Stormwater Management Policy

September 2017





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Fairfield City Council Stormwater Management Policy September 2017.

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AVERAGE RECURRENCE INTERVAL (ARI) - the average time interval (expressed in years or fraction of years) between recurrences of a rainfall event of a given intensity and duration.

DETENTION – refers to the holding of stormwater for short time periods aimed at reducing peak flows. The detained stormwater is released to the stormwater system following the peak flow event.

FREEBOARD – A margin of safety applied to calculations that estimate the water surface during a storm event. The freeboard accounts for the inaccuracies in calculation methods. The height between water level and the underside of a structure or top of an embankment/channel wall is referred to as freeboard.

GROUNDWATER – water contained within the voids and spaces in rocks or soils

IMPERVIOUS – a surface that does not allow water to infiltrate into the ground, including roofs, roads, pavements, hard surfaced sports courts, any "sealed" areas and permanent water bodies such as swimming pools.

INFILTRATION – the downward movement of water from the surface to the subsoil.

INTERALLOTMENT DRAINAGE – common stormwater drainage system that serves one or more private properties.

LAND APPLICATION SYSTEM - an ecologically sustainable method of applying treated or untreated wastewater to land which also does not cause an additional public health risk nor detracts from the local amenity of the area.

NON-POTABLE WATER – water that is to be used for non-drinking purposes such as toilet flushing, laundry use, garden watering, car washing, etc.

OVERLAND FLOW PATH – the path that stormwater may take if the piped or channelled stormwater system becomes blocked or its capacity exceeded. Overland flow paths provide a fail-safe system to ensure that stormwater is not likely to cause flood damage.

PEAK FLOWS – the maximum instantaneous outflow from a catchment during a storm event.

PERMISSIBLE SITE DISCHARGE – the maximum discharge from the site during a 1 in 5 year ARI storm event under pre-development (existing) site conditions.

PERVIOUS - a surface that permits water to infiltrate into the ground.

POTABLE WATER – water that may be consumed.

PUMP-OUT SYSTEMS – a system comprising pumps and pipes to convey stormwater from a stormwater sump or storage to a gravity draining stormwater system.

ROOFWATER - rain (water) that falls on the roof of a building.

RETENTION – the storing of a form of water for beneficial use. Can apply to all forms of water including rainwater, stormwater and recycled water. May occur by storing water in a tank or by infiltration.

RUNOFF – interchangeable with stormwater (see Stormwater).

SEWAGE – any form of wastewater (refer to Wastewater) connected to the sewerage system.

SOIL & WATER MANAGEMENT PLAN (SWMP) - strategies and controls for a development or site to prevent pollution of the environment from all pollutants during the construction stage.

STORMWATER – rainfall that is concentrated after it runs off all urban surfaces such as roofs, pavements, carparks, roads, gardens and vegetated open space and includes water in stormwater pipes and channels.

SUMP – a cavity or depression where water drains to and which may then be pumped out.

WATER SENSITIVE URBAN DESIGN – a design approach promoting sustainable management of the total water cycle through the ecologically sensitive design of homes, streets (and their drainage systems) and whole suburbs.



AR&R	Australian Rainfall and Runoff	PSD	Permissible Site Discharge
ARI	Average Recurrence Interval	RC	Reinforced Concrete (Pipe)
AHD	Australian Height Datum	RHS	Rectangular Hollow Section (Pipe)
BASIX	The Building Sustainability Index,	ROL	Road Occupancy Licence
	developed State Environmental Planning Policy	ROLA	Road Occupancy Licence Application
CDC	Complying Development Certificate	SEPP	State Environmental Planning Policy
FRC	Fibre Reinforced Concrete (Pipe)	SDP	Stormwater Design Plan
HED	High Early Discharge	PSD	Permissible Site Discharge
LIS	Land Information Systems	SSR	Site Storage Requirements
LGA	Local Government AreA	ТСР	Traffic Control Plan
MUSIC	Model for Urban Stormwater	WHS	Work Health and Safety
MOSIC	Improvement Conceptualisation	тмс	Transport Management Centre
OPLINC	Online Planned Incident System	TWL	Top Water Level
OSD	On-site detention.	WSUD	Water Sensitive Urban Design



THIS POLICY AIMS TO PROTECT THE FAIRFIELD'S EXISTING AND FUTURE RESIDENTS.

1. INTRODUCTION

Stormwater management is an integral part of the planning and development process that requires careful consideration at the initial stages of a development to ensure a successful, fast and cost effective outcome. It has moved from the outlook of 'dealing with a nuisance' to focusing on the management of stormwater as a resource and discharging stormwater in a sustainable manner.

This policy aims to protect the Fairfield's existing and future residents, infrastructure and environment by providing guidance on stormwater controls to ensure that stormwater is managed effectively, consistently and sustainability. It focuses on providing a robust, safe and low maintenance stormwater system that is directly related to the impact of development being undertaken.

The policy also introduces Water Sensitive Urban Design (WSUD) elements to the stormwater outcomes of development in the Fairfield LGA for the first time. Whilst these targets are currently only required for specific industrial developments, Council encourages all developers to incorporate the elements of WSUD in their design process to improve aesthetics, reduce operational costs and enhance marketability of their developments to potential clients.

1.1. OUTLINE

As a consent authority, Council requires all developers to demonstrate that any development / building work proposed will comply with all relevant codes, standards and policies.

This policy is intended to provide a clear statement of objectives, requirements and methods relating to stormwater drainage for residential, commercial, industrial and all other types of development and applies to all land within the Fairfield Local Government Area. It is written in the order of consideration of the planning, design & construction phases of development

Adherence to the policy and provision of necessary will expedite Council approvals. This policy is not a comprehensive design manual, rather it is intended to be read in conjunction with and as a supplement to:

- State and Regional Environmental Planning Policies and Acts;
- Local Environmental Plans and Development Control Plans;
- Fairfield City Council's Specification for Roadworks

and Drainage associated with subdivision or other development;

- NSW Floodplain Development Manual;
- Australian Rainfall & Runoff;
- Australian Runoff Quality;
- Building Code of Australia;
- AS/NZS 3500.3-2015 Plumbing and Drainage; and
- NSW Housing's Managing Urban Stormwater – Soils and Construction.

Nothing in this policy is to be construed as limiting, in any way, Council's rights to impose differing conditions when approving development proposals, nor limiting the discretion of Council to vary any necessary engineering requirements in respect of a particular development, having regard to industry best practice.

In addition to the above, Council has introduced Performance Criteria throughout this document which exemplify the requirements of the chapter. If the prescriptive controls listed within the chapter are unable to met, the developer may work towards other methods that meet the performance criteria.

1.2. DOCUMENT STRUCTURE

This document has six sections which cover the components of managing stormwater drainage when undertaking development in Fairfield City Council. An outline of these sections is as follows:

SECTION 1: INTRODUCTION TO THE POLICY

An introduction to the intent of the Policy, its structure and application to development proposals.

SECTION 2: APPROVAL & CONSTRUCTION PROCESS

The approval and construction process including submission guidelines

SECTION 3: DISPOSAL OF STORMWATER AND CONNECTION TO COUNCIL'S STORMWATER SYSTEM

Objectives, controls and design considerations for stormwater drainage, in terms of collecting and controlling stormwater runoff to an approved point of discharge.

SECTION 4: ON-SITE DETENTION SYSTEMS

Objectives, controls and design considerations for On-Site Detention design in the Fairfield LGA

SECTION 5: WATER CONSERVATION REQUIREMENTS

Objectives, controls and design considerations for water conservation in the Fairfield LGA

SECTION 6: WATER QUALITY IMPROVEMENT SYSTEMS

Objectives, controls and design considerations for Water Quality Improvement design in the Fairfield LGA

1.3. WHERE POLICY APPLIES

Table 1 - Stormwater Management Policy Requirements for development type

Landuse	Development Type	Stormwater Disposal	On-Site Detention	Water Conservation	Water Quality Improvement
al	Alterations, additions and new dwelling houses and dual occupancy with imperviousness less than 70% for overall site	V	×	×	×
Residential	Alterations, additions and new dwelling houses and dual occupancy with imperviousness greater than 70% for overall site	V	V	×	×
	New town houses, villas & residential flat buildings	v	~	×	×
	Change in use	×	×	×	×
Commercial & Industrial	New premises, alterations & additions outside the Wetherill Park Industrial Area	V	V	×	V
Commerc	New premises, alterations & additions within the Wetherill Park Industrial Area	V	×	V	V

	Information Required	Stormwater Design Plan	Deemed to comply	Deemed to comply or WSUD Strategy
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STORMWATER MANAGEMENT IS AN INTEGRAL PART OF THE PLANNING AND DEVELOPMENT PROCESS.

1.4. SELECTING CONSULTANTS

The choice of qualified and experienced consultants with an understanding of Council's requirements and relevant guidelines and standards can expedite the approval of developments submitted to Council. Experienced consultants are also more likely to provide a more amenable and cost effective design.

The design and certification of site drainage set out and OSD systems in this document will only be accepted from persons having suitable professional accreditation. The designer shall be a professional engineer registered, or eligible for registration, with the National Engineering Register in Civil or Environmental Engineering, specialising in stormwater design. The designer shall identify their professional accreditation in the design submission with the Development Application, Construction Certificate and Works-as-Executed submission.

1.5. AVAILABLE INFORMATION

There is a wide range of information available from Council and other Authorities that can assist with planning your development. Please see the sections below for further details.

1.5.1. MAINSTREAM AND OVERLAND FLOODING

Generic flood information can be found on Councils Flood Planning Maps, available in the Planning and Building section of Council's website. Site specific flooding information is provided via the Section 149 Certificate. To purchase the Flood Information Sheet, purchase the Section 149 (2) & (5) Planning Certificate for each lot. If the property is food affected, the Flood Information Sheet will provide the flood risk precincts as well flood levels (in mAHD) for a range of events.

1.5.2. PIPED STORMWATER DRAINAGE NETWORK

Maps are available for viewing at the Council's Customer Service desk. Maps are indicative only and the pipe network should be investigated on site. Copies of such maps cannot be purchased from Council.

1.5.3. CONTOUR MAPS

Council can provide contour maps at 0.5m intervals for purchase to assist with determining the sites catchment size. Please contact Council's Land Information Systems (LIS) team on (02) 97250222.

1.5.4. UNDERGROUND UTILITIES

Dial Before You Dig is a referral service for information on locating underground utilities. The majority of underground utility owners in NSW are members and this free service can be contacted directly at www.1100.com.au.

THE USE OF QUALIFIED AND EXPERIENCED CONSULTANTS CAN EXPEDITE THE APPROVAL OF DEVELOPMENTS

THE MAIN CONTRIBUTOR TO INCREASES IN IMPERVOUS AREA IS PRIVATE DEVELOPMENT.

2. APPROVAL AND CONSTRUCTION PROCESS

2.1. EXEMPT DEVELOPMENT

Exempt development is minor development which does not need any approval from Council. State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (Codes SEPP) details the type of development that is exempt development and outlines the general standards and specific requirements that must be met

.Even though no approval is required from Council, there may be other legislative or approval requirements such as licences and/or permits. Please check the most current version of the Codes SEPP contained on the NSW Government Legislation web site for more details:

http://www.legislation.nsw.gov.au/maintop/search/ inforce.

Seek advice from Council staff as to whether nominated exempt development types are applicable to your site and circumstances.

2.2. COMPLYING DEVELOPMENT

Complying development is a category of development which does not require development consent. If the development meets predetermined criteria a Complying Development Certificate (CDC) may be issued by Council or an accredited private certifier for that development. Development Consent is not required for development the subject of a CDC.

State Environmental Planning Policy (Exempt and Complying Development Codes) 2008 (Codes SEPP) details the type of development that is complying development, and the standards that must be met.

The Codes SEPP contains the following development codes, which specify applicable development controls, as of 22 February 2014:

- General Housing Code
- Rural Housing Code
- Housing Alterations Code

- General Development Code
- Commercial and Industrial Alterations Code
- Commercial and Industrial (New Buildings and Additions) Code
- Subdivisions Code
- Demolition Code
- Fire Safety Code

To determine whether these codes apply to your property you should check your Planning Certificate (Section 149).

2.3. DEVELOPMENT APPLICATION

If your development proposal is not exempt or complying development under the provisions of the Codes SEPP, then you may need to lodge a Development Application with Council. Some examples of proposals which require the submission of a Development Application are:

- Dwelling houses and ancillary development that do not comply with the development standards nominated within the Codes SEPP.
- New residential flat buildings, multi dwelling housing development or dual occupancies.
- Heritage items Demolition or alteration of a building or place that is a heritage item.
- All new industrial buildings greater than 20,000m² in area.
- All new commercial premises.
- Certain additions or alterations to existing commercial and industrial buildings that are not deemed as complying development under the Codes SEPP.

Please contact Fairfield City Council's Customer Service Centre on 9725 0222 and ask to speak with the Duty Planner if in doubt as to whether your proposal requires Council approval.

2.3.1. STORMWATER DESIGN PLAN

All Development Applications will require a Stormwater Design Plan (SDP) that contains full stormwater system engineering design details and calculations. Two (2) printed copies of the SDP and one hard and soft (USB) copy of the design calculations are to be submitted. Where the development is integrated, one (1) additional printed copy will be required for each integrated component of the development. The designer shall be a professional engineer registered, or eligible for registration, with the National Engineering Register in Civil or Environmental Engineering, specialising in stormwater drainage.

The SDP will be required to meet all conditions of consent and Council's standards. For this purpose, the plans and supporting information submitted shall:

- Provide full and independent verification of the design proposed;
- Be of sufficient quality to enable accurate construction of the drainage system by a tradesman;
- Be in accordance with the Checklist provided in Appendix A

All plans are required to clearly show within the title block the company preparing the plans, contact details, date prepared, drawing numbers and revision details. SDP's that do not have all required information cannot be assessed.

If an On-Site Detention System is required as part of the development, the detailed design and DRAINS runoff routing calculations will need to be submitted as part of the SDP (see Section 4 for further information). A checklist is provided in Appendix B listing the additional On-Site Detention requirements that are to be submitted with the SDP.

2.3.2. DEEMED TO COMPLY

There are several 'Deemed to Comply' solutions throughout this policy which are designed to simplify design requirements for various development types. If these solutions are being used, they must be clearly stated on the Stormwater Design Plan. Any applicant may choose not to apply the following Deemed to Comply solution and instead provide all design details and calculations

2.3.3. WSUD STRATEGY

A Water Sensitive Urban Design Strategy is a written report detailing the stormwater quality control measures to be implemented as part of a development, and include the following detail:

- Proposed development Describe the proposed development at the site, including site boundaries and proposed land uses.
- WSUD objectives Identify the WSUD objectives that apply to the proposed development.
- Stormwater quality demonstrate how the stormwater quality targets will be met. It should include stormwater quality modelling results and identify the location, size and configuration of stormwater treatment measures proposed for the development.
- Details of MUSIC Modelling (or equivalent) Modelling parameters to determine the size and configuration of WSUD elements must be undertaken in MUSIC (or equivalent
- Costs Prepare capital and operation and maintenance cost estimates of proposed water cycle management measures. Both typical annual maintenance costs and corrective maintenance or renewal/adaptation costs should be included.
- Draft Operation and Maintenance plan An indicative list of inclusions in the maintenance plan is included in Checklist provided in Section 6 of this document
- Checklist outlining the details of the WSUD Strategy and reference of the information source.

2.4. CONSTRUCTION CERTIFICATE

2.4.1. CONSTRUCTION PLANS

It is expected that there will be minimal change between the approved SDP and Construction plans, other than the addition of minor construction details. If any details are proposed to change, an application to modify consent must be lodged.

2.4.2. EROSION AND SEDIMENT CONTROL PLAN

All development sites require provision to be made for sediment control on the site. The detail of the erosion and sediment control plan will vary considerably depending on the size of the site and potential of works to promote sediment release etc. An Erosion and Sediment Control plan is required for all development sites with a disturbed site area and shall be in accordance with the requirements outlined in the recent edition of the Landcom's "Managing Urban Stormwater – Soils and Construction".

Contact Council's Environmental Management Branch for more information. Penalties exist for non-compliance with erosion and sediment control requirements.

2.5. ENGINEERING APPROVAL - CONSTRUCTION CERTIFICATE

A separate Engineering Approval - Construction Certificate will be required where it has been included as a condition of development consent. A separate Engineering Approval - Construction Certificate will generally be required for works outside the development site such as, but not limited to, interallotment drainage, extension of Council's drainage system, major connections to the Council system, roadworks or other significant activities. Unless otherwise directed, three (3) copies of plans for Engineering Approval - Construction Certificate are required to be submitted to Council. Where the development is integrated one (1) additional hard and soft (USB) copy will be required for each integrated component of the development.

2.6. OCCUPATION CERTIFICATE

Work as Executed Plans/details required as part of the development consent are in general required to indicate whether the constructed works have conformed to the development consent and approved design. This requires that where a design level occurs on the approved plan a corresponding Works as Executed level is required to be given at this location. Also, any variations or amendments shall be clearly highlighted. Where the approved drainage system has been varied, calculations may be required to indicate that the constructed system performs to the appropriate standard.

If an On-Site Detention System was required as part of the development, the allowable construction tolerances are listed in Section 4.6.1. Where works are outside these tolerances, the defective work shall be rectified to comply with the approved design prior to construction certification and issue of an Occupation Certificate.



2.7. BONDS

Where works are proposed to be carried out on Council or public land (i.e. roads, parks etc) by or on behalf of an applicant, a bond may 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's Engineering Assessment Branch upon issue of the Engineering Approval - Construction Certificate.

The bond shall consist of a Deed of Agreement and approved plans detailing the extent of works covered by the bond, and a cash deposit or bank guarantee. Council's standard Deed of Agreement can be obtained by contacting Council's Engineering Assessment Branch.

Application may be made for release of a bond upon:

- Completion of bonded works;
- Submission of works-as-executed plans;
- Satisfactory final inspection by Council; and,
- Payment of a Maintenance Bond.

The value of the Maintenance Bond will generally be 10% of the original bond, and generally be held for a period of twelve (12) months. The value and period of the bond may vary depending on the works being bonded.

An inspection will be carried out at the end of the maintenance period and if the works have performed satisfactorily over the period, the maintenance bond may be released.

A bond administration fee is payable in accordance with Council's Fees & Charges.

2.8. INSPECTIONS

Where works are to be carried out on a public roadway, involve inter-allotment drainage, or involve Council owned/operated structures, then advanced notice and inspections will be required at specified stages during the works to ensure compliance with Council's Specification for Roadworks and Drainage Associated with Subdivision or Other Development. The developer shall be required to pay for inspections in accordance with Council's Fees and Charges.

A minimum of one (1) working days' notice shall be given to Council to obtain an inspection. Works shall not commence until the works or activity covered by the inspection is approved.

2.9. TRAFFIC CONTROL AND SAFETY

Any works within the road reserve shall have adequate provision to ensure safety, considering the impact of the works on public transport and passengers, cyclists, pedestrians, motorists and commercial operations. Before works commence within the road reserve adequate controls shall be in place.

2.9.1. TRAFFIC MANAGEMENT PLAN

A Traffic Management Plan (TMP) integrates an activity into the operation of the road network. The plan assesses an activity's impact on traffic flow. It describes the activities being proposed, their impact on the general area and how these impacts are being addressed. A Traffic Management Plan may be requested by Council depending on the type of risks, and to address these risks.

2.9.2. RISK MANAGEMENT

The developer has a responsibility to undertake a risk assessment of the activities described in the road occupancy application, per the Work Health and Safety Act 2011.

Some of the risks that should be considered are listed below. If any of these risks are applicable, a Traffic Management Plan shall be submitted to address these risks.

- Proximity of work site to live traffic
- Speed and volume of traffic
- Type of traffic (clear lane width is applicable to traffic flow)
- Noise levels (Office of Environment & Heritage has certain restrictions/requirements)
- Heavy weather, and other delays to project programming

2.9.3. TRAFFIC CONTROL PLAN

A Traffic Control Plan (TCP) is a document that shows how traffic is to be safely separated from workers at the work site or work route. Traffic Control Plans are to be prepared by RMS accredited persons.

2.9.4. TRAFFIC CONTROL AT WORK SITES

The application of the principles outlined in Traffic Control at Work Sites manual (Version 4.0 issue June 2010) will ensure that road users will be able to travel through, past or around road and bridge work sites in safety. Adherence to the manual will also ensure that the workers will be able to work safely in the vicinity of road users and their vehicles and work site plant.

2.9.5. ROAD OCCUPANCY LICENCE

A Road Occupancy Licence (ROL) will be required approval from the Transport Management Centre (TMC) where works are proposed;

- On a State Road;
- Some unclassified (council) roads, which are considered critical to the efficient operation of major RMS Road Networks (please check with Council);
- Signals within 100m of site; and
- Roundabouts within 100m of the site.

A ROL is required from local Council to undertake works on local roads. A traffic Control Plan must be submitted with all Road Occupancy Licences. The Traffic Control Plan must be endorsed with the name of the person preparing the plan along with their level of certified qualification and certificate number.

To submit a Road Occupancy Licence Application (ROLA) to Transport Management Centre the applicant is to use the Online Planned Incident System (OPLINC). To use the online system, the applicant must register at https://myrta.com/oplinc2.

2.9.6. UNLICENSED ROADWORKS

Obtaining an ROL for the specified activities is a legal requirement under Section 138 of the Roads Act. If a ROL is not obtained you will be forced to cease activities and will be required to remove all impacts on the traffic flow. A NSW Police Officer or the Authorised Road Officer may issue this direction.

THIS POLICY AIMS TO PROTECT THE FAIRFIELD'S EXISTING AND FUTURE RESIDENTS.

3. DISPOSAL OF STORMWATER AND CONNECTION TO COUNCILS STORMWATER SYSTEM

3.1. OBJECTIVES

- 1. To direct stormwater runoff to Council's drainage system without adversely impacting on adjoining or downstream properties.
- 2. To ensure the efficient and effective planning, management and maintenance of Council's existing and future stormwater systems and reduce environmental and property damage.

3.2. PERFORMANCE CRITERIA

- 1. The following performance criteria apply to the collection and disposal of stormwater and connection to Councils stormwater system.
- 2. To direct stormwater runoff from all impervious areas to Council's drainage system without adversely impacting on adjoining or downstream properties and to ensure the continued capacity of the stormwater network.
- 3. The proposed development will follow the major/minor drainage system concept by providing the relevant infrastructure to discharge minor flows from the site and a well-defined overland flowpath to safely convey major flows.
- 4. All stormwater drainage must be via a gravity system where possible.
- 5. All designs should not create any unnecessary maintenance burdens for existing or future owners of the site.
- 6. The proposed development should not result in significant impacts on the amenity of the site and surrounding area.
- 7. The proposed development should not result in any increased risk to human life.
- 8. The proposed development shall meet all Australian Standards, the Building Code of Australia and Australian Rainfall and Runoff design requirements.

9. Stormwater drainage design shall be completed

by a professional engineer registered, or eligible for registration, with the National Engineering Register in Civil or Environmental Engineering, specialising in stormwater design. All plans submitted for assessment shall be detailed design drawings to ensure Council is satisfied thatall of the abovementioned performance criteria have been met.

3.3. DEVELOPMENT TO WHICH DISPOSAL OF STORMWATER AND CONNECTION TO COUNCILS STORMWATER SYSTEM APPLIES

This chapter applies to all development within the Fairfield LGA

3.4. CONTROLS

3.4.1. STANDARD GRAVITY CONNECTIONS

Stormwater runoff from all impervious areas in a site should be collected and directed to Council's kerb and gutter or underground drainage system by gravity. The following sections detail the requirements for standard gravity connections. Please see Appendix C for Council's design standards.

3.4.1.1. KERB AND GUTTER

Dwelling connections to street kerb and gutter shall be made by a standard kerb adaptor as shown in Figure 1, sewer grade pipe or 125 x 75 galvanised RHS. The outlet to the street should have a maximum 100 mm diameter section to allow re-instatement of kerb. The invert of the outlet pipe shall be placed 10 mm above the invert of the kerb. Multiple connections to the kerb will require the provision of a lintel over the outlet pipes.



Figure 1 - Charged system configuration

When installing the street outlets, 300mm of kerb either side from the centre must be removed and replaced. If there is a joint within 600mm of the centre, concrete must be replaced up to the joint on that side.

Direct discharge to the kerb and gutter shall contained within three 125 x 75 galvanised RHS pipes. If site discharge is greater than this, a direct connection will be required to Council's underground pipe system. OSD can be provided where not required, or the provision of OSD can be increased, to limit discharge to the allowable requirements.

Where it can be demonstrated that gutter flow widths will not exceed 2 meters in front of and downstream of the development, and that pedestrian and vehicular safety is maintained, a higher discharge to the gutter may be permissible subject to the discretion of Council's Development Engineer.

3.4.1.2. COUNCIL'S PIPED DRAINAGE SYSTEM

Where stormwater disposal can be facilitated by direct connection to Council's piped trunk drainage system, connection to the system will be permissible by means of connection to an existing pit or construction of a new pit to Council's specification. Council will endeavour to keep the number of connections into its underground drainage system to a minimum.

Connecting to existing pits is the favoured method of connection and pipes connected to existing pits shall be cut flush with the internal wall of the pit and rendered. Depending on the pit condition, reconstruction may be required. The pipe should enter the pit perpendicular to the pit wall and all damage to the internal wall of the pit around the pipe connection shall be repaired to the satisfaction of Council's Subdivision Engineer. A bond will be taken for such works, prior to the issue of a Construction Certificate. New pits are to be designed and constructed in accordance with the Design Process chapter of this policy and Council's Specification for Roadworks and Drainage Associated with Subdivision or Other Development. A separate Engineering Approval will be required for construction of a new street pit.

For property drainage systems up to 225 mm diameter, Council may consent connection to an existing Council drainage line via a slope junction providing Council's pipe diameter is three times greater than the proposed connection. Only one slope connection is permissible from the development to Council's system and should be made using an approved proprietary clamp or saddle. The connection shall be completed to the satisfaction of Council's Subdivision Inspector. A bond will be taken for such works, prior to the issue of a Construction Certificate.

3.4.1.3. TABLE DRAIN

In rural areas where no formal street gutter exists, discharge to an existing table drain will be permitted subject to the headwall and concrete dish pan at the outlet is not within 10m inside of the property boundary to prevent damage and erosion.

3.4.1.4.EXTENSION OF COUNCILS PIPED DRAINAGE SYSTEM

Consideration will be given to the extension of Council's system under the kerb and gutter or along a public road to facilitate disposal of stormwater from the property. A kerb inlet pit will need to be constructed at the junction of the internal drainage and extended street system. The extended system is to be a minimum 375 mm diameter rubber ring jointed reinforced concrete (RC) pipe or fibre reinforced concrete (FRC) pipe. A separate Engineering Approval for all works involving extension of Council's street drainage system will be required. Full hydraulic details are to be undertaken in accordance with Council's design standards as per the Design Process chapter in this document. Also refer to Council's specification for Road and Drainage Works Associated with Subdivision or Other Development for construction standards.

All design, construction and administration costs associated with extension of the drainage system within the public road shall be borne by the applicant and must allow for the relocation and restoration of all services, including any private works or infrastructure. A bond may be payable in accordance with section 2.7.

3.4.1.5. CONCRETE LINED CHANNELS

Council's concrete lined channels, especially within the Wetherill Park Industrial Area, have suitably sized stubs provided for the connection of the internal stormwater discharge for each lot backing onto the channel. Where a stub has been provided it is a requirement that the site drainage is designed to connect into this point. In all other cases the site drainage shall be made with a single connection to the channel.

A separate Engineering Construction Certificate will be required where a new connection to the channel is proposed. The following information is to be submitted with separate engineering plans for such a proposal:

- Connection detail including full construction notes;
- Longitudinal section for pipeline between the site boundary and channel; and
- Appropriate calculations including a hydraulic grade line analysis.

Any new pipe connections will be made at 45° to the channel. The pipe invert shall be in accordance with the diagram in appendix D and the developer must reinstate the lining of the channel at the connection point to Council's satisfaction.

A bond for such works will be determined from the approved details. The bond will be payable to Council prior to the release of the Engineering Approval. General detail has been provided in Appendix D for assistance in preparing a suitable connection design to the channel.

3.4.1.6. CREEKS AND NATURAL CHANNELS

Discharge to a suitable natural watercourse, creek or grassed channel may be allowed subject to approval by Council. The watercourse is to be protected against erosion at the point of discharge. In this regard an outfall apron or energy dissipation structure is to be provided in accordance with this Section. Stabilising a small length of the watercourse in the vicinity of the outlet is not appropriate as it can cause problems of erosion upstream and downstream of the stabilised section.

Only a single connection point to the watercourse from the development will be permissible.

The piping, covering or alteration of a natural watercourse will not be approved by Council. Instead, existing natural watercourses must be retained, along with any native vegetation within the riparian zone. In addition, the rehabilitation of degraded, piped or channelled watercourses to a more natural state will be encouraged and supported wherever possible.

If a stormwater connection is to be created, you must liaise with council to agree on a connection point. You must prepare a broad catchment plan to identify the most ideal locations to connect to the natural waterway. The plan must consider the:

- land contours
- location of infrastructure
- intended land use

The proposed connection must be able to effectively service both the intended development and other future developments within the adjacent and/ or upstream area, and must not hinder overall future land management. The discharge point must meet the following requirements to ensure the output flow does not adversely impact the waterway and the headwall is safe and stable:

- Outlet angle is to be no greater than 30 degrees in the direction of the channel flow.
- The cover over the pipe must be a minimum of 300 mm
- The pipe must finish flush with the headwall.
- The headwall shall be placed so as to avoid vertical drops of over 900 mm.

- For locations where the vertical drop is greater than 900 mm and where rock batters are steeper than 1H:1V, a safety fence must be installed to prevent falls.
- The headwall foundation must sit on a geotextile fabric of Bidim A44 or approved equivalent.
- Rock sizing and location should be in accordance with the 'Rock Sizing for Single Pipe Outlets" practice note produced by Catchments & Creeks P/L, available in Appendix E.

3.4.2. STORMWATER DRAINAGE TO REAR OF PROPERTY

If stormwater runoff from all impervious areas in a site cannot be collected and directed to Councils kerb and gutter or underground drainage system via gravity, stormwater may be disposed from the site through any of the options below where allowable circumstances exist. Please see Appendix C for Council's design standards.

Option (in order of preference)	Where it applies
1. Private drainage easement	Preferred option in all circumstances.
2. Through publicly owned land	When property drains to the rear towards a public reserve.
3. Charged system	Only allowed for dwelling houses, dwelling houses on narrow lots, secondary dwellings and attached dual occupancies where a private drainage easement cannot be acquired.
4. Elevated Line	Only allowed for basement car park areas as part of residential development (excluding secondary dwellings).
5. Pump out system	Only allowed for basement car park areas as part of residential development (excluding secondary dwellings).
6. Absorption trench	Only for minor paved areas of less than 50m ² where an elevated pipe or charged line system has been provided for the site, except for secondary dwellings.

Table 2 – Stormwater drainage to rear of property order of preference

3.4.2.1.PRIVATE/INTER-ALLOTMENT DRAINAGE EASEMENT

Permitted for: All development.

Where the land falls away from the road or there is no provision for drainage to the street through public land, the applicant will be required to provide private drainage through an easement to carry the stormwater from the development to Council's drainage system. The following section highlights the development process, whilst Section provides design information.

DEVELOPMENT COMMENCEMENT

A Deferred Commencement may be issued for developments requiring inter-allotment drainage, although the consent will not become operative until the easement has been registered by the office of Land & Property Information NSW. Full design information for all inter-allotment drainage is to be provided with the plans submitted for approval.

The process for obtaining a private easement is:

- Request drainage easement through all required downstream properties (see Appendix F for sample letter)
- Registered Surveyor to prepare plan of survey.
- Development application with easement and drainage plans to be submitted to Council for approval.
- If Development application acceptable deferred commencement provided
- Plan and application to be lodged with owners approval at NSW Land and Property Information and fees paid.
- Council to be advised of lodgement details.
- NSW Land and Property Information advises applicant / owner and Council of registration.
- Operational consent issued.
- Construction certificate issued

SEPARATE ENGINEERING APPROVAL

A separate Engineering Approval will be conditioned for approval of works relating to the private drainage line. Private drainage lines shall be constructed in accordance with Council's Specification for Roadwork and Drainage Associated with Subdivision or Other Development. Inspections shall be carried out during construction by Council's Subdivision Inspector or a private engineering certifier if applicable.

OCCUPATION/SUBDIVISION CERTIFICATE ISSUE

Prior to the issue of an Occupation Certificate or Subdivision Certificate, the developer will be required to submit work-as-executed plans and certification from a registered surveyor stating that all pipes, pits and associated structures for encroaching drainage lines are constructed wholly within their respective easements. Creation of the easement shall be as per the NSW Conveyancing Act 1919.

ENGINEERING PLAN DETAILS

Private drainage proposals shall be supported by the following details:

- Plan & Longitudinal section including appropriate invert and surface levels;
- Connection detail to Council's system;
- Survey details of easement including all structures/features in the vicinity;
- Documentation confirming the easement is to be registered in favour of the land to be developed;
- Details of flow path for flows in excess of the pipe capacity; and
- Hydraulic Grade Line analysis of pipe and overland flowpath

Demonstration that an easement cannot be obtained

In order to use other drainage to rear options, it is 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 will 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.

3.4.2.2. THROUGH PUBLICLY OWNED LAND

Permitted for: All development.

Council will consider an application to lay pipes within public land such as reserves and parkland. Any proposal to drain stormwater through a reserve or park must first obtain approval from Council's City Assets team prior to submitting the DA to the Council for assessment. The decision as to whether such a proposal is allowable will depend upon the classification of the land, whether any Plan of Management that may apply permits the work, and the intended future use of the reserve. Issues such as potential environmental damage to the parkland and land devaluation will be considered and Council reserves the right to require an easement be created over the land, and to approve or reject the proposal on its merits based on criteria, including but not limited to environmental assessment and site conditions.

To prevent multiple pipelines from passing through the public land, the pipeline must be sized to allow for adjoining properties, in future, to connect to it. The minimum pipe size for the pipe must be 375mm diameter and constructed of RC or FRC pipe. The pipeline shall comply with this policy and Council's Specification for Roadworks and Drainage Associated with Subdivision or Other Development.

All design, construction and administration costs associated with providing the pipework across a public park shall be borne by the applicant. A bond is payable in accordance with Clause 4.1. Council is likely to seek compensation for proposed pipelines/easements through public owned land.

3.4.2.3. CHARGED SYSTEMS

Permitted for: Dwelling houses, dwelling houses on narrow lots, secondary dwellings and attached dual occupancies when a private drainage easement cannot be acquired.

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". These systems are not ideal as they are unable to drain areas below the point of discharge, blockage of the system can result in complete failure with water travelling away from the discharge point, and the system has higher maintenance requirements.

DEEMED TO COMPLY

- 1. The charge within the line must be a minimum of 900mm
- 2. The distance from the tank outlet to the kerb outlet must not be greater than 50m
- 3. The roof area must not exceed 350m²
- 4. The catchment area per downpipe as per below must not be exceeded





Figure 2 - Charged system configuration

If the deemed to comply conditions cannot be met, then a full hydraulic grade line analysis will need to be submitted to prove that the proposed system is suitable.

The following conditions also apply to ALL charged systems:

- Documentary evidence must submitted with the application demonstrating that an easement to enable a gravity drainage system cannot be acquired from downstream properties, based on a reasonable offer (see Section 3.4.2.1).
- Roof gutters, downpipes and pipelines shall be sized for the 100-year ARI design storm.
- All charged lines must be of pressure grade and joints are to be solvent welded
- The pipe system including downpipes must be constructed from suitably durable materials.
- The system must discharge to a boundary junction pit prior to discharge to the public drainage infrastructure
- Flushing points/cleaning eyes are to be provided at lowest points in the system and should be easy to access
- Gravity fall shall be provided across the footpath where this can be achieved with minor filling of the footpath approved through levels issued by Council's Inspections Officer.

3.4.2.4. ELEVATED LINES

Permitted for: Dwelling houses, dwelling houses on narrow lots and attached dual occupancies when a private drainage easement cannot be acquired.

Dwellings within 300mm of top of kerb level at the building line, elevated lines may be used to assist in achieving gravity fall to the street. Elevated pipes can be attached to the side of the dwelling and then go under the front courtyard to the street.

Elevated lines will be permitted for single dwellings and dual occupancy dwellings. They will only be permitted subject to the following conditions;

- Documentary evidence being submitted with the application demonstrating that an easement to enable a gravity drainage system cannot be acquired from downstream properties, based on a reasonable offer.
- They achieve gravity fall (minimum grade = 0.5%);
- Where attached to the building the elevated pipe will not interfere with openings to the dwelling or impair its function;
- They are decorative and UV resistant and that consultation has been undertaken with Council's Assessing Officer in relation to their positioning;
- Pipes through the front can be contained within carefully designed garden beds within the front building setback in consultation with Council's Assessing Officer;

- Any minor filling required in the front courtyard shall not obstruct or divert the natural flow of water from the adjoining upstream property and this will need to be demonstrated in the application;
- Gravity fall shall be provided across the footpath with any required minor filling of the footpath approved through levels issued by Council's Inspections Officer; and
- Architectural elevations are to show stormwater lines.

Please note that pipelines attached to boundary fencing will not be approved. Elevated lines may be considered in extreme circumstances for narrow lot development

3.4.3. STORMWATER DISPOSAL FOR MINOR AREAS

3.4.3.1. PUMP OUT SYSTEMS

Permitted for: Basement garages in all residential development except secondary dwellings.

DEEMED TO COMPLY

- Maximum driveway area draining to garage basement is to be 60m² for all dwelling houses and dual occupancies, and 100m² for all other residential developments
- The sump storage area is to be 1m³ per 10m² of driveway draining to the garage basement with a minimum of 3m3 between the high and low pump working levels
- 3. The garage floor area is to be a minimum of half the driveway area
- 4. The capacity of each pump shall be a minimum of 4 litres per minute per

If the deemed to comply conditions cannot be met, then a full hydraulic assessment will need to be undertaken meeting the conditions below:

- Maximum driveway area draining to garage basement is to be 60m² for all dwelling houses and dual occupancies, and 100m² for all other residential developments
- The sump storage minimum area is to contain the total volume of runoff generated by the 3 hour 1 in 100-year storm assuming pumps are not working.
- Flood water within the basement shall not rise to more than 300mm in depth of stormwater in the event of a power outage or pump failure. The designer must assume a 24 hour 100 year ARI rainfall event to determine the flood water depth.
- Each pump shall have a minimum capacity based on the flow rate generated from a 1% AEP 5-minute duration storm event of the area of the ramp that draining into the system.

The following conditions also apply to ALL garage basement pump out systems:

- Surface stormwater runoff from the remainder of site must be diverted away from the basement area and the drainage systems are to be isolated from each other hydraulically.
- The basement car parking area shall be graded to fall to the sump and pump system.
- The pump-out system shall be sized and constructed in accordance with section 8.4 of AS 3500.3 and comprise of two (2) alternating submersible pumps with level switches and activation of dual operation at top water level. The two pumps shall be designed to work on an alternating basis to ensure both pumps receive equal use and neither remains continuously idle.
- The pump-out system must be independent of any gravity drainage lines and pumped to a site boundary pit. The site boundary pit may be used as a junction pit to connect local gravity drainage lines, if they are hydraulically isolated from the pump out system. From the site boundary pit, stormwater will be gravity fed to the kerb to reduce flows to acceptable velocities.
- Backflow prevention devices/ measures shall be provided to the outlet of the pump-out system to minimise or eliminate the risk of backflows into the basement.
- Alarm systems must be provided to give a flood warning in case of pump failure, including:
 - o non-audible alarm positioned at the main entrance to the basement car park;

- o audible alarms positioned at the first-floor level of each common property stairwell within the building; and
 - o signage at all the aforementioned locations to inform residents of the cause of the alarm
- Storage areas and areas used for purposes other than car parking or access aisles are to be constructed a minimum of 300mm above the level of the surrounding area.
- Full details of the following must be submitted for approval by Council:
 - o catchment area
 - o grade of ground level leading towards holding tank
 - o holding tank capacity and location
 - o pump type, pump curves detailing pump rate vs head (System Curve against the Pump Curve), the discharge rate
 - o delivery line size
 - o switching system
- A Positive Covenant and a restriction of use of land will be required to be placed on the title of the property to inform owners of their responsibility for operation, protect from alteration and ensuring regularly maintenance of the system and to indemnify Council from any claims for damages arising from failure of the pump system. See Appendix G for sample wording.

3.4.3.2. ABSORPTION TRENCHES

Permitted for: Urban areas for driveways, paths and minor paved areas of less than 50m² where a charged system or elevated pipe has been provided for the site

DEEMED TO COMPLY

- 1. To drain a maximum of 50m² of driveways, paths and minor paved areas per site
- 2. Sized at the rate of 2.5m³/50m²;
- 3. Designed to allow full infiltration into an aggregate layer beneath;
- 4. A silt arrestor should be placed before the trench to prevent sediment from entering and compromising the absorption trench;
- 5. Trenching shall be located parallel to site contours; and
- 6. The absorption trench shall be located as far as possible from the downstream property boundary with a minimum distance of 5m from buildings and downstream property boundary and 4m from all other boundaries.

This is the only solution available to drain driveways, paths and minor paved areas of less than 50m² where a charged system or elevated pipe has been provided for the site.

Absorption trenches may be provided by suitable proprietary products or aggregate trenches where void ratios have been determined.



3.5. DESIGN CONSIDERATIONS

3.5.1. MAJOR/MINOR DRAINAGE

A stormwater drainage system shall be provided in accordance with the "major/minor" system concept set out in Chapter 14 of the AR&R (1998); that is, the "major" system shall provide safe, well-defined overland flow paths for rare and extreme storm runoff events while "minor" system shall be capable of carrying and controlling flows from frequent storm run-off events.

The minor drainage system is that part of a drainage system in a catchment that conveys flows from the minor design storm such as the 2 and 5-year Average Recurrence Interval (ARI) events and usually comprises kerb and gutter, gully inlet pits, underground pipes and outlets.

The major drainage system is that part of a drainage system in a catchment that is designed to safely convey rare design storms, and may comprise open space floodway channels, road reserves, pavement expanses, overland flow paths, natural or constructed waterways and detention basins. Piping of major flows cannot be relied upon for managing major flows as it is unlikely that all flows could be captured by inlets and blockage of the minor system can occur. In all instances, a major flow path will still need to be provided.

3.5.2. IMPACT ON ADJOINING PROPERTIES

When designing a development, the engineer is to be aware of the impact the development could have on adjoining properties. In terms of stormwater, the following issues will need to be addressed;

- Changes in site levels shall not cause a restriction to flows from upstream properties;
- Diversion of flows from one drainage catchment to another will not be permitted in most circumstances;
- Any development shall not concentrate the overland flow of stormwater onto an adjoining property
- A person has a common-law obligation not to carry out any work on their property that will adversely affect adjoining properties.
- Developments that have an adverse impact on adjoining/surrounding properties in relation to the above issues will not be approved.

- The height of floor level above the natural ground levels shall be limited to 600mm except where it is required to be raised to achieve a suitable freeboard above the flood level or the 100 year ARI water level of an on-site detention basin.
- Any development shall not impact the amenity of the surrounding areas as per the appropriate Fairfield LGA Development Control Plan (DCP).

3.5.3. MAINSTREAM, OVERLAND AND LOCAL FLOODING

Council's planning process distinguishes between two distinct kinds of flooding – mainstream flooding (overbank flow from rivers, creeks or dams) and overland flooding (inundation by local runoff). If a property is registered as affected by either mainstream or overland flooding within the Section 149 Planning Certificate (available from Council), the development process must adhere to the to the Flood Risk Management section of the Fairfield Citywide DCP (Chapter 11).

There is also 'local flooding' which generally consists of stormwater less than 150mm deep flowing to the local road and stormwater network through natural flowpaths. This local flooding can still have a substantial impact on proposed and existing development. Council may require properties without a mainstream or overland flooding registration to quantify the flow of stormwater passing through the property and ensure the local flooding flowpath is maintained.

Where a property is impacted by overland or local flooding from upstream properties the applicant needs to demonstrate how these flows are to be managed for the proposed development. The following key principles shall be considered:

- The development shall not have an adverse impact on surrounding properties through the diversion, concentration or ponding of flows;
- The development shall accommodate the passage of flow over the site and, where applicable, shall be designed to withstand damage due to scour, debris or buoyancy forces;
- The development must not be sited where flows may result in a hazardous situation for future occupants in terms of depth and velocity of flows through the property;
- Flows shall be directed through common areas and should not be directed through private courtyards or on-site detention systems;
- The flowpath must not be obstructed by landscaping, kerbing, retaining walls or fencing;
- Design elements such as concrete or paving shall be used to fix critical levels in flowpaths to minimise interference by future occupiers; and

• The development must provide adequate freeboard to finished floor levels in accordance with Table 9 in this policy.

Where considered necessary, Council may impose conditions of consent on a proposed development to protect flow paths. A Restriction on Use and Positive Covenant may also be required to protect overland flow paths. Refer to Appendix H for standard wording/ terms.

Council's Development Engineer can be contacted for advice as to whether a particular property may be affected by local flooding. An assessment and site inspection by an experienced professional may also assist in confirming whether a particular site is affected by local flooding.

3.5.4. SITE ANALYSIS

A preliminary site analysis should be prepared before undertaking the design of the site drainage. This should be undertaken as part of the architectural and landscape preliminary design process.

The site analysis should consider all aspects of the development proposal and should integrate the drainage design into the design of building and landscape works. This is particularly important for identifying overland flow paths and storage areas that may impose level constraints.

The drainage site analysis shall include:

- Site slope;
- External overland flow paths entering or adjacent to the site;
- Existing and proposed ground levels;
- Existing structures and vegetation on the site as well as adjoining land;
- Proposed points of discharge;
- Proposed internal overland flow paths and on-site detention (OSD) storage areas;
- Existing and proposed means of access to the site; and
- The hydraulics of the piped network and pipe cover requirements.

3.5.5. EASEMENTS TO DRAIN WATER

3.5.5.1. INTER-ALLOTMENT EASEMENTS

In most cases, easements for drainage purposes will be required where the proposed development site slopes away from the street. Where easements are required over downstream properties the written agreement from the registered proprietor granting an easement to drain water shall be submitted with the Development Application. Such agreement must acknowledge the size and location of the required easement. All easements to drain water over downstream properties are required to be registered with the Land and Property Information prior to the issue of an operational consent.

3.5.5.2. EASEMENTS IN FAVOUR OF COUNCIL

Stormwater assets are usually located along the alignment of original watercourses (such as creeks or rivers), which also contains the overland flowpath. Therefore, deviation of a pipeline and its easement to accommodate development is not likely to be approved, unless it can be proven that it is improving conveyance, there is no increase in flood affects or to the risk to people and property in the 100 year ARI.

In cases where existing Council drainage infrastructure is located within the development site and is not protected by an easement, or where such infrastructure is not within its easement, Council will require the creation of an easement in its favour over the drainage infrastructure. Where an easement is required for Council drainage, only Council shall be empowered to release, vary or modify any restriction or covenant. Documents giving effect to the creation of the restriction and covenant shall be submitted to Council for approval prior to construction.

3.5.5.3. BUILDING ADJACENT TO EASEMENTS

Building a structure over or adjacent to a stormwater asset can increase flooding and the costs to manage the asset. Council aims to keep these structures to a minimum to ensure the community's safety and avoid passing increased costs to our ratepayers.

In most circumstances, structures will not be permitted to encroach upon an easement to drain water. Eave overhangs are permitted subject to at least 4.5m clearance to ground level. The foundations of adjoining structures shall extend at least 200mm below the pipe invert or solid rock (Figure 2). Similarly, the location of proposed easements and associated drainage infrastructure shall be located to ensure that existing buildings and structures are not compromised. No filling or other works will be permitted in the drainage easement which will adversely impact on:

- The conveyance of surface flows;
- The condition and loading on the drainage infrastructure; and
- The rights and costs of the beneficiaries to access, maintain and replace the drainage infrastructure as required.

Council prohibits the construction of most types of structures over drainage easements and stormwater pipelines. The following is a list of extremely light demountable structures that do not impede conveyance Council will consider for approval:

- Simple concrete driveway
- Soft landscaping
- Paving
- Open type awnings (paved flooring only and must not interfere with 4.5m eave clearance)



Figure 3 - Footings adjacent to pipes

3.5.5.4. ATTACHED BUILDING DEVELOPMENT

Attached building developments present unique issues in relation to roof drainage. Where the runoff from the attached roofline runs from one lot to the adjoining one, an easement is required over the roof area, valleys, guttering, downpipes and stormwater lines of the downstream lot along the route of runoff as per Appendix I. A positive covenant for the maintenance of the roof, guttering, etc. is required also. In this respect, it is advisable that careful consideration of the roof and drainage layout is given by the architect/consultants prior to the submission of plans for such developments.

THE MAIN CONTRIBUTOR TO INCREASES IN IMPERVOUS AREA IS PRIVATE DEVELOPMENT.

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4. ON SITE DETENTION SYSTEMS

Impervious surfaces are areas of the earth that have been covered by any material that impedes the infiltration of water into the soil, including roof areas, concrete driveways and decks. These areas increase the runoff of rain during a storm, which in turn increases flooding and has a variety of impacts on our local creeks and rivers.

The main contributor to increases in impervious area in the Fairfield Local Government Areas is private development and it is essential to keep the impacts of this change to a minimum. Therefore, Council encourages that all impervious surfaces are kept to a minimum to reduce the long-term impacts to our floodplains and local creeks and rivers.

Council combats the increased frequency and severity of flooding due to the increased flows from these impervious surfaces by enforcing On Site Detention. On Site Detention limits the peak discharge from sites in a controlled way to reduce the impact on the local drainage network, as well as to ensure that downstream flooding problems are not exacerbated.

Therefore, to not exacerbate flooding the impervious area of a residential site should not exceed 70%. If this cannot be achieved, on site detention shall be required for the site to reduce the impact of the increased rainfall runoff. All commercial and industrial developments where the impervious surface area is to be increased will also require on site detention, and more detail is available in Table 1.

Development within the Fairfield LGA has experienced significant growth and correspondingly the volume and rate of stormwater runoff from developed areas to the public drainage network and the local creeks have escalated over this time.

To counter the effects of development, Council adopted an onsite detention policy in 1990 that reduces the rate of stormwater runoff discharged from development, consistent with the predeveloped state of the catchment.

Onsite detention (OSD) is a component of the property drainage system which reduces the rate of runoff, mimicking the pre-developed state of the catchment. Therefore, as the rate of water exiting the system is less than the rate of watering entering, OSD systems require a basin area to buffer flows.

4.1. OBJECTIVES

The objectives of this policy with regard to On Site Detention are;

• To ensure that through the use of OSD, stormwater discharge is controlled thereby ensuring development does not increase the risk

of downstream flooding, erosion of unstable waterways or a reduction of the capacity of Council's drainage network.

4.2. PERFORMANCE CRITERIA

The following performance criteria apply to the implementation of OSD within the Fairfield LGA:

URBAN ZONE

- Maximum PSD of 140 l/sec/ha for the 9 hour 100 year ARI for the total site **AND**
- Maximum PSD of pre-developed site discharge for the 5, 15, 30, 60, 90, 120 and 540 minute duration storms for the 5 and 100 year ARIs for the total site

RURAL ZONE

• Maximum PSD of 78 l/sec/ha for the 5, 15, 30, 60, 180, 360 and 540-minute duration storms for the 5 and 100 year ARIs for the developed site

4.3. DEVELOPMENTS TO WHICH OSD APPLIES

The LGA is separated into three distinct stormwater management zones (please contact Council to confirm zone boundaries);



Figure 4– Stormwater Management Zones

On site detention is required for the following developments;

URBAN ZONE

- Single dwellings and dual occupancies where the final site impervious area is greater than 70%
- All multi dwelling housing and residential flat buildings
- All commercial and industrial development
- Buildings, car parks and other sealed areas (including artificial lawn) of sporting and recreational facilities

RURAL ZONE

- All development greater than 30m² except:
- For properties less than or equal to 1ha OSD is not required for up to 100m² of non-habitable building/ impervious area
- For properties greater than 1ha OSD is not required for up to 1% of the site for a non-habitable building/ impervious area (i.e. 150m² building for a 1.5ha site)

On site detention is not required for the following developments;

URBAN ZONE

- Single dwellings and dual occupancies where the final site impervious area is less than 70%
- Development that lies within the High & Medium Flood Risk Precincts (100 year ARI floodplain) – development that straddles the Medium and Low risk precincts is expected to provide OSD for the area outside of the Medium Risk Precinct.
- Change of use where no physical changes to the outside of the building are proposed

RURAL ZONE

- For properties less than or equal to 1ha for only one non-habitable building/impervious area up to 100m²
- For properties greater than 1ha for only one nonhabitable building/impervious area up to 1% of the site (i.e. 150m² building for a 1.5ha site)
- Development that lies within the High & Medium Risk Precincts (100 year ARI floodplain) – development that straddles the Medium and Low risk precincts is expected to provide OSD for the area inside the Low Risk Precinct.
- Change of use where no physical changes to the outside of the building are proposes **WETHERILL PARK INDUSTRIAL AREA**
- OSD is not required within the Wetherill Park Industrial Area

4.4. CONTROLS

The following permissible site discharge (PSD) and site storage requirements (SSR) need to be satisfied by the OSD system.

4.4.1. URBAN ZONE

- Maximum PSD of 140 l/sec/ha for the 9 hour 100 year ARI for the total site AND
- Maximum PSD of pre-developed site discharge for the 5, 15, 30, 60, 90, 120 and 540-minute duration storms for the 5 and 100 year ARIs for the total site

4.4.2. RURAL ZONE

- Maximum PSD of 78 l/sec/ha for the 5, 15, 30, 60, 180, 360 and 540-minute duration storms for the 5 and 100 year ARIs for the developed site OR
- SSR of 4.09m³ per 100m² of developed site using the simplified method (section 4.5.1.2)

4.5. DESIGN CONSIDERATIONS

The following general requirements also apply in the design of OSD systems;

- OSD needs to be considered and incorporated into a development as early as possible to ensure a holistic and economical design. The entire site drainage system needs to be considered during the design of a development to ensure that all runoff from impervious surfaces (roofs, gutters, paved yard areas and driveways, etc) is designed to flow into the OSD facility. In addition, a deliberate overland flow path must be created to convey these flows to the facility in the event of blockage or overload, free of obstructions such as fences, buildings, etc.
- The OSD design shall be completed by a professional engineer registered, or eligible for registration, with the National Engineering Register in Civil or Environmental Engineering, specialised in stormwater design.
- The OSD system should be located prior to the point of discharge, generally in the lowest point of the site and located in a common area to facilitate access. This can possibly include a car park, open space area or even roof top areas where no underground storage is possible.
- The OSD storage shall be designed such that run-off in small frequent storms is stored where minimal inconvenience results. In larger storm events, the additional run-off may be stored aboveground in landscaped areas, car parks or driveways where it will cause some inconvenience.

- Any stormwater overflow from the gutters of proposed buildings shall be collected by inlet pits on the ground and/or drained via overland flows paths into the detention system. Where this is not possible, the gutter and stormwater system shall be designed to convey the 1% AEP storm event to the detention system.
- Detention storage shall be provided above ground wherever possible and permissible. Underground tanks will only be accepted where above ground storage systems are not feasible due to the site constraints.
- Designers are encouraged to utilise driveway/carpark areas for implementing OSD basin and landscape the grassed detention basin such that the style of planting in the landscape area does not reduce storage volumes or that provision is made for this loss in the design. Pine bark and leaf litter are not to be used and substituted with an alternative weed control medium
- The OSD designer needs to review the final landscape and architectural plans to verify that the OSD design has not been compromised and there are no anomalies in the plans. Development approval will not be issued until all inconsistencies between plans have been addressed.
- A Restriction On The Use Of Land and Positive Covenant must be executed and registered against the title of the lots containing OSD systems to require maintenance of the system. This positive covenant must be prepared prior to issue of the occupation certificate.
- Large systems may require approval of the Dam Safety Committee.

4.5.1. ESTIMATING STORAGE VOLUMES

4.5.1.1. RUNOFF ROUTING AND RESERVOIR ROUTING METHOD

Council's preferred method for estimating storage volumes is by using a runoff routing software package such as DRAINS, Council's preferred software. DRAINS provides a robust calculation process, and can often achieve the required PSD with a smaller volume than Council's SSR. If this method is used, all calculations and models are to be provided to Council to Council with the Development Application and full details of the OSD system is to be provided on the Stormwater Drainage Plan.

4.5.1.2. SIMPLIFIED METHOD (RURAL ZONE ONLY)

Where the applicant decides that the storage volume below for the relevant zone can be accommodated within the proposed development and the following design criteria can be met, the following relationship may be used:

Rural Zone

V = 4.09 x A / 100m²

Where V = Volume (m³)

A = Total developed site area plus all catchment leading to the OSD storage (m²)

This is provided that:

- A High Early Discharge (HED) control is used
- A singular rectangular shape off-line storage basin is provided and
- The outlet is to restrict the discharges to the relevant PSD for the zone,

4.5.2. HYDRAULIC CONTROL

An important element in preserving the integrity of the OSD design is ensuring that the system functions independently of the street drainage network. The system is not intended to handle surcharge flows from the street drainage network.

For stormwater events where the OSD would be operating there is a high possibility that the street system would surcharge. Due to these effects, whether connection is made to the underground drainage system or the kerb and gutter, the starting hydraulic grade-line level is to be the top of the kerb and gutter at the discharge point to the street drainage system. Locating the outlet control device above this level ensures that the discharges from the basin are unaffected by the downstream hydraulic grade-line or water surface levels. for further details.



Figure 5 – Unacceptable hydraulic control conditions



Figure 6 - Undesirable hydraulic control conditions



Figure 7 – Desirable hydraulic control conditions

4.5.3. FINISHED FLOOR LEVEL FREEBOARD

The minimum freeboard for the floors of any new structures such as garages, dwellings, commercial and industrial buildings to be constructed on the site, above the adjacent local 100 Year ARI water surface level or 100 Year ARI storage water surface level in the facility, shall be as per Table 3.

Minimum 0SD Freeboard		
Habitable floors (including industrial)	300mm	
Non-habitable floors	100mm	

4.5.4. DISCHARGE CONTROL PIT

The discharge control pit is to meet the following conditions;

- Minimal risk of becoming blocked
- Located in accessible position for easy access for inspection and cleaning
- Minimal risk of tampering
- Step irons are required for pits greater than 1200mm depth
- Subsoil drainage is required for discharge control pits with an above ground storage to prevent the ground becoming saturated during prolonged wet weather

The orifice plate within the discharge control pit is to meet the following conditions;

• The orifice hole diameter is to be sized using the following equation:

D = Q0.619.62*H*4 П

Where

- H = Depth to centreline of orifice opening
- Q = Permissable Site Discharge

- Manufactured from corrosion resistant stainless steel plate with a minimum thickness of 3mm (5mm where orifice diameter exceeds 150mm), with a central circular hole machined to 0.5mm accuracy.
- Machined hole is to retain a sharp edge.
- Plate to be permanently fixed to the pit wall and be epoxy sealed to prevent the entrance of water around the edges.
- Have an orifice diameter not less than 40mm.
- The plates are to be engraved with the orifice diameter and an identifying mark. The orifice diameters are to be certified by the manufacturers.

The trash screen within the discharge control pit is to meet the following conditions;

- Manufactured from galvanised Lysaght RH3030 Maximesh (or approved equivalent) with galvanised angle steel frame.
- Is to screen all pit inflows to the orifice.
- Shall be 50 times the orifice area.
- Located to a minimum distance of 150mm from the outlet orifice.
- Positioned as close to vertical as possible. Pits up to 600mm deep should have screens no flatter than 45 degrees. In pits over 600mm deep or in remote positions this should be increased to 60 degrees.
- Shall include handle(s) for easy removal.

A sump is required in the base of the discharge control pit to assist in avoiding turbulence near the pit floor from affecting the hydraulic performance of the orifice outlet, to prevent silt and debris from blocking the orifice outlet and to allow simple installation of the orifice plate. To ensure drainage of the discharge control pit sump, the following are to be provided:

- The invert of the sump is to be 1.5 times the orifice diameter or 200mm (whichever is greater) below the centre of the orifice outlet.
- The discharge control pit is to be constructed on an aggregate base (minimum 100mm thick) wrapped in geotextile fabric.
- Sufficient weepholes in the sump floor that are to be kept unblocked by construction debris. (Note: Weepholes are not to be installed in sumps where the OSD storage has a combined use and may be affected by pollutants ie. Firefighting water storage, chemical bund storage, spillage control etc.)

A diagram of a typical discharge control pit is in Appendix J

4.5.5. HIGH EARLY DISCHARGE PIT

In addition to the requirements listed above for a Discharge Control Pit, the following conditions need to be met for a High Early Discharge (HED) Pit.

- The minimum height from the centre line of the orifice to the HED overflow weir level is to be 400mm
- The 100 year ARI storage TWL is to be at, or below, the HED overflow weir level
- The PSD Head level (i.e. 100mm above the HED overflow weir) is to be used for sizing the orifice
- The HED overflow weir is to be a minimum of 0.1m long. The length is to be linearly interpolated from the table below

Table 4 - HED Weir Length

Impervious area draining to OSD (m²)	Weir Length (m)
100	0.1
250	0.2
500	0.4
750	0.6
1000	0.8
2000	1.7
3000	2.5
4000	3.3
5000	4.1

A diagram of a typical HED control pit is in Appendix K



4.5.6. DRAINAGE SYSTEM

The drainage system is to be gravity drained, (i.e. no pump systems will be permitted by Council) and all developments are required to be connected to Council's stormwater system. For properties with adverse grade conditions i.e. falls to the rear, where no inter-allotment drainage is existing, a drainage easement will need to be created over neighbouring properties to achieve connection to the stormwater system.

Full hydrological and hydraulic grade-line (HGL) calculations are to be submitted for the piped internal drainage. The drainage lines must be sized for a minimum of the 1 in 5-year event. Where the piped drainage system is designed for less than a 1 in 100 year ARI event, the designer must show that the overflows

of the drainage system are directed to the OSD basins. The controlling hydraulic level for the piped internal drainage system is the peak water surface level of the basins. By providing hydraulic calculations problems such as hydraulically interconnected basins and unexpected surcharging of the internal drainage system will be highlighted.

Roof gutters and downpipes are also an integral part of the OSD system. As most roof gutters are only able to accommodate approximately the 1 in 20-year storm runoff, any storm events of higher duration can be expected to overflow the guttering. If this overflow is not directed to the originally destined detention basin, either the roof guttering and downpipes have to be designed to accommodate up to the 100-year runoff or the overall drainage design is to take into account this redirection of these additional overflows.

4.5.7. BASIN OVERFLOWS

To avoid nuisance flows, overflow weirs and spillways are not to become operational in normal circumstances in storms up to and including the 1 in 5-year ARI event. All flows up to this point are to be directed via orifice and pipe discharge.

Overflow weirs/spillways are to be designed to accommodate the maximum 1 in 100 year AR1 discharge, assuming the OSD basin storage is full and the orifice outlet is blocked. Checks should be made to ensure this discharge from the overflow weir / spillway will not inundate nearby dwellings and that the overflows are directed to a flow path through the development and do not concentrate flows onto an adjoining property and the flow path is free of all obstructions.

4.5.8. LOCAL FLOWS

Local flows which enter the site from surrounding properties are to be collected and conveyed through the development. These flows are to be kept isolated from the detention basin systems for all storm events. This discharge is not to be considered in the calculation of the peak discharges of the Permissible Site Discharge.

4.5.9. ABOVE GROUND STORAGE

The following ponding depths will apply to all above ground OSD systems.

Table 5 – OSD	Ponding	Depths
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Storage area	Suggested depth	Frequency of inundation
Pedestrian areas	Beginning to pond	Once in 5 years
	50mm (max depth)	Once in 100 years
	Beginning to pond	Numerous times per year
Parking & driveways	100mm	Once in 5 years
	200mm (max depth)	Once in 100 years
	Beginning to pond	Once a year
	200mm	Once in 5 years
Garden areas	500mm (maximum depth without fence)	Once in 100 years
	1200mm (fenced maximum)	Once in 100 years

Where above ground storage is provided in hardstand areas used for car parking and pedestrian access the following criteria must be addressed in the design:

- The first 10% or 1m³ of the storage volume, whichever is the greater, shall be provided in an area where frequent ponding in a one year ARI 2-hour event will not create a nuisance. This may be in an area not required for access or in an underground tank or oversized pit or pipe etc;
- Stored water shall not inundate gardens or areas with bare soil, mulch or the like around parking or other hardstand areas. These areas should be above the storage top water level or protected by concrete kerbing or other robust treatment capable of withstanding vehicle impact;

The following criteria shall be considered for the design of above ground storage in landscaped areas:

- All landscaped storage areas should be within common property;
- The design should be undertaken in consultation with the landscape designer to ensure that the plans are not in conflict;
- The first 10% or 1m³ of the storage volume, whichever is the greater, shall be provided in an area where frequent ponding in minor storms will not create a nuisance. This may be in an area not required for access or in an underground tank or oversized pit or pipe etc;
- Batter slopes in landscaped areas shall be generally 1:6 (V:H).
- Where vegetated landscaped areas are to be used for storage (excluding grass only), an additional 20% storage volume, in excess of the design volume, shall be provided to allow for vegetation growth.
- Vegetated landscaped areas are to be a maximum of 20% of adjusted basin size, with the remaining 80% to be grassed.
- Grassed only landscaped areas are not to be positioned in the front setback
- Careful consideration shall be given to types of planting and landscaping treatment within the basin, to ensure the area can be readily maintained and the storage volume is not reduced over time, and that there is a variety of plant species to be aesthetically pleasing;
- Landscaping shall be designed so as not to generate large amounts of debris or other material likely to cause stormwater pollution. Treatments such as bark chips/mulch or bare soil and the like shall not be permitted within the area of inundation. Only the use of 30-40mm rock as mulch will be permitted;
- Within the Rural zone, the OSD storage should

be made as pervious as possible and storages on impervious areas should be avoided.

- Vertical sides near driveways or pedestrian areas should be protected with an appropriate treatment such as fencing, kerb, edging or landscaping to minimise hazard to pedestrians and vehicles;
- Suitable access shall be provided for maintenance purposes which may include ramps or accessible gradients;
- Consideration must be given to the likelihood of access by children in rainfall events and the subsequent need for fencing or other controls;
- Where fencing is required it shall be childproof pool type fencing including a self-closing gate;
- Subsoil drainage shall be installed in landscaped storage areas to prevent the area remaining saturated during wet weather;
- The base of landscaped storage is to have a minimum 1% fall to the outlet pit;
- Designers are not to use pine log/timber sleepers as a retaining wall for the storage basin. Brick work or decorative block work only to be used.
- At least one dry access/escape route shall be available to individual residences.

The following criteria shall be considered for the design of above ground storage in tanks (only to be used for non-habitable buildings within the rural zone):

- The design of aboveground tanks must consider appearance and urban design issues.
- Aboveground tanks shall comply with the appropriate engineering criteria as belowground tanks and the same planning criteria as rainwater tanks.
- For dual use tanks, any permanent water storage volumes will not count as part of the SSR
- Additionally, when using rainwater tanks for OSD, consideration must be made to the fact that it is difficult to fit an orifice plate to the tank. The use of an equivalent pipe diameter in place of an orifice is not acceptable as the discharge through a pipe is not the same as through an orifice of the same diameter. Therefore, the design should ensure that suitable calculations are used to determine the discharge pipe diameter and required storage.

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4.5.10. BELOW GROUND STORAGE

Below ground storage should only be used where no suitable hardstand or landscaped area is available. The following design criteria must be met for below ground storage tanks:

- Storage tanks should not be located under habitable floors;
- Storage tanks under non-habitable floors will only be permitted where storage is not possible in any other location;
- For dual use tanks, any permanent water storage volumes will not count as part of the OSD storage;
- Storage tanks shall not be penetrated by any site services such as water, sewer, gas etc;
- A minimum internal (head) height of 1.2m is to be provided. This may be reduced to 750mm for commercial/industrial development or 500mm for residential development, but only where all other practical alternatives have been exhausted and where it can be demonstrated that consideration has been made to allow easy access by the owner of the system to facilitate inspection and maintenance.
- Sufficient ventilation and access points (usually hinged grated lids) must be provided to the storage tank.
- Grates are to be placed in a manner to ensure that the maximum distance from any point in the tank to the edge of the nearest grate is not greater than 3m. This is to facilitate access and maintenance of the storage tank.
- At a minimum, two grated inlet/access points shall be provided on opposite sides of the tank to facilitate ventilation. One shall be located over the outlet control pit/screen for maintenance and cleaning and a minimum of 600mm x 900mm;
- Grates are to have a maximum lifting weight of 20 kg. The grate may need to have a double opening to achieve this requirement.
- Grates are to be placed in a manner to ensure that the maximum distance from any point in the tank to the edge of the nearest grate is not greater than 3m.
- Underground storage facilities shall be designed to adequately withstand all service loads and provide adequate service life of 50 years.
- Step irons shall be provided for all storages greater than 1200mm deep, and shall be staggered to give a 300mm spacing vertically and 220mm spacing horizontally;

- Grates should be fitted with appropriate locking mechanisms to prevent ingress by children or non-authorised persons;
- For safety, all maintenance access to pits must conform to current Australian Standards and regulations for confined spaces. It is the responsibility of the designer to ensure compliance with these requirements;
- The location of the tank and inspection access should also consider safety of persons undertaking maintenance and inspections. Access points should be located away from driveways or heavily trafficked areas wherever possible.
- The floor of the storage tank shall be graded at a minimum of 1% longitudinally and laterally to the outlet to ensure free and complete dewatering of the system;
- The tank shall be reinforced concrete or masonry;
- The tank shall be certified by an appropriately qualified and experienced engineer for structural adequacy against appropriate live and dead loads, earth loads, traffic, internal hydrostatic loads as well as external hydrostatic loads (buoyancy).

4.5.11. SIGNAGE

Standard On-Site Detention marker plates are to be fixed on all OSD basins to indicate to owners, residents and maintenance personnel the location of the OSD system. The requirements of the standard On-Site Detention marker plate are as below.

Minimum Size:	150mm x 60mm
Material:	Non-corrosive metal or 4mm thick laminated plastic
Location:	Screwed to the nearest concrete or permanent surface to the OSD system and be above the expected water surface level in the basin. If in doubt, contact Council
Wording:	Minimum letter height of 5mm. Wording to consist of;



4.6. CONSTRUCTION AND MANAGEMENT

4.6.1. CONSTRUCTION & CERTIFICATION

The construction of the OSD system shall be in accordance with this policy and relevant Australian Standards.

Construction supervision is essential in achieving a properly working OSD system. The designer can contribute to the construction process by providing clear detail on the design drawings with construction set out and level detail that minimises the need for interpretation on site. OSD systems require closer attention to set-out and levels than a conventional drainage system. Without adequate supervision during construction (preferably by the designer or someone very familiar with the design intent), expensive and time consuming rectification works are often necessary prior to certification of construction works by the design engineer and issue of an Occupation Certificate. The walls of basins and tanks shall be wholly contained within the parent property or common/community property and shall not form a common boundary with adjoining private property whether part of the community/strata scheme or not.

The original drainage design consultant is required to provide two forms of certification of construction to Council.

The first is provided prior to backfilling of the internal drainage lines and is to state that the system has been inspected and found to be in accordance with the approved design, or within the construction tolerances listed below. Where works are outside the construction tolerances the defective work shall be rectified to comply with the approved design prior to certification.

Element of OSD system	Construction tolerance
Percentage of area not detained	+/- 5%
Storage Volume	+/- 5% design
Site Discharge	+/-5% design
Freeboard	+/-10% required
Storage Depth	+/-10% or 50mm whichever is lesser
Storage Depth Parking Areas	+/-5% design depth
Pipe Grades	+/- 10% design grade
Tank Height	+/- 5%
Screen Fit	+ 5mm gap between wall and floor

Table 6 – On site detention construction tolerances

The second certificate is provided on completion of the drainage works and prior to the issue of a satisfactory Final Inspection. The checklist for this certificate in Appendix L includes:

- Certification that the OSD system will function in accordance with the approved design.
- Identification of any variations from the approved design and certify they are within the construction tolerances.
- Certification and evidence of any elements that were outside the construction tolerances that have been rectified to be within the tolerances and that these variations will not impair the performance of the OSD system
- Verification that all structural elements including storage tanks and retaining walls are structurally sound and fit for purpose;
- Work as Executed Plans prepared by a registered surveyor on a copy of the stamped approved construction plan and include the following;
- o Registered surveyor's details and signature;
- o Sufficient levels and dimensions to verify the OSD volumes;
- o Location and surface and invert levels of all drainage pits;
- o Invert levels of the internal drainage lines and pipe gradients;
- o Finished floor levels of structures such as units and garages;
- o Verification that the orifice plates have been fitted and the diameter of the fitted plates;
- Verification that trash screens have been correctly installed;
- o Location and finished contour levels on any overland flow paths formed through the site;
- o Detail of any variations or omissions made from the approved plans.
- o Weir dimensions and levels; and
- o Extent of the above ground storage.

4.6.2. REGISTRATION

OSD systems are long term structures intended to control discharges from the site over the entire life of the development. A well designed and properly constructed system can still be rendered ineffectual by alterations, such as filling of the detention basin and planting of garden beds across flowpath, or by poor maintenance. Therefore, it is necessary that these systems are protected and regularly maintained.

Council requires that the design parameters, location and maintenance requirements are registered in the form of both a Restriction On The Use Of Land and a Positive Covenant on the title of the land prior to occupation of the development, issue of an occupation certificate or issue of a subdivision certificate for the development, whichever comes first.

The developer must supply Council with evidence the Instrument setting out the terms of the Restriction On The Use Of Land and Positive Covenant have been created pursuant to Section 88B or Section 88E of the Conveyancing Act, 1919. The location of the "Onsite Stormwater Detention System" shall be shown on the Deposited Plan or included as a site plan attached to the appropriate documents.

Refer to Appendix M for typical wording for registering a Restriction On The Use Of Land and Positive Covenant to the development site.

4.6.3. MAINTENANCE

An OSD maintenance schedule shall be prepared for the OSD system. The maintenance manual should be a simple set of operating instructions for future property managers, owners and occupiers. It should include a simplified plan showing the layout of the OSD system.

The maintenance schedule needs to set out simply and clearly the routine maintenance necessary to keep the OSD system working including:

- The location of storages and critical elements;
- Internal and external overland flow paths;
- Frequency of cleaning/inspection for each element;
- How access is gained for cleaning;
- Equipment/methods needed for cleaning;
- Who can undertake maintenance e.g. handyman, owner, specialist for tanks;
- WHS issues (in particular tanks);
- Critical aspects such as levels in landscaped areas; and
- Any other matters specific to the particular system.

The maintenance schedule shall be submitted to the PCA prior to the issue of an Occupation Certificate. A copy of the maintenance schedule shall be provided to Council with any notification of the issue of an Occupation Certificate. A sample maintenance schedule is included in Appendix N that can be modified to suit your site.



BRINGING COMMERCIAL AND INDUSTRIAL DEVELOPMENT IN LINE WITH RESIDENTIAL DEVELOPMENT

5. WATER CONSERVATION

Potable mains water conservation seeks to reduce demand on water resources and wastewater discharges to the environment. The conditions below aim to bring commercial and industrial development into line with the existing BASIX controls for residential development.

5.1. OBJECTIVES

- Reduce water consumption in non-residential properties, consistent with the BASIX scheme requirements in residential properties
- Enable use of non-potable water for toilet flushing, irrigation and other non-potable uses.

5.2. PERFORMANCE CRITERIA

• Reduce water consumption in non-residential properties by 40% consistent with the BASIX Scheme

5.3. DEVELOPMENTS TO WHICH WATER CONSERVATION APPLIES

This chapter applies to all commercial and industrial development (including additions greater than 150m²) in the LGA.

5.4. CONTROLS

All new commercial and industrial buildings and additions greater than 150m² (i.e. not covered by the State Environmental Planning Policy – BASIX) must:

- Ensure that 80% of the roof area of the development is to drain to a tank(s) that has a capacity of 3,000 litres per 100m² of roof area of the development. The tank(s) is to be connected to all non-potable uses including toilet flushing, irrigation, wash down, and laundry
- Ensure any water use fittings demonstrate minimum standards defined by the Water Efficiency Labelling and Standards (WELS) Scheme. Minimum WELS ratings are 4 star dual-flush toilets, 3 star showerheads, 4 star taps (for all taps other than bath outlets and garden taps) and 3 star urinals. Water efficient washing machines and dishwashers are to be used wherever possible.
- Incorporate passive cooling methods that rely on improved natural ventilation to supplement or preclude mechanical cooling
- Ensure any cooling towers are:
 - o connected to a conductivity meter to ensure optimum circulation before discharge
 - o include a water meter connected to a building energy and water metering system to monitor water usage
 - o employ alternative water sources for cooling towers where practical and in accordance with the Public Health Act and NSW Health Guidelines
- Water use within public open space (for uses such as irrigation, pools, water features etc) should be supplied from sources other than potable mains water (e.g. treated stormwater or greywater) to meet 80% water use demand.

5.5. DESIGN CONSIDERATIONS

The following general requirements apply to the design of WSUD systems;

- Rainwater runoff from roofs, can be captured and used for toilet flushing, irrigation, washing machines and hot water systems.
- Tanks should be sized according to the area of roof capturing rain water connected to the tank and water demands. Rainwater tanks are most effective when they are sized when the demands are well-matched to the runoff from the roof area. A desired level of reliability can be achieved with the selection of an appropriately sized tank.
- Roof area and construction The roof area available for rainwater harvesting is determined by the roof configuration and the number of downpipes connected to the rainwater tank. Roofs constructed of cement or terracotta tiles, Colorbond®, galvanised steel, Zincalume®, polycarbonate, fibreglass or slate are suitable for the collection of rainwater.
- Reliability of potable water supply and quality It is important that the quality of harvested rainwater meets the requirements of the reuse application and is sufficient in quantity. The quality of supply is typically guaranteed by using a first flush diverter. A first flush diverter is a simple device that diverts the first portion of runoff, containing leaf debris et cetera, away from the tank and once full allows water from the roof to pass directly into the tank.
- Tanks can also be fitted with potable water topup devices to ensure supply availability available, even during periods of no or little rainfall. This is important if rainwater is used for indoor demands such as toilet flushing. Potable water top-up is achieved by plumbing potable water into the tank with an air gap. Where potable water top-up is used the tank will need a float activated switch to ensure

no cross contamination can occur (using appropriate valves) and a backflow prevention device to prevent rainwater from entering the potable supply.

- Applications for rainwater collected stormwater from roofed areas is suitable for irrigation, toilet flushing and laundry uses. Tank water can also be used in hot water systems, where a storage temperature of 60 degrees centigrade will effectively destroy most pathogens in a short amount of time (see Part 4.2 of AS/NZS 3500 for more information).
- Installation A licensed plumber is required to install the rainwater tank with all installations conforming to Australian Standards (AS3500.1.2 Water Supply: Acceptable Solutions). Refer to the Green Plumbers http://www.greenplumbers.com.au for additional information.
- Rainwater tanks require regular preventative maintenance to avoid the need for corrective action.
 If a pump system is used, the pump manufacturer should be consulted for advice on necessary maintenance. Recommended maintenance includes:
 - Inspecting roof areas and gutters once every six months to ensure they are relatively free of leaves and debris.
 - o Pruning of vegetation and trees that overhang the roof.
 - o Checking and cleaning of first flush devices once every 3 to 6 months.
 - Inspecting bypass screens at inlet and overflow points once every 6 months to check for fouling and clean when required.
 - o Checking tanks once every 2 to 3 years for the accumulation of sludge. Sludge may become a problem if it is deep enough to reach the level of the out take pipe which can produce discoloured or sediment-laden water, or affect storage capacity. When necessary, sludge can be

COLLECTED ROOFWATER IS SUITABLE FOR IRRIGATION, TOILET FLUSHING AND LAUNDRY USES.

FAIRFIELD COUNCIL NEEDS TO ENSURE THAT WE DO NOT INCREASE THE BURDEN ON OUR FUTURE RESIDENTS.

6. WATER QUALITY IMPROVEMENT

There are many pressures impacting water quality throughout the Fairfield LGA with some of the more intense pressures arising from population growth and the associated expansion and intensification of infrastructure, industry and urban areas. This not only places a strain on our drainage infrastructure, but also impacts the quality of water in our creeks and rivers.

Fairfield Council needs to ensure that we do not increase the burden on our future residents, by ensuring that current development is sustainable, and ensures we keep our waterways as healthy as possible. Water Sensitive Urban Design (WSUD) is the sustainable management of these pressures through intelligent and integrated design.

WSUD includes technologies such as rainwater tanks to reduce potable water consumption and costs, bioretention systems (raingardens), swales, wetlands, proprietary devices and other approved site-specific measures to reduce pollution from stormwater entering local waterways.

WSUD, like traditional drainage, needs to be integrated into the site, and therefore considered at the initial planning stages. Designers and engineers who choose to leave WSUD as an addition at the end of the design process will find they will achieve poor amenity and water quality outcomes, that will require redesign before Council approval.

WSUD will be used to work towards our community's priority of a 'Cleaner Environment', by improving the cleanliness of our waterways.

Development within the Fairfield LGA has experienced significant growth and correspondingly the quality of stormwater in our local creeks and receiving waters has deteriorated. Water quality and ecosystem health is poor in Prospect and Cabramatta Creeks, which also impacts the Georges River, downstream of the Fairfield LGA.

To counter the effects of development, Council has introduced water quality improvement to this policy to ensure we at least maintain the current condition of our local creeks. The incorporation of Water Sensitive Urban Design (WSUD) in the property drainage design process allows for the capture and treatment of stormwater ensuring the improvement of water quality.

6.1. OBJECTIVES

The objectives of this policy with respect to water quality improvement are;

- Mitigate the impacts of development on stormwater quality
- Minimise the potential impacts of development and other associated activities on the aesthetic, recreational and ecological values of our local creeks.

6.2. PERFORMANCE CRITERIA

The following stormwater reduction targets must be met by development within the Wetherill Park Industrial Area (taken from the Botany Bay Coastal Catchments Initiative, Prepared by BMT WBM for GRCCC, 2013)

Table 7 – Stormwater quality improvement targets

	Commercial & industrial development
Gross Pollutants	90%
Total suspended solids (TSS)	80%
Total phosphorus (TP)	55%
Total nitrogen (TN)	40%

To meet the targets, developments have the choice of either submitting a deemed to comply solution or a WSUD strategy, as outlined below.

6.3. DEVELOPMENTS TO WHICH WATER QUALITY IMPROVEMENT APPLIES

The LGA is separated into three distinct stormwater management zones (please contact Council to confirm zone boundaries)



Figure 8 – Stormwater Management Zones

WETHERILL PARK INDUSTRIAL AREA:

• Water quality improvement is required for all development within the Wetherill Park Industrial Area where the impervious area in increased.

URBAN ZONE

• Water quality improvement is not required within the Urban Zone

RURAL ZONE

• Water quality improvement is not required within the Rural Zone

6.4. CONTROLS

6.4.1. DEEMED TO COMPLY

Developments can demonstrate that they achieve the water quality targets by adoption the following deemed to comply solution:

DEEMED TO COMPLY

- Ensure that 80% of the roof area of the development is to drain to a tank(s) that has a capacity of 3,000 litres per 100m² of roof area of the development. The tank(s) is to be connected to all nonpotable uses including toilet flushing, irrigation, wash down, and laundry.
- 2. Provide a bioretention system(s) which has a surface area of at least 1.5% of the total impervious area that does not drain to a rainwater tank.
- The development is to ensure all flows not directed to a rainwater tank are directed to the bioretention system(s)
- 4. The bioretention system(s) is to have a filter media layer 500-600mm deep
- 5. Batters from the raingarden to the natural surface are to be a minimum of 1:6

6.4.2. ALTERNATIVE SOLUTION – WSUD STRATEGY

If a developer seeks an alternate pathway to meet control, the option of a Water Sensitive Urban Design Strategy available. A WSUD strategy is a written report detailing the stormwater quality control measures to be implemented as part of a development, and include the following detail:

- Proposed development Describe the proposed development at the site, including site boundaries and proposed land uses.
- WSUD objectives Identify the WSUD objectives that apply to the proposed development.
- Stormwater quality demonstrate how the stormwater quality targets will be met. It should include stormwater quality modelling results and identify the location, size and configuration of stormwater treatment measures proposed for the development.

- Details of MUSIC Modelling (or equivalent) Modelling parameters to determine the size and configuration of WSUD elements must be undertaken in MUSIC (or equivalent) and use the parameters included in Appendix O of this document.
- Costs Prepare capital and operation and maintenance cost estimates of proposed water cycle management measures. Both typical annual maintenance costs and corrective maintenance or renewal/adaptation costs should be included.
- Draft Operation and Maintenance plan An indicative list of inclusions in the maintenance plan is included in Checklist provided in Appendix P of this document
- Checklist outlining the details of the WSUD Strategy and reference of the information source.

Development that needs to consider on-site detention are to refer to Council's Engineering Specifications and Stormwater Drainage for Building Developments documents.

6.5. DESIGN CONSIDERATIONS

The following general requirements apply to the design of ALL water quality improvement systems;

- The entire disturbed area is to drain through WSUD system
- The WSUD system should be located prior to the point of discharge, generally in the lowest point of the site and located in a common area to facilitate access.
- Filtration shall be provided above ground wherever possible and permissible. Underground units will only be accepted where above ground systems are not feasible due to the site constraints.
- Designers are encouraged to utilise setback areas for implementing WSUD and to ensure planting within this area is attractive to improve the aesthetics of the area.
- A Restriction On The Use Of Land and Positive Covenant must be executed and registered against the title of the lots containing WSUD systems to require maintenance of the system. This positive covenant must be prepared prior to issue of the occupation certificate.

6.5.1. BIORETENTION SYSTEMS

Bioretention systems are commonly used in Sydney to meet stormwater quality targets, and are further described in this section. Bioretention systems are vegetated soil media filters, which treat stormwater by allowing it to pond on the vegetated surface, then slowly infiltrate through the soil media. Treated water is captured at the base of the system and discharged via outlet pipes. A typical cross-section of a bioretention system is shown in Figure 8.



Figure 9 - Bioretention system typical arrangement (Water by Design 2009)

Bioretention systems can be implemented in almost any size/shape in many different locations including street trees in the footpath, or road or traffic calming devices within streetscapes. It is important to have sufficient depth (normally at least 0.8 m) between the inlet and outlet of a bioretention system, therefore they may not be suitable at sites with shallow bedrock or other depth constraints, however they are otherwise a very flexible and effective treatment measure for both suspended and dissolved pollutants.

Bioretention systems are able to meet the meet the stormwater treatment targets identified in Council's DCP and are typically sized to have a filter area of approximately 1.5% of the catchment draining to the treatment element. This size will vary based on the imperviousness of the development and elements of the bioretention system such as extended detention depth and filter depth

STREET TREES

Street tree bioretention systems are small systems that are incorporated into street tree plantings. These systems can be integrated into high-density urban environments and can take on a variety of forms. The filter media should be at least 0.8 m deep to allow for root growth of the tree, therefore substantial depth is required between the inlet and outlet. Examples of street tree bioretention systems are shown in Figure 9.

BIORETENTION RAIN-GARDENS

Rain-gardens can be incorporated in a range of locations, as they can be any shape and size. They are essentially small bioretention basin systems, with typical locations including pocket parks, traffic calming measures and between parking bays. Examples of raingardens are shown in Figure 10.



Figure 10 – WSUD in Street Tree pits - Hornsby (left), Meadowbank shops, Ryde (centre left), Sydney University (centre right) (Photos: Equatica).

6.5.1.1. ELEMENTS OF A BIORETENTION SYSTEM

A bioretention system includes the following components:

- Vegetation prevents surface clogging and assists in pollutant removal via biological processes.
 Some plant species that can be used include:
- o *Fincia nodosa* (Syn. *Isolepis nodosa*) (Knobby Club Rush),
- o Cymbopogon refractus (barbed wire grass)
- o Dichelachne micrantha (short-hair plume-grass)
- o Daviesia gensitifolia (Bitter pea)
- o Goodenia hederacea subsp Hederacea (Hop bush)
- o Juncus usitatus (Common Rush),
- o Themeda triandra (Kangaroo Grass)



A minimum of 10 plants per square metre is recommended. Shrubs or trees may also be included.

- Extended detention (or ponding depth) stores stormwater temporarily on the surface to buffer flows so that a greater volume can be treated.
- The filter media is the principal treatment zone. As stormwater passes through the filter media, pollutants are removed by filtration, adsorption and biological processes. The filter media should normally be 0.6 m deep, and 0.5 m is the minimum acceptable depth where the site is constrained. The filter media should be a loamy sand with a permeability of 100-300 mm/hr under compaction and should be clean and free of weeds. The filter media should contain some organic matter (less than 5%) but be low in nutrient content. No fertiliser is to be added.
- A **transition layer** of clean well graded sand/coarse sand prevents the filter media from washing out of the system
- The drainage layer of clean fine gravel (2-5 mm) collects treated water at the base of the system and contains 90-100 mm perforated pipes to convey treated water out of the system
- An impervious liner may be required to prevent infiltration into surrounding soils, particularly if the treatment system is immediately adjacent to roads or buildings where infiltration may cause structural issues. Note that geotextile filters should not be used within the bioretention system, as they are prone to clogging. If perforated pipes come with a geotextile sock, this should be discarded before installation.
- An **inlet** for stormwater runoff. The inlet should be designed to protect the surface of the bioretention system from scour and erosion
- An **overflow pit** (or other controlled overflow point) to allow high flows, beyond the capacity of the treatment system, to escape to the stormwater drainage system in a controlled manner
- A **flushing point** connected to the perforated pipes, so they can be cleaned in the event of blockage
- Edge treatment (e.g. a raised kerb or series of bollards) may be required to protect the bioretention system from traffic
- **Pre-treatment** is recommended when sediment loads are likely to be high, or if there is a risk of spills. The simplest option is to incorporate a pit with a sump immediately upstream of the bioretention system



6.5.2. PROPRIETARY STORMWATER TREATMENT DEVICES

Council may consider approving the use of certain proprietary devices in place of bioretention measures, however prior to approval the following information must be provided for Council's consideration:

- The proposed reduction efficiencies need to be justified by rigorous scientific testing and results published in a credible engineering/scientific journals
- Pollutant reduction parameters independently verified using a method to suit local or regional conditions (comparison between climate, pollutant concentrations and soluble pollutants)
- Information on the performance under dry weather flows (to account for potential pollutant leaching)
- Information on the assumed high-flow bypass rate and details about how it was determined, and
- The modelled pollutant reduction efficiency reflects the published figures.





APPENDIX A - CHECKLIST FOR STORMWATER DESIGN PLANS

Survey Information Requirements	Provided
Boundaries.	
Services within the public footway.	
Site features ie trees, depressions.	
Sufficient levels to provide contour levels at 0.1 m for flat sites ranging to 0.5 m for steep sites on plan extending 10 m into the adjoining properties or as required for detail purposes	
Top of kerb levels.	
Boundary levels.	
North point.	
Levels to AHD where site is affected by overland flows/flooding.	
Benchmark to be indicated on the plans.	
Design Information Requirements	
Plans to be to a suitable scale 1:100 or 1:200	
Designers name, qualifications and contact details are to be included on the plans	
Full hydraulic/hydrological calculations prepared in accordance with the requirements of this policy including catchment plans, overland flow calculations and hydraulic grade line analysis etc.	
Details of the development layout including finished floor, garage and ground levels in accordance with the requirements of this policy	
Driveway levels at boundary and as required	
Full details of connection to Council's stormwater system including levels appropriate details and construction notes	
Location of all public utility services where they cross proposed pipelines from the development connecting directly into the street drainage system as required	
Drainage layout with all pit/ pipe types, sizes, grades, invert and surface levels	
Location and level of all proposed retaining walls	
Plan in accordance with Council's Policy For Erosion and Sediment Control and/or the Department of Housing's "Managing Urban Stormwater– Soils and Construction"	

APPENDIX B - OSD DESIGN CHECKLISTS

URBAN ZONE

Has a minimum of 300mm freeboard been provided between the habitable floor levels (or 100mm for non-habitable) and the OSD design storage top water level?	Yes/No
Detailed run-off and reservoir routing calculations provided - preferably in the form of DRAINS	Yes/No
Basin stage-storage-discharge relationship provided?	Yes/No
5 & 100 Year ARI pre and post development site discharges provided?	Yes/No
Above ground OSD storage	Yes/No
First 10% or 1m ³ ponds where it will not create a nuisance	Yes/No
Vegetated areas are increased by 20% to accommodate growth	Yes/No
Rock mulch (30-40mm) specified, and no bark chips/organic mulch	Yes/No
Fenced if greater than 500mm deep	Yes/No/NA
No greater than 1.2m deep	Yes/No/NA
Base has fall greater than 1%	Yes/No
Below ground OSD tanks	Yes/no
Have 2 x 600mm x 900mm access grates been provided?	Yes/No
Maximum distance within the tank to a grate is no greater than 3m?	Yes/No
Access point away from trafficked areas?	Yes/No
Have step irons been provided for tanks deeper than 1200mm?	Yes/No
Plans to AHD and to a 1:100 scale, which include the following in addition to the standard SDP requirements:-	
The location, extent and maximum depth of all OSD storage areas and their contributing catchments.	Yes/No
Details of the OSD basin discharge control pit, weir, orifice, trash screen and sump	Yes/No
Detailed cross-sections through each storage area.	Yes/No
The discharge points to Council's system (including weirs).	Yes/No
Pipe long-sections showing size, grade, invert levels and hydraulic grade line levels.	Yes/No
Landscape plan and planting schedule	Yes/No
Letter of intention to grant a drainage easement if inter-allotment easements are required through downstream properties.	Yes/No/NA

DESIGN ENGINEER:

DATE:

QUALIFICATIONS:

RURAL ZONE

Has a minimum of 300mm freeboard been provided between the habitable floor levels (or 100mm for non-habitable) and the OSD design storage top water level?	Yes/No
Detailed run-off and reservoir routing calculations provided - preferably in the form of DRAINS	Yes/No
Basin stage-storage-discharge relationship provided?	Yes/No
5 & 100 Year ARI pre and post development site discharges provided?	Yes/No
Above ground OSD storage	Yes/No
First 10% or 1m ³ ponds where it will not create a nuisance	Yes/No
Vegetated areas are increased by 20% to accommodate growth	Yes/No
Rock mulch (30-40mm) specified, and no bark chips/organic mulch	Yes/No
Fenced if greater than 500mm deep	Yes/No/NA
No greater than 1.2m deep	Yes/No/NA
Base has fall greater than 1%	Yes/No
Below ground OSD tanks	Yes/no
Have 2 x 600mm x 900mm access grates been provided?	Yes/No
Maximum distance within the tank to a grate is no greater than 3m?	Yes/No
Access point away from trafficked areas?	Yes/No
Have step irons been provided for tanks deeper than 1200mm?	Yes/No
Plans to AHD and to a 1:100 scale, which include the following in addition to the standard SDP requirements:-	
The location, extent and maximum depth of all OSD storage areas and their contributing catchments.	Yes/No
Details of the OSD basin discharge control pit, weir, orifice, trash screen and sump	Yes/No
Detailed cross-sections through each storage area.	Yes/No
The discharge points to Council's system (including weirs).	Yes/No
Pipe long-sections showing size, grade, invert levels and hydraulic grade line levels.	Yes/No
Landscape plan and planting schedule	Yes/No
Letter of intention to grant a drainage easement if inter-allotment easements are required through downstream properties.	Yes/No/NA

DESIGN ENGINEER:

DATE:

QUALIFICATIONS:

APPENDIX C – NATIONAL AND COUNCIL STANDARDS

AUSTRALIAN STANDARDS

NATIONAL CONSTRUCTION CODE

The National Construction Code (NCC) is a uniform set of technical provisions for the design and construction of buildings & other structures throughout Australia. It sets the minimum requirements for design and construction. The Plumbing Code of Australia is contained in NCC Volume three, and should be adhered to with guidance for stormwater systems provided in section D. The remaining volumes provide relevant stormwater requirements based on building class.

AS/NZS 3500

The Australian and New Zealand Standard 3500 was prepared to provide solutions to comply with the NCC. AS/ NZS 3500.3 is focuses on stormwater drainage and sets out requirements for materials, design, installation and testing of roof drainage systems, surface drainage systems and subsoil drainage systems to the point of connection with Councils drainage systems. AS/NZS 3500.1 is also used to detail rainwater tank details and connections.

AUSTRALIAN RAINFALL & RUNOFF

Australian Rainfall & Runoff (ARR) is a national guideline for the estimation of design flood characteristics in Australia and is currently undergoing revision. It provides procedures for rainfall estimation, peak flow estimation and flood hydraulics. Where practical, the requirements from ARR have been summarised in this policy for easy reference

COUNCIL STANDARDS

DESIGN ARIS

The following design ARI's should be applied to the following components of the stormwater system:

Stormwater Design Element	Design Average Recurrence Interval (Years)
Local flowpath	100
Surface/piped drainage	5
Surface/piped drainage – critical facilities	100
Eaves gutters/downpipes	20
Eaves gutters/downpipes – charged line drainage systems	100
Eaves gutters/downpipes –in association with an OSD system where overflows have not been directed into the basin	100
Box gutters	100
Outlet to natural watercourse	20
Inter-allotment drainage (where a flowpath for flow in excess of the pipe capacity has been provided)	5

Table 8 - Design ARIs

FREEBOARD

The following freeboards have been adopted to protect development from inundation of stormwater:

Table 9 - Minimum freeboard

Description	Minimum Freeboard (mm)
Floor level of dwelling in relation to peak water surface level of 100 year local flowpath	300
Garage level in relation to surrounding ground levels and above peak water surface level of 100year local flowpath	100
Underside of solid fencing in relation to finished ground levels or the top water surface level of overland flow or flood levels	100
OSD – Habitable Floor Level	300
OSD – Garage floor level	100

Properties affected by mainstream and overland flooding are referred to Council's Citywide Development Control Plan – Chapter 11 for appropriate freeboard levels.

TAILWATER

Water surface level calculations are required to recognise the effect of any downstream controls due to the location of structures or known water surface levels, whether on the development site or external to the site.

Table 10 - Tailwater conditions

Condition	Tailwater
Free outfall	Pipe obvert
Discharge to receiving waters	Flood level of creek during pipe design ARI event
Discharge to kerb & gutter or existing pipe	Top of kerb
Discharge to a point designed to surcharge	Height of surcharge

Consideration will be given to accepting a lower starting level where this is supported by appropriate calculations demonstrating that this is suitable. Conversely, a higher starting level will be applicable in some circumstances, particularly near sag pits where the flow of water may exceed the top of kerb.

HAZARD

In the urban area, the velocity and depth product (flow hazard) shall be less than 0.4 in local flowpaths. Council may require a lower ratio where the development usage may warrant higher safety standards

Easement widths

The following standard easement widths shall be adopted:

Table 11 -	Stormwater	pipe	easements	widths
------------	------------	------	-----------	--------

Pipe Diameter (mm)	Width of Easement to Drain Water (m)	
100, 150, 225]*	
300	1.5	
375, 400	2	
252, 600, 675	2.5	
750, 825, 900	3	
1050, 1200	3.5	
1350, 1500	4	
1650, 1800	4.5	
>1800 and box culverts	As required by Council	
Flowpath/floodway	Full width of nominated flowpath/floodway plus 0.2m	

* The easement width may be reduced to 0.9m between existing dwellings & boundary

The above table is only an indication of easement widths for shallow pipe systems. Consideration may be given to the reduction of the required easement widths where it is demonstrated that the full easement width cannot be obtained and the proposed pipe can be installed, maintained and replaced satisfactorily. Where multiple pipes are proposed, a larger easement will be required. Wider easements may also be required where the pipe depth warrants such an approach for the future maintenance/repairs of a pipeline.

INTERNAL DRAINAGE ELEMENTS

The design of the individual drainage components within the property shall be undertaken in accordance with the relevant Australian Standards. The following information provides a general summary/reference for individual components of the system.

ROOF RUNOFF

Gutters and downpipes shall be sized in accordance with Section 3 of AS/NZS 3500.3. Gutter and downpipes can be sized using the formulas and tables provided. In the case of OSD design where overflow of the roof system is not directed to the OSD system ALL roof drainage shall be designed for the 100 year ARI event. Design of the roof system shall account for flows in excess of the capacity of the system such that they do not cause nuisance to the drained or downstream properties.

INTERNAL STORMWATER PITS

Stormwater pits or cleaning eyes shall be provided at the following locations where appropriate to provide access and maintenance functions:

- At all junctions, changes of gradient, changes in diameter and changes in direction of site stormwater drains;
- Inspection openings within buildings;
- Reflux valves;
- Flap valves fitted at the downstream ends of subsoil drains; and
- At a maximum spacing of 30m for cleaning access

Inlet pits are to designed in accordance with AS/NZS 3500.3 and be installed in locations such that:

- All run-off from roofed and paved areas is collected;
- Run-off does not enter garages or buildings;
- Long term ponding of stormwater does not occur;
- Pedestrian access is not affected by depths of flow; and
- Flows over the public footway are minimised

The following minimum internal pit dimensions shall be incorporated as per Section 7 of AS/NZS 3500.3.

Table 12 - Depth to invert of stormwater pipe outlet

	Minimum internal dimensions			
Depth to invert of outlet	Rectan	Circular		
	Width (mm)	Length (mm)	Diameter (mm)	
≤ 600	450	450	600	
> 600 ≤ 900	600	600	900	
> 900 ≤ 1200	600	900	1000	
> 1200*	900	900	1000	

* Step irons to be provided for pits in excess of 1.2m deep
INTERNAL STORMWATER PIPES

Pipe sizes shall be sufficient to cater for the run-off capacity of the attached system. Stormwater pipes shall be designed in accordance with the requirements of AS/NZS 3500.3. The minimum diameter of any pipeline draining a roofed area shall be 90 mm and following longitudinal grades shall be used as per section 6 of AS/NZS 3500.3;

Nominal Size	Minimum Gradient (% fall)	Nominal Size	Minimum Gradient (% fall)
90	1.00	225	0.50
100	1.00	300	0.40
150	1.00	375	0.33

Table 13 - Stormwater pipe gradients

In very flat areas, and where minor filling is not acceptable, consideration will be given to use of a lower gradient. It will need to be demonstrated that the pipe will have a sufficient velocity so that siltation blockage does not occur. Extra provision for cleaning access with pits at every 15 m shall be provided to facilitate the lower gradient.

Minimum pipe cover for internal property drainage systems shall be in accordance with Table 6.2.5 of AS/NZS 3500.3. Inter-allotment drainage lines in non-trafficable areas require a minimum of 450 mm cover and road drainage requires a minimum cover of 600 mm in accordance with Council's Specification For Roadworks & Drainage Associated With Subdivision or Other Development

For smaller developments, hydraulic design charts are detailed in Figure 5.4.11.2 of AS/NZS 3500.3 to assist with sizing pipelines.

The minimum pipe velocity should be 0.6 m/s and a maximum velocity of 6 m/s during the design storm

SILT ARRESTERS

Silt/oil arresters must be placed at the last storm water drainage pit before discharging into Council's drainage system, except for single or dual occupancy type residential development. The silt arrester shall be designed in accordance with the provisions in Section 7 of AS/NZS 3500.3 and will be constructed from a suitable galvanised steel mesh.

SUBSOIL DRAINAGE

Subsoil drainage shall be provided as part of the stormwater management system to protect structures (especially in the industrial area, retaining walls and basements) and mitigate long term surface water ponding. When required, all subsoil drainage shall be in accordance with Section 6 of AS/NZS 3500.3 and the details of proposed connection to the stormwater system shall be provided.

STORMWATER LINES UNDER BUILDINGS

Site stormwater drainage lines proposed under buildings will not be allowed by Council and will only permitted where there is no practicable alternative and pipes cannot be routed around the building. The design must be considered at the DA stage and approved by Council on its merit. Short-circuiting the pipe layout, to save costs, will not be considered.

Design of any stormwater lines under buildings must be in accordance with Section 6 of AS/NZS 3500.3 as well as the following constraints;

- the number of pipes underneath the building is to be minimised as much as practicable
- piping underneath buildings is to be straight with no bends or junctions
- inspection openings must be provided at all points of entry and exit under the building.
- Structural foundation design must account for the stormwater drainage pipes in the details. The proposed flooring system and foundation design must be suitable for any proposed stormwater pipes beneath the building. Details of penetrations and expansion material must be included in the foundation design.
- Stormwater pipes beneath the building are to be fully water tight and protected against mechanical movement and damage from the foundation system and must be sewer grade or better.
- All narrow lot development to install sewer grade twin pipes to provide redundancy if one pipe is damaged.

PRIVATE/INTER-ALLOTMENT DRAINAGE DESIGN

The following conditions must be followed when designing a private/inter-allotment drainage line:

- The private drainage system (pipe and overland flowpath) shall accommodate runoff generated from all impervious areas of the development based on a 100 year ARI design storm events. A minimum of the 5 year ARI is to be contained within the private drainage pipe.
- The private drainage system shall be designed to accept concentrated drainage from existing and future buildings and paved areas on each allotment. An assumption of 80% impervious will be suitable for most single residential developments, but will be decided on a case by case basis.
- Pipes shall be designed to flow full at the design discharge without surcharging at inspection pts.
- The pipeline shall be minimum of 150 mm diameter, and UPVC sewer grade.
- A major flowpath shall be provided above the pipeline.
- Inspection pits are to be provided at the following locations:
- o At the upstream end of all lines;
- o At all changes in horizontal and/or vertical alignments; and
- o At all changes in pipe sizes.
- Private drainage shall be connected to Council's stormwater system in accordance with Section 3.4.1. The conversion from the private drainage pipe to the steel sections shall be achieved by the construction of an inspection pit inside the property boundary.

FLOW RATE DETERMINATION AND HYDRAULIC DESIGN

The characteristics of modern urban stormwater management have evolved beyond the objectives and design solutions that were recommended in even the most recent editions of Australian Rainfall & Runoff. The predictions of peak stormwater flows using the Rational Method may not adequately represent the processes occurring within urban catchments. The use of computer modelling has changed flow rate estimation and hydraulic grade line analysis considerably, with models being able to undertake a large variety of complex calculations. This includes the ability to account for the degree of urbanisation for different land uses, storages in urban catchments (rainwater tanks, OSD & detention basins) and apply unsteady flow throughout conveyance networks. Therefore modern modelling software is the preferred method for flow rate estimation and hydraulic design.

The use of industry standard computer models by Professional Engineers for stormwater design is supported by Council. Should Consultants wish to use a program not mentioned here, details are to be submitted to Council prior to use. In this regard, Council's preferred modelling software is DRAINS, TUFLOW, HEC-RAS & MUSIC. When using these models the following will apply;

- Parameters used in these models must be in accordance with the values acceptable to Council as outlined in Appendix Q and consistent with values recommended in AR&R
- Where values other than those recommended in Appendix Q are used, their use must be justified.
- Documentary evidence of the parameters used must be supplied with any submission to Council; and
- Electronic copies of final input and output computer files together with accompanying catchment and layout plans, for hydrological, hydraulic and water quality models must be provided for Council's records at the time of lodging detailed engineering plans
- Where models are produced using software other than what Council has specified above, full details of the model set-up and detailed output files and interpretation will be required in the form of a written report. ILSAX models are not permitted and will not be assessed.

RAINFALL IFD CHART FOR FAIRFIELD CITY COUNCIL

Rainfall intensity in mm/hr for various duration and return periods

DURATION		RETURN PERIOD	
MINUTES	5 YEARS	20 YEARS	100 YEARS
5	133.59	170.89	219.37
6	125.09	160.24	205.89
7	118.04	151.25	194.38
8	112.05	143.54	184.44
9	106.85	136.82	175.76
10	102.28	130.91	168.11
11	98.22	125.65	161.30
12	94.58	120.92	155.19
13	91.28	116.66	149.66
14	88.27	112.77	144.64
15	85.52	109.22	140.04
16	82.99	105.95	135.82
18	78.46	100.12	128.31
20	74.54	95.08	121.81
22	71.09	90.65	116.12
24	68.02	86.73	111.09
26	65.27	83.23	106.59
28	62.80	80.06	102.54
30	60.55	77.20	98.87
35	55.72	71.06	91.02
40	51.76	66.04	84.61
45	48.44	61.83	79.25
50	45.61	58.25	74.69
55	43.17	55.16	70.75
60	41.03	52.45	67.31
90	32.17	41.26	53.08
120	26.95	34.65	44.68
180	20.91	27.00	34.94
540	10.48	13.73	18.01

APPENDIX D - CONNECTION DETAIL TO COUNCIL'S CONCRETE LINED CHANNEL





APPENDIX E - ROCK SIZING FOR SINGLE PIPE OUTLETS

The following Rock Sizing for Single Pipe Outlets is the property of Catchments and Creeks Pty Ltd

www.catchmentsandcreeks.com.au/docs/Rock-Sizing-For-Single-Pipe-Outlets.pdf

Rock Sizing for Single Pipe Outlets

STORMWATER MANAGEMENT PRACTICES







Photo 2 - Rock pad outlet structure

1. Introduction

The primary performance objectives typically relate to minimising the risk of bed erosion at the outlet, and preventing undermining of the outlet head wall. The critical design parameters are the mean rock size (d_{50}) and length of rock protection (L).

The various design charts and tables presented in this fact sheet are based on the acceptance that some degree of rock movement (rearrangement) is expected following installation and that some degree of bed scour will still occur downstream of the rock pad during major flows. The minimum pad length is based on practicality issues and will not necessarily prevent all bed scour, especially when high tailwater levels exist.

2. Sizing rock for single pipe outlet structures

Recommended minimum mean (d_{50}) rock sizes are presented in tables 2 and 3. These values have been rounded up to the next 100 mm increment in recognition of the limited availability of rock sizes and the high variability of expected outcomes. Mean rock sizes are also presented graphically in Figure 1. Some minor variations should be expected between Figure 1 and the tabulated values.

A 36% increase in rock size is recommended if rounded rocks are used instead of angular rock.

The rock pad should be straight and aligned with the direction of the discharge. The recommended minimum length of rock protection (L) may be determined from tables 4 & 5. The recommended minimum width of the rock pad immediately downstream of the outlet (W₁) is the greater of the width of the outlet apron or the pipe diameter plus 0.6 m, and at the downstream end of the rock pad (W₂) the greater of W₁ or (D + 0.4L) as shown in Figure 2.

In circumstance where the width of the rock pad is governed by the width of the receiving channel, then the rock protection may need to extend partially up the banks of the channel if suitable vegetation cannot be established on the channel banks.

The thickness of the rock pad should be based on at least two layers of rock. This typically results in an overall pad thickness as presented in Table 1.

The surface elevation of the downstream end of the rock pad should be level with the invert of the receiving channel, i.e. the rocks should be recessed into the outlet channel (Figure 3) to minimise the risk of erosion around the outer edges of the rock pad.

The placement of filter cloth under the rock pad is generally considered mandatory for all permanent structures; however, if heavy sedimentation is expected within the rock voids, then the 'need' for the filter cloth is reduced. The placement of filter cloth is essential in circumstances where it is only practical to place a single layer of rock.



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3. Selecting the appropriate length of rock protection

During low tailwater conditions (TW < D/2) flow exiting the pipe will normally spread rapidly unless confined within the receiving discharge channel. Under such tailwater conditions the rock pad provides scour control benefits as well as energy dissipation. Typically the nominated minimum length of rock protection is considered adequate under these conditions.

As tailwater levels increase in elevation (D/2 < TW < D) energy dissipation as a direct result of the rock pad begins to decrease causing more flow energy to pass over the rocks. In such cases the length of the rock pad may be doubled (i.e. twice the minimum length), but only if it is essential to minimise soil erosion downstream of the rock pad.

When the outlet is submerged (TW > D) an outlet 'jet' can pass over the rock pad with minimal energy dissipation. In such cases the rock pad still provides essential scour protection adjacent to the pipe outlet, but extending the rock protection beyond the nominated minimum length may not necessarily provide any significant increase in energy dissipation or scour control.

Outlet jetting occurs when the outlet is submerged and outlet velocity is significantly greater than the receiving water velocity. High velocity jets can cause bank erosion problems if the outlet is aimed at a downstream embankment. Typically, such problems only occur if an unprotected embankment is less than 10 to 13 times the pipe diameter away from the outlet.



Figure 3 - Rock pad recessed into the receiving channel

4. Background to rock sizing for multi-cell culverts

The rock sizes presented in tables 2 and 3 represent an average of the values achieved by the application of the equations and design tables presented by ASCE (1992), Bohan (1970, for low tailwater) and Orange County (1989). The values have been rounded up to the next 100 mm increment in recognition of the wide variations in recommended rock sizes presented in the various literature.

Alternatively, rock size [m] may be determined from Equations 1 as presented in ASCE (1992).

$$d_{50} = 0.066 \, Q^{4/3} \, / \, (TW \, . \, D) \tag{1}$$

For multiple pipe outlets, refer to the separate fact sheet prepared for 'multi-cell pipe and culvert outlets'.

5. References

ASCE 1992, Design and construction of urban stormwater management systems. ASCE Manuals and Reports of Engineering Practice No. 77, and Water Environment Federation Manual of Practice FD-20, American Society of Civil Engineers, New York, USA. ISBN 0-87262-855-8

Bohan, J.P., 1970, Erosion and riprap requirements at culvert and storm-drain outlets. Research Report H-70-2, U.S. Army Engineer Waterway Experiment Station, Vicksburg, Mississippi, USA

Isbash, S.V. 1936, Construction of dams by depositing rock in running water, Transactions, Second Congress on Large Dams, Washington, D.C. USA

Orange County, 1989, Soil Erosion and Sediment Control Manual. Orange County Planning Department, Hillsborough, North Carolina, USA

Page 3

Outflow velocity	Culvert height or pipe diameter (mm)								
(m/s)	300	375	450	525	600	750	900		
0.50	100	100	100	100	100	100	100		
1.00	100	100	100	100	100	100	100		
1.50	100	100	100	100	100	200	200		
2.00	100	100	200	200	200	200	200		
2.50	100	200	200	200	200	200	200		
3.00	200	200	200	200	200	200	200		
3.50	200	200	200	200	200	300	300		
3.75	200	200	200	200	300	300	300		
4.00	200	200	200	300	300	300	400		
4.25	200	200	300	300	300	300	400		
4.50	200	300	300	300	300	400	400		
4.75	200	300	300	300	300	<mark>400</mark>	500		
5.00	300	300	300	300	400	400	500		
5.25	300	300	300	400	400	500	500		
5.50	300	300	300	400	500	500	500		
5.75	300	300	400	500	500	500	500		
6.00	300	400	500	500	500	500	600		

Table 3 - Mean rock size, d₅₀ (mm) for culvert outlet scour protection

Outflow		C	ulvert heigh	nt or pipe di	ameter (mr	n)	
velocity (m/s)	1050	1200	1350	1500	1800	2100	2400
0.50	100	100	100	100	100	100	100
1.00	100	100	200	200	200	200	200
1.50	200	200	200	200	200	300	300
2.00	200	200	200	200	300	300	300
2.50	200	300	300	300	300	400	400
3.00	300	300	300	300	400	500	500
3.50	300	400	400	400	500	500	500
3.75	400	400	400	400	500	500	600
4.00	400	400	500	500	500	600	600
4.25	400	500	500	500	600	600	600
4.50	500	500	500	500	600	600	600
4.75	500	5 <mark>0</mark> 0	500	600	600	600	700
5.00	500	500	600	600	600	700	700
5.25	500	600	600	600	600	700	700
5.50	600	600	600	600	700	700	900
5.75	600	600	600	600	700	900	900
6.00	600	600	600	700	700	900	900

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Outflow	Culvert height or pipe diameter (mm)								
velocity (m/s)	300	375	450	525	600	750	900		
0.50	3	3	3	3	3	3	3		
1.00	3	3	3	3	3	3	3		
1.50	3	3	3	3	3	3	3		
2.00	3	3	3	3	3	3	3		
2.50	3	3	3	3	3	3	3		
3.00	3	3	3	3	3	3	3		
3.50	3	3	3	3	3	4	4		
3.75	3	3	3	3	4	4	4		
4.00	3	3	3	4	4	4	4		
4.25	3	3	4	4	4	4	4		
4.50	3	4	4	4	4	4	4		
4.75	3	4	4	4	4	4	5		
5.00	4	4	4	4	4	4	5		
5.25	4	4	4	4	4	5	5		
5.50	4	4	4	6	6	6	6		
5.75	4	4	6	6	6	6	6		
6.00	4	6	6	6	6	6	6		

Table 4 - Minimum length (L) of rock pad relative to cell height (H) for culvert outlet

Table 5 – Minimum length (L) of rock pad relative to cell height (H) for culvert outlet protection ^[1,2]

Outflow velocity (m/s)	Culvert height or pipe diameter (mm)									
	1050	1200	1350	1500	1800	2100	2400			
0.50	3	3	3	3	3	3	3			
1.00	3	3	3	3	3	3	4			
1.50	3	3	3	3	3	4	4			
2.00	3	3	3	3	4	4	4			
2.50	3	4	4	4	4	4	4			
3.00	4	4	4	4	4	4	4			
3.50	4	4	4	4	5	5	5			
3.75	4	4	4	4	5	5	5			
4.00	4	4	5	5	5	5	5			
4.25	4	5	5	5	5	5	5			
4.50	5	5	5	5	5	5	5			
4.75	5	5	5	5	5	5	5			
5.00	5	5	5	5	6	6	6			
5.25	6	6	6	6	6	6				
5.50	6	6	6	6	6					
5.75	6	6	6	6	6	1				
6.00	6	6	6	6	6	1				

[1] Values represent the recommended minimum length of rock protection to prevent significant scour; however, some degree of soil erosion should be expected downstream of the rock protection.

Under high tailwater conditions (TW > D/2) outlet jetting may extend beyond the rock protection during high tailwater conditions resulting in bed and/or bank erosion downstream of the rock [2] protection. Extending the length of the rock protection will not necessarily reduce the risk of downstream bank erosion under high tailwater conditions.

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Appendices

APPENDIX F - SAMPLE LETTER FOR EASEMENT REQUEST

0 0 0

Dear Sir/ Madam

Re: Request for drainage easement through your property

I (Bill Bloggs) of (Ace Designs Pty Ltd) am proposing a (multi-unit housing) development at (Lot 1234 DP 2005678) being (10 Abbey Road, Fairfield).

As part of this development I am investigating the possibility of draining the proposed development to (Penny Lane) through your property. The proposed works, should you agree to the proposal, would involve constructing a (225mm) diameter pipe through your property and creation of a (1) metre wide easement in accordance with the attached sketch.

I am prepared to offer fair and reasonable compensation for the right to drain through your property and to this effect I offer (\$xxxx.xx) as has been determined by a registered Land Valuer. I have attached a copy of the valuation for your information.

The construction of the proposed drainage line would be undertaken by licensed tradesmen, under the supervision of Fairfield City Council or an Accredited Certifier.

Any disturbance of your property during the construction phase will be restored to its original condition. I am willing to enter into an agreement to this effect. All costs associated with the pipe construction and easement will be at my expense. Any ongoing maintenance costs will be the responsibility of the owner/s of the proposed development

I urge you to give this proposal serious consideration but regardless request that you fill in the details at the bottom of the letter to state whether or not you will or will not consent to a drainage easement through your property. Please do not hesitate to contact me on (1234 5678) if you require further information or wish to discuss the matter.

Yours faithfully

Bill Bloggs

.....

Owner's Statement

I will/ will not consent to a drainage easement through my property as detailed in the letter from Bill Bloggs dated ().

Signed:.....

APPENDIX G - POSITIVE COVENANT FOR BASEMENT STORMWATER PUMP

Where a development incorporates a Basement Stormwater Pump System in accordance with this policy a Positive Covenant shall be created over the system in the following terms:

Positive Covenant

The registered proprietor of the lot(s) hereby burdened will in respect of the basement stormwater pump-out system:

1. Maintain and repair at the sole expense of the registered proprietors the whole of the basement stormwater pump-out system so that if functions in a safe and efficient manner;

2. Permit the Council or its authorised agents from time to time and upon giving reasonable notice (but at any time and without notice in the case of an emergency) to enter and inspect the land for the compliance with the requirements of this covenant; and

3. Comply with the terms of any written notice issued by the Council in respect of the requirements of this covenant within the time stated in the notice.

The expression "basement stormwater pump-out system" shall include all pump mechanisms, rising mains, collection sumps, ancillary gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to direct stormwater to the basement stormwater pump-out system.

Pursuant to Section 88F(3) of the Conveyancing Act 1919 the Council shall have the following additional powers:

1. In the event that the registered proprietor fails to comply with the terms of any written notice issued by the Council as set out above the Council or its authorised agents may enter the land with all necessary materials and equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to above; and

2. The Council may recover from the registered proprietor in a Court of competent jurisdiction:

a. Any expense reasonably incurred by it in exercising its powers under subparagraph (1) hereof. Such expense shall include reasonable wages for the Council's employees engaged in effecting the work referred to in (1) above, supervising and administering the said work together with costs, reasonably estimated by the Council, for the use of materials, machinery, tools and equipment in conjunction with the said work.

b. Legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs and expenses of registration of a covenant charge pursuant to Section 88F of the Act or providing any certificate required pursuant to Section 88G of the Act or obtaining any injunction pursuant to Section 88H of the Act.

This covenant shall bind all persons who are of claim under the registered proprietor(s) as stipulated in Section 88E(5) of the Act.

Name of Authority having the power to release vary or modify the Positive Covenant shall be Fairfield City Council.

APPENDIX H - RESTRICTION ON USE AND POSITIVE COVENANT FOR LOCAL FLOWPATHS

Restriction on the Use of Land

1) The proprietor of the burdened lot shall not:

a) Erect, construct or place any building or other structure,

b) Make alterations to the ground surface levels, kerbs, driveways or any other structure, within the land so burdened without the prior written consent of Fairfield City Council.

2) No fencing, including boundary fencing shall be erected within the land hereby burdened unless such fencing is of an open style which will not obstruct the flow of water across the land.

Name of authority empowered to release, vary or modify terms of the Restriction on use of land is Fairfield City Council.

Positive Covenant

1) The proprietor of the burdened lot from time to time shall do all things necessary to maintain, repair and replace the storm water overland flow path within the land so burdened to the satisfaction of Fairfield City Council and in this regard must comply with any written request of the Council with such reasonable time period as nominated in the said written request.

2) Where the proprietor of the burdened lot fails to comply with any written request of the Fairfield City Council referred to in (1) above the proprietor shall meet any reasonable cost incurred by the Council in completing the work requested.

3) Full and free right for the Fairfield City Council and every person authorized by it to enter upon the burdened lot in order to inspect, maintain, cleanse, replace, repair any pipeline, grate, pit, other structure or alter surface levels to ensure the maintenance of the overland flow path within the land so burdened.

Evidence of registration of the restriction shall be submitted to the Principal Certifying Authority, prior to occupation.

Name of authority empowered to release, vary or modify the terms of the Positive Covenant is Fairfield City Council.

APPENDIX I - EASEMENT AND POSITIVE COVENANT FOR ROOF WATER

Terms of Easement

An easement to drain storm water to permit the storm water from the roof of the benefited lot across the roof, along the guttering and through the storm water pipes of the affected lot while the building erected on the benefited lot at the time of granting this easement shall remain on the lot benefited.

Terms of Positive covenant

The registered proprietor(s) of the burdened lots covenant with the Council that they will maintain and repair the structure and works on the land in accordance with the following terms and conditions:

1) The registered proprietor(s) will:

a) Keep the structure and works clean and free from silt, rubbish and debris;

b) Maintain and repair at the sole expense of the registered proprietor(s) the whole of the structure and works so that it functions in a safe and efficient manner.

2) For the purpose of ensuring observance of the covenant the Council may by its servants or agents at any reasonable time of the day upon giving to the person against whole the covenant is enforceable not less than two days' notice (but at any time without notice in the case of an emergency) enter the land and view the condition of the land and the state of construction maintenance or repair of the structure and works on the land.

3) By written notice the Council may require the registered proprietor(s) to attend to any matter and to carry out such work within such time as the Council may require to ensure the proper and efficient performance of the structure and works and to the extent Section 88F(2)(a) of the Act is hereby agreed to be amended accordingly.

4) Pursuant to Section 88F(3) of the Act the authority shall have the following additional powers pursuant to this consent:

a) in the event that the registered proprietor(s) fails to comply with the terms of any written notice issued by the Council as set out above the Council or its authorized agents may enter the land with all necessary equipment and carry out any work which the Council in its discretion considers reasonable to comply with the said notice referred to in 3 hereof;

b) the Council may recover from the registered proprietor(s) in a Court of competent jurisdiction:

i) any expense reasonably incurred by it in exercising its powers under subparagraph (a) hereof. Such expense shall include reasonable wages for the Council's own employees engaged in effecting the said work, supervising the said work and administering the said work ;

ii) legal costs on an indemnity basis for issue of the said notices and recovery of the said costs and expenses together with the costs and expenses of registration of a covenant charge pursuant to 88F of the Act, or providing any certificate required pursuant to Section 88G of the Act, or obtaining any injunction pursuant to Section 88H of the Act.

5) This covenant shall bind all persons who claim under the registered proprietor(s) as stipulated in Section 88E(5) of the Act.

For the purposes of this covenant:

Structure and works shall mean the storm water drainage system constructed on the land including all roof gutters, pipes, drains, walls, kerbs, pits, grates, tanks, chambers, basins and surfaces designed to control storm water on the land.

Name of Authority having the power to release vary or modify the Easement and Positive Covenant shall be Fairfield City Council.



APPENDIX J - TYPICAL DISCHARGE CONTROL PIT



APPENDIX K - TYPICAL HIGH EARLY **DISCHARGE CONTROL PIT**

APPENDIX L - OSD CERTIFICATION CHECKLIST

OSD Certification Requirements	Provided
Certification that the OSD system will function in accordance with the approved design.	
Identification of any variations from the approved design and certify they are within the construction tolerances.	
Certification and evidence of any elements that were outside the construction tolerances that have been rectified to be within the tolerances and that these variations will not impair the performance of the OSD system	
Verification that all structural elements including storage tanks and retaining walls are structurally sound and fit for purpose;	
Work as Executed Plans prepared by a registered surveyor on a copy of the stamped approved construction plan and include the following;	
Registered surveyor's details and signature;	
Sufficient levels and dimensions to verify the OSD volumes;	
Location and surface and invert levels of all drainage pits;	
Invert levels of the internal drainage lines and pipe gradients;	
Finished floor levels of structures such as units and garages;	
Verification that the orifice plates have been fitted and the diameter of the fitted plates;	
Verification that trash screens have been correctly installed;	
Location and finished contour levels on any overland flow paths formed through the site;	
Detail of any variations or omissions made from the approved plans.	
Weir dimensions and levels; and	
Extent of the above ground storage	

APPENDIX M - RESTRICTION ON USE AND POSITIVE COVENANT FOR ON-SITE DETENTION SYSTEMS

URBAN ZONE

Terms of Positive Covenant

1) The proprietor of the burdened lot from time to time shall do all things necessary to maintain, repair and replace the outlet grates and pipes and structures of and incidental to the stormwater detention system within the land so burdened to the satisfaction of Fairfield City Council and in this regard must comply with any written request of the Council within such reasonable time period as nominated in the said written request.

2) Where the proprietor of the burdened lot fails to comply with any written request of the Fairfield City Council referred to in (1) above the proprietor shall meet any reasonable cost incurred by the Council in completing the work requested.

3) Full and free right for the Fairfield City Council and every person authorised by it to enter upon the burdened lot in order to inspect, maintain, cleanse, replace, repair any pipeline, grate, pit other structure or alter surface levels to ensure the on-site detention system within the land so burdened functions to:

a) Restrict discharge from the site in the nine (9) hour 100 year ARI event to 140 litres per second per hectare;

b) Limit the outflow from the site in the shorter duration 100 year ARI storm events to the pre-developed site discharge; and

c) Restrict the outflow from the site in the shorter duration 5 year ARI storm events to the pre-developed site discharges.

NAME OF AUTHORITY EMPOWERED TO RELEASE, VARY OR MODIFY THE TERMS OF THE POSITIVE COVENANT IS FAIRFIELD CITY COUNCIL.

Terms of Restriction on Use

The proprietor of the burdened lot shall not:

1) Erect, construct or place any building or other structure,

2) Make alterations to the ground surface levels, grates, pits, kerbs, tanks, gutters or any other structure associated with the on-site detention system.

Within the land so burdened without the prior written consent of the Fairfield City Council.

NAME OF AUTHORITY EMPOWERED TO RELEASE, VARY OR MODIFY TERMS OF THE RESTRICTION ON USE OF LAND IS FAIRFIELD CITY COUNCIL.

RURAL ZONE

Terms of Positive Covenant

1) The proprietor of the burdened lot from time to time shall do all things necessary to maintain, repair and replace the outlet grates and pipes and structures of and incidental to the stormwater detention system within the land so burdened to the satisfaction of Fairfield City Council and in this regard must comply with any written request of the Council within such reasonable time period as nominated in the said written request.

2) Where the proprietor of the burdened lot fails to comply with any written request of the Fairfield City Council referred to in (1) above the proprietor shall meet any reasonable cost incurred by the Council in completing the work requested.

3) Full and free right for the Fairfield City Council and every person authorised by it to enter upon the burdened lot in order to inspect, maintain, cleanse, replace, repair any pipeline, grate, pit other structure or alter surface levels to ensure the on-site detention system within the land so burdened functions to:

a) Restrict discharge from impervious area to 78 litres per second per hectare for all 100 year ARI design rainfall up to and including 12 hour duration.

NAME OF AUTHORITY EMPOWERED TO RELEASE, VARY OR MODIFY THE ABOVE POSITIVE COVENANT IS FAIRFIELD CITY COUNCIL.

Terms of Restriction on Use of Land

The proprietor of the burdened lot shall not:

1) Erect, construct or place any building or other structure,

2) Make alterations to the ground surface levels, grates, pits, kerbs, tanks, gutters or any other structure associated with the on-site detention system.

Within the land so burdened without the prior written consent of the Fairfield City Council.

NAME OF AUTHORITY EMPOWERED TO RELEASE, VARY OR MODIFY THE ABOVE RESTRICTION IS FAIRFIELD CITY COUNCIL.

Name of Authority having the power to release, vary or modify the Easement and Positive Covenant shall be Fairfield City Council.

Name of Authority having the power to release, vary or modify the Easement and Positive Covenant shall be Fairfield City Council.

APPENDIX N - OSD MAINTENANCE CHECKLIST

MAINTENANCE	FREQUENCY	RESPONSIBILITY	PROCEDURE
ACTION			
Inspect & remove any blockage of orifices	Six monthly	Owner	Remove grate & screen to inspect orifice and clear of any blockage.
Check attachment of orifice plates to wall of chamber and/or pit (gaps less than 5 mm)	Annually	Maintenance Contractor	Remove grate and screen. Ensure plates are mounted securely, tighten fixings if required. Seal gaps as required.
Check orifice diameters are correct and retain sharp edges	Five yearly	Maintenance Contractor	Compare diameter to design (see Work-as-Executed) and ensure edge is not pitted or damaged.
Inspect screen and clean	Six monthly	Owner	Remove grate(s) and screens and remove and debris.
Check attachment of screens to wall of chamber or pit	Annually	Maintenance Contractor	Remove grate(s) and screen(s). Ensure screen fixings are secure. Repair as required.
Check screen(s) for corrosion	Annually	Maintenance Contractor	Remove grate(s) and examine screen(s) for rust or corrosion, especially at corners or welds. Replace screen if corrosion is found in two or more locations or is greater than 10% of the screen.
Inspect walls (internal and external, if appropriate) for cracks or spalling	Annually	Maintenance Contractor	Remove grate(s) to inspect internal walls. Repair as required. Clear vegetation from external walls if necessary and repair as required.
Inspect outlet sumps & remove any sediment/sludge	Six monthly	Owner	Remove grate(s) and screen(s). Remove sediment/sludge build-up and check orifices are clear.
Inspect grate(s) for damage or blockage	Six monthly	Owner	Check both sides of a grate for corrosion, (especially corners and welds) damage or blockage. Remove debris and replace grate if corrosion in 2 or more locations or greater than 10% of the grate.

APPENDIX N - OSD MAINTENANCE CHECKLIST

k remove Six monthly Maintenance Contractor Contractor Contractor Contractor Intenance Six monthly Maintenance Contractor Maintenance Contractor Nove any Six monthly Owner Contractor Six monthly Owner Life Contractor ks or kng to the Six monthly Owner Contractor with the Six monthly Owner Contractor Kana Annually Maintenance Contractor Annually Owner Contractor Annually Owner Contractor Annually Maintenance Contractor Annually Owner Contractor Annually Maintenance Contractor Contractor Contractor Annually Owner Contractor Co	MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
step irons for corrosion Annually Maintenance Contractor fixing of step irons is Six monthly Maintenance Contractor AGE Contractor Contractor at storage & remove any Six monthly Owner Contractor at internal walls of Annually Maintenance (and external, if and external, if a contractor for cracks or any debris/ Six monthly Owner Contractor at a reas draining to the Six monthly Owner Contractor are storage volume to creens/grates approved. (Rectify if a phonelly Maintenance approved. (Rectify if a phonelly Contractor Six monthly Owner Six Six monthly Owner Six	Inspect outlet pipe & remove any blockage	Six monthly	Maintenance Contractor	Remove grate(s) and screen(s). Ventilate underground storage if present. Check orifices and remove any blockages in outlet pipe. Flush outlet pipe to confirm it drains freely. Check for sludge/debris on upstream side of return line.
fixing of step irons is Six monthly Maintenance Contractor AGE Contractor I storage & remove any Six monthly Owner I storage & remove any Six monthly Owner of and external, if Annually Contractor or internal walls of Annually Contractor or internal if a semove any debris/ Six monthly Owner of a second and the six monthly Owner of the storage volume to creens/grates Annually Contractor of the storage for Annually Owner Six monthly Owner of the storage storage volume to Annually Owner Six monthly Owner of the storage volume to creens/grates Annually Contractor Six monthly Owner Six	Check step irons for corrosion	Annually	Maintenance Contractor	Remove grate. Examine step irons and repair any corrosion or damage.
AGE t storage & remove any Six monthly Owner ent/sludge in pit t internal walls of Annually Maintenance e (and external, if e (and external, if e contractor e (and external, if e contractor t & remove any debris/ Six monthly Owner t & remove any debris/ Six monthly Owner t & remove debris/ (inter etc blocking t areas draining to the Six monthly Owner e(s) & remove debris/ (litter etc likely to creens/grates approved. (Rectify if approved. (Rectify if e approved. (Rectify if e for t storages for t storages for t storages for t storages for t storages for t storage for t stor	Check fixing of step irons is secure	Six monthly	Maintenance Contractor	Remove grate(s) and ensure fixings are secure prior to placing weight on step iron.
t storage & remove any Six monthly Owner ant/sludge in pit tinternal walls of Annually Maintenance (and external, if contractor riate) for cracks or tarte) for cracks or tarte for cracks or tarte for cracks or the state of the	STORAGE			
tinternal walls of Annually Maintenance e (and external, if contractor riate) for cracks or t & remove any debris/ t & remove any debris/ t & remove any debris/ t & remove any debris/ litter etc blocking t areas draining to the e(s) & remove debris/ litter etc likely to creens/grates t & renage volume to t & storage volume to t & storage for t & remove debris/ litter etc likely to creens/grates t & removed. (Rectify if t & mually t & mually & mual		Six monthly	Owner	Remove grate(s) and screen(s). Remove sediment/sludge build-up.
t & remove any debris/ Six monthly Owner nulch etc blocking tareas draining to the Six monthly Owner e(s) & remove debris/ litter etc likely to creens/grates Maintenance te storage volume to Annually Maintenance Contractor approved. (Rectify if Annually Maintenance Contractor Six)	Inspect internal walls of storage (and external, if appropriate) for cracks or spalling	Annually	Maintenance Contractor	Remove grate(s) to inspect internal walls. Repair as required. Clear vegetation from external walls if necessary and repair as required.
Six monthly Owner Annually Maintenance Contractor Annually Maintenance	Inspect & remove any debris/ litter/mulch etc blocking grates	Six monthly	Owner	Check for blockages on grates or within the storage, and remove and debris found.
lume to Annually Maintenance kectify if Contractor Annually Maintenance	Inspect areas draining to the storage(s) & remove debris/ mulch/litter etc likely to block screens/grates	Six monthly	Owner	Remove debris and floatable material likely to be carried to grates.
Annually Maintenance	Compare storage volume to volume approved. (Rectify if loss > 5%)	Annually	Maintenance Contractor	Compare actual storage available with Work-as Executed plans. If volume loss is greater than 5%, arrange for reconstruction to replace the volume lost or trim vegetation as required is. Council to be notified of the proposal.
	Inspect storages for subsidence near pits	Annually	Maintenance Contractor	Check along drainage lines and at pits for subsidence likely to indicate leakages.

Updated from original source: On-site Stormwater Detention Handbook (Fourth Edition), Upper Parramatta River Catchment Trust, December 2005

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APPENDIX O - MUSIC MODEL PARAMETERS

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12 INTRODUCTION

This section of the Blacktown Council Developer Handbook for Water Conservation, Water Quality and Waterway Stability Treatment Measures Part 4 provides guidance on the modelling of treatment measures and strategies using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC can be used by designers, consultants, developers and Council to undertake conceptual design (size, configuration, depths) of treatment measures.

Part R of the Blacktown Development Control Plan (DCP) 2006 sets out what development types require water conservation and water quality treatments and any minimum area thresholds. Where Part R applies, Blacktown City Council requires that the MUSIC model must be used to assess conceptual stormwater quality treatment and harvesting strategies, unless the development satisfies the "Deemed to Comply Solutions" from Appendix A. These guidelines are provided to ensure consultants, developers and Council have a consistent and uniform approach to stormwater quality and harvesting modelling within the Blacktown Local Government Area (LGA). The guidelines provide specific guidance on rainfall and evaporation inputs, source node selection, rainfall runoff parameters, pollutant generation parameters and treatment nodes.

This Handbook is an adaptation of the Gold Coast City Council *MUSIC Modelling Guidelines* and should be read in conjunction with the *MUSIC User Guide*.

The original version was produced by EDAW and AECOM based on MUSIC 3. This current version has been significantly updated to adapt to the use of MUSIC 5.1 and incorporate MUSIC modelling practises developed at Blacktown Council over a number of years following the adoption of Council's Water Sensitive Urban and Integrated Water Cycle Management DCP Part R.

These modelling guidelines apply to all of Blacktown City Council area including the growth centres and employment lands.



There are several steps to be undertaken prior to running a MUSIC model network, as summarised in Figure 1. These steps include selecting the appropriate meteorological data (rainfall and evaporation inputs), defining catchment areas (source nodes) to be incorporated into the model, and inputting soil properties (rainfall runoff properties) and pollutant generation characteristics for selected source nodes.



Figure 8: Schematic of MUSIC modelling process (as adapted from the Gold Coast City Council MUSIC Guidelines)

14 RAINFALL AND EVAPORATION INPUTS

Blacktown rainfall is typically 700 to 900 millimetres per year, with maximum rainfall in summer and minimum in winter.

Stormwater runoff (represented as surface runoff and baseflow) is generated in MUSIC through the interaction of rainfall, evapotranspiration and the MUSIC Rainfall-Runoff Model (see *MUSIC User Guide* for a full description of Rainfall-Runoff Model). The following sections outline Blacktown City Council's preferred rainfall and evapotranspiration datasets.

14.1 Rainfall Data for Water Quality Modelling

Blacktown City Council requires the following approach to rainfall simulation be adopted for modelling:

- Continuous simulation of a minimum of 10 years should be used.
- A 6 minute time step should be used to allow for the appropriate definition of storm hydrograph movement through small-scale treatment measures such as vegetated swales and bioretention systems.

To provide a consistent approach to modelling, Blacktown City Council has identified an appropriate rainfall station for the Blacktown LGA, and periods of modelling to be utilised within the MUSIC model. Two 6 minute data stations were investigated for their suitability. These were the rainfall stations at:

- 067033 Richmond RAAF Base, located approximately 8 kilometres north-west of Blacktown LGA.
- 067035 Liverpool (Whitlam Centre), located approximately 11 kilometres south of Blacktown LGA.

Rainfall data from each of these stations was compared to daily data available at Blacktown (gauge no. 067059), to see which bore a closer resemblance to rainfall conditions within the Blacktown LGA. A common period was compared for all stations: 1964 to 1992. The results of this investigation are shown in figure 2.



Figure 2: 6 minute rainfall station comparison

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The recommended 6 minute rainfall station for use within Blacktown LGA is 067035 Liverpool (Whitlam Centre).

Both the Liverpool and Richmond stations provide a reasonable match to Blacktown in terms of average monthly rainfall, but the Liverpool data matches Blacktown's rainday pattern better than the Richmond data.

A reasonable length of record is available from Liverpool, with 6 minute records starting in 1965 and continuing to 2001 (with one significant gap during 1978 to 1980). In 2001 the station was closed, but was replaced with Station 067020 Liverpool (Michael Wenden Centre). To ensure a continuous data set, data from both stations will need to be used.

Given the above, Blacktown City Council requires all stormwater quality modelling in MUSIC to be undertaken using the Liverpool 6 minute rainfall data. A modelling period of 1967 to 1976 is recommended, as for this period, the annual rainfall is representative of the long-term average.

Table 1 includes details of the recommended data.

Table 1: Recommended 6 Minute Rainfall Station

Rainfall station	Modelling period	Annual rainfall (millimetres)
067035 Liverpool (Whitlam Centre)	1967 to 1976	857

14.2 Rainfall Data for Hydrologic Modelling

Blacktown City Council requires the following approach to rainfall simulation be adopted for hydrologic assessment modelling (that is, stormwater harvesting and stormwater storage design including rainwater tank sizing on a catchment basis):

- Continuous simulation of a minimum of 20 years should be used.
- A daily time step should be utilised for simulating rainwater/stormwater storage sizes and estimating supply reliability.

A number of daily rainfall stations were investigated for use, as shown in Table 2. The gauges investigated were those with longer available records.

Station	Approximate location in the LGA	Data availability	Mean annual rainfall (millimetres)	Mean number of days per year with equal to or greater than 1 millimetre rain
067059 Blacktown	Central	1963 to 1993	854	84
067076 Quakers Hill Treatment Works	Central	1948 to date	851	77
067016 Minchinbury	South west	1901 to 1970	778	59
067026 Seven Hills (Collins Street)	East	1950 to date	926	86

Table 2: Selected daily rainfall gauges in Blacktown LGA

To provide a consistent approach to modelling, Blacktown City Council has identified 2 appropriate daily rainfall stations for Blacktown LGA and periods of modelling to be utilised within the MUSIC model. The preferred station is 067059 Blacktown, due to its longer record of good quality data (1963 to 1993; 30 years), however 067076 Quakers Hill Treatment Works is also acceptable, for the years specified, due to its location within the catchment. The 1971 to 1992 period has been recommended to avoid significant gaps in the data.

The recommended daily rainfall stations are shown in Table 3. For sub-daily simulation the Liverpool rainfall station must be used, however Liverpool is not recommended for daily

simulation, as there is a gap in the data from 1978 to 1981 and the 1981 to 2001 period (the longest unbroken period of record available) has a relatively low average annual rainfall. Minchinbury and Seven Hills gauges are not recommended as they exhibit average rainfall conditions somewhat different to those recorded at Blacktown.

Table 3: Recommended daily rainfall station

Rainfall station			Modelling period	Mean annual rainfall (milllimetres)
067059 Blacktown (preferred)		1963-1993	854	
067076	Quakers	Hill	1971-1992	832
Treatment Works				

14.3 Potential Evapotranspiration (PET) Data

Blacktown City Council requires the following when considering potential evapotranspiration (PET) data in MUSIC:

- Local PET information is preferred (where available).
- In most cases, local data will not be available in which case average monthly data from Sydney (available within the MUSIC model) can be used.
- Average Sydney PET data is suitable for use in modelling water quality and hydrology. The monthly PET values for the Sydney region, including Blacktown, are shown in table 4.

Table 4: Monthly evapotranspiration for the Sydney region

Month	Jan	Feb	Mar	Apr	Мау	Jun	July	Aug	Sept	Oct	Nov	Dec
PET millimetres	180	135	128	85	58	43	43	58	88	127	152	163

Evaporative loss should normally range from 75 per cent of PET for completely open water to 125 per cent of PET for heavily vegetated water bodies.

3.4 Electronic Modelling

Council is able to supply the Liverpool (Whitlam Centre) rainfall data and evapotranspiration data electronically upon request. This MUSIC file also includes the Source Nodes and some Treatment Nodes acceptable to Blacktown.



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15 SOURCE NODES AND POLLUTANT GENERATION

Once the meteorological data has been input into the model the user must then define the source nodes to reflect the details (that is, area and landuse) of the contributing catchments. MUSIC currently has five standard land uses, these being:

- Urban.
- Agricultural.
- Forest.
- User Defined.
- Imported Data.

These five source nodes are however not commonly used in the Blacktown LGA. The main exception is "Forest" that can only be utilised where there is a permanent forested conservation area and its use will need to be justified for the particular scenario. Instead for Blacktown the "Urban" node is broken down into four components.

- Roof.
- Road.
- Other Impervious Areas.
- Pervious Areas.

As outlined in the MUSIC User Guide, a comprehensive review of stormwater quality in urban catchments was undertaken by Duncan (1999) and this review forms the basis for the default values of event mean concentrations in MUSIC for TSS, TP and TN. More recently, Fletcher et al (2004) has updated the values provided in Duncan (1999) and specifically provides guidance on appropriate land type breakdown. Table **5** presents the recommended model defaults for various land use categories. These values are consistent with those recommended by the Growth Centres Commission (GCC). Note that for all simulations the MUSIC model must be run with pollutant export estimation method set to "stochastic generated".

Land-use category		Log ₁₀ TSS (milligrams per litre)		Log ₁₀ TP (milligrams per litre)		Log ₁₀ TN (milligrams per litre)	
		Storm flow	Base flow*	Storm flow	Base flow*	Storm flow	Base flow*
Roof Areas	Mean	1.30	1.20	-0.89	-0.85	0.30	0.11
	Std Dev	0.32	0.17	0.25	0.19	0.19	0.12
Road Areas	Mean	2.43	1.20	-0.30	-0.85	0.34	0.11
	Std Dev	0.32	0.17	0.25	0.19	0.19	0.12
Other Impervious Areas	Mean Std Dev	2.15 0.32	1.20 0.17	-0.60 0.25	-0.85 0.19	0.30 0.19	0.11 0.12
Pervious	Mean	2.15	1.20	-0.60	-0.85	0.30	0.11
Areas	Std Dev	0.32	0.17	0.25	0.19	0.19	0.12

* Base flows are only generated from pervious areas; therefore, these parameters are not relevant to impervious areas

16 RAINFALL RUNOFF PARAMETERS

As outlined in Section 4, stormwater runoff (represented as storm flow and baseflow) is generated in MUSIC through the interaction of rainfall, evapotranspiration and the MUSIC Rainfall-Runoff Model. A full description of the MUSIC Rainfall-Runoff Model is provided in the *MUSIC User Guide*.

If the reader of this Handbook has no MUSIC modelling experience they should review *MUSIC User Guide* before reading further.

MUSIC rainfall-runoff parameters have been derived for the Western Sydney region from model calibration studies. The parameters recommended in Table **6** are the same as those recommended by the Growth Centres Commission (GCC) for use in GCC areas. The GCC recommends adoption of these parameters, but also suggests that a sanity check can be performed on total runoff volumes by comparing with the values presented in Figure 2.3 of the CRC-CH's Technical Report 04/8 (*Stormwater Flow and Quality, and the Effectiveness of Non-proprietary Stormwater Treatment Measures – A Review and Gap Analysis*, Fletcher et. al., 2004).

Table 6:	Rainfall-runoff	parameters

Parameter	Recommended values
Rainfall Threshold (millimetres)	1.4
Soil Capacity (millimetres)	170
Initial Storage (per cent)	30
Field Capacity (millimetres)	70
Infiltration Capacity Coefficient a	210
Infiltration Capacity Coefficient b	4.7
Initial Depth (millimetres)	10
Daily Recharge Rate (per cent)	50
Daily Baseflow Rate (per cent)	4
Deep Seepage (per cent)	0

The steps for setting up the rainfall runoff parameters are described below.

Step 1: Estimate Fraction Impervious

An initial estimate of the impervious fraction for the particular landuse should be made. The impervious area should be based on building density controls developed by Blacktown City Council as well as the development's urban planners and architects.

The building density controls that are of relevance include minimum soft landscaping area, maximum building envelopes, floor space ratios and road design guidelines. These estimates should also be compared to aerial photos of similar recent developments in the vicinity of the proposed development. Where differences between the estimates and the on ground impervious area are significant then estimates should be revised or the differences justified.

As a guide, the fraction impervious for the different development types described in Table 3.3 of the Blacktown City Council *Engineering Guide for Development* (2005) are:

- Public recreation areas 50 per cent.
- New residential lot only 80 per cent.
- Medium density development (villas etc) 85 per cent.
- Half width Road Reserve 95 per cent.

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• Industrial areas / commercial areas - 100 per cent.

The above fraction impervious percentage for lots applies to areas outside the growth centres. In the growth centres new residential lots are considered as 85 per cent impervious.

Where landscape areas are over below ground garages, podiums, or basements, consider the area 100 % impervious.

Step 2: Split MUSIC Catchments into Land Use Types

The catchment must be split into the various land types (that is, roads, roofs, other impervious and pervious surfaces). Each individual source node, with the exception of the Imported Data Node, requires the total area and impervious percentage of the site to be defined.

For a specific development, the site area is to be split into the four landuse source nodes from section 4. For new subdivisions calculate the area of new roads and the area of new lots. The lots can be agglomerated into the four source nodes upstream of the treatment devices.

For low density residential subdivisions **outside the growth centres** allow the following percentages for land use for the new lots only, considering 80 per cent impervious:

- Roof 55 per cent (of which a maximum of 50% goes to the rainwater tank).
- Road (driveways) 10 per cent.
- Other Impervious Areas (courtyards, paths) 15 per cent.
- Pervious Areas 20 per cent.

For low density residential subdivisions **within the growth centres** allow the following percentages for land use for the new lots only, considering 85 per cent impervious:

- Roof 55 per cent (of which a maximum of 50% goes to the rainwater tank).
- Road (driveways) 10 per cent.
- Other Impervious Areas (courtyards, paths) 20 per cent.
- Pervious Areas 15 per cent.

When utilising this approach:

- Roof areas are to be modelled as 100 per cent impervious. If there is a rainwater tank then it should be modelled immediately downstream of the roof. If only a portion of the roof drains to the rainwater tank, then the roof will need to be split into two separate nodes, one of which bypasses the rainwater tank. Generally Council will only consider a maximum of 50% of the roof area of residential developments draining to the rainwater tank unless there is specific information that provides a different figure when considering a specific development. In such cases the roof areas must match with the BASIX certificate for residential development.
- Roads, driveways, car parks and other areas open to vehicular traffic should be modelled with all the impervious area in the "Roads" node. Any pervious areas (for example, verges) associated with impervious areas such as roads and car parks should be included in the "Pervious areas" node. Future Council roads however may be considered with the Roads node as 95% impervious and 5% pervious.

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- The "Other impervious areas" node should include areas such as footpaths, courtyards and decks (including timber decks).
- All pervious areas should be included in the "Pervious areas" node. Pervious areas should be directly connected to the treatment systems. The area of the treatment device itself such as for a bioretention basin, swale, or wetland also needs to be included as a pervious source node.
- The MUSIC model must account for all the areas being developed. Where areas cannot drain to a treatment device these areas are considered as bypass and the specific land use(s) identified.

Step 3: Set Soil Properties

For impervious source nodes, the only rainfall-runoff parameter that plays a part is the rainfall threshold, which should be set to 1.4 millimetres. For all pervious source nodes, the soil characteristics shown in Table **6** should be adopted in MUSIC. For all treatment nodes the Exfiltration Rate (mm/hr) is to be set to zero.

17 LINK ROUTING

Drainage links are used in MUSIC to connect source nodes to treatment nodes and / or collection points. The drainage links account for the passage of stormwater and the time of travel between 2 nodes. There are 3 options for the routing of stormwater available within the drainage link:

- No routing.
- Translation of the flood wave (only).
- Muskingum Cunge method of stream routing.

For single lots and subdivision developments with only a small number of lots no routing is required. For larger subdivisions the applicant may choose not to apply routing to reduce the complexity of the generated model, however, it is noted that this will result in the performance of the treatment measures being underestimated as peak inflows into the treatment nodes will increase. For MUSIC model simulations of large catchments where routing is to be undertaken it is recommended that the translation routing option in MUSIC be used to reflect the travel time for flood wave propagation through the catchment. The user is referred to the *MUSIC User Guide* for further details.

18 STORMWATER QUALITY TREATMENT MEASURES

Following the determination of the site's water quality and hydrologic objectives the user (if required) is to develop an appropriate treatment train for the development dependent on site constraints and opportunities.

Within the current version of MUSIC the user has several treatment options available:

Wetland	
Pond	Wetland.
	• Pond.
Sedimentation Basin	 Sedimentation Basin.
Detention Basin	Detention Basin
Infiltration System	Detention Basin
Bioretention	Infiltration System.
Bioretention	Bioretention.
Media Filtration	Media Filtration.
GPT	
Buffer	• GPT.
	Buffer.
Swale	Swale
Rainwater Tank	Rainwater Tank.
Generic	
	Generic Node.

Figure 3: Treatment options available in MUSIC

The default parameters in MUSIC for the first order decay k-C* model used to define the treatment efficiency of each treatment measure should be used unless local relevant treatment performance monitoring can be used as reasonable justification for modification of the default parameters. Reference should be made to the *MUSIC User Guide* (2005, or subsequent versions).

Note: The following measures are not to be modelled in MUSIC: natural waterways, natural wetlands, naturalised channel systems, trunk drainage, environmental buffers and ornamental lake / pond systems.

In order to reduce the confusion of conflicting aspects of treatment node implementation Blacktown City Council provides the following advice for modelling stormwater quality treatment systems within Blacktown LGA.

MUSIC gives the option under the "More" tab to access the "Advanced Properties" for each treatment nodes to k-C* values, orifice discharge and weir coefficients, void ratio and number of CSTR cells. Council does not permit these MUSIC default values to be changed.

For residential developments Council does not permit treatment devices to be located in private courtyards or rear yards. They must be positioned in common areas, or front yards.

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18.1 Wetlands

Constructed wetland systems use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater.

Constructed wetland systems consist of an inlet zone (sediment basin to remove coarse sediments), a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and uptake of soluble pollutants) and a high flow bypass channel from the inlet pond (to protect the macrophyte zone). Provide a deeper water zone typically 1.8 m deep and absolute maximum 2.0 m deep.

Wetlands are suitable downstream of pre-treatment measures such as swales, sediment basins, or GPTs designed to remove coarse sediment.

- Input the appropriate bypass characteristics to reduce the impacts on macrophytes within the wetland. The high flow bypass flowrate should be set to the peak 1 year ARI flowrate.
- Estimate the inlet pond volume based on a surface area of 10 per cent of the macrophyte zone surface area, and a maximum depth of 1.8 metres with batters.
- Enter the proposed surface area of wetland macrophyte zone under "Storage Properties". Note that the surface area is the figure that when multiplied by the Extended Detention Depth will give the volume of Storage. Where the sides of the basin are battered the Surface Area is the area at half the Extended Detention Depth i.e. the average basin area.
- Set extended detention depth of between 0.25 to 0.75 metres. Note that any flood storage above the extended detention depth must not be included in the extended detention depth.
- Set the permanent pool volume as the volume of water permanently submerging macrophytes. Set by multiplying the average depth (typically 0.25 metres to 0.4 metres) by the surface area.
- Exfiltration is the water lost from the treatment measure into the surrounding soil (Council requires 0 millimetres per hour for wetlands, which should have a liner or 300 mm of compacted clay under to retain water).
- Adjust the Equivalent Pipe Diameter to ensure the treatment measure has a notional detention time of approximately 48 to preferably 72 hours. This is assumed to be at the Extended Detention Depth.
- Tick "Use Custom Outflow and Storage Relationship" where there is significant non linearity in the storage i.e. major

area at nail the Extended Detention	Deptil	00
Properties of Wetland	l	<u> </u>
Location Wetland		
Inlet Properties		
Low Flow By-pass (cubic metres per sec)	0.000	1
High Flow By-pass (cubic metres per sec)	100.000	
Inlet Pond Volume (cubic metres)	170.0	
Storage Properties		
Surface Area (square metres)	1600.0	1
Extended Detention Depth (metres)	0.60	
Permanent Pool Volume (cubic metres)	550.0	
Vegetation Cover (% of surface area)	50.0	
Exfiltration Rate (mm/hr)	0.00	
Evaporative Loss as % of PET	125.00	
Outlet Properties		
Equivalent Pipe Diameter (mm)	45	
Overflow Weir Width (metres)	4.0	
Notional Detention Time (hrs)	73.0	Enter th
Use Custom Outflow and Storage Relationship		
Define Custom Outflow and Storage	t Defined	
Re-use Fluxes Notes	More	
X Cancel <> Back	V Ein	hish
	New Post of the Second	

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variations in height versus area.

Figure 4: Example of properties of a Wetland in MUSIC

Other design considerations for wetlands include:

- Provide an internal wall system to increase residence time and avoid short circuiting.
- Provide concrete vehicular maintenance access to the basin at a maximum 10 % grade.
- When designing a wetland within a detention basin, the outlet control structure of the
 detention basin should be placed at the end of the wetland high flow bypass channel.
 This ensures flood flows as 'backwater' across the wetland thus protecting the
 macrophyte vegetation from scour by high velocity flows. The detention node will be
 positioned downstream of the wetland node in MUSIC.
- Allow for an internal drainage system that will allow for the permanent pool and remainder of wetland to be totally drained for maintenance.
- Allow for various water level controls to better control the operation of the wetland particularly during establishment.
- Provide macrophyte zones at varying depths to allow planting of a diverse range of plant species typically from 0.25 to 0.5 m.

18.2 Ponds

Ponds can be sized for three different purposes:

- Pollutant removal.
- Stormwater storage for reuse.
- Ornamental.

For the former two purposes, MUSIC can be used to size the pond and assess its performance as described following. All ponds, though, should be preceded by appropriate pre-treatment to remove coarse sediment.

Water Quality Ponds

Water Quality ponds rely on settling of suspended solids as the principal treatment mechanism. Vegetation (including submerged macrophytes in a deep pond) can promote nutrient removal, and open water can promote ultra violet (UV) disinfection, however these processes are not currently able to be modelled in MUSIC.

Pre-treatment is essential upstream of ponds. In MUSIC, the pollutant removal parameters associated with ponds are based on an assumption that pre-treatment has occurred upstream, and therefore it is essential to include an appropriate treatment train upstream of a pond in the MUSIC model. This could include a swale, sedimentation basin, or a suitable GPT, capable of removing a substantial proportion of coarse suspended solids.

Input parameters include:

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- Identify any high flow or low flow bypasses proposed for the treatment measure.
- Input the surface area of the pond. Note that the surface area is the figure that when multiplied by the Extended Detention Depth will give the volume of Storage. Where the sides of the basin are battered the Surface Area is the area at half the Extended Detention Depth i.e. the average basin area.
- The extended detention depth is the depth between the top of the permanent pool and the lip of the overflow weir. Typically 0.25 to 01.0 m.
- Estimate the permanent volume of water within the treatment measure.
- Exfiltration is the water lost from the treatment measure into the surrounding soil (Council requires 0 millimetres per hour for ponds, which should be lined, or 300 mm of compacted clay under to retain water).
- Evaporative loss as % of PET allow 75% for open water bodies with little to no vegetation.
- Modify the discharge pipe diameter to ensure a detention time long enough to allow settling of the target particle size. This is assumed to be at the Extended Detention Depth.
- Tick "Use Custom Outflow and Storage Relationship" where there is significant non linearity in the storage i.e. major variations in height versus area

Properties of Pond	83
Location Pond	
Inlet Properties	
Low Flow By-pass (cubic metres per sec)	0.000
High Flow By-pass (cubic metres per sec)	100.000
Storage Properties	
Surface Area (square metres)	800.0
Extended Detention Depth (metres)	0.50
Permanent Pool Volume (cubic metres)	1200.0
Vegetation Cover (% of surface area)	10.0
Exfiltration Rate (mm/hr)	0.00
Evaporative Loss as % of PET	75.00
Outlet Properties	
Equivalent Pipe Diameter (mm)	200
Overflow Weir Width (metres)	5.0
Notional Detention Time (hrs)	1.69
Use Custom Outflow and Storage Relations	ship
Define Custom Dutflow and Storage	Not Defined
Re-use Fluxes Notes	More
X <u>C</u>ancel <⇒ <u>B</u> ack	Einish

Figure 5: Example of properties for a Pond in MUSIC

Storage ponds

If a pond is used to store treated stormwater for reuse, its performance in balancing supplies and demands can be modelled using MUSIC. In this case, the pond may or may not be modelled with extended detention.

The permanent pool actually represents the volume available for reuse, and the quantity of water is likely to fluctuate widely depending on supplies and demands.

If a storage pond has a permanent pool below the volume available for reuse, this permanent pool should be ignored.

Input parameters are as for above, but add:



• Enter Re-use details to represent the intended demands on water from the storage pond.

The effectiveness of the pond as a storage system with reuse can be evaluated by checking the node water balance of the pond node once the model has run.

Figure 6: Example of properties for Reuse in a Pond in MUSIC

18.3 Sedimentation Basins

Sediment basins are used to retain coarse sediments from runoff. They operate by reducing flow velocities and encouraging sediments to settle out of the water column.

They are frequently used for trapping sediment in runoff during construction activities and for pre-treatment to measures such as wetlands (for example, an inlet pond).

Sediment basins can drain during periods without rainfall and then fill during runoff events.

Sediment basins are sized according to the design storm discharge and the target particle size for trapping (generally 0.125 millimetres).

Input parameters include:

- Identify any high flow or low flow bypasses proposed for the treatment measure.
- Input the surface area of the basin. Note that the surface area is the figure that when multiplied by the Extended Detention Depth will give the volume of Storage. Where the sides of the basin are battered the Surface Area is the area at half the Extended Detention Depth i.e. the average basin area
- The extended detention depth is the depth between the top of the permanent pool (or ground if no permanent pool) and the lip of the overflow weir.
- Estimate the permanent volume of water within the treatment measure. Pool depths can be up to 2 m, but need to allow for batter slopes when calculating volumes.
- Exfiltration is the water lost from the treatment measure into the surrounding soil (Council requires 0 millimetres per hour for sedimentation basins, which should be lined, or 300 mm of compacted clay under, to retain water).
- Evaporative loss as % of PET allow 75% for open water bodies.

Properties of Sedimentation Basin	X
Location Sedimentation Basin	
Inlet Properties	
Low Flow By-pass (cubic metres per sec)	0.000
High Flow By-pass (cubic metres per sec)	100.000
Storage Properties	
Surface Area (square metres)	40.0
Extended Detention Depth (metres)	0.60
Permanent Pool Volume (cubic metres)	70.0
Exfiltration Rate (mm/hr)	0.00
Evaporative Loss as % of PET	75.00
Outlet Properties	
Equivalent Pipe Diameter (mm)	100
Overflow Weir Width (metres)	2.0
Notional Detention Time (hrs)	0.369
Use Custom Outflow and Storage Relationship)
Define Custom Outflow and Storage	Not Defined
Re-use Fluxes Notes	More
X <u>C</u>ancel	✓ <u>F</u> inish

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- Modify the discharge pipe diameter to ensure a detention time long enough to allow settling of the target particle size.
- Tick "Use Custom Outflow and Storage Relationship" where there is significant non linearity in the storage i.e. major variations in height versus area

Figure 7: Example of properties of a Sedimentation Basin in MUSIC

Note: This treatment measure can be utilised as pre-treatment measure upstream of a wetland or sand filter and allows for a diversion of flows above recommended scour velocities.

18.4 Detention Basins

Detention basins can be above ground, or below ground in tanks. Above ground basins are favoured by Council as they are easier to maintain and avoid confined space entry and the associated risks. Council current has two approaches to detention systems. The older established areas of Blacktown LGA use a High Early Discharge (HED) system. HED directs as much of the site as possible straight to the small HED control pit which fills up and thereby reaches close to the maximum discharge quickly. Detention with HED requires a smaller storage volume than a conventional detention system. A conventional detention system is one where the discharge rate rises more slowly than with HED as the storage fills over the entire basin area. The conventional detention system is predominantly used in the growth centres. The default Detention Basin node in MUSIC is based on a conventional detention system with a single outlet. It cannot be used to represent a detention basin with a HED outlet. This needs to be represented differently in MUSIC.

Where water quality treatment (e.g. bioretention, or proprietary filters or devices) is incorporated into a detention basin itself, or enlarged HED pit, the treated flow must discharge downstream of the discharge control pit to ensure ongoing treatment throughout a range of storms. This may require adjustment to the discharge controls to ensure the design discharge is maintained and account for the bypass.

Council's requirement for concrete detention tanks, or above ground detention basins with a concrete base, is for the base to have a minimum grade of 2%. This grade ensures that settled material is flushed from the system. No allowance can therefore be made for the settlement of material and consequently no reduction in TSS, TP, or TN is permitted for concrete detention tanks, or above ground basins with a concrete base. Reduction in TSS, TP or TN is only permitted for vegetated (including turfing) above ground detention basin where settled material can be trapped by the vegetation. Where vegetated above ground detention basins incorporate bioretention in the base, the area of bioretention is to be excluded from the area in detention node.

Conventional Detention Basins

Figure 8: Example of properties of a conventional Detention Basin in MUSIC



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Input parameters include:

- Identify any high flow or low flow bypasses proposed for the treatment measure.
- Input the surface area of the basin. Note that the surface area is the figure that when multiplied by the Extended Detention Depth will give the volume of Storage. Where the sides of the basin are battered, the Surface Area is the area at half the Extended Detention Depth i.e. the average basin area.
- The extended detention depth is the depth between the average base level of the storage (generally not the centreline of the outlet pipe or orifice) and the lip of the overflow weir, or design storage level.
- Evaporative loss as % of PET allow 0% for tanks and 75% for above ground detention systems.
- Exfiltration is the water lost from the treatment measure into the surrounding soil (Council requires 0 millimetres per hour for detention basins, which should be concrete, or on a compacted clay base, or lined to retain water).
- The Low Flow Pipe discharge rate will be initially determined from the detention calculations. Using this discharge a nominal orifice size (low flow pipe diameter) is calculated using the extended detention depth from above and not the actual depth to the orifice or pipe centreline.
- Tick the "Use Custom Outflow and Storage" box for more complex, or multiple basin discharges with the option of importing a discharge spreadsheet where required. This method should be utilised for landscaped above ground basins with uneven base levels and/or batter slopes to better represent the settlement of pollutants over smaller surface areas in more frequent storm events.
- Where a detention node is used for a concrete tank, or an above ground detention basin with a concrete base then, click the "More" tab in MUSIC, and set the "k" values for TSS, TP and TN all to "0". This ensures that no treatment occurs in this type of basin as settled material is flushed from the base.

High Early Discharge (HED) Configuration in MUSIC

The HED discharge control pit has no silt trap in accordance with Council requirements, but contains either a Maximesh, or Weldlok screen (for orifices greater than 150mm diameter). A Generic Node is used to represent the HED pit. As there is no way to contain any pollutants that settle out in the HED pit there is no reduction in TSS, TP, or TN (they simply wash through). Gross pollutants are defined as material that would be retained by a five millimetre mesh screen. It is common not to include Gross Pollutant removal in this HED node, however where required allow 50% removal for Maximesh Screens and 10% removal for Weldlok Screens. The critical input for the HED node is the High Flow Bypass in (m³/s). Council has produced a spreadsheet for calculation of the on-site detention systems with HED. The spreadsheet provides a discharge rate for "High early discharge" in I/s. This is the discharge before overtopping of the weir into the extended detention storage area. To input into the node this flow needs to be converted to m³/s.

A typical arrangement for a system with HED is detailed below in figure 9.





The MUSIC model above is set up with the primary flow from the orifice discharging downstream to the next node. The red dashed secondary drainage link is then directed to the detention basin node. This secondary flow is set to the high flow bypass from the HED pit. The detention basin node is as set up for the conventional detention basin excluding the area of the HED pit. The Low Flow Pipe Diameter is set to the orifice size in the HED pit. As Council requires as much of the site as practical to discharge direct to the HED pit, only the area that directly falls within the above ground basin, or for a tank the area above the tank that discharges straight into the tank due to the frequent pit grates, is permitted to be directed to the detention basin node.

The use of this arrangement in MUSIC will provide some assistance in achieving the water quality objectives for above ground landscaped detention basins, but will not achieve overly significant benefits. Many designers choose not to undertake this additional modelling step in smaller developments.

As noted above in the introduction to section 7.4, for concrete detention tanks, or above ground basins with a concrete base, no allowance can be made for the settlement of material and consequently no reduction in TSS, TP, or TN is permitted. Similarly the use of the HED generic node and secondary bypass to the detention node as a modelling approach has limited application for concrete detention tanks, or above ground basins with a concrete base. The only benefit in undertaking this additional modelling step is where the water quality treatment device is downstream of the detention and the reduction in flow rates through this node provides improved performance of this water quality device. Otherwise it is not required.

18.5 Infiltration Systems

Infiltration measures encourage stormwater to infiltrate into surrounding soils. Infiltration measures are highly dependent on local soil characteristics and are best suited to sandy soils with deep groundwater. Infiltration is not recommended in areas of sodic or saline soils or soil contamination, where infiltration could mobilise salts or contaminants. Given the presence of

clay throughout the LGA as well as significant areas of sodic and saline soils, infiltration will not be permitted in the Blacktown LGA.

18.6 Bioretention Systems

Bioretention systems are a combination of vegetation and filter substrate that provides treatment of stormwater through filtration, extended detention and some biological uptake.

The systems are designed to accept stormwater runoff and allow it to percolate through the filtration media. At the base of the filter media, treated stormwater is collected within a drainage layer comprising a system of perforated pipes laid in gravel, to ensure the treatment measures are drained adequately.

Bioretention systems need to be densely planted out with sedges and shrubs to help maintain the conductivity of the filter media, promote nutrient removal, and create an attractive landscaped form/feature. Large shrubs and some trees are permitted subjected to larger filter media thicknesses. See also Handbook 5 for allowable plant species.

Inlet Properties Low Flow By-pass (cubic metres per sec)		Links Description	Construction of the second sec
Low Flow By-pass (cubic metres per sec)		Lining Properties	
	0.000	Is Base Lined?	🗹 Yes 📃 No
High Flow By-pass (cubic metres per sec)	100.000	Vegetation Properties	
Storage Properties		Vegetated with Effective Nutrient Removal F	1
Extended Detention Depth (metres)	0.30		iants
Surface Area (square metres)	120.00	Vegetated with Ineffective Nutrient Removal	Plants
Filter and Media Properties] O Unvegetated	
Filter Area (square metres)	100.00		
Unlined Filter Media Perimeter (metres)	0.10	Outlet Properties	2.00
Saturated Hydraulic Conductivity (mm/hour)	100.00	Overflow Weir Width (metres)	2.00
Filter Depth (metres)	0.50	Underdrain Present?	🗹 Yes 🔲 No
TN Content of Filter Media (mg/kg)	800	Submerged Zone With Carbon Present?	🔄 Yes 📝 No
Orthophosphate Content of Filter Media (mg/kg)	40.0	Depth (metres)	0.45
Infiltration Properties			
Exfiltration Rate (mm/hr)	0.00	Fluxes Notes	More

Figure 10: Example of properties of a Bioretention System in MUSIC

Input parameters include:

- Identify whether a bypass structure shall be included within or upstream of the treatment measure to control flows.
- Identify the Extended Detention Depth (ponding depth) in metres prior to overflowing the control weir of the treatment measure. The maximum Extended Detention Depth is 0.4 metres for Blacktown generally, however for public basins within

Council property the maximum Extended Detention Depth is 0.3 metres. Where a bioretention swale is proposed the Extended Detention Depth is set to zero.

- Provide the Surface Area (m²) of the treatment measure based upon site constraints. Note that the surface area is the figure that when multiplied by the Extended Detention Depth will give the volume of Storage. Where the sides of the basin are battered the Surface Area is the area at half the Extended Detention Depth i.e. the average basin area.
- Filter Area (m) is the area of bioretention filter media available for planting and excludes the areas of pits, sediment traps, steps and scour protection.
- Unlined Filter Media Perimeter (m) is set to 0.1 m. (Filter is fully lined).
- The filter media is a sandy-loam mixture designed to provide adequate organic material for vegetation/root growth yet still ensure sufficient flow through drainage characteristics. A typical rate of Saturated Hydraulic Conductivity is 100 millimetres per hour. The maximum Saturated Hydraulic Conductivity permitted in Blacktown is 125 millimetres per hour. (Note Council requires certification from the filter media supplier that that the bioretention filter media has a minimum hydraulic conductivity as defined by ASTM F1815-06 (actual, not predicted) of twice the rate specified in MUSIC.)
- Provide the proposed depth of filter media in metres within the treatment measure. **The minimum Filter Depth is 0.4 metres for Blacktown.** The following depths are recommended as a minimum within the treatment measure: 0.4 metres for sedges and small shrubs and up to 0.8 metres for tree species. This will ensure adequate area for root growth is provided within the treatment measure. This depth does not include the transition layer, or drainage layer. See also Handbook 5 for minimum depths for specific plant species.
- TN Content of Filter Media (mg/kg) Blacktown requires 800 mg/kg.
- Orthophosphate Content of Filter Media (mg/kg) Blacktown requires 40 mg/kg.
- Exfiltration is the water lost from the treatment measure into the surrounding soil (Council requires 0 mm/hr for bioretention basins, which should be lined to retain water).
- Is Base Lined? tick "Yes"
- Vegetation Properties. Highlight "Vegetated with Effective Nutrient Removal Plants". See Handbook 5 for specific plant species. Grass is not acceptable.
- Overflow Weir Width (metres) as per design.
- Underdrain Present? Tick "Yes" (Council requires unsocked PSC slotted pipes within the drainage layer.
- Submerged Zone with Carbon Present? Tick "No". Blacktown does not permit submerged or saturated zones for bioretention.
- The default k-C* values for the bioretention system must not be adjusted without prior approval from Blacktown City Council.

Additional Design Information for Bioretention Systems

- The bioretention system is to be encased in a low permeability compacted clay (typically 300 mm), in an HDPE liner, or other approved liner.
- The invert levels of all pipes discharging to the bioretention system must be above the top of the filter media. Surcharge pits are not permitted.
- Where bioretention is incorporated as part of a detention basin the subsoil drainage must discharge downstream of the discharge control pit to ensure ongoing treatment through a range of storms.
- Note that where bioretention basins are incorporated as part of an on-site detention system the detention basin storage must exclude the Extended Detention Depth of the bioretention.
- Bioretention systems are very vulnerable to sediment loading and must be protected by pretreating discharges to remove as much sediment as possible. A silt arrestor pit with screen, or a proprietary gross pollutant trap (GPT) is required upstream. Pipe diameters 375 mm or greater must provide a proprietary GPT, but it is also preferred for smaller pipe sizes such as 300 mm diameter, or even 225 mm. Council will accept a MUSIC node for a proprietary GPT (where the device is approved for use in Blacktown), but not for the default silt arrestor pit. Minimum silt arrestor pit sizes are detailed below.

Outlet Pipe Diameter (mm)	Pit Dimensions (mm)	Screen Type	Minimum Silt Trap Depth (mm)
100	600 x 600	Maximesh Rh3030	300
150	900 x 900	Maximesh Rh3030	400
225	1200 x 1200	Weldlok F40/203	400
300 (max)	2100 x 2100	Weldlok F40/203	400

Table 7: Silt Arrestor Pit Size and Configuration for Pre-treating Bioretention Systems

18.7 Media Filtration

Media filtration usually refers to sand filters that treat stormwater via infiltration through a soil or sand media. Sand filters, unlike bioretention systems, are not vegetated, are often constructed in tanks underground and can be constructed with much higher filtration rates.

Due to the fact that sand filters are not vegetated, they can be prone to clogging unless adequate pre-treatment is provided upstream of the sand filter. They can also be maintenance intensive. Sediment removal is particularly important to minimise the risk of clogging, and it is recommended that pre-treatment should meet the target for a minimum of 70 per cent removal of the TSS load. Sand filters must be constructed of fine to fine/medium sand, or sandy loam. Coarse sand, or fine gravel materials are not permitted as the top layer for Media Filtration in Blacktown as they will not remove a significant pollutant load. It is common to use the same media in the top layer as for bioretention.

Media filtration should contain a number of common elements.

- The media filtration system must include a sedimentation basin upstream of the filter as a node in MUSIC. See section 7.3. This basin is designed to capture a minimum 85% of 125 μm particle size, or larger.
- The sedimentation basin must include a high flow bypass set to the 1 year flow or less with a baffle to retain oils and floatables.
- The media filter material should be free of fines and have a relatively uniform grain size distribution.
- Energy dissipaters and flow spreading is required to minimise scour prior to discharge to the filter media.
- System will include a transition layer and drainage layer.
- Frequent safe access is required for maintenance for the raking or replacement of sand. This is a major consideration with confined space entry into a tank.

Input Parameters into the MUSIC node include:

- Identify any high flow or low flow bypasses proposed for the treatment measure.
- Identify the ponding depth of stormwater runoff prior to its overflowing the control weir of the treatment measure (extended detention depth).
- Provide the estimated surface area (m²) of the storage. Most sand filters in tanks will have vertical sides and the area will match the filter area, however where the sides of the basin are battered the Surface Area is the area at half the Extended Detention Depth i.e. the average basin area for storage.
- Exfiltration is the water lost from the treatment measure into the surrounding soil (Council requires 0 mm/hr for media filtration basins, which should be lined or within a concrete tank to retain water).
- Input the surface area of the filter media (m²) within the treatment measure.
- Provide the proposed depth of filter media (m) within the treatment measure. This depth does not include the transition or drainage layer. Minimum is 0.2 m, but 0.4 to 0.6 m is typical.
- Identify the type of filter media proposed based upon Filter Median Particle Size (mm) and Saturated Hydraulic Conductivity (mm/hr). See examples in Table 7. The maximum Saturated Hydraulic Conductivity for a sand media filter in Blacktown is 600 mm/hr. (Note Council requires certification from the filter media supplier, or engineer that that the filter media has a minimum hydraulic conductivity as defined by ASTM F1815-06 (actual, not predicted) of twice the rate specified in MUSIC.).

Properties of Media Filtration	X
Location Media Filtration	Products >>
- Inlet Properties	
Low Flow By-pass (cubic metres per sec)	0.000
High Flow By-pass (cubic metres per sec)	100.000
Storage Properties	
Extended Detention Depth (metres)	0.50
Surface Area (square metres)	60.0
Exfiltration Rate (mm/hr)	0.00
Filtration Properties	
Filter Area (square metres)	60.0
Filter Depth (metres)	0.4
Filter Median Particle Diameter (mm)	0.45
Saturated Hydraulic Conductivity (mm/hr)	100.00
Depth below underdrain pipe (% of Filter Depth)	0.0
Outlet Properties	
Overflow Weir Width (metres)	2.0
Fluxes Notes	More
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Figure 11: Example of properties of Media Filtration in MUSIC

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Soil Type	Median Particle Size (mm)	Saturated Hydraulic Conductivity (mm/hr)
Sand	0.7	300
Sandy loam	0.45	125

Table 7 : Typical Filter Median Particle Size and Saturated Hydraulic Conductivity

• The depth below underdrain pipe should normally be zero. This parameter is only relevant when the filter media extends below the slotted drainage pipe.

18.8 Gross Pollutant Traps (GPTs)

GPTs typically remove rubbish and debris, and can also remove sediment and hydrocarbons from stormwater runoff.

These treatment measures can be very effective in the removal of solids conveyed within stormwater which are typically larger than 5 millimetres in size. Some devices are capable of removing finer sediments. Many devices will not remove any TSS, TP or TN.

All proprietary GPT nodes have to be pre-approved by Blacktown City Council. Council currently has MUSIC nodes available for a range of devices and designers need to contact Council to obtain them. These nodes will set the removal rates for the pollutants within MUSIC.

The only Input parameter is:

 Calculate the required high flow bypass for the site (often the 3 or 6 month ARI peak flow). Match this flow with the nearest appropriately sized approved proprietary device, or the upstream diversionary weir to the GPT. In some cases the allowable flow through the device approved by Council may be less than that claimed by the manufacturer.

Vortex-type GPTs have been shown to remove some TSS and TP. For further information see Appendix C of the *MUSIC User Guide*. Vortex-type GPTs have TSS removal up to 70 per cent for inflow concentrations greater than 75 milligrams per litre. TP removal can be up to 30 per cent for inflow concentrations greater than 0.5 milligrams per litre. TN removal should be left at zero. Other approved devices will have varying removal rates. Check with Council.

GPTs must have the ability to retain free oil, unless alternate specific hydrocarbon removal measures are undertaken.



Figure 12: Example of TSS removal in a Vortex style CDS unit in MUSIC

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18.9 Buffers

Buffer or filter strips, in the context of urban stormwater, are grassed or vegetated areas over which stormwater runoff from adjoining impervious catchments traverses en route to the stormwater drainage system or receiving environment.

Buffer strips are intended to provide discontinuity between impervious surfaces and the drainage system. They take water from impervious surfaces in a distributed manner, promote even flows and filter sediments and coarse pollutants entrained in the runoff.

The key to their operation is an even shallow flow over a wide vegetated area. Utilise buffer treatment measures upstream of other treatment measures to assist in sediment drop out prior to stormwater entering secondary treatment measures such as swales.

Distributed flows and a shallow grade (1 to 5 per cent) are essential. The low hydraulic loading over the vegetation allows flows to filter through the vegetation and pollutants to settle out. They also provide a detention role to slow flows down. Where grades exceed 5%, this area is not considered as buffer and is to be excluded from the MUSIC model.

Input parameters include

- Calculate the percentage of upstream area that shall actually pass over buffer. This refers to the **proportion of the Source Node's impervious area** which has buffer strips applied to it. For example, in a Source Node with 20 ha of impervious area, 16 ha (or 80%) may have buffer strips applied. Note that the pervious area of the source node is ignored.
- Calculate the size of the proposed buffer area as a percentage of the upstream catchments impervious area. This is a measure of the actual size of buffer strips, defined as the percentage of the Source Node impervious area. The default value is 5%. This means that the total area of buffer strip is equivalent to 5% of the Source Node impervious area.
- The exfiltration rate must be set to zero.

Location	Buffer		
Treatment Percentag	Properties e of upstream area	a buffered (%)	80.0
Buffer Are	a (% of upstream in	npervious area)	5.0
Exfiltration	Rate (mm/hr)		0.00
		Fluxes	Notes

Figure 13: Example of Buffer properties in MUSIC

18.10 Swales

Vegetated swales are open vegetated channels that can be used as an alternative stormwater conveyance system to conventional kerb and channel along roads and associated underground pipe. The interaction of surface flows with the vegetation in a swale facilitates an even distribution and slowing of flows thus encouraging particulate pollutant settlement. Swales can be incorporated into streetscape designs and can add to the aesthetic character of an area. They are also ideal as a pre-treatment measure for stormwater, particularly for coarse sediment removal. Where there are significant point loads coming in partway along the length of the bioretention swale, the swale needs to be broken up into smaller swale lengths at these points.

Standard Swale Input parameters include:

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Figure 14: Example of properties of a Swale in MUSIC

- Identify the length of the swale based upon location and site constraints
- Determine the longitudinal slope of the swale. Swales with bed slopes greater than 5 per cent are not recommended as treatment measures (however rock check dams can be used to design swales with steeper slopes and these can still be used as conveyance treatment measures).
- Swales with bed slopes less than 1 per cent are to incorporate a gravel trench with un-socked subsoil line (the gravel trench is to be wrapped in geotextile) within the base of the treatment measure to promote adequate drainage.

Inlet Properties Low Flow By-Pass (cubic metres per sec)	0.000
Storage Properties	
Length (metres)	100.0
Bed Slope (%)	2.00
Base Width (metres)	1.0
Top Width (metres)	5.0
Depth (metres)	0.50
Vegetation Height (metres)	0.150
Exfiltration Rate (mm/hr)	0.00
Fluxes Notes	More

- Provide dimensions for the base and top width of the swale.
- Calculate the depth of the treatment measure based upon the base and top width characteristics and identify the height of vegetation within the treatment measure. Vegetation heights of 0.05 to 0.3 metres are acceptable, however MUSIC assumes that swales are heavily vegetated when modelling their treatment performance. Mown grass swales should not be expected to provide significant stormwater treatment and should not be modelled in MUSIC.
- Exfiltration is the water lost from the treatment measure into the surrounding soil (Council requires 0.00 mm/hr for swales).

Special Requirements for Bioretention Swales

Where a bioretention swale is specified in MUSIC the requirements are as for section 7.6 Bioretention except that:

- The Surface Area must match the Filter Area.
- The Filter Area is calculated as the length of the bioretention swale component multiplied by the width of the filter (this needs to be level across). This ignores any other standard swales that may be further upstream and that need to be modelled separately.
- The Extended Detention Depth is set to zero.
- Where there are significant point loads coming in partway along the length of the bioretention swale, the swale needs to be broken up into smaller swale lengths at these points.

There are two options for MUSIC modelling. Firstly you can ignore the swale aspect altogether and simply model the bioretention component as detailed above. This is simpler and easier and commonly undertaken. The second option is that you include the bioretention and swale as two separate nodes in MUSIC.

The first node is the bioretention node as noted above (i.e. consider the bioretention filter surface by itself). The second (downstream) node is the standard swale node with a single change.

- Swale characteristics are as detailed above for a standard swale ensuring the bed slope does not exceed 5%.
- The only change is that a low flow bypass into the treatment measure needs to be calculated. This is the flow infiltrating through the surface of the bioretention into the underdrain pipes.

This low flow bypass is calculated by the following formulae:

Low Flow Bypass = BSA x k_{sat} / (1000 x 3600) in m³/s

Where: BSA = Bioretention surface area k_{sat} = Saturated Hydraulic Conductivity of the filter media in mm/hr (max 125 mm/hr).

18.11 Rainwater and StormwaterTanks

Rainwater tanks can serve two main purposes. Primarily, they are designed to provide an alternative source of water for non-potable uses such as irrigation, toilet flushing, laundry, hot water, or industrial process water. They are not intended, nor should they be seen as a component of detention. Rainwater tanks are to only accept runoff from a Roof source node.

To design a rainwater tank for reuse involves balancing the supply and demand and selecting an appropriate tank size to meet a reasonable proportion of demand. This can be achieved in MUSIC.

Rainwater tanks can also be designed to act as a treatment measure, as some settling occurs in the tank, and when rainwater is utilised, some pollutants are removed along with the water.

Non-potable Reuse Rates for Modelling Rainwater Tanks in MUSIC

The following rates are provided as a guide for MUSIC modelling purposes.

Residential development (excluding home units or multistorey dwellings) allow for rainwater reuse per dwelling based on the area of lots as follows:

- Lots > 720 m² allow 0.14 KL/day internal use & 100 KL/year as PET- Rain
- Lots > 520 & < 720 m² allow 0.12 KL/day internal use & 75 KL/year as PET- Rain
- Lots > 320 & < 520 m² allow 0.10 KL/day internal use & 50 KL/year as PET- Rain
- Lots < 320 m² allow 0.08 KL/day internal use & 25 KL/year as PET- Rain

NOTE: Consider each Villa and/or Townhouse dwelling as Lots < 320 m²

Industrial and commercial developments, including schools, child-care centres, hotels/motels, hospitals, halls, sporting fields and aged care and places of worship (including not-for-profits), allow for rainwater reuse as follows:

• For internal rainwater reuse, allow 0.1 KL/day per toilet, or urinal in industrial/commercial developments and generally ignore any disabled toilet. However where the site is only occupied say 6 days per week the daily usage rate is to be

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proportioned by 6 / 7. Similarly where there is an additional afternoon, or night shift using less staff, increase the rate proportionally.

• Other internal usage may involve vehicle washing or other industrial usage and specific data will need to be supplied to justify these reuse rates.

• For irrigation of landscaped areas only allow 0.4 kL/year/m² as PET-Rain for sprinkler systems and 0.3 kL/year/m² for subsurface irrigation. For bioretention filter areas only allow 0.4 kL/year/m² as PET-Rain (subsurface irrigation only). Higher rates may be required by the landscape architect for specific landscape requirements, however such rates will not be accepted by Council in the MUSIC model. This does not stop the Landscape Architect increasing the rainwater tank size to cover such requirements.

First Flush Systems and Rainwater Tank Pre-Treatment

As a means of improving the water quality of the stored water in a rainwater tank, it is common to remove a certain volume of runoff off the roof, referred to as the first flush, on the understanding that most of the pollutants will be contained in this runoff. This reduces the chance of thes pollutants entering the rainwater tank. Typically this may be the first one or two millimetres of runoff off the roof. These systems are then drained via a low flow or dribble pipe. In MUSIC the roof node would connect direct to a detention node to represent the properties of the first flush tank and low flow outlet. The primary flow will be directed to wherever the low flow pipe drains to and the weir overflow will be directed as secondary flow to the rainwater tank.

Where a first flush system is not used, other pre-treatment is usually required for the rainwater tank typically as a screen and silt trap. Unless these are a proprietary device accepted by Council, no credit will be given in MUSIC. Specific requirements for such devices may be required in charged systems under pressure.

Rainwater Tank Sizes

Allow for a 20% loss in rainwater tank volume in MUSIC to allow for anaerobic zones, mains water top up levels and overflow levels. e.g. where a 10 kL tank is specified on the drainage plan it is to be modelled as 8 kL in MUSIC.

For residential development the tank size is as required for BASIX. Where rainwater tank sizes are proposed by the designer are larger than those specified in BASIX, or the roof area draining to the tank varies, the BASIX certificate is to be amended to match.

When assessing low density residential subdivisions allow for a rainwater tank size of 2.5 kL supplied, but modelled as 2.0 kL in MUSIC per dwelling. Also allow for a Surface Area of rainwater tank of 1.7 m² per dwelling.

For industrial and residential development the rainwater tank size will be determined to meet the 80% non-potable reuse requirement.

Figure 15: Example of properties of a Rainwater Tank in MUSIC



Input parameters include:

- Identify any high flow or low flow bypasses proposed for the treatment measure. Generally the default values are retained.
- Input the tank volume (with 20% reduction as noted above).
- The depth above overflow, can be estimated roughly or left at default values. This parameter does not have a significant influence on the results.
- The surface area can be determined from available information, or roughly estimated.
- The overflow pipe diameter can be estimated roughly or left at default values. This parameter does not have a significant influence on the results.
- Tick "Use stored water for irrigation or other purpose". For irrigation usage PET -Rain is recommended. It is defined as an annual demand (kL/yr) and scaled according to the daily PET value minus the daily rainfall data contained in the Meteorological Template used to create the model rainfall (i.e. when PET exceeds rainfall, reuse will occur, or more simply you don't water the garden when it is raining.) Daily demand (kL/day) refers to more constant internal usage such as toilet flushing, laundry use, some industrial processes, or vehicle washing. Monthly distribution would only apply to a specific industrial reuse. Details of general allowable rates are indicated above.

The effectiveness of the rainwater tank at meeting the demands upon it can be evaluated by clicking on the Rainwater Tank Node after running MUSIC. Right click on "Statistics" and under "Node Water Balance" review the "% Reuse Demand Met" result in the Flow column. For residential development there is no specific reuse target as the development is subject to BASIX. For commercial and industrial development, Council requires a minimum of 80 % non-potable reuse to be met through rainwater. Residential development is subject to BASIX and has no minimum % reuse requirement for Council. An example MUSIC model setup, showing the location of a rainwater tank, was shown in figure 9.

Stormwater Tank Modelling Constraints

Stormwater tanks differ from rainwater tanks in that they may collect water from a variety of sources including driveways, parking areas and landscaped areas as well as rainwater tank overflows. This adversely affects the quality of water and the range of pollutants that may be captured. Some such pollutants may be adverse to public health and may include poisons used on the garden or chemicals spilt on the driveway, or parking areas. Consequently stormwater reuse is not permitted for residential development at all, nor is it permitted for toilet flushing for commercial or industrial developments. Stormwater reuse is permitted for subsurface drainage of landscaped area for commercial or industrial developments subject to a high level of filtering and any other additional treatments as required by your consultant. Stormwater reuse may also permitted for some industrial processes subject to a more detailed review and risk assessment.

The characteristics of a Stormwater Tank in MUSIC is identical to that of a Rainwater Tank. The designer mainly needs to ensure that when the "Use stored water for irrigation or other purpose box" is checked, that the demands are appropriate and fit for purpose.

18.12 Generic Node

This node allows the user to simulate the treatment performance of treatment measures not listed within the default parameters. The use of these nodes for specific treatment devices is not permitted without direct approval from Blacktown City Council. A range of approved Generic Nodes is available from Council for a range of existing proprietary devices.

The use of the generic node is permitted when used for a flow transfer function without any treatment. This may be to represent a diversion weir, or as an HED pit as detailed in Figure 9. Such nodes are also used when determining the Stream Erosion Index (SEI) as detailed in section 8.

18.13 Hydrocarbons

Council requires the post development average annual load reduction of 90% for Total Hydrocarbons. Hydrocarbons in water can be found as free floating, emulsified, dissolved, or adsorbed to suspended solids. A hydrocarbon, by definition, is one of a group of chemical compounds composed only of hydrogen and carbon. Microbes in the soils and water have a natural ability to breakdown many of these compounds and any hydrocarbon which is exposed to the air will also have an affinity to volatilise. As well, reactions including photochemistry and the various transformations of the hydrocarbon through these reactions, can enhance the hydrocarbon decomposition. This includes free oils and emulsified hydrocarbons.

MUSIC at this time is unable to assess the removal of Total Hydrocarbons. Consequently empirical methods are required to achieve the required load reduction.

To meet the 90% target for hydrocarbon removal for on-line flows, a system is to be provided capable of retaining hydrocarbons through an appropriately sized baffle system that reduces the flow velocities sufficiently to contain and store the hydrocarbons for the peak flow.

To meet the 90% target for hydrocarbon removal for off-line flows, the system is to be designed to treat the six (6) month flow using a proprietary hydrocarbon removal device, or gross pollutant trap with oil baffle, or an appropriately sized baffle system that reduces the flow velocities sufficiently to contain the hydrocarbons.

Industrial or commercial development with carparks, or manoeuvring areas greater than 1000 m^2 must provide a device that specifically targets the removal of hydrocarbons from the treatment train.

19 CALCULATION OF THE STREAM EROSION INDEX

19.1 How to estimate the Stream Erosion Index (SEI)

Blacktown City Council uses the method developed in the Draft NSW MUSIC Modelling Guide (Aug 2010) that is adapted from Blackham and G. Wettenhall (2010).

Water Sensitive Urban Design (WSUD) strategies are typically modelled using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC can be used to estimate the SEI for a development's stormwater management strategy to determine compliance with the SEI objective.

Blacktown Council requires that the post development duration of stream forming flows shall be no greater than 3.5 times the pre developed duration of stream forming flows with a stretch target of 1.

The Four Steps for Estimating Stream Erosion Index

- 1. Estimate the critical flow for the receiving waterway above which mobilisation of bed material or shear erosion of bank material commences.
- Develop and run a calibrated MUSIC model of the area of interest for predevelopment conditions to estimate the mean annual runoff volume above the critical flow.
- 3. Develop and run a MUSIC model for the post developed scenario to estimate the mean annual runoff volume above the critical flow.
- 4. Use the outputs from steps 3 and 4 to calculate the SEI for the proposed scenario.

19.2 Estimating the critical flow for the receiving waterway

The critical flow for a waterway is defined as the flow threshold below which no erosion is expected to occur within the waterway. This has been estimated (EarthTech, 2005) as a percentage of the pre-development two year ARI peak flow at the location in question. For Blacktown this percentage is 25% based on the dispersive characteristics of the typical local clay soils. The peak flow from the two year ARI storm event corresponding for pre-developed conditions is to be calculated using the probabilistic rational method as described in Australian Rainfall and Runoff¹.

- 1. Using the area of the site (in km²), calculate the Time of Concentration using the probabilistic rational method from equation 1.4 of AR&R Volume 1, Book 4. $t_c = 0.76A^{0.38}$ ($A(km^2 = Ha/100), t_c(hour)$)
- Select I₂ (mm/hr) from the Rainfall Intensity Chart in the Engineering Guide for Development based on the 2 year ARI and the calculated t_c in minutes.
- Determine the two year ARI runoff coefficient C₂ using equation 1.5 of AR&R Volume 1, Book 4,

 $C_2 = C_{10} \times FF_2 = 0.6 \times 0.74 = 0.444$ where C_{10} is the 10 year runoff coefficient from Fig 5.1 from AR&R Volume 2 = 60%, and

 FF_2 = the 2 year frequency factor from Table 1.1 of AR&R Volume 1, Book 4 = 0.74.

Using the rational method Q₂ = 0.278 x C₂ x I₂ x A, substitute results from 2 and 3 above.

 $Q_2 (m^3/s) = 0.278 \times 0.444 \times I_2 \times A = 0.1234 \times I_2 (mm/hr) \times A (km^2)$

5. $Q_{critical} = Q_2 \times 25\%$.

19.3 Estimating the mean annual flow for pre and post-development.

The data required for estimating SEI can be directly extracted from MUSIC by interrogating a generic node that is added to the treatment train immediately upstream of the receiving waterway or in this case the receiving node. The generic node in MUSIC provides a flow transfer function which can be simply defined to easily calculate the annual volume of flow above the critical flow. The generic node should be set up to convert all inflows at, or below the critical flow to zero outflows. Flows above the critical flow will be passed through the node at the magnitude by which flow exceeds the critical flow, as described below:

Two MUSIC models are to be prepared.

The pre-development model shall incorporate a realistic assessment of the site impervious percentage and any natural features such as ponds or farm dams. The use of the default MUSIC source nodes for Agriculture and Forest may be applicable for some pre-development modelling.

The post development MUSIC model is the same model required to meet the water quality systems targets, but with the Generic flow transfer node added. Note for some subdivisions where Generic nodes are needed to represent future on-site treatment for certain development types, an additional MUSIC model may need to be developed to reflect the use of rainwater tanks and other flow attenuating systems to ensure compliance with the Stream Erosion Index targets.

19.4 Calculating SEI.

Check the flow transfer generic nodes at the downstream end of the MUSIC models for pre and post-development conditions by:

- 1. Right clicking the generic node
- 2. Clicking on 'Statistics' then 'Mean Annual Load'
- 3. Copying the flow output value

The SEI is calculated as the ratio of the output mean annual flow from the generic node for the post-developed model over the corresponding value for the pre-development model as detailed below:

SEI = $\sum (Q_{post} - Q_{critical}) / \sum (Q_{pre} - Q_{critical})$

The SEI has to be less than 3.5 with a stretch target of 1.

EDAW AECOM

APPENDIX P - RAINGARDEN INSPECTION AND MAINTENANCE FORM

APPENDIX P - RAINGARDEN INSPECTION AND MAINTENANCE FORM

This form should be used during inspection and maintenance, as it provides a checklist of the key inspection elements and a permanent record of the maintenance activities undertaken. This form should be submitted to the asset manager following every inspection and maintenance event so that any persistent problems or

issues requiring further investigation can be identified and responded to.	
ASSET TYPE	
ΓΟCATION	
INSPECTING OFFICER'S NAME	
DATE	DATE OF LAST RAINFALL
Photos of site (explanatory notes)	
2	
m	
4	
5	
General comments, sketches, description of maintenance undertaken	

ITEM	WHAT TO CHECK FOR	INSPECTION FREQUENCY	MAINTENANCE UNDERTAKEN	FURTHER ACTION REQUIRED OR COMMENT
CIVIL COMPONENTS	NTS			
Inlet	No evidence of erosion, blockage, damage or standing water.	Six monthly and following significant storm events		
Outlet	No evidence of erosion, blockage, damage or standing water. Outlet freely draining	Six monthly and following significant storm events		
Other Structures	No evidence of erosion and damage to other structures, e.g. pits, pipes access ramps, walls and rock protection	Yearly		
Batters and bunds	No evidence of erosion	Yearly		
Hydraulic conductivity or permeability	Filter media is draining freely. No water ponded on the surface of the raingarden for more than 12 hours after rainfall.	Yearly and following significant storm events		
Sediment accumulation	Sediment forebay less than 75% full. No major sediment accumulation on surface of the raingarden.	Yearly		
Filter media surface	No surface scour depressions	Yearly		

FURTHER ACTION REQUIRED OR COMMENT						
FURTHER A COMMENT						
MAINTENANCE UNDERTAKEN						
INSPECTION FREQUENCY	Yearly	Yearly	Yearly		Six monthly	
WHAT TO CHECK FOR	No impermeable or clayey surface on the filter media. No major surface crusting (<3mm depth across less	than 10% of the filter area is permissible). Mo major algal growth (less than 10% of the raingarden	v filter nulation m.	MPONENTS	Greater than 90% vegetation cover.	Plants healthy, free from disease and vigorously prowing
ITEM	Fine sediment surface crust	Algal or moss growth	Inspection openeings	LANDSCAPE COMPONENTS	Vegetation cover - filter media	

ITEM	WHAT TO CHECK FOR	INSPECTION FREQUENCY	MAINTENANCE UNDERTAKEN	FURTHER ACTION REQUIRED OR COMMENT
Vegetation cover - batters	Continuous vegetation cover along the lower batter.	Six monthly		
	Greater that 90% vegetation cover.			
	Plants healthy, free from disease and growing vigorously.			
Weeds	Less than 10% of the filter media surface and batters	Six monthly		
- filter media	covered in weeds.			
- batters				
Litter	Filter media surface and batters free of litter (i.e. less than 1 piece per 4m2)	Six monthly		
Pests	No damage by pest animals and insects	Yearly		

APPENDIX Q - DRAINS MODEL PARAMETERS

PARAMETERS TO BE USED IN DRAINS MODELLING

- Use of values other than those listed here requires Councils prior approval.
- Where a range of values is given, use of the value selected needs to be justified
- Where there is any possibility of variation in values, multiple runs to test sensitivity will be required
- DRAINS runs are to be carried out for a range of storms depending on the ARI of the minor system

PARAMETER DESCRIPTION	VALUE
Soil type - normal	4.0
Paved (impervious) area depression storage	1 mm
Supplementary area depression storage	1 mm
Grassed (pervious) area depression storage	5 mm
Antecedent moisture conditions for all ARIs	4.0 mm
Sag Pit blockage factor (major systems)	50%
On grade pit blockage factor	30%
Inlet pit capacity	Max 100l/s for on grade pits
Minimum pit freeboard	150mm

APPENDIX R - EXAMPLE STORMWATER DESIGN PLANS

SINGLE DWELLING WITH CHARGED LINE

SINGLE DWELLING WITH BASEMENT CAR PARKING

MULTI UNIT RESIDENTIAL BUILDING WITH ABOVE GROUND ON-SITE DETENTION

