface that is directly connected to the constructed drainage system. It is not necessary to treat runoff from a porous paving system through site discharge controls.

4.8.2 Materials

There are a range of porous paving products on the market. In order that they can be considered for use on a development site, the selected paving must be capable of: Dispersing vertical load to the subgrade without excessive deflection or damaging the subgrade or pavement itself. In general, porous paving will not be suitable for high traffic areas including public road surface.

Retaining the volume requirement (mm) of rainfall without expunging runoff. This will mean a typical thickness of about three times the volume requirement.

Figure 4.8.1 - Porous paving (Bruce Street, Newcastle)

4.8.3 Slope

Porous paving is not suitable for slopes in excess of 5% (ie. 50mm fall per metre of run).

The porous paving area is to drain surface water in all events such that the time of infiltration of the stormwater to the drainage layer shall not lead to excessive retention of surface water.

4.8.4 Overflows

It will be necessary to drain the surface of any porous paving system in a conventional manner. Overflows from porous paving can be connected directly to Council's drainage system.

4.8.5 Under pavement drainage

All porous paving areas are to be provided with an under drainage cell system to the full extent of the paving (refer to Figure 4.8.2). The under drainage system shall be connected to the sites discharge controls, with the site discharge controls further connecting to Council's drainage system.

Typically, porous paving shall consist of a porous paving layer, a minimum 100mm thick pervious bedding layer and a under drainage system. The under drainage system shall be fully lined and over lapped with pervious geofabric.

The subgrade of the porous paving area shall be compacted with regard to the proposed vertical loading of the area.

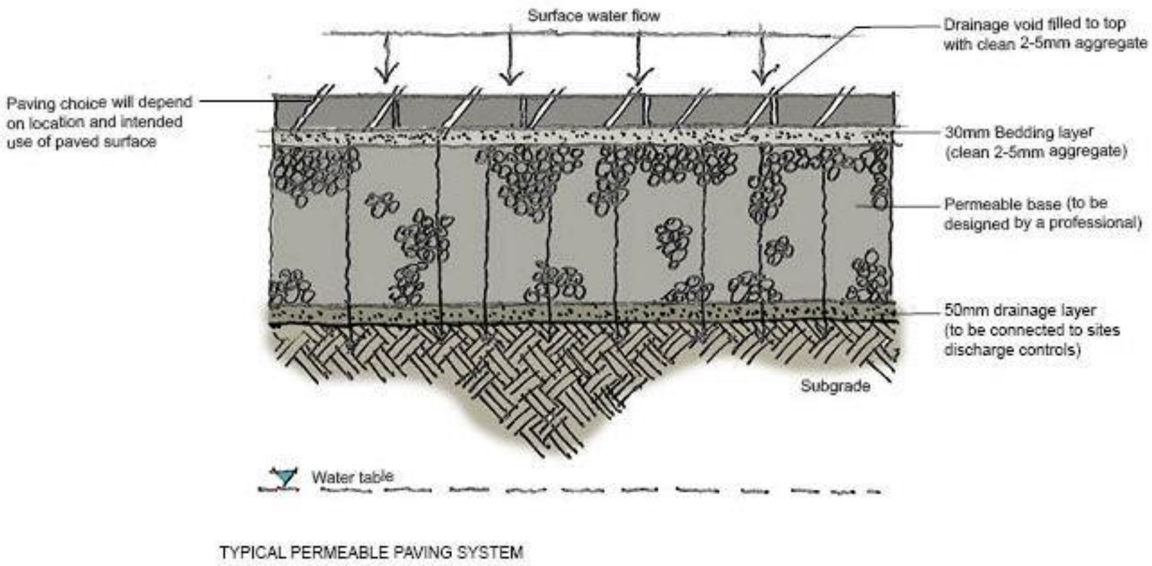


Figure 4.8.2 - Preferred configuration for paving

4.8.6 Maintenance

A Maintenance Manual for the porous paving is to be provided. The Manual is to address maintenance issues concerning the paving including routine monitoring, cleaning and maintenance. The pores of the system can become blocked or blinded reducing its ability to transfer water through the system. Periodic monitoring and maintenance is to ensure the system functions as designed and meets water quality targets over the life cycle of the device.

4.9 Sand filters within basins

4.9.1 Application

Sand filters operate in a similar manner to bioretention systems, with the exception that stormwater passes through a filter media (typically sand) that has no vegetation growing on the surface. Sand filters do not incorporate vegetation because the filter media does not retain sufficient moisture to support plant growth and they are often installed underground (therefore light limits plant growth). The absence of vegetation and the associated biologically active soil layer typically created around the root zone of vegetation planted in bioretention systems, means sand filters have a reduced stormwater treatment performance compared to bioretention systems.

Sand filters should only be considered where site conditions, such as space or drainage grades, limit the use of bioretention systems. This is most likely related to retrofit situations where the surrounding urban environment is already developed. Treatment can then be achieved underground with sand filters, in areas such as high density developments with little or no landscape areas. Their lack of vegetation requires more regular maintenance than bioretention systems to ensure the surface of the sand filter media remains porous and does not become clogged with accumulated sediments. This typically involves regular inspections and routine removal of fine sediments that have formed a ‘crust’ on the sand filter surface.

Prior to entering a sand filter, flows must be subjected to pretreatment to remove litter, debris and coarse sediments. Following pre-treatment, flows are spread over the sand filtration media and water percolates downwards and is intercepted by perforated pipes located at the base of the sand media. The perforated pipes collect treated water for conveyance downstream. During higher flows, water can pond on the surface of the sand filter increasing the volume of water that can be treated. Very high flows are diverted around sand filters to protect the sand media from scour.

Figure 4.9.1 - Sand filter within basin

4.9.2 Council's minimum requirements

The minimum standards for sand filters within basins are as follows:

- the sand filter shall be sized based on $0.8m^3$ per $100m^2$ contributing catchment
- the time of mean filtration shall be 24 hours and no longer than 48 hours
- the desirable water storage depth of the basin is to be 0.5m
- the minimum depth of the filter media in the filter is to be 0.4m

  the filter media is to be clean loamy sand in accordance with the *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).. In a temperate climate the prescribed hydraulic conductivity will generally be between 100 – 300mm/hr in order to meet best practise water quality targets. In order to ensure that the system functions adequately at its eventual hydraulic conductivity, a safety factor of 2 should be used, ie. designs should be modelled using half the prescribed hydraulic conductivity. Any variation from these standards is to be supported by comprehensive laboratory testing
- the maximum batter grade within the basin is to be 1(V):6(H) (if turfed).
- batters are to be constructed to reduce scouring and preferably landscaped
- the sand filter and associated detention basin is to be designed so that the basin does not require fencing
- an online upstream Gross Pollutant Trap is to be provided
- a concrete level spreader with letter box dispersion and energy reduction devices are to be supplied at the pipe outlet to the basin. The width of the level spreader is to be 10 x the diameter of the outlet pipe and at least 5m in length. A gabion mattress is to adjoin the level spreader device to prevent scouring of the area

- a settlement basin is to be provided to receive the stormwater from the level spreader and is to be constructed at the basin depth. The settlement basin is to be constructed out of concrete
- a network of 100mm subsoil pipes located within a drainage layer minimum of 150 - 200mm thick, will be provided over the base of the filter, have flush out surface points with concrete surrounds and caps and be connected to a receiving pit
- an overflow weir is to be provided with a minimum freeboard of 0.1m to the inlet of the receiving pit
- a trafficable access is to be provided to the detention basin, settlement area and sand filter to council's standards
- off street parking bay for the Council Maintenance Truck is to be provided within 1m horizontal distance and 2m vertical distance from the GPT, diversion pit and sediment bays to facilitate cleaning of these devices.

4.9.3 Maintenance

Maintaining the flow through a sand filter relies on regular inspection and removal of the top layer of accumulated sediment. Inspections should be conducted after the first few significant rainfall events following installation and then at least every six months following. The inspections will help to determine the long term cleaning frequency for the sedimentation chamber and the surface of the sand media.

Removing fine sediment from the surface of the sand media can typically be performed with a flat bottomed shovel or vacuum machinery. Tilling below this surface layer can also maintain infiltration rates. Access is required to the complete surface area of the sand filter and this shall be considered during design.

Sediment accumulation in the sedimentation chamber needs to be monitored. Depending on catchment activities (eg. building phase), sediment deposition can overwhelm the chamber, increase blinding of the device and reduce flow capacities.

Debris removal is an ongoing maintenance function. If not removed, debris can block inlets or outlets, and be unsightly if located in a visible location. Inspection and removal of debris / litter should be carried out regularly.

A Maintenance Manual for the sand filter is to be provided. The Manual is to address maintenance issues concerning the sand filter including routine monitoring and maintenance. Periodic monitoring and maintenance is to ensure the system functions as designed and meets water quality targets over the life cycle of the device.

4.9.4 Water quality targets

The Water Quality Targets as described in Table 4: Section 7.06 'Controls', 6. (f) of Newcastle Development Control Plan 2012 are to be achieved post construction for the life of the device.

4.9.5 Public safety issues

Basin design is to consider the following aspects relating to public safety.

(a) The basins should have batter slopes of 1(V):6(H) or less

(b) The basin should be designed so as not to require fencing

(c) The maximum velocity through the pond based on a 1 in 1 year storm should not exceed 0.3m/s

(d) Freeboard of 0.1m should be provided between a restricted discharge outlet for the pond and an overflow weir. Width of weir is to be designed so flows over the weir comply with a vd≤0.36m2/s (in accordance with Section 3.1.3 of the Technical Manual) and a depth of no greater than 0.3m

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

(f) Where necessary, depth indicators shall be provided indicating maximum depth in the basin and spillway

(g) Where necessary, appropriate hazard signage shall be provided for the basin and spillway

(h) Protection of the receiving pit 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

(j) No basin shall be located upstream of an urban area.

4.9.6 Further information

For further information on sand filters within basins please refer to the following best practice guidelines:

Guidelines for filter media in stormwater biofiltration systems, Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).

4.10 Maintenance and signage

4.10.1 Marker plates – all on-site storage systems

Each on-site stormwater detention systems shall be indicated on site by fixing a marker plate or sign in a prominent position. This plate is to be of minimum size 150mm x 100mm and is to be made from non-corrosive metal or 4mm thick laminated plastic. It is to be fixed to the nearest concrete or permanent surface or erected on a galvanised iron pole and footing in a prominent position. The wording on the marker plate is to be:

THIS IS AN
ON-SITE STORMWATER STORAGE SYSTEM

REQUIRED BY THE CITY OF NEWCASTLE

IT IS AN OFFENCE TO REDUCE THE VOLUME OF THE TANK OR BASIN OR TO INTERFERE WITH THE ORIFICE THAT CONTROLS THE OUTFLOW.

THE BASE OF THE OUTLET CONTROL PIT AND THE DEBRIS SCREEN MUST BE CLEANED OF DEBRIS AND SEDIMENT ON A REGULAR BASIS BY THE OWNER

THIS PLATE MUST NOT BE REMOVED

Figure 4.10.1 - Proposed wording for marker plate

Part 4b Site Discharge Controls – large scale development (greater than 5,000m^2)

This section of the technical manual assists with all development applications where the area identified by the legal property description is greater than 5,000m^2 lodged with The City of Newcastle within all development zones within the Newcastle LGA.

4.11 Applicability

In accordance with the size threshold identified in DCP 7.06, proposed development cannot be broken into stages so that each stage is less than 5,000m^2, the proposed treatments are required to address the entire development when fully operational.

This section will provide an outline of the requirements that relate to large developments in accordance with the controls established through DCP 7.06. This section will not provide additional commentary or details on the site discharge controls detailed in Part 4a of this manual.

Specifically, these requirements include the following:

- It will be necessary to undertake a more rigorous hydrologic and hydraulic assessment to demonstrate that the flooding and run off regime requirements and hydrology objectives for those catchments draining to coastal wetlands identified in the DCP are being satisfied.
- It will also be necessary to undertake a more rigorous modelling assessment to demonstrate that the pollutant reduction targets identified in the DCP will be met using a MUSIC link model.

Refer to Appendix 9 for a map showing relevant catchment areas relating to MUSIC link nodes and the coastal wetland catchment.

4.12 Specialist advice

Applicants will need to have regard to the size and complexity of the proposed development when selecting specialist consultants. For large scale developments a justified WSUD strategy and appropriate development application documentation will be required and should be prepared by appropriately qualified and experienced practitioners.

For any development where infrastructure is proposed to be constructed and later contributed to Council, applicants are encouraged to discuss development proposals with Council's Development Assessment staff through a pre-lodgement meeting.

Applicants and developers are encouraged to employ the services of appropriately qualified and experienced practitioners, for example stormwater/environmental engineer or hydrologist for the development of appropriate WSUD plans and strategies. The involvement of consultants with demonstrated capacity to fulfil the requirements of Council's DCP will generally contribute to a smoother and more straightforward approval and consultation process.

Prior to commencing planning for a large development please consider the need to contact Council. Council will be able to provide examples of acceptable stormwater management strategies and development application documentation relating to the project, including WSUD elements.

4.13 Process flow chart

4.13.1 How to apply this section of the technical manual in relation to the DCP

Figure 4.b.1 shows how to apply this section of the technical manual in relation to the DCP and the relevant best practice guidelines.

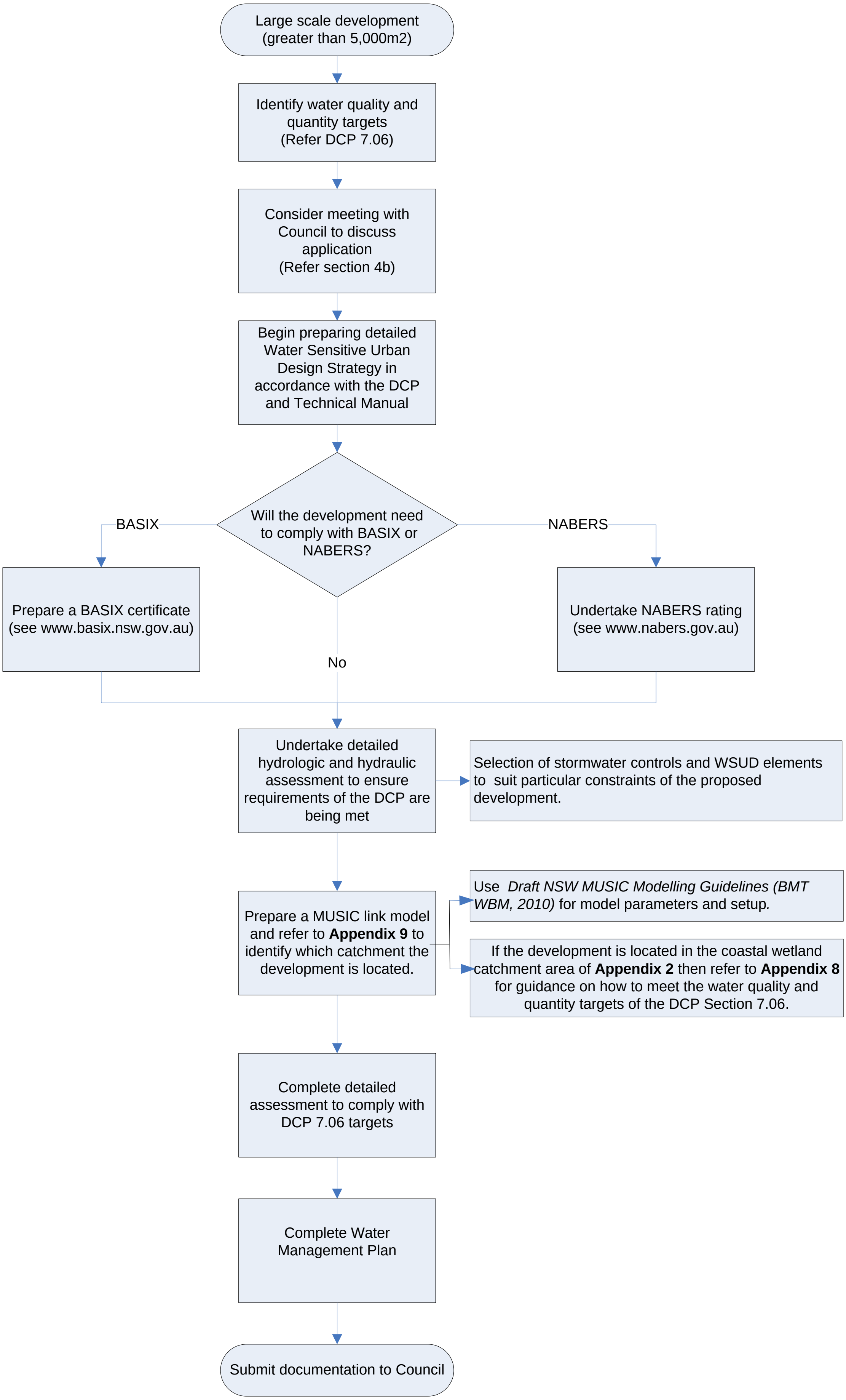


Figure 4.b.1 - Process flow chart for large development

4.14 Stormwater targets

4.14.1 DCP 7.06 Stormwater quality and quantity targets

The City of Newcastle's stormwater pollution reduction and stormwater quantity targets have been established through DCP 7.06 (refer to Table 3 in DCP 7.06). For large development, these targets can be met through stormwater treatment systems, such as bioretention systems, swales and wetlands, which can be incorporated into public open space, streetscapes, or on lots. In addition to the information provided on a variety of devices in Part 4a, this section will provide a brief overview of the stormwater treatment systems that may be considered for large scale development.

4.15 Stream Erosion Index (SEI)

The preferred method for determining the SEI is based on a magnitude of flow and flow duration method due to the tendency for the other method to underestimate erosion.

4.15.1 Modelling

The SEI is to be determined through continuous rainfall runoff simulation modelling software such as MUSIC or approved equivalent.

1. Rainfall gauge, time step and modelling period

The modelling shall be undertaken at a 6 minute time step using pluviograph data from the Williamtown rain gauge over the time period 1/1/2002 – 31/12/2006 as a minimum.

2. Soil store parameters

When selecting soil store parameters, the modeller should select values that represent the local soil conditions, bearing in mind that Newcastle is situated across areas of loamy clays and areas of sandy soils. Ideally, the MUSIC model will be calibrated to a local waterway or one in a neighbouring catchment with similar geology and topography. In lieu of calibration data, applicants are referred to the *Draft NSW MUSIC Modelling Guidelines* (August 2010).

3. Node, link and treatment train set up

Continuous hydrologic models are to be established for the predevelopment scenario and the developed scenario with the selected treatment train and discharge control measures in place.

Link routing between source nodes and receiving nodes is recommended for large catchments where the time of concentration is greater than 6 minutes. It may be useful to split a large natural catchment into several subcatchments. The same approach to routing developed subcatchments should be followed for an accurate comparison.

4. Stream forming flow

The Stream Forming Flow is expressed as a fraction of the 2 year ARI pre development flow for the following catchments:

Catchment	Stream Forming Flow
All areas of Newcastle	0.5 x Q 2yr ARI pre development

The 2 year ARI predevelopment flow rate can be calculated by the following means.

5. Hydrologic modelling

The Q 2yr ARI pre development is best selected from a continuous time series hydrograph output using partial flood series approach as described in Australian Rainfall and Runoff.

For a 6 year simulation, the Q 2yr ARI pre development should occur approximately 3 times across the modelling period. Longer simulation periods will give more accurate estimates of results.

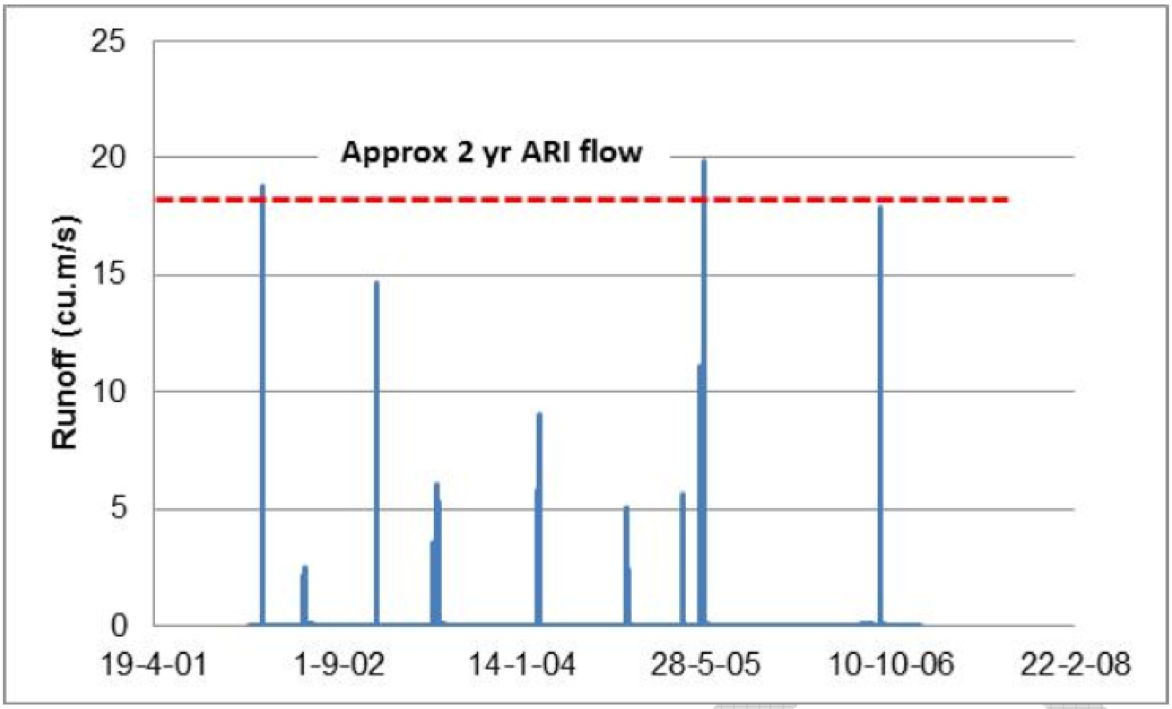


Figure 4.b.2 – An estimate of the 2 year flow is represented by the red dashed line on the continuous hydrograph

Please note that flood modelling hydrologic software (RORB, RAFTS, WBNM, etc) may produce a different estimate of Q 2yr ARI pre development to the partial flood series approach due to differences in the assumptions behind rainfall patterns. It is recommended that the same software be used to calculate the Q 2yr ARI pre development as is used to design the stormwater quality management treatment train.

6. Calculating SEI

The SEI is a dimensionless metric that represents the ratio of post development flows to predevelopment flows above the stream forming flow.

The method of calculation adopted by Newcastle Council represents the frequency, flow duration and flow rate of run off that exceeds the stream forming flow rate.

The SEI shall be calculated as follows:

$$SEI = \frac{\textit{Sum of all post development flows exceeding the stream forming flow}}{\textit{Sum of all pre development flows exceeding the stream forming flow}}$$

This can be calculated by:

1. Exporting the entire pre development and post development hydrographs to MS Excel at a 6 minute time step. Please note, the processing of results becomes laboured for continuous 6 minute hydrographs that are longer than 6 years in duration.

2. Using a generic node in MUSIC to “clip off” all flows less than the stream forming flow and using the internal MUSIC function to tally and average the resultant runoff volume over the simulation period.

7. Reporting on SEI

When reporting on SEI, a summarised table of adopted modelling parameters shall be provided to Council with Development Application documentation.

4.16 Stormwater treatment

Generally speaking, stormwater treatment devices can be classed into three categories. These include:

Bioretention systems

Bioretention systems filter stormwater runoff through a vegetated soil media layer. The treated stormwater is collected at the base of the system via perforated pipes, from where it flows to downstream waterways or storages for reuse. Temporary ponding above the filter media provides additional treatment. Bioretention systems are not intended to be infiltration systems where treated stormwater would discharge into groundwater. Typically, flood flows will be designed to bypass the system thereby preventing high flow velocities that can dislodge collected pollutants and scour vegetation. Bioretention systems can be installed at various scales.

Vegetated swales and buffer strips

Vegetated swales can be used instead of pipes to convey stormwater and provide a ‘buffer’ between the impervious areas of a development and the receiving water. They can be integrated with landscape features in public open space, or incorporated into streetscapes. The interaction with vegetation facilitates an even distribution and slowing of flow, thus encouraging pollutant settlement and retention in the vegetation.

Constructed wetlands

Constructed wetland systems remove pollutants through sedimentation and absorption of nutrients and other associated contaminants. They generally consist of an inlet zone (a **sediment basin**) to remove coarse sediments), a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and take up soluble pollutants) and a high flow bypass channel (to protect the macrophyte zone). Refer to the following figures for further details on preferred edge treatments for constructed wetlands.

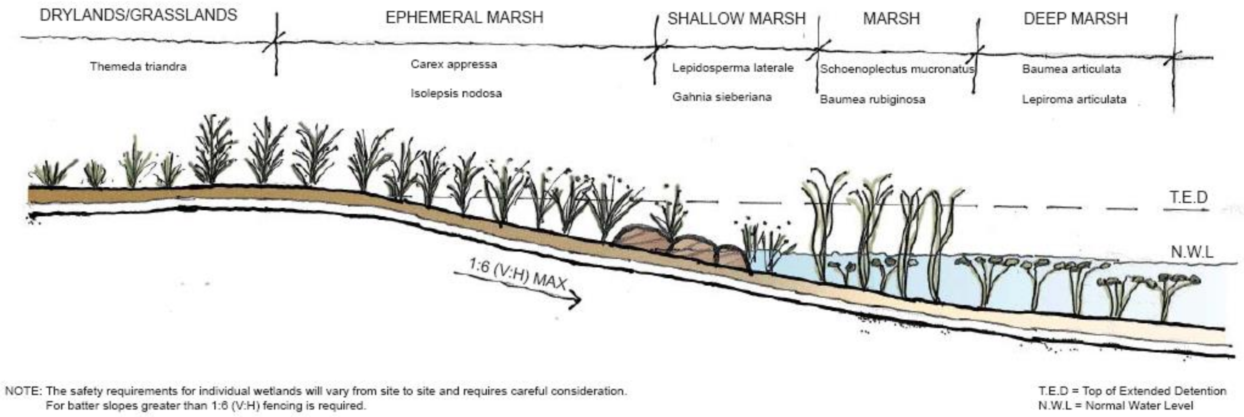


Figure 4.b.3 - Edge treatments for constructed wetlands

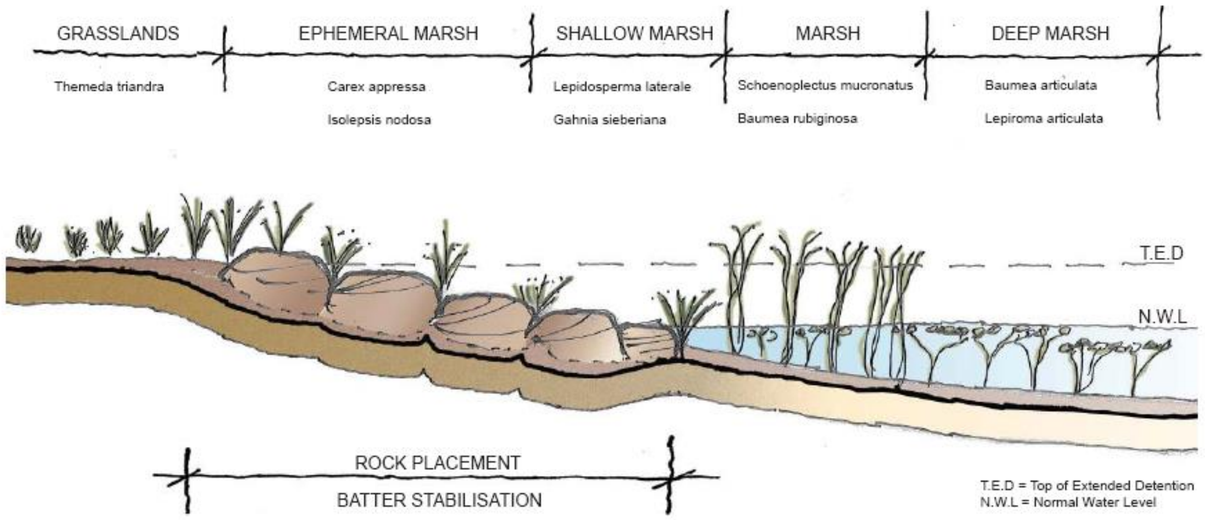


Figure 4.b.4 - Edge treatments for constructed wetlands

Stormwater treatment trains

A series of treatment measures that collectively address all stormwater pollutants is termed a “treatment train”. The selection and order of treatments is a critical factor in developing treatment trains. The coarse fraction of pollutants generally requires removal so that treatments that target fine pollutants can operate effectively. The proximity of a treatment to its source and the distribution of treatments throughout a catchment are other factors which are important in developing a treatment train.

Stormwater treatments that target the removal of gross pollutants and coarse sediments such as gross pollutant traps (GPTs) and sedimentation basins can operate under high hydraulic loading and can treat high flow rates.

As the target pollutant particle size reduces, the nature of the treatment process changes to include enhanced sedimentation, bio film absorption and biological transformation of the pollutants. The treatment processes include grass swales, vegetated buffer strips, wetlands and bioinfiltration systems which require longer detention times than for GPTs, in order to allow various pollutant removal processes to occur. The hydraulic loading on these treatment processes is relatively low in comparison to gross pollutant removal measures.

A treatment train consists of a combination of treatment measures that can address the range of pollutant particle sizes in stormwater. Therefore, a treatment train employs a range of processes to achieve pollutant reduction targets such as physical screening, enhanced sedimentation and filtration.

4.17 Modelling guidelines for developments larger than 5,000m^2

All modelling shall be undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) or similar software model approved by Council. Specific nodes for Newcastle catchments are available using MUSIC link with reference to Appendix 9. For developments where a more complicated WSUD solution is required, developers shall use the *Draft NSW MUSIC Modelling Guidelines (BMT WBM, 2010).* This document is free to download and should be used by developers as a priority.

A copy of the summary and data files will be required to be submitted with any application that relies on modelling in addition to a MUSIC link report.

4.18 Maintenance

Maintenance must be considered as part of the design process and proof of this will be required. A maintenance manual and schedule is required to be submitted which sets out the routine maintenance necessary to retain the systems viability. The resident/owner of the property shall receive a copy of this schedule on approval of the development. The schedule should be signed to indicate that it has been received and understood. A copy of the signed manual shall also be submitted to Council.

The maintenance manual should contain information on the following issues:

- where the storages are located
- which parts of the system need to be accessed for cleaning and how access is obtained
- a description of any equipment needed (such as keys and lifting devices) and where they can be obtained
- the location of grates/covers and how they can be removed for cleaning
- who should do the maintenance
- how often the maintenance should be done.

Systems should be designed such that specialist personnel (eg. confined spaces certified) are not required to perform ongoing maintenance.

Part 4c Site Discharge Controls – Council (public) assets

Land ownership and asset ownership are key considerations prior to the planning, design and construction of a stormwater treatment device. This section will outline specific requirements for assets that will be contributed to Council. These requirements shall be followed for all developments that will result in infrastructure being contributed to Council, irrespective of the size of the development. In general, the process that is required to be followed is similar to that outlined for large development in Part 4b. Additional requirements will be outlined in the following section.

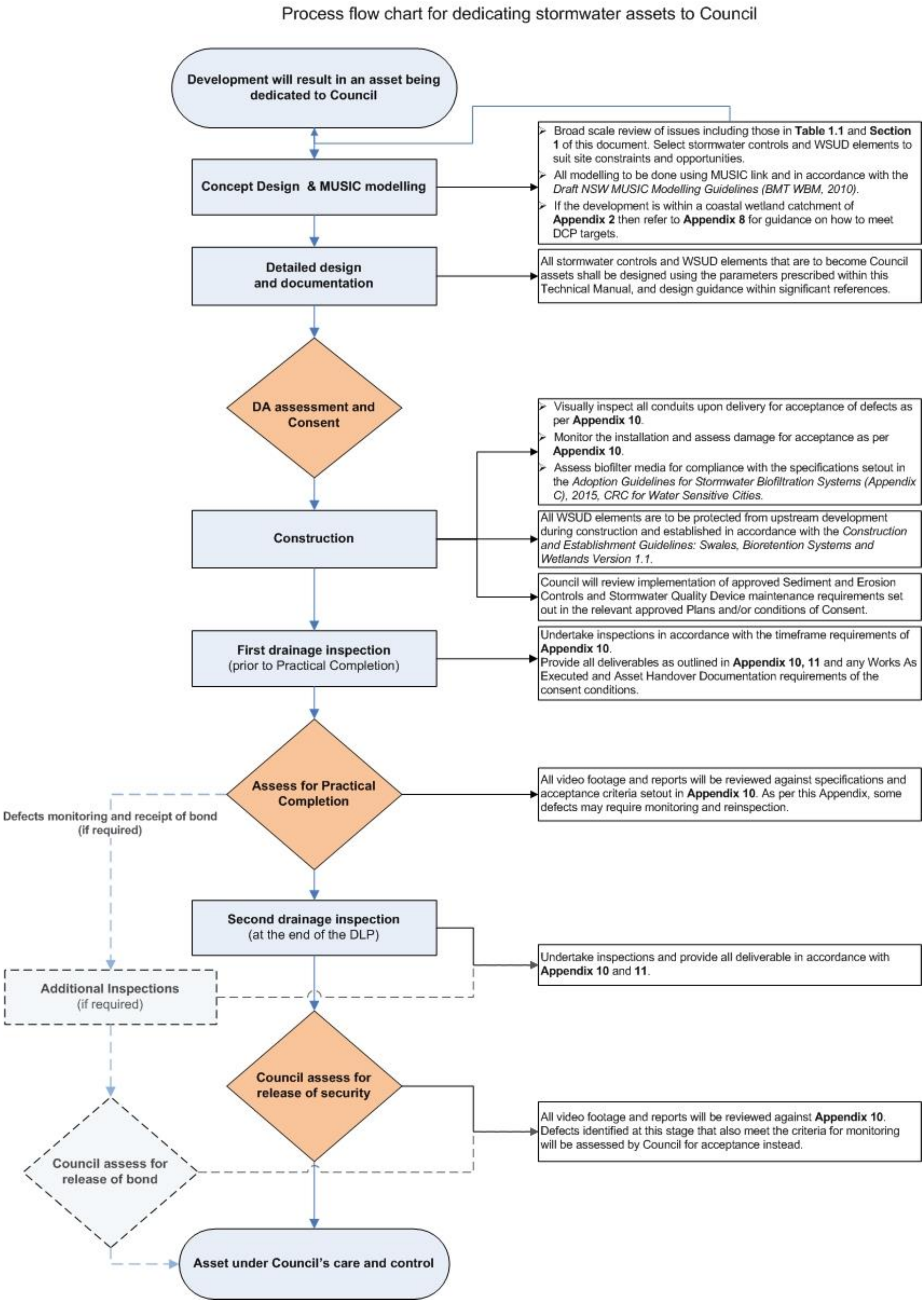
4.19 Process flow chart for the creation of public assets

4.20 General requirements

4.21 Stormwater treatment trains

4.22 Asset transfer checklist

4.19 Process flow chart for the creation of public stormwater assets



4.20 General

1. The requirements contained within this section apply to all developments within the City of Newcastle that will result in the creation of an asset that will be dedicated to The City of Newcastle.

2. Follow the process in clause 4.19 and all relevant specifications when creating public stormwater assets. Appendix 10 specifies the procedure for identifying defects in conduits and assessing for compliance with Council's standards for new public assets.

3. The responsibility for the submission of satisfactory details as required in these guidelines must rest solely with the applicant.

4. Detailed plans showing the proposed method of stormwater disposal are to be submitted to Council with the Development Application, and are to be shown on the plans prepared in support of the Construction Certificate, as approval will not be granted for any work commencing on site until the stormwater system has been approved.

5. The guidelines that follow are grouped into sub-sections, each dealing with separate issues.

6. Generally, all stormwater designs/investigations must be prepared in accordance with all relevant sections in this manual. To prevent delays in assessment, the applicant should ensure that all necessary details included in this manual and DCP Section 7.06 are submitted.

7. All Water Sensitive Urban Design (WSUD) systems require integration with surrounding open space. Site specific investigations need to include local topography, soil profiles, landscaping, public utilities, services and existing watercourses and any other relevant features.

8. All WSUD systems are to be designed to account for The City of Newcastle Maintenance Requirements and Work Health Safety.

9. All devices are to be designed to eliminate the need for fencing. Public safety should be considered in all designs which should help determine their location, configuration and proximity to other public infrastructure.

10. Devices are to be configured in such a way as to ensure that major flow does not enter the device. A major flow bypass is to be provided.

11. The maximum batter grades to be 1 (V): 6 (H) turfed and 1 (V): 3 (H) landscaped.

12. Off Street parking bay for Council Maintenance Trucks is to be provided within 1m horizontal distance and 2m vertical distance from the GPT, diversion pit and sediment bay. The Parking bay is to be designed in accordance with the Australian Standard for Parking Facilities AS2890-2 2002 and Austroads Design Vehicles and Turning Path Templates (2013 Edition) for a Heavy Mass Vehicle GVM 37 tonne Single Unit Truck(12.5m) with a 12.5m radius turning circle.

13. Removable bollards should be installed at 1.2m centres across access to all access points.

14. All WSUD system elements are to be in accordance with Council's Standard Drawings – A2400 Series.

15. At steep sites, high velocity can easily cause scour and erosion. Energy dissipation is a key consideration for the design.

16. To minimize velocities consider the use of drop structures and pipe grades to be a maximum of 1% grade discharging to a level spreader outlet structure.

4.21 Stormwater treatment trains

A series of treatment measures that collectively address all stormwater pollutants is termed a “treatment train”. The selection and order of treatments is a critical factor in developing treatment trains. The coarse fraction of pollutants generally requires removal so that treatments that target fine pollutants can operate effectively. The proximity of a treatment to its source and the distribution of treatments throughout a catchment are other factors which are important in developing a treatment train.

Stormwater treatments that target the removal of gross pollutants and coarse sediments such as gross pollutant traps (GPTs) and sedimentation basins can operate under high hydraulic loading and can treat high flow rates.

As the target pollutant particle size reduces, the nature of the treatment process changes to include enhanced sedimentation, bio film absorption and biological transformation of the pollutants. The treatment processes include grass swales, vegetated buffer strips, wetlands and bioinfiltration systems which require longer detention times than for GPTs, in order to allow various pollutant removal processes to occur. The hydraulic loading on these treatment processes is relatively low in comparison to gross pollutant removal measures.

A treatment train consists of a combination of treatment measures that can address the range of pollutant particle sizes in stormwater. Therefore, a treatment train employs a range of processes to achieve pollutant reduction targets such as physical screening, enhanced sedimentation and filtration.

Kerb Inlet Pits

- All new public kerb inlet pits installed in a commercial area and within 200m walk from a commercial area require litter basket inserts to Council's requirements.
- All driveways are to be a minimum of 1m from the edge of the kerb inlet pit (lintel).
- The double grating of pits for driveway access is not acceptable.

Constructed Wetlands

The design and construction of constructed wetlands, which are to be dedicated to Council, are to meet the following minimum requirements:

- The volume of the pond is to provide the required residence time to ensure that the post development stormwater pollution loads are reduced to pre development levels. Pollutant removal should be enhanced by minimising short-circuiting and minimising areas of potentially stagnant water.
- The volume is to be calculated using a daily time series analysis, by water quality computer modelling in an iterative manner. The analysis is to take into account the frequency of occurrence of events, pond conditions at the commencement of events, and the pattern of intervals between events.

- The wetlands should generally be offline with a major flow bypass for storm events greater than the design storm event.
- A buffer zone is to be provided around the wetland and planted with indigenous riparian vegetation.
- Between 10% and 30% of the basin surface is to be planted with macrophytes.
- The surcharge volume is to be sufficient to contain the first flush runoff from the upstream catchment.
- The surcharge volume is to be fully available 48 hours after cessation of stormwater inflow.
- the maximum batter of the slopes is not to exceed 1:8 (V:H) around the perimeter, however a steeper slope of up to 1:4 may be used below the permanent water level to provide additional water quality treatment volume.
- The embankment height is to be at least 500mm above the spillway crest.
- The minimum embankment crest width is to be not less than 3m.
- The full spillway area is to be protected using armoured Enkamat or equivalent.
- Any area where the water depth for the 20-year ARI storm event is greater than 1.2m and there exists a gradient of greater than 1:8 (V:H) from the edge of the stored water for any time during storms up to the 100-year storm event shall have access restricted.
- Warning signs shall be supplied and installed around the perimeter of the wetland. These signs shall be in accordance with Council's standard Floodway Warning Sign and include a "No Swimming" notice. They shall be located within the line of sight of the adjacent signs on the perimeter but not exceeding a spacing of 50m.
- A sediment control system and a trash rack are to be provided upstream of the inlet to the basin.
- Where on-site stormwater detention requirements are being provided within the same basin, the detention volume is to be provided in addition to and above the static level of the basin. The basin is to have minimum 300mm freeboard above the 100 year ARI storm event ponding level.
- A maintenance plan is to be provided with the design. This will need to include the removal of sediment from the sediment trap, macrophyte plant harvesting, and mosquito and weed control.
- Indigenous aquatic plant species are to be planted in the wetlands, with the quality, spacing and types specified on a landscape plan. A variety of species should be used and they should be established by transplantation of seedlings during spring and early summer. The base of the wetlands is to be over-excavated to provide for a minimum soil depth of 300mm. Suitable local horizon A mulched soils shall be used to provide the 300mm macrophyte planting bed substrate. Refer: *AS 4419-1998 Soils for Landscaping & Gardening.* The location and arrangement of the semi-permanent stored water associated with the water control facility shall be such as to minimise potential nuisance on habitable areas and amenities within the development.
- The wetland should be constructed prior to the commencement of other construction work.

Bioretention and Sand filters within basins

The design and construction of basins comprising bioretention or sand filters, which are to be dedicated to Council, are to meet the following minimum requirements:

- All sediment and gross pollutants are to be removed upstream of Bioretention Basins or Sand filters.
- All devices are to be designed to treat the 6 month ARI storm event.
- The finished surface of the bioretention filter media or sand filter must be flat to ensure full engagement of the filter media by stormwater flows.
- The extended detention depth above the filter media shall not exceed 0.3m.
- The time of mean filtration shall be 24 hours and no longer than 48 hours.
- An impermeable liner to the bioretention filter is to be provided in areas where the saturated hydraulic conductivity of the bioretention filter media is less than 10 times that of the native surrounding soils or on steep sites to prevent transverse seepage from the device. Example of liner Bentofix or Equal.
- Where a liner is not required the base and walls of the filter media is to be lined with BIDIM A14 Geofabric or Equal.
- A network of 100mm slotted UPVC subsoil pipes is to be provided over the base of the filter, have flush out surface points with concrete surrounds and caps and be connected to a receiving pit.
- Joints are to be solvent cement glued.
- Maximum spacing between subsoil collection pipes to be 5m. In a large system a collection pipe (minimum 225mm is to be provided).
- Mulch is to be provided to all landscaped batters and bioretention media surface, but not to sand filters.
- Mulch to be minimum 75mm deep of 20mm double washed gravel or equal.
- Where required, an overflow weir is to be provided with a minimum freeboard of 0.1m to the inlet of the receiving pit.
- Overflow weir is to be constructed level and rock pitched to prevent scour – minimum 400mm diameter sandstone rock is to be used. Rock is to be placed in accordance with the guidelines for rock placement shown on standard Drawing A 2402.
- A trafficable access is to be provided to the base of the Biorentention/Sand Filter to Council's standards for maintenance purposes.
- In large devices consider the use of a flow spreader to evenly distribute flows to ensure engagement of the entire media surface.
- A settlement basin and level spreader is to be provided at the inlet to the basin, energy dissipation and scour protection are to be provided in accordance with Standard Drawing A2402 and A2405 to protect the filter media from scour.

Bioretention Material specifications

- All bioretention media should be in accordance with the *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC)..
- All materials used for media, transition or drainage layers is to be tested and certified compliant.
- For Bioretention systems in a temperate climate the prescribed hydraulic conductivity will be between 100 – 300mm/hr, as measured using the ASTM F1815-06 method.

- In order to ensure that the system functions adequately at its eventual hydraulic conductivity, a safety factor of 2 should be used, ie. designs should be modelled using half the prescribed hydraulic conductivity.
- The filter media should be well graded ie. it should have all particle size ranges present from 0.075mm to 4.75mm sieve (AS1289.3.6.1 – 1995).
- There should be no gap in particle size grading and the composition should not be dominated by a small particle size range. An ideal particle distribution is as follows:

Clay and silt	(<0.05mm)	<3%
Very Fine sand	(0.05-0.15mm)	5-30%
Fine sand	(0.15-0.25mm)	10-30%
Medium to coarse sand	(0.25-1.0mm)	40-60%
Coarse sand	(1.0-2.0mm)	7-10%
Fine Gravel	(2.0-3.4mm)	<3%

Organic Matter Content – less than 5% (w/w).
pH – as specified for 'natural soils and soil blends' 5.5 – 7.5(pH 1:5 in water)
Electrical conductivity(EC) - as specified for 'natural soils and soil blends' <1.2dS/m.
Orthoposhate (PO34) - <80mg/kg.
Total Nitrogen(TN) content - <1000mg/kg.

- The transition layer prevents the media from washing into the drainage layer and shall be a clean, well graded sand material containing <2%fines. To avoid migration of the fines, the particle distribution of the sand should be assessed to ensure it meets the 'bridging criteria', Ie. the smallest 15% of sand particles bridge with the larger 15% of the filter media particles CRC WSC, 2015).
- The Drainage Layer collects the treated water at the bottom of the system and conveys it to the slotted drainage lines. Drainage material is to be clean fined gravel 2 – 5mm washed screenings. 'Bridging criteria' should be applied to avoid migration of the transition layer in accordance with FAWB.

Sand Filter Material specifications

- Sand Filter material to be in accordance with the WSUD Technical Guidelines for SEQ Version 1 June 2003 Section 8.3.4.1. Material with particle distributions as follows to be used for sourcing materials:

% passing	9.5mm	100%
	6.3mm	95 – 100%
	3.17mm	80 – 100%
	1.5mm	50 – 85%
	0.8mm	25 - 60%
	0.5mm	10 – 30%
	0.25mm	2 – 10%

This grading is based on TP10 (ARC2003).

- Sand filters require a drainage layer to prevent migration of sand filter material into the slotted drainage pipes. The particle size of the drainage material is selected with consideration to its need to bridge the particle size of the sand filter media and the slot size of the drainage pipes. It is preferred to use a coarse sand however a clean washed fine gravel can be used.

Plant selection for Bioretention devices

For local plant selection and planting guidance please refer to Appendix 4.

Vegetated and Bioretention Swales

A swale is a shallow trapezoidal channel lined with vegetation used for conveyance of stormwater flows. Bioretention swales include a vegetated infiltration trench within the base of the swale to provide water quality improvements to stormwater.

Both vegetated and bioretention swales are to be designed in accordance with Council's Standard Drawings and the following minimum criteria:

- The desirable maximum longitudinal grade of the swale is 4%.
- The minimum longitudinal grade of the swale is 1%.
- For longitudinal grades steeper than 4%, check dams (minimum 100mm high) are to be placed at regular intervals along the invert of the swale. The spacing of the check dams will depend on the grade of the swale.
- Swales can use a variety of vegetation including sedges and tufted grasses covering the whole width of the swale.
- Swales located within footpaths (ie. road verges) must consider the standard location for services within the verge and ensure access for maintenance of services.
- Velocities of flows within the swale component for both minor (2-10 year ARI) and major (50-100 year ARI) rainfall events are to be kept preferably below 0.5m/s and not more than 2.0m/s (for major flooding) to avoid scouring of the swale.
- Depth x Velocity products shall not exceed 0.36m^2/s for all flows.
- The extended detention depth above the base of the swale shall not exceed 0.3m.
- Driveway crossings constructed within swales at grade (refer Figure 4.4.3) shall be constructed at 1(V):6(H) and comply with Council's driveway specification.
- The maximum batter grade within the vegetated swale between roadways and the swale shall be 1(V):3(H) and the opposing side of the swale shall be 1(V):3(H).
- A concrete flush edge restraint 0.2m wide x 0.3m (min) deep shall be provided at the interface between the road pavement and the batter of the swale in areas adjoining roads (as per Figure 4.5.2). For concrete roads, the edge restraint shall be integrated into the concrete pavement. A 40mm drop down from the surface of the edge restraint to the top of the landscaping is to be provided to prevent material moving onto the road surface.
- All swales are to be designed so that they do not require fencing.

Bioretention media to be in accordance with the *Guidelines for filter media in stormwater biofiltration systems,* Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC) and criteria as detailed in section above.

4.22 Asset transfer checklist

Land ownership and asset ownership are key considerations prior to construction of a stormwater treatment device. A proposed design is to clearly identify the ultimate asset owner and who is responsible for its ongoing maintenance. In addition to the requirements outlined above, Council will use the asset transfer checklist when the asset is to be transferred to the City of Newcastle. Please refer to Appendix 5 for a sample Asset Transfer Checklist.

Maintenance Manual

Prior to asset transfer, all required maintenance activities must be specified in a maintenance plan (and associated maintenance inspection forms) to be developed as part of the design and asset handover process. Maintenance personnel and asset managers will use this plan to ensure the device continues to function as designed. As a minimum, the maintenance plan/s and form/s must address the following:

- inspection frequency
- maintenance frequency
- data collection/storage requirements (ie. during inspections)
- detailed cleanout procedures (main element of the plans) including:
    - equipment needs
    - maintenance techniques
    - workplace (occupational) health and safety
    - public safety
    - environmental management considerations
    - disposal requirements (of material removed)
    - access issues
    - stakeholder notification requirements
- data collection requirements (if any)
- design details.

An example operation and maintenance inspection form is included in Appendix 6

Bonds

Where works are proposed to be carried out on Council or public land (ie. roads, parks, etc) by or on behalf of an applicant, a bond will be required to cover the cost of the construction and potential rectification works. The value of the bond will depend on the works proposed, and be determined by Council.

Further information

For further information please refer to the following best practice guidelines:

General

- Water Sensitive Urban Design Book 4 Maintenance (Landcom)
  www.landcom.com.au/downloads/uploaded/WSUD_Book4_Maintenance_Draft_0409_5312.pdf
- Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands *Version 1.1* (South East Queensland Healthy Waterways Partnership, 2010)
  www.waterbydesign.com.au/ceguide/

Guidelines for filter media in stormwater biofiltration systems, Appendix C in the *Adoption guidelines for stormwater biofiltration systems* (2015) by the Cooperative Research Centre for Water Sensitive Cities (CRC WSC).Maintenance

- Wetlands
  - Water Sensitive Urban Design Book 4 Maintenance (Landcom)
    www.landcom.com.au/downloads/uploaded/WSUD_Book4_Maintenance_Draft_0409_5312.pdf
- Swales
  - Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (South East Queensland Healthy Waterways Partnership, 2006)
    http://hlw.org.au/resources/documents
    Section reference: 2.6 Maintenance requirements
- Bioretention swales
  - Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (South East Queensland Healthy Waterways Partnership, 2006)
    http://hlw.org.au/resources/documents
    Section reference: 3.6 Maintenance requirements
- Sediment Basins
  - Water Sensitive Urban Design Technical Design Guidelines for South East Queensland (South East Queensland Healthy Waterways Partnership, 2006)
    http://hlw.org.au/resources/documents

Part 5 Overflow disposal

Where site discharge controls are installed in accordance with this manual, they will treat the majority of runoff on an average annual basis. However, larger events will exceed the capacities of these systems from time to time. It is necessary to dispose of excess flows to the public drainage system in a manner that does not cause nuisance to neighbouring properties.

Off site disposal describes how the discharge to the public drainage system should be managed without affecting neighbouring properties.

5.1 Drainage to street

For properties that fall to the street, overflow from the drainage controls should be connected to the street drainage system. Connection to the kerb and gutter, or the pipe drainage system should be made in accordance with the technical manual guidelines.

5.1.1 Connection to kerb and gutter

Stormwater may be discharged to the street kerb and gutter subject to the following.

Single pipe discharges should not exceed 25 litres per second per 15m run of kerb in the 20 Year ARI event. Maximum total site discharge piped to the kerb should not exceed 50 litres per second. Discharges may be increased subject to a full catchment analysis by a Consulting Engineer. Such analysis should show immediately downstream of the proposed discharge point(s) that:

- at least a 3m clearway is maintained on the road carriageway during the total catchment 10 year ARI runoff
- depth of flow does not exceed 100mm
- velocity-depth product does not exceed the recommended products given in Keller and Mitsch and reproduced in Appendix 7 and given by equation 3.1.

The type of pipe crossing from the boundary to the kerb and gutter will depend on the size of on site drainage leading to it. Circular pipe capacities can be obtained from manufacturers.

The following rectangular hollow sections (RHS) can be assumed to have the same flow capacity as the nominated circular sections.

- 1 x 150 x 50 mm RHS = 90mm dia pipe
- 1 x 200 x 100 mm RHS = 150mm dia pipe
- 2 x 200 x 100 mm RHS = 225mm dia pipe

For standard 150mm-kerb height, one of the following pipe crossings, from boundary line to kerb should be used:

- 1 or 2 x 100mm diameter sewer grade uPVC pipe(s) except under brick paved footways
- 1 or 2 x 200mm x 100mm x 6mm thick RHS galvanised except under brick paved footways
- 1 or 2 x 150mm x 50mm x 4mm thick RHS galvanised.

Kerb converters are available for most standard kerb profiles at hardware stores and plumbing suppliers. Kerb outlets should be separated by a minimum 300mm.

Connections across the footway to the street gutter should be a minimum of 60 degrees to the kerb.

5.1.2 Direct connection to Council's underground pipe system

Stormwater may be discharged to the street piped drainage system subject to the 10 year ARI hydraulic grade line of the street pipe being lower than the property drainage system.

For attachment of subsoil lines and pipes up to 100mm diameter, direct connection to Council's underground pipe system should be made using an approved proprietary clamp or saddle. Larger pipes should be connected via an inspection or grated kerb inlet to suit entry for cleaning.

Notwithstanding the above requirements, any over-riding requirements of the relevant roads authority must be met.

Where the above requirements cannot be met or there is no kerb or pipe available in the street, then the downstream street drainage system is to be extended to the development site.

Design criteria are to be obtained from the relevant roads authority. In general, Council's new pipelines should be:

- Minimum 375mm diameter rubber ring jointed reinforced concrete (class 4).
- Laid at a minimum grade of 1% except for lengths of up to 50m of 675mm diameter or larger pipes can be laid as flat as 0.5%.
- Covered by a minimum depth of 450mm in roads or 300mm in footways or in accordance with their recommended load ratings.
- There should be a new grated surface inlet pit with lintel outside the development site.
- Access points or kerb entry pits are required for cleaning to be provided at no greater than 50m spacing. Shorter distances may be required for collection of design flows.
- Grated surface inlet pits should be constructed in accordance with Council's Standard Drawings A2200 series.
- Junction pits not on the kerb alignment should be in accordance with Council's Standard Drawings.
- A junction or surface inlet pit is to be constructed within the property at the boundary, at the point of the discharge from the site.

Proposed designs for pipeline or kerb extensions should be prepared by a consulting civil engineer or registered surveyor and submitted to Council for approval.

Any longitudinal drainage within footways requires the separate approval of Council under the Roads Act 1993. Such consent will not be given unless the applicant demonstrates the concurrence of all utilities authorities. For further information about works on the public road reserve, refer to the section on 'Road opening permits'.

5.2 Connection to other drainage

For properties that are intersected by or are adjacent to a public drainage system (pipes or open channels), connection can be made in accordance with this section.

5.2.1 Connection to public drainage system within the development site

Where a pipe or channel intersects the site and is not covered by an easement, an easement should be created in favour of Council. A suitable easement width for an existing Council drain will generally be the width of the pipe, box, or channel section, plus an additional 1.5m, with an overall minimum width of 3.0m.

Direct connections to Council stormwater channels must satisfy the following criteria:

- The channel is within or directly adjacent to the site.
- The design tailwater level for a sealed pipe drainage system is the top of the channel.
- The angle of entry of the pipe is a maximum of 30° (in the horizontal plane) to the direction of flow in the channel.
- Any other site specific requirements of Council.

Connections to Council stormwater pipes must satisfy the following criteria and any other site specific requirements of Council:

- For attachment of subsoil lines and pipes up to 100mm diameter, direct connection to Council's underground pipe system should be made using an approved proprietary clamp or saddle. Larger pipes should be connected via an inspection or grated kerb inlet to suit entry for cleaning.
- Grated surface inlet pits should be constructed in accordance with Council's Standard Drawings A2200 series.
- Junction pits not on the kerb alignment should be 900mm x 900mm internal dimensions with 900mm diameter circular lid with "NCC" or "STORMWATER" cast into the top.

5.2.2 Direct connection to Hunter Water Corporation channels

Connections to stormwater pipes and channels operated by the Hunter Water Corporation must satisfy the following criteria and any other requirements of the Hunter Water Corporation:

- Written consent must be obtained from the Hunter Water Corporation (a copy of which is supplied with the construction certificate application or complying development certificate application).
- The design tailwater level for a sealed piped drainage system connecting to such a channel is the top of the channel.

5.2.3 Direct connection to natural watercourses

Direct connections to natural watercourses are generally discouraged, however, where they are necessary, the number should be minimised and should comply with the following criteria:

- NSW Office of Water guidelines.
- Water should not be deflected from another catchment.
- Flow must be controlled in order to replicate the predevelopment hydrological regime.
- Concentrated flows are not permitted including piped drainage.

- Adequate measures must be provided to prevent streambank erosion, scour and other damage for flows up to the 100 year ARI event. Such measures need to be aesthetically compatible with the existing riparian environment and may be the subject of separate approval under the *Water Management Act* 2000.

5.2.4 Modifications to Watercourses

Modifications to natural watercourses are generally not permitted, as they adversely impact on a number of issues including:

- Hydraulic function
- Channel pattern and form
- Long-term channel stability
- Aesthetic appearance
- Aquatic and riparian habitat diversity
- Water quality.

Any proposals involving modifications to watercourses will require the submission of a detailed hydraulic assessment as well as a thorough environmental impact assessment of the prepared watercourse modification. Modifications to watercourses will only be considered where no other alternative exists, such as when scour within the watercourse threatens the stability of a dwelling or other high value asset. The reduction of development potential as a result of not modifying a watercourse will not be considered justification for such modification.

Note: Lodgement of an Integrated Development Application will be required for any proposal involving the modification of a watercourse since the concurrence of the NSW Office of Water will be required pursuant to the requirements of the *Water Management Act* 2000.

5.3 Drainage to rear

For properties that fall away from the street, overflow from site discharge controls may be disposed from the site through any of the options in Table 5.1 where all the allowable circumstances exist.

Table 5.1 – Options for draining to rear

Option	Circumstances in which option may be applied
Private drainage easements	Preferred option in all circumstances.
Charged systems	Only for residential properties up to and including a single dwelling.
	Private drainage easement cannot be obtained.
	Available head between roof gutter and road or pipe HGL must be >1.5m
Infiltration trenches	Private drainage easement cannot be obtained.
	Analysis of soil shows sufficient capacity to dispose of peak 20 year ARI discharge.
Dispersion Trenches	Only for residential properties up to and including a single dwelling.
	Private drainage easement is not available and cannot be obtained.
Pump out systems	Only for basement carpark areas.
	Private drainage easement cannot be obtained.
	maximum catchment 60m2
	pump failure will not cause inundation of neighbouring properties or habitable floor areas
Overflow to public reserve	Public reserve has drainage system with adequate capacity to intercept flow before it affects other properties.

5.3.1 Easements

Suitable drainage easements should be created where it is necessary to discharge stormwater across downstream properties in order to access the public drainage system. Drainage easements are the preferred option for drainage to the rear in all cases.

Easements must have sufficient width having regard to:

- proposed pipe diameter
- structural requirements of pipes and any adjoining structure
- stormwater surface flow path capacity requirements
- requirements for access and maintenance.

Suitable easement widths will generally be 2.0m. However, a lesser width (minimum 0.9m) may be suitable where there is an existing structure along the proposed line of the easement. Where Council is a party benefited by the easement, a width of 3m is generally required. Easements should not be created under existing or future proposed buildings. Easements are to generally follow an overland flow path. Easements are not to flow against the grade.

Piped drains within private inter-allotment drainage easements should have sufficient capacity to convey the 100-year ARI peak flow. The minimum pipe diameter is 150mm.

The 100-year ARI requirement can be reduced to 20 year ARI if a long-term overland flow path, such as a paved driveway with kerbing, is secured over the length of the easement of sufficient capacity to carry the major flow. The pipe system should be designed by a consulting engineer using hydraulic grade line analysis.

Easements will need to satisfy the following criteria:

- A written agreement is to be made between all relevant parties agreeing to its creation. A copy of this agreement should be provided to Council in support of any development application that requires it.
- A survey plan of the proposed easement should be prepared by a registered surveyor and endorsed with a statement to the effect that all pipelines are wholly contained within the proposed easement.
- The City of Newcastle must be nominated on the instrument creating the easement as a party whose consent is required to release, vary or modify the easement.
- Evidence of the creation of the easement should be provided to the certifying authority as part of the documentation accompanying a construction certificate application or complying development certificate application. Evidence of the written agreement to the creation of the easement is to be submitted with a development application. In this case the consent authority may grant deferred commencement consent subject to easement creation.
- Where the easement benefits private property only, Council does not wish to have dominant tenemency over the easement.

5.3.2 Demonstration that an easement cannot be obtained

In order that other drainage to rear options can be used, it will be necessary to demonstrate that an easement over all downhill neighbouring properties cannot be obtained.

To demonstrate that a drainage easement cannot be obtained, the following documentary evidence should be submitted to the consent or certifying authority:

- A copy of letter(s) sent to the owner(s) of neighbouring property(s) along all feasible easement routes. The letter is to include offer of financial compensation and is to indicate that the burdened property is not responsible for easement maintenance. Financial compensation may be determined by inquiry to a registered valuer.
- A signed copy of a letter(s) from the owner(s) of the neighbouring property(s) in which it is stated that an easement will not be granted. Should it not be possible to obtain such a letter(s) then a written account of any responses obtained from the owner(s) is required which may then be subject to independent verification by the certifying authority.

5.3.3 Charged Systems

Charged systems rely on the difference in level (head) between the overflow of the site discharge control and the street gutter to drive water “uphill”. One key feature of a charged system is that it holds stagnant water for a period of time until the next rain event. The ability to clean a charged system is therefore very important.

Charged systems are an option for the drainage of a single unit dwelling only and do not apply to medium density developments. They should satisfy the following criteria:

- Minimum of 1.0m head must be available from overflow to discharge point, or the pipe system should be designed by hydraulic grade line analysis.
- The piped system must be completely sealed.
- The pipe system including downpipes must be constructed from suitably durable materials.
- A cleaning eye must be provided at the lowest point of all pipes.
- Gravity drainage to the street kerb should be provided from a suitably located access pit.
- The system should be designed by a Consulting Engineer who undertakes a hydraulic grade line analysis to demonstrate that the system can discharge the 20 year ARI storm runoff without roof gutter surcharge.
- A design plan is prepared by a Consulting Engineer which shows a longitudinal section of the entire piped system from roof gutter to street gutter showing invert levels, flow rates and hydraulic grade lines. Hydraulic grade line calculations are to be shown.

5.3.4 Infiltration Trenches

Infiltration trenches can be used to dispose of site stormwater. Such trenches can be deemed a substitute for site discharge controls if desired.

An infiltration trench drainage system is to be designed by a Consulting Engineer. The design is to be based on a site test report to be provided by a geotechnical engineer. The design, supporting calculations and the site test report are to be submitted for approval by the consent/certifying authority.

Site testing is to be undertaken, and a report prepared by a geotechnical engineer in accordance with the following:

- A minimum of 2 tests are to be made at the location of the proposed infiltration trench(es) and at the invert level of the proposed trench(es).
- Infiltration is to be measured in pre-saturated soil by a double-ring infiltrometer test or equivalent.
- Permeability is to be reported in metres per day or centimetres per second and also in litres per second per metre squared for a mid-depth level of water in the proposed trench.
- The depth to any underlying rock stratum or water table is to be determined if within 2m of the proposed trench invert level.
- Provision of borehole log evaluation of soil types.
- Recommended offset of trench from buildings.
- The likely impact, if any, to neighbouring properties including footings and basement areas.

Infiltration trench design is to be undertaken in accordance with the following criteria:

- The trench system must fully infiltrate the 20 year ARI runoff from all impervious areas for all storm durations without surcharge onto neighbouring properties. The minimum impervious area to be used should be 80% of the total site area to cater for future development.
- Impervious areas include all rooves, paved areas and pools, whether or not other site discharge controls are provided.
- Any proposed pervious area contribution must also be included.
- The design method is to be a suitable time-area computer model such as ILSAX or the mass-curve technique in AR&R. Such methods can accurately assess adequacy of proposed storage volumes.
- Pre-treatment sediment, gross litter and oil traps are to be installed upstream of the trench.
- The trench is to be oversized to account for a 20% blockage factor at the trench – soil interface.

- Single-sized blue metal, gravel or sand can be assumed to have a 30% void ratio.
- The base of the trench is to be at least 1.0m above the underlying watertable or rock stratum (if present).
- Trenches are to be offset at least 2m from boundaries and 3m from buildings unless a structural engineer certifies the adequacy of the footings in closer proximity to the trenches.
- The design infiltration area is the area of the base(s) of the trench(es) only and does not include the sides of the proposed trench(es).

5.3.5 Dispersion Trenches

Dispersion trenches are suitable for the disposal of the overflow from site discharge controls for single dwelling houses only. They are an option for the disposal of water in circumstances where no other opportunities exist and are intended to permit the redevelopment of existing residential sites larger than 600m^2 only.

Dispersion trenches should

- Have a cross-sectional area of at least 600mm x 600mm, with a length of one metre for every 25m^2 of catchment.
- Be oriented parallel to the ground surface contour.
- Be lined with geofabric to prevent silt entering the trench from the base, top and side walls.
- Be filled with large – single sized aggregate to as near as practicable to the surface.
- Not cut through the root systems of trees covered by Council's Tree Preservation Order.
- Receive stormwater via a slotted pipe laid across the full length of the trench at the half-depth level.
- Be covered by the geofabric with a 150mm overlap beyond the trench walls. A further 75mm aggregate should then be placed over the trench.
- Be offset at least 2m from boundaries and 3m from buildings unless a structural engineer certifies the adequacy of the footings in closer proximity to the trench.

5.3.6 Pump-out Systems

Pump-out drainage systems may be used for basement carpark areas but should be avoided for catchments greater than 60m^2.

Pump-out drainage systems should be designed by a Consulting Engineer to the following criteria:

- Dual alternating pumps with level switches and activation of dual operation at top water level.
- Provision of pump description including manufacturer, model number and published data sheets.
- Automatic alarm during pump failure.
- The rising main should terminate at a stilling pit from which gravity drainage to the street gutter is provided.
- The pump wet well is to have a storage capacity of at least the two hour 10 year ARI storm runoff and is to be checked for adequacy up to the 100 year ARI event by a time-area computer model or the mass-curve technique in AR&R.
- Noise levels will not affect neighbouring properties above recognised standards.

The consent authority may impose a requirement to create a positive covenant on the title of the property requiring regular maintenance, and reporting to Council, of the pump-out system by a suitable independent practitioner.

5.3.7 Discharge to or across public lands

Council cannot grant private drainage easements across public land. In some circumstances, site drainage systems may be allowed to overflow directly to public land. However, this will not be considered unless all other options have been investigated and found to be unsuitable to Council's satisfaction. In general, the provisions of the *Local Government Act 1993* and Plans of Management for Community Land prohibit the construction of pipe work in Council's reserves for private developments.

Concentrated stormwater flows shall not be discharged and overflows should generally not be discharged to or across:

- Reserves administered by the National Parks and Wildlife Service
- Crown reserves
- Community Land administered by Council including parks and reserves
- Other public land that consists predominantly of native vegetation.

Drainage across public land may only be approved after consultation with the relevant authority prior to the issue of development consent. In general the drainage must be designed in accordance with the following criteria:

- It must not be concentrated and must be commensurate with predevelopment flow rates for all events.
- It must not create conditions likely to give rise to landslip or other geotechnical hazards.
- It must be approved by the relevant public authority prior to the issue of a construction certificate or a complying development certificate.
- It must be in accordance with relevant laws and plans of management regulating or authorising the use of that public land.
- It must incorporate erosion, sediment, water quality control and other environmental management measures to the satisfaction of the relevant public authority.
- In the case of Community Land administered by Council, it must not involve the construction of pipes or other drainage facilities.

5.3.8 Laneways

Where a proposed development site has frontage to a laneway and the laneway is lower than the site, the development may be drained to the surface but only if:

- it is a single dwelling house with full frontage to the street at the front (not lane at the rear), and
- the discharge is via a dispersion trench in accordance with the above criteria.

Where it is proposed to drain other development to a laneway, the underground street drainage should be extended into the laneway to receive the overflows in accordance with section 5.1 of this manual.

Glossary

Terms used in this manual

A term used in this manual has the same meaning as it has in the Newcastle Local Environmental Plan 2012 and Newcastle Development Control Plan 2012, unless it is otherwise defined in this manual. In the event of an inconsistency, the definitions contained within the statutory planning documents will prevail.

Accredited certifier

A person who is accredited by a professional body approved by the Minister. Accredited certifiers may:

- issue complying development certificates
- issue construction certificates
- issue compliance certificates
- issue occupation certificates
- act as a principal certifying authority.

Accredited certifiers may only undertake tasks relevant to their expertise.

The names of accredited certifiers working in this area may be ascertained by checking with relevant professional associations.

Annual Exceedance Probability (AEP)

Is the probability that a flood of a given or larger magnitude will occur within a period of one year. Its reciprocal is equivalent to average recurrence interval (refer to Appendix 1 for further details).

Australian Rainfall & Runoff (AR&R)

A technical manual providing guidance on current drainage design practice published by the Institution of Engineers Australia.

Average Recurrence Interval (ARI)

The average period between the recurrence of a storm event of at least a given rainfall intensity. The ARI represents a statistical probability. For example, a 10 year ARI indicates an average of 10 events over 100 years. The ARI is not the period between actual events (refer to Appendix 1 for further details).

Australian Height Datum (AHD)

A standard datum for expressing vertical information.

Building

A building includes a structure.

Black water

Water contaminated by faecal matter or pathogens. Commonly, all wastewater originating from toilets is black water.

Bore water

Surface water originating from groundwater and pumped to the surface via a bore drilled into the ground.

Certifying authority

A person authorised to issue complying development certificates, construction certificates, compliance certificates, occupation certificates, and subdivision certificates. This person may be the Council or an accredited certifier.

Complying development

Development that is declared to be 'complying development' by the Newcastle Local Environmental Plan or by some other environmental planning instrument.

Complying development includes relatively simple types of development that are subject to defined standards or requirements specified in a development control plan, local environmental plan or other planning instrument.

Complying development certificate (CDC)

A certificate that states that particular proposed development is complying development and (if carried out as specified in the certificate) will comply with all development standards applicable to the development.

A complying development certificate is the means by which 'approval' is given to complying development. It combines the functions of a development consent and a construction certificate. A complying development certificate may be issued either by the Council or an accredited certifier.

Construction certificate

A certificate certifying that construction drawings and specifications are consistent with the development consent and relevant construction standards, such as the Building Code of Australia. A construction certificate may be issued either by the Council or an accredited certifier.

Compliance certificate

A certificate certifying that specified development complies with relevant standards, specifications or conditions of consent. Compliance certificates are intended to apply to specific aspects of building and subdivision work.

Community land

Land that is classified as community land under Chapter 6, Part 2, Div 1 of the *Local Government Act 1993*. Community land is required to be used and managed in accordance with a plan of management.

Consulting Engineer

A person suitably qualified to be eligible for membership of the Institution of Engineers, Australia and who is experienced in the field of stormwater hydraulics and hydrology.

the Council

City of Newcastle.

Covenant

A restriction on the use of land recorded on the property title and binding upon successive landowners. Covenants may be 'negative' (imposing restrictions) or 'positive' (imposing positive obligations). Covenants are imposed under the Conveyancing Act 1919.

Creek

A small water course in or out of its "natural condition" and defined by topography rather than whether or not it contains water.

Development

Under the *Environmental Planning and Assessment Act 1979*, development is defined to be:

- the use of land
- the subdivision of land
- the erection of a building
- the carrying out of a work
- the demolition of a building or work
- other acts, matters or things controlled by an environmental planning instrument.

Development Application (DA)

An application for permission to perform works or use land in accordance with the provisions of the *Environmental Planning and Assessment Act 1979.* A development application typically consists of:

- plans and drawings of the proposed development
- a Statement of Environmental Effects and other documentation
- a completed application form and fees.

Development Control Plan (DCP)

A policy document that provides more detail than contained in a local environmental plan. DCPs are prepared under section 72 of the *Environmental Planning and Assessment Act 1979*.

The provisions of a DCP are guidelines that must be considered by the Council when it determines a development application.

A DCP must also be taken into consideration by a certifying authority when determining a complying development certificate application. Complying development must be carried out in accordance with a DCP, and any standards or requirements contained within the DCP have the status of compulsory 'development standards'.

Dwelling-house

A building that contains only one dwelling.

Easement

A legal right held by an owner of land in respect of another land parcel. Easements are commonly created to enable access across other properties, such as for drainage, pipelines, footways, etc.

Ecologically sustainable development (ESD)

An approach to development that considers the needs of future generations whilst satisfying present day aspirations, and integrates social, economic and environmental considerations in decision-making processes. Under the Local Government Act 1993, it is part of the Council's charter to promote the following ESD principles and programs:

- The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
- Conservation of biological diversity and ecological integrity - namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration.
- Improved valuation, pricing and incentive mechanisms - namely, that environmental factors should be included in the valuation of assets and services.

Exempt development

Development that is declared to be 'exempt development' by the Newcastle Local Environmental Plan 2012 or by some other environmental planning instrument.

Exempt development includes minor development having minimal environmental impact. It may be carried out without the need to obtain development consent or a construction certificate. However, exempt development must be carried out in accordance with any requirements of the applicable planning instrument.

Flooding

The inundation by water of land that is not usually inundated. Flooding may occur due to a variety of reasons, either separately or in combination. Important types of flooding include:

- River flooding - caused when a river or stream overtops its banks onto the floodplain.
- Stormwater flooding - caused by stormwater during an intense rainfall event. This may be due to surface flow, surcharge from piped drainage systems or overflow from man-made stormwater channels.
- Tidal inundation - caused by inundation by sea water. This may be due to king tides, storm surge, barometric effects, tsunami, shoreline recession, subsidence, the enhanced greenhouse effect or other causes.

Grey water

Wastewater that is not contaminated by faecal matter or pathogens. Commonly, all sewer water is grey water with the exception of water originating from toilets. It may be contaminated by detergents and other common household products liberated by washing.

Groundwater

Water that flows thorough the ground soil mass. This is different from soil moisture in that the water below the groundwater table usually saturates the soil and flows from one place to another. Groundwater can reappear as springs or flow along the beds of creeks.

Gross pollutants

Large particulate matter not normally found in water including litter and coarse sediment.

Gully

Any depression, generally deeper than 0.3m deep in the local topography that conveys or has the potential to convey ephemeral surface water.

Hydraulics

The study of the flow characteristics of water in a conduit. In relation to drainage design, hydraulics relates to the characteristics and capacity of flow control devices, open channels and pipes.

Hydrology

The science of water interrelationships interactions between water and the environment.

Infill development

A general term for new urban development within existing developed areas. It usually involves a more intensive use of the site. Infill development may encompass housing, retail, business, education, community service or industrial activities.

Impervious surface

A surface that does not allow rainwater to infiltrate to the soil, such as buildings (roofs), roads, parking areas, courtyards.

Infiltration

The process by which rainfall infiltrates the soil and enters the subsurface drainage or groundwater systems.

Integrated development

Development that, in order to be carried out, requires one or more of the approvals listed in section 91 of the *Environmental Planning and Assessment Act 1979* in addition to development consent. Integrated development does not include complying development.

Major drainage system

The part of the public drainage system in an urban area that carries relatively large flows. It consists of the system of streams, floodways, stormwater channels, retarding basins and street pavements. It is generally designed to protect people and indoor property from the effects of an extreme flood.

Minor drainage system

The part of the public drainage system in an urban area that carries relatively minor flows. It consists of the system of kerbs, gutters, roadside channels, swales, sumps and underground pipes. It is generally designed to control 'nuisance flows' which occur on a day-to-day basis.

Occupation certificate

A certificate issued by the Principal Certifying Authority that authorises the occupation and use of a new building, or a change of building use for an existing building. Occupation certificates are not required for 'Class 1a' or 'Class 10' buildings under the Building Code of Australia (for example, detached dwellings, garages and other domestic outbuildings).

On site stormwater detention (OSD)

A stormwater management practice that limits the rate of discharge from a site using outlet restriction devices. Stormwater flows in excess of the capacity of the outflow control device are temporarily stored either in tanks or surface depressions until the storm event recedes. Stormwater flows are released at a controlled rate back to the public drainage system.

On-site stormwater retention (OSR)

Stormwater management practices where on-site stormwater runoff is captured and retained within the site for re-use.

Permissible site discharge (PSD)

The maximum rate at which stormwater is permitted to be discharged from a given site area.

Porous paving

A paving system capable of storing and infiltrating water in accordance with the principles of this manual.

Principal certifying authority

The certifying authority appointed by a person to oversee the construction process. Only the principal certifying authority may issue an occupation certificate.

Public drainage system

A natural drainage channel or a constructed drainage system owned and operated by the Council or the Hunter Water Corporation.

Rill

A depression in the local topography, generally less than 0.3m deep that conveys or has the potential to convey ephemeral surface water.

Riparian zone

An area of river or creek bank. Usually riparian pertains to vegetation typical to this zone. For the purposes of this document and the *Water Management Act*, it is defined as being 40m from the top bank of the watercourse.

Runoff

The portion of rainfall that flows across the ground surface as water.

Single dwelling/single dwelling-house

A dwelling or dwelling-house located on an allotment of land on which no other dwellings are located.

Site discharge control

A drainage structure that controls the rate of discharge in the most frequent rain events to a predetermined rate in accordance with Council’s policy.

Site drainage line

A piped drain that conveys stormwater from a development site to the public drainage system.

Statement of environmental effects

A statement lodged with a development application that outlines the likely impacts of a development proposal, and the proposed measures to mitigate these impacts.

Stormwater

The runoff from rainfall events.

Soil mass

All solid matter, usually silica based under the surface of the ground including topsoils, sands, clays and rocks.

Soil and water management plan

A plan lodged with a development application that illustrates how stormwater, runoff and soils will be managed on the site. The Plan should demonstrate the feasibility of both the proposed stormwater management system, and the proposed erosion, sediment and water quality controls measures. The plan should be supported by preliminary hydrological calculations and other information in the accompanying Statement of Environmental Effects.

Stormwater surface flowpath

A strip of land carrying concentrated surface flow during a rainfall event, the width, shape and gradient of which is designed to cater for the flow produced by a 100 year ARI rainfall event. Includes a flow path from the spillway of an on-site detention system.

Subdivision certificate

A certificate issued by the Council that authorises the registration of a plan of subdivision in the Land Titles Office. At present, accredited certifiers may not issue a subdivision certificate

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Appendices

Appendix 1 - Intensity Frequency Duration data

Appendix 2 - Coastal Management SEPP Wetlands Catchment

Appendix 3 - Planning for Erosion and Sediment Control

Appendix 4 - Planting list

Appendix 5 - Asset transfer checklist example

Appendix 6 - Example maintenance checklist for bioretention basins

Appendix 7 - Stability of children and cars in flooded streets

Appendix 8 - Guidance on meeting requirements for coastal wetland catchments

Appendix 9 - MUSIC model map (catchment areas)

Appendix 10 - Specification for Acceptance of Drainage Defects

Appendix 11 - Specification for Drainage Inspection Reporting

Appendix 1 - Intensity frequency duration data

	Average recurrence interval (years)								
Duration	**1**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**500**
5 mins	85.51	109.90	141.42	158.38	181.93	212.69	236.05	254.44	285.44
6	80.12	102.99	132.59	148.53	170.65	199.55	221.51	238.93	268.11
7	75.62	97.23	125.23	140.30	161.23	188.58	209.35	225.71	253.31
8	71.79	92.31	118.93	133.28	153.19	179.20	198.97	214.33	240.55
9	68.45	88.04	113.46	127.18	146.19	171.05	189.94	204.41	229.42
10	65.52	84.27	108.65	121.80	140.03	163.86	181.98	195.68	219.63
11	62.91	80.92	104.36	117.01	134.54	157.46	174.89	187.91	210.92
12	60.56	77.91	100.51	112.71	129.61	151.71	168.51	180.95	203.11
13	58.44	75.19	97.02	108.81	125.14	146.50	162.74	174.66	196.05
14	56.50	72.71	93.84	105.26	121.07	141.75	157.48	168.94	189.64
15	54.73	70.44	90.93	102.01	117.34	137.40	152.65	163.71	183.77
16	53.10	68.34	88.25	99.01	113.91	133.39	148.21	158.90	178.38
17	51.60	66.41	85.77	96.24	110.73	129.68	144.10	154.46	173.39
18	50.20	64.61	83.47	93.66	107.78	126.24	140.28	150.34	168.77
20	47.68	61.38	79.32	89.03	102.46	120.03	133.40	142.92	160.45
25	42.60	54.86	70.95	79.67	91.72	107.49	119.50	127.97	143.70
30	38.73	49.89	64.56	72.52	83.52	97.91	108.88	116.55	130.89
35	35.65	45.94	59.49	66.84	77.00	90.29	100.42	107.45	120.69
40	33.14	42.71	55.33	62.19	71.66	84.05	93.50	99.97	112.31
45	31.04	40.00	51.86	58.30	67.19	78.83	87.70	93.70	105.28
50	29.25	37.70	48.90	54.98	63.38	74.37	82.75	88.33	99.26
55	27.70	35.72	46.34	52.12	60.08	70.52	78.48	83.68	94.05
60	26.35	33.98	44.10	49.61	57.20	67.15	74.74	79.60	89.48
75	22.96	29.62	38.46	43.28	49.91	58.61	65.24	69.85	78.54
90	20.49	26.43	34.34	38.65	44.58	52.36	58.29	62.62	70.43
2 hours	17.08	22.04	28.65	32.25	37.22	43.73	48.69	52.51	59.08
3	13.17	17.00	22.13	24.93	28.77	33.82	37.68	40.76	45.89
4	10.95	14.13	18.41	20.74	23.95	28.16	31.38	34.01	38.30
5	9.48	12.25	15.96	17.99	20.77	24.44	27.23	29.57	33.31
6	8.44	10.89	14.20	16.01	18.50	21.76	24.26	26.40	29.76
8	7.01	9.06	11.82	13.33	15.41	18.13	20.22	22.14	24.98
10	6.08	7.86	10.26	11.57	13.38	15.75	17.56	19.38	21.88
12	5.41	7.00	9.13	10.31	11.92	14.03	15.65	17.43	19.68
14	4.93	6.37	8.33	9.40	10.87	12.81	14.28	15.96	18.03
16	4.54	5.88	7.68	8.68	10.04	11.83	13.20	14.81	16.74
18	4.23	5.47	7.16	8.08	9.35	11.02	12.30	13.87	15.69
20	3.96	5.13	6.71	7.59	8.78	10.35	11.55	13.09	14.81
22	3.74	4.84	6.33	7.16	8.29	9.77	10.91	12.43	14.07
24	3.54	4.58	6.00	6.79	7.86	9.27	10.35	11.86	13.43
36	2.74	3.55	4.66	5.27	6.11	7.21	8.05	9.52	10.81
48	2.26	2.93	3.85	4.37	5.06	5.98	6.68	8.10	9.20
60	1.94	2.51	3.30	3.75	4.35	5.14	5.74	7.07	8.05
72	1.70	2.20	2.90	3.29	3.81	4.51	5.05	6.27	7.14

I_{1hr} = 34.0mm/hr I_{1hr} = 67.0mm/hr

I_{12hr} = 7.0mm/hr I_{12hr} = 14.0mm/hr

I_{72hr} = 2.2mm/hr I_{72hr} = 4.5mm/hr

How does AEP relate to ARI?

With ARI expressed in years, the relationship is:

$$AEP = 1 - \exp\left(\frac{-1}{ARI}\right)$$

which results in the following conversion table:

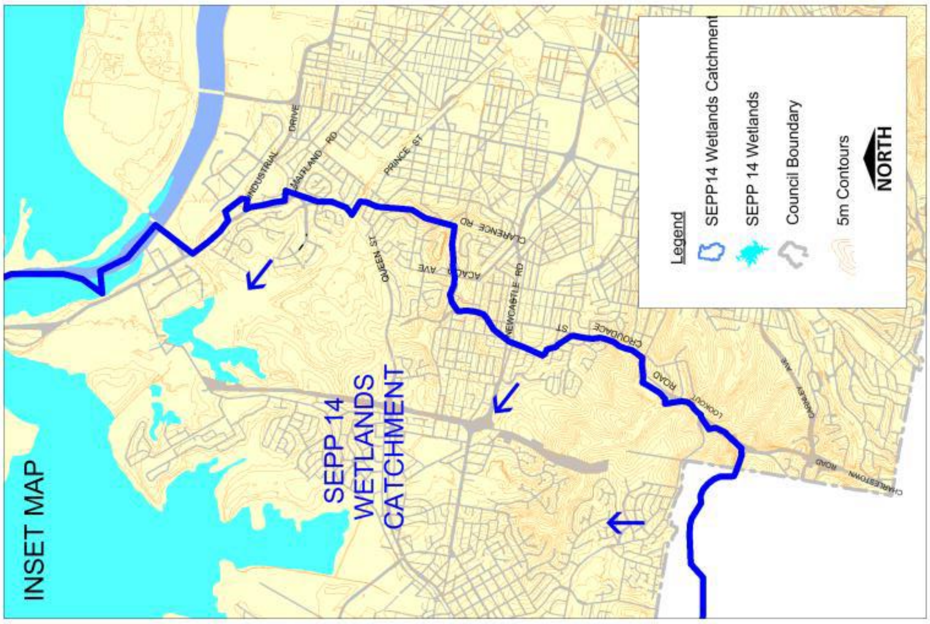
ARI (years)	AEP
1	0.632
2	0.393
5	0.181
10	0.095
20	0.049
50	0.020
100	0.010

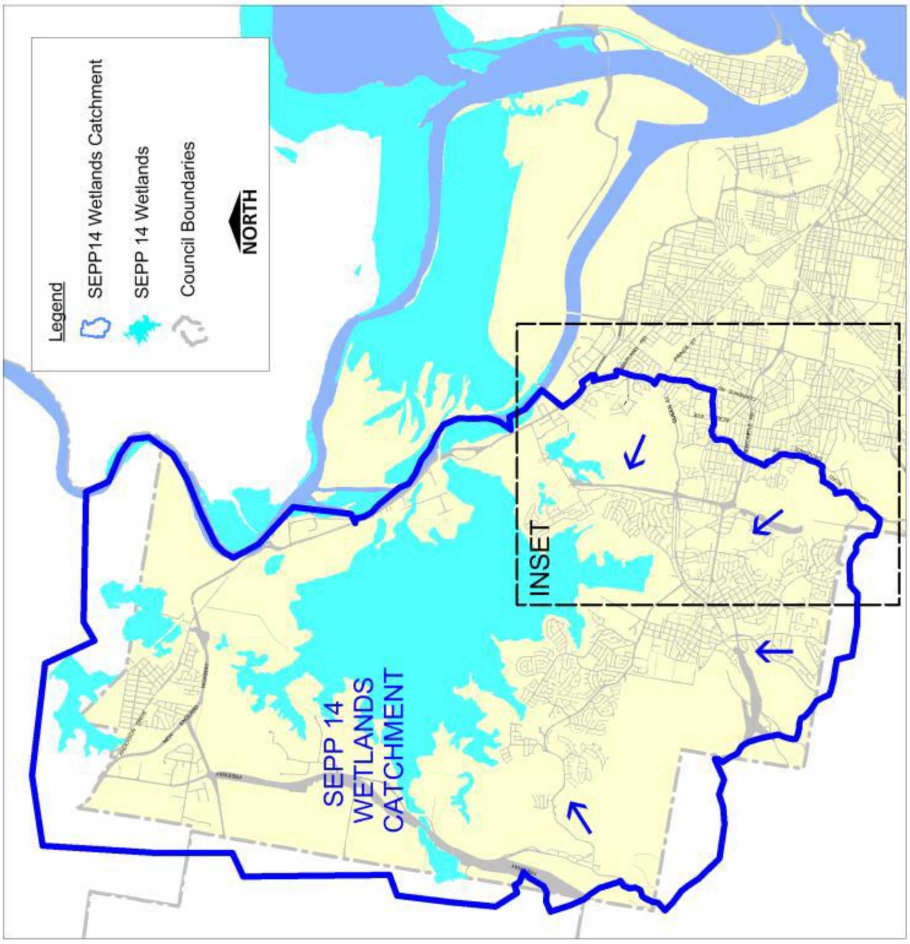
ARIs of greater than 10 years are very closely approximated by the reciprocal of the AEP.

For a more detailed account, see *Back to Basics on Flood Frequency Analysis by E.M. Laurenson*, Civil Engineering Transactions, 1987, pp. 47 to 53.

Source: Australian Bureau of Metorology, *Glossary ARI and AEP,*
http://www.bom.gov.au/water/designRainfalls/ifd/glossary.shtml

Appendix 2 - Coastal Management SEPP Wetlands Catchment

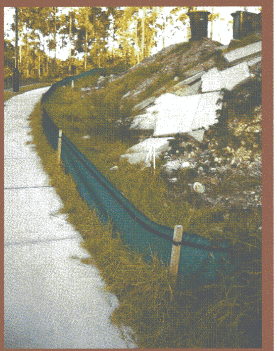


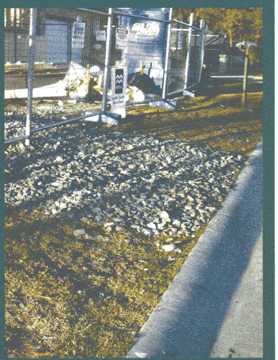


Catchment where hydrologic metrics in Water Sensitive Urban Design Solutions for Catchments Above Wetlands take precedence over the SEI. Note SEPP 14 has been updated to the Coastal Management SEPP, however the catchment area for the wetland remains unchanged.

Planning for Erosion Prevention and Sediment Control

The City of Newcastle





When is an Erosion and Sediment Control Plan required?

All builders/developers are required to prepare an Erosion and Sediment Control Plan showing how they will minimise soil erosion and trap sediment that may be eroded from the site during the construction of a building. The complexity of the Plan depends upon the nature and the scale of the particular development, especially the amount of land likely to be disturbed. In the Newcastle local government area, proposals involving disturbed areas larger than 50m² require an Erosion and Sediment Control Plan. Small-scale development, such as house extensions or the construction of standard driveways, may not require a Plan, but should still be undertaken in a manner that reduces pollution risk.

What goes in the Plan & what are my responsibilities?

Responsibilities for stormwater management arise from the Protection of the Environment Operations (POEO) Act 1997. You can comply with the POEO Act by preparing an Erosion and Sediment Control Plan that shows how you will minimise stormwater pollution and implement the Plan after Council approval.

The plan should be a stand-alone document consisting of both drawings and a commentary that can be understood easily by all site workers. This brochure outlines the information to be contained in a Plan for a single residential allotment. Make sure everyone working on the site understands the Plan and how important it is to not pollute stormwater.

The POEO Act gives Council the powers to issue clean up or prevention notices and on the spot fines of up to $1,500. Higher penalties can be imposed for serious pollution incidents, should Council institute legal action. You are required to notify Newcastle City Council when a pollution incident occurs that causes or threatens environmental harm.

Builders/developers have the responsibility to manage the following pollution sources:

- air pollution, including dust emissions;
- noise that might interfere with neighbouring properties;
- discharges, including erosion, leakage or spills of construction materials, soil, sand, gravel slurries and concrete that may enter stormwater;
- trade and domestic rubbish, including litter packaging, off-cuts and spoiled materials; and
- toxic chemicals, including fuels, paints, solvents, sealants, adhesives, lubricants and pesticides.

A number of these matters may be addressed in the Erosion and Sediment Control Plan.

COMPULSORY SIGNAGE FOR CONSTRUCTION SITES

Newcastle City Council requires all construction sites to display this sign provided by Council upon approval of a development application.

The sign must be displayed on-site at all times and be visible to the public and site workers.

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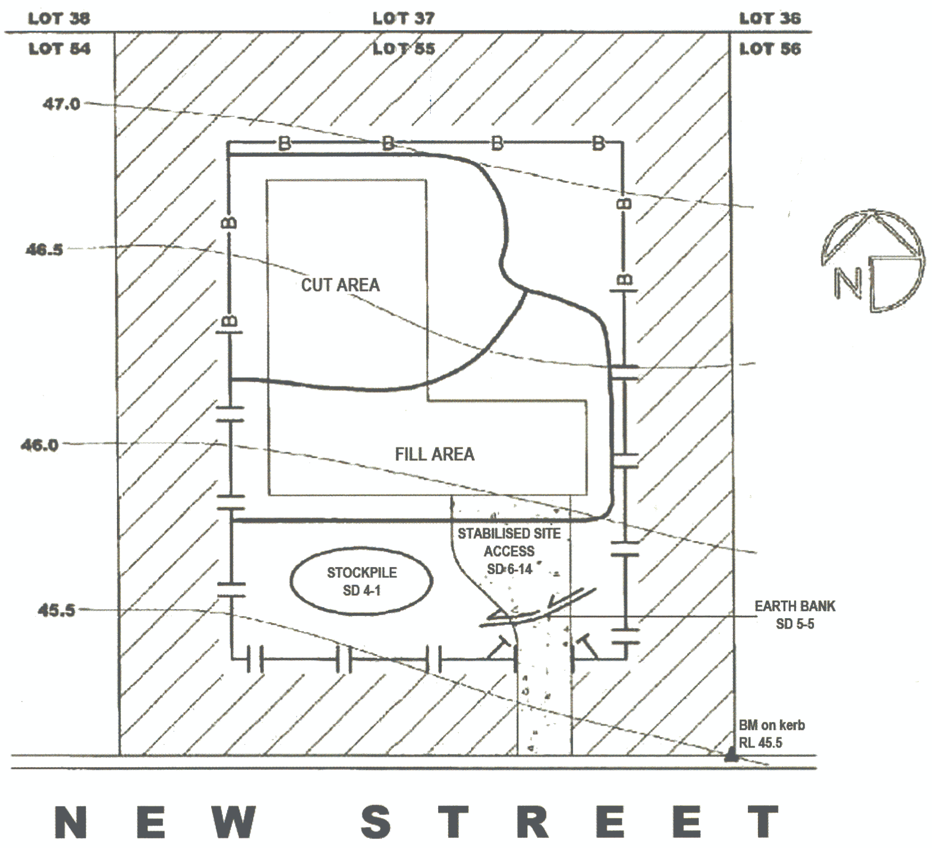
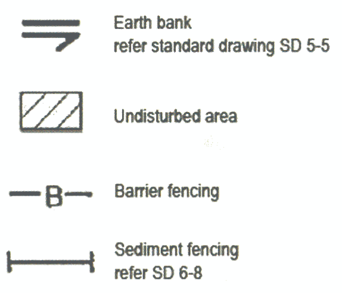
A Model Erosion and Sediment Control Plan



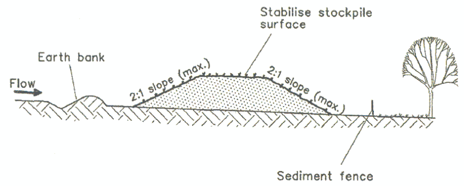
LEGEND



NOTES

1. Site works are not to start until the erosion and sediment control measures are installed and functional.
2. Entry and departure of vehicles is to be confined to the stabilised site access.
3. Topsoil is to be stripped and stockpiled for later use in landscaping the site. Topsoil is to be respread and all disturbed areas rehabilitated (turfed) within 20 working days of completion of works.
4. The footpath, other than the stabilised site access is not to be disturbed, including stockpiling of materials. Where essential works (eg drainage) are required, the footpath is to be rehabilitated (turfed) as soon as possible.
5. Bins are to be provided for building waste and arrangements are to be made for regular collection and disposal.
6. Roof guttering is to be connected to the stormwater system as soon as practicable.
7. All erosion controls are to be checked daily (at a minimum weekly) and after all rain events to ensure they are maintained in fully functional condition.

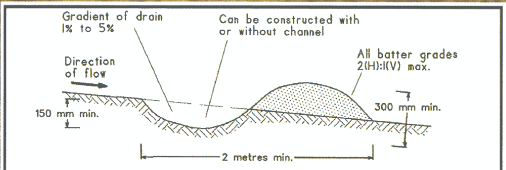
Standard Drawings



Construction Notes

1. Where possible locate stockpile at least 5 metres from existing vegetation, concentrated water flows, roads and hazard areas.
2. Construct on the contour as a low, flat, elongated mound.
3. Where there is sufficient area topsoil stockpiles shall be less than 2 metres in height.
4. Rehabilitate in accordance with the SWMP/ESCP.
5. Construct earth bank (Standard Drawing 5-5) on the upslope side to divert run off around the stockpile and a sediment fence (Standard Drawing 6-8) 1 to 2 metres downslope of stockpile.

TOPSOIL STOCKPILE SD 4-1

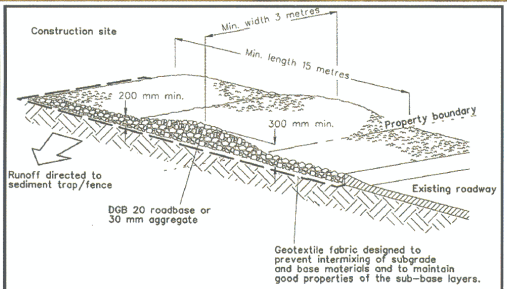


NOTE: Only to be used as temporary bank where maximum upslope length is 80 metres.

Construction Notes

1. Construct with gradient of 1 per cent to 5 per cent.
2. Avoid removing trees and shrubs if possible.
3. Drains to be of circular, parabolic or trapezoidal cross section not V-shaped.
4. Earth banks to be adequately compacted in order to prevent failure.
5. Permanent or temporary stabilisation of the earth bank to be completed within 10 days of construction.
6. All outlets from disturbed lands are to feed into a sediment basin or similar.
7. Discharge runoff collected from undisturbed lands onto either a stabilised or an undisturbed disposal site within the same subcatchment area from which the water originated.
8. Compact bank with a suitable implement in situations where they are required to function for more than five days.
9. Earth banks to be free of projections or other irregularities that will impede normal flow.

EARTH BANK (LOW FLOW) SD 5-5

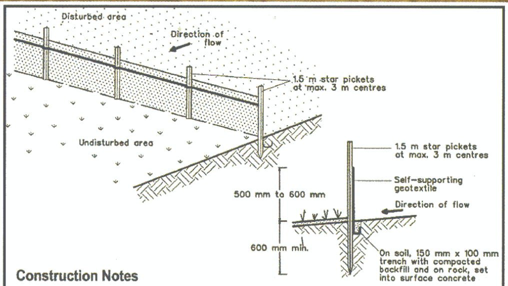


Geofabric may be a woven or needle punched product with a minimum CBR burst strength (AS3706.4–90) of 2500 N

Construction Notes

1. Strip topsoil and level site.
2. Compact subgrade.
3. Cover area with needle-punched geotextile.
4. Construct 200 mm thick pad over geotextile using roadbase or 30 mm aggregate. Minimum length 15 metres or to building alignment. Minimum width 3 metres.
5. Construct hump immediately within boundary to divert water to a sediment fence or other sediment trap.

STABILISED SITE ACCESS SD 6-14



SECTION DETAIL

Construction Notes

1. Construct sediment fence as close as possible to parallel to the contours of the site.
2. Drive 1.5 metre long star pickets into ground, 2.5 metres apart (max.).
3. Dig a 150 mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
4. Fix self-supporting geotextile to upslope side of posts with wire ties or as recommended by geotextile manufacturer.
5. Join sections of fabric at a support post with a 150 mm overlap.
6. Backfill the trenchover the base of the fabric and compact it thoroughly over the geotextile

SEDIMENT FENCE SD 6-8

Maintenance of Controls

All erosion and sediment control works should be checked daily (at a minimum weekly) and after each rainfall event to ensure they are working properly. Maintenance might include:
(i) Removing sediment trapped in sediment fences, catch drains or other areas;
(ii) Topping up the gravel on the stabilised access;
(iii) Repairing any erosion of drainage channels; or
(iv) Repairing damage to sediment fences.

Remember that the erosion and sediment control works might need to change as the slope and drainage paths change during the development phase. Best practice includes anticipation of the likely risks and being prepared for unusual circumstances, e.g. having spare sediment fence material on the site.

WAYS YOU CAN REDUCE EROSION AND CONTROL SEDIMENT ON A BUILDING OR CONSTRUCTION SITE

Follow these site management practices and you will help reduce impact on our waterways and avoid incurring a fine.

1 LIMIT DISTURBANCE WHEN EXCAVATING
Preserve as much of the vegetated area as possible. Vegetation improves the appearance of the site, greatly reduces the erosion hazard and can be a very effective natural sediment filter. The erosion hazard of well-vegetated lands is often less than 1 percent of those that have been cleared.

2 DIVERT UPSLOPE STORMWATER
Where possible to do so, divert upslope stormwater around all lands that do not have a protective vegetation cover - See Standard Drawing 5-5. Water Sheeting over the ground is one of the most effective causes of soil erosion and should be minimised.

3 INSTALL A SEDIMENT FENCE
Install sediment fences downslope of all disturbed areas to capture sediment before it gets into the gutters, drains and watercourses. For details on sediment fence construction see Standard Drawing 6-8.

4 WASH EQUIPMENT IN DESIGNATED AREA
Wash all equipment, including that with concrete waste in a designated are that does not drain to the stormwater system.

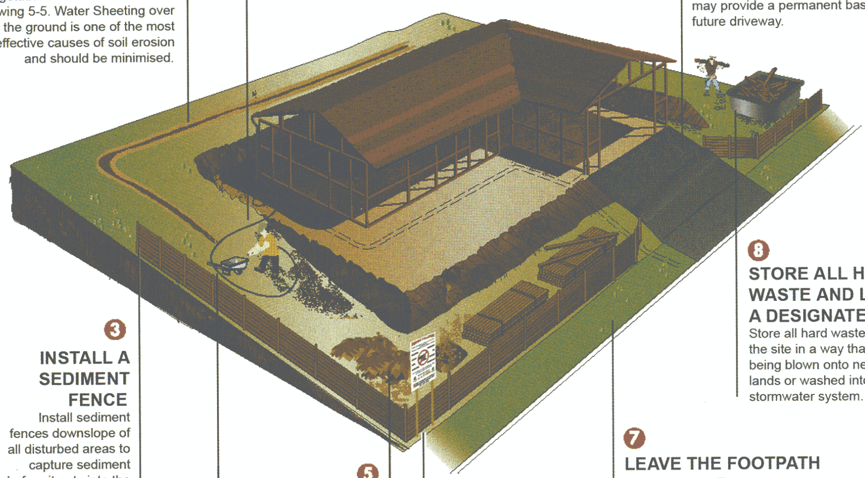
5 PLACE STOCKPILES BEHIND A SEDIMENT FENCE
Place all stockpiles totally on the site well away from drainage paths and where they comprise erodible materials such as sand and soil, behind a sediment barrier - see Standard Drawing 4-1. Ensure soil and cement bags are covered at the end of each day.

6 ERECT SIGNAGE
'Prevent Pollution' signage provided by Council must be displayed on all construction sites and be clearly visible to the public. This sign explains to builders and sub-contractors their responsibility to prevent water pollution and increases community awareness of pollution issues.

7 LEAVE THE FOOTPATH VEGETATED
Apart from the stabilised entrance, maintain a well vegetated (grassed) footpath. Keeping lands vegetated is the single most important thing that can be done to reduce erosion hazard.

8 STORE ALL HARD WASTE AND LITTER IN A DESIGNATED AREA
Store all hard waste and litter on the site in a way that will prevent it being blown onto neighbouring lands or washed into the stormwater system.

9 RESTRICT VEHICLE MOVEMENTS TO A STABILISED ACCESS
Restrict all vehicle movements onto the site to a stabilised access as shown on Standard Drawings. This allows all-weather entry/exit, reduces how much soil is carried to the street and may provide a permanent base for the future driveway.



Site Rehabilitation

The Rehabilitation of construction sites should be carried out quickly, progressively stabilising disturbed areas with vegetation or landscaping. Maintenance of sediment controls will continue to be necessary until all pollution sources from the site are stabilised (e.g. maintain sediment fences until turf establishes).

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Information contained in this brochure is courtesy of: Landcom (2004) *Managing Urban Stormwater: Soils and Construction*, 4th Edition.

Appendix 4 - Planting List

Lists the major macrophyte plant species that may be used within biofiltration devices in the City of Newcastle.

Recommended planting density is 5 per square metre. Plant selection is to consider areas of differing wetting and drying regime over the entire device.

Emergent Macrophytes for permanent water zones	Growth Form	Max Height	Zone	Growth Rate	Salt Tolerance
Baumea rubiginosa Soft Twigrush	Rhizomatous	2.0	0-500 Shallow marsh	Slow	Mod
Bolboschoenus caldwellii Sea clubrush	Rhizomatous	1.0	0-300 Shallow marsh	Fast (Bulb)	Mod-High
Bolboschoenus fluvitiatilis Marsh clubrush	Rhizomatous	1.5	0-300 Shallow marsh	Fast (Bulb)	Mod
Carex appressa Tussock Sedge	Tufted	1.0	Sporadically Flooded Ephemeral zone	slow	Low
Cyperus exaltatus Giant Sedge	Tufted	2.0	0.300 Shallow marsh	fast	Low-Mod
Cyperus laevigatus Smooth Flatsedge		1.5	0.300 Shallow marsh	Mod	High
Phragmites australis Common Reed	Rhizomatous	3.0	0-600 shallow-Deep Marsh	Mod	Mod-high
Shoenoplectus mucronatus Bog Bulrush	Tufted	1.2	0-600 shallow Marsh	Mod	Low
Shoenoplectus validus River clubrush	Rhizomatous	2.0	0-400 shallow Marsh	mod	Low-mod
Gahnia sieberiana Sawsedge	Tufted	2.5	Sporadically Flooded Ephemeral zone	slow	Low
Juncus usitatus Common Rush	Tufted	1.2	Sporadically Flooded Ephemeral zone	slow	Low
Juncus krausii Sea rush	Clump forming	1.5	Sporadically Flooded Ephemeral zone	Slow	High
Bioretention rain garden and swales	**Growth Form**	**Max Height**	**Zone**	**Growth Rate**	**Salt Tolerance**
Carex appressa Tussock Sedge	Tufted	1.0	Base	slow	Low
Juncus usitatus Common Rush	Tufted	1.2	Base	slow	Low
Juncus krausii Sea rush	Clump forming	1.5	Base	Slow	High
Gahnia sieberiana Sawsedge	Tufted	2.5	Base	slow	Low
Lomandra Longifolia Spiny-Headed Mat Rush	Clump forming	0.7	Base		Mod
Crinum peduncalutum Swamp lilly		1-2	Base		Mod
Isolepis nodosa Knobby Club Rush	Clump forming	0.7	Batters / sides		Mod
Carpobrotus glaucescens Coastal Pigface	Ground cover	0.2	Batters / sides		High
Leptospermum Laevigatum Coastal Tea Tree	Shrub	1-2	Batters / sides		Mod

THE FOLLOWING IS A LIST OF MACROPHYTE PLANTS, THAT CAN BE USED TO INCREASE THE BIODIVERSITY OF THE PLANTING AREA, BUT ARE NOT SUITABLE FOR LARGE AREA PLANTINGS

Alisma plantago-aquatica Water plantain	Emergent broad leaf, tufted	1.0	0.300 Shallow marsh	fast	low
Philydrum lanuginosum Wolly frogmouth	Emergent narrow leaf, tufted	2.0	0-2000 Shallow-deep	Mod-fast	low

Appendix 5 - Asset Transfer Checklist Example

Asset I.D.:		
Asset Location:		
Construction by:		
Defects and Liability Period:		
TREATMENT	**Yes**	**No**
System appears to be working as designed visually?		
No obvious signs of under-performance?		
MAINTENANCE	**Yes**	**No**
Maintenance plans and indicative maintenance costs provided for each asset?		
Vegetation establishment period completed (as per requirements)?		
Inspection and maintenance undertaken as per maintenance plan?		
Inspection and maintenance forms provided?		
ASSET INSPECTED FOR DEFECTS AND/OR MAINTENANCE ISSUES AT TIME OF ASSET TRANSFER	**Yes**	**No**
Sediment accumulation at inflow points?		
Litter within device?		
Erosion at inlet or other key structures?		
Traffic damage present?		
Evidence of dumping (eg. building waste)?		
Vegetation condition satisfactory (density, weeds)?		
Watering of vegetation required?		
Replanting required?		
Mowing/slashing required?		
Clogging of drainage points (sediment or debris)?		
Evidence of ponding?		
Damage/vandalism to structures present?		
Surface clogging visible?		
Drainage system inspected?		
COMMENTS / ACTIONS REQUIRED FOR ASSET TRANSFER		
ASSET INFORMATION	**Yes**	**No**
Design Assessment Checklist provided?		
As constructed plans provided?		
Copies of all required permits (both construction and operational) submitted?		
Proprietary information provided (if applicable)?		
Digital files (eg drawings, survey, models) provided?		
Asset listed on asset register or database?		
Name:		
Position:		
Signature:		

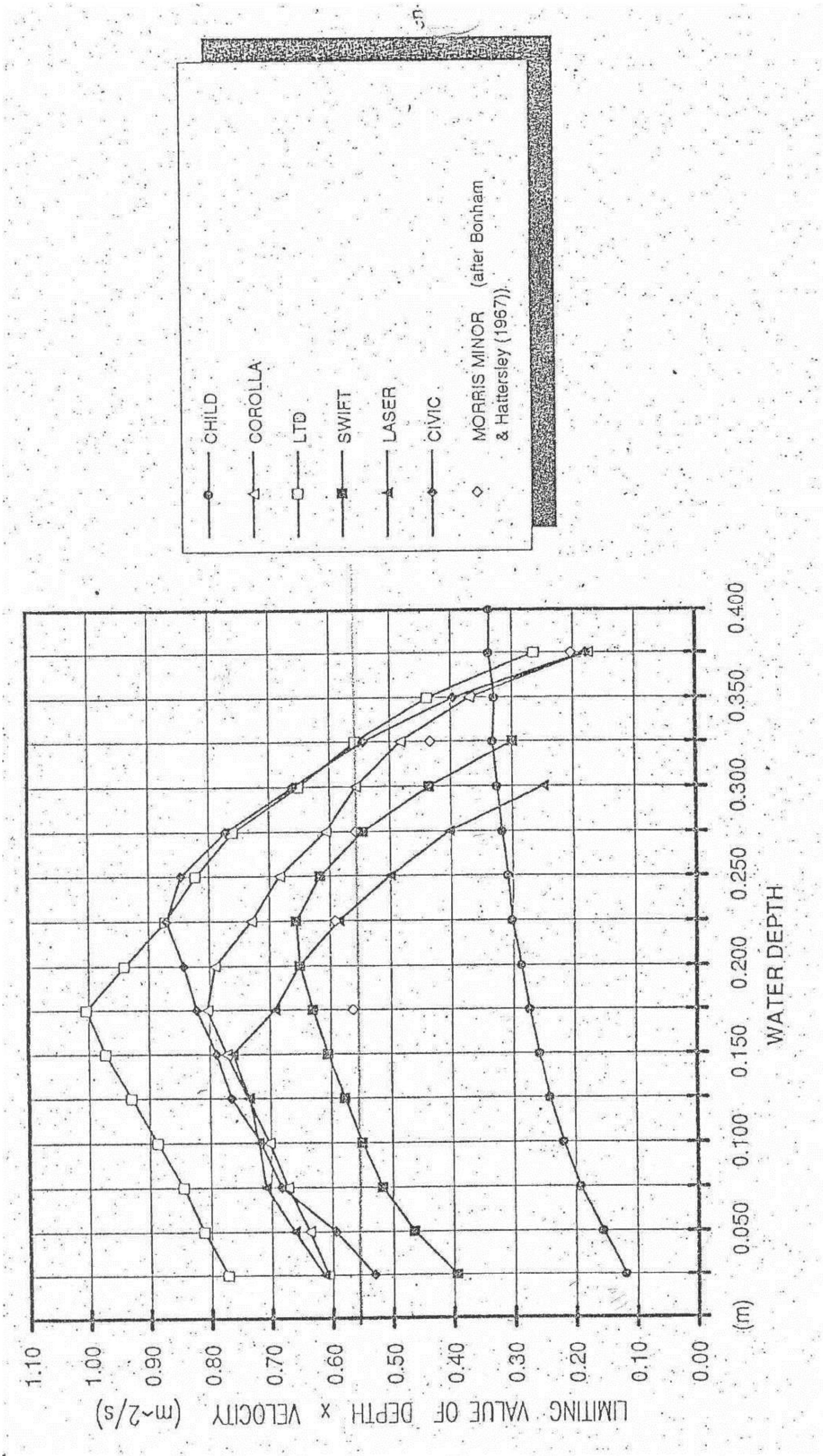
Appendix 6 - Example regular maintenance checklist for Bioretention Basins

(after Landcom Water Sensitive Urban Design Book 4 Maintenance Guidelines)

Item		Performance target	Schedule maintenance or investigation	Immediate action required	Comment	Action processed
		(circle relevant category)				
1	GPT / trash rack/s	GPT clear of litter	GPT 10 percent full	Greater than 30 percent full		
2	Inlet structures	Clear and undamaged	Partially blocked observed damage	Mostly blocked Severe damage		
3	Overflow pits	Clear and undamaged	Partially blocked observed damage	Mostly blocked Severe damage		
4	Underdrains	Clear and undamaged	Partially blocked observed damage	Mostly blocked Severe damage		
5	Sediment Forebay	Sediment absent	Sediment accumulation appears excessive	Sediment accumulation to half the basin depth		
6	Erosion	Erosion absent	Erosion damage visible, but function not impaired	Severe erosion. Damage impairing function of device	eg. Location (mark on attached map of bioretention basin)	
7	Sediment accumulation (bioretention basin)	Sediment absent	Sediment accumulation appears excessive in sediment forebay. Fine sediment accumulation apparent on bioretention media surface.	Sediment accumulation to half the forebay depth. Coarse sediment or large volumes of sediment accumulation apparent on the bioretention media surface.	eg. Location (mark on attached map of bioretention basin)	
8	Compaction of filter media surface	No compaction evident	Localised compaction or subsidence evident. Localised ponding longer than 24 hours after storm event.	Water remains ponding longer than 24 hours after storm event.	eg. Location (mark on attached map of bioretention basin)	
9	Weeds	No weeds present	Weeds present	Noxious or environmental weeds present, or weed cover more than 25%	eg. Location (mark on attached map of bioretention basin) Identify weed species	

Item		Performance target	Schedule maintenance or investigation	Immediate action required	Comment	Action processed
		(circle relevant category)				
10	Plant condition	Healthy vegetation	Poorly growing or visibly stressed	Die back/dead plants	eg. Location (mark on attached map of bioretention basin) Identify species requiring replacement	
11	Litter (organic)	No litter visible	Litter visible	Litter thickly covers filter media surface or detracting from visual amenity	eg. Location (mark on attached map of bioretention basin) Note type of litter removed	
12	Litter (anthropogeni c)	No litter visible	Litter visible	Litter blocking structures or detracting from visual amenity	eg. Location (mark on attached map of bioretention basin) Note type of litter removed	
13	Oil spills/ inflows	No visible oil	Persistent but limited visible oil	Extensive or localised thick layer of oil visible.		

Appendix 7 - Stability of children and cars in flooded streets



Appendix 8 - Guidance on meeting requirements for coastal wetland catchments

Introduction

Hexham Swamp is a large mosaic wetland located in the floodplain of the Hunter River. Hexham Swamp is a costal wetland and is protected under the Coastal Management SEPP. It has been substantially modified due to past flood management practices (installation of flood gates on outlets from the swamp into the Hunter River), previous land use practices including agricultural, residential and industrial development and construction of major infrastructure services (e.g. rail and road corridor).

Changes to the DCP and Technical Manual have been made in early 2017 which effects development in catchments which drain to coastal wetlands. The key change is to provide clearer guidance on the hydrology objectives for management of new development in these catchments.

The central justification for this update is that it is clear that the current objectives and guidance are not sufficient. Furthermore it is not clear what is being required from developers in catchments draining to coastal wetlands.

The water quality and water quantity targets in Table 4 of the DCP aim to mitigate the impacts of development on both the quantity and quality of stormwater generated from urban areas. The targets for coastal wetlands are different for those in other catchments, where a best management practice approach is required. Whilst the targets are different in coast wetlands, the approach for meeting the requirements remains similar to other parts of the LGA, where applications are broken into small and large scale developments based on their size.

For small scale developments in coastal wetland catchments, applicants can simply follow the deemed to comply solution that has been tested and fulfils the targets of the DCP.

For large scale developments in coastal wetland catchments, applicants can either follow the deemed to comply solution or develop their own unique stormwater treatment train that meets the targets of the DCP. Large Scale developments are required to demonstrate that the DCP targets have been satisfied with hydrological and water quality modelling.

Deemed to comply requirements for coastal wetland catchments

Suitable for both small and large scale developments.

For the majority of developments, particularly those on low permeability clay soils and without access to high non-potable demands, this deemed to comply approach is recommended to be adopted. For developments, such as those on higher permeability sandy soils, developments with a high non-potable water demand or high density developments, an alternate strategy which meets the objectives should be considered. A tailored strategy for these types of development is recommended, but is not required. Guidance is provided for this in the following section. Note that a deemed to comply solution is still acceptable in all instances.

The deemed to comply scenario includes the following components:

1. Rainwater tanks configured such that:
    - 100% of the roof area drains to a rainwater tank.
    - All roofs greater than 10 m^2 drain to a rainwater tank
    - The tank is only to be connected to roof areas
    - The size of the tank is based on the roof area. Refer to DCP table 3 for details.

2. 50% of the rainwater tank is to be provided as air space. The top half of the rainwater tank is to drain to a small 5mm weep hole into an infiltration basin located on the lot. The weep hole is to be located at the mid-point of the tank and is to drain to the overflow pipe for the rainwater tank:

3. The rainwater tanks must re-use water volumes as outline in Table 4.1 of this manual and shall be plumbed into the following non potable uses:
   - irrigation
   - outside taps
   - all toilets
   - washing machine taps and all laundry basin taps
   - hot water service

4. Other than for a single dwelling house with an allotment area less than 600m^2 an end of pipe bioretention system(s) is required which treats the entire runoff from the development in addition to the rainwater tank. Section 4.6 describes how the bioretention system can be configured. Alternatively an On-site Retention tank (see Section 4.3 of this manual) can be used in cases where bioretention is constrained in a development.

   In addition to Section 4.6, the bioretention shall have the following parameters:
   - A filter area which is 2.75% of the total impervious area within the development including all hard surfaces in the catchment draining such as roofs, driveways, paved areas, footpaths, roads, etc)
   - A minimum of 500mm depth of free draining bioretention system filter media
   - An unlined saturated zone at the base of the bioretention zone which contains at least 400mm depth below the free draining portion of the bioretention system (i.e. a minimum total depth of all media in the bioretention system of 900mm, consisting of a minimum 500mm free draining material and a minimum of 400mm saturated material). This media can consist of the transition layer and gravel
   - A total phosphorous content less than 30 mg/kg for any media (filter, transition or drainage layer) placed in the bioretention system
   - A pump offtake pit is to be provided for potential reuse by Council where the bioretention is located in public land. The pump pit must allow draining of the entire saturated zone of the bioretention system and is to be easily accessible by a small maintenance vehicle.

Satisfying DCP targets for Coastal Wetlands

The approach for stormwater management solutions for catchments draining to coastal wetlands is to provide a site specific solution for all large scale development with supporting MUSIC modelling and hydrology analysis. This can be achieved using the methods below for meeting the hydrology objectives of the DCP:

1. Deemed to comply - a prescribed solution that can be used to inform certain aspects of the site specific approach

   To meet the hydrology objectives for development draining to coastal wetlands, a deemed to comply solution has been developed. For the majority of developments, particularly those on low permeability clay soils and without access to high non-potable demands, this approach can be adopted and is outlined by the rainwater tank sizing in Section 7.06 Stormwater of the DCP, and the inclusion of site discharge controls that consist of either an on-site retention system (Section 4.3) or a bioretention system (Section 4.6.8).

2. Site specific - a tailored solution requiring a detailed MUSIC model and hydrology analysis in a spreadsheet, to demonstrate that the site specific approach meets the hydrology objectives

   For developments such as those on higher permeability sandy soils, developments with a high non-potable water demand or high density developments, an alternate strategy which meets the objectives should be considered. A tailored strategy for these development is recommended, but is not required. Guidance is provided for this in the following section. Note that a deemed to comply solution is still acceptable in all instances.

The key attributes of wetland hydrology are expressed in two indices that can be calculated relatively simply for pre- and post-development catchment conditions. These two indices include the high and low flow duration frequency curves. Details of these indices and a procedure for their calculation are described below.

Drying and flooding hydrology are defined by the following parameters:

1. Drying hydrology: Low Flow Duration Frequency Curve for the September-February period (this period has been identified as the critical wetland drying period in Newcastle, as on average, potential evapotranspiration exceeds rainfall during these months)

2. Flooding hydrology: High Flow Duration Frequency Curve for the entire year

Low and High Flow Duration Frequency Curves are produced for a particular "reference duration". These parameters are described in detail in the following sections, including information on how to produce the curves.

Low Flow Duration Frequency Curve

The low flow duration frequency curve is based on the average daily flow over 30 days for coastal wetlands in the Newcastle LGA. This duration has been selected to reflect the natural periods over which wetting and drying cycles occur. For the key period of interest (i.e. September – February which is the key dry season), the <u>lowest average flow</u> over the 30 day duration is identified during this period and the <u>annual values</u> are ranked, and plotted against the exceedance probability.

The low flow duration frequency curve is produced by the following steps:

1. Run MUSIC at a six minute time step for three scenarios
   - pre development. The pre-development scenario must consist of 100% pervious catchment node.
   - post development without mitigation.
   - post development with proposed mitigation measures
2. For all scenarios adopt the MUSIC-Link soil parameters for the particular catchment area
3. MUSIC is to be run for the following 10 year period from 1/1/1999 to 31/12/2008 using the 61078 Williamtown Pluviograph
4. Export the results from MUSIC at the outlet ("receiving water" node) into a <u>daily flow</u> time series
5. For each daily time step, calculate the average flow for the previous 30 days
6. For the period September to February, determine the minimum average flow (one value each year)

7. Rank the minimum average flows from highest to lowest and plot a probability distribution curve

An example of two low flow duration frequency curves is shown in Figure 4.16.1. This was produced for a 30 day reference duration, for a hypothetical 10 ha catchment before and after development (without any measures to mitigate hydrological impacts). Figure shows, for example:

- Before development, the average 30 day flow reaches a value greater than $10m^3$/day in only 10% of all dry seasons.
- After development, the average 30-day flow reaches a value greater than $10m^3$/day in 60% of all dry seasons (a significant change).

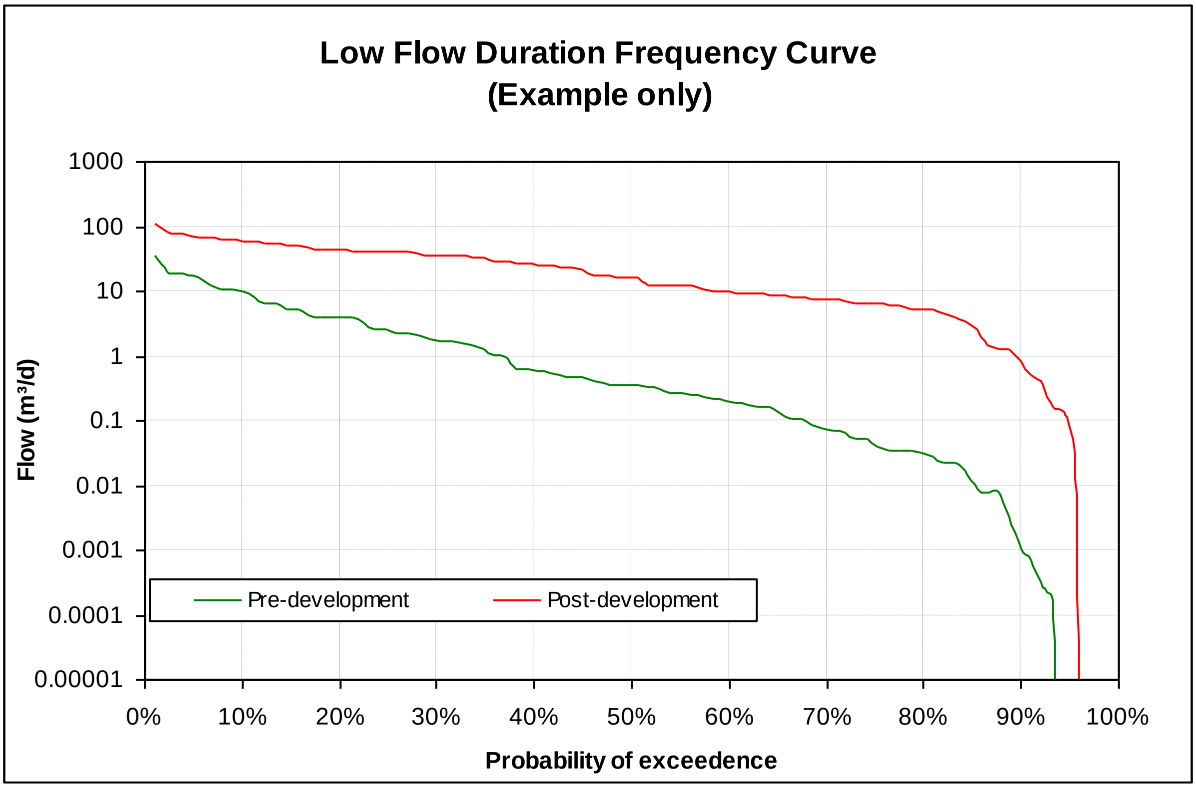


Figure 4.16.1: Example low flow duration frequency curve

High Flow Duration Frequency Curve

The high flow duration frequency curve is based on the average daily flow over a 7 day period. The high flow duration is produced for the entire year (as a flood event can occur at any time of the year). The highest average 7 day flow is identified for each year and these are plotted against exceedance probability.

The high flow duration frequency curve is produced via a similar method to the low flow duration frequency curve, and Steps 1 to 5 are identical:

1. Run MUSIC at a six minute time step for three scenarios
   - pre development. The pre-development scenario must consist of 100% pervious catchment node.
   - post development without mitigation.

- post development with proposed mitigation measures

2. For all scenarios adopt the MUSIC-Link soil parameters for the particular catchment area
3. MUSIC is to be run for the following 10 year period from 1/1/1999 to 31/12/2008 using the 61078 Williamtown Pluviograph
4. Export the results from MUSIC at the outlet ("receiving water" node) into a daily flow time series
5. For each daily time step, calculate the average flow for the previous 7 days
6. Determine the maximum average flow for the entire year (January to December)
7. Rank the maximum average flows for each year from highest to lowest and plot a probability distribution curve

An example of two high flow duration frequency curves is shown in Figure 4.16.2. This was produced for the same hypothetical scenario as Figure 4.16.1. Figure 4.16.2 shows, for example:

- Before development, the average 7 day flow exceeds 1,000 m^3/s in approximately 20% of all years
- After development, the average 7 day flow exceeds 1,000 m^3/s in approximately 30% of all years

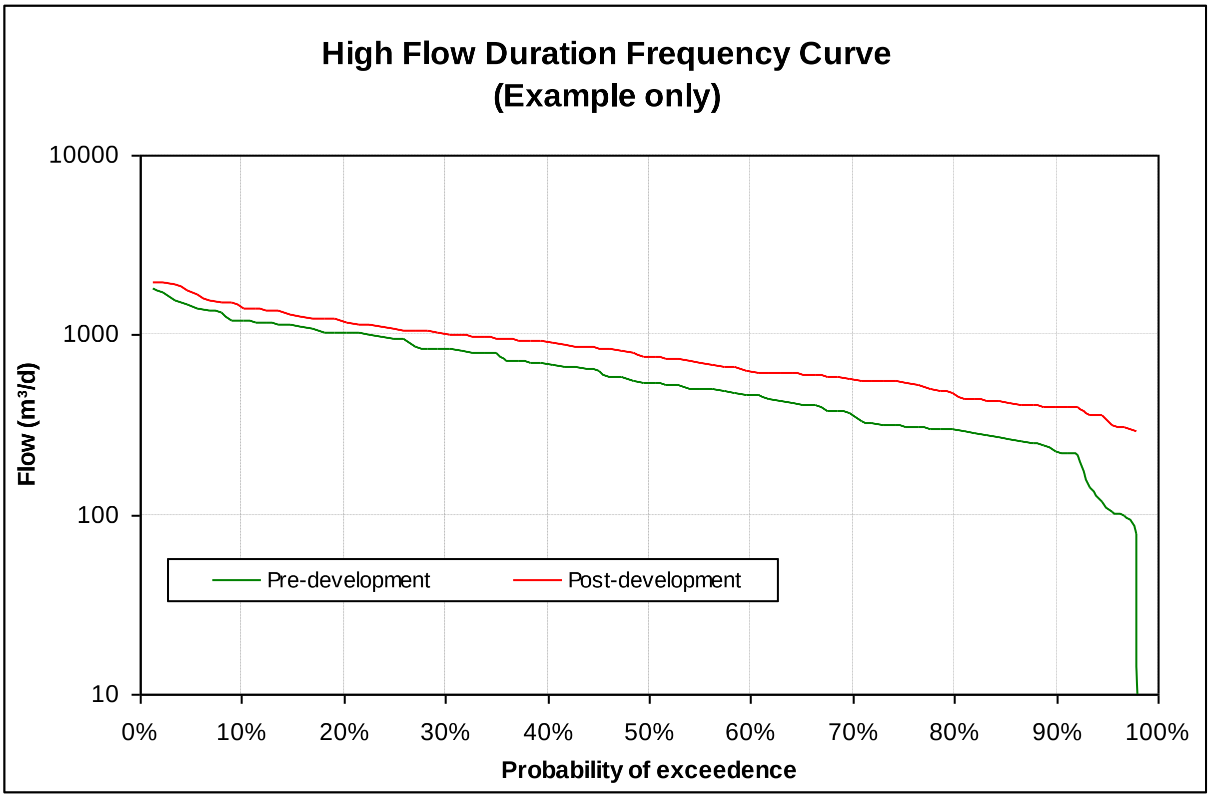


Figure 4.16.2: Example high flow duration frequency curve

Demonstrating compliance with the objectives

In order to demonstrate compliance with the hydrology objectives, it is necessary to produce the relevant high and low flow duration frequency curves, for:

- Pre development conditions (100% pervious)
- Post-development conditions without mitigation
- Post-development conditions with mitigation

To achieve compliance the following is required:

- Low flow duration frequency curve: the post development with mitigation is equal to or less than the pre-development for all values up to and including the 80 percentile
- High flow duration frequency curve: the post development with mitigation is equal to or less than the pre-development for all values up to and including the 80 percentile

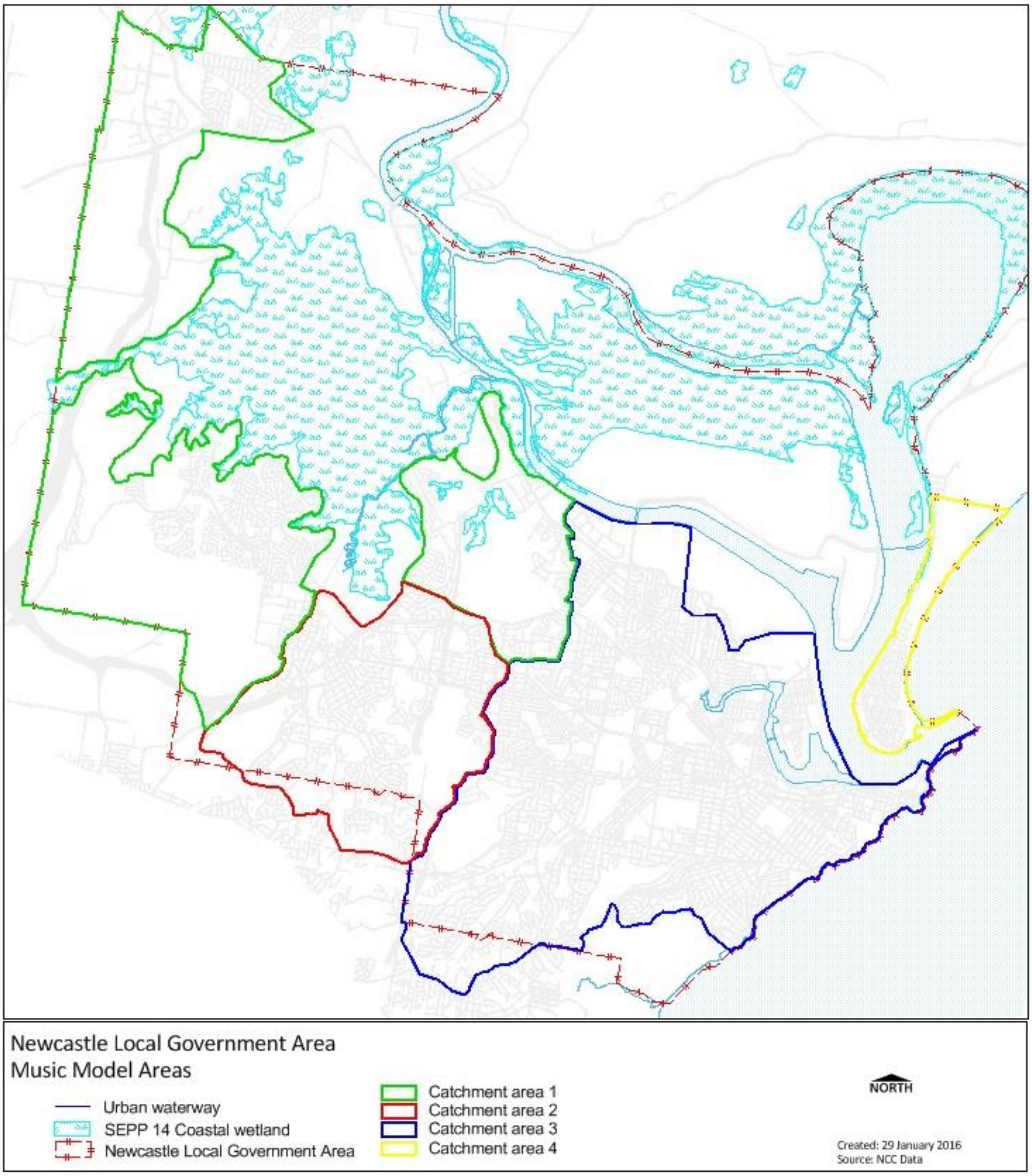
All devices which use infiltration must clearly state the infiltration rate adopted. The infiltration rate adopted must be accompanied by site specific soil investigations including field infiltration tests and laboratory tests by a suitably qualified geotechnical or soil scientist. The infiltration rate(s) is to be used in MUSIC for the relevant treatment node(s).

Soil infiltration testing must be undertaken at all proposed locations of end of pipe treatment systems with a minimum of 3 field and 3 lab tests per end of pipe treatment location.

For those proposed mitigation measures which utilise stormwater reuse, the proposed (or actual) reuse demands are to be clearly stated. The proposed reuse demands adopted are to be clearly stated and justification of the values adopted is to be provided. The proposed reuse demands are to be compared to appropriate benchmarks (e.g. for irrigation demand this would be ML /Ha of irrigated field). Where actual reuse demands (e.g. existing sports ovals, existing industrial non-potable demands) historical water consumption values are to be adopted and data provided on these demands.

The adopted impervious area must be clearly stated. Providing generic rates or values for impervious areas for the development is not suitable and all post-development impervious rates must be substantiated. The impervious area values are to be justified using either development plans showing proposed lot sizes and house footprints as well as proposed road layouts or alternatively using an adjacent –development which has been recently developed which is considered to be of similar density to the proposed development. Proponents are encouraged to minimise the amount of impervious area in catchments draining to coastal wetlands.

Appendix 9 - MUSIC model map (catchment areas)



Note: Catchment 1 and 2 are in the coastal wetland catchment where specific hydrology objectives apply. Standard objectives apply to catchments 3 and 4.

Appendix 10 - Specification for Acceptance of Drainage Defects

ACCEPTANCE OF DRAINAGE DEFECTS

PREFACE

This document was prepared by Newcastle City Council (Council) to specify the process of identifying and assessing defects for acceptance in drainage infrastructure that is to be dedicated to Council.

Council's minimum condition standards for new drainage infrastructure are set out by this Specification which references WSA 05-2008 2.2 for acceptability of defects. Defects that are unacceptable require remediation in order to achieve the minimum standard for Council to accept as public assets.

Table 3 of this document supplements WSA 05-2008-2.2 Table F1 by specifying Council's position when required to review crack defects in reinforced concrete conduits for acceptance.

This document also specifies:

- The acceptability of manufacturer defects and handling damage in pipes and culverts prior to installation,
- When stormwater inspections are required, and
- Acceptable remediation techniques for cracks in pipes and culverts.

The term 'defect' has been used in this specification to define damage to an asset identified during the construction stage and up until the end of the Defects Liability Period. All crack defects in reinforced concrete pipes and culverts are subject to assessment under this Specification when receiving delivered items, claiming Practical Completion and before release of security held for the Defects Liability Period.

Practical Completion may not be achieved should Council's minimum condition standards not be met or the project contains defects that require monitoring. In this event, Council may propose an agreement which imposes further security in exchange for a Subdivision Certificate.

Defects identified during the Defects Liability Period are subject to the requirements of the Conditions of Consent for the development.
The term 'conduit' has been used in this specification to signify pipe or culvert stormwater drainage assets.

DAMAGE BEFORE INSTALLATION

1. All conduits are to be visually inspected for acceptance when receiving delivery. The site supervisor has the authority to reject any conduit that does not meet the relevant Australian Standard. **Reject delivery policy**

2. The acceptance of pipes upon delivery to the site shall be in accordance with Table 1 (which has been simplified from AS4058). **Defects in delivered pipes**

Table 1 - Acceptance of Defects in Delivered Pipes

Defect Description (AS4058 classification)	**Acceptance**
Hairline cracks or crazing cracks associated with concrete shrinkage.	• Accepted
Type 1 & 2 • Cracks up to 0.15mm not extending through the wall. • Cracks over 0.1mm in pipes intended for marine use.	 • Accepted • Accepted
Type 3 • Cracks over 0.15mm or cracks extending through the wall. • Cracks over 0.1mm in pipes intended for marine use.	 • Rejected • Rejected

Type 4 • Dents, bulges, chips and spalls up to 2.5mm deep/high and up to 50mm long. • Surface blowholes less than 4mm deep and less than 10mm in diameter	• Accepted • Accepted
Type 5 • Dents, bulges, chips, spalls and bony patches up to 5mm deep/high and up to 50mm long. • Bony patches on socket back walls less than 5mm deep. • Surface blowholes less than 4mm deep and more than 10mm in diameter. • Visible inclusions of foreign matter less than 0.1% of either the inside or outside surface with no individual area more than 400mm^2 in area.	• Acceptable after repair • Acceptable after repair • Acceptable after repair • Acceptable after repair
Type 6 • Dents, bulges, chips, spalls and bony patches more than 5mm deep/high and up to 50mm long. • Bony patches on socket back walls more than 5mm deep. • Surface blowholes more than 4mm deep. • Defects as described above that are confined to the joints.	• Rejected • Rejected • Rejected • Acceptable after repair
Type 7 • Visible inclusions of foreign matter more than 0.1% of either the inside or outside surface or with an individual area more than 400mm^2 in area. • Defects as described above that are confined to the joints.	• Rejected • Acceptable after repair

3. The acceptance of culverts upon delivery to the site shall be in accordance with Table 2 (which has been simplified from AS4058). **Defects in delivered culverts**

Table 2 - Acceptance of Defects in Delivered Culverts

Defect Description (AS1597 classification)	**Acceptance**
Type 1 • Cracks up to 0.15mm not extending through the wall for B1 environment. • Cracks up to 0.20mm not extending through the wall for B2 and C environments.	• Accepted • Accepted
Type 2 • Cracks up to 0.30mm not extending through the wall.	• Acceptable after repair
Type 3 • Cracks over 0.30mm or cracks extending through the wall.	• Rejected
Type 4 • Dents, bulges, chips and spalls up to 5mm deep/high and up to 50mm from its centroid. • Surface blowholes less than 5mm deep and less than 10mm in diameter.	• Accepted • Accepted
Type 5 • Dents, bulges, chips and spalls 5mm deep/high and up to three quarters of the cover. • Bony patches of depth not more than the cover and extending not more than 150mm from its centroid. • Surface blowholes larger than 5mm deep and more than 10mm in diameter. • Visible inclusions of foreign matter less than 0.1% of the precast surface area either inside or outside. No individual inclusion greater than 500mm^2 in area.	• Acceptable after repair • Acceptable after repair • Acceptable after repair • Acceptable after repair
Type 6 • Dents, bulges, chips and spalls and visible inclusions of foreign matter larger than type 5.	• Rejected

DAMAGE DURING INSTALLATION

1. Conduits that experience damage while being handled are to be reassessed against Table 1 or Table 2, whichever is relevant. Conduits with defects that are 'Rejected' or 'Acceptable after repair' are to be replaced or repaired at time of installation. **Damage during handling**

2. In order to avoid damaging the conduit during installation, ensure minimum thicknesses of embedment or backfill layers are met and compaction machinery and techniques are acceptable. **Damage during installation**

3. In order to avoid damaging newly installed conduits, ensure construction traffic loads do not exceed the pipe's capacity. Temporary protection measures, such as bridging plates or exclusion zones, should be implemented where required to mitigate damage. **Construction loads**

INSPECTION REQUIREMENTS FOR DEDICATING ASSETS TO COUNCIL

1. A minimum of two (2) inspections will be required to be undertaken for all installed conduits to be dedicated to Council, to demonstrate the standard of constructed infrastructure is acceptable when claiming Practical Completion and release of security held for the Defects Liability Period (DLP). recovery **Inspections**

2. Existing conduits that are to be utilised within the design are also to be inspected and reported to Council. Council will advise if any repair / upgrades to the existing system are required. **Connecting infrastructure**

3. For conduits installed under road pavement, the first inspection shall be undertaken after the final pavement seal has been placed and not more than two (2) weeks before Practical Completion. **First inspection**

   For conduits installed within the road reserve (but not under road pavement), the first inspection shall be undertaken not more than two (2) weeks before Practical Completion.

   For conduits installed outside the road reserve, the first inspection shall be undertaken after the final placement of topsoil and not more than two (2) weeks before Practical Completion.

4. A second inspection of all drainage is required to be undertaken (2) weeks before expiration of the DLP. **Second inspection**

5. Additional inspections as required: **Additional inspections (as required)**
   - To inspect remediation / repair works,
   - When inspections are not performed in accordance with relevant specifications, and
   - At the end of any required monitor periods (refer Table 3).

INSPECTION METHODS

1. Conduits up to 2000mm in diameter or 2000mm high by 900mm wide are to be remotely CCTV inspected to WSA 08-2008 2.2. **Up to 2000mm dia**

2. Conduits greater than 2000mm diameter or 2000mm high by 900mm wide and where a CCTV camera cannot be maintained centrally (±10% of diameter or vertical and horizontal dimensions) the conduit is to be inspected by way of handheld video camera. Compliance with the WHS Act and Regulations must be achieved, in particular those pertaining to Confined Space Entry. Defects are to be photographed and accurately measured using appropriate tools (such as feeler gauges to AS4058 Appendix C). **Over 2000mm dia**

INSPECTIONS AND REPORTING

1. The inspection shall be carried out in accordance with Council's Specification for Drainage Inspection Reporting with reference to Water Services Association of Australia (WSAA) "Conduit Inspection Reporting Code of Australia" (WSA 05-2008 2.2). **Inspections and reporting**

2. Prepare and submit a Microsoft Excel compatible spreadsheet listing all defects with the following information: **Defect assessment spreadsheet**
   - Line (drainage line reference)
   - Starting pit
   - Finishing pit
   - Defect chainage (m)
   - Defect/Feature (as inspected to WSA 05-2008 2.2)
   - Characterisation 1 (as inspected to WSA 05-2008 2.2)
   - Characterisation 2 (as inspected to WSA 05-2008 2.2)
   - Quantification 1 (as inspected to WSA 05-2008 2.2, width in mm for cracks)
   - Acceptance determination (to WSA 05-2008 2.2 Table F1 and Table 3 of this Specification)

ACCEPTANCE CRITERIA AND REMEDIAL ACTION FOR DEFECTS AFTER INSTALLATION

1. The inspection and drainage infrastructure will be acceptable if Council is satisfied that the inspection was performed in accordance with the relevant specifications and no defects are assessed as 'Rejected' or 'Not acceptable'. **Acceptance of inspection**

2. Council understand that inspectors can inaccurately quantify CCTV measurements; therefore, all measurements are subject to Council's review for accuracy, adoption, or adjustment prior to assessment. It shall be at the sole discretion of Council to determine the severity of the defect. Council may seek written advice from the inspector or the conduit manufacturer on these matters. **Significance of defect**

3. The acceptance of defects identified after installation shall be in accordance with WSA 05-2008 2.2 (Table F1 for reinforced concrete pipes). In the event that a crack defect is assessed as 'Not acceptable - subject to asset owner review' refer below. **Defect acceptance**

4. The acceptance or rejection of crack defects in conduits after installation shall be in accordance with Table 3. Q1 values (width measurement for crack defects) are significant in this assessment. Other crack defect factors such as length, alignment, stability, potential autogenous healing, additional soil consolidation, untested loading and proximity to other assets will also be assessed when determining the significance of each crack defect. **Crack acceptance criteria**

Table 3 - Assessment of Crack Defects

Type of Crack Defect (WSA 05-2008 2.2 coding)		**Acceptance and Remedial Action**
Circumferential (C)	**Longitudinal (L)**	
Ch1: C **Ch2:** S (Surface) **Q1:** ≤ 0.5mm (≤0.1mm for tidal zone)	**Ch1:** L **Ch2:** S **Q1:** ≤ 0.15mm (≤0.1mm for tidal zone)	**Accepted**
Ch1: C **Ch2:** S or W (Wall) **Q1:** > 0.5mm to 1.0mm	**Ch1:** L **Ch2:** S or W **Q1:** > 0.15mm to 0.5mm	First Inspection **Monitor** (Re-assess after 12 months) Second Inspection **Accepted** or **Rejected** (Council to assess significance and determine action) *Remediation Techniques: A, B, C, or D*
Ch1: C **Ch2:** S or W **Q1:** > 1.0mm but not fractured (>0.1mm for tidal zone)	**Ch1:** L **Ch2:** S or W **Q1:** > 0.5mm but not fractured (>0.1mm for tidal zone)	**Rejected** *Remediation Techniques: C or D*

5. In the event that a crack defect is identified during the Defects Liability Period and assessed as requiring 'Monitoring' as per Table 3, Council may assess the significance and determine action instead.

SUBMISSION

1. Submit all deliverables as set out in this specification and Council's Specification for Drainage Inspection Reporting, including digital photographs and Structural Engineer Certifications (if obtained).

IF REMEDIATION WORKS ARE REQUIRED

1. Remedial action techniques are to be determined using Table 3 and shall be performed in accordance with the applicable technique described below, or as directed or approved by Council.

   Remediation techniques:

   A. Access the defect via pit or maintenance hole. Grind out the crack to solid concrete and fill with an approved epoxy resin. The epoxy resin shall not be less than 1mm thick and extended at least 100mm from the crack in all directions. Contractor to provide written certification by a Structural Engineer that the work is acceptable and has been carried out in accordance the technique.

   Epoxy repair

   B. For circumferential cracks only, repair by installation of bandage or alternatively as approved by Council. Ensure water tight and shear resistant connections are achieved.

   Bandage repair

   C. Replace the conduit section. Reconnect using appropriate techniques. Ensure water tight and shear resistant connections are achieved.

   Replacement

   D. Structural relining repairs technique to be chosen from ISO 11295:2010 and approved by Council. Any structural lining must be designed in accordance with the relevant ISO standard and Australian Standard (for flexible pipe, AS2566) to ensure it satisfies the required loading criteria. Reline from maintenance hole to maintenance hole. The relined section must conform to the original hydraulic design criteria. Contractor to provide certification by a suitably qualified engineer on the acceptability of remedial works undertaken.

   Structural reline

2. All costs associated with the inspection and rectification works shall be borne by the Applicant.

   Costs

3. A follow-up inspection and assessment, also in accordance with this specification, is required for any repaired or replaced infrastructure, to demonstrate that the remediation measures undertaken are satisfactory to Council. Provide all inspection deliverables along with relevant engineering certifications to Council for review.

   Post remediation

Appendix 11 - Specification for Drainage Inspection

PREFACE

This specification details requirements for inspecting and reporting on Council's underground stormwater conduits and maintenance structures.

All inspections and reporting of inspections shall be in accordance with this Specification, and The Conduit Inspection Reporting Code of Australia (WSA 05-2008 Version 2.2).

The nomination of underground stormwater conduits and maintenance structure to be reported in accordance with this Technical Specification requires that all functions described in this Technical Specification shall be performed and not just those that strictly relate to the Conduit Inspection Reporting Code of Australia WSA 02 -2008 Version 2.2.

INSPECTION PERSONNEL

Persons responsible for identifying and recording defects, service conditions and construction features, for preparing reports and operating CCTV equipment shall hold appropriate qualifications required by the Water Industry Training Package NWP07. These qualifications must be issued by a Registered Training Organisation (RTO).

REPORT ON CONDUIT CONDITION

The Applicant shall provide the following information to Council for review;

1 Colour Digital recording

A complete colour digital video recording in MPEG-1 (.mpg, .mpeg) format of each conduit containing:

a. A header at the beginning of each disk displaying the Title (Including DA number where applicable), Location (Suburbs / Streets) and Inspection Date

b. Digital Video footage of the street name and adjacent house number where practical at each set up (pit entry) location

c. Digital Video footage of the ground surface directly above and along the entire length of each individual conduit to be surveyed prior to the conduit inspection

d. Digital Video footage of the inside of the manhole, stormwater pit or maintenance structure to be entered panning slowly on all walls and the floor showing all connections

e. A header at the start of each individual conduit inspected, displaying:

- Asset number (NCC Asset number or Subdivision Pit Number - labelling assets as 'UNKNOWN' will not be accepted). NCC Asset numbers used are to be provided by Council (where available) and are to be reported in accordance with section 3.3.
- Road name/ Suburb / Location
- The Longitudinal Reference Point used in the inspection
- From node (start asset number)
- To node (finish asset number)
- Direction of inspection (upstream or downstream)
- Time of start of inspection
- Name of Company undertaking the inspection
- Operator’s Name

- Conduit dimensions
- Conduit material type
- Depth to invert of the conduit being inspected. The invert depth is measured from the centre of the top of the pit lid to the conduit invert (or when lid has been removed, it will be the assumed location of the centre of the top of the pit lid to the conduit invert)

f. Continuous Digital Video footage of the conduit or maintenance structure, displaying the following data:

- The camera's longitudinal position along the conduit, automatically updated, in metres to an accuracy of two decimal places (e.g. 1.23m). The point of zero position for such measurements shall be recorded as the Longitudinal Reference Point (LRP) in accordance with the Conduit Inspection Reporting Code of Australia WSA 05-2008 Version 2.2. The adopted LRP for all conduit inspections is to be the inside face of the wall of the starting node. Where this cannot be achieved the Principal's representative can approve an alternate LRP.
- Nominal conduit size and conduit material composition
- Node reference numbers, with start and finish nodes clearly identified
- Direction of inspection
- Date of inspection

The size and position of the displayed data shall be such as not to interfere with the main subject of the picture.

g. A complete pan of each defect from a position 90^0 to the defect, pausing on it while displaying the chainage and Conduit Inspection Reporting Code of Australia WSA 05-2008 Version 2.2, including all information relevant to the defect (i.e. clock references, percentages etc.)

h. A complete pan at the finish manhole, stormwater pit or maintenance structure displaying all walls, the roof and floor and any connections.

2 Digital Video Cover

The digital video cover shall display the location of inspection and date of inspection.

3 Digital Video Format

Each surveyed conduit shall be its own MPEG-1 file named as follows:

[AssetID]_[InspectionDate]_[xxInspectionNumber].file type

Where*,*

[AssetID] refers to the asset number for the inspected conduit as provided by Council (when available), and shall be either denoted as;

- 'PP*1234567*' for stormwater conduits; or
- 'CV*1234567*' for stormwater culverts

For example,

Stormwater pipeline asset p1234 shall be denoted as PP0001234

or,

Stormwater culvert asset cv123 shall be denoted as CV0000123

[InspectionDate] refers to the date at which the Inspection occurred, provided in YYYYMMDD format.

[xxInspectionNumber] refers to the number of Inspections undertaken of the conduit. In this instance ‘00’ refers to the first inspection, ‘01’ refers to the second inspection, and so on.

file type is to be in MPEG-1 format (.mpg, .mpeg)

For example, the applicant's CCTV inspection provider is requested to complete a conduit inspection of stormwater pipeline asset number p12345. The inspection was completed by the Service Provider on 1 February 2015. One inspection was undertaken of stormwater pipeline asset p12345 on this date.

The Inspection Digital Video footage is to be named as follows:

PP0012345_20150201_00.mpg

The reporting of all assets inspected must accurately identify the asset identification number provided by the Principal's representative.

4 Digital and Hard Copy Report Requirements

A bound hard copy text report, a digital copy of the report, as well as a Microsoft Access compatible database file. The report must be in accordance with the Conduit Inspection Reporting Code of Australia WSA 05-2008 Version 2.2 for each individual conduit inspected, containing but not limited to:

a. Accurate lengths of all conduits inspected
b. All Defects
c. Reference to pit and conduit identifiers (ie unique asset numbers)
d. Assessors Comments
e. Observation Codes
f. Note the nature of any surface defect that may be related to a specific main observation code during the internal inspection within the remarks area for that code
g. Conduit condition rating and scoring of defects. Structural Grading and Service Grading Mean and Peak scores are to be provided for each conduit. A specified length of 1m is to be used for Peak Score calculations.

The digital copy of the report is to be provided in .PDF file format. The Report will be a single file containing the above information for all conduits inspected on a single day. The Report is to be named as follows:

DA number and/or Location.pdf

The digital copy of the Microsoft Access compatible database will be named as follows:

DA number and/or Location.mdb