Government of South Australia
Department for Housing and Urban Development

**Draft for Consultation**

# South Australian Growth Areas Technical Manual

2025

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# 1 Executive Summary

This Technical Manual has been designed and developed to inform the implementation of the Design Standard 1 - Engineering Requirements for Land Division and the subsequent construction of infrastructure approved under this design standard. The Technical Manual delivers a set of consistent standardised, best practice technical details and specifications that relate to civil infrastructure.

The Technical Manual has been developed with regard to existing standards in use by local government authorities, relevant asset owners and best practice standards in use by industry.

A consistent approach to technical standards and construction specifications have been undertaken to ensure that growth area Councils, landowners, developers and consultants clearly understand the expectations and commitments that exist when undertaking greenfield development. The establishment of clear expectations and technical requirements will ensure in a more efficient and streamlined process for the assessment, approval and construction of civil infrastructure to support residential growth areas within the state.

## 1.1 Document Principles

In the development of Technical Manual, the following principles have been developed to inform the form and interpretation of this document:

- Establishing consistent requirements and expectations between council areas and developments
- Developing standards which are practical, fit for purpose and achievable
- Providing certainty to industry and relevant authorities in the design and construction of civil infrastructure.
- Design requirements having regard to asset lifespan, whole of life costs and associated affordability considerations
- Provision of flexibility to encourage innovation and best practice and to take into account specific site constraints, local conditions and servicing considerations.
- Principles of sustainability relating to water quality, tree canopy and construction techniques

## 1.2 Review and Continuous improvement

Technical detail, standards and processes outlined in this manual have been developed with regard to current details, approaches and best practice considerations. It is recognised that innovation will need to be considered and encouraged where necessary to address changing requirements, industry, authority and market expectations.

A continuous improvement approach will be adopted through an ongoing consultation process and modification of the standards prescribed in this manual based on experience gained through its' implementation. It is identified that the initial version of the Technical Manual will be reviewed by the Department of Housing and Urban Development following 24 months of implementation and use to ensure that the document remains robust, fit for purpose and one which is able to adapt to changing environments.

# 2 Definitions

**Alignment** – The geometric form of the centreline (or other reference line) of a carriageway in both the horizontal and vertical directions.

**Annual Exceedance Probability (AEP)** – The probability that a particular storm or flood event will be equalled or exceeded in any year. It is the complement of the return period or the average recurrence interval.

**Australian Rainfall and Runoff (AR&R)** – The abbreviation of Australian Rainfall and Runoff, a publication produced by Engineers Australia.

**Austroads** – The national association of road traffic authorities in Australia.

**Auxiliary Lane** – A portion of the carriageway adjoining the through traffic lanes, used for purposes supplementary to the through traffic movement.

**Average Recurrence Interval (ARI)** – Usually expressed in years, provides a statistical approximation of how likely an event of a given magnitude will occur. Importantly, it does not mean that once an event occurs there is then a certain numbers of years before an equivalent event occurs again. Rainfall magnitudes are based on long term statistical assessments. Due to the potential confusion created by ARI to the public, it is recommended that storm magnitudes generally be expressed as AEP.

**Barrier Kerb** – A kerb with a profile and height sufficient to prevent or discourage vehicles moving off the carriageway.

**Batter Slope** – Receding slope of a wall, structure, or earthwork.

**Carriageway** – The portion of a road or bridge devoted to the use of vehicles, inclusive of shoulders and auxiliary lanes.

**Catchment** – An area of land from which all run-off water flows to a low point.

**Catchment Management Plans** - Strategic documents outlining the management of water resources within a specific catchment area, addressing water quality, flood mitigation, and environmental sustainability.

**Centreline** – The basic line which defines the axis or alignment of the centre of a road or other works.

**Coefficient of Runoff** – Is dimensionless coefficient relating to the amount of runoff to the amount of precipitation received.

**Cross Fall** – The slope, measured at right angles to the alignment, of the surface any part of a carriageway.

**Crown** – The highest point on the cross section of a carriageway with two-way crossfall.

**Department for Infrastructure and Transport -** The South Australian government agency responsible for managing infrastructure planning, construction, and maintenance, including roads, public transport, and water systems.

**Design Principle –** Provides the objectives that are sought to be achieved through the design requirements.

**Design Requirement (DR)** – The assessment criteria that must be met to satisfy the design standard.

**Design Requirement Table** – Supplementary quantitative information to a design requirement that must be met to satisfy the design standard.

**Design Vehicle** – A hypothetical road vehicle whose mass, dimensions and operating characteristics are used to determine geometric requirements.

**Detention Systems** – Are holding storages which temporarily store stormwater to control and reduce downstream flow rates. They are designed to retard stormwater during intense rainfall and to empty once the peak of the storm has passed.

**Development** – Includes the erection of any building, the subdivision of land and the carrying out of any works.

**Drainage Easements** – Common law rights attached to land whereby another parcel of land has the right to use part of all the land for the purpose of draining water.

**Drainage Reserves** – Land vested and reserved for drainage purposes.

**DRAINS** – A form of electronic drainage model.

**Drain-Waste-Vent System -** A plumbing system designed to manage wastewater and vent gases from buildings using a network of interconnected pipes.

**Freeboard** – the height between water level and the underside of a structure or top of an embankment/channel wall. Generally, between 300mm, or 500mm in higher risk areas.

**Floodway** – A section of road or area that have been designed to be overtopped by floodwater during high annual exceedance probability flood events, as high as 5% AEP.

**Grades** – A length of carriageway sloping longitudinally.

**Gross Pollutant Traps (GPT) -** Is a structure which acts as the initial water pollution control measure typically located on the trunk drainage system. They act to intercept and retain coarse sediment, trash and debris.

**Gross-pollutant** - Debris items larger than around five millimetres. Typically includes litter (such as paper and plastics) and vegetation (such as leaves and twigs), which are transported by stormwater runoff.

**Hydraulic Grade Line (HGL) -** A graphical representation of the pressure head in a fluid system, indicating the energy level available to overcome elevation and friction losses in a pipeline.

**Intensity Frequency Duration (IFD) -** A hydrological metric used to predict the likelihood and severity of rainfall events over a specific duration and frequency.

**Longitudinal Section** – A vertical section, usually with an exaggerated vertical scale, showing the existing and design levels along a road design line, or another specified line.

**Median** – A strip of road, not normally intended for use by traffic, which separates carriageways for traffic travelling in opposite directions.

**Median Opening** – A gap in a median provided for crossing and turning traffic.

**MUSIC** – 'Model of Urban Stormwater Improvement Conceptualisation' software developed by eWater. Used to undertake primarily performance assessments of a development's treatment train, although is commonly utilised for other uses such as water balance analysis.

**Orifice** – An opening sized up to restrict the flow to desired rate, to reduce the runoff onto public property. Generally, a metal plate with a hole varying in diameter (typically 25mm – 300mm) is placed on the wall of a control pit, over the outlet pipe.

**Outfall** – A point of discharge from a sewer or drain to a water body.

**Scour Protection** – Employing various materials and methodologies to shield structures against the erosive action of water flow, mitigating damages caused by scouring, hence ensuring longevity and resilience.

**Splitter Island** – A raised island on the centre line of the main carriageway.

**Standard Drawing (SD)** – Detailed specification for construction including dimensions, materials and construction methods.

**Stormwater** – Rainfall that runs off all urban surfaces such as roofs, pavements, carparks, roads, gardens and vegetated open spaces.

**Stormwater Detention** – Refers to stormwater volumes captured during rainfall events and released without long-term storage. Examples include peak flow mitigation basins.

Stormwater Drainage Reserve – A regulated area to protect the water quality and hydrology of the drainage system.

**Stormwater Quality Improvement Device (SQID)** – A SQID is a device which is included within a development of the purpose of improving water quality by removing pollutants. Examples of SQID's include bioretention systems, constructed wetlands, gross pollutant traps, vegetated swales, litter baskets etc.

**Stormwater Retention** – Refers to stormwater volumes which are captured for long-term storage. Examples include rainwater tanks and ponds.

**Superelevation** – A slope on a curved pavement selected to enhance forces assisting a vehicle to maintaining a circular path.

**Swales** – A grassed open channel, designed to intercept and convey surface runoff to a drainage network inlet, promote infiltration, promote interception of particulate material by the vegetation, and to provide a landscape element.

**Swept Path** – The area or space that a vehicle occupies while performing a turning manoeuvre.

**Technical Manual**- The *South Australian Growth Areas Technical Manual.* Provides technical detail and context for the design and construction relating to the corresponding section of the design standard.

**Tactile Ground Surface Indicators -** Raised tactile features, such as truncated cones or bars, installed on surfaces to assist blind or vision-impaired individuals with navigation and hazard awareness.

**Trunk Drains** – The stormwater drainage system that links property, inter-allotment and street drainage with the receiving waters.

**Unplasticised Polyvinyl Chloride**: A durable, rigid material commonly used in construction for pipes and fittings due to its strength, corrosion resistance, and longevity.

- The rate of longitudinal rise (or fall) of a carriageway with respect to the horizontal, expressed as a percentage.
- To design the longitudinal profile of a road.

**Verge** – That area between the reserve boundary and the nearest road shoulder, kerb or edge of carriageway.

**Vertical Alignment** – The longitudinal profile along the centreline of a road.

**Vertical Curve** – A curve (generally parabolic) in the longitude profile of a carriageway to provide for a change of grade at a specified vertical acceleration.

# 3 Documentation

## 3.1 Plans

Plans must be prepared as outlined in the following sections. Electronic submissions of plans will be such that any reproduction from the electronic files will achieve a hardcopy that is an exact duplicate of any hardcopy submission.

For any works that impact on or interface with Department of Infrastructure and Transport (DIT) assets, contact shall be made with DIT for advice, which may include design and documentation to DIT standards and require DIT approval.

### 3.1.1 Sheet Size

Plans must be submitted at a size that complies with AS/NZS 1100 Part 3.

### 3.1.2 Scales

Plans should be submitted so that they can be read and reproduced on an A3 sheet size. The plans should be prepared at a scale which allows sufficient detail and information to be clearly shown.

Scales adopted should allow plans to be reduced in size while retaining a standard scale. For general consultation, prior to any approvals, plans may be submitted as A1 or A3 sheets.

Plans should generally be submitted on A3 or A1 sheets at maximum scale of 1:2000. When requesting approval of functional layout for developments, plans should be submitted on A3 or A1 sheets with the following maximum scales:

**Table 3-1 Sheet Scales**

| Plan | Scale |
|---|---|
| Lot Layout | 1:2000 |
| Roads Plan | 1:1000 |
| Intersection Plans | 1:500 |
| Stormwater Drainage Plans | 1:1000 |

When requesting detailed design approval or final design approval, or providing 'As Constructed' information, plans should be prepared at A1 size submitted with the following scales.

**Table 3-2 Sheet Scales**

| Plan | Scale (Horizontal) | Scale (Vertical) |
|---|---|---|
| Layout Plans | 1:500 | |
| Longitudinal Sections | 1:250 | 1:50 |
| Cross Sections | 1:100 | 1:50 or 1:100 |
| Intersection Plans | 1:200 or 1:100 | |
| Details | 1:10 or 1:25 | |

### 3.1.3 Standard Details

It is desirable that all construction details comply with the standard detail drawings modified to suit the specific site requirements. Where special structures or modifications to standard drawings are required, details of such works are to be submitted with the detailed construction plans for detailed design approval.

Standard detail drawings are provided in the dwg format and should be included on the drawing set.

### 3.1.4 Standard Drawings

The Design Engineer shall adopt details as shown on the standard drawings.

Standard drawings shall not replace responsibly engineered and detailed designs. If the standard drawings are deemed unsuitable for the specific application, all deviations must be fully documented. Cross-referencing standard drawings with variations annotated in notes is acceptable only when the variations are minor, and the directions are unambiguous.

It is the responsibility of the Design Engineer to ensure that the standard drawing used is correct for the application.

# 4 Stormwater Design

## 4.1 Introduction

This section sets out the standard design criteria for stormwater drainage design. It is not intended to prohibit any alternative arrangements or approaches. If development approval is issued for an alternate design, then that advice supersedes the information below.

Innovative or non-standard designs may be considered, but not necessarily accepted. Sufficient data and principles of design for any innovative or nonstandard design shall be submitted for consideration.

Aspects not specifically referred to in this Manual should be generally in accordance with the following documents:

- The Australian Rainfall and Runoff: A guide to flood estimation (ARR) 2019.
- Australian Runoff Quality: A guide to Water Sensitive Urban Design 2006.
- Austroads “Road Design Guidelines – Part 5 General and Hydrology Considerations”.
- Austroads “Road Design Guidelines – Part 5A Drainage – Road Surfaces, Networks, Basins and Subsurface”
- Water Sensitive Urban Design in Greater Adelaide Technical Manual.
- Queensland Urban Drainage Manual (QUDM) 2013
- Storm drainage design in small urban catchments: a handbook for Australian practice / by John R. Argue
- AS/NZS 3500.3 2003 – Plumbing and Drainage.
- Standard Drawings

## 4.2 Design Principles

Drainage design and its objectives are:

- To collect, control and manage all stormwater generated from the development or project.
- To collect stormwater from a catchment and convey it to its receiving waters with minimal nuisance, danger, flooding or damage to the environment.
- To prevent flooding of public and private property both within the catchment, upstream and downstream through adequate design of the development.

- To provide an effective outlet for all collected stormwater to a natural watercourse or approved outfall with outlet erosion control.
- To review and ensure that design levels, maximum water depth, grades and safety requirements are reviewed during the design,
- To facilitate optimal water quality, as well as opportunities for stormwater harvesting and reuse; and
- To achieve these objectives without detrimentally affecting the environment generally, surface and subsurface water quality, the adjoining landowners in the vicinity of the stormwater drainage outlet and watercourses either upstream or downstream of the development.
- To provide for free and unrestricted access and safety of staff and contractors required to construct and maintain all components of the network;
- To contribute wherever possible to the enjoyment of open space.
- To integrate stormwater drainage quantity and quality management as part of a total streetscape/ open space approach to maximise opportunities for multiple objectives (including safety, amenity, passive and/or active recreation, biodiversity, water quality and flood protection) to be achieved;
- Preserve natural drainage systems, including the associated environmental flows.

## 4.3 General

Stormwater drainage design and the design and management of stormwater runoff must be in accordance with any current stormwater management strategies or catchment management plans (CMP) in place.

Where the stormwater drainage system has not been previously defined in the Planning and Design Code, Developers will be required to provide a Stormwater Management Plan (SMP). This SMP must address all runoff generated within the project area or transmitted from upstream catchments through the project area.

The SMP submission must reference the relevant Approval Documents and include catchment and sub-catchment plans, conceptual stormwater drainage systems including treatment, detention, retention, mitigation and proposed location and method of stormwater discharge from the system.

The plan should also consider water quality, erosion management and flood management. The impact on the overarching Development Approval must be clearly stated.

The need for the Stormwater Management Plan may be triggered by any of the following:

- Significant increase in runoff because of proposed development.
- If in the opinion of the Relevant Authority, the additional stormwater may exceed the capacity of the downstream network.
- Where a stage (or stages) of a development includes the construction of any of the following:
    - A new detention basin.
    - A new treatment facility.
    - A new stormwater drainage outfall.

Where a Stormwater Management Plan has been prepared prior to the issue of Planning and Design Code consent, the submitted design documentation will not receive endorsement until the design documentation is approved in principle as being consistent with the approved SMP and Development Approval by the Relevant Authority.

Stormwater drainage design submitted for a stage (or stages) of a Development Approval must take the entire stormwater drainage catchment into account, not just the area included.

## 4.4 Major and Minor Stormwater Drainage Systems

The Design Engineer must adopt the ‘major / minor’ approach to stormwater drainage systems as outlined in “Australian Rainfall and Runoff”. The ‘Minor’ system refers to the underground system, designed to an AEP as determined in Section 2.6. The ‘Major’ system refers to overland flow paths that are to be designed to convey the major storm flows when the capacity of the minor system is exceeded.

The stormwater drainage system should be designed in accordance with the current requirements of Engineers Australia publications, Australian Rainfall and Runoff, Australian Runoff Quality, a guide to Water Sensitive Urban Design, the WSUD chapter of this document (Chapter 10) and all stormwater conveyance should be in accordance with the National Plumbing and Drainage Code and AS 3500.3.

The minor system refers to a pipeline network with sufficient capacity to intercept and collect the flows from nominated design storm events. These pipelines manage risks by minimising stormwater damage to properties and limiting the frequency and quantity of surface water to a level, that is acceptable to the community.

A major stormwater drainage system caters for the runoff from storms of higher intensity than for which the minor stormwater drainage system has been designed. The major stormwater drainage system is designed to mitigate and convey flooding resulting from the major storms, with consideration given to larger storm events when the project will incorporate sensitive development. It may be at times required for the major stormwater drainage system to hold water in rare occurrences.

These flows must follow a designated overland flow path, which must be:

- A road if the catchment area is small; and / or
- A stormwater drainage reserve if it is impractical or not suitable for a road to carry the excess flows.

### 4.4.1 Finished Floor Levels

Finished Floor Levels are to be as follows:

- A minimum of 300mm above 1% AEP for residential properties that grade towards the road unless otherwise advised by the local Authority or in response to a known local risk
- Properties that grade away from the road should have the Finished Floor Level built up wherever possible, however if not practical, the level of the driveway and front boundary is to be raised at least 200mm above 1% AEP to provide freeboard.
- Finished Floor Levels for developments of a sensitive nature (i.e., Emergency services, schools, adjacent water courses etc.) are not covered by these Standards and are to be assessed by the Relevant Authority on a merit-based assessment, but not of lesser requirements than that discussed in dot point 1.

## 4.5 Hydrology

The stormwater drainage design must include a stormwater drainage catchment plan showing the total catchment area and sub-areas that are the basis of the design, together with an electronic drainage model (such as DRAINS or approved equivalent) This is to be approved as part of a Development Approval or which is consistent with an adopted regional stormwater strategy.

The catchment plan should incorporate clear, defined contours. Partial areas must be considered when determining peak flow sites; particularly in instances where the catchment contains sub areas, such as reserves, that may have an increased concentration in conjunction with a small coefficient of runoff.

The largest flow must be used for the design of the stormwater system downstream of the connection point. The Design Engineer must determine the most appropriate methodology when assessing the major stormwater drainage. Regardless of the method used, detailed documentation and electronic files must be submitted as Design Documentation for approval.

## 4.6 Rainfall Data

Intensity Frequency Duration (IFD) charts are available from the Bureau of Meteorology website. Charts for any Australian location can be created on this website using latitude and longitude of the location and describe how the very frequent and rare design rainfalls are estimated. Rainfall data for a relevant design is to be assessed against this data.

## 4.7 Annual Exceedance Probability (AEP)

Design rainfalls are probabilistic or statistically based estimate of the likelihood of a specific rainfall depth being recorded at a particular location within a defined duration.

With reference to the design of a stormwater drainage systems and AEP calculations, it should be noted that the design of a system should be based around the local climate and topography, using suitable references to determine this, such as the Bureau of Meteorology IFD charts and/or the Department of Environment and Water Topographic and Cadastral Maps.

The design of the stormwater drainage system must be based on the Annual Exceedance Probability (AEP), albeit localised. AEP calculations for higher graded terrain and lower graded terrain are listed in Table 4-1**Error! Reference source not found.**. The Hydraulic Grade Line (HGL) determined by the topography of the local area and calculations surrounding the hydraulic modelling of the drainage system will determine the applicable AEP and associated requirements.

The capacity of the road carriageway, inclusive of the underground system, shall comply with the major events as detailed below.

**Table 4-1 Average Exceedance Probability**

| Stormwater Drainage System (Topographically Steep) | Capacity (Minor Event) | Capacity (Major Event) |
|---|---|---|
| Residential Areas | 0.11 EY | 1% AEP |
| Areas prone to local flooding | As approved as part of Development Approval, otherwise<br>1% AEP | As approved as part of Development Approval, otherwise<br>1% AEP |

## 4.8 Coefficients of Runoff

A range of typical coefficients of runoff to be used in the design of stormwater drainage systems are shown below, adapted from Austroads Guide to Road Design Part 5. The run-off coefficient relates the volume of water that is discharged from a catchment to the rain falling over the catchment. The value is not constant but varies with rainfall intensity and the proportion of impervious areas.

**Table 4-3 Coefficients of Runoff**

| Catchment Type | Coefficient of runoff |
|---|---|
| Predevelopment Conditions | 0.25 |
| Residential Areas (Allotments 1000m$^2$ – 2,000m$^2$) | 0.50 |
| Residential Areas (Allotments 600m$^2$ - 1000m$^2$) | 0.60 |
| Residential Areas (Allotments 450m$^2$ - 600m$^2$) | 0.75 |
| Residential Areas (Allotments 300m$^2$ - 450m$^2$) | 0.80 |
| Residential Areas (Allotments < 300m$^2$) | 0.90 |
| Residential Areas Medium Density | 0.90 |
| Commercial Land Uses | 0.90 |
| Paved Areas | 0.90 |
| Pools, Stormwater Basins, Lakes & Wetlands | 1.00 |

## 4.9 Hydraulic Design

Designs must be based on hydraulic grade line (HGL) analysis using appropriate pipe friction and stormwater drainage head loss coefficients.

- The HGL must be at least 150mm below the invert of the kerb for minor flows.
- The HGL must be contained within the road carriageway for major flows.
- The HGL due to partial full flows is to be ignored and is assumed to match the obvert of the pipe.
- However, part full velocities must be checked.

Pipe designs are to be based on hydraulic grade line analysis, using the appropriate pipe parameters for Colebrook – White formula or Manning's formula as shown below

**Table 4 - 4 Pipe Roughness Values**

| Pipe Material | N | K |
|---|---|---|
| Spun Precast Concrete | 0.013 | 0.600 |
| UPVC | 0.009 | 0.060 |

Where surcharge due to blockage of the primary (minor) stormwater drainage system could flood existing or future buildings on an allotment, a secondary (major) protective stormwater flow path shall be provided (in addition to any rear of allotment stormwater drainage system), such as a double side entry pit.

### 4.9.1 Pipe Velocities

The design pipe velocities are as follows:

**Table 4-5 Pipe Velocities**

| Parameter | Velocity |
|---|---|
| **Pipes Running Partially Full** | |
| Absolute Minimum | 0.7m/s |
| Desirable Minimum | 1.2m/s |
| Desirable Maximum | 4.7m/s |
| Absolute Maximum | 7.0m/s |
| **Pipes Running Full** | |
| Absolute Minimum | 0.6m/s |
| Desirable Minimum | 1.0m/s |
| Desirable Maximum | 4.0m/s |
| Absolute Maximum | 6.0m/s |
| Minimum flow velocities apply to 1EY storm events and apply to all pipe materials. | |
| Maximum flow velocities apply to concrete pipes. For other pipe materials, refer to the manufacturer's advice. | |

### 4.9.2 Minimum Pipe Grades

For design of piped stormwater systems, the absolute minimum grade of a DN375mm stormwater pipe is to be 0.40% to ensure that water velocities are sufficient for self-cleansing. For larger pipes, this grade may be reduced where the model is able to demonstrate that self-cleaning velocities are able to be achieved. In such instances, pipe grades are to not be below 0.3%. Refer to Queensland Urban Drainage Manual for further information.

### 4.9.3 Minimum Pipe Cover

The minimum cover will be the greater of:

Manufacturers Recommendation.

Australian Standards.

Standard Drawings.

Additional cover should be provided wherever crossings with large sized services are anticipated.

The minimum vertical and horizontal clearances between a stormwater pipe and any other pipe or service conduit shall be as required by the service provider. Refer to Chapter 99 for Services Infrastructure requirements as well as the Standard Drawing for further service conduit clearance requirements.

### 4.9.4 Pipe Class

Pipe classes must be determined having regard to the proposed cover and loading to be encountered during construction. All pipes shall be a minimum Class 2, unless designing for pipes within a road reserve, where Class 3 pipes are the acceptable minimum requirement and pipes crossing a road being a minimum Class 4. Any exceptions to the minimum cover requirements are to be discussed with the Relevant Authority and are to be assessed on merit considering constraints of site.

### 4.9.5 Splays

A pit is to be constructed wherever there is a substantial change in horizontal or vertical alignment of stormwater pipes, where a bandage joint is not acceptable in alignment with the manufacturer's recommendations Splays are permitted in circumstances where it is critical to reduce hydraulic losses on flat gradients.

For further information refer to Standard Drawings.

### 4.9.6 Pipe Alignments at Pits

The pipes at junctions should be aligned such that the projected area of the upstream pipe is wholly contained within the downstream pipe unless such design is unable to be practically achieved.

Side entry pits should be spaced so that the pits are able to convey the design flows adequately and generally should not be spaced greater than 100 metres away from each other in roadways for maintenance purposes.

### 4.9.7 Pit Losses

Pit losses are to be allowed for and must be calculated in accordance with Austroads "Road Design Guidelines – Part 5 General and Hydrology Considerations" or DRAINS.

### 4.9.8 Pit Locations

Side entry pits are to be spaced so that the length of flow in water tables does not exceed 80 metres, or the "depth x velocity" does not exceed safe levels ( 0.4m2/s), or flow width is less than 2.5 metres in a minor storm.

Side entry pits should be sufficiently set back from intersections and road corners to minimise damage by vehicle traffic (including construction traffic) or where this is not possible, shall be of heavy-duty construction in accordance with standard details for side entry pits.

Junction boxes shall be provided at all junctions and to provide access to the pipe at distances not exceeding 120 metres when there are no accessible side entry pits. Junction boxes shall be located outside of road carriageways to allow safe access.

Channel flow approaching an intersection is to be collected before the tangent point, except where it can be demonstrated that adequate capacity is available in the kerb and channel to carry water around the return.

Side entry pits are to be clear of kerb returns and kerb crossings. Double side entry pits must be used where approach grades to intersections are in excess of 6% and at all low points in roads, unless the Design Engineer demonstrates that a single side entry pit provides sufficient inlet capacity for the pipes to operate at their required capacity. Side Entry Pits must be located at least one metre from the tangent point.

Deflectors are to be used where the grade of the water table exceeds 5%.

In all cases, design consideration must be given to pit location and pit inlet capacities and in accordance with the standard drawings.

Pits should be installed upstream of kerb crossings and pedestrian crossings.

### 4.9.9 Trunk Drains

Pipes with a diameter of 750mm or more are to be designed as trunk drains, and as such, large direction changes through standard pits are to be avoided. Use of special manholes, additional pits and streamlining / benching at all changes of direction is to be considered

Design criteria for the outfalls of trunk drains must be consistent with a relevant Development Approval or an adopted regional drainage strategy if such approval does not exist.

## 4.10 Pipes

### 4.10.1 Pipe Materials

**Reinforced Concrete Pipes & Culverts**

Reinforced concrete pipes are to have a spigot-and-socket profile, secured by a rubber ring joint and be manufactured to meet the requirements of AS 4058, AS 1597, AS 2041 and AS 5100. Pipes with a diameter of 750mm or less are to have rubber ring joints.

Larger pipes and culverts are to be flush jointed, with the installation of rubber ring joints, with additional external bands installed in accordance with the manufacturer's recommendations

**UPVC Pipes**

UPVC pipes shall be used and installed in accordance with AS/NZS 3500.3:2003 – Plumbing and Drainage.

Pipe Class shall be as required and recommended by the manufacturer for the pipes intended application. Predominantly, these pipes will be used as property connections in alignment with Standard Drawings.

**Other Pipe Profiles and/or Materials**

Prior approval in writing from the relevant asset owner is required for all other methods and materials of pipe profiles, such as FRP, HDPE or equivalent.

### 4.10.2 Pipe Diameters

The minimum pipe diameter is generally 90mm UPVC for outlets servicing a single property or 225mm for 2 or more properties. The minimum pipe size for rear of allotment drains should be designed, with a minimum diameter of 225mm. Additional outlets may be required where discharge from the property dictates.

Pipes that are to be under the ownership of a Relevant Authority are not required to convey runoff from a road or street, must have a minimum diameter of 150mm.

Pipes that are to be under the ownership of a Relevant Authority and convey runoff from a road or street must have a minimum diameter of 375mm to reduce the risk of blockage.

### 4.10.3 Standards for Design & Installation of Pipes

**General**

All pipes must be designed and installed according to the relevant Australian Standards for that type of pipe. When selecting the type and class of pipe to be used, due regard must be given to the external loading (including during construction), the pipe characteristics and the construction technique to be used.

The pipe embedment materials and procedures must comply with any specific recommendations published by the pipe manufacturer, and all relevant controls must be applied to plant and compaction techniques when required for a particular type and class of pipe. Refer to the Standard Drawings for further information.

**Reinforced Concrete Pipes**

Reinforced concrete pipes must be designed and installed in accordance with AS 3725, which outline specifics on the allowable width of crack, and with the guidelines published by the Concrete Pipe Association of Australia.

**CCTV**

CCTV of the installed drainage system is to be carried out in accordance with WSA 05-2020 Conduit Inspection Reporting Code of Australia Version 4.1, with respect to stormwater.

## 4.11 Structures

### 4.11.1 Stormwater Drainage Structures

Stormwater drainage structures must comply with the standard drawings of this document for such structures, or as otherwise published by the relevant asset owner. Where modification to details or a special structure is required, details must be submitted with the detailed design documentation. Acute intersection angles between stormwater drainage lines at pits will not be permitted.

### 4.11.2 Side Entry and Grated Pits

Pit functions and capacities must be in accordance with Austroads “Road Design Guidelines – Part 5A Drainage – Road Surfaces, Networks, Basins and Subsurface” and any DIT Supplement to those guidelines. Pit construction must be in accordance with the standard drawings of this document, or as otherwise published by the relevant asset owner.

Prefabricated pits (steel or FRP) are to be used unless otherwise approved. A certificate shall be provided by a Qualified Engineer to confirm the structural integrity of any pits approved to be cast in situ or prefabricated.

All pits shall be designed for the road class and include some redundancy to allow for minor site modifications typical to construction

### 4.11.3 Pit Covers

Pit covers are to be in accordance with the standard details' drawings, as provided in this document or as otherwise published by the asset owner, and a minimum of Class D within road reserves. Trafficable load bearing covers are to be provided on all pits located in exposed kerb areas, and on all pits.

Class B Terra Firma lock down covers (or equivalent standard) for SEP's are acceptable for non-trafficable areas (not within the road corridor).

## 4.12 Gross Pollutant Traps

Approved gross pollutant traps must be provided towards the end of any stormwater drainage line that discharges to a watercourse and/or a stormwater drainage basin based on an overall assessment of the drainage catchment both upstream and downstream off the site, for the development.

GPTs shall be located where there is an overland flow path downstream though a public road or open space to account for surcharge flows, which may result from blockages or other causes. GPTs are recognised to be used for primary treatment only.

The total Suspended Solids (TSS) removal rate shall be in accordance with EPA minimum standards

Gross pollutant traps shall be designed to treat the peak 4EY (Exceedance Year) storm event, whilst flows up to the peak 1 EY storm event will bypass the system.

The selection of a GPT for a particular application shall be detailed for assessment in the submitted Design Documentation.

The GPT must be located such that safe and convenient access by maintenance vehicles is achieved with an all-weather access track and hardstand that allows the maintenance vehicle to be clear of the road carriageway to enable cleaning by a Vacuum / Combo Truck.

## 4.13 Outfall Structures

Outfall structures or discharge points must be designed and constructed to meet the following requirements:

- Scour protection components are to be designed for the design discharge volume and velocity of the outlet structure in accordance with Austroads guidelines.
- Consideration shall be made for safe access/maintenance.
- Slopes behind wing walls shall be considered and provided with adequate measures to protect from erosion.
- Be designed to avoid the creation of 'dead space' which has low passive surveillance or which is difficult to access.

## 4.14 Subsoil Drainage

Consideration should be given to appropriate sub-surface stormwater drainage installation where ground water or overland flows may adversely affect the performance of areas set aside as Public Open Space or Reserves.

## 4.15 Property Drains

A stormwater connection point shall be provided for each allotment.

Where residential properties grade towards the street, a galvanised steel kerb adaptor shall be provided and cast into the kerb on the lower side of the allotment.

Where an allotment grades to the rear and there is no rear of allotment stormwater drainage provided and not filled to grade towards the road; a stormwater drainage easement will need to be obtained for the outfall pipe through neighbouring property for connection to the street water table, at the Developer's expense. Such drains must comply with the standard drawings.

Such drains shall be designed to accommodate stormwater from the entirety of the respective developed allotments in the occurrence of a 1 EY (Exceedance Year) storm event.

The minimum diameter of the pipe shall be 90mm and each allotment shall be provided with a grated inlet pit / junction box, comprising of a 600 x 600mm slab and 100 x 100mm grate. located at the lowest corner of each respective allotment.

Rear allotment stormwater drainage shall also be provided where allotments back onto reserves. Easements are to be in favour of the relevant asset owner for all rear of allotment drains other than one single allotment, with access available for the authority to be unobstructed.

## 4.16 Major Storm Drainage Requirements

The major storm drainage system must collect major storm runoff from a catchment, in excess of the capacity of the minor stormwater drainage system and convey this runoff to the receiving waters with minimal nuisance, danger or damage.

The major stormwater drainage system must be so designed and constructed as to ensure a reasonable level of safety and access for pedestrian and vehicular traffic, limits flooding of private and public property and minimises the inflow of pollutants to receiving waters.

Minimum requirements of the major stormwater drainage system are as follows:

- Design of major storm drainage systems must be based on the critical major storm, with some consideration given to the impact of a rarer storm event (0.005EY). The critical storm must be determined by routing storms of varying duration until major peak flows are identified.
- Hydraulic Grade Line analysis must be used for design of floodways, low flow pipes and detention / retention basins. The width of major floodways must be governed by the greater of the hydraulic requirements or the width for suitable maintenance (including mowing of grassed swales and drains).
- The depth of overland flows in urban areas must be controlled by freeboard to properties or upper limits of surface flow depth / velocity criteria for public safety as detailed in Austroads “Road Design Guidelines – Part 5A Drainage – Road Surfaces, Networks, Basins and Subsurface” and any DIT supplement to those guidelines. As a guide, flows conveyed through the road network during the critical major storm must be designed to not exceed kerb heights.

## 4.17 Floodway Design and flowpaths

A major floodway generally comprises engineered open waterways, and often makes use of roadways, swales and sometimes sheet flow through open spaces.

Major floodways are generally located within road reserves, stormwater drainage reserves or public open spaces. Major floodways through easements on private land and major flows should not be contained entirely within reserves and road reserves. Major floodways are to be reflected in the Development Approval documents for the associated land division.

When overland floodways or storage is to be altered or changed as part of a Development, compensatory works must be assessed and implemented.

Where active floodways are present, hydraulic modelling and analysis will be required. The Designer may also be requested to submit a risk assessment report including details of the proposed works to ensure that the potential for loss of life, risk to health and damage to property is minimised and how the flood conveyance or storage will be accommodated.

The Designer must ensure that the hydraulic modelling, analysis and resulting work does not detrimentally affect any adjacent landholders because of the proposal.

For Developments, the analysis must also identify the extent, velocities and depth of overland flows on the Development. The alteration or change to any existing wetland must only be considered after all other alternatives have been considered.

The minimum requirements that apply to the design and treatment of floodways and open unlined drains and swales are as follows:

- Depth of floodways should be kept to a minimum (generally less than 1.2m).
- Desirable maximum batter slope is 1:8; absolute maximum batter slope is 1:5.
- Desirable minimum cross fall for inverts is 1:40. The minimum bed width is to be 2.5 metres.
- Permissible scour velocities and minimum permissible velocities for public safety must govern maximum longitudinal grades for major floodways.
- Desirable maximum longitudinal grade for major floodways is 1:500 to minimise the likelihood of ponding and siltation. Absolute minimum grade is 1:1000.
- Flexible structures, utilising rock gabions, rock mattresses and geotextile fabric are preferred for grade control structures, minor energy dissipaters and major erosion / scour protection measures.
- Floodway Design utilising a low flow pipe must be sized for the entire major AEP design flow based on the assumption that the low flow pipeline is fully blocked during major storms. Low Flow pipes must be designed in accordance with the following:
- Desirable minimum cover for low flow pipes is to be in accordance with manufacturer’s requirements. Appropriate pipe classes should be adopted accordingly for the design circumstance and with due consideration to plant used for drain maintenance.
    - Low flow pipes providing outlet stormwater drainage for detention basins must be designed with invert levels of adequate depth to command the pipes located within the basin.
    - The design flow for low flow pipes must be for a 3EY storm event flow as an absolute minimum.
    - Minimum grade of low flow pipes must be sufficient to generate self-cleansing velocities.
- Minimum diameter of low flow pipes is 375mm

    - Low flow pipelines, including pits and other structures should be aligned to minimise hydraulic losses. In some cases, however, pits / structures may be specifically designed to dissipate energy.
- Major floodways that cannot be provided with a low flow pipe due to inadequate longitudinal grades or level constraints must be designed with a lined low flow invert or trickle flow channel where feasible.
- Pipes discharging into major floodways must be connected to the low flow pipe with surcharge pits provided as necessary.

## 4.18 Stormwater Drainage Reserves

Where stormwater drainage reserves are incorporated into Developments, the Reserve widths must accommodate a drain with sufficient capacity to cater for a major storm event. Consideration should be made for safe access/maintenance. Stormwater drainage reserves are to be considered as part of the associated land division application and must be reflected in the Development Approval prior to submission of Design Documentation.

Any pump stations, electrical equipment, water-quality treatment infrastructure or any other service must be sited with sufficient clearance for construction and maintenance vehicle turning at an appropriate location. Pump station locations are to be part of a Development Approval prior to submission of Design Documentation and should be placed in unobtrusive areas

## 4.19 Stormwater Drainage Easements

Stormwater easements shall only be utilised where discharge to the road reserve or existing drainage reserve is not feasible. Approval of new easements is at the discretion of the Relevant Authority and should be detailed in the associated Development Approval.

Where stormwater drainage easements are required to facilitate future access to the stormwater drainage network, the Relevant Authority and Developer will take the necessary measures to ensure that the stormwater drainage will be vested under the ownership of the Relevant Authority and appropriate width of easement is considered. Easements shall be provided over all drains in any allotments not being a road reserve. Unless otherwise required by the asset owner such easements shall be three (2) metres wide when the easement contains only a single drain or pipe less than 900mm and at least four (4) metres wide when the easement contains more than one drain or pipe, where they shall be separated by a minimum of 1 metre.

Easements shall be matched and aligned with those existing on adjacent properties to provide continuity for utility services and ensure the proposed use for which the easement is created can be achieved.

Where an easement is required to be provided to account for upstream stormwater flows as part of a regional drainage strategy, stormwater deed, infrastructure scheme or existing flow path, the development shall look to provide for the vesting of such easement at an early stage of the development.to avoid unnecessary prejudice of upstream sites, or construction of sacrificial or interim infrastructure.

Stormwater pipes and easements to be constructed over only one property are to be in favour of the source property. Consent from the asset owner is required to construct a permanent building or structure over an easement vested for drainage purposes.

## 4.20 Retention/Detention Basins

### 4.20.1 Objectives

- To ensure that the capacity of existing stormwater infrastructure is not detrimentally impacted because of the Development
- To consider the likely cumulative impact of similar projects or Developments on the existing stormwater system
- To reduce runoff and peak flows from catchments into receiving waters.
- To limit, as much as possible, the number of retention / detention basins servicing an area to reduce the Relevant Authority's future maintenance expenditure.
- To ensure that standalone detention basins drain completely within a reasonable time with consideration of the catchment's response and risk factors following each rainfall event and, wherever practicable, are constructed so that the area can be used for passive or active recreation.
- To minimise costs of stormwater drainage infrastructure by reducing peak flows.
- To ensure that on-site detention systems can be effectively maintained by landowners and provide a cost-effective method of meeting the other objectives of this section.
- To incorporate stormwater treatment, sedimentation traps and litter traps into the retention / detention basin design where practical and required in the applicable Development Approval.
- To ensure that retention / detention basins are so designed and constructed as to:
    - Be visually appropriate and suitable
    - Consider the area where they will be located.

- Form part of the open space.
- Avoid any adverse impact on amenity in the surrounding areas such as odour and mosquitos.

### 4.20.2 General

Detailed design and documentation of stormwater basins and/or similar detention facilities are to be prepared by the Design Engineer and submitted as part of the Design Documentation.

It must be demonstrated that any required stormwater retention or detention systems can be integrated into the existing stormwater drainage system. Any design must be consistent with the requirements of the Development Approval for the land division, any regional stormwater considerations and other authorities such as NRM Boards, with discharge limits not exceeding pre-development flows.

Land that has been identified for stormwater retention or detention purposes that is to be vested, whether existing or proposed, must be shown on the Plan of Division as Drainage Reserve for stormwater drainage purposes and be vested to the Relevant Authority.

When a retention / detention basin is required for any Development, the basin and any overland flow paths should be constructed as part of the first stage of works.

Where the Design Engineer considers that the retention / detention basin is not required to service the first stage of the works, they must submit plans, calculations and approvals from relevant authorities, demonstrating that satisfactory alternate provisions can be made for storage and outfall.

## 4.21 Retention/Detention Basin Design Requirements

### 4.21.1 Location and Siting

Retention / Detention basins should not be sited in areas identified as being affected by 1% AEP overland flooding.

Retention / Detention basins may need to be protected from unrelated overland flows entering the basin and therefore, apart from the above limitations, must not be in areas designated as active floodways. Works must be carried out to minimise erosion and maintenance resulting from overland flows entering and leaving the basin. Retention/Detention basin locations are to be approved as part of a Development Approval for the applicable land division.

Siting of retention / detention basins must have regard to:

- The physical dimensions required for storage volume including the flattest possible batter slopes, access to the basin bed and maintenance of batters and edges.
- Catchment layout
- Existing stormwater drainage including pipes, open drains and flow paths.
- Existing and proposed stormwater drainage easements.
- Ground water depth and seasonal fluctuations.
- Subsoil characteristics.
- Location and point of discharge.
- Soil type and seepage rate.
- Land uses and zoning.
- Effect of overland flows external to the catchment.
- Consider safety in design considerations and safety to all users and community, fauna and flora.
- Amenity of the area:
    - Benefiting landholder issues.
    - Provision of a suitable discharge method by:
        - Selection of a suitable pump station and associated electrical equipment location capable of being close to public view.
        - Gravity.
- A combination of gravity and pumped outfall, where applicable
- Availability of mains electricity for pumping and/or future telemetry.
- Safe all-weather access for maintenance vehicles such as, but not limited to Backhoe's, 3T excavators, Trucks and Utilities
- Water quality.
- The location of overland flows into the basin and the treatments to minimise erosion.
- Inlet / outlet velocities and the need to install energy dissipation structures.
- 1% AEP flood level.

Furthermore, where basins discharge to watercourse, a multilevel outlet control structure is required to limit 1% AEP (Major), 10% AEP (Minor) and 1EY (frequent) peak post development flow to predevelopment

### 4.21.2 Design Criteria

Retention / Detention basins must be designed for the critical major storm.

Basins with downstream established areas and no clear and safe overland flow paths must be designed for the critical major storm with consideration given to a rarer storm event (0.005EY).

The minimum freeboard must be 300mm , noting that allowance for wind action will be required for retention basins and permanent water bodies.

Furthermore:

- The top water level in the retention / detention basin resulting from the minor stormwater drainage storm event must be no higher than the invert of the lowest inlet pipe to the basin.
- The overland flow path for a major storm must be designed such that the minor system contribution to flow is included, i.e. inlet pipe is blocked.
- Long term storage in upstream pipes and pits is discouraged. For storage calculations, DRAINS software should be used to consider the storage within pipes.

Where on-site detention is required prior to discharge into an existing stormwater drainage network, the Design Engineer must provide calculations to the satisfaction of the Relevant Authority which show how the permissible rate of discharge and volume of on-site detention have been determined.

A self-cleansing velocity of 0.7m/s must be maintained.

The Design Engineer must also demonstrate that the existing stormwater drainage system will not be adversely impacted by the project.

### 4.21.3 Inlet Structures

Any inlet to a basin must have an approved inlet stormwater drainage structures including a headwall and approved post and rail barrier or equivalent to prevent falls and to identify the location of headwalls and wing walls.

All inlet headwalls shall be fitted with appropriate energy dissipation structures.

### 4.21.4 Overflow Systems

A suitable overflow system (i.e., weir, spillway) must be provided to cater for major storm events than what the system has been designed for and to provide for a blockage in the system.

All overflows are to be directed away from buildings, adjoining properties, and associated infrastructure. The overflow system must be designed to cater for a major storm event.

The maximum depth of overland flow must be designed so that it is no higher than 300mm below the lowest floor level of any dwelling impacted by the overflow.

### 4.21.5 Depth of Basins

Where it is recognised that there is a localised elevated ground water table, it will be necessary that all excavations are limited to 0.5 metres above the water table.

Retention / Detention basins may require an impervious lining or other treatment to the approval of the Relevant Authority to prevent the ingress of groundwater.

The maximum depth of all basins in public areas will be determined regarding public safety and the detention volumes required for the development. Basin detention volumes, inverts and levels are to be approved at a conceptual design level as part of a Development Approval.

### 4.21.6 Batter Slopes in Earthen Basins

Where public access is to be provided the maximum batter slope for retention / detention basins is 1:5 for both cut and fill situations.

The use of any slope greater than the maximum slope of 1:5 requires specific permission to be sought from the Relevant Authority after provision of methodology regarding access, maintenance, and stability. Additional treatment such as vegetation or grasses could be an option to provide a steeper maximum slope. For safety provisions and consideration, the desirable minimum cross fall for the floor is 1:400 graded to the outlet point.

### 4.21.7 Access Requirements

All weather access is to be provided to the retention / detention basin and any associated structures and pumps to enable maintenance to be carried out. The access must be designed so that the maintenance vehicle is clear of the road carriageway.

To ensure that maintenance of any portion of the basin and its associated infrastructure can be safety carried out, a consideration of an access track around the perimeter and down batter to the basin invert should be designed and have approved as part of a Development Approval.

### 4.21.8 Risk Analysis

A risk assessment report is to be prepared by the Design Engineer for all design aspects of the land division. The risk assessment should be undertaken in accordance with the principles of AS ISO 31000:2018 Risk Management.

The Design Engineer is responsible for deciding on the action required in response to the risk assessment report and its recommendations, however consultation with the Relevant Authority is encouraged if recommendations are complicated, require community involvement or have significant ongoing maintenance issues.

A copy of the risk assessment report, with recommendations and associated works must be provided as part of Design Documentation.

### 4.21.9 Fencing and Security

Unless otherwise approved in a Development Approval, all basins in restrictive areas, which are not accessible to the public, must be fenced and secured against casual access.

Suitable access via lockable gates must be provided for maintenance purposes.

Inlet and outlet structures shall be secured with a removable and lockable grate or equivalent to prevent access.

### 4.21.10 Landscaping

Landscaping design is to align with the WSUD requirements set out in chapter 10. A detailed landscape plan for all basins and drainage reserves must be provided to the Relevant Authority for approval.

### 4.21.11 Maintenance

Pits, pipes and screens that require regular cleaning and maintenance are to be readily accessible with all openings to be of suitable geometry to allow for cleaning and removal of debris and silt accumulations.

## 4.22 Stormwater Discharge Points

### 4.22.1 Objectives

Stormwater discharge points will be determined having regard to the following objectives:

- To avoid the capacity of existing stormwater infrastructure being exceeded beyond the levels for which the infrastructure was originally designed because of development.
- For the overflow system to be provided with erosion protection and energy dissipators to create laminar flow conditions where practical.
- To limit the percentage increase of the stormwater flow being generated when compared to the whole catchment.
- To provide on-site detention to protect the existing stormwater drainage system capacity for the uses and areas for which it was originally designed.
- To consider that any new drain required to be constructed has been assessed from the perspective of serving the future catchment
- To ensure that stormwater is effectively treated and that either the resultant discharge or the treatment processes themselves have an adverse impact on the environment and surrounding properties.

The impacts of new Developments on the existing stormwater drainage network must be assessed prior to discharge into the network and approved as part of a Development Approval for the relevant land division. It is imperative that more frequent flooding episodes do not occur and that any existing drainage deficiencies are not exacerbated because of additional runoff and volume.

The SMP should include the following information:

- Site plan showing the extent of works, including proposed pervious and impervious areas, and drawn to scale with clear contours.
- Provide design details of any stormwater pump systems including backflow prevention.
- Calculations from DRAINS model
- Existing and proposed surface levels at an interval not exceeding 10 metres.
- Description of the proposed project.
- Catchment
- Locality plan showing the site location regarding catchment boundaries.
- Location and size of existing drains and easements and reserves within and adjacent to the project site.

# 5 Road Design

## 5.1 Introduction

This section sets out the standard design criteria for road works. It is expected that any alternative arrangement would be considered and approved as part of a Development Approval for a relevant division. where such approval exists, any alternate detail would be considered to supersede the relevant portion of these standards.

In instances where a non-standard design is proposed it may be necessary to amend the relevant Development Approval, and this detail should be confirmed with the Relevant Authority.

Aspects not specifically referred to in this Manual should be generally in accordance with the following documents:

- Austroads Guides
- South Australia's Department of Infrastructure and Transport (DIT) Manual of Legal Responsibilities and Technical Requirements for Traffic Control Devices
- Relevant Legislation
- Australian Standards
- Standard Drawings (Appendix A)
- AS1428 (Design for access and mobility)
- AS1742 (Traffic control devices)

## 5.2 Design Criteria

### 5.2.1 Design Speed

The desired maximum design speed, on which the geometric design of each road type is based, shall be:

**DRT 5-1 Design Speeds**

| Zone | Road Type | Maximum design Speed |
|---|---|---|

| | | |
|---|---|---|
| Residential | Access Lane | 30km/hour |
| | Local | 60km/hour |
| | Collector | 70km/hour |
| All | Arterial | Road Authority Specifies |

* Note that the design speed is not necessarily the posted or operating speed.

### 5.2.2 Design Vehicle

The design vehicle(s) to be adopted shall be selected in accordance with the current version of the “Austroads Design Vehicles and Turning Path Templates”.

Turning radii and vehicle speeds used in road design shall be confirmed with the Relevant Authority at the commencement of design development. In instances where larger design vehicles are identified, this detail shall be confirmed at Development Approval stage.

### 5.2.3 Vehicle Turning Movements

Vehicle turning movements are to be examined for design vehicles and check vehicles using the current Austroads Design Vehicle and Turning Path Templates. Road space should be provided such that the design vehicle is able to negotiate a left turn from the left lane without crossing opposite direction lanes or medians and without the need to reverse to complete the turning movement. The identified Checking Vehicle may impinge upon opposite lanes except where a median is present as they represent infrequent vehicles accessing local streets, such as articulated vehicles delivering building materials in new estates or furniture carrying vehicles.

All intersection designs must be such that additional clearance from above ground structures is applied to the total swept path of the design vehicle, and not just to the wheel path. The additional clearance required is typically 600 mm, unless otherwise specified. In Other instances, justification of the adopted additional clearance shall be provided by the Relevant Authority. Vehicle accesses and driveways are not to be used for turning movements. All roadways, rights-of-way and vehicle crossings are to be designed to accommodate a standard vehicle (car).

Turning movement plans must be provided to the Relevant Authority and must show turning movements as nominated below. Where a vehicle may cross onto the opposite lane, adequate sight distance should be provided to allow the manoeuvre to be undertaken safely as required by the Australian Standards. Sight distance requirements are set out below in section 5.3.

**DRT 5-2 Design Vehicles and Turning Radii**

| Intersecting Road Types | Design Vehicle | Checking Vehicle |
|---|---|---|
| Arterial / Arterial | Single Articulated (19.0m) Turning Radius 15m | Long single articulated (25m) Turning Radius 15m |
| Arterial / Collector | Single Unit Truck/Bus (12.5m) Turning Radius 12.5m | Single articulated (19m) Turning Radius 15m |
| Arterial/Local (Residential) | Service vehicle (8.8m) Radius 12.5m | Single Unit Truck/Bus (12.5m) Turning Radius 12.5m |
| Collector / Collector (Residential) | Single Unit Truck/Bus (12.5m) Turning Radius 12.5m | Single articulated (19m) Turning Radius 15m |
| Collector / Local (Residential) | Service vehicle (8.8m) Radius 9.0m | Single Unit Truck/Bus (12.5m) Turning Radius 12.5m |
| Local / Local (Residential) | Service vehicle (8.8m) Radius 9.0m | Single Unit Truck/Bus (12.5m) Turning Radius 12.5m |

In situations where it is appropriate to design for a car only, the Austroads design passenger vehicle (based on the B99 dimensions of AS/NZS 2890.1-2004) should be used.

## 5.3 Sight Distance

The requirements for sight distance on all roads and intersections to be in accordance with the current Austroads Guide to Road Design. Reference must be made to the relevant Austroads “Guide to Road Design” and any DIT supplement to those guidelines as follows:

- Austroads “Guide to Road Design – Part 3: Geometric Design”
- Austroads “Guide to Road Design – Part 4a: Signalised and Unsignalised Intersections”
- Austroads “Guide to Road Design – Part 4b: Roundabouts”

## 5.4 Horizontal Alignment

### 5.4.1 General

The horizontal alignment of a road is usually a series of straights (tangents) and circular curves that may or may not be connected by transition curves.

The speed adopted on an open road is affected more by the driver's perception of the horizontal alignment of the road than by any other single design feature. For this reason, whenever curves are used to change the direction of travel or to suit the topography, the radii must be large enough to permit travel speeds commensurate with those expected on adjoining straights or along the whole of the section being designed.

Horizontal alignment of all roads shall be designed in accordance with the requirements of Austroads Guide to Road Design, specifically Part 3: Geometric Design.

### 5.4.2 Superelevated

Where curves are superelevated, it is necessary to ensure that any low points in the kerb and channel resulting from the application of superelevation are provided with free and unrestricted drain so that there are no trapped low points resulting in trapped water.

## 5.5 Vertical Alignment

### 5.5.1 Longitudinal Grades

**Maximum Grades**

For normal design purposes, the desirable grades outlined in DRT 5-3 should be prioritised. When the topography presents challenges that prevent adherence to these grades, it is permissible to adopt the "Absolute" grades specified in the table.

**DRT 5-3 Longitudinal Grades**

| Type of grade | Road longitudinal grade |
|---|---|
| Desirable MINIMUM grade | 0.5% |
| Absolute MINIMUM grade | 0.3% |
| Desirable MAXIMUM grade | 10% |
| Absolute MAXIMUM grade | 15% |

**Minimum Grades**

The desirable minimum grade for kerb returns is 1.0% and the absolute minimum is 0.50%.

### 5.5.2 Vertical Curves

**General**

A vertical curve must be provided at all changes of grade in road centreline greater than 1%, or changes in grade of kerb and channel greater than 1.0%. A vertical curve needs to comply with the guidelines set out in the Austroads publication 'Guide to Road Design – Part 3: Geometric Design' and any DIT supplement.

Road design grading should be extended a minimum of 50m beyond the end of the street where such street is to be extended in the future.

All vertical curves shall be designed in accordance with Austroads Guidelines.

## 5.6 Cross Fall

### 5.6.1 Normal Cross Section

On straight lengths of two-way road, the pavement cross section will normally be graded with the high point (crown) on the pavement centreline, with a fall to each channel.

On steep side slopes, the crown may be offset, towards the higher side of the road to obtain better conformity of road levels with the natural side slope.

On divided roads each pavement will normally be graded to fall from the median to the outer channel.

For laneways, a central spoon drain shall be designed and constructed for connection to the drainage system.

### 5.6.2 Normal Cross Fall

The normal cross fall of street pavements is to be a minimum of 3.0%. Where cross fall exceeds 3.0% then a discussion with the local authority shall commence to determine adequate and suitable cross fall requirements. One-way cross fall may be permitted on slopes where one-way cross fall will reduce the amount of earthworks required or for WSUD cross sections. Due to the risk of aquaplaning, one-way cross falls should not be used on roads with a posted speed greater than 60 km/hour.

### 5.6.3 Maximum and Minimum Cross Fall

Where steeper or flatter cross falls than the normal are required, for example at the approach to intersections, or turning circles of cul-de-sacs, the maximum and minimum permissible pavement cross fall shall be determined in consultation with the Relevant Authority, in alignment with Austroads guidelines. Intersections shall be designed to avoid ponding and be free draining.

## 5.7 Kerb and Channel

### 5.7.1 Location

Concrete, or equivalent comparable product kerb and channel shall be provided on both sides of all residential roads. Concrete edge strips are to be used for the application within laneways.

Kerb ramps shall be provided at every corner radius where footpaths are proposed, with the location to be approved by the Relevant Authority in accordance with DH-RD-1025.Kerb ramps shall comply with the AS1428 standards.

### 5.7.2 Kerb and Channel Types

The standard kerb and channel profile shall be as shown in the Standard Drawings. Kerb outlet sleeves for the disposal of stormwater shall be provided for each allotment that drains to the road. Kerb types to be used shall be in accordance with the Standard Drawings for the specific application.

Upright kerbs or barrier kerbs are preferred within residential areas, unless such detail is approved as part of a design standard at Development Approval. Upright kerb or barrier kerb is to be used adjacent to reserves, at intersections and other locations where vehicular access is to be restricted and confine traffic within the roadway.

General minimum kerb and channel grade shall be 0.5%.For flatter grades, designers should consider the use of grated trenches.

### 5.7.3 Kerb Radii

Kerb radii shall allow for the nominated design vehicle to move through the swept path without impedance.

Swept paths shall not cross over the road centreline except for in access lanes, places and streets.

The radius of the kerb and channel, measured from the face of kerb, at an intersection shall be selected in accordance with “Austroads Guide to Road Design Part 3 – Geometric Design” and current versions of the “Austroads Design Vehicles and Turning Path Templates”.

At intersections, the minimum kerb returns, or edge of seal radius is as follows:

- Access Road6.0 m.
- Collector Road 12.50 m.
- Arterial Road 15.0 m.

Note that smaller radii may be considered by the Relevant Authority for special circumstances subject to demonstration that vehicle swept paths are acceptable. Swept paths shall be clear of on street parking spaces.

## 5.8 Footpaths and Nature strips

### 5.8.1 Cross Section

In accordance with Austroads Guide to Road Design Part 6A: Paths for walking and cycling, Healthy by Design principles and best practise the footpaths should be the following widths:

- 3m for shared paths, adjacent bus stop areas and in front of commercial buildings and Activity Centres
- 1.5m when a footpath proposed on one side of road, 1.5 if located on both sides of road.

The minimum pedestrian path width for movement is 1.5 metres or greater which allows space for pedestrians and cyclists. Place-related pedestrian activities on the footpath require additional width and should be reflected in a relevant Development Approval.

### 5.8.2 Cross Fall

The paved pedestrian footpath cross fall may vary from flat (but achieving an adequately drained surface) to 2.5% (1:40).

Where paths are for pedestrian use or other users (i.e. mobility impaired pedestrians), all needs shall be considered. A path cross fall should not exceed 2.5%.

Nature strip cross falls should be up to 5% (1:20) to prevent puddles of water from developing, and where suitable drainage provision can be demonstrated.

Batter slopes should be as is appropriate for the predominant use of the locality, but in areas within a keep clear zone, maximum batter slopes are as follows:

- Desirable: 1:6; Maximum 1:4 (investigation required to determine if an errant vehicle can recover or if guard rails are required).
- Residential area driveway slopes 1:10 maximum.

Standard cross falls shall not be exceeded at any location where vehicular access to allotments may be required and should be matched in with the verge and/or footpath.

### 5.8.3 Provision of Tactile Ground Surface Indicators

Use of Tactile Ground Surface Indicators (TGSI) shall be in accordance with AS1428.4.1 and DH-RD-1025.

TGSIs are not required to be installed on a kerb ramp where:

- The distance between the building line/boundary and the top of the kerb ramp is less than 3.0m
- The change in gradient between that of the pedestrian surface at the top of the kerb ramp and the gradient of the kerb ramp surface lies between 1 in 8 (1 in 12.5) to 1 in 8.5 (1 in 12), and
- The kerb ramp is aligned with the building line and in the direction of travel across the carriageway.

TGSI's are required at all kerb ramps that do not comply with the above, at all mid-block crossings, and at high usage vehicle crossovers, e.g. service stations and shopping centre car parks.

Directional TGSI's are to be used where a kerb ramp is not located on the direct extension of the property line in an accessible path of travel from the building / boundary line and will lead to warning indicators installed at the crossing (kerb ramp) point.

## 5.9 Access to Frontage Allotments

### 5.9.1 General

Vehicular access to all allotments within a land subdivision development must be provided during the planning and design of the development.

Where a new or upgrade to a road includes construction of barrier kerb and channel or semi-mountable kerb and channel, a vehicle crossing and layback section in the kerb and channel must be provided to each allotment frontage.

The horizontal design or layout of all driveways shall be in accordance with AS/NZS 2890.1, AS/NZS 1428.1 “Design for Access and Mobility”, and B85 Template Swept Path with 300 mm minimum clearance each side.

Within any subdivision where the final surface level at the edge of the road reserve will be more than 500mm different to the natural surface level, the Developer shall demonstrate how vehicular access will be achieved in accordance with AS/NZS 2890.1. This shall be required to be provided for all lots so affected by the planned earthworks. This will need to be demonstrated on a civil ‘longitudinal section’ identifying individual transitions and must be based on a realistic finished floor level and the requirements of the Planning and Design Code. If the Finished floor level is restricted this shall be noted on the design plans.

All access to the properties must provide safe and convenient access in accordance with the Planning and Design Code. Driveways providing access and egress to allotments on the low side of the road shall be designed to ensure that there is a sufficient vehicle standing area within the property to provide adequate visibility for motorists when exiting the property.

The provision for vehicle crossovers and inverts, and the reinstatement of existing crossovers not required by the Development shall be carried out by the Developer to the satisfaction of the Relevant Authority with this detail being provided in the Design Documentation with regard to the considerations of this Section.

The construction and finish of driveways between the kerb and the property boundary shall either be consistent with the existing footpath and sympathetic to the existing streetscape.

Vehicle crossings must be constructed in accordance with the Standard Drawings, unless site parameters do not provide for this design. In instances where the Standard Drawing cannot be achieved, access design shall best align with considerations of this Section.

### 5.9.2 Vehicle Crossings

The maximum number of vehicle crossings to residential properties shall not exceed two (2) crossings, with neither exceeding 4 metres in width. Where two crossings are provided, the minimum distance between them should be 9.0 metres.

single crossovers shall have a minimum width of 3.0 metres and a maximum of 6.0 metres. All vehicle crossings shall be constructed in general accordance with the Standard Drawings.

Where crossings on adjacent properties with a frontage of 10m or less adjoining, these shall be fully combined, with a maximum width of 6.0 metres, or have a minimum separation of 6m to allow an on-street park between driveways.

Vehicle crossings to corner allotments are to be located a minimum of 6 metres from the tangent point of the kerb return at intersection of road reserves and 1 metre clear of pedestrian kerb crossings, street trees, signs, bollards and other street furniture in accordance with AS 2890.1.

Vehicle crossing points should aim to be aligned to crossing points on the opposite side of the road where practicable to ensure that on-street car parking is minimised opposite each driveway.

All crossings must be constructed with an all-weather surface for that section of crossing contained within the road reserve. That portion of the crossing that passes through the footpath zone must conform to the requirements of Australian Standard AS/NZS 1428.1 'Design for Access and Mobility'.

A surface that matches the texture and colour of the adjacent footpaths is preferred; however alternative surfaces may be approved conditional upon compliance with AS/NZS 1428.1 'Design for Access and Mobility'. Patterns that result in surface irregularities of greater than 5 mm are prohibited. Coloured edge strips will only be permitted adjacent and parallel to the alignment of footpaths. Feature edge strips must not cross the path of travel along the footpath.

Where grades through vehicle crossings exceeding 6.7% the Design Engineer must demonstrate using standard car templates that appropriate residential access can be provided to all allotments.

## 5.10 Treatments to Minimise Driveway Excavations

### 5.10.1 Offsetting the Crown and One Way Cross Fall

In circumstances where the natural cross slope of the existing terrain will lead to unreasonably high cut batters, offsetting the crown or one-way cross fall may be considered.

Offsetting of the crown, on a two-way road, is permissible, provided that sufficient stormwater capacity is retained in the channel and roadway on the high side of the road.

Required capacity will depend on catchment, and on the spacing of storm water entry pits.

Offset crown widths shall be sufficient to ensure that the crown is able to be laid with asphalt machinery.

A pavement with one-way cross fall may be approved only where drainage requirements can be adequately met.

### 5.10.2 Reverse Cross Fall – Divided Roads

In extreme cases, reverse cross fall, on the uphill lane of divided roads, is permissible provided that adequate drainage capacity is provided in the uphill median channel, and precautions taken to intercept flow at median openings.

### 5.10.3 Median Cross Fall

Median cross fall, on divided roads, should desirably not exceed a maximum of 16%, with 33% as an absolute maximum, unless a retaining wall is provided and there are no proposed median breaks in the median.

At median openings however, the pavement cross fall shall not exceed 5%.

### 5.10.4 A Split-Level Road

Modification of the road section to accommodate a split-level road will only be considered by the Relevant Authority in extreme circumstance.

## 5.11 Roundabouts

Roundabouts are to be designed and constructed to comply with the requirements of Austroads publication “Guide to Traffic Engineering and Practice, Part 4B, Roundabouts” and DIT requirements. Also refer to Standard Drawings for further specifications.

Vehicular access to individual residential lots shall not be to or from the circulating roadway of a roundabout.

Landscaping of the central roundabout island shall not be of such nature and height as to compromise the sight distance requirements for vehicles set out in the above standards. Landscaping should not extend past a height of 200mm.

## 5.12 Intersection Design

Intersections are to be designed and constructed such that they function in a safe, convenient and appropriate manner for the type of road.

Intersections are to be designed in accordance with:

- Austroads publication “Guide to Road Design Part 4A: Non-Signalised and Signalised Intersections”
- Austroads “Guide to Road Design Part 4B: Roundabouts”
- DIT’s “Manual of Legal Responsibilities and Technical Requirements for Traffic Control Devices” and any other DIT supplement to those guidelines.

Corner cut offs or truncations of suitable dimensions to allow adequate sight distance, must be provided at all corners of new and upgraded intersections in accordance with the following:

- Vehicle design speeds of less than 50km/h – 3m x 3m truncation.
- Vehicle design speeds greater than 50km/h – 5m x 5m truncation.

## 5.13 Cul de Sacs and Turning Areas

Where a residential street includes a Cul de Sac or a court, provision must be made for a standard 12.5 metre service vehicle (Fire Truck) to turn in a “three-point move” (drive in - reverse – drive out) on the pavement area.

Vehicle crossings must not form part of the paved turn area.

At the temporary end of a street, which will be extended in a later stage of the development, provision must be made for a standard single unit / truck or bus 12.5 metre design vehicle to turn in a ‘three-point turn (drive forward – reverse – drive out) on a paved area.

The turning area may comprise either a temporary pavement or residential vehicle crossing.

If a vehicle crossing forms part of the temporary turning area it must constructed as a Heavy-Duty Crossing.

# 6 Road Corridor Design

## 6.1 Urban Roads

The design and construction of roads and allotment accesses should meet or exceed the requirements of the AUSTROADS, the Planning, Development and Infrastructure Act 2016, this Infrastructure Guideline (SA) and any other relevant Acts, Regulations and Australian Standards. Where the road or infrastructure interfaces with DIT infrastructure, the requirements of DIT's Code of Technical Requirements shall be met (which in some instances may override the fore mentioned documents).

### 6.1.1 Road Classification

The classification of residential streets within any Development should be in accordance with the 'DRT 6.1 Metropolitan Road / Street Characteristics Table' found within Section 6.1.2

The engineering standards for road corridors will not affect pre-existing road hierarchies or established network management plans. The road classification referred to within this Growth Area Engineering Standards document relates specifically to the design and construction of new or upgraded roads.

Consideration of relevant State Government documents such as the latest Integrated Transport and Land Use Plan should also be given when determining road class and how the network fits within the overall State/Federal network. Road classifications may also be subject to the Road hierarchy structure plans associated with an Infrastructure Scheme developed by Department of Housing and Urban Development (DHUD) or existing infrastructure deeds which may apply to the land.

Ultimate traffic volumes for road classification and road design are to be based upon approved multipliers of existing traffic movements (measured), through traffic, and an estimate of traffic generated by proposed and future Development. Estimated traffic volumes for undeveloped areas must be based upon:

- Recognised guidelines;
- Residential allotments (a guide is trip generation of 6-10 vehicle movements per day per lot).

Where alternative traffic generations assumptions are used in the preparation of a Traffic Impact Study, details of alternatives must be provided to the Relevant Authority for approval.

Where the Relevant Authority holds traffic count data on relevant roads, this information may be made available to the Design Engineer. In some instances, the Developer may be asked to undertake additional traffic count data collection on affected roads to ascertain predevelopment traffic volumes and types. This will generally only be asked of the Developer when traffic count data is greater than three years old, or significant Development has taken place since traffic count data was last collected. Where traffic volumes and type vary seasonally, the Design Engineer must use data conservatively and clearly present assumptions with the request for approval of functional layout.

### 6.1.2 Road / Street Characteristics and Road Reserve Widths

Road reserve widths and road carriageway widths should be based on the road function and should consider the following:

- Ultimate traffic volume and the type and volume of commercial vehicles;
- Road carriageway width should include allowance for on street parking, cycle lanes/paths, medians, sheltered lanes, service roads, footpaths, and underground services. Cycle lanes or widened kerb side lanes should be provided in conjunction with shared paths to allow for commuter cyclists, where required as part of an existing transport strategy for an area.
- Road verges should include allowance for footpaths and shared paths, landscaping, WSUD, street trees, adequate separation from property to carriageway, above ground and underground services and stormwater pipes.
- Understanding the crucial role that road reserves play in addressing major flood events by functioning as key elements of flood management and stormwater drainage systems.
- Minimise impervious areas;
- Minimum verge width (see Table 1) to provide for the mature growth of a street tree with significant canopy in accordance with the 30 Year Plan for Greater Adelaide canopy targets;
- Street trees should have a minimum 2.4 metres tree zone to allow for growth and pruning to provide vertical height clearances;
- Shared paths on higher order roads, typically 2.5-3.0 metres wide;
- Footpaths, minimum 1.5 metres wide and to be suitable for pedestrians and cyclists;
- Public lighting – located to adequately light footpaths and the carriageway, and consideration of future road widening;
- Connection of utilities and services to properties, including water, sewer, gas, telecommunications and Power
- Location for waste bins;

- Access for Australia Post.
- Intersection treatments such as roundabouts and traffic signals

Road carriageway width and design have variable properties dependent on the location, DRT 6-1 details the Deemed to comply requirements for ‘Metropolitan’ Road / Streets which are expected to apply within the growth areas. Clever design, for example incorporating indented parking bays with street trees inline and either side, can result in the objectives being met with lesser road carriageway widths. Such design is encouraged.

The table nominates typical parking provisions, footpath provisions and cycle provisions for the given street type, and the minimum carriageway and road reserve widths reflect these provisions. Where provisions are not considered appropriate (i.e. if there is no demand for on-street parking or no benefit for providing a cycle lane etc.), the Relevant Authority will consider a reduction based on engineering best practice.

Minimum road reserve widths will not be allowed where they compromise the provision and standard of these road users.

Note that current state legislation permits the use of bicycles on footpaths, in some instances reducing the requirement for on-street cycle lanes. If cycle use is anticipated to be high a shared path configuration may be more appropriate. Where the footpath frequently crosses property driveways or provides access to commercial premises including shop fronts, on-street cycle lanes remain the preferred method of providing cycle provisions.

There is a distinct difference between the function and usage of a shared use path compared to on-street cycle lane. The on-street cycle lane is for the conveyance of commuter cyclists, while a shared use path is primarily used by at risk or social cyclists.

Road reserve boundaries may be curved around cul-de-sacs, but where they are to be fenced as chords, these should not be less than 10 metres. Where a number of such chords occur adjacent to each other, they should, as far as possible, be practically equal.

Cross sections of the various street types shown can be found in the Standard Drawings.

## DRT 6-1 'Metropolitan' Road / Street Characteristics – Design Considerations

| Street Type | Indicative Maximum Traffic Volume | Minimum Carriageway Width | Minimum Reserve Width | Minimum Verge Width[3] | Parking Provision within Carriageway | Comments[4] |
|---|---|---|---|---|---|---|
| Access Lane (second road frontage) | 50 veh/day | 5.5 m[5] | 8.0 m | 0.5 m | No | No footpath unless a pedestrian link |
| Access/Local/Residential Street | 1500 veh/day max | 7.2 m | 15.0 m | 2.6 m | Yes (both sides) | Footpath one side. No separate cycle provision |
| Level 1 Collector/Connector Street | 3000 veh/day max | 11.0 m | 18.0 m | 3.5 m | Yes (both sides) | Footpath on both sides no cycle lanes |
| Level 2 Collector/ Connector Street (On-Road Cycleway) | 15,000 veh/day max | 17.0 m (2 x 7m + 2 x 1.5m cycle lanes) | 24 m | 3.5 m | Yes (both sides) | Footpath on both sides Cycle lanes on both sides |
| Level 2 Collector/ Connector Street (Off-Road Cycleway) | 15,000 veh/day max | 14.0 m | 24 m | 5.0 m | Yes (both sides) | Footpath/Shared Pathway on both sides No cycle lanes |
| Level 2 Collector/ Connector Street (On-Road Cycleway) | >15,000 veh/day max | To be designed, 2 lanes minimum each way | To be designed | 3.5 m | Yes (both sides) | Footpath on both sides. Cycle lanes on both sides |
| Level 2 Collector/ Connector Street (Off-Road Cycleway) | >15,000 veh/day max | To be designed, 2 lanes minimum each way | To be designed | 5.0 m | Yes (both sides) | Footpath/Shared Pathway on both sides No cycle lanes |
| Residential Cul-de-sac | | 12.5 m radius | 32.0 m | 2.6 m | n/a | Footpath one side. No separate cycle provision |

[1] Minimum Road Verges widths shall be increased where practical to typically 4.5 metres to allow for a footpath/shared path, street tree and waste bin. Road verge widths need not be the same on both sides of the road and the road carriageway can be off set within the road reserve. The Designer must ensure that verge widths are sufficient to accommodate all services that are required to be located within the verge.
[2] Footpath and cycle lane provisions have been noted, but where appropriate a footpath and/or a cycle lane may be substituted with a shared path.
[3] 0.5m separation shall be provided between property boundaries and the back of path for shared paths and pedestrian paths as a minimum requirement.
[4] verge designs are to be undertaken with regard to the provisions within chapter 10 relating to street trees and required planting zones and separations from infrastructure and services.
[5] Designers need to ensure that the road reserve width adopted complies with the requirements of the following documents and Authority requirements:

- DIT - Public Transport Guidelines
- Various walkability and bicycle strategies
- Country Fire Service / Metropolitan Fire Service may require the minimum Carriageway width to be 7.3 metres in certain areas unless parking is restricted to one side.

# 7 Pavement Design

## 7.1 General Requirements

The minimum depth of flexible or rigid pavement for the proposed pavement and proposed pavement materials must be determined by design by a Qualified Engineer, with the pavement design submitted to the Relevant Authority's Engineering Department for approval.

Geotechnical information on the subgrade material and any non-standard pavement materials are to be provided with the design and submitted for assessment.

Design Requirement Design Requirement Table 7-1 below identifies the minimum design traffic to be used for the design of each of the various road classifications. All Road Design shall be designed for the below minimum design traffic unless otherwise specified in the relevant Development Approval.

**Design Requirement Table 7-1 Design Traffic**

| Road Classification | Design Traffic (ESAs) |
|---|---|
| Access Lane with w single traffic lane | $4 \times 10^3$ |
| Access Place or Cul-de-sac with two traffic lanes | $6 \times 10^3$ |
| Local Access Road with no buses | $6 \times 10^4$ |
| Local Access Road with buses | $1 \times 10^5$ |
| Collector Road with no buses | $6 \times 10^5$ |
| Collector Road with buses | $1 \times 10^6$ |

## 7.2 Sub-Grade Analyses

Pavement designs must be based on the results of sub-grade analysis, including testing for 4 Day soaked Californian Bearing Ratio (CBR) tests carried out by a NATA registered testing laboratory, with this detail submitted as part of the Design Documentation. The location and frequency of sub-grade soil sampling is required to be determined by the Design/Geotechnical Engineer considering local soil conditions and geology, terrain, presence of fill and existing pavement type (if present).

The design CBR adopted must consider all sub-grade test results but be conservative in the adoption. Full details of sub-grade test results and core samples must be submitted to the Relevant Authority with the detailed design plans.

Where pavement subgrade is identified to be highly reactive, the pavement design should be designed in accordance with AUSTROADS 'Guide to Pavement Technology'.

## 7.3 Flexible Sealed Road Pavements

Flexible sealed road pavement designs must be undertaken in accordance with the current version of AUSTROADS 'Guide to Pavement Technology Part 2 – Pavement Structural Design'. Pavement design must be carried out using equivalent standard axle loadings based on the ultimate design traffic and a 30-year minimum design life for residential roads. The Department for Infrastructure and Transport (DIT) Master Specification (Part RD-PV-D1 – Pavement Investigation and Design) should also be referred to, as this document contains a range of specific information relevant to South Australia.

To take into account the heavy vehicle traffic generated by construction during the development of land divisions, the Design Traffic computed for design of flexible pavements, (Design number of Equivalent Standard Axles (DESA), shall be increased by not less than the values outlined below:

- Access Lane 5%
- Access Street/Residential Cul-de-sac 4%
- Collector/Connector Street 3%

For low volume residential roads DIT's Fine AC mix is recommended. The use of polymer modified binders in the asphalt is encouraged and can be particularly relevant for heavy duty pavements. A design which utilises polymer modified binders shall be in accordance with the DIT Supplement to AUSTROADS 'Guide to Pavement Technology Part 2'.

For medium and high-volume collector roads, as identified in the relevant Development Approval, deep lift asphalt is required to resist fatigue of the wearing course. Deep lift or full depth asphalt pavements may also be desirable to achieve sufficient pavement strength whilst minimising pavement thickness particularly in areas with shallow services.

## 7.4 Concrete Street Pavements

Concrete street pavement design must be based on the current version of AUSTROADS 'Guide to Pavement Technology – Part 2' and DIT Master Specification (Part RD-PV-D3 – Concrete Road Pavements), for a minimum 30-year design life.

## 7.5 Interlocking Pavers

For safety, operational, noise and maintenance requirements, interlocking block street pavements are not to be used unless approved on request from the Relevant Authority. However, in situations such as traffic calming devices and where WSUD principles are to be incorporated.

Where required or approved by the Relevant Authority, pavement and pavers must be designed in accordance with the CMAA Segmental Paving Technical Manuals, to a minimum 30-year design life. Note that the paver thickness is not to be included in the road pavement design thickness (i.e. overall thickness is the design pavement thickness plus the paver thickness).

Interlocking paving shall be shape type A, and constructed in a herringbone pattern unless otherwise specified by the relevant Development Approval. The road slope should not exceed 10% (or in accordance with manufacturers specifications or a relevant Development Approval) and on slopes exceeding 5% suitable drainage shall be installed to minimise sand and water migration.

Concrete paving units shall comply with the specifications CMAA Segmental Paving Technical Manuals and AS/NZS 4455.2 Masonry Units, Pavers, Flags and Segmental Retaining Wall Units – Part 2 Pavers and Flags. They shall be a minimum of 80 mm thick for trafficable areas. The colour and shape are to be agreed with the Relevant Authority.

Design documentation shall detail that paving bedding sand shall be an approved washed or unwashed pit, river or quarry material. It shall be free of pebbles, clay lumps, organic or deleterious matter, soluble salts or other contaminants likely to cause efflorescence or lead to reduced skid resistance. It shall comply with the DIT standard specification for sand (Sa-A) as per the DIT Master Specification.

The material used for filling between pavers shall be an approved proprietary silicone-based sand product, which may be broomed and vibrated into place but which ultimately provides an effective, flexible, bound sealant that will resist unintended extraction by vacuum street cleaning equipment.

The finished levels of the block paving shall be to an even and plane surface to within +3 mm, -0 mm from the design levels shown on the drawings. The design shall ensure that the levels of adjoining units correspond and that the units along the edges are between 5 and 10 mm above the lip of the adjacent concrete gutter to provide proper stormwater drainage of the pavement.

The skid resistance of the final block paved surface shall be at least equal to that of the adjoining asphalt surfaces.

Permeable Pavers may be used with prior approval but are not recommended for use over clay or reactive subgrades. Permeable Paver pavements shall be designed in accordance with the Permeable Interlocking Concrete Pavements – Design and Construction Guide (PE01) published by the Construction Masonry Association of Australia (CMAA).

## 7.6 Stabilised Pavements

Pavement strength can often be improved by stabilising a reactive subgrade or stabilising the actual pavement materials. Typical forms of stabilisation may include the addition of lime, cement or foamed bitumen. Geotextiles and geogrids are another means to increase pavement strength over particularly soft or reactive subgrades. Where pavement stabilisation is required, the design shall be in accordance with AUSTROADS Guide to Pavement Technology Part 5 – Pavement Evaluation and Treatment Design and DIT Master Specification (Part RD-PV-C3 – Insitu Pavement Stabilisation).

## 7.7 Minimum Pavement Thickness

Where the pavement design suggests a minimalistic pavement thickness, the pavement thickness adopted shall not be less than 300 mm for roads in which kerb and channel is to be constructed, 200 mm for non-kerbed roads, and 180 mm for car parks.

If the asset is to be transferred to DIT or interfaces with DIT, DIT minimum requirements may govern. The sub-base layer must extend a minimum of 300 mm past the rear face of any kerb and/or guttering and approval for any such works shall be obtained from DIT and submitted as part of Design Documentation.

Note minimum thicknesses are based on unbound granular pavement configurations, and lesser thicknesses may be appropriate for full depth asphalt or rigid pavements.

## 7.8 Minimum Shoulder Thickness

For non-kerbed roads, the pavement must extend at least to the nominated width of the shoulder, and must be a minimum thickness of 180 mm.

## 7.9 Compaction Requirements

Depending on traffic volumes, from the associated Development Approval, and actual pavement design, compaction will be in accordance with DIT Master Specification. Compaction testing of subgrade, sub-base and base material must be carried out by a NATA approved laboratory. Different test procedures are required for unbound (granular) and bound (asphalt) pavement layers. Reference shall be made to the DIT Master Specification for typical testing frequencies and acceptance criteria, and the relevant Australian Standards for test procedures. An Inspection & Testing Plan (ITP) is to be prepared and completed and submitted to the Relevant Authority prior to Practical Completion. Copies of all test results are to be submitted to the Relevant Authority's Engineering Department.

## 7.10 Road Material

Roads shall be constructed using materials conforming to the requirements of DIT Master Specification (Part RD-PV-S1 – Supply of Pavement Materials).

Typical pavement materials used are PM 1 / 20QG for the base course layer and PM 2 / 20QG for sub-base layers, however, a number of variations are generally acceptable. Larger aggregate mixes such as PM 2 / 30QG or PM 2 /40QG are typically acceptable for heavy duty or industrial pavements. Recycled pavement materials such as PM 2 / 20RG and PM 2 / 30RG are typically acceptable for sub-base layers or working platforms but are not suitable for the base material directly under a seal. PM3 (Class 3) materials are acceptable for creating a working platform.

The selection of materials shall form part of the overall pavement design which is required to be approved by the Relevant Authority's Engineering Department prior to construction. If materials other than those specifically listed above are proposed to be used, detail is required as part of Design Documentation for assessment by the Relevant Authority.

## 7.11 Sub-Grade

The subgrade must be compacted to 98% standard maximum dry density (SMDD) in accordance with the Construction Specification and/or AS 3798.

## 7.12 Sub-Base

The typical flexible pavement sub-base which is generally PM2/20QG must be compacted to the relative modified maximum dry density (MMDD) of 95%. Frequency of Testing is to be in accordance with AS 3798 and AS 1289 Geotechnical Testing. Test locations shall be selected on a random stratified basis in accordance with AS1289. Frequency of testing is to be one test per 400m2 with a minimum of 4 tests.

## 7.13 Base

The typical flexible pavement base, which is generally fine crushed rock (PM1/20QG), must be compacted to the relative modified maximum dry density (MMDD) of 98% in accordance with AS 1289.5.2.1. The number of tests to be undertaken shall be in accordance with DIT's Master Specification with consideration given to intersections and cul-de-sacs. Tests must be evenly spaced and taken on alternate sides of the road with test locations to be approximately one (1) metre offset from the kerb or edge of seal and measured at 2/3rd the depth of the layer.

## 7.14 Pavement Wearing Course

The wearing course that is to be constructed on all residential roads is to be a minimum of 40mm of AC10M asphalt on access roads, collector roads and distributor roads with more than 400 vehicles per day. The surface of the wearing course shall be 5mm proud of the concrete water table, however it is to be flush with the lip of the kerb and channel at all footpath kerb crossings to eliminate trip hazards.

All AC10 Asphalt placed on low traffic local roads shall conform to the Hot Mix Asphalt Mixes of the DIT Master Specification (Part RD-BP-S2 - Supply of Asphalt and RD-BP-C3 – Construction of Asphalt Pavements).

All new and upgraded roads, including widened roads, that are located in or adjacent to any Collector Street must be sealed with an AC10H Asphaltic Concrete of suitable thickness for the expected traffic loading (minimum thickness to be 40 mm).

All new or upgraded roundabouts must be sealed with an AC10M heavy duty mix Asphaltic Concrete preferably with a polymer modified binder (A5E) and shall be of suitable thickness for the expected traffic loading (minimum thickness to be 40 mm).

The Design Engineer must, prior to construction, specify the hotmix design or attention to the design mix including aggregate size and any additives e.g. colour additives.

# 8 Earthworks Design

## 8.1 Objectives

Earthworks may involve activities such as lot filling, constructing basins, stormwater drainage systems (including open channels), levee banks, access tracks, excavation, flood protection devices and overland flow paths.

The objectives of the earthworks and lot filling requirements are as follows:

- To ensure buildings are situated on natural ground or approved fill that is above the 1% AEP flood level, or is otherwise consistent with levels approved in an approval issued under the Planning and Design Code and to comply with the constraints of National Construction Code, part 3.2 and the South Australian public Health Act 2011.
- To prevent earthworks, lot filling, or development from causing or worsening flooding on adjacent properties, ensuring that existing runoff storage areas or flow paths are not obstructed unless proper permits are obtained.
- To prevent erosion, dust, mud, or debris from being released from the site during earthworks and lot filling activities.
- To safeguard the privacy and security of neighbouring landowners.

## 8.2 General Notes

The approval of engineering plans by the Relevant Authority's Engineering team is limited to ensuring the adequacy of earthworks needed to accommodate road and stormwater drainage systems. This approval does not replace any requirement for Planning and Design Code consent and/or Development Approval for such works.

The Developer is responsible for obtaining any other consents for earthworks where such approval is otherwise required.

When roads, footpaths, or shared paths are constructed over filled areas, the pavement materials, structure, and geometry must be designed by a Qualified Engineer. The associated drawings and calculations (where relevant) must be submitted to the Relevant Authority’s Development Engineering team for approval.

## 8.3 Earthwork Design Requirements

Aspects not specifically referred to in this Manual should be generally in accordance with the following documents:

**Fill:**

- Fill material must comply with AS 3798 Guidelines on Earthworks for Commercial and Residential Developments. Unsuitable materials include topsoil, organic matter, clays with high plasticity, and materials with excessive moisture content.
- The extent and depth of all proposed lot filling must be denoted on the construction plans. Where depths of fill on allotments exceed 300mm, those areas are to be clearly differentiated from fill of depth less than 300mm.
- Fills deeper than 5m are not covered by AS3798, and therefore require specific engineering assessment.
- Retaining walls must be provided when the depth of fill exceeds 300mm or maximum batter slopes are exceeded.
- Fill must be deposited in uniform horizontal layers, with each layer compacted before the next is placed.

**Flood Mitigation:**

- The finished floor level of buildings is to be a minimum of 300mm above the 1% AEP flood level or is otherwise consistent with levels approved in an approval issued under the Planning and Design Code.
- The finished surface of any lot filling must be equal to or above the 1% AEP flood level unless otherwise approved by the Relevant Authority.

**Grading:**

- Earthworks shall grade away from structures towards approved drainage paths and infrastructure.
- All new allotments on sloping sites shall be graded, cut or filled, such that a minimum grade of 1 in 200 is achieved along the low side of the allotment towards the stormwater drainage outlet.

**Environment:**

No water is to be directed to flow into adjoining properties unless suitable arrangements are in place. Where fill is imported onto any development site, written records must be provided to indicate the source of the fill and to provide evidence that the soil is not contaminated as per Environment Protection Authority (EPA) waste fill requirements.

Before commencing works on site, a Construction Environment Management Plan (CEMP) shall be submitted which demonstrates the following:

- All reasonable precautions should be taken to prevent the spread of noxious weeds from or to the development site. Special requirements may apply in certain areas.
- Dust, mud and debris must be managed and controlled from leaving any site during and after construction.
- All areas that are to involve earthworks are to have the topsoil stripped, stockpiled and reinstated. Before completion of the site works, the depth of topsoil replicating pre-development depths must be placed and rehabilitated over all areas where there have been earthworks.
- Where a site has been subject to biological or chemical contamination, the developer shall provide analysis as required by the EPA or Relevant authority to demonstrate that that remediation and works are to be undertaken in a manner as specified in the relevant Development Approval.

# 9 Service Infrastructure

## 9.1 General Requirements

All services, including communications and electricity, shall be placed underground to the requirements of the relevant service providers. Where appropriate, services should be provided in a common service trench located as detailed in the Road Corridor design chapter of this engineering standard document and as shown on the typical cross section drawings.

The design of services within the development will be approved by the relevant authority, including but not limited to:

- Electrical distribution to be approved by SAPN.
- Communications to be approved by NBN or nominated communication provider.
- Potable water and sewer to be approved by SA Water (where applicable) or water/wastewater authority
- Third pipe recycled water systems to be modelled and approved by SA Water (or relevant water authority). A separate meter is required for each allotment.
- Broadband pit and pipe where applicable

Tree root barriers should be installed a minimum 750mm radius of newly planted trees (measured from the trunk of the tree) from new services or to the extents of the established tree canopies. New services should not be installed within a minimum 750mm radius of newly planted trees. New services should not be installed in the tree protection zone (TPZ) of significant and regulated trees.

New services that are laid in an existing road for a service authority by a third-party contractor are to be in accordance with the Relevant Authority's trenching policy and may require separate approval. New electrical services being installed within verges should be located underground and to the kerb edge of the verge.

## 9.2 Electrical Distribution/Lighting

Street lighting is to be provided throughout a land division in any new division.

All street lights and poles shall be of an approved SA Power Networks standard and AS1158 compliant.

Underground electrical power shall be provided to each allotment in accordance with a design approved by SA Power Networks and the Relevant Authority.

The lighting system shall comply with SA Power Networks standards.

The light column shall be located behind the kerb, with a minimum distance behind the kerb that is consistent with what is set out in the road corridor cross sections of this engineering standards document.

Additional setback is required where the footpath is wider. Pad mounted transformers and switching cabinets are not to be located within the Relevant Authority's reserves without approval. Where a transformer is located within a reserve, the following considerations must be met:

- Located in corners of reserve (where possible)
- Not located adjacent collector road or shared paths
- Provided with landscape screening
- Evidence to demonstrate that a location with the lowest visibility has been chosen.

If the Relevant Authority's reserve is demonstrated as the preferred location, it is to be located to the side boundary of the reserve, preferably a corner to reduce visual impact. Any open space calculation as shown on an approved plan of division is to be updated to reflect any change to the quantum of open space provided in the approval.

Electrical cabinets and similar associated infrastructure should be located within private land in accessible locations, generally fronting the road, with appropriate easements in place.

## 9.3 Water Supply

Water supply services, where required, shall be installed in accordance with design requirements and relevant standards of SA Water, for the provision of an adequate water supply to each created allotment. Where an alternate provider has been approved for the division, the standards of this provider shall apply.

## 9.4 Waste Water Disposal

Waste Water Disposal services, where required, shall be installed in accordance with design requirements and relevant standards (SA Health, SA Water/Water Services Association of Australia codes, LGA CWMS codes) for the provision of an adequate waste disposal from each created allotment. Where waste water disposal is via an alternate, approved provider, the system shall be designed and constructed to the standards of the provider and as required under the relevant legislation.

## 9.5 Communications

Communication network services shall be installed in accordance with design requirements and relevant standards of the service provider for the provision of an adequate supply to each created allotment.

# 10 Street Trees

The Department for Housing and Urban Development (DHUD) is committed to meeting The Greater Adelaide Regional Plan targets of achieving 30% tree canopy cover across Adelaide by 2051. This commitment involves the protection of existing trees as well as the planting of new ones.

Trees in streets are essential for a high quality streetscape. This chapter enlarges on this concept providing more detailed technical information.

Healthy, established urban trees provide a long term legacy for the community. Many of the most memorable streets and localities can attribute their noteworthy status to the presence of large healthy trees. At the regional scale street trees contribute to the overall percentage canopy cover which in turn delivers a variety of environmental benefits.

In emerging and existing growth areas, the planting of street trees with all good intention is not sufficient to achieve a high quality streetscape. To achieve successful streetscapes critical factors such as selection of the most appropriate tree species, quality of the plant stock and planning for adequate soil and water are essential. This chapter looks to address these matters.

The following provisions guide the design and location of street trees in new residential streets:

a. Street trees are a legacy for the community. Maximise planting of trees in all streets and retain existing trees wherever possible.

b. Street trees should contribute to the overall unity of the streetscape, through their layout, scale and character. Careful selection of the tree species will provide scale and visual cohesion to the street. Beyond this generic design intent for the street trees, trees can also form landmarks, contribute to both contextual character and the general amenity of a place.

c. Select the most appropriate tree species to satisfy the design intent and the physical conditions of the site both natural and man made. Respond to other functional requirements such as solar access, vehicle clearances etc.

d. Optimise soil conditions for trees. Locate trees to maximise available soil volume. Ensure that there is a sufficient quantity and quality of soil within the anticipated root zone to support the intended mature tree and that adequate moisture is provided to that zone.

e. Street trees need adequate water to flourish. Street tree location and design should optimise passive watering of all street trees.

f. Minimise infrastructure and functional conflicts. Locate trees and utility services to minimise potential conflicts between street elements and functions, such as streetlights being blocked by the tree canopy, or car doors being opened into tree trunks.

g. Where appropriate integrate water sensitive urban design (WSUD) initiatives with the provision of street trees

### 1. Existing Trees

Where possible every effort shall be made to ensure the retention of all existing trees within the development site to the reasonable satisfaction of the approval authority. All trees shall be identified on the site survey.

Any existing tree with a trunk circumference of 1.0m or more measured at 1m above the ground, is regulated under the *Planning, Development and Infrastructure (General) Regulations 2017 and*, therefore, must be appropriately protected. In addition to this, trees with a trunk circumference of 2.0m or more are classified as 'significant' and may require higher levels of protection.

For sites that may have regulated/significant trees (including trees located outside the site boundary but with a canopy overhanging the development land), a vegetation survey/report shall be undertaken by a qualified Arborist. The survey must provide the position of each regulated/significant tree as well as identify the following:

- Botanical species name
- Approximate height
- Approximate girth of the trunk
- Condition rating
- Estimated remaining lifespan

- Structural root zone (SRZ)
- Tree protection zone (TPZ)

The “Existing Tree Survey” plan may be either:

- a separate plan, or
- included within the Land Division Plan

The potential impact of the land division upon existing trees must be clearly shown on the plan and must contain the following information.

- identification of the species including the botanical name of the tree.
- the location of the tree accurately indicated.
- the height and canopy of the tree and girth of the trunk.
- the Tree Protection Zone (TPZ) and Critical Root Zone (CRZ); and
- the location of any roads, structures, services or infrastructure which cross or encroach on the TPZ or CRZ

The “Existing Tree Survey” plan must also indicate whether it is proposed that the tree is to be removed or retained

**2. Tree Protection Zones**

The Tree Protection Zone (TPZ) is the critical zone of root extension from the tree trunk. It is calculated by multiplying the diameter of the tree trunk at 1.5 m above ground level by a factor of 10. A TPZ defines an area that must be left undisturbed during development to safeguard the ongoing health of the retained trees and prevent damage to their roots, trunks, and canopies. Any future development, construction or demolition shall take the TPZ into account.

As part of the development assessment application, a site plan shall be lodged showing all TPZs. A building envelope may be required in situations where it is unclear if a proposed division of land would impact on the future retention of a Regulated or Significant tree.

All construction plans including earthworks, drainage and service drawings, shall show all regulated/significant trees and the TPZs.

Prior to any site demolition or construction, the following actions must be taken to establish the tree protection zones (in addition to any recommendations outlined in the arborist report:

- Watering regime determined
- A 100mm layer of composted mulch shall be spread across the tree protection zone
- 1.8m high temporary fence is to be installed around the TPZ boundary
- Signage shall be fixed to the fencing in a clearly visible manner. The signage shall identify the area as a Tree Protection Zone and indicate that no unauthorised access is allowed.

The TPZ must be protected from all development works (including construction and demolition). Examples of activities that are specifically prohibited within any TPZ include:

- excavation or filling.
- stockpiling of soil or rubble.
- storage of materials, machinery or site buildings etc.
- mixing and/ or disposal of cement, chemicals or other substances.

All protection measures shall remain in place, and be maintained, until all works are completed and have been handed over to the Relevant Authority.

### 3. New Trees

It is a requirement that trees are planted in the verge space of all road reserves and in all public open space within a new development.

Street trees are to be provided in front of all properties at the centre of the allotment at a rate of one (1) per allotment, or at a rate necessary to provide a maximum spacing of eight (8) metres.

The species, size, age, method of planting and the location of the street trees is to be approved by the Relevant Authority in writing prior to planting.

Species should be selected such that the ultimate mature size is in scale with the relevant street, taking into consideration the site constraints, such as verge widths, overhead powerlines, building setbacks and vehicle clearances.

Trees shall have a minimum height of 2 metres at the time of planting, be double staked with 50mm hardwood stakes installed parallel to the road and loose tied and be planted in a mulched 1 metre diameter bowl to facilitate watering and water retention.

A minimum setback of 0.6 m is required between face of the kerb and the anticipated face of the tree trunk or plant at maturity, for all street trees to enable pedestrians, including small children, to observe the traffic from the refuge of the verge or median, and so that pedestrians and signs can be seen by other road users.

Tree planting in road corridors must achieve the minimum sight distances for intersections, pedestrian crossings, traffic signals and other traffic control devices and approved signs, as prescribed in:

- *Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections*
- *Austroads Guide to Road Design Part 3: Geometric Design*
- *Austroads Guide to Traffic Management Part 10: Transport Control of Devices,*
- *Australian Standard AS 1742.2 Manual of Uniform Traffic Control Devices Part 2: Traffic control devices for general use.*

## 4. Design Considerations

The following points shall be considered (where applicable) during the detailed design documentation phase:

- One tree shall be provided per lot for the front verge and/ or more than one tree for a wider frontage lot (1 every 8m with a frontage of 16m or more)
- The height and canopy of the trees at full maturity must be considered for more than one tree to be accommodated.

- Three trees shall be provided per corner lot/ side boundaries. The height and canopy of the trees at full maturity must achieve head-to-head canopy coverage.
- Where possible, deciduous tree species should be specified for streets with an east-west orientation, while evergreen tree species should be specified for streets with a north-south orientation.
- Trees to be central in verge unless otherwise agreed.
- Street trees planted within road verges are to be provided with a 1.2metre x 1.2 metre planting zone to allow for establishments of plantings. Where design conditions do not provide for this dimension, a comparable increase in the opposing dimension of the planting zone is to be provided (i.e. 1 metre x 1.4 metre)
- Where a tree is located within 1.0m of hard surface such as footpaths, kerb etc, a 600mm deep root barrier to be installed 1.5m on either side of the centre of tree.
- Side fence lines with trees to have root barriers house side of tree (3m wide x 0.9m deep)
- Tree species planted adjacent to high-voltage power lines must be in line with the South Australia Power Networks (SAPN) approved tree species list
- Street trees shall be bunted with orange mesh bunting where dwellings are under construction as per the standard tree details (noted on plan/construction details)
- The predicted size of mature trees should be annotated on landscape drawings.
- Trees species alongside fence lines to have an appropriately sized canopy that does not encroach into adjacent properties
- Tree species shall be appropriate to the area and align with adjacent development stages
- Street trees are to be located the following distances from built infrastructure:
  - Driveways - minimum 1m,
  - Services and Service lines (including water, sewage, comms and electrical) as per utility requirements
  - Stormwater gully pits, side entry pits, pipes, culverts and headwalls - minimum 2m

- Bus Stops - pedestrian and vehicle line of site to be clear in the direction of oncoming traffic and signage to be visible (considering the trees full mature size)
- Intersections - pedestrian and vehicle line of site to be clear
- Street Lights - minimum of 5m (dependent on light pole selection and tree species)
- Powerlines - as per SAPN tree species guidelines
- Street Signs - minimum of 2m from street signs (dependent on tree species and line of sight)

- All tree stock supplied for installation shall meet the requirements of Australian Standard AS2303
- Tree details shall align with the standard details

## 5. Biodiversity and Habitat

Where appropriate, consideration should be given to planting trees which provide a linkage between open space or other vegetated areas and natural stands of vegetation or bushland to assist in the movement of wildlife (fauna and birdlife) between those areas. These species should contain some benefits to wildlife including the physical benefits of protection, shelter, nesting sites and food sources.

Species that are locally indigenous to an area are likely to provide the most benefit to local wildlife, however these species are not always successful when planted in a highly urbanised situation. In some situations, exotic species can provide similar attributes, such as habitat and linkages, for wildlife.

Tree species selected should require a minimum of maintenance following the establishment period. Species should also be adaptable to pruning and shaping where required to achieve clearances and appropriate form.

To achieve the best outcome for environmental benefits and design intent the tree population should be managed through a life cycle management approach with a mix of tree age classes maintained in order to spread recurrent expenditure and management actions.

Selected tree species should be resistant to disease and significant pest infestations. The control of pest problems in large trees using chemical methods is both impractical and inappropriate in urban areas. Species that have known susceptibility to debilitating pest or disease infestations should be avoided.

The use of a diversity of species within a neighbourhood or region is also important in reducing the impact of diseases

# 11 Water Sensitive Urban Design

## 11.1 Introduction

Water Sensitive Urban Design (WSUD) is defined by an integrated approach to urban water management that seeks to balance the demands of urbanisation with the need to protect and enhance natural water systems. WSUD adopts the use of multi-functional infrastructure to manage stormwater quality, preserve water resources, and in some cases, enhance the ecological integrity of receiving waterways.

WSUD by its nature is extremely broad and the engineering design standards identified within this document will overlap with numerous other competing technical priorities, different stakeholders, government policies and development outcomes. As such, this document focuses on the following elements:

- Guidance on site planning, device selection and modelling.
- Engineering design standards for specific stormwater quality improvement devices.

Where possible, discussion and guidance on the engineering considerations for inclusion of green infrastructure has been provided. Green infrastructure extends beyond the prescriptive nature of engineering standards within this document and as such is not intended to be a comprehensive guide on its implementation.

The key principles of WSUD presented within this document are to:

- Preserve natural features and support ecological features.
- Preserve the natural hydrological behaviour of sites.
- Safeguard the quality of surface water and groundwater.
- Incorporate water into the urban landscape to enrich the aesthetic, social, cultural, and ecological features.

## 11.2 Assessment Triggers – Water Quality

The Planning and Design Code includes assessment triggers for deemed-to-satisfy and performance assessment pathways. A performance assessment pathway requires numerical modelling using MUSIC to be undertaken to demonstrate the WSUD performance where WSUD has been incorporated into a Development Approval.

Under the Planning and Design Code, small-scale residential developments up to and including four (4) allotments (allotment size up to 500m2 per allotment) can adopt a 'deemed-to-satisfy' pathway. As these small-scale developments are not the focus of this standard, Water Sensitive SA's guideline 'Residential development, deemed-to-satisfy solutions for stormwater management' is referenced. The guideline provides significant guidance on the requirements under this pathway. For small scale developments where a 'deemed-to-satisfy' pathway is available, a performance assessment pathway can be utilised where preferred by the developer.

For all other development, a performance assessment pathway is required, demonstrating the performance of the selected treatment train to achieve the water quality objectives.

## 11.3 Water Quality Objectives

The water quality objectives have been developed to protect and, where required, enhance the health and quality of runoff entering receiving water environments.

These objectives aim to reduce urban runoff contaminations to:

- Maintain aquatic health and biodiversity.
- Maintain amenity of waterways.
- Protect coastal environments.

### 11.3.1 Runoff Quality - Pollutant Load Reductions

The mean annual pollutant loads to be achieved are as follows, when compared to the unmitigated stormwater runoff.

- 80% for Total Suspended Solids (TSS)
- 60% for Total phosphorus (TP)
- 45% for Total nitrogen (TN)
- 90% for Gross pollutants (GP)

The targets specified above are intended for use as a minimum requirement on all development projects (including re-development) which meet the relevant triggers outlined in Section 11.2. In addition to these objectives, each development site is required to be in accordance with the *Environment Protection Act*, Environment Protection (Water Quality) Policy, and/or alternative State/Federal legislation and site-based assessment (e.g. ecological requirements), as approved in a relevant Development Approval. These considerations may result in a development need to achieve additional water quality objectives.

### 11.3.2 Integrated Design

The implementation of WSUD elements must be planned, designed and managed to promote the establishment of 'green infrastructure'. It is intended that this will achieve multiple outcomes including public amenity, improved urban ecology outcomes, biodiversity gains through the potential utilisation of existing habitat links and reduced energy use.

The State's Water Sensitive Urban Design Policy (2013) requires *"Evidence that relevant stakeholders are engaged at appropriate stages of planning, designing, constructing and managing WSUD measures to maximise the potential for WSUD to contribute to 'green infrastructure' and other relevant State, regional and local objectives"*.

### 11.3.3 Hydrocarbons

Although hydrocarbon pollutant load reductions are not identified within this manual, they can be a significant pollutant in stormwater runoff in urban areas.

Development of land uses, such as refuelling stations and car washes, will have specific requirements to manage hydrocarbons These additional requirements are not included within the scope of this document. Developers of certain land uses are required to make themselves informed of these requirements and demonstrate compliance as part of the Development Approval process. By way of an example, hydrocarbon separators and emergency spill storage are generally required for large refuelling areas.

### 11.3.4 Construction Phase Water Quality Objectives

This chapter does not aim to provide guidance on the water quality objectives during the construction phase of a project. For further advice on providing construction phase water quality objectives, refer relevant Environmental Management Design Standards in Section 12.

It is acknowledged that SQID's delivered as part of land development and can be significantly impacted by house builders' activities. This includes sediment, litter and cementitious pollutants being drained into a newly delivered SQID's (such as a bioretention system), causing premature failures and reductions in operational life span. Advice on managing this commonly encountered issue is provided in Section 11.6.3.11.

## 11.4 Open Space Integration

The integration of WSUD elements into public open spaces should prioritise natural processes (where appropriate) to promote the establishment of 'green infrastructure'. Key elements to consider in the design process include:

- Active Recreation: Incorporate walking paths, cycling routes, and dog walking areas to encourage physical activity and community engagement.
- Public Safety: Ensure that open spaces are well-lit and designed with visibility in mind to enhance safety.
- Maintenance Burden: Design low-maintenance landscapes to reduce the burden on local Authorities.
- Open Space Uses: Create multifunctional spaces that can be used for various activities, including picnics, sports, and events.
- Landscaping: Use native plants and sustainable landscaping practices to enhance biodiversity and reduce water usage.
- Enhancing Public Connection to Water: Design features that allow the public to interact with water, such as inquisitive play areas, water viewing areas and educational signage.
- Site Conditions: Consider the site's grade, soil conditions, and stormwater management strategies in the design.
- Environmental Requirements: Address site-specific environmental requirements, including planning overlay requirements and ecological assessments.
- WSUD Sizing: Ensure that WSUD elements are appropriately sized to achieve necessary water quality reductions.
- Flooding: Regional flood levels and immunity requirements of infrastructure within green corridors.

## 11.5 Performance Modelling

Where the need for a performance-based assessment is identified in Section 11.2, pollutant load reductions identified in Section 11.3.1 are required to be achieved. The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) by eWater is the adopted software package to be used for demonstrating compliance with these objectives.

The conceptual development and sizing of a proposed treatment train is to be completed in accordance with the latest version of The South Australian MUSIC Guidelines, developed by Water Sensitive SA.

### 11.5.1 Assessment

A copy of the corresponding MUSIC model is to be supplied to the Relevant Assessment Authority.

Reports demonstrating the performance-based assessment must be suitably detailed to enable assessment and approval by the Relevant Authority, without the need for model interrogation within MUSIC.

## 11.6 Device Design and Selection

Stormwater quality improvement devices (SQID's) accepted to be adopted within the performance-based assessment of urban developments are identified below:

- Off-Site Stormwater Solutions
- Bioretention Systems (including end-of-line, at-source and bioswales).
- Constructed Wetlands
- Gross Pollutant Traps (GPTs)
- Vegetated Swales
- Emerging and Proprietary Systems
- Infiltration Systems
- Litter Baskets
- Pervious Pavement

In addition to the above devices, off-site stormwater solutions are discussed in Section 11.6.1 .

### 11.6.1 Off-site Stormwater Solutions

Off-site stormwater solutions may exist in areas where a regional stormwater masterplan is in effect, or where a Relevant Authority operates an existing, downstream treatment system or discharge location. Generally, such systems are publicly owned by a Relevant Authority, although in some instances they may be privately owned.

Any design which relies on an off-site stormwater solution must be consistent with a Development Approval issued from the Relevant Authority.

Use of an off-site solution must demonstrate that this does not result in damage (or reduced performance) to the surrounding environment, infrastructure or property.

For example, if a development has an environmentally sensitive area between it and the treatment device discharging untreated water may not be appropriate.

Where an off-site treatment area is also providing a peak-flow mitigation function, then the increase in runoff due to development must be considered between the development areas and the treatment areas in the information submitted for assessment.

Where these areas are separated by existing local infrastructure, demonstration of capacity in existing systems, or detail relating to the required infrastructure upgrades will be required for assessment.

#### 11.6.1.1 Privately Provided

The concept for one or more developers to provide a locally applied off-site stormwater solution to achieve the necessary water quality objectives is possible in situations where approval for any such solution has been provided by the Relevant Authority as part of the Development Approval. A copy of any approval is required as part of submitted documentation for assessment

Submitted detail for any privately provided off-site stormwater solutions must comply with the following requirements:

- All development areas being offset must be located within the same local catchment as the off-site treatment device.
- In the event where an existing public drainage system is utilised to connect the development area to the offsite treatment area, water quality objectives for total suspended solids (TSS) and gross pollutants (GP) shall be achieved prior to discharge from the development site.

- To protect natural waterways, all stormwater (up to the treatable flow rates required) shall make its way to the off-site treatment area without entering the natural environment (i.e. via piped drainage or constructed open channel drainage system).
- The off-site treatment device must be operational prior to the upstream pollutant source being completed. For a residential subdivision, this is prior to plan sealing/creation of the developed lots (prior to house builders coming onsite). This can include staged development and staged expansion of the treatment device, with sufficient treatment being provided for each stage of development.
- Evidence of relevant infrastructure agreement or other delivery agreement between all relevant developers, landowners and relevant authorities is to be provided as part of Development Approval documentation.
- If a development site requires flows to be conveyed through private property to reach the treatment device, the landowners of the private properties must be included in and signatory to the above agreement.

#### 11.6.1.2 Publicly Provided

Where the Relevant Authority voluntarily provides mechanisms for developers in lieu of achieving the water quality reductions for TSS, TP, TN and GP, this detail is to be specified in the Development Approval for the related land division. Further, submitted engineering documentation must demonstrate the following:

- The water quality reductions offset are for total phosphorus (TP) and total nitrogen (TN) only, with water quality objectives for total suspended solids (TSS) and gross pollutants (GP) required to be achieved prior to discharge off-site.
- Detail of the off-site solution, which is to be used, along with relevant detail of water treatment.

Such mechanism is only available when voluntarily offered and agreed to by the Relevant Authority.

## 11.6.2 Bioretention Systems

### 11.6.2.1 General Function

Figure 11-1 below shows the typical components of a bioretention system.

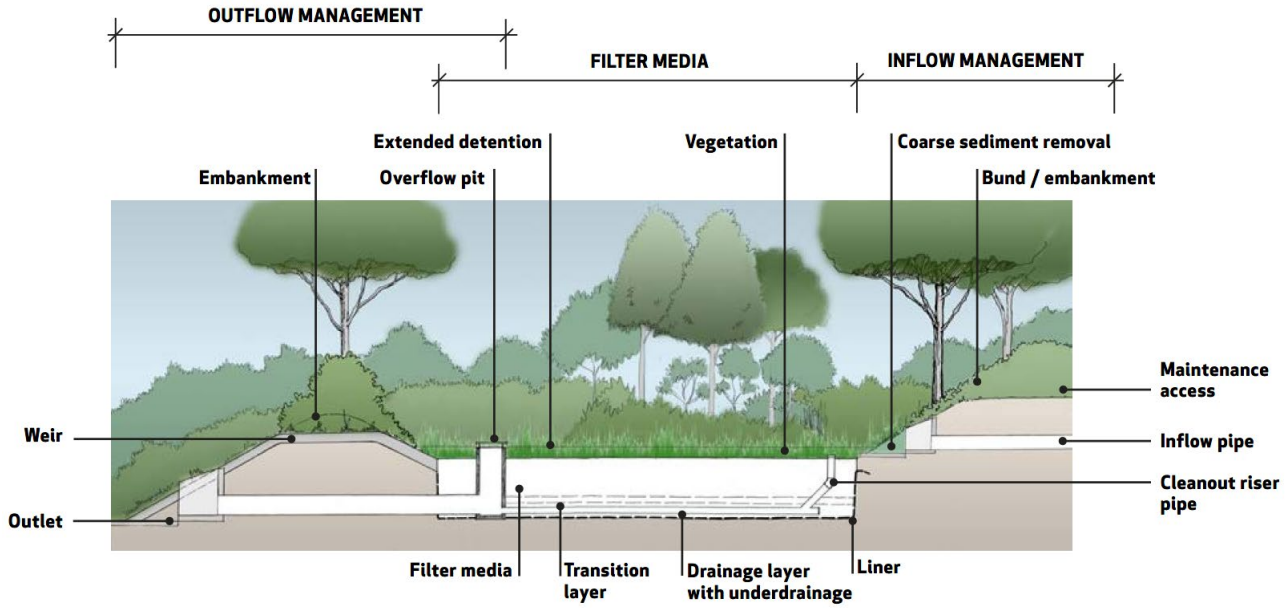



FIGURE 11-1 – BIORETENTION SYSTEM COMPONENTS (SOURCE: WATER BY DESIGN)

### 11.6.2.2 Bioretention System Types

Bioretention systems are generally classified into the following two categories:

- At-Source, which include Bioretention Pods and Bioretention Tree Pits. These devices receive runoff directly from a source (i.e. as overland flow from adjacent roads, car parks, hardstand areas and allotments).
- End-of Line, which are commonly referred to as Bioretention Basins and receive runoff at or near the downstream end of a drainage network. Due to the reduced ongoing maintenance cost relative to at-source bioretention, end-of-line bioretention is preferred where possible.

#### Bioretention Swales

Design of bioretention swales shall consider the following:

- Rainfall and Catchment – In sizing the end-of-line bioretention swales the quantity of runoff needs to be considered. Vegetation towards the downstream end of a long bioretention swale may die-off if with limited catchments and rainfall only inundating the upstream end of the devices. At-Source bioretention swales that receive runoff along the full length of the swale are less prone to die-off.

- Conveyance – Design for conveyance of flows needs to allow for the roughness associated with vegetation proposed within the swale invert.
- No EDD – as the device needs to convey runoff there is no allowance for ponding, hence no storage in extended detention depth. Outlet pit crests are set at levels at or just above the downstream invert of the swale.
- Grade / Slope – Being a vegetated surface there is potential for flow velocities (in particular, during periods of short or sparse vegetation, or during establishment of vegetation) to cause scour and erosion of the bioretention filter surface. It is recommended that bioretention swales are limited to a grade / slope of not more that 4%.

#### 11.6.2.3 Design Considerations

It is recommended that background investigations be undertaken to identify constraints and opportunities that may influence the configuration of the bioretention system. Refer to Section 3.1.1 of the Water by Design Bioretention Technical Design Guidelines (2014) for further details. Information to be gathered and assessments undertaken should include (but not be limited to) the following:

- Rainfall – For locations that experience long periods without rainfall (i.e. greater than three weeks) consideration should be given to the use of a submerged or saturated zone at the bottom of the filter profile.
- Topography – The use of end-of-line bioretention basins is preferred where sufficient fall exists to enable the drainage network to discharge onto the surface of the filter and freely discharge from the basin. Where a site is constrained by grade the use of at-source systems may be required.
- Surrounding Soils – Bioretention systems in locations subject to ASS or where soils are classified as sodic or dispersive, the use of sealed impermeable liner to prevent exfiltration from the system is required.
- Presence of Tidal Water and Groundwater – Areas subject to tidal inundation are generally considered to be unsuitable for bioretention systems, as the ingress of salt water into the system will kill bioretention vegetation. The prolonged wetting associated with the presence of shallow groundwater can also affect plant health and the ability for the filter media to retain pollutants. Where bioretention systems are proposed in locations subject to either of these conditions it is recommended that a sealed impermeable liner is utilised allowing for extension of the liner above the groundwater or Highest Astronomical Tide (HAT). Further details for consideration are provided in Section 3.2.3.3 of the Water by Design Bioretention Technical Design Guidelines (2014).
- When located adjacent to watercourses there is the potential for Bioretention Basins to become inundated and damaged by regional flooding. Where achievable, basins are to have immunity to the 5% AEP regional flood level.

- Size – To be determined through performance modelling.
- Layout – To assist with maintenance and reduce the potential for inconsistent distribution of runoff across a systems filter surface (and partial die-off of vegetation) the following is recommended:
    - System is designed to a maximum length of 40m with length to width ratio of 3:1.
    - System is designed to a maximum width of 20m where maintenance access to the system can be provided from more than one side, or 10m where maintenance access to the system can be provided from only one side.
    - For basins with filter area greater than 800m2, filter is broken up into cells (with inflows distributed to each cell) with a maximum cell size of 800m2.

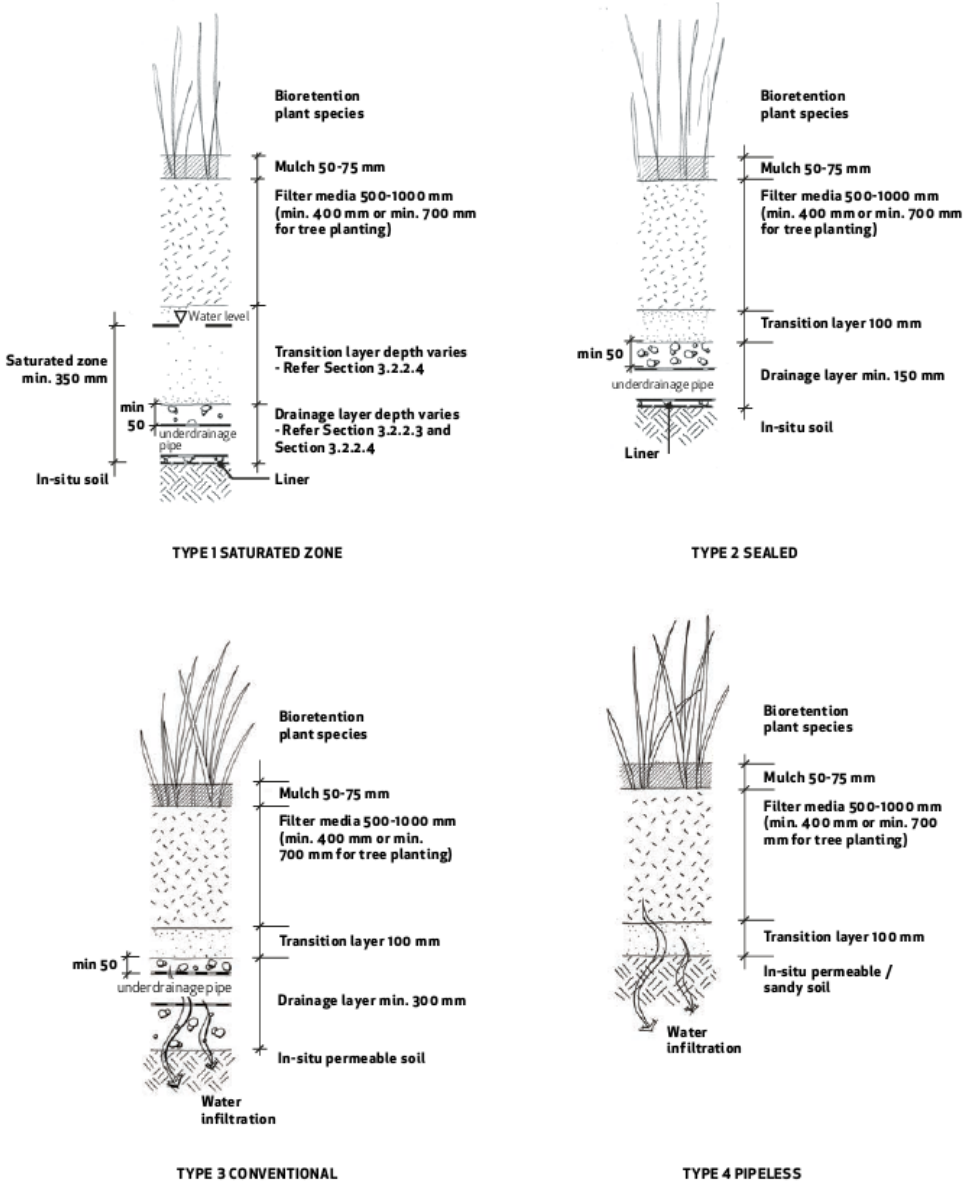
**Filter Profiles**

Four common filter profile configurations (i.e. arrangement of filter media, transition and drainage layers, and underlying drainage elements) as per Section 2.4 of the Water by Design Bioretention Technical Design Guidelines (2014) are recommended for use. They are as follows

- Type 1 – Saturated Zone
- Type 2 – Sealed
- Type 3 – Conventional
- Type 4 – Pipeless.

Examples of each profile are presented in Figure 11-2.

**Figure 11-2 – Filter Profile Configurations (*Source: Water by Design*)**




Refer to the Section 2.4 of the Water by Design Bioretention Technical Design Guidelines (2014) for further details.

### Filter Media, Transition & Drainage Layer Specification

The selection of appropriate media for filtration and drainage is crucial to ensuring the effectiveness of the bioretention system to support surface vegetation, enable infiltration and remove pollutants.

The specification for filter media, transition and drainage layers shall be in accordance with Appendix C (Table 1): Guidelines for filter media in stormwater biofiltration systems (Version 4.01) of the CRC for Water Sensitive Cities Adoption Guidelines for Stormwater Biofiltration Systems (2015).

Where a submerged or saturated zone is proposed then a carbon source is to be provided in accordance with that specified in Section 5 of the Appendix C: Guidelines for filter media in stormwater biofiltration systems (Version 4.01).

**System Liners**

It is recommended that all bioretention systems be lined, either with a pervious or impervious liner (based to the type of filter profile, soil properties and other site conditions). The following is noted:

- Impermeable Liners are to be utilised on filter profile Types 1 and 2.
- Permeable liners are to be utilised on filter profile Types 3 and 4.

Refer to Sections 3.2.4 and 4.2.3 of the Water by Design Bioretention Technical Design Guidelines (2014) for design details

In addition to the above, design consideration is to be given to the following:

- Short-circuiting of flows within the basin is to be avoided. Extensions of liners up basin batters to the top of extended detention is required in sandy soils. Short-circuiting of flows within the filter also commonly occurs against smooth walls such as around inlet pits and retaining walls, leading to ‘piping’ and erosion within the filter media. Refer Standard Drawing DH-SW-6113 on required treatment.
- The migration of fine sediment particles from in situ clayey soils into the filter and drainage media is to be avoided. Impermeable liners or permeable liners (such as non-woven geotextiles) can be utilised to prevent this migration.

**Extended Detention Depth (EDD)**

The Extended Detention Depth for a bioretention system should provide sufficient storage of runoff for treatment but not be detrimental to vegetation health. EDD should range between 100mm (for at-source systems) to 300mm (for end-of line systems). EDD over 300mm is not allowable.

### Subsurface Drainage & Riser Pipes

Refer to Section 3.5.1 and 3.5.2 of the Water by Design Bioretention Technical Design Guidelines (2014) for the configuration of subsurface pipes / under drainage within the base of the filter profile, the configuration of collector pipes (which convey treated runoff from the subsurface pipes to the outlet pit) and riser pipes which enable inspection and cleanout.

Refer to Section 4.2.4 of the Water by Design Bioretention Technical Design Guidelines (2014) for subsurface drainage and riser pipe specifications.

The use of slotted PVC pipes for subsurface drainage is to be designed due to flexible perforated ag-pipe being easily crushed and prone to blockage. Standard PVC pipe (without slots) is to be used for risers (to prevent short-circuiting).

### Inlet Design

The design of bioretention system inlets is subject to the type of system proposed. Inlet design for at-source systems (receiving runoff directly from roads) differs greatly to the design for end-of-line basins (receiving runoff from a drainage pipe). The reader is referred to Section 3.4 of the Water by Design Bioretention Technical Design Guidelines (2014) for assistance with the design.

The following is noted:

- Unless incorporated into the base of a detention basin, end-of-line bioretention basins are to be offline to major flows. High flows into basins can create scour and erosion of the bioretention filter and damage to vegetation. Where an end-of-line bioretention basin is co-located with a detention basin, inlet forebays are to be appropriately designed to prevent scour and re-suspension of captured sediment at the inlet.
- Where upstream pre-treatment for coarse sediment is provided (i.e. GPT or sediment pond), coarse sediment forebays are required on all end-of-line bioretention systems.
- Small coarse sediment forebays are required on bioretention pods. Refer Standard DrawingDH-SW-6121.

### Outlet Design

Outlet design for bioretention basins involves the provision of elements to discharge runoff from the system, ether to a downstream drainage networks or overland flow path.

Refer to Section 3.5 of the Water by Design Bioretention Technical Design Guidelines (2014) for design parameters.

The design should incorporate the following:

- All end-of-line bioretention system Types 1, 2 & 3 should incorporate an outlet pit towards the downstream end of the system to enable collection and discharge of treated runoff from the subsurface drainage, and to control the EDD using an inlet elevated above the filter surface.
- The concentration of outflows to a downstream overland flow path is to consider the potential for scour and erosion. The use of level spreading devices immediately downstream of outlets shall be employed where required to manage concentrated outflows.

**Embankments, Batters and Retaining Walls**

Basin batters, embankments and retaining walls are to be designed generally in accordance with the Water by Design Bioretention Technical Design Guidelines (2014).

The following is to be incorporated where provided for under a Development Approval:

- For maintained grass batters (i.e. mown) the slope of the batter needs to consider the safe operation of a maintenance equipment (i.e. ride-on-mower). For publicly maintained basins, turfed batters are to have a maximum batter slope of 1 in 5. Where privately maintained, 1 in 4 batter slopes may be adopted. For steeper batter slopes it is recommended to establish vegetation that does not require mowing or regular maintenance.
- Top width of basin embankments and weirs need to provide for other uses (pedestrian movement, maintenance access etc.).
- Minimum embankment height is to account for the greater of the following:
    - 20% of the difference in elevation between the filter surface and maximum water level, noting the maximum water level incorporates the head above the inlet pit.
    - 50mm.
- Retaining walls exceeding 1.0m in height are to incorporate a safety rail / fence. This limit should be reduced where ponding water (drowning hazard) exists at the base of the wall.
- Within or adjacent to public spaces (parks, reserves) the configuration of batters, embankments and retaining walls shall enable the integration of pedestrian pathways and incorporate Crime Prevention Through Environmental Design (CPTED) principles.

## Vegetation

Vegetation is an essential part to all bioretention systems and is integral in maintaining the effectiveness of the device to provide treatment.

The unique wetting/drying conditions present within bioretention devices limit the availability of plant species which can reliability thrive in filter areas. Species identified for use within bioretention systems are identified in DRT 11-1 below, extracted from Table 28 of Water by Design's Bioretention Technical Design Guideline (2014). Where possible, plant species native to South Australia and have been demonstrated to be effective in bioretention devices should be prioritised.

Plant spacings are to be specified by the projects landscaping consultant, to achieve 90% coverage of the filter area within 2 growing seasons.

**DRT 11-1 Species list for bioretention filter bed and batters (Water by Design)**

| Plant Species | Use in Filter Media? | Use in Batter? | Vegetation Type |
|---|---|---|---|
| Carex appressa* | Yes | Yes | Groundcover - sedge |
| Ficinia nodosa* | Yes | | Groundcover - sedge |
| Cymbopogon refractus | | Yes | Groundcover - grass |
| Dianella caerulea | | Yes | Groundcover - herb |
| Gahnia sieberiana | Yes | Yes | Groundcover - sedge |
| Imperata cylindrica* | Yes | Yes | Groundcover - grass |
| Lomandra longifolia | Yes | Yes | Groundcover - herb |
| Lomandra hystrix | | Yes | Groundcover - herb |
| Poa labillardieri* | Yes | | Groundcover - grass |
| Themeda triandra | | Yes | Groundcover - grass |
| Callistemon viminalis | Yes | Yes | Shrub/small tree |
| Banksia robur | Yes | Yes | Shrub/small tree |
| Melaleuca nodosa | Yes | Yes | Shrub |
| Eucalyptus tereticornis | | Yes | Tree |
| Waterhousia floribunda | Yes | Yes | Tree |

*Denotes core functional bioretention plant species planted in filter media.

## Access

While access to shallow at-source bioretention systems can be provided via adjacent road or driveways, a dedicated access into an end-of-line bioretention basin to clean out a coarse sediment forebay, inlet and outlet structures is required.

Design shall be in accordance with Section 11.3.6.1 and Figure 34 of the Water by Design Bioretention Technical Design Guidelines (2014) and shall account for design requirements for access tracks into basins for the clean out of coarse sediment forebays.

**Construction and Establishment**

Development and building works have the potential to mobilise large quantities of sediment in runoff. For Bioretention Systems to perform as designed there is a need to protect filter media and vegetation during this phase of the development. Therefore, a staged construction and establishment method for construction of the Bioretention System is required to be followed in Design Documentation.

Below is an installation procedure for Bioretention Systems which shall be, generally in accordance with Option 1 of the Staged Construction and Establishment Methodology as outlined in Table 3.6 and Section 3.8.1 of the Healthy Land & Water Construction and Establishment Guidelines (2011). A summary of this methodology is presented below and should be provided for in Design Detail.

- Civil Works (Functional Installation) – Initially Bioretention Systems will be used for erosion and sediment control. Once the majority of the civil construction works are complete, earthworks and shaping to create the layout and functional elements of the Bioretention Systems will be undertaken. The installation of functional elements (e.g. inlets, outlets structures, subsoil drainage, transition layers and filter media) shall be undertaken as per the methodology detailed in Section 3.8.1 in the Water by Design Construction and Establishment Guidelines (2011). Prior to the commencement of the Building Phase, sediment fences will be erected around the perimeter of the Bioretention System to avoid the entry of sediment. Laying a temporary filter cloth (non-woven geotextile), 25-50mm of topsoil and turfing to the Bioretention System shall protect the Bioretention Systems during both the Civil Works and the Building Phase.
- Building Phase (Building Construction) – During this phase Bioretention Systems shall continue to operate. Sediment fences shall remain around the perimeter of the Bioretention System (both around the filter media and the top of batter) to restrict sediment inflow. Clear indications of the restriction of traffic to the Bioretention systems shall also be displayed.
- Landscape Establishment (Operational Establishment) – When the Building Phase is 80% complete, the temporary protective measures and accumulated sediments within Bioretention System can be removed. The Bioretention System shall then be planted with vegetation and landscaped as proposed. Sufficient watering and removal of weeds following planting shall be undertaken in accordance with Section 3.9.3 of the Water by Design Construction and Establishment Guidelines (2011).

A construction bond will be held by the relevant authority for the removal of interim protection measures and install/establish the ultimate vegetation. To ensure bonds are not held for indefinite timeframes, conversion works can be commenced 24 months after the bioretention device being accepted 'On Maintenance' if 80% build out has not been achieved.

**Maintenance**

Bioretention maintenance is to be carried out generally in accordance with Water by Design's guideline 'Maintaining Vegetated Stormwater Assets'. Refer Section 11.7 for Operation and Maintenance Manual requirements.

## 11.6.3 Constructed Wetlands

Where proposed, or subject to a Development Approval for a development, the performance of constructed wetlands to achieve water quality reductions are to be modelled and assessed using MUSIC, adopting the approach identified within Section 11.5.

The detailed design of Constructed Wetlands shall be completed generally in accordance with Water by Design's Wetland Technical Design Guidelines. Locally relevant guidance and departures to the Water by Design standard are provided within the below sections.

Floating wetlands are considered an emerging technology in the context of this manual (refer to Section 11.6.6 ).

### 11.6.3.1 General Layout and Function

- A 'Constructed Wetland' is a system of multiple elements which includes a sediment pond, high flow bypass, macrophyte zone (including inlet/outlet pools and marsh areas) and outlet controls.
- The suitability to incorporate a wetland into an urban development is dependent upon multiple factors including site grade and conditions, water quality objectives, temporal climate, groundwater conditions and upstream contributing catchment area. These factors should be considered prior to proposing the use of a constructed wetland within a development's treatment train and this detail (including a water balance analysis) is to be approved as part of a Development Approval for a land division. All constructed wetlands are to be designed as off-line systems from the major flow path.

### 11.6.3.2 Extended Detention Depth and Residence Time

For design, an extended detention depth between 350mm and 500mm is to be adopted (generally 500mm).

For South Australian growth areas, a residence time of 72hrs (90th percentile) is to be adopted for design purposes. Ideal residence times differ between wetlands depending on factors such as climate, vegetation species and water quality. As such, flexibility to adjust the residence time shall be included within the outlet design.

Outlets are required to be easily modified, adjusting for the nominal water surface level, extended detention depth and residence time.

#### 11.6.3.3 Reliability

A major design consideration required to be demonstrated as part of wetland design is the long-term reliability and viability of a wetland to function in a particular area.

To maintain sufficient turnover of water within a wetland, a turnover rate of 20 days is required. To confirm this turnover rate, a water balance analysis must be completed. The analysis must consider long-term rainfall data and climate variability. It is for this reason that wetlands need a suitably sized upstream catchment to ensure sufficient inflows into the wetland.

Additionally, a mechanical means of active water circulation is to be incorporated into all constructed wetlands, providing circulation and aeration to the water already within the wetland. While this active circulation does not contribute to the hydraulic turnover of the system, it provides the infrastructure to ensure water levels between different pools is balanced, protecting both fish and vegetation during times of drought and prolonged periods without rainfall. With the increased adoption of solar technologies, Design Documentation should consider the use of such technologies as a more affordable layer of protection towards the health of the wetland.

#### 11.6.3.4 Gross Pollutant Traps (GPTs)

GPTs are required to be installed upstream of sediment ponds where the upstream catchment exceeds 8 hectares. Selection of this GPT device shall focus on the capture of litter, ensuring downstream open waterbodies are free of floating litter and debris. Refer Section 11.6.3.4 for GPT design requirements.

#### 11.6.3.5 Sediment Ponds

Sediment ponds are required immediately upstream of constructed wetlands. The pond design must account for 2 primary functions including:

- The removal of coarse sediment.
- Act as a high-flow bypass junction whereby flows above the design flows entering the macrophyte zone are bypassed around the macrophyte zone, protecting it from high velocities where the topography of a site does not allow for the inclusion of sediment ponds due to constraints relating to grade, Design Documentation is required to demonstrate comparable water treatment through the use of GPT's as may be required.

Sediment basins are to be separated from the macrophyte zone, such that high flows do not enter the macrophyte zone.

Refer Section 11.6.3.8 for edge treatments.

#### 11.6.3.6 High-Flow Bypass

In addition to the main outlet, an emergency spillway/weir may be necessary as upstream flows can continue to enter the sediment pond once the extended detention volume has been achieved. Design considerations are to include:

- Spillway level is to set at the top of the extended detention level.
- A maximum water depth in the wetland is to be not greater than 300mm above the top of extended detention.
- Must be appropriately sized for the maximum flow entering the sediment pond.
- Public safety, including but not limited to associated hazard of flows over the spillway.
- The spillway shall be designed in a way preventing erosion/scour of the spillway itself and the downstream environment.
- The major regional flood event (generally the 1% AEP event) must not backflow into the sediment pond or vegetated macrophyte zone.

#### 11.6.3.7 Macrophyte Zone

The vegetated macrophyte zone shall be designed in accordance with Water by Design's Wetland Technical Design Guideline. Design must consider the following:

- Ensure appropriate flow distribution is provided with no short circuiting.
- Velocities through the macrophyte zone (marsh areas) must not exceed 0.5m/s in a 1% AEP event or 0.05m/s during a 3-month event.
- Piped inflows into the macrophyte zone from the inlet pond are not to exceed 0.5m/s and are to discharge into the inlet deep pool such that the energy from inflows is dispersed by the inlet pond.
- Where possible local plant species known to perform well in wetland areas should be provided.

#### 11.6.3.8 Edge Treatments

Soft edge treatments are to be provided in accordance with Standard Drawing DH-SW-6230.

Hard edge treatments are to be limited within the wetland, generally limited to selected locations where the associated landscaping design identifies an intention to provide a connection between users and the open water. This would likely occur at one of the deep pools and would require a pathway or viewing platform (or similar) to provide connection with the water. Hard edge treatments for extended lengths are not encouraged. Where proposed, hard-edge treatments are adopted, they shall be designed in accordance with Standard Drawing DH-SW-6230.

### 11.6.3.9 Vegetation Selection

Where possible local plant species known to perform well in wetland areas should be provided and specific advice by a suitable qualified landscape specialist should be sought as part of Design Documentation.

In lieu of specific local advice, the species in DRT 11-3 and

DRT 11-4 below have been extracted from Water by Design's Wetland Technical Design Guidelines. Refer **Error! Not a valid bookmark self-reference.** below for corresponding planting zone classifications.

**DRT 11-2 - Wetland Planting Zones (Water by Design)**

| ID | Planting Zone | Depth Range |
|---|---|---|
| TE | Terrestrial | >+0.2m |
| EB | Ephemeral batter | NWL to +0.2m |
| SM | Shallow marsh | NWL to -0.2m |
| DM | Deep marsh | -0.2m to -0.4m |
| SU | Submerged marsh | -0.4 to -0.7m |

**DRT 11-3 - Core functional plant species for the shallow marsh, deep marsh and submerged marsh zones (Water by Design)**

| Species name | Common name | Planting zone | Lifeform[1] |
|---|---|---|---|
| Actinoscirpus grossus | Giant Bur Rush | SM, DM | E |
| Baumea articulata Jointed | Twig-rush | DM | E |
| Bolboschoenus caldwellii | Sea Club-rush | SM | E |
| Bolboschoenus fluviatalis | Marsh Club-rush | DM | E |
| Cladium procerum | Leafy twig-rush | SM, DM | E |
| Eleocharis acuta | Common Spike-rush | SM | E |

| Species name | Common name | Planting zone | Lifeform[1] |
|---|---|---|---|
| Eleocharis dulcis | Chinese Water Chestnut | SM, DM | E |
| Eleocharis equisetina | Spike-rush | SM | E |
| Eleocharis sphacelata | Tall Spike-rush | DM | E |
| Lepironia articulata | Grey Rush | SM, DM | E |
| Phragmites australis | Common reed | SM, DM | E |
| Schoenoplectus subulatus | Shore Club-rush | SM, DM | E |
| Schoenoplectus validus | River Club-rush | SM | E |
| Triglochin procera | Water-ribbon | SM, DM | F |
| Ceratophyllum demersum | Hornwort | SU S | NA |
| Hydrilla verticillata | Water thyme | SU S | NA |
| Myriophyllum verrucosum | Red Water-milfoil | SU S | NA |
| Potamogeton ochreatus | Blunt Pondweed | SU S | NA |
| Vallisneria australis | Ribbonweed | SU S | NA |

**DRT 11-4 - Supplementary plant species for the shallow marsh, deep marsh, submerged marsh and ephemeral batter zones (water by design)**

| Plant Species | Common Name | Planting Zone | Lifeform[1] |
|---|---|---|---|
| Baumea arthrophylla Wet edge only | Fine Twig-rush | EB, SM | E |
| Baumea juncea Wet edge only | Bare Twig-rush | EB, SM | E |
| Baumea rubiginosa Wet edge only | Soft Twig-rush | EB | E |
| Carex appressa | Tall Sedge | EB | E |
| Carex fasicularis Wet edge only | Tassel Sedge | SM | E |
| Carex gaudichadiana Wet edge only | Tufted sedge | SM | E |
| Carex polyantha Wet edge only | Creek Sedge | EB | E |
| Cyperus alopecuroides | Foxtail Flat Sedge | EB, SM | E |
| Cyperus exaltatus Wet edge only | Giant Sedge | SM | E |
| Cyperus gunnii Wet edge only | Flecked Flat Sedge | EB | E |
| Cyperus javanicus | Javanese Flat Sedge | EB | E |
| Cyperus polystachyos | Bunchy Sedge | EB | E |

| Plant Species | Common Name | Planting Zone | Lifeform[1] |
|---|---|---|---|
| Eleocharis geniculata | Nodding Spike-rush | EM | E |
| Ficnia nodosa | Knobby Club-rush | EB | E |
| Isolepis inundata Wet edge only | Swamp Club-rush | SM | E |
| Juncus flavidus | Yellow Rush | EB | E |
| Juncus krausii | Sea Rush | EB, SM | E |
| Juncus pristmatocarpus Wet edge only | Branching Rush | EB, SM | E |
| Juncus usitatus Wet edge only | Common Rush | EB | E |
| Ludwigia peploides Wet edge only | Water Primrose | EB | E |
| Marsilea mutica | Banded Nardoo | SM | F |
| Nymphaea gigantea | Blue Water Lily | SU | F |
| Bacopa monnieri Wet edge only | Bacopa | EB | G |
| Baloskion pallens Wet edge only | Cord Rush | EB | G |
| Baloskion tetraphyllum Wet edge only | Tassel Cord-rush | EB | G |
| Cynodon dactylon | Common couch | EB | G |
| Eclipta prostrata | White Eclipta | EB | G |

| Plant Species | Common Name | Planting Zone | Lifeform[1] |
|---|---|---|---|
| Gahnia clarkei | Tall Saw-sedge | EB | G |
| Gahnia siberiana | Red-fruited Sword Sedge | EB | G |
| Imperata cylindrica | Blady Grass | EB | G |
| Ischaemum australe Wet edge only | Southern Grass | EB, SM | G |
| Ischaemum rugosum Wet edge only | Ribbed Muraina Grass | EB, SM | G |
| Leersia hexandra | Swamp Rice Grass | EB, SM | G |
| Lepidosperma longitudinale | Common Sword-sedge | EB | G |
| Leptochloa neesii Wet edge only | Umbrella Canegrass | EB, SM | G |
| Lomandra hystrix | River Mat Rush | EB | G |
| Lomandra longifolia | Spiny-headed Mat Rush | EB | G |
| Oryza australiensis Wet edge only | Native Rice | EB | G |
| Persicaria decipiens Wet edge only | Slender Knotweed | EB | G |
| Persicaria strigosa Wet edge only | Spotted Knotweed | EB | G |

| Plant Species | Common Name | Planting Zone | Lifeform[1] |
|---|---|---|---|
| Poa labillardieri | Tussock Grass | EB | G |

[1] Lifeform Key F – Floating macrophyte, S – Submerged macrophyte, E – Emergent macrophyte, G – Groundcover, SH – Shrub, T – Tree.

#### 11.6.3.10 Outlet Design

A well-designed outlet is crucial to a wetland's establishment, performance and long-term health.

Outlets are required to be easily modified, adjusting for the nominal water surface level, extended detention depth and residence time. Refer Standard Drawing DH-SW-6220.

#### 11.6.3.11 Construction and Establishment

Construction and establishment of constructed wetlands shall be completed in accordance with Water by Design's 'Guidelines for the construction and establishment of bioretention systems and wetlands' (2022).

**Establishment**

Establishment of macrophyte vegetation is to be informed by the landscaping specialists involved on the project. Tube stock raised is a nursery may encounter difficulties if planted directly into a marsh zone, potentially causing plant death with significant financial implications.

The outlet design of the wetland must therefore include sufficient capabilities to actively manage the water levels within the wetland during the establishment phase.

### 11.6.4 Gross-Pollutant Traps

#### 11.6.4.1 Location

- To be located on a piped drainage network or within an engineered waterway.
- GPT structures are to be below finished surface levels, with lockable maintenance access provided at finished level.
- GPTs shall be located at the end of all major drainage lines discharging directly into a watercourse.

- GPT devices being publicly maintained are to be located within public land and easily accessible by maintenance staff.
- Privately owned and maintained GPT devices shall be located in areas where it can be easily maintained without special access requirements of major disruption. A standard vacuum truck will commonly be utilised for these works.
- Where subject to frequent tidal inundation, back flow mitigation devices shall be installed to prevent backflow and re-suspension of captured pollutants.

#### 11.6.4.2 GPT Types and Classifications

- It is anticipated that the majority of GPTs incorporated into urban development projects will be proprietary 'off-the-shelf' GPT Devices. Refer Section 11.6.6 for additional details on the use and modelling of proprietary devices.
- Where possible, dry sump GPTs are generally preferred due to concerns surrounding the anaerobic decomposition what can occur in wet sump GPTs. This preference is highlighted when there is no downstream treatment device removing dissolved nutrients prior to discharging into a watercourse.
- Grills/mesh have a self-cleansing mechanism to prevent blockage.
- GPTs must have the ability to be hydraulically isolated for maintenance.
- Where the Relevant Authority will take ownership and will be required to provide ongoing maintenance, device selection and design must additionally be in line with the below points.
    - Devices must be designed to be easily maintained through the use of a standard vacuum truck, with no additional specialised equipment being required.
    - Devices must not require the replacement of any part as part of regular maintenance (including filters, filter media etc).
    - Devices shall be designed to be sufficiently robust, limiting ongoing maintenance burdens.
    - To simplify maintenance, devices should match devices already publicly owned and operated within the area.

Where a device is proposed which meets the requirements of the above, but is not a device preferred by the Relevant Authority, the Relevant Authority may specify an alternate device which is to be used in place of the proposed, provided that such device meets the following requirements:

- The device has comparable performance relating to water quality.
- The device is of a comparable cost and is readily obtainable.

This requirement is to simplify maintenance operations, reducing the overall maintenance burden as well as the amount of proprietary/special maintenance equipment required by ensuring consistency in product use.

#### 11.6.4.3 Sizing and Performance

Sizing of GPTs is to focus on treatable flow rates. In most cases the 63% AEP event is required to be treated as a minimum, however sizing of the GPT needs to consider the maximum amount of flows being conveyed through it by the upstream drainage system.

If an upstream drainage network is small enough where all piped flows (generally the minor storm event) are within the treatable flow rates specified for the system, then the GPT can be installed as an on-line system. Where the maximum flow rate of the pipe exceeds the treatable flow rates of the system, the GPT must be installed as an off-line system.

While not limited to, high-flow bypass manholes are commonly utilised to divert the 63% AEP storm event to the GPT with over and above flows bypassing the system.

GPTs shall include a suitable internal overflow mechanism which, in the event of blockage or irregular maintenance, can bypass flows through the system while aiming to not resuspend any already captured gross pollutants.

The energy loss/hydraulic impact of the device is to be considered and accounted for when designing upstream drainage systems.

Proprietary GPT systems are to be designed and constructed in accordance with manufacturer specifications.

Sediment trap volume to be based on a cleaning frequency of no more than 2 times per annum (on average).

#### 11.6.4.4 Maintenance

GPT selection must ensure compatibility between the systems maintenance requirements and the maintenance capabilities of the provider.

Maintenance is generally undertaken through the use of a vacuum truck or removeable basket. Appropriate maintenance and access tracks are required to be provided. Design is to consider vehicle manoeuvring, lifting operations and works area.

Refer Section 11.7 for additional maintenance requirements.

### 11.6.5 Vegetated Swales

This sectionis not intended to provide specific hydraulic design advice for the design of a swale. Where vegetated swales are adopted to provide water quality treatment the following requirements are to be achieved.

- Not to be used for urban development where the swale is required to cross residential driveways.
- Must be appropriately design in accordance with industry guidelines, considering factors including, but not limited to, public safety (hazard, egress etc.), hydraulic performance, long term performance, reliability and maintenance.

### 11.6.6 Emerging and Proprietary Technologies/Devices

The ongoing innovation and emergence of new stormwater quality improvement devices and technologies is encouraged. However, providing widespread acceptance of new devices and technologies introduces difficult challenges for both designers and approving authorities, as well as introducing complications through non-standard construction techniques and ongoing maintenance. These guidelines therefore seek to continue the encouragement of technological development, balanced against the need to enforce fair and reasonable performance modelling, real-world stormwater improvements and future maintenance burdens. The requirements for the adoption of emerging and proprietary technology/devices within urban developments is as follows:

Allowed in developments where the device is wholly located within private property and where the future maintenance burden is taken on by the property owner.

The Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP), administered by Stormwater Australia, is an independent evaluation process used to verify a devices performance in improving stormwater quality. The performance of adopted proprietary devices and technologies must be demonstrated through numerical modelling (MUSIC) using the approved SQIDEP performance specifications. This will generally include both a treatable flow rates and pollutant load reductions. Devices are to be designed, modelled, constructed, operated and maintained in accordance with the SQIDEP verification and manufacturers specifications.

The use of devices without a SQIDEP verification is at the sole discretion of the relevant authority and requires express approval as part of the Development Approval. If proposing the use of an emerging technology, it is highly encouraged to seek approval from the approving authority prior to submission.

Where the implementation of an emerging technology is proposed as a test-site, it is expected that performance testing of that device will be undertaken and reported on. Additional restrictions such as performance bonds or to have a design that can be easily converted into a conventional system may be required.

### 11.6.7 Infiltration Systems

Infiltration systems can play an important part of urban stormwater management through the recharge of groundwater and assist with the management of flows.

To extend the lifespan of infiltration devices, stormwater shall be treated to meet water quality targets prior to infiltration.

Infiltration systems are not to be included within MUSIC modelling as a treatment device contributing to the performance of a development in achieving necessary water quality objectives. Infiltrating nutrients into the groundwater does not remove them from the environment.

Where infiltration systems are proposed, design consideration should cover:

- The potential for infiltration systems to become clogged by sediment and organic matter (including pre-treatment).
- Potential for infiltrated water to impact nearby infrastructure.
- Soil types, including the infiltration capacity, hydraulic conductivity and avoiding dispersive/sodic soils.
- Existing groundwater conditions. Noting high groundwater can result in leaching of groundwater into infiltration systems and potentially backing up into other infrastructure.

### 11.6.8 Litter Baskets

Litter baskets are proprietary devices installed within field inlets and kerb pit, designed to capture at-source gross-pollutants.

The use of litter baskets is approved within private property when they are privately owned and maintained.

The use of litter baskets within developments is discouraged where the future maintenance burden is handed over to the Relevant Authority, except for where such devices have been approved as a WSUD outcome as part of a Development Approval relevant to the Site. Approval to utilise litter baskets within public infrastructure may be granted under specific circumstances where alternate WSUD outcomes cannot be considered, and such treatment is requested by the Relevant Authority. To simplify maintenance operations, where a device is proposed in Design Documentation, a Relevant Authority may nominate an alternative proprietary device as substitute, provided that cost, water quality outcomes and construction requirements of the substitute device are comparable.

Litter baskets shall be modelled in accordance with their Stormwater Quality Improvement Device Evaluation Protocol (SQIDEP) performance specifications. Where a device is not SQIDEP verified, the Relevant Authority may accept the product or nominate a substitute device in accordance with above provisions.

Design Documentation requirements apply to the use of litter baskets:

- Devices shall be designed, constructed and maintained in accordance with manufactures specifications.
- Devices are required to include an internal high-flow bypass, suitable for the minor storm event, in the event the basket becomes blocked.
- Design must ensure the inclusion of the basket does not interfere with the performance of the drainage network.
- The bottom of the basket must be 100mm clear of pipe flows (minor storm event) through the pit.
- There should be no permanent ponding within the pit which would cause the anaerobic decomposition of collected matter.
- If being installed in an area of tidal influence, downstream backflow prevention may be required to prevent the resuspension and bypass of captured matter (litter and organic matter).

### 11.6.9 Pervious Pavements

Pervious pavement, also known as porous or permeable pavement, is a load bearing surface permeable to water. Its use is generally limited to pedestrian area and low-speed trafficable areas such as driveways, parking lots and low-traffic streets (such as cul-de-sacs and laneways).

Pervious pavements are approved for use only on developments where it will be privately owned, operated and maintained. Pervious pavements are not approved for use on roadways which will be handed over to The Relevant Authority.

Pollutant load reductions must be modelled in accordance with the South Australian MUSIC Guidelines by Water Sensitive SA.

The design of pervious pavement is to be completed generally in accordance with Chapter 7 (Pervious Pavements) of the Technical Manual for Water Sensitive Urban Design in Greater Adelaide.

Specific design considerations include:

- Subgrade stability and ensuring underlying soils do not weaken under load. The filter lining and underdrainage is to be designed based on the underlying soil type.
- Vicinity to structures, ensuring potential shrinking and swelling does not cause structural damage.
- Pavement structure shall withstand the intended traffic loads without deformation or failure.
- The pavement shall achieve adequate permeability to prevent ponding of surface water.
- The slope of porous pavement must not exceed 4%.
- Adequate access to undertake maintenance shall be provided to ensure regular cleaning and repairs are undertaken as required.
- The pavement surface and underdrain (if present) are to drain flows to the receiving stormwater drainage network, SQIDs or receiving waterway.
- Porus pavements may become partially or fully blocked over its operational lifetime if improperly designed and maintained. Surface grading shall consider the operation of the system under difference scenarios including pavement blockage and heavy rainfall events (where rainfall may exceed infiltration capacity).
- To reduce clogging, where possible, apply pre-treatment measures (i.e. sediment traps, buffer strips) to minimise the amount of sediment reaching the pavement. Additionally, avoid installation in areas likely to receive high sediment loads.

## 11.7 Designing for Maintenance

The planning and design of stormwater assets (especially SQID's) should minimise the need for frequent maintenance and where required, maintenance to be easily undertaken without significant burden. To ensure the need for frequent maintenance (beyond what is expected for a comparable asset) is reduced, design and planning must consider appropriate uses of materials, system function and development demands.

### 11.7.1 Access

Regular maintenance is required for all SQID's. To ensure this maintenance can occur without undue burden, access tracks and ramps shall:

- Consist of a min 3.0m wide track constructed from reinforced concrete or a 200mm deep layer of cement treated (6%) road base.
- Provide sufficient room for turning movements of relevant maintenance vehicles.
- Provided with a lockable gate to restrict public access.
- Be capable of supporting the weight of a 20t excavator.
- Have a maximum longitudinal grade of 1 in 6.

### 11.7.2 Operation and Maintenance Manual

As part of submissions for Design Documentation, an Operation and Maintenance Manual must be provided. The manual must identify the following:

- Device Identification
    - Provide a description of how each device has been designed to operate.
    - Provide an engineering plans for each device, as well as an overall plan showing the location of each device.
- Safety and Environment
    - Identify all safety precautions.
    - Identify any areas of particular concern (e.g. where confined space access may be required).
    - Identify any training or specific equipment required to be used.
    - Identify environmental considerations.
- Operation Procedures
    - Identify normal operational conditions and any seasonal variances to be expected.
    - Any emergency operational procedures.
- Maintenance Procedures
    - Routine inspections and maintenance schedules.
    - Specific maintenance for each WSUD device.
    - Safety precautions and relevant guidelines.
    - Where relevant, identify how to hydraulically isolate each device for maintenance.
- Troubleshooting Guides
    - Identify common issues, their causes and steps for diagnosing and resolving problems.

    - Identify industry guidelines for reference by future maintenance personnel.
- Appendices
    - Manufacturers manuals and data sheets.
    - Additional resources.

# 12 Environmental Management Plan

## 12.1 General

The Superintendent and Contractors engaged must ensure that during the construction of works all appropriate steps are taken to minimise any detrimental impact on the environment and compliance with the requirements of all applicable Environmental Legislation. All earthworks must be undertaken in accordance with the provisions of AS3798 “Guidelines on Earthworks for Commercial and Residential Developments”.

## 12.2 Erosion Control and Sediment Discharge

To maintain effective erosion controls and measures for the works, prior to commencing work on site, the developer shall be responsible for the provision of detail which demonstrates appropriate detail to minimise the effects of runoff and erosion on the site and downstream areas. A ‘treatment train’ approach should be used, implementing the following measures, as appropriate:

- Stage earthworks and undertake rehabilitation/stabilisation as soon as practicable to minimise the area of bare earth.
- Establish sediment control structures around all areas prone to erosion, including stockpiles, batters and drainage lines.
- Install cut-off drains to intercept surface water before it reaches areas of disturbed earth.
- Install silt control measures prior to the entrance of all drains to minimise the discharge of silt offsite. All measures should be inspected after rain events and repaired as required. Typical measures may include one or more of the following:
    - Settlement ponds.
    - Fence filters.
- Silt Socks made from a geo-textile sleeve for placement at kerbside stormwater drainage pits.
    - Straw bales on open, cut-off or diversions drains.
    - Temporary sumps in selected and approved stormwater drainage pits.
    - Landscaping or the promotion of vegetation downstream of the works but still within the site.
- Locate any stockpiles away from drainage lines and in locations with minimal susceptibility to wind. Consider covering to reduce wind/ rain erosion and limiting height.

- Ensure erosion control measures are fully operational prior to commencing earthworks and for the duration of the works.
- Biofiltration systems, including raingardens, must be protected from siltation by measures that may include one or more of the following:
    - Installation of a bund, excluding silt laden stormwater from entering treatment zones.
    - Installation of temporary turf over treatment zones to protect filter media.

The above details should be generally consistent with the recommendations within AUSTROAD “Road Design Guidelines - Part 5 – General and Hydrology Considerations” and any DIT Supplement to those guidelines and EPA Publications.

Dust, mud and debris must be managed and/or prevented from leaving any site during construction.

Detail must be provided on measures to minimise the number of stabilisation areas needed. The developer shall specify vehicle cleaning procedures and identify road sections to be cleaned if mud is tracked onto them. Limit the number of access points to a stage to one, unless multiple existing access points are already in use.

Detail shall be provided showing how soil movement at access and exit points is to be controlled through appropriate means, this may include using a rumble grid or by requiring vehicles to travel the length of a stabilised access track.

All machinery shall be prevented from accessing non-essential parts of the site.

Batter slopes should be kept at a grade of not more than 2:1 as per EPA guidelines with a minimum thickness of 75 mm of weed-free topsoil topped with either weed mat, mulch or hydro-mulched to establish vegetation such as suitable grass species to ensure that erosion is minimised. Batters should be contained within the boundary of the site. Batter slopes should be finished within 2 weeks from completion. All land division public land boundaries are to be suitably protected and maintained with adequate sediment control measures (i.e. sediment fence) upon completion of works.

## 12.3 Site Control

The Developer/Contractor shall observe all rules and regulations in force on the site and shall comply with all notices and instructions issued by the Relevant Authority. Prior to works commencing, the Developer/Contractor shall submit to the Relevant Authority proposals for traffic movement, temporary structures, cleaning up, erosion control and environmental protection measures within an Environmental Management Plan (EMP).

Space for the storage of materials and for building sheds, offices and workshops shall be located wholly within the site, with necessary approvals obtained prior to commencing works.

## 12.4 Environmental Control

The Developer's Construction Engineer shall be responsible for ensuring that the provisions of this section and any other environmental protection provisions in the contract are complied with and that the requirements of any statute, by-law, standard and the like related to environmental protection are observed.

The Contractor shall, prior to the commencement of work on the site, submit to the Relevant Authority a Construction Environmental Management Plan (CEMP) which details their proposals for traffic movements, temporary structures, cleaning up, waste management, erosion control and the like. The Superintendent shall be responsible for ensuring that the approved proposals are implemented and maintained. The Contractor shall carry out the work with reference to the EPA Codes of Practice.

Submitted drawings and detail shall demonstrate that pollutants such as dust, sediment, litter and wash down water do not leave the site during construction of the works.

The Construction Engineer shall prepare a Soil Erosion and Drainage Management Plan (SEDMP) showing how Environmental Controls are to be achieved. The plan shall include a site layout together with a written procedure and implementation plan, and approval is required from the Relevant Authority's Development Engineering team prior to the commencement of work on site. The SEDMP shall include all aspects of site management including

- Site access from public or private roads.
- Access around the site.
- Areas of earthworks, stockpiles and loading areas.
- Site stormwater management including all relevant information such as sediment collection devices, stormwater drainage lines and discharge points.
- Management of creek or river flows.

The Construction Engineer shall ensure that the following principles are included in the SEDMP and achieved on the site throughout the construction period. This will need to be documented in the CEMP with approval being obtained prior to the commencement of works.

- Limit site access to nominated and controlled locations and ensure that sediment is not transported off the site on vehicles or by vehicle was down activities.
- Locate all stockpiles away from concentrated water flow paths.

- Ensure that the least amount of land is exposed to the risk of erosion for the shortest period of time.
- Ensure that erosion control and sediment collection structures are located to maximise their effectiveness and are in place prior to the commencement of site clearing works.
- Locate sediment traps and basins in locations that will not create flood risks to adjoining properties.
- Where control of creek or river flows is necessary, ensure that both low and high flows are managed to minimise erosion. For example, if access across a creek is required, construction of a ford may be preferable to construction of a culvert and roadway.
- Rehabilitate all disturbed areas, with approved topsoil, as soon as possible including the reinstatement of riparian areas and the installation of ground cover planning progressively as earthworks are completed.
- Batter slopes should be kept at a grade of not more than 1:5 and finished as soon as possible with a minimum thickness of 75mm of topsoil topped with either weed mat, mulch or hydro-mulched to establish vegetation such as suitable grass species to ensure that erosion is minimised.
- All subdivision public land boundaries are to be suitably protected and maintained with adequate sediment control measures as soon as is practical upon completion of earthworks.
- Effectively maintain the erosion control and sediment collection devices.
- Decommission sediment traps and basins only after completion of final works.

## 12.5 Soil, Liquid and Gaseous Contaminants

The Contractor shall be responsible for the proper disposal of all solid, liquid and gaseous contaminants in accordance with all statutory and contractual requirements, as may be required under relevant legislation. Where such requirements exist, the developer shall provide a copy of the relevant approval required, including endorsed details by the EPA or other relevant authority for the proposed relocation, disposal or treatment of such contaminants. No construction approval shall be issued until such approval is provided to the Relevant Authority.

## 12.6 Preservation of Flora

The Contractor shall refrain from destroying, removing or clearing trees and vegetation to an extent greater than that shown on the approved plans.

As flora preservation requirements will vary depending on location the site-specific requirements of the relevant approval authorities will need to be referenced. Below is a general approach that should be tailored to suit the specific site requirements.

Any areas which are to be cleared shall be clearly depicted on the plans and consistent with the requirements of the Development Approval. Any inconsistency to these plans may require update to the Development Approval. Plans which show all construction activities, including storage of materials, vehicles, equipment and rubbish are to be kept clear of existing trees which are to be retained. Vehicles are not be driven or parked within tree protection zones.

Tree protection zones are to be determined and shown on plans. Protections shall be installed prior to any works being undertaken on the site in accordance with AS4970. Where there are existing trees to be retained on the site, the tree protection measures advised by a qualified arborist are to be established prior to commencement of any demolition, construction, building or civil works.

The tree protection zone should be adequately fenced to prevent access and accidental construction works. The Superintendent shall ensure that the provisions of any existing agreement for protection or retention in respect to trees are complied with.

## 12.7 Working Hours

The construction Environment Management Plan (CEMP) shall specify that construction activities on the site shall be carried out between the following hours:

- Monday to Saturday – 7am to 5pm.
- Sunday, Public Holidays – no work shall be undertaken other than necessary watering for dust control and any emergency activities.

Night work or works on Sundays will be assessed on a case-by-case basis based on the benefit to the local community. Additional advanced notification may be required.

## 12.8 Site Access

The developer shall provide a copy of consent as required under the PDI Act 2016 or Local Government Act 1999 for any site access.

## 12.9 Dust During Construction

The CEMP must provide details to demonstrate that dust suppression is able to be undertaken in the form of constant water spraying or other natural based proprietary dust suppressant, provision of wind break fencing, shade cloth on perimeter fencing, or some combination of measures to ensure that dust caused by vehicles moving along roads to the site and within the site do not cause a nuisance to surrounding properties.

## 12.10 Pollution

The CEMP must address all possible sources of pollution and methods of control.

## 12.11 Noise

The CEMP must demonstrate that all noise emitted from the site is within the specified limits, set by the EPA for the relevant activity at all times.

- The Developer/Contractor shall ensure all noise emissions comply with EPA requirements. Noise control measures shall include:
- Selection and maintenance of low-noise equipment.
- Strategic positioning of noisy plant away from sensitive areas.
- Implementation of noise barriers where required.
- Proper maintenance of all equipment.
- Response procedures for noise complaints.

## 12.12 Weed Importation and Transportation

Section 175 of the Natural Resources Management Act 2004 provides offences relating to precautions that must be taken when moving soil, sand, gravel or stone which may be infested with noxious weeds.

Accordingly measures in the CEMP shall make provision for the following:

- Specification that any imported fill to the site will be sourced be free of weeds.
- Detail for remediation and removal noxious weeds or seeds of noxious weeds onto land where encountered.
- Specification to ensure that weed species are not transported on earthworks equipment or in soil or material leaving or entering the worksite.

## 12.13 Contamination

Removal of surplus fill from the site, or the importation of fill from sites (other than commercial quarries/ suppliers) must comply with the EPA standard for the Production and Use of Waste Derived Fill including appropriate testing. Certification relating to the appropriate classification of soil is to be provided prior to any soil being transported from the site for disposal or to the site for use.

If contaminated material is found or suspected, including contaminated soils or groundwater, rubbish or asbestos it must be managed in accordance with EPA requirements. Prior to any works commencing, an environmental management plan prepared by a suitably qualified environmental consultant must be provided. If contaminated material is found on a residential allotment it must be removed or treated to the satisfaction of an environmental auditor and in accordance with the National Environment Protection Measures.

## 12.14 Construction Environmental Management Plan

The CEMP shall detail all measures to protect the existing environment during construction works. The plan shall include:

- Site layout showing access points, storage areas, and protection measures.
- Erosion and drainage management methodology.
- Dust and noise control measures.
- Vegetation protection methods.
- Waste management procedures.
- Incident management and other such detail as identified within this chapter and within the Environmental Controls section below. Alternatively, other section notes CEMP requirements so need to include this in the list.
- Contamination Management.

## 12.15 Environmental Controls

### 12.15.1 Erosion and Sediment Control

The Developer/Contractor shall provide detail of erosion control measures prior to approval being issued. Measures shall include sediment retention at drainage points, stabilised site access, and protection of stormwater systems. Controls shall be maintained throughout the construction period.

### 12.15.2 Dust Control

Specification to be provided for dust suppression prior to approval. this shall be maintained during construction using water or approved dust suppressants. Vehicle movements shall be controlled and exposed areas minimised.

### 12.15.3 Pollution Prevention

The Developer/Contractor shall specify detail for proper management of all potential contaminants. This includes appropriate storage of materials, spill response procedures, and proper disposal of solid, liquid and gaseous contaminants.

### 12.15.4 Waste Management

Construction waste shall be regularly removed from site. Waste storage plans shall be provided for containment of windblown litter.

## 12.16 Statutory Compliance

Works shall comply with relevant legislation including:

- Environment Protection Act 1993.
- Native Vegetation Act 1991.
- Local Nuisance and Litter Control Act 2016.
- Aboriginal Heritage Act 1988.
- Natural Resources Management Act 2004.

Construction works shall conform with:

- AS/NZS 3798 Guidelines on Earthworks.
- AS 4970 Protection of Trees.
- EPA Codes of Practice.

# Appendix A: Standard Drawings